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

1. Board information

1.1 Board features

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

F_{sw} = 600 kHz

L = 150 nH (11.15 mm x 10 mm x 3.8 mm, DCR = 0.55 mΩ)

C_{in} = 1 x 2.2 nF (25 V, ceramic 0402) + 1 x 4.7 nF (25 V, ceramic 0603) + 8 x 22 µF (25 V, ceramic 0805) + 1 x 390 µF (20 V, electrolytic, optional)

C_{out} = 16 x 47 µF (6.3 V, ceramic 0805) + 1 x 4.7 µF (6.3 V, ceramic 0603) + 1 x 0.1 µF (50 V, ceramic 0402) + 2 x 470 µF (2.5 V, 3 mΩ, 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.

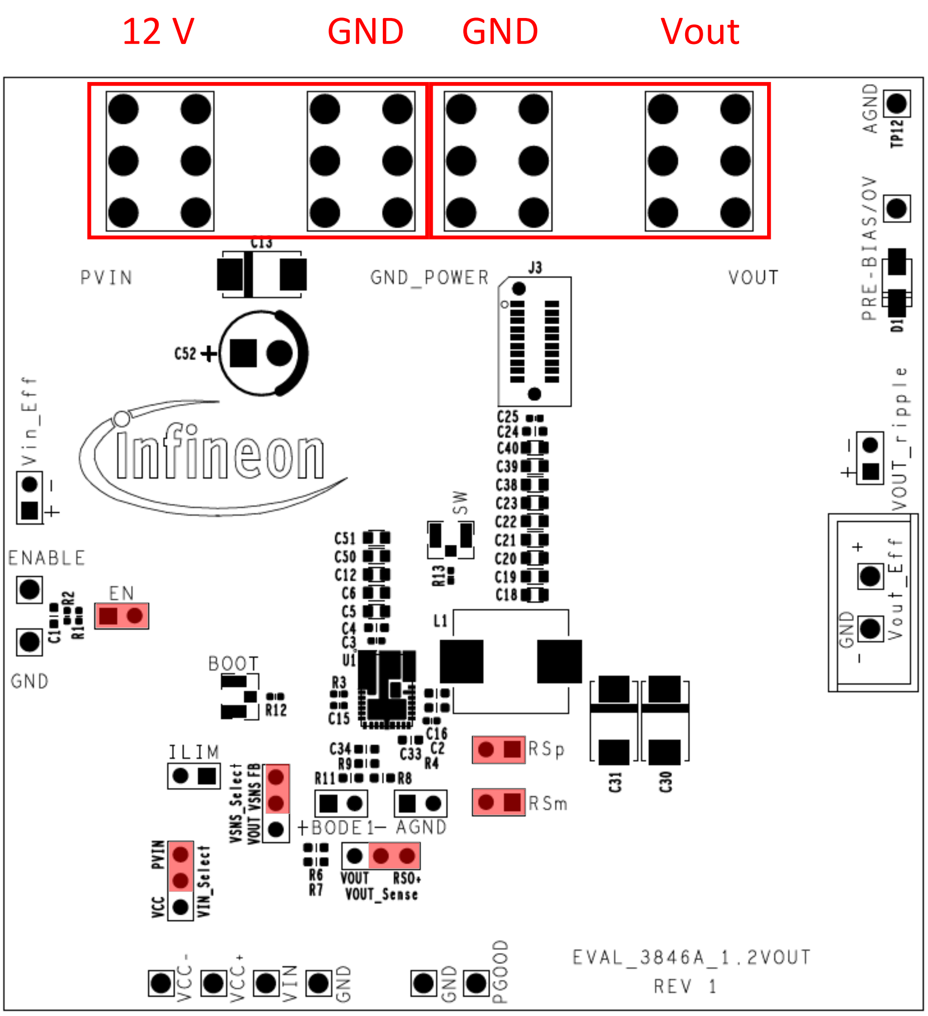


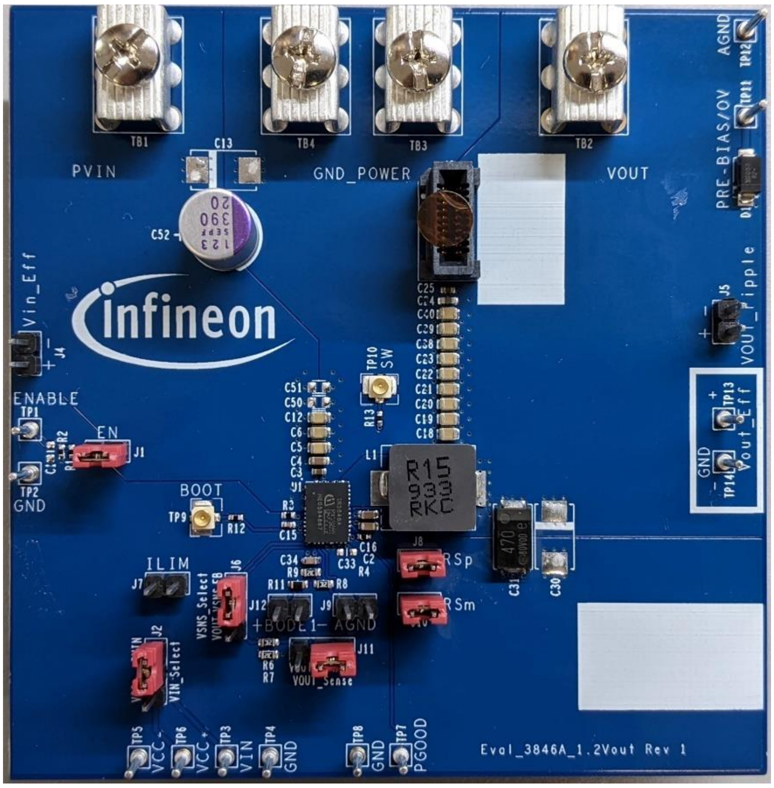
Figure 1 IR3846A evaluation board connections

