LMZ12008,LMZ12010,LMZ13608,LMZ13610

Application Note 2134 LMZ13610/8/6 and LMZ12010/8/6 Evaluation Board

Literature Number: SNVA478B

LMZ13610/8/6 and LMZ12010/8/6 Evaluation Board

National Semiconductor
Application Note 2134
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Introduction

The LMZ13610/8/6 and LMZ12010/8/6 SIMPLE SWITCHER® power modules are easy-to-use DC-DC solution capable of driving up to a 10, 8 or 6 ampere load. They are available in an innovative package that enhances thermal performance and allows for hand or machine soldering. The LMZ13610/8/6 can accept an input voltage rail between 6V and 36V and the LMZ12010/8/6 can accept an input voltage rail between 6V and 20V.

The evaluation board is highly configurable. The output voltage can be adjusted to 5V, 3.3V, 2.5V or 1.2V with a jumper change. The external soft-start capacitor facilitates a controlled and adjustable startup rise time of the output. The board temperature can be measured with the onboard resistor and the UVLO can be adjusted by changing one resistor. In addition the board comes preconfigured with an LC input filter to pass CISPR-22 class B conducted and radiated emissions.

The LMZ13610 and LMZ12010 family is a reliable and robust solution with the following features: loss-less cycle-by-cycle valley current limit to protect for over current or short-circuit fault, thermal shutdown, input under-voltage lockout, and will start up into a pre-biased output.

Board Specifications

- V_{IN} = 6V to 36V (LMZ13610/8/6)
- V_{IN} = 6V to 20V (LMZ12010/8/6)
- V_{OUT} = 1.2V, 2.5V, 3.3V or 5V (minimum input voltage of 7V required for 5V output)
- I_{OUT} = 0 to 10, 8, or 6 Amps
- θ_{JA} = 9.9 °C / W, θ_{JC} = 1.0 °C/W
- Designed on four layers; Inner are 1 oz copper; Outer are 2 oz copper.
- Measures 2.95" x 3.54" (75 mm x 90 mm) and is 62 mils (1.57 mm) thick of FR4 laminate material

For additional circuit considerations, including additional output voltage options, refer to the Applications Section section of the LMZ13610/8/6 or LMZ12010/8/6 data sheets. For negative output voltage connections see AN-2027.

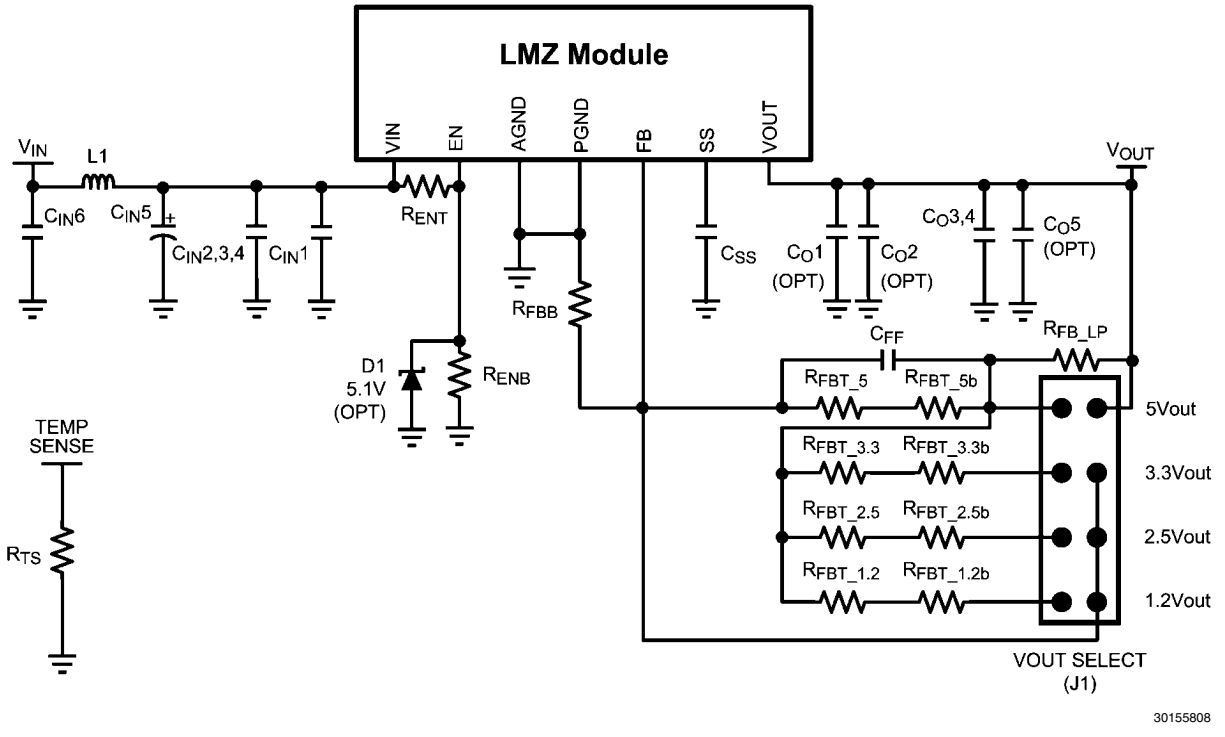

FIGURE 1. Simplified Schematic

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Test Connections

The board should be connected to a power supply and load as shown below in *Figure 2*. The EN post is connected to the UVLO circuit on the back of the board. There is a resistive divider implemented on the board that can be used to establish a precision UVLO level for the board that is currently set to 5.7V. A common user change to this circuit is to adjust the value of RENT and RENB to adjust the operating UVLO to that of the target application. Refer to the respective data sheet for calculation. Note that if in the end application the EN pin voltage does not exceed 5.5V at maximum Vin, then the enable clamp zener D1 can be omitted. (On revision A of the board the overlay for the zener diode has the cathode and anode incorrectly labeled). Pull EN low to shutdown the module.

