

# User manual for IR3846A evaluation board

## 40 A single-phase buck regulator with 1.2 V output

### About this document

#### Scope and purpose

The IR3846A is a synchronous buck converter, providing a compact, high-performance and flexible solution in a small 5 mm x 7 mm power QFN package.

Key features offered by the IR3846A include internal digital soft-start, precision 0.6 V reference voltage, power good ( $P_{good}$ ), thermal protection, enable input, input undervoltage lockout (UVLO) for proper start-up, latched off overvoltage protection (OVP) and pre-bias start-up.

Output overcurrent protection (OCP) function is implemented by sensing the voltage developed across the on-resistance of the synchronous MOSFET for optimum cost and performance, and the current limit is thermally compensated.

This user manual contains the schematic and bill of materials for the EVAL\_3846A\_1.2V engineering evaluation board. The manual describes operation and use of the evaluation board itself. Detailed application information for IR3846A is available in the IR3846A datasheet.

#### Intended audience

This document is intended as a guide for design engineers evaluating IR3846A performance with the engineering EVAL\_3846A\_1.2V demo board.

### Table of contents

<b>About this document</b> .....	<b>1</b>
<b>Table of contents</b> .....	<b>1</b>
<b>1. Board information</b> .....	<b>2</b>
1.1 Board features .....	2
1.2 Connections and operating instructions.....	2
1.3 Layout .....	3
1.4 PCB layout .....	5
1.5 Bill of materials.....	10
<b>2. Typical operating waveforms</b> .....	<b>12</b>
<b>Revision history</b> .....	<b>17</b>

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## 40 A single-phase buck regulator with 1.2 V output

### Board information

## 1. Board information

### 1.1 Board features

$V_{in} = +12\text{ V}$ ,  $V_{out} = +1.2\text{ V}$  at 0 to 40 A

$F_{sw} = 600\text{ kHz}$

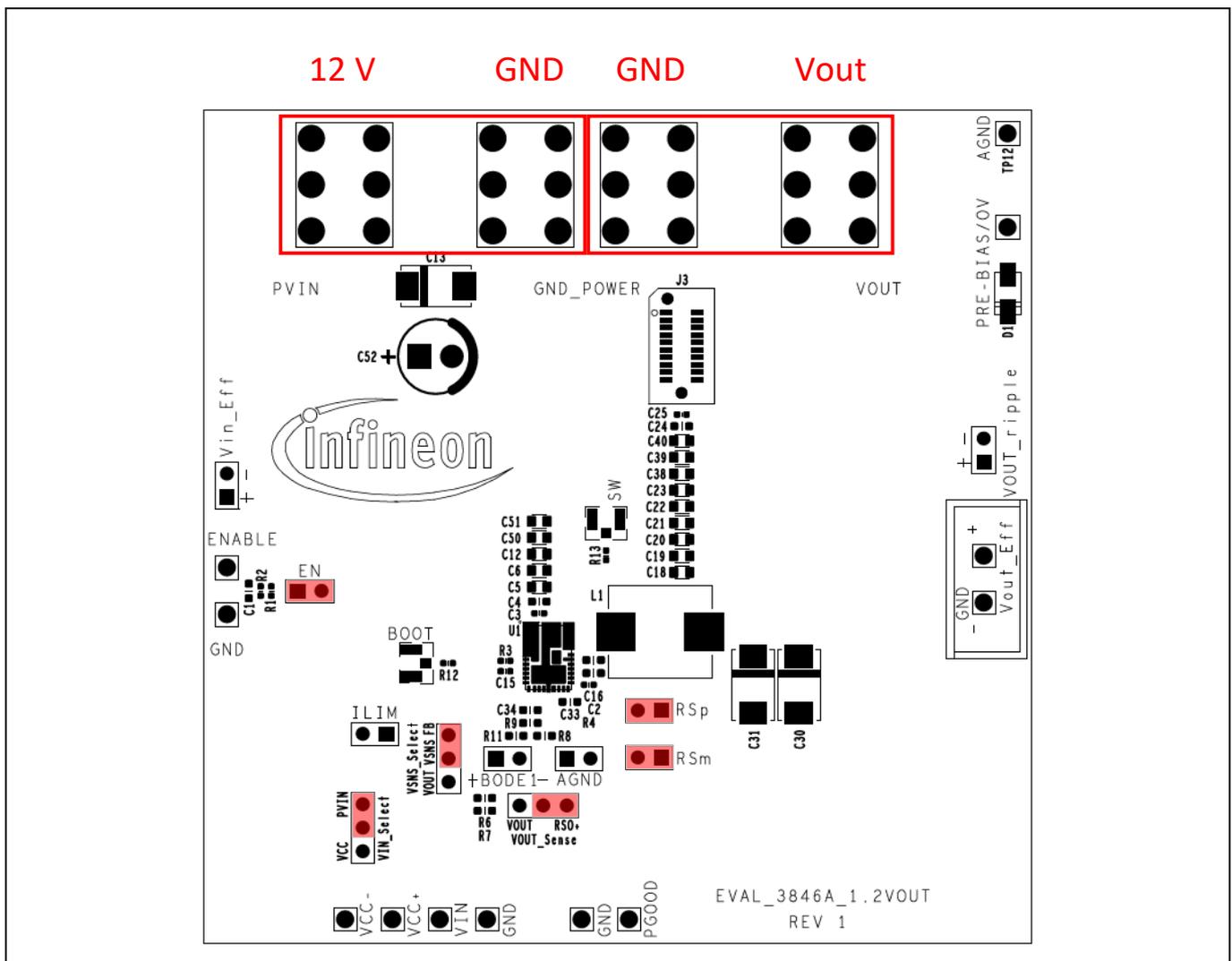
$L = 150\text{ nH}$  (11.15 mm x 10 mm x 3.8 mm, DCR = 0.55 m $\Omega$ )

$C_{in} = 1 \times 2.2\text{ nF}$  (25 V, ceramic 0402) +  $1 \times 4.7\text{ nF}$  (25 V, ceramic 0603) +  $8 \times 22\text{ }\mu\text{F}$  (25 V, ceramic 0805) +  $1 \times 390\text{ }\mu\text{F}$  (20 V, electrolytic, optional)

$C_{out} = 16 \times 47\text{ }\mu\text{F}$  (6.3 V, ceramic 0805) +  $1 \times 4.7\text{ }\mu\text{F}$  (6.3 V, ceramic 0603) +  $1 \times 0.1\text{ }\mu\text{F}$  (50 V, ceramic 0402) +  $2 \times 470\text{ }\mu\text{F}$  (2.5 V, 3 m $\Omega$ , SP-cap)

### 1.2 Connections and operating instructions

The IR3846A demo board requires a single +12 V for the input power and can deliver up to 40 A load current. The operation settings can be selected through the jumper configurations. **Figure 1** highlights the demo board I/O connections and jumper configurations for power-up.



**Figure 1** IR3846A evaluation board connections

**Board information**

**Table 1 Connections**

Label		Description
Input	PVIN	Connect input power (+12 V) to this pin
	PVIN_GND	Return of input power
	VIN_EFF	Sense pins for the input voltage
Output	VOUT	Connect a load (40 A max.) to this pin
	VOUT_GND	Return of $V_{out}$
	VOUT_EFF, GND	Sense pins for the output voltage, output voltage ripple
	VOUT_ripple	
Enable	ENABLE	Connect a scope probe to this pin to monitor enable signal. Or, an external enable signal can be applied to this pin to overdrive the onboard enable signal.
	GND	
	EN	Use a jumper to use $P_{VIN}$ for enable. Remove jumper if using an external enable.
Bode	BODE1	For bode plot measurement
OCP limit	ILIM	Use a jumper to make one of two OCP limit selections. Short = 39 A and open = 53.5 A
$P_{good}$	PGOOD	Connect a scope probe to this pin to monitor power good signal
	GND	GND
$V_{CC}$	VCC+	Connect a scope probe to monitor the output of the internal LDO or use to connect external $V_{CC}$ voltage
	VCC-	
VIN_Select	PVIN	Place a jumper for operation using internal LDO
	VCC	Place a jumper for operation using external $V_{CC}$
VSNS_Select	VOUT, VSNS	Place a jumper to use $V_{out}$ for VSNS through a resistor divider
	FB, VSNS	Place a jumper to use FB for VSNS
$V_{out}$ sense	VOUT	Place jumper on $V_{out}$ to operate in single-ended configuration
	RSO+	Place jumpers on RSO+ to operate in pseudo-remote sense configuration
$RS_p$	$RS_p$	Place jumper for pseudo-remote sensing and remove for single-ended sensing
$RS_m$	$RS_m$	Place jumper for pseudo-remote sensing and remove for single-ended sensing
$AGND$	AGND	Populate jumper for single-ended sensing and remove for pseudo-remote sense configuration
Switch node	SW	Use UMCC cable to monitor the switch node on a scope
Boot	BOOT	Use UMCC cable to monitor the BOOT-to-GND voltage on a scope
Pre-bias	Pre-bias/OV, AGND	Use to apply an external pre-bias voltage on output

### 1.3 Layout

The PCB is an eight-layer board (3.55 in. x 3.5 in.) using FR4 material. The top, bottom and inner layers use 2 oz. copper. The PCB thickness is 0.063 in. The IR3846A and other major power components are mounted on the top side of the board.