Table 1 Connections

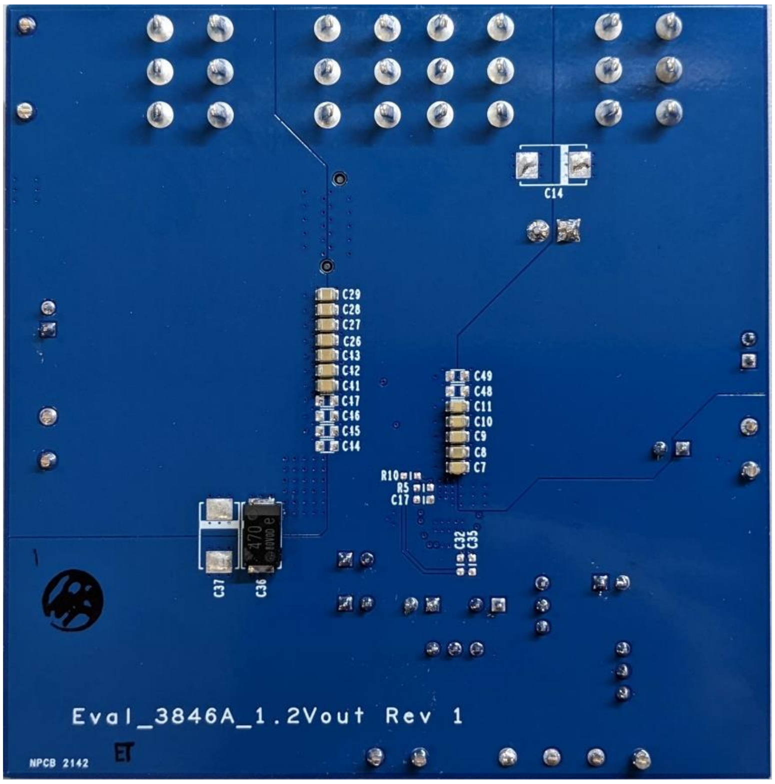
Label		Description
Input	PVIN	Connect input power (+12 V) to this pin
	PVIN_GND	Return of input power
	VIN_EFF	Sense pins for the input voltage
Output	VOUT	Connect a load (40 A max.) to this pin
	VOUT_GND	Return of V_{out}
	VOUT_EFF, GND	Sense pins for the output voltage, output voltage ripple
	VOUT_ripple	
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	RSp	Place jumper for pseudo-remote sensing and remove for single-ended sensing
RS_m	RSm	Place jumper for pseudo-remote sensing and remove for single-ended sensing
A_{GND}	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.