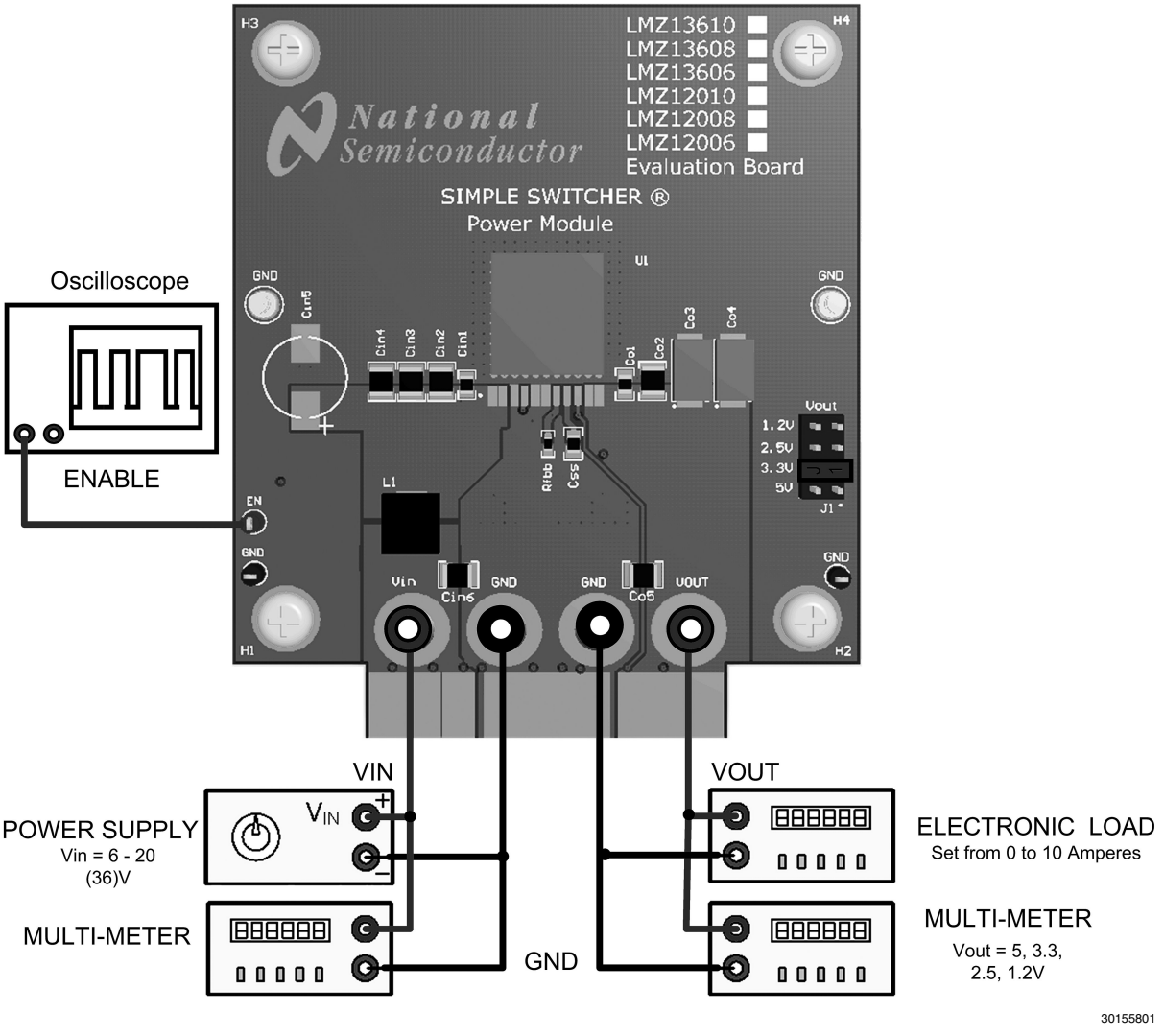


FIGURE 2. Board Connection Diagram

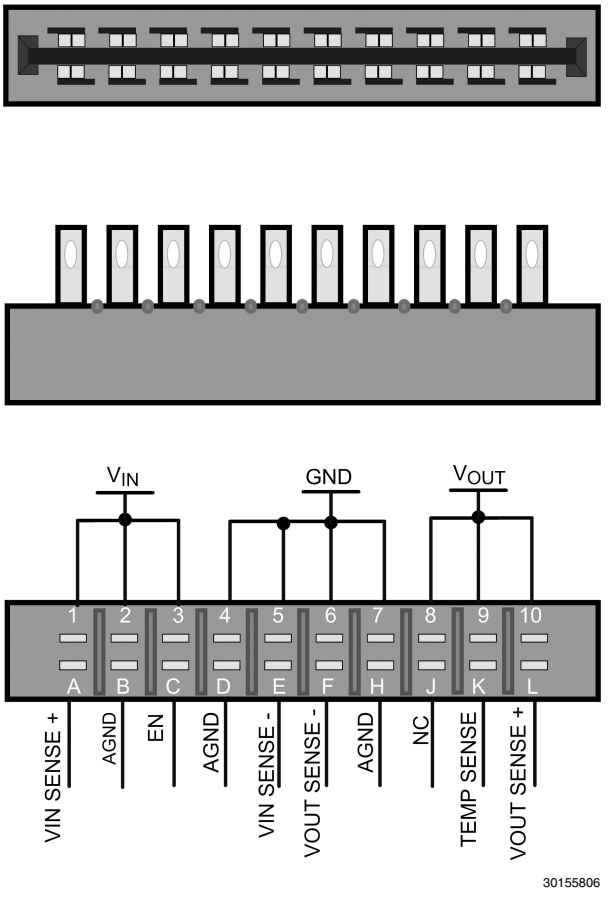


FIGURE 3. Edge Connector Diagram

The evaluation board is also compatible with the 20-pin edge connector shown in *Figure 3*. The table below explains the functionality of the pins.