Board information

1.4 PCB layout

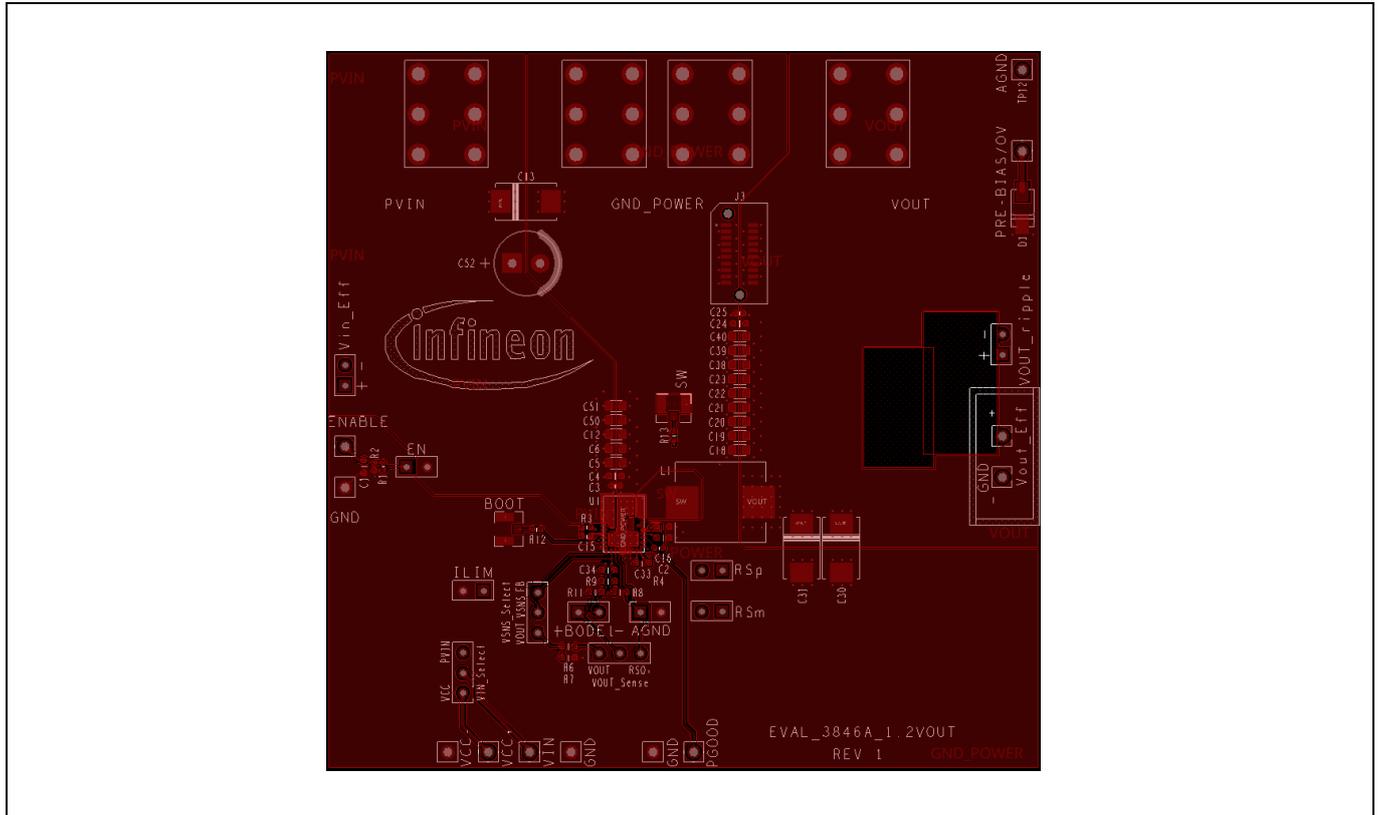


Figure 3 Top layer

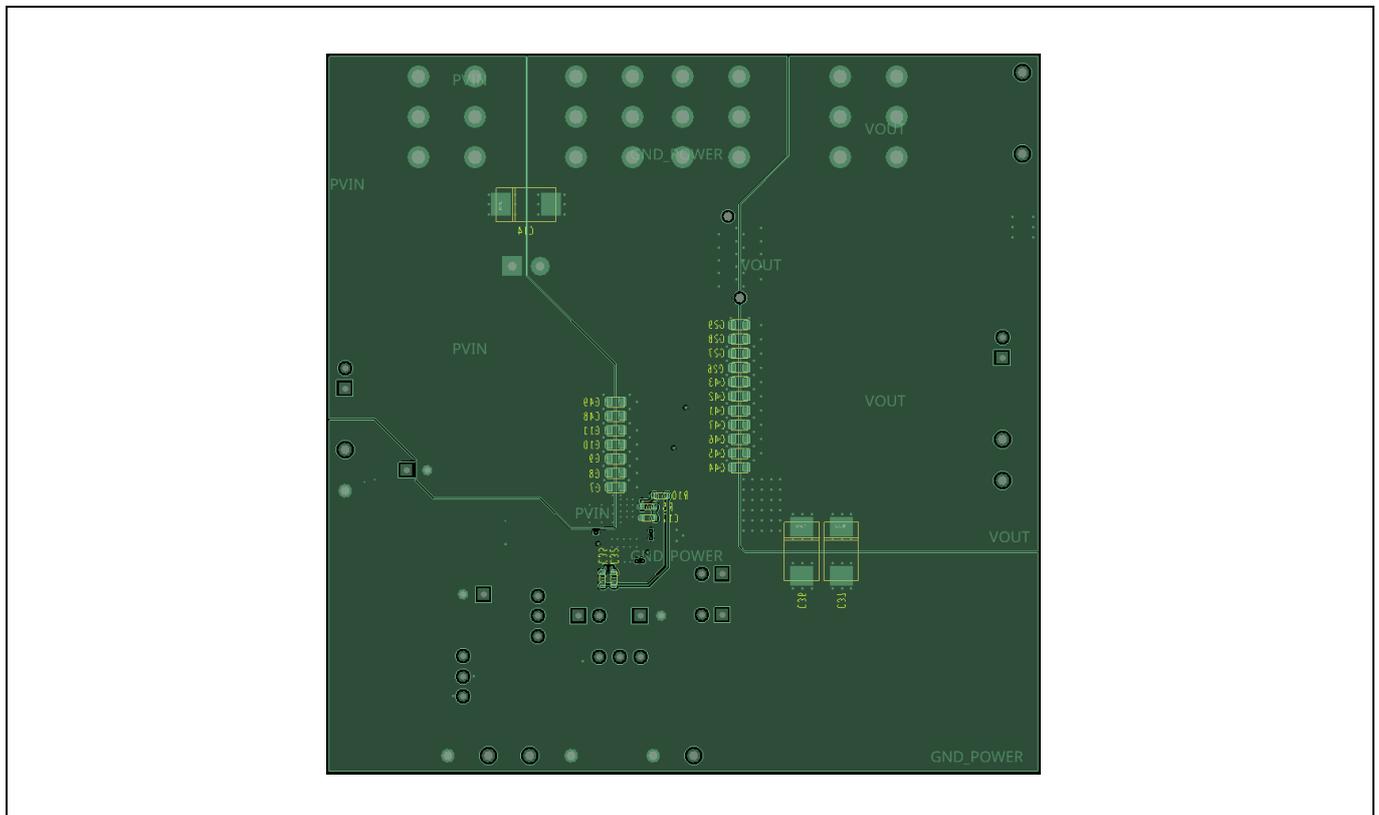


Figure 4 Bottom layer

Board information

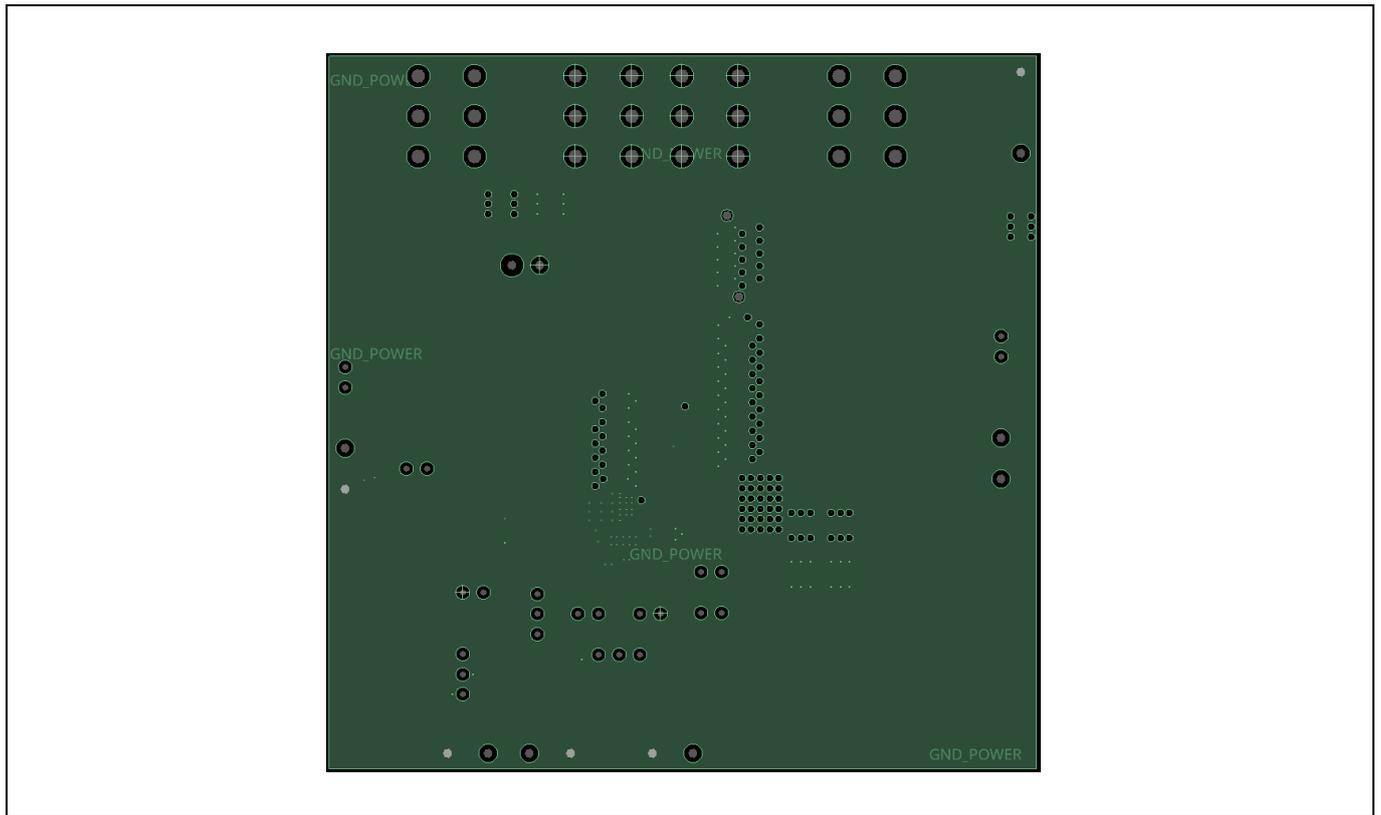


Figure 5 Mid layer 1

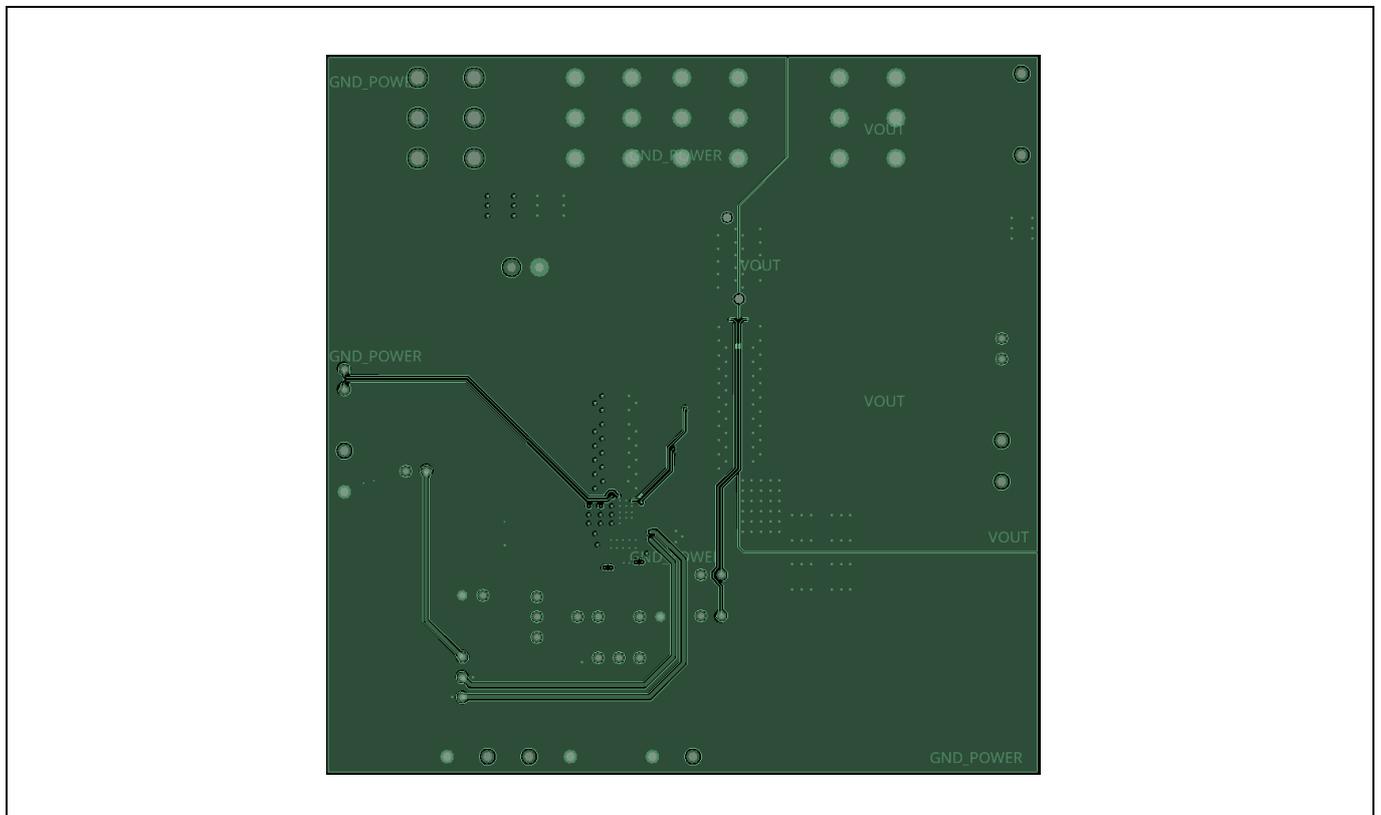


Figure 6 Mid layer 2