Top



Bottom

Figure 2 **Top and bottom view of IR3846A evaluation board**

1.4 PCB layout

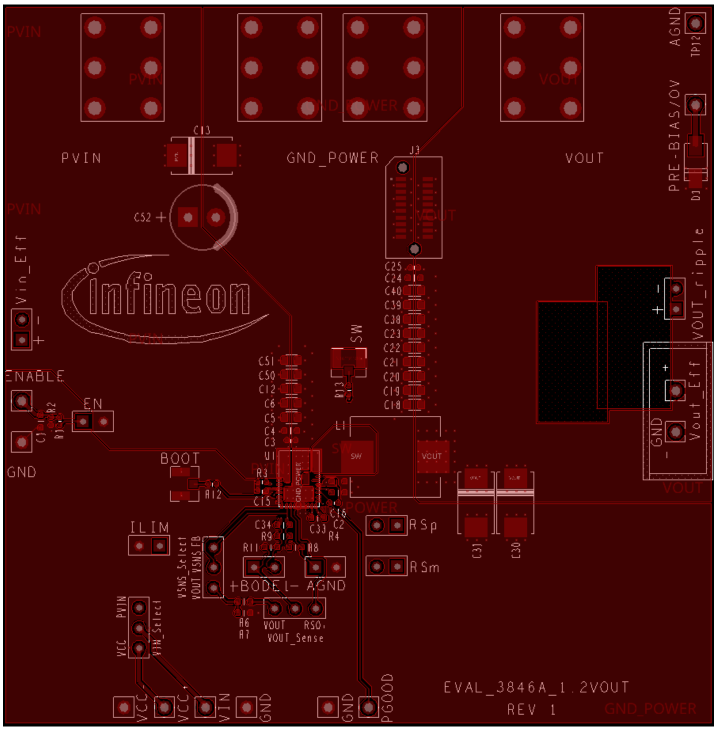


Figure 3 Top layer

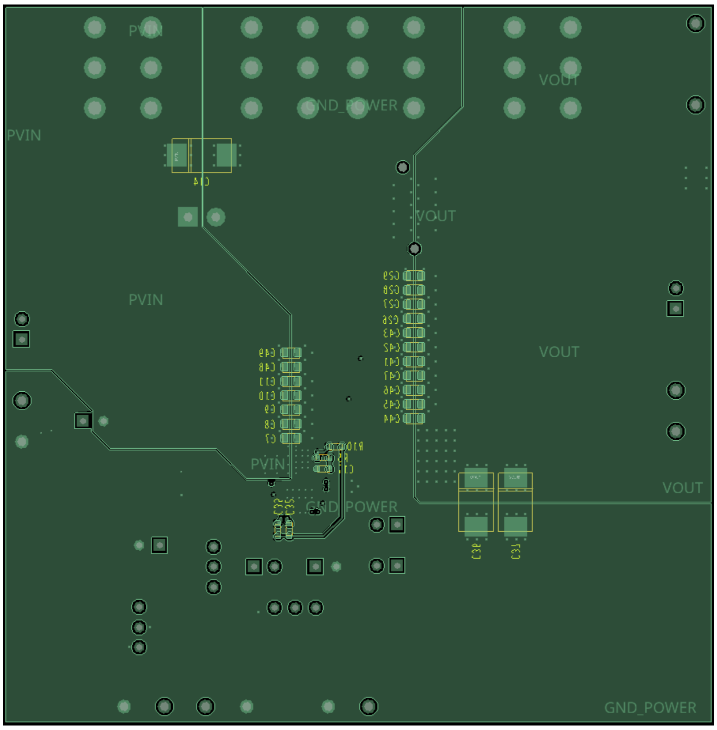


Figure 4 Bottom layer

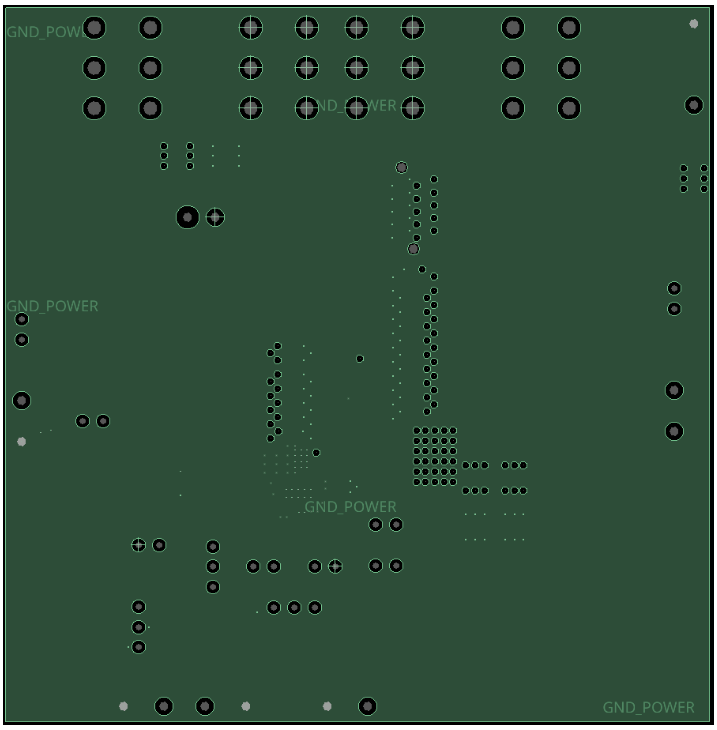


Figure 5 Mid layer 1

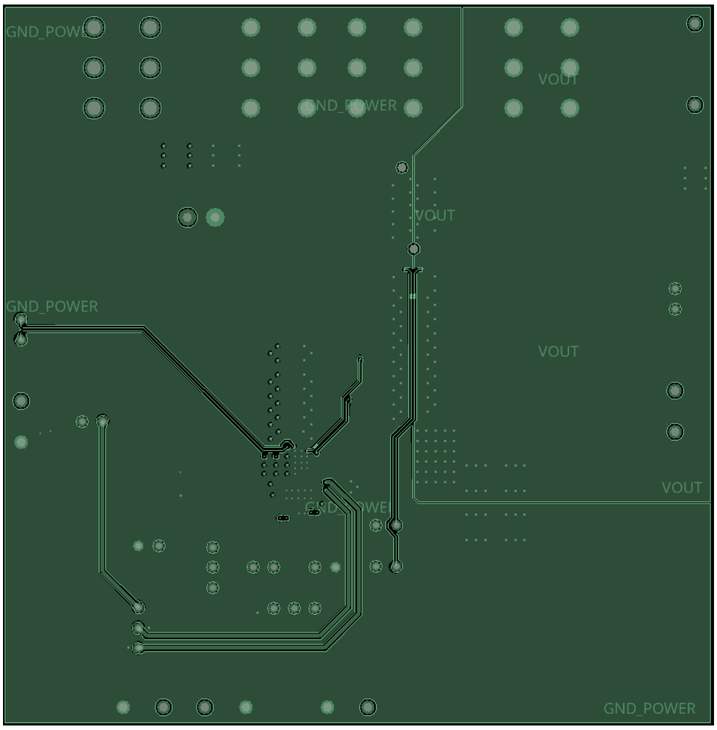


Figure 6 Mid layer 2

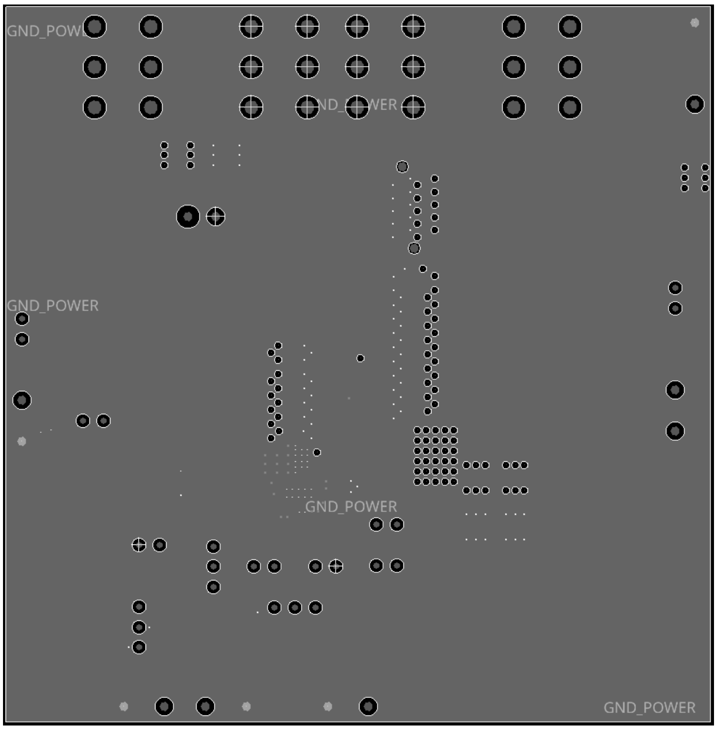


Figure 7 Mid layer 3

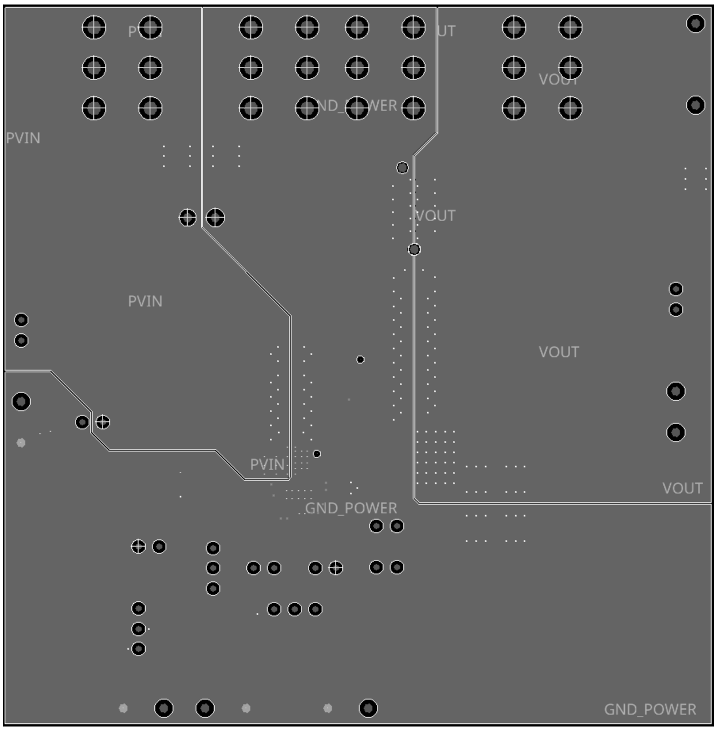


Figure 8 Mid layer 4

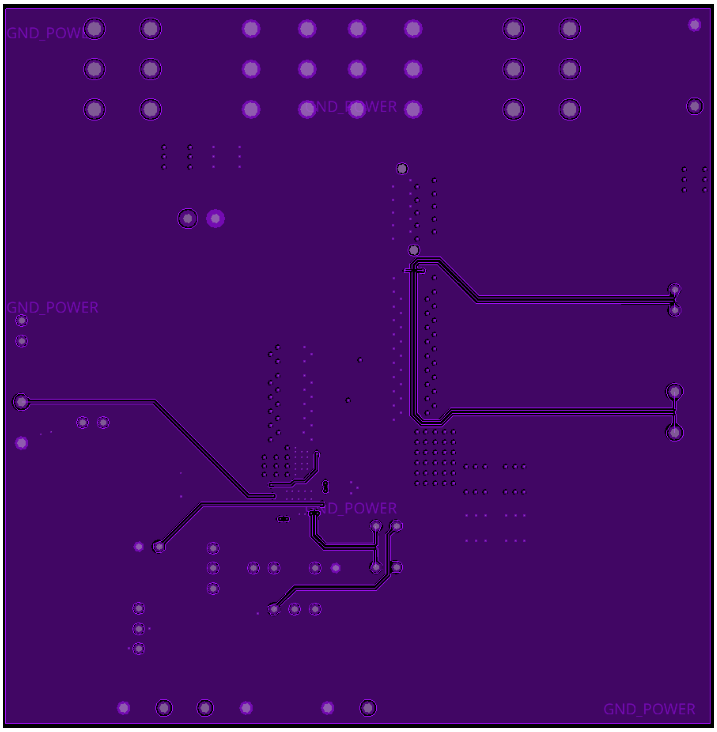


Figure 9 Mid layer 5

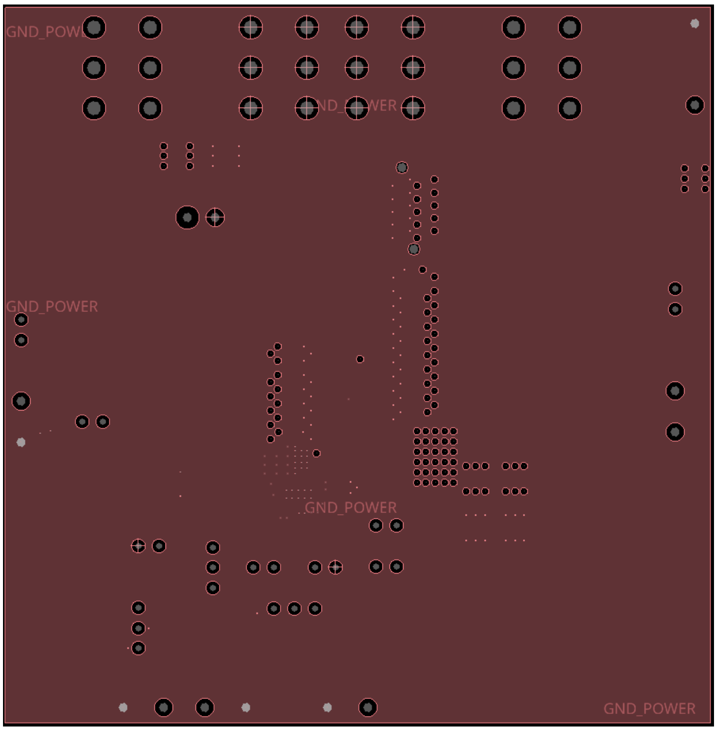


Figure 10 Mid layer 6

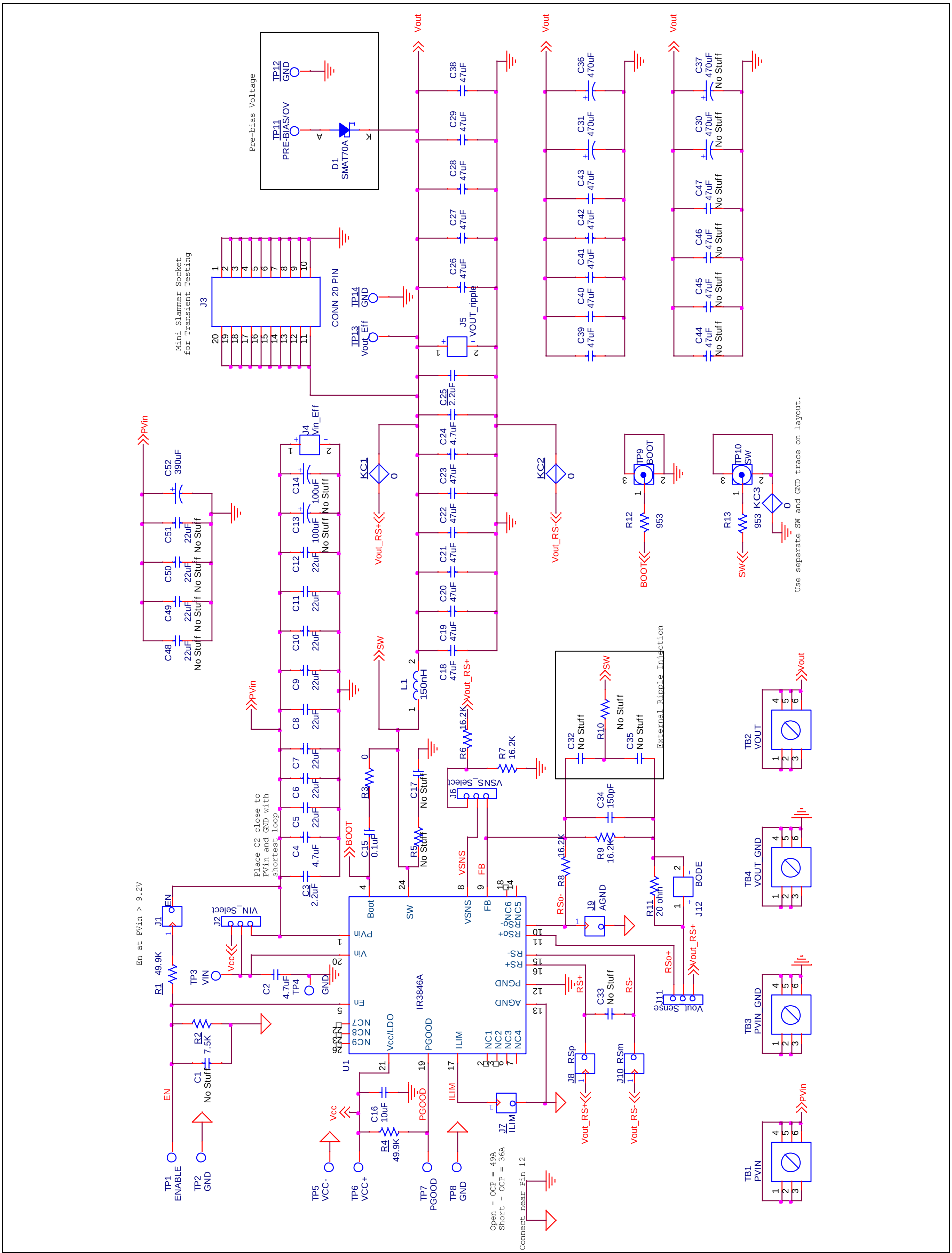