Pin	Name	Description
1, 2, 3	VIN	Input supply — Nominal operating range is from 6V to 20V for the LMZ12010/8/6 and from 6V to 36V for the LMZ13610/8/6.
4, 5, 6, 7	GND	Power Ground — Electrical path for the power circuits within the module.
8, 9, 10	VOUT	Output Voltage — Regulated 5, 3.3, 2.5 or 1.2V.
A	VIN SENSE +	Positive Kelvin Sense of Input voltage — Tied to VIN pin of the LMZ module.
E	VIN SENSE -	Negative Kelvin Sense of Input voltage — Tied to PGND (EP) of the LMZ module.
L	VOUT SENSE +	Positive Kelvin Sense of Output voltage — Tied to Vout banana jack.
F	VOUT SENSE -	Negative Kelvin Sense of Output voltage — Tied to AGND of the LMZ module.
B, D, H	AGND	AGND Ground — Tied to AGND pin of module.
J	NC	No Connect — This pin must remain floating, do not ground.
C	EN	Enable — Input to the precision enable comparator of the LMZ Module.
K	TEMP SENSE	Connected to top of the Rts temperature sensing resistor. Temperature measurements can be made by measuring the temperature dependant resistance between TEMP SENSE and VIN SENSE -. Convert the resistance to temperature with the following equation: Temperature (C) ≅ 2.6245 x Resistance (Ω) - 262.7

Adjusting the Output Voltage

The output voltage of the evaluation board is adjusted to either 5V, 3.3V, 2.5V, or 1.2V by moving jumper J1. For other voltage options see the datasheet for adjusting the feedback resistors.

Optional Components

The evaluation board has many options for input and output filtering. C_O1, C_O2 and C_O5 have been installed to decrease high frequency noise on the output. Their removal will not effect other performance parameters of the design. Similarly, $C_{IN}1$ has been installed to provide a high frequency bypass for the input current. The second order filter consisting of L1 and $C_{IN}6$ has been designed to provide enough attenuation of the conducted noise to comply with EN 55022. This filtering is not required for normal operation of the module.

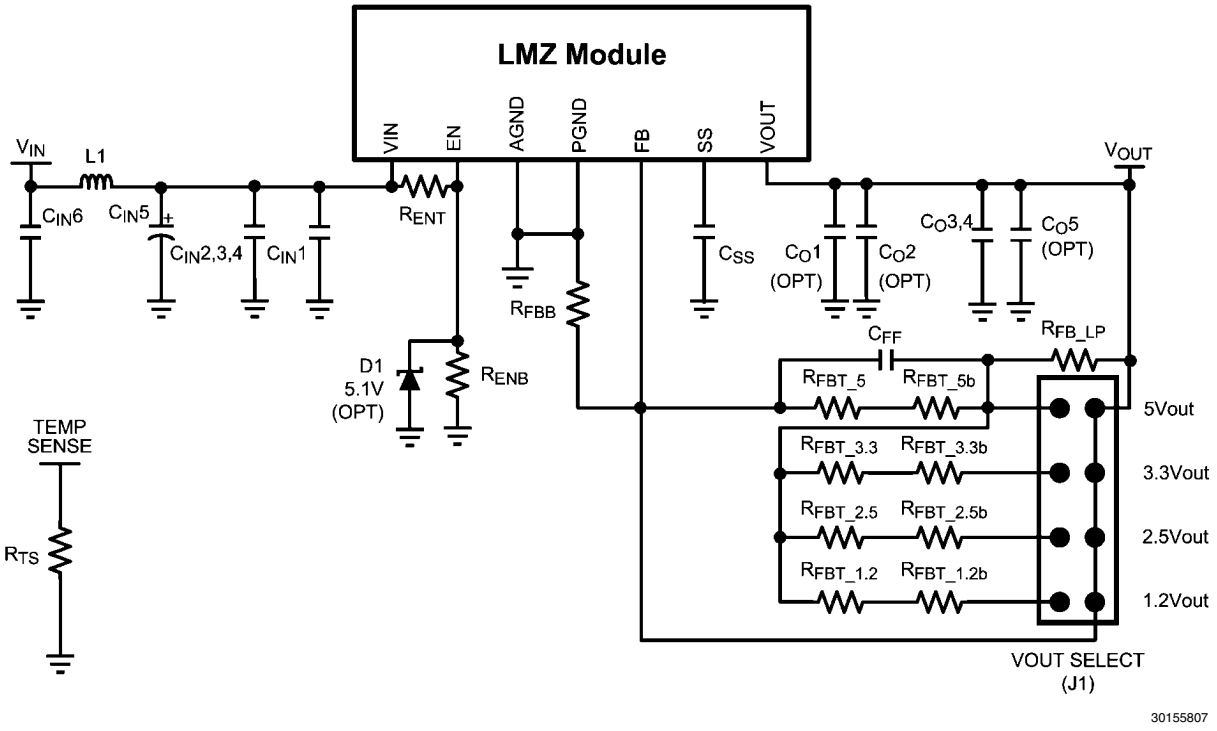


FIGURE 4. Evaluation Board Schematic

Bill of Materials

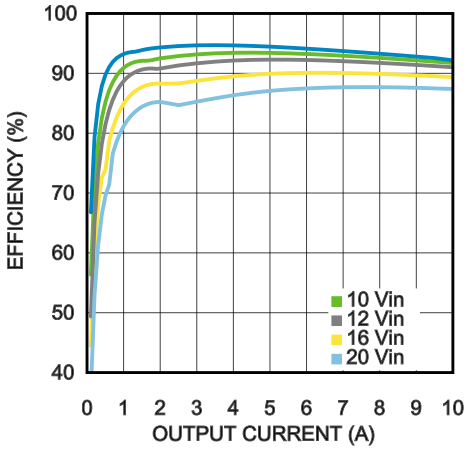
TABLE 1. Evaluation Board Bill of Materials, V_{IN} = 6V to 36V (20V), V_{OUT} = 1.2 / 3.3V / 5V, $I_{OUT\ (MAX)}$ = 10/08/06A