Board information

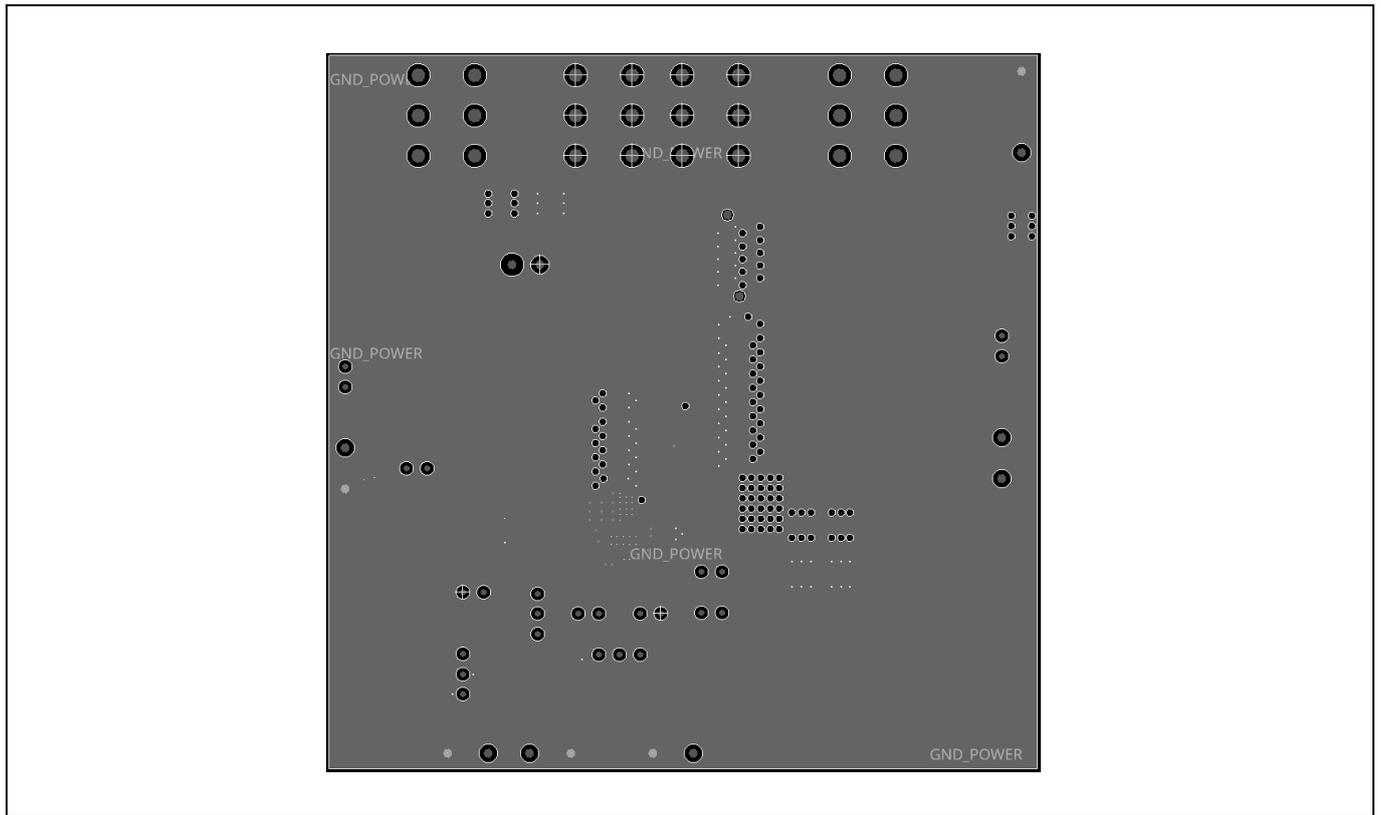


Figure 7 Mid layer 3

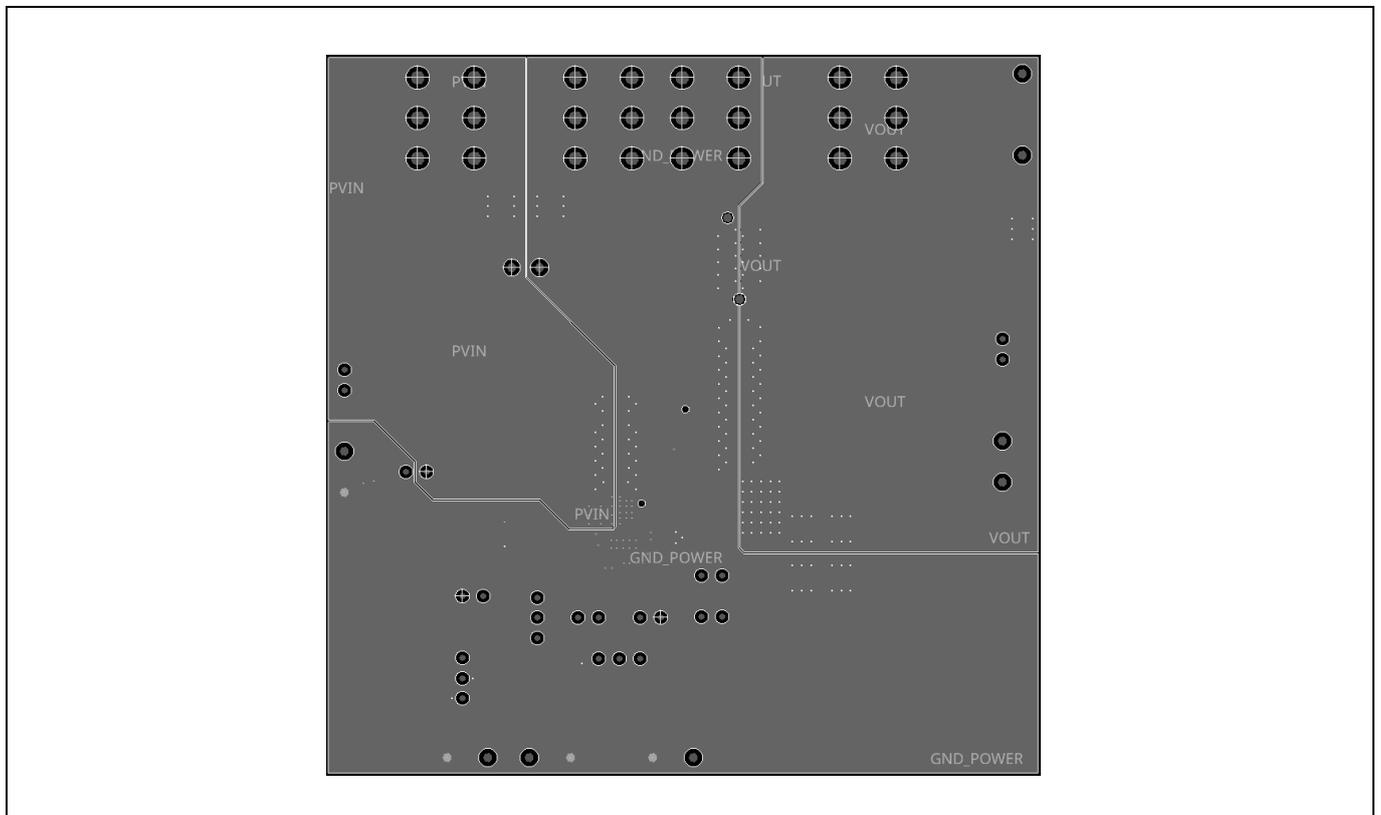


Figure 8 Mid layer 4

Board information

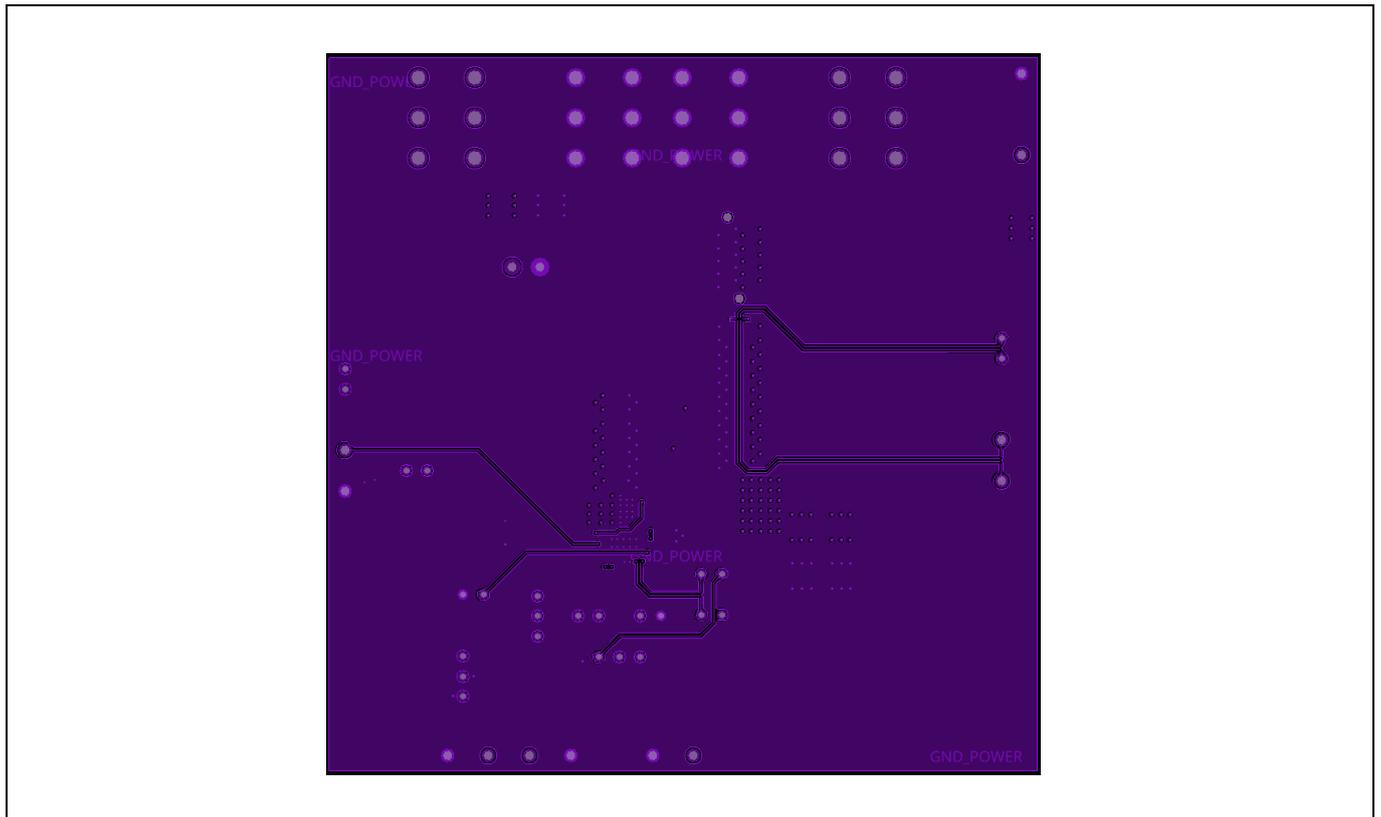


Figure 9 Mid layer 5

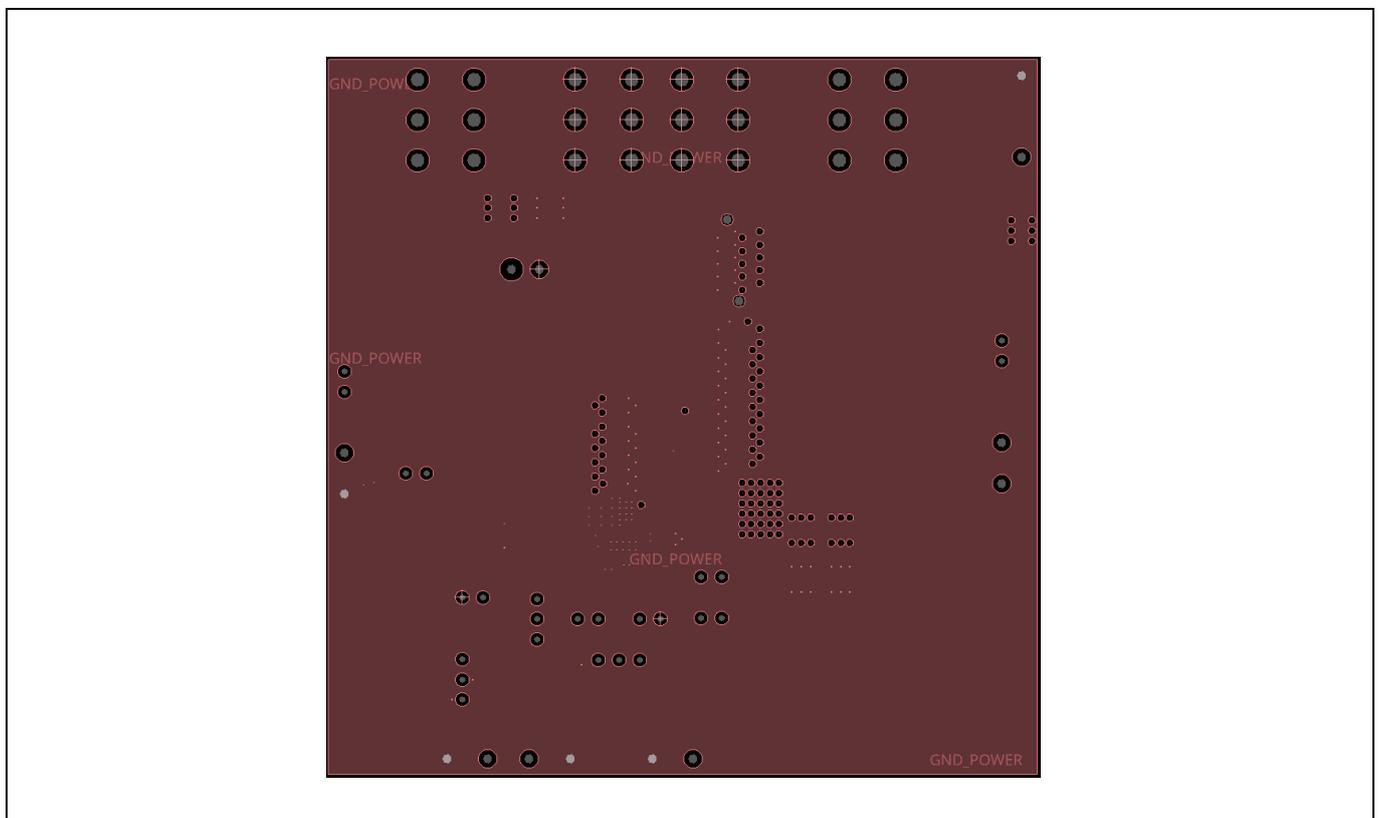


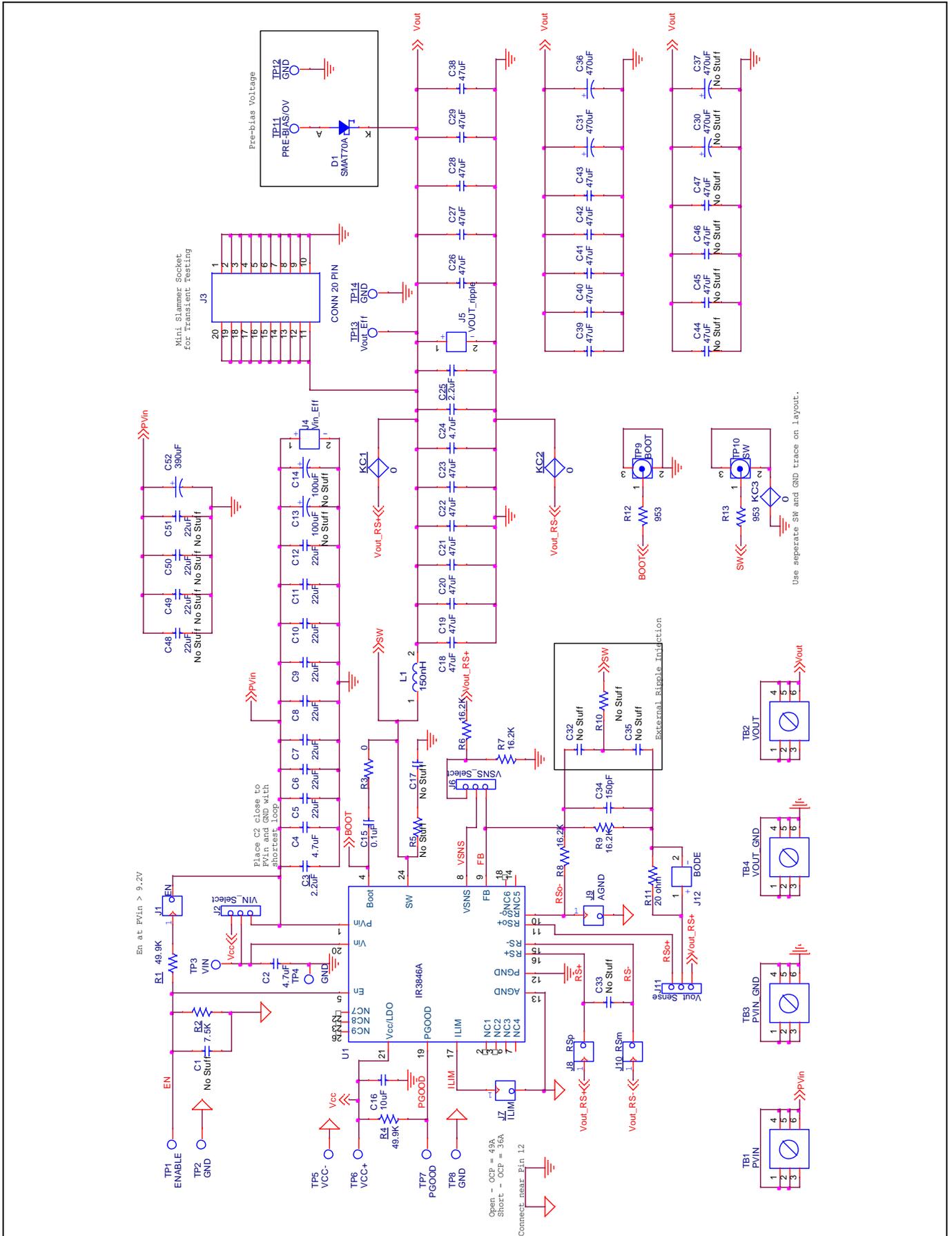
Figure 10 Mid layer 6

# User manual for IR3846A evaluation board

## 40 A single-phase buck regulator with 1.2 V output



### Board information



**Figure 11 Schematic of the EVAL\_3846A\_1.2V board  $V_{in} = 12\text{ V}$ ,  $V_{out} = 1.2\text{ V}$ ,  $I_{outmax} = 40\text{ A}$**