Figure 11 **Schematic of the EVAL_3846A_1.2V board V_{in} = 12 V, V_{out} = 1.2 V, I_{outmax} = 40 A**

1.5 Bill of materials

Table 2 Bill of materials

Qty	Reference	Value	Manufacturer	Part number	Description
2	C3, C25	2.2 µF	Murata	GRM155C81E225ME11D	2.2 µF, 0402, 25 V, X6S, 20%
1	C15	0.1 µF	TDK	C1005X7R1H104K050BB	0.1 µF, 0402, 50 V, X7R, 10%
2	C2, C4	4.7 µF	Murata	GRM188C81E475KE11	4.7 µF, 0603, 25 V, X6S, 20%
1	C16	10 µF	Murata	GRM188C81C106MA73	10 µF, 0603, 16 V, X6S, 20%
1	C24	4.7 µF	Samsung	CL10A475MQ8NNNC	4.7 µF, 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 µF	Murata	GRM21BR61E226ME44L	22 µF, 0805, 25 V, X5R, 20%
16	C18, C19, C20, C21, C22, C23, C26, C27, C28, C29, C38, C39, C40, C41, C42, C43	47 µF	TDK	C2012X5R0J476M	47 µF, 0805, 6.3 V, X5R, 20%
2	C31, C36	470 µF	Panasonic	EEF-GX0E471R	Aluminum polymer capacitor, 470 µF, 20%, 2.5 V, SMD
1	C52	390 µF	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 mΩ
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 Ω	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

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 V, V_{out} = 1.2 V, I_{out} = 0 to 40 A, room temperature with no airflow.

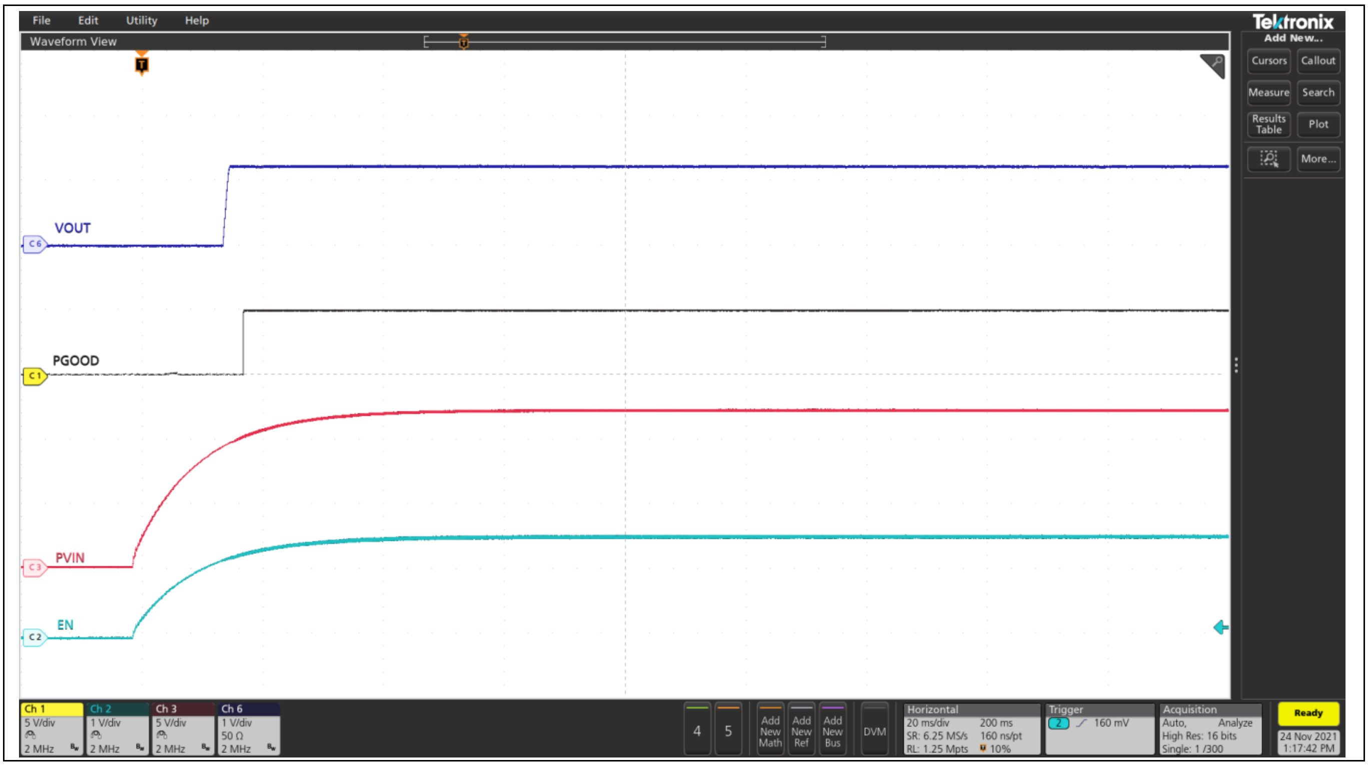


Figure 12 Start-up at 40 A load, (Ch1: P_{good}, Ch2: enable, Ch3: P_{Vin}, Ch6: V_{out})