Designator	Description	Case Size	Manufacturer	Manufacturer P/N	Quantity
U1	SIMPLE SWITCHER®	TO-PMOD-11	National Semiconductor	LMZ13610/08/06 or LMZ12010/08/06	1
Cin1 Co1 Co5	0.047uF, X7R, 50V	0805	Kemet	C0805C473K5RACTU	3
Cin2 Cin3 Cin4 Cin6	10 µF, X7S, 50V	1210	TDK	C3225X7S1H106M	4
Cin5	150 µF, Aluminum Electrolytic, 50V	G	Panasonic	EEE-FK1H151P	1
Co2	47uF, X5R, 10V	1210	Murata	GRM32ER61A476KE20L	1
Co3 Co4	330µF, 6.3V, 0.015 ohm,	2917	Kemet	T520D337M006ATE015	2
Cff	4700 pF, X7R, 50V	0805	Kemet	C0805C472K5RACTU	1
Css	0.15uF, X7R, 10V	0603	Murata	GRM188R71A154KA01D	2
L1	Shielded Drum Core, Powdered Iron, 3.3uH, 12A, 0.011 ohm		Wurth	744314330	1
L1_alternate *used in conducted EMI measurement	Shielded Drum Core, 3.3uH, 0.011 ohm		Toko	892NAS-3R3M	
D1	4.7V, 500mW	SOD-123	Vishay	MMSZ4688-V-GS08	1
Rent	4.12k ohm, 1%, 0.125W	0805	Vishay-Dale	CRCW08054K12FKEA	1
Renb	1.27k ohm, 1%, 0.125W	0805	Vishay-Dale	CRCW08051K27FKEA	1
Rfbb	1.07k ohm, 1%, 0.125W	0805	Vishay-Dale	CRCW08051K07FKEA	1
Rfbt_1.2	576 ohm, 1%, 0.125W	0805	Vishay-Dale	CRCW0805576RFKEA	1
Rfbt_1.2b	9.53 ohm, 1%, 0.125W	0805	Vishay-Dale	CRCW08059R53FKEA	1
Rfbt_2.5	3.74k ohm, 1%, 0.125W	0805	Vishay-Dale	CRCW08053K74FKEA	1
Rfbt_2.5b	84.5 ohm, 1%, 0.125W	0805	Vishay-Dale	CRCW080584R5FKEA	1
Rfbt_3.3	8.06k ohm, 1%, 0.125W	0805	Vishay-Dale	CRCW08058K06FKEA	1
Rfbt_3.3b	169 ohm, 1%, 0.125W	0805	Vishay-Dale	CRCW0805169RFKEA	1
Rfbt_5	5.6k ohm, 1%, 0.125W	0805	Vishay-Dale	CRCW08055K60FKEA	1
Rfbt_5b	73.2 ohm, 1%, 0.125W	0805	Vishay-Dale	CRCW080573R2FKEA	1
RFB_LP	20 Ω	0805	Vishay-Dale	CRCW080520R0FKEA	1
Rts	100 ohm,Temp Sense Resistor	0805	Vishay	PTS08051B100RP 100	1
EN	Test Point, TH, Miniature, Red		Keystone Electronics	5000	1
GND GND	Test Point, TH, Miniature, Black		Keystone Electronics	5001	2
GND GND VIN VOUT	Banana Jack Connector		Keystone Electronics	575-8	4
SH-1	Shunt, 100mil, Gold plated, Black		Amp	382811-6	1

Designator	Description	Case Size	Manufacturer	Manufacturer P/N	Quantity
H1 H2 H3 H4	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead		B and FFastener Supply	NY PMS 440 0025 PH	4
H5 H6 H7 H8	Standoff, Hex, 0.5"L #4-40 Nylon		Keystone	1902C	4
J1	Header, 4x2, Gold plated, 230 mil above insulator	TH, 100mil	Samtec Inc.	TSW-104-07-G-D	1
J2	20-Pin Dual Edge Connector, 0.156" pitch		EDAC	305-020-500-202	0

Performance Characteristics

Efficiency, V_{OUT} = 5.0V



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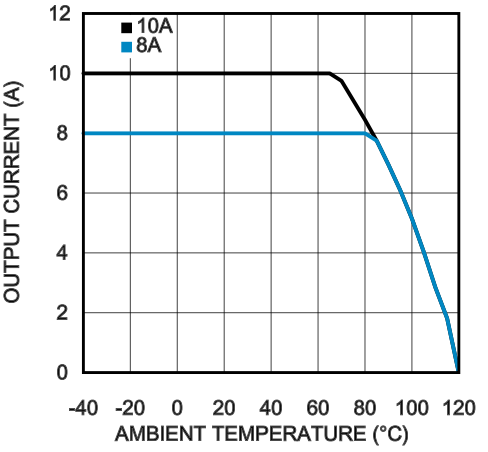
Thermal Derating, V_{OUT} = 5.0V



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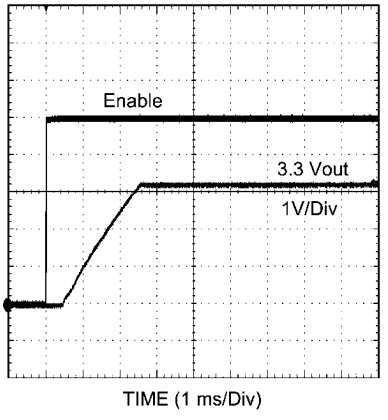
Startup, V_{IN} = 12V, V_{OUT} = 3.3V



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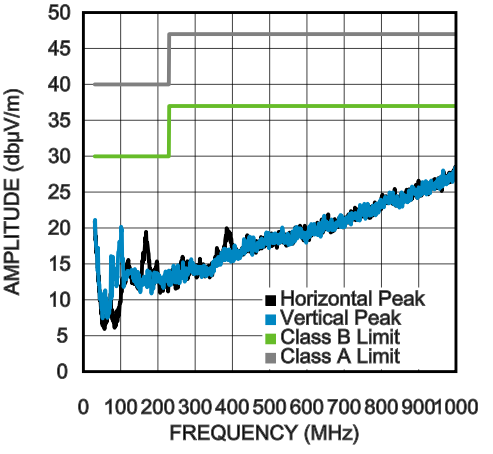
Radiated EMI (EN 55022)
V_{IN} = 12V, V_{OUT} = 5.0V, I_{OUT} = 10A



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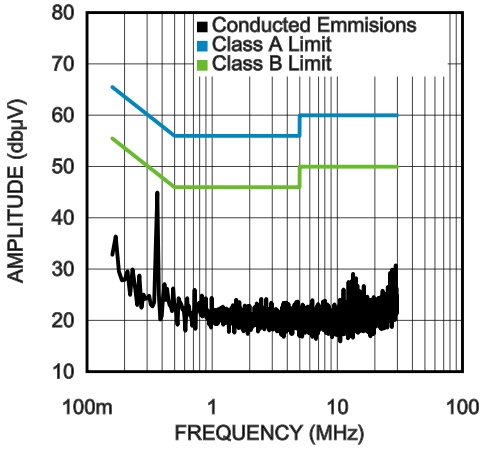
Conducted EMI (EN 55022) *L1_alternate
V_{IN} = 12V, V_{OUT} = 5.0V, I_{OUT} = 10A



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PCB Layout Diagrams

Gerber and CAD files can be downloaded from the associated product folder.