**Board information**

**1.5 Bill of materials**

**Table 2 Bill of materials**

Qty	Reference	Value	Manufacturer	Part number	Description
2	C3, C25	2.2 $\mu$ F	Murata	GRM155C81E225ME11D	2.2 $\mu$ F, 0402, 25 V, X6S, 20%
1	C15	0.1 $\mu$ F	TDK	C1005X7R1H104K050BB	0.1 $\mu$ F, 0402, 50 V, X7R, 10%
2	C2, C4	4.7 $\mu$ F	Murata	GRM188C81E475KE11	4.7 $\mu$ F, 0603, 25 V, X6S, 20%
1	C16	10 $\mu$ F	Murata	GRM188C81C106MA73	10 $\mu$ F, 0603, 16 V, X6S, 20%
1	C24	4.7 $\mu$ F	Samsung	CL10A475MQ8NNNC	4.7 $\mu$ F, 0603, 6.3 V, X5R, 20%
1	C34	150 pF	Samsung	CL10C151JB8NNNC	150 pF, 0603, 50 V, C0G, 5%
8	C5, C6, C7, C8, C9, C10, C11, C12	22 $\mu$ F	Murata	GRM21BR61E226ME44L	22 $\mu$ F, 0805, 25 V, X5R, 20%
16	C18, C19, C20, C21, C22, C23, C26, C27, C28, C29, C38, C39, C40, C41, C42, C43	47 $\mu$ F	TDK	C2012X5R0J476M	47 $\mu$ F, 0805, 6.3 V, X5R, 20%
2	C31, C36	470 $\mu$ F	Panasonic	EEF-GX0E471R	Aluminum polymer capacitor, 470 $\mu$ F, 20%, 2.5 V, SMD
1	C52	390 $\mu$ F	Panasonic	20SEPF390M	Capacitor, 8 mm, 20 V, TOL. %
2	TP9, TP10	-	TE Conn./Amp	1909763-1	UMCC receptor – style A
1	J3	Connector 20-pin	Samtec	HSEC8-110-01-S-DV-A-K-TR	3M edge connector SPD08
1	L1	150 nH	Delta	CMLS104T-R15MS	IND, SMT, 11p15 x 10 mm, 0.55 m $\Omega$
8	J1, J7, J8, J9, J10, J4, J5, J12	EN	Harwin	M20-9990246	Header, 1x2, TH, 0.025 Sq, 0.1 inch space
2	R1, R4	49.9 K	Yageo	RC0402FR-0749K9L	Resistor, 0402, 1/16 W, 1%
1	R2	7.5 K	Yageo	RC0402FR-077K5L	Resistor, 0402, 1/16 W, 1%
1	R3	0	Yageo	RC0402FR-070RL	Resistor, 0402, 1/16 W, 1%
2	R12, R13	953	Yageo	RC0402FR-07953RL	Resistor, 0402, 1/16 W, 1%
4	R6, R7, R8, R9	16.2 K	Yageo	RC0603FR-0716K2L	Resistor, 0603, 1/10 W, 1%
1	R11	20 $\Omega$	Yageo	RC0603FR-0720RL	Resistor, 0603, 1/10 W, 1%
3	J2, J6, J11	VIN_Select	Harwin	M20-9990346	Header, 1x3, TH, 0.025 Sq, 0.1 inch space

# User manual for IR3846A evaluation board

## 40 A single-phase buck regulator with 1.2 V output



### Board information

Qty	Reference	Value	Manufacturer	Part number	Description
1	D1	SMAT70A	Diodes, Inc.	SMAT70A	SMA, 3.5 V, 40 A
4	TB1, TB2, TB3, TB4	-	Keystone	8199	Terminal block, 1 position, 30 A, 300 V
12	TP1, TP2, TP4, TP8, TP14, TP3, TP5, TP6, TP7, TP11, TP12, TP13	-	Vector	K24C/M	Test point V1055_ND
1	U1	IR3846A	Infineon	IR3846MTRPBF	IR3846A, PQFN, 5 mm x 7 mm

## 2. Typical operating waveforms

$V_{in} = 12.0\text{ V}$ ,  $V_{out} = 1.2\text{ V}$ ,  $I_{out} = 0\text{ to }40\text{ A}$ , room temperature with no airflow.

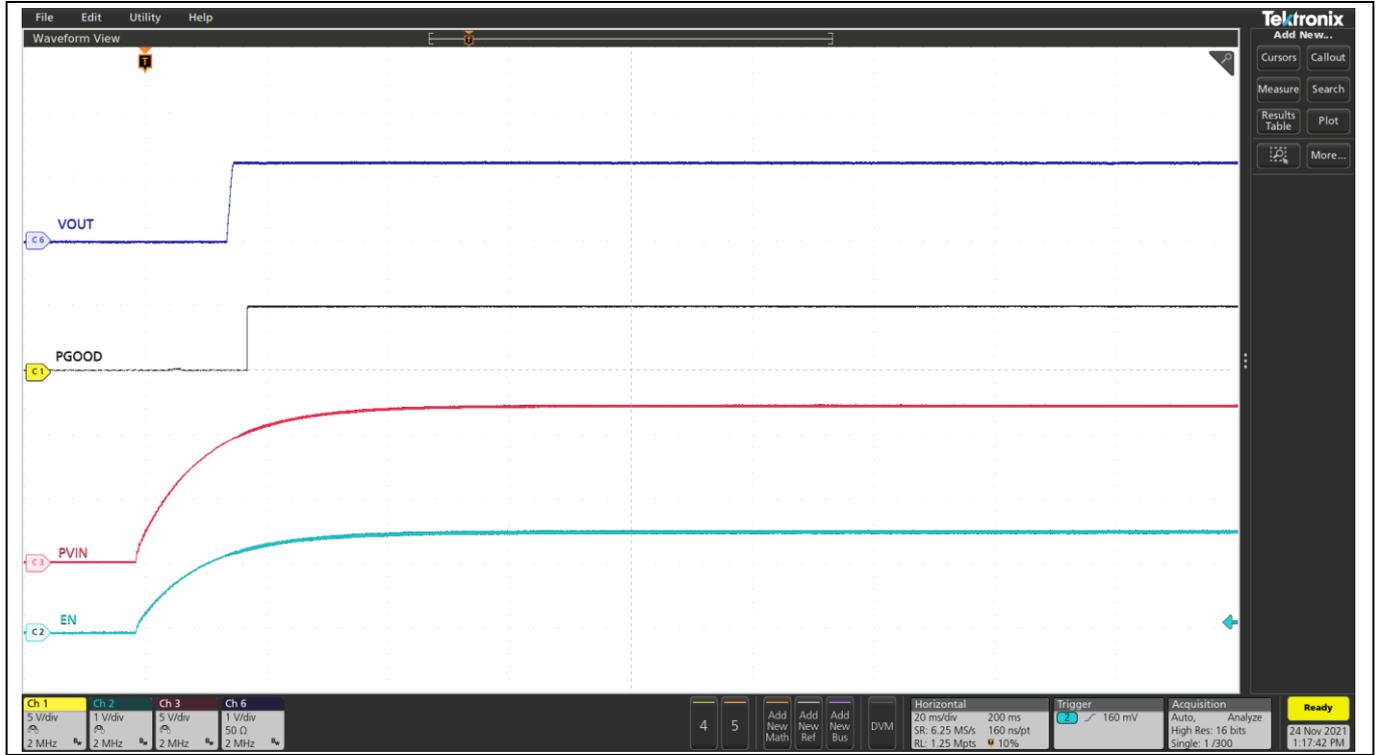


Figure 12 Start-up at 40 A load, (Ch1: P<sub>good</sub>, Ch2: enable, Ch3: P<sub>Vin</sub>, Ch6: V<sub>out</sub>)