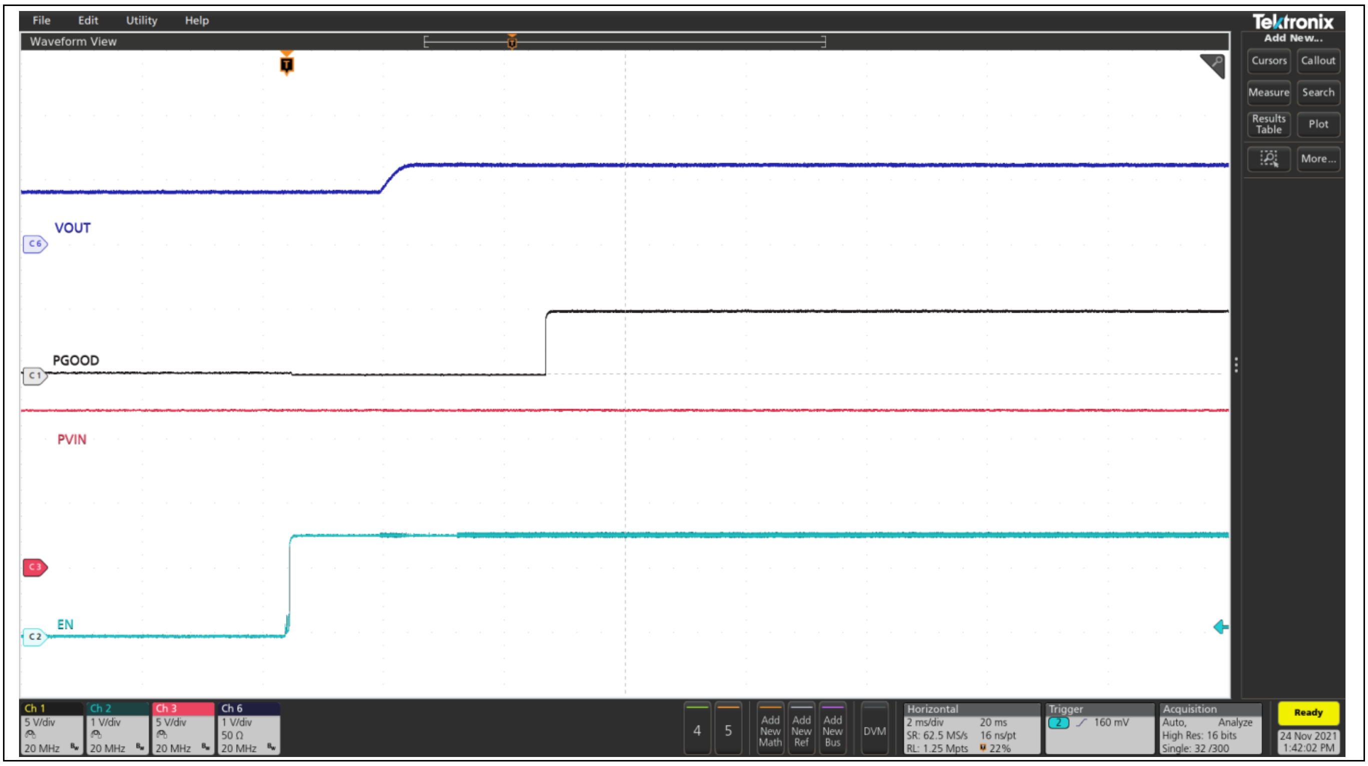


Figure 13 Pre-bias start-up at 0 A load, (Ch1: P_{good}, Ch2: enable, Ch3: P_{Vin}, Ch6: V_{out})