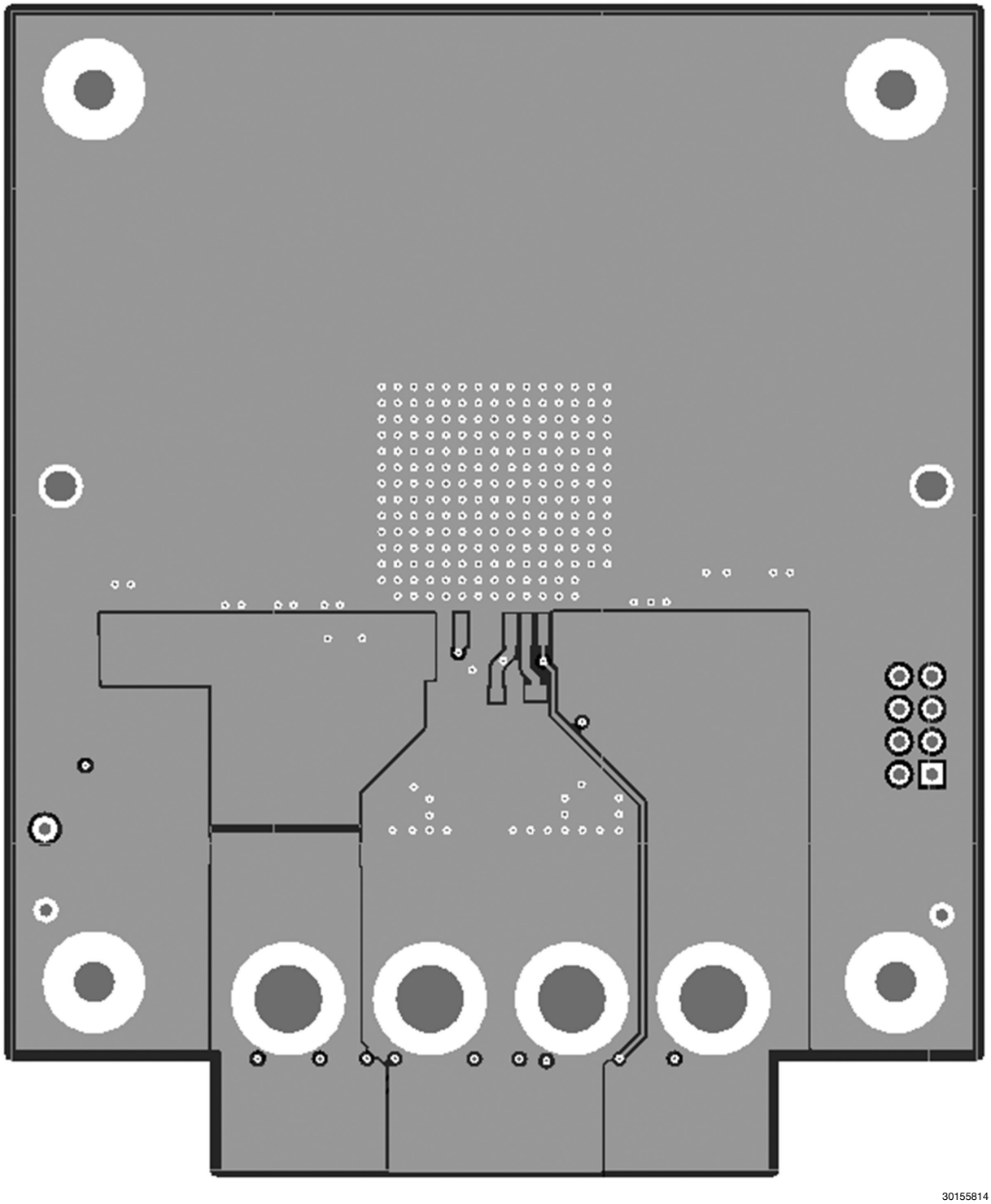

FIGURE 5. Top Layer

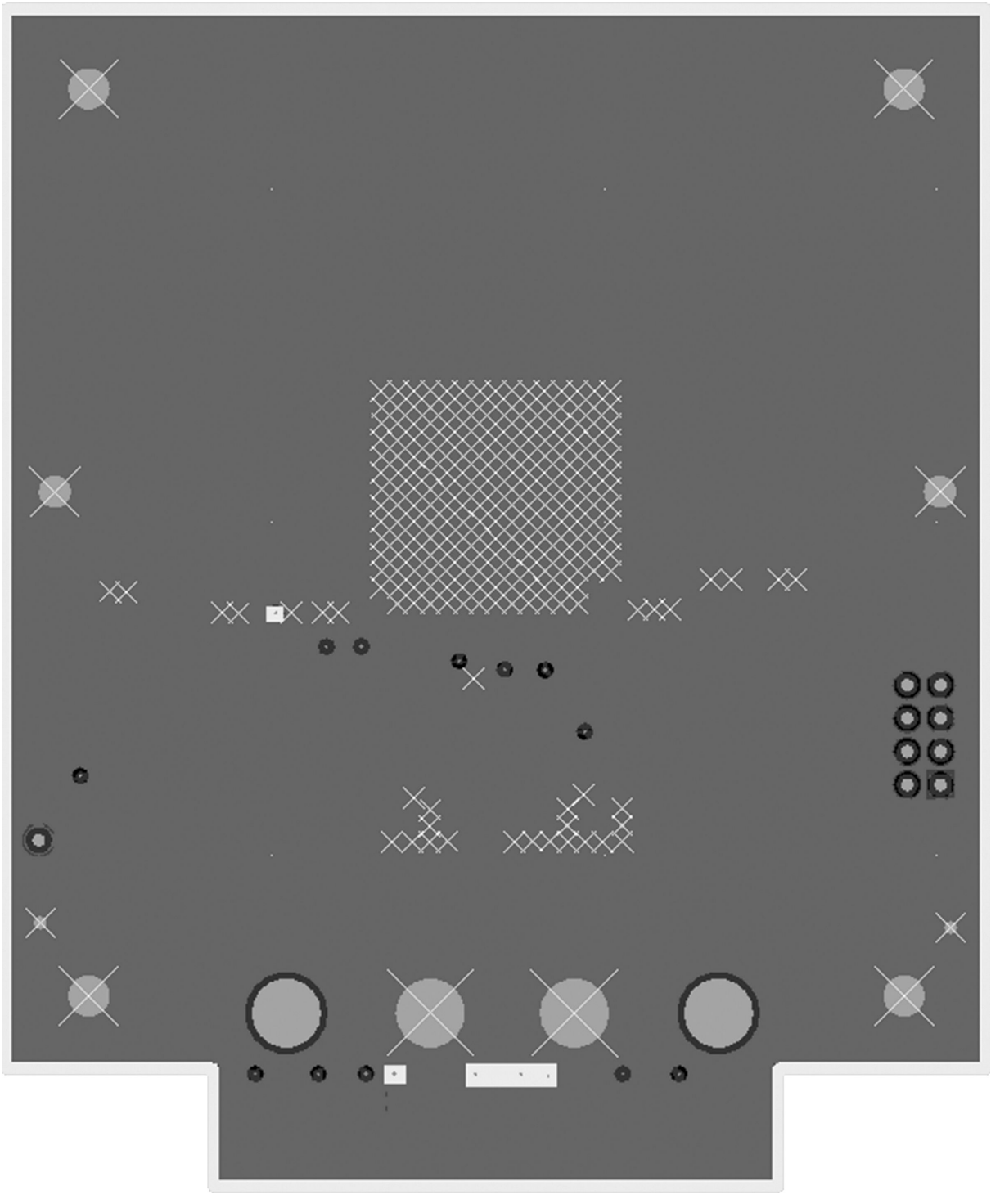

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FIGURE 6. Internal Layer I (Ground)