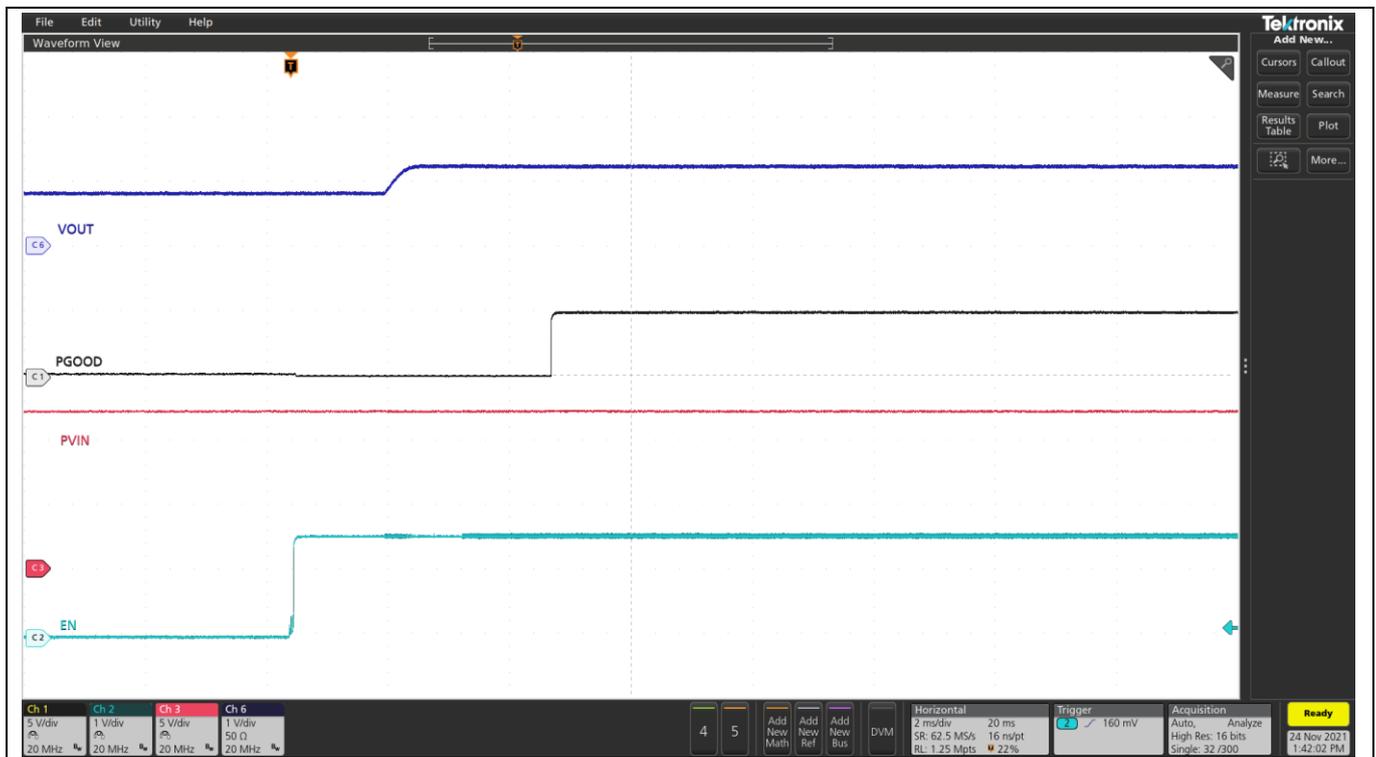
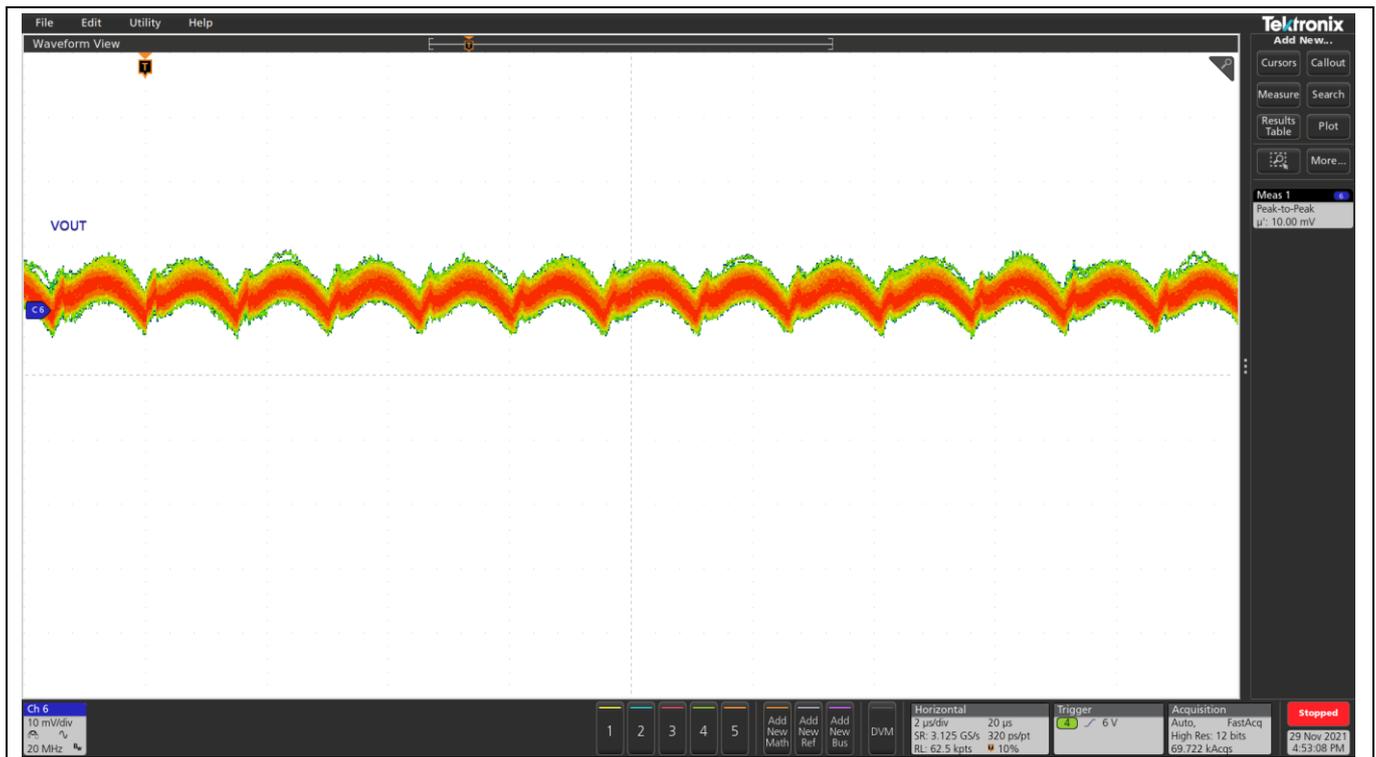
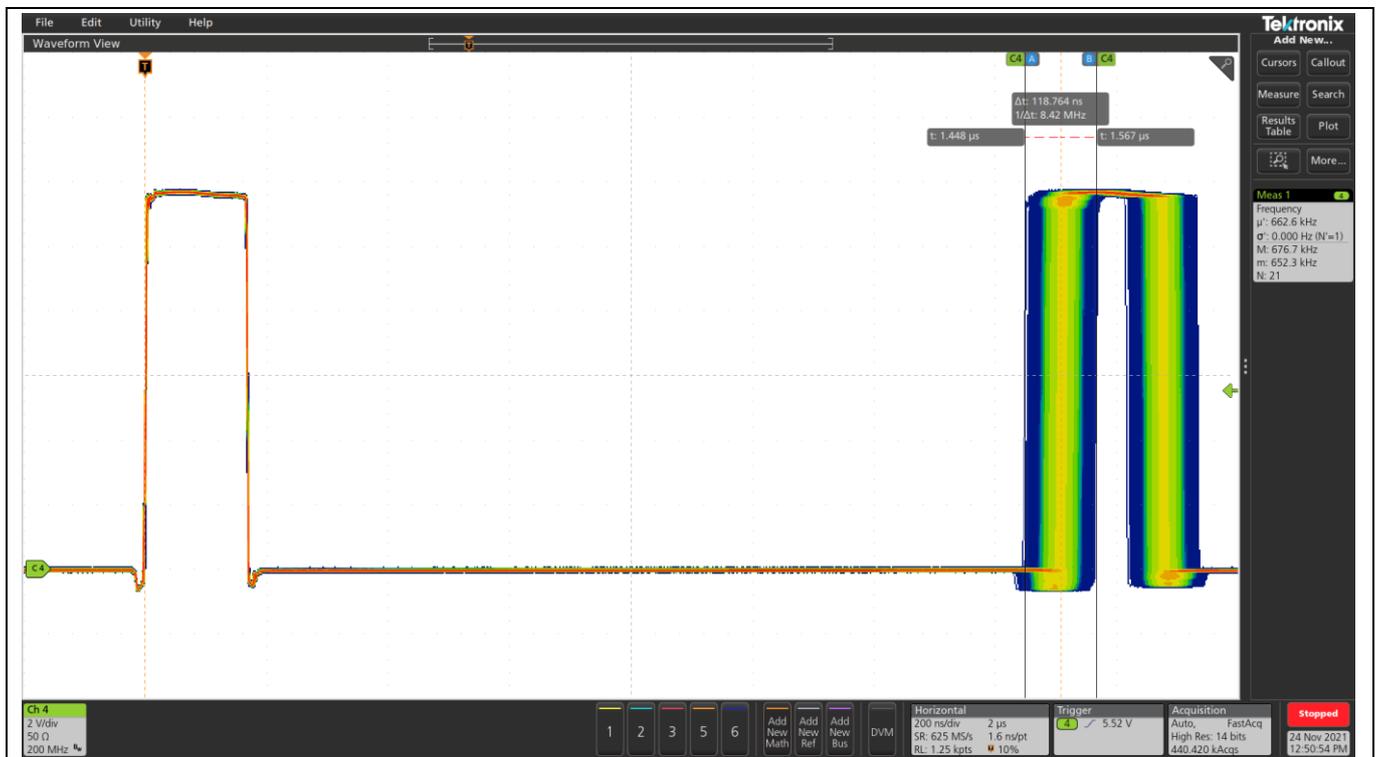


Figure 13 Pre-bias start-up at 0 A load, (Ch1: P<sub>good</sub>, Ch2: enable, Ch3: P<sub>Vin</sub>, Ch6: V<sub>out</sub>)

**User manual for IR3846A evaluation board**  
**40 A single-phase buck regulator with 1.2 V output**  
**Typical operating waveforms**