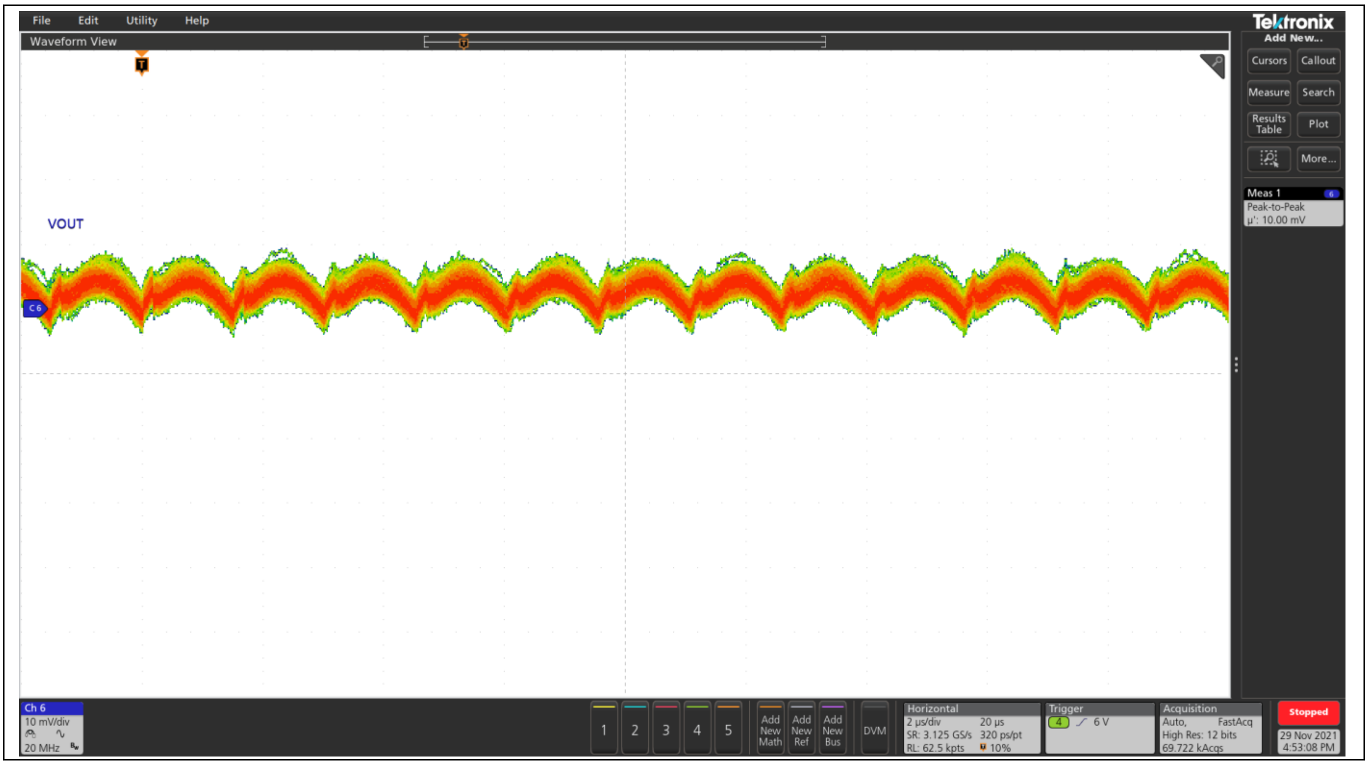


Figure 14 V_{out} ripple at 40 A load, f_{sw} = 600 kHz, (Ch6: V_{out})

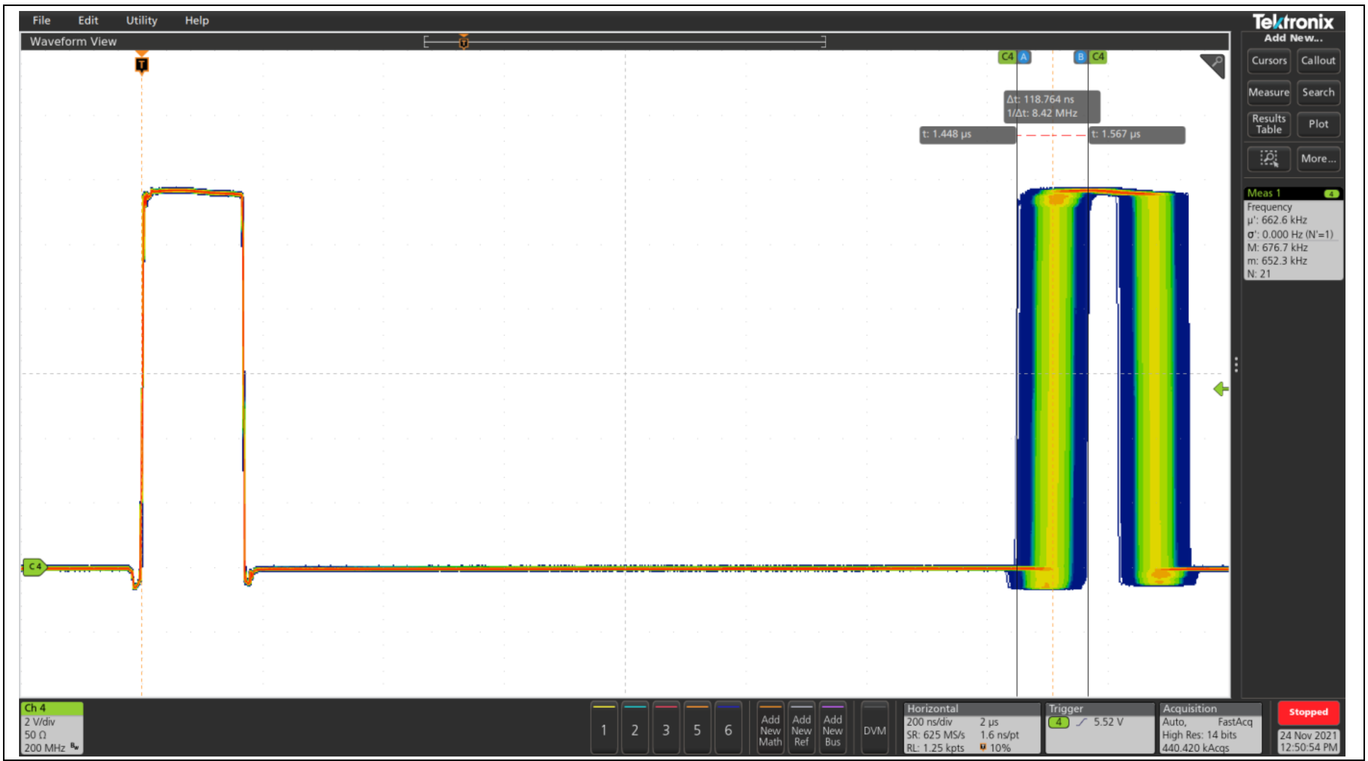


Figure 15 SW node, 40 A load, f_{sw} = 600 kHz, (Ch4: SW)