Heat Sinking Layer

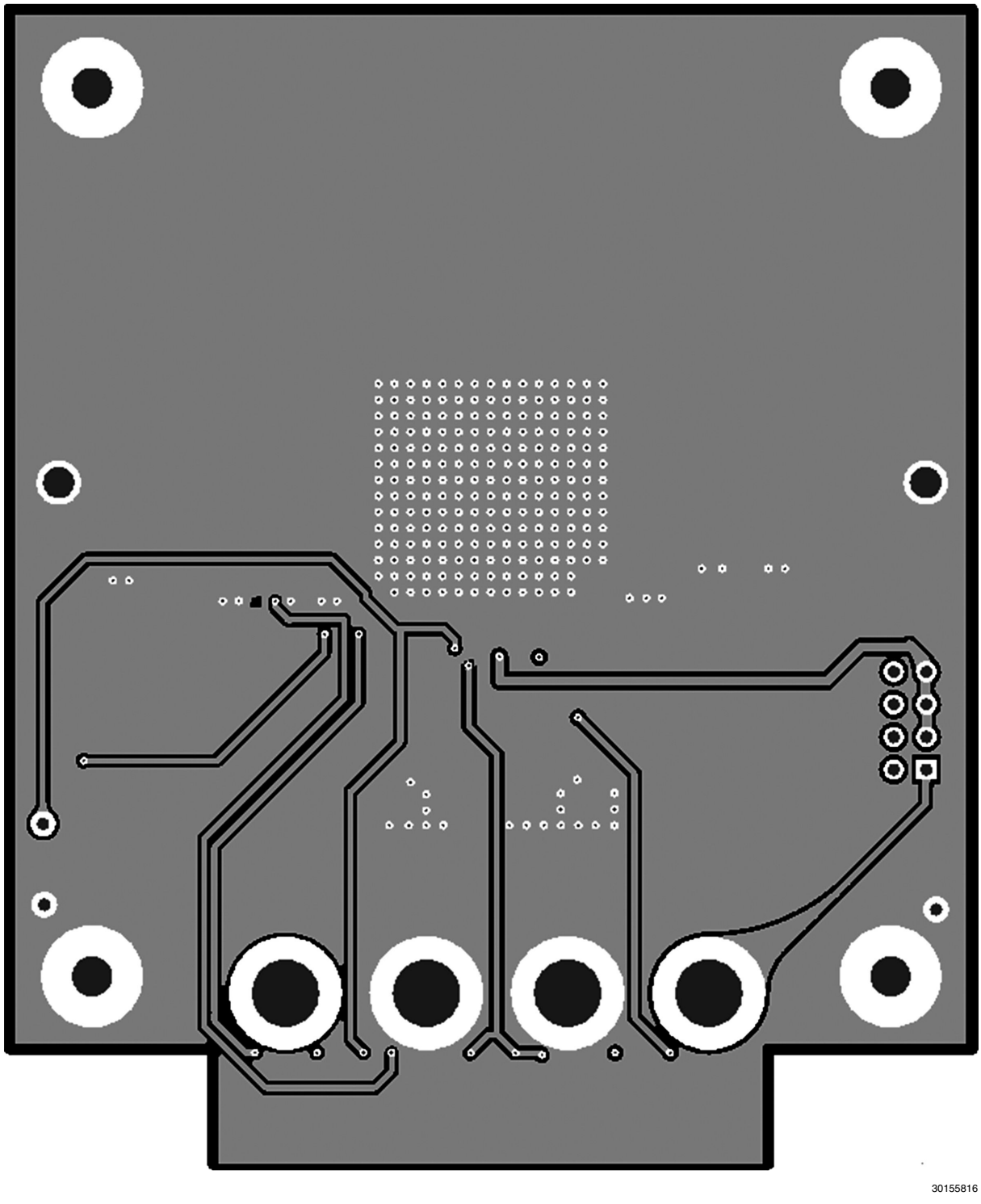

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FIGURE 7. Internal Layer II (Routing)
Heat Sinking Layer