**Figure 14**  $V_{out}$  ripple at 40 A load,  $f_{sw} = 600$  kHz, (Ch6:  $V_{out}$ )



**Figure 15** SW node, 40 A load,  $f_{sw} = 600$  kHz, (Ch4: SW)

Typical operating waveforms

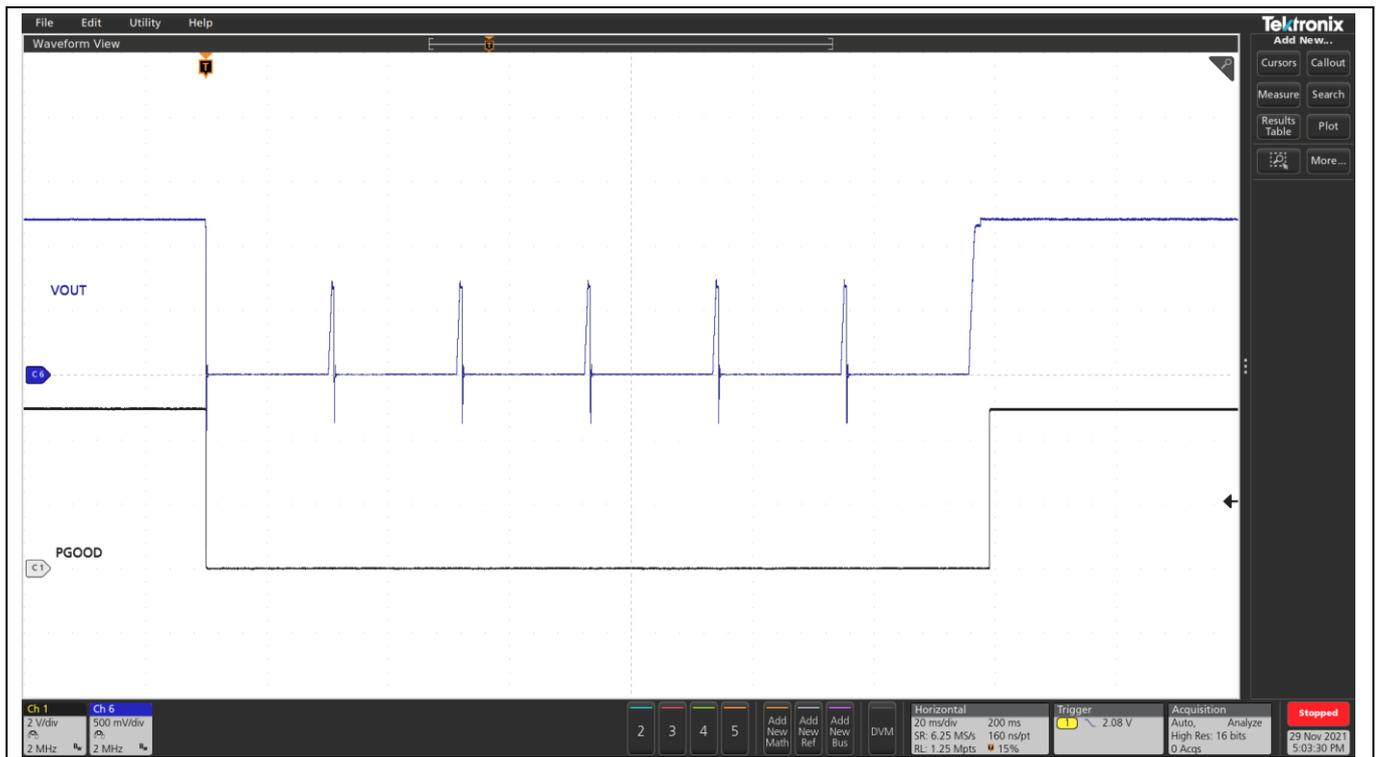


Figure 16 Short-circuit and UVP (hiccup and recovery), (Ch1: P<sub>good</sub>, Ch6: V<sub>out</sub>)

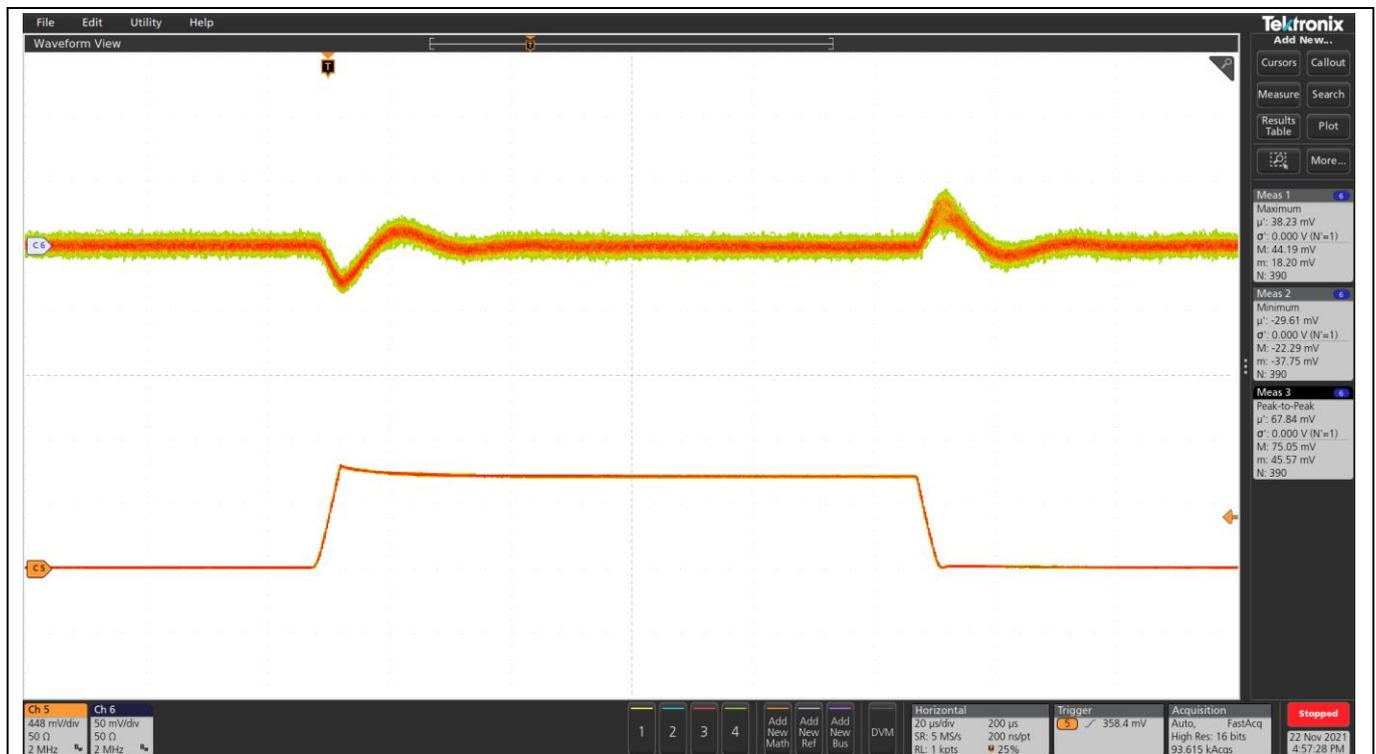


Figure 17 Transient response at 12 A step load current at 2.5 A/ $\mu$ s: I<sub>out</sub> = 24 A – 36 A, (Ch6: V<sub>out</sub>, Ch5: I<sub>out</sub>), pk-pk: 67.84 mV, f<sub>sw</sub> = 600 kHz

Note: The load transient test is performed using an Intel mini-slammer and a DC electronic load. The load transient of 12 A was applied using an Intel mini-slammer, i.e., 0 A to 12 A load step at 2.5 A/ $\mu$ s. A static load of 24 A was applied using the DC electronic load.

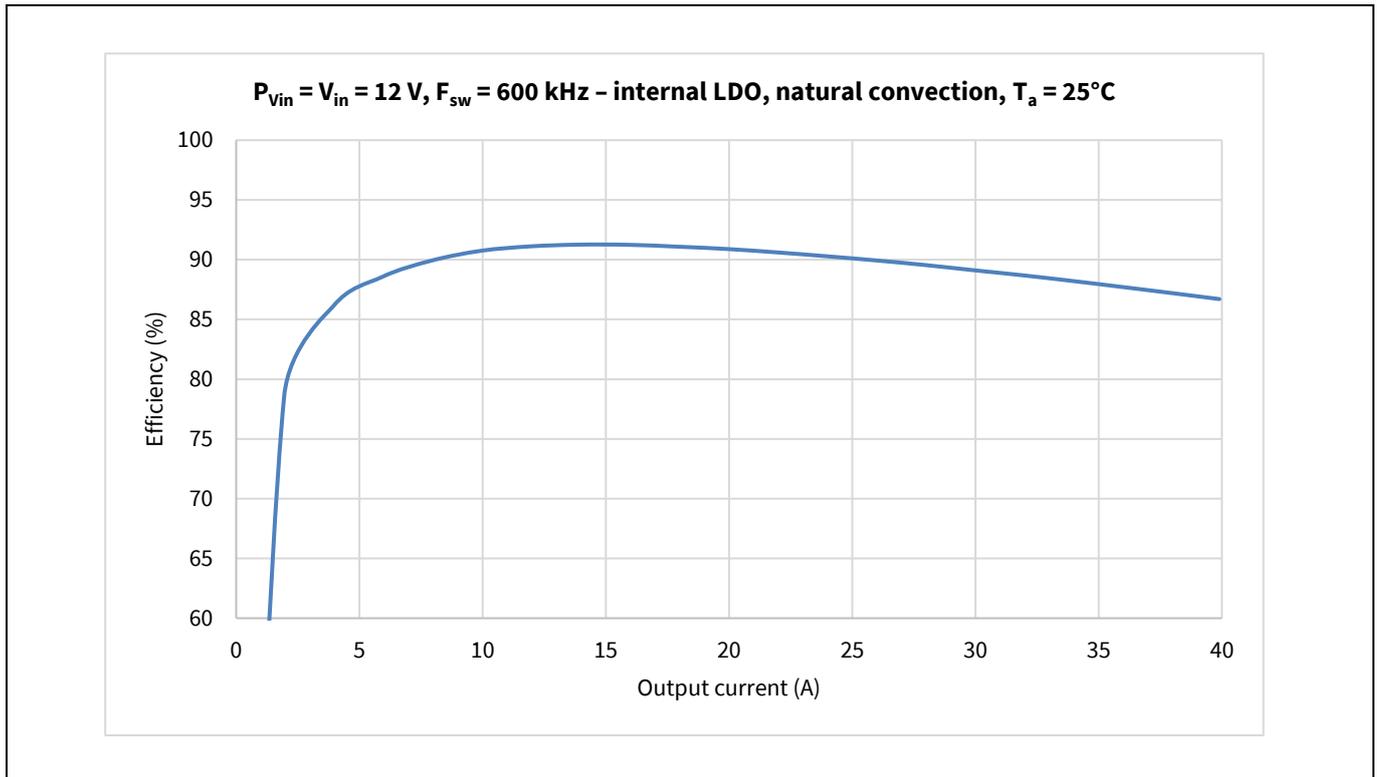


Figure 18 Efficiency vs. load current – natural convection (12 V<sub>in</sub>, 1.2 V<sub>out</sub>, 600 kHz, T<sub>a</sub> = 25°C, FCCM)

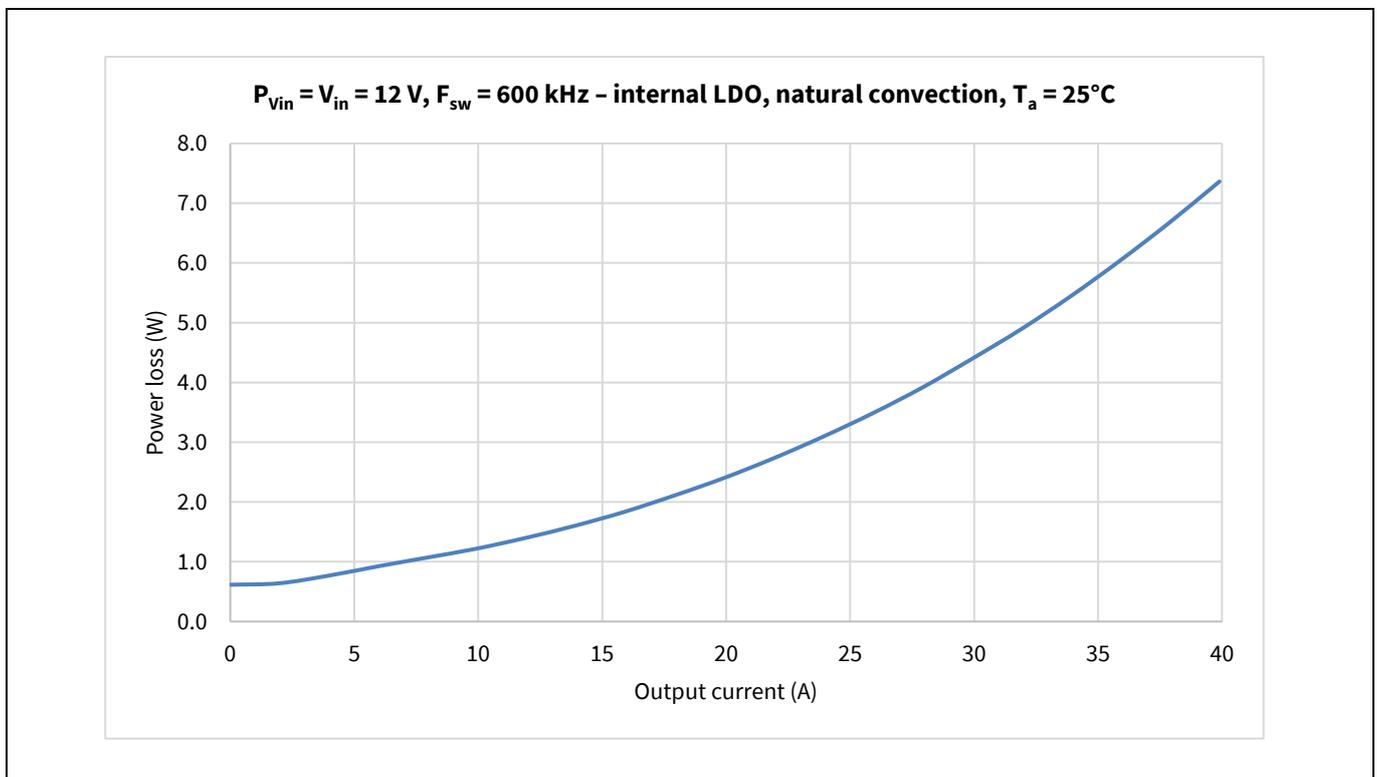


Figure 19 Power loss vs. load current – natural convection (12 V<sub>in</sub>, 1.2 V<sub>out</sub>, 600 kHz, T<sub>a</sub> = 25°C, FCCM)

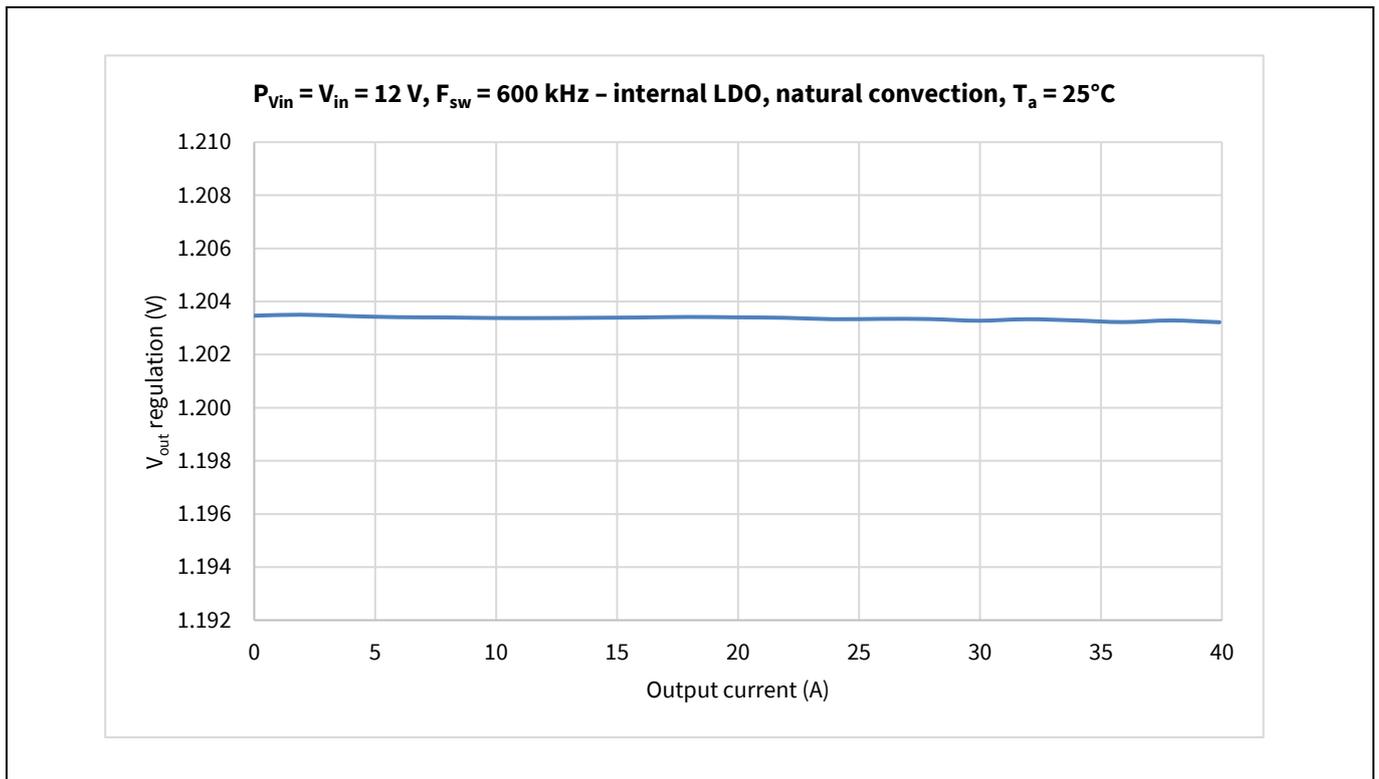


Figure 20 IR3846A  $V_{out}$  regulation (12  $V_{in}$ , 1.2  $V_{out}$ , 600 kHz,  $T_a = 25^\circ\text{C}$ , FCCM)

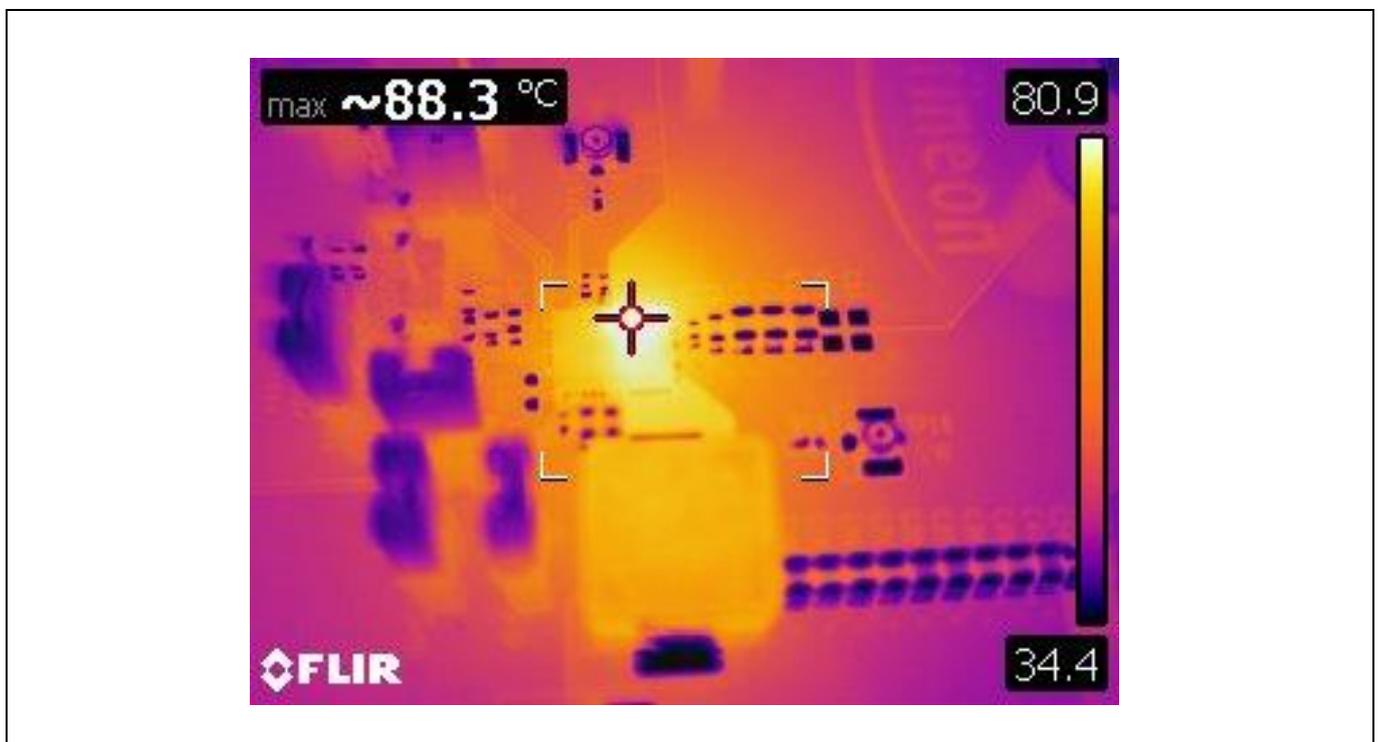


Figure 21 Thermal image of the board at 40 A load, IR3846A = 88.3°C,  $F_{sw} = 600\text{ kHz}$ ,  $T_a = \text{room temperature}$ , natural convection

## Revision history

Document version	Date of release	Description of changes
V 1.0	2022-07-28	Initial release

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