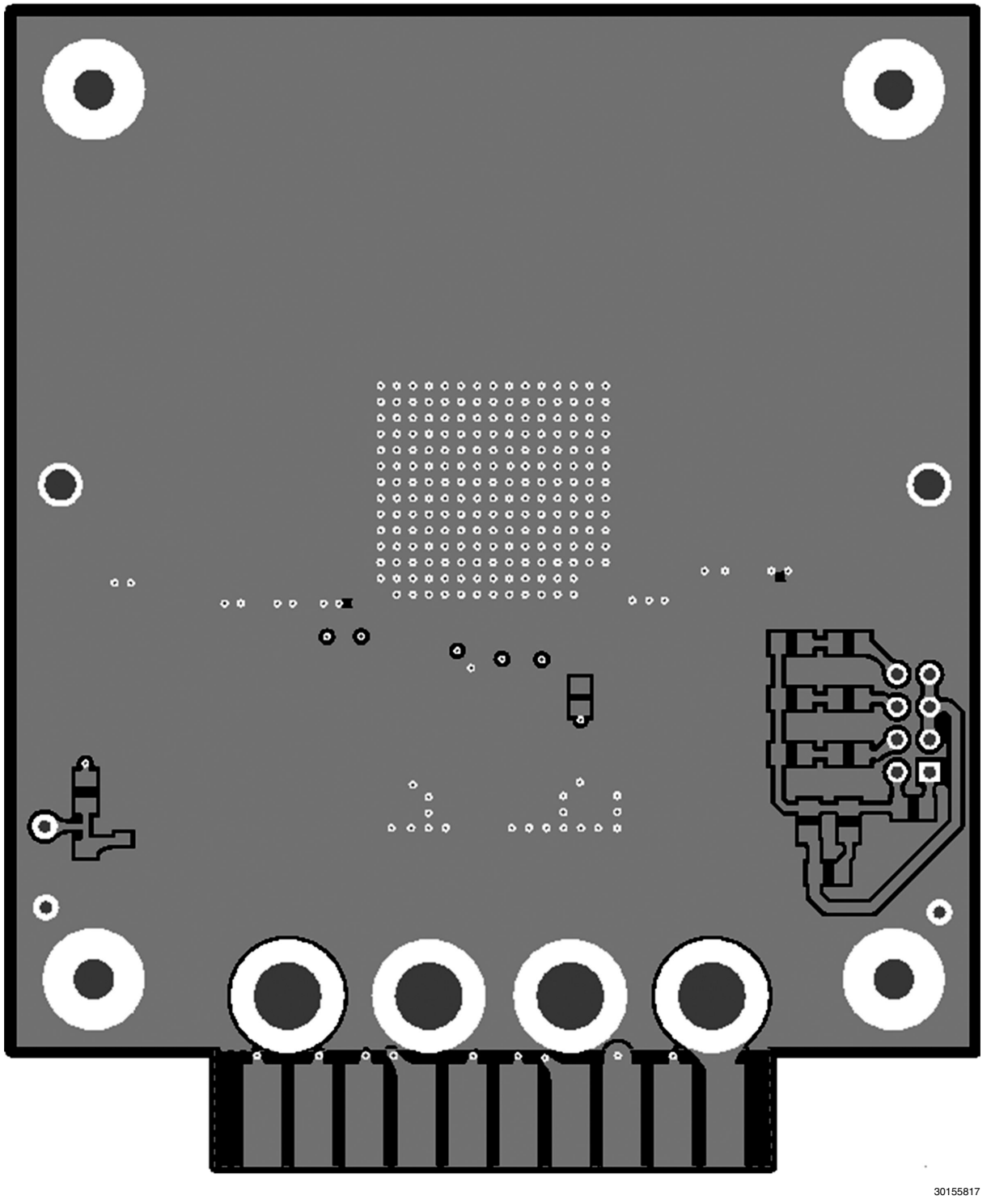

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FIGURE 8. Bottom Layer (Ground and Routing)
Heat Sinking Layer

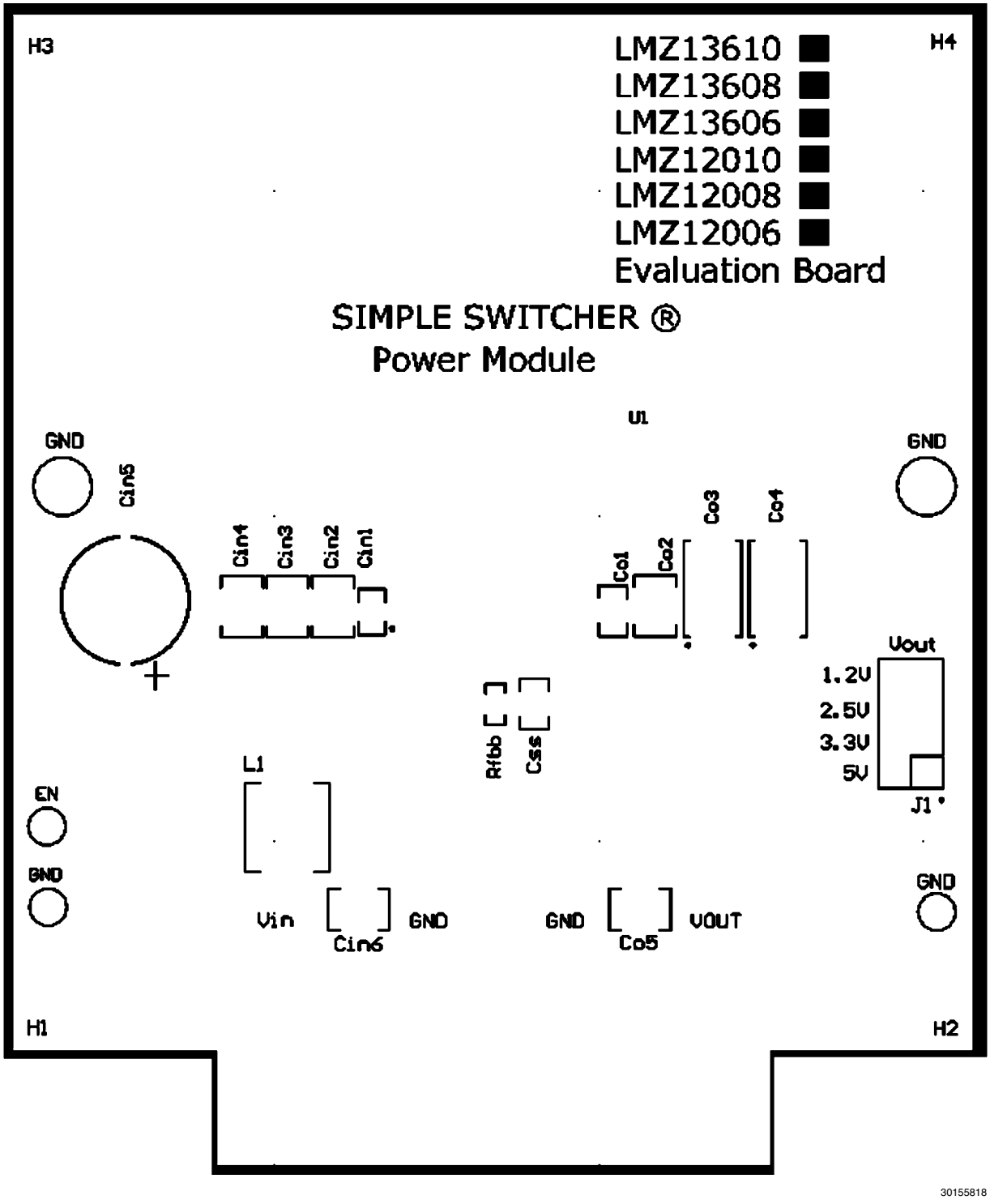

FIGURE 9. Top Silkscreen

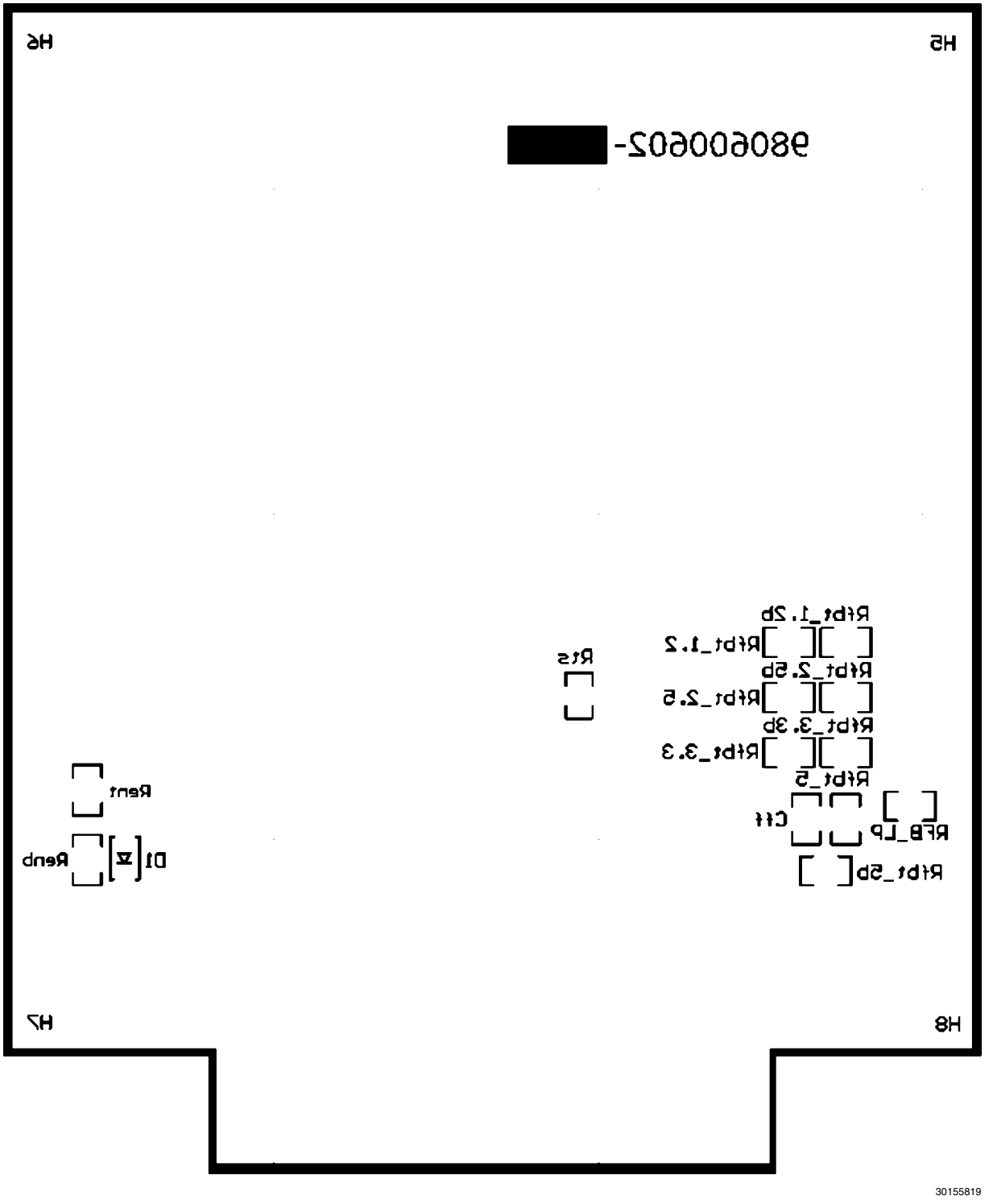

FIGURE 10. Bottom Silkscreen

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