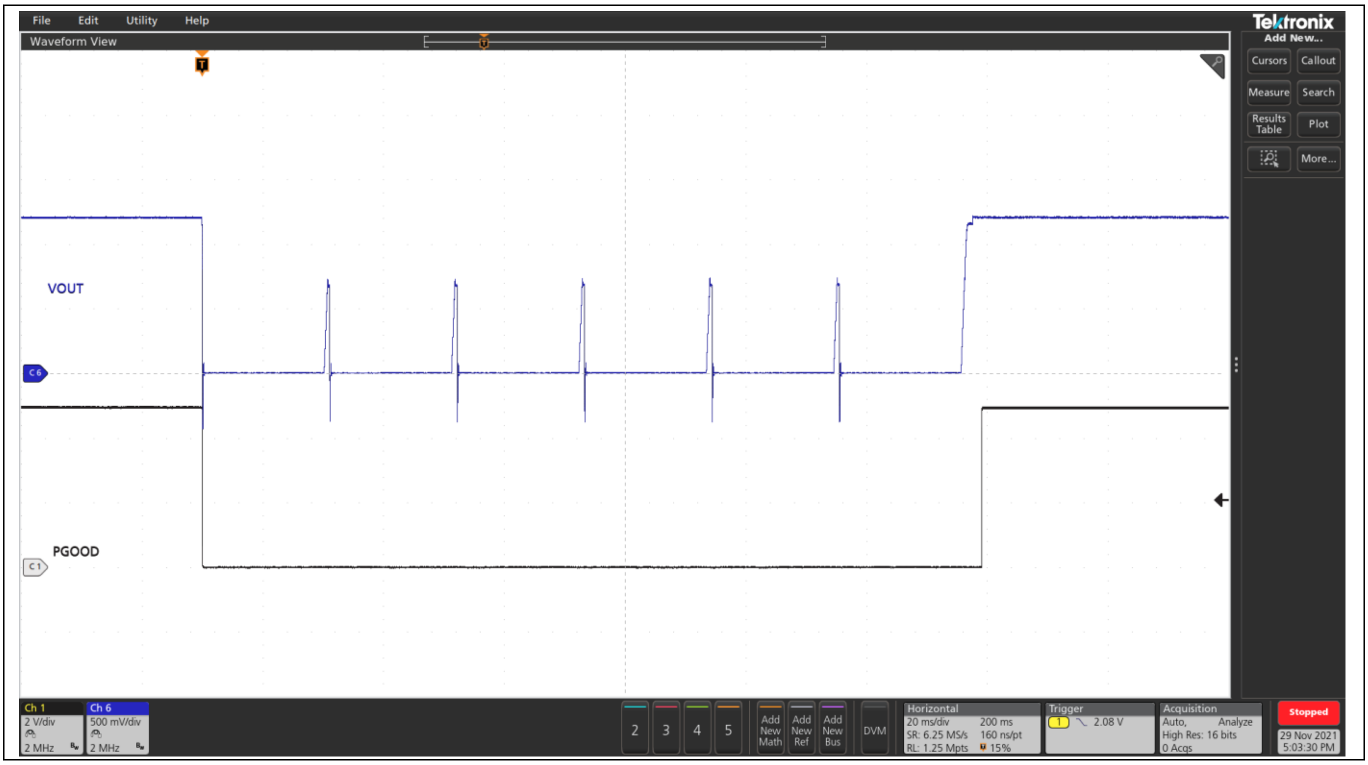


Figure 16 **Short-circuit and UVP (hiccup and recovery), (Ch1: P_{good}, Ch6: V_{out})**

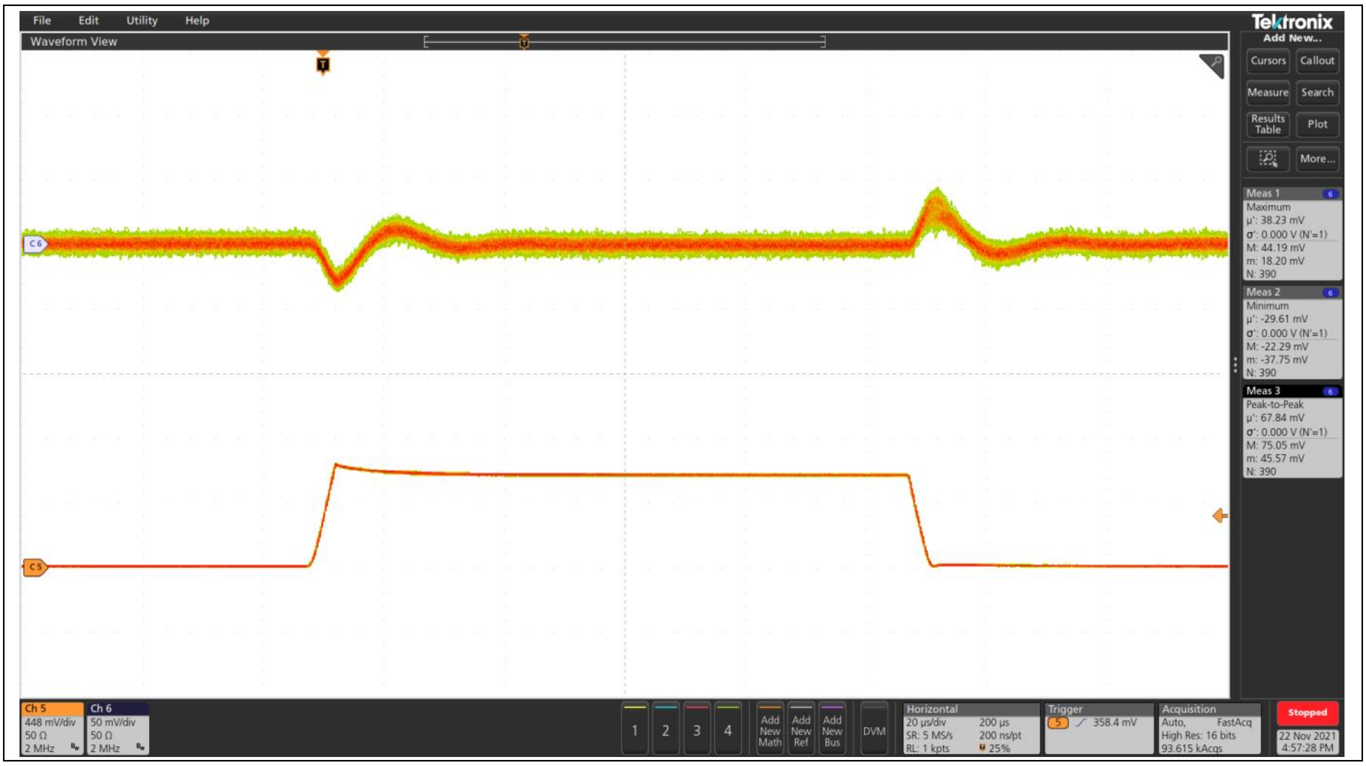


Figure 17 **Transient response at 12 A step load current at 2.5 A/µs: I_{out} = 24 A – 36 A, (Ch6: V_{out}, Ch5: I_{out}), pk-pk: 67.84 mV, f_{sw} = 600 kHz**

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/µs. A static load of 24 A was applied using the DC electronic load.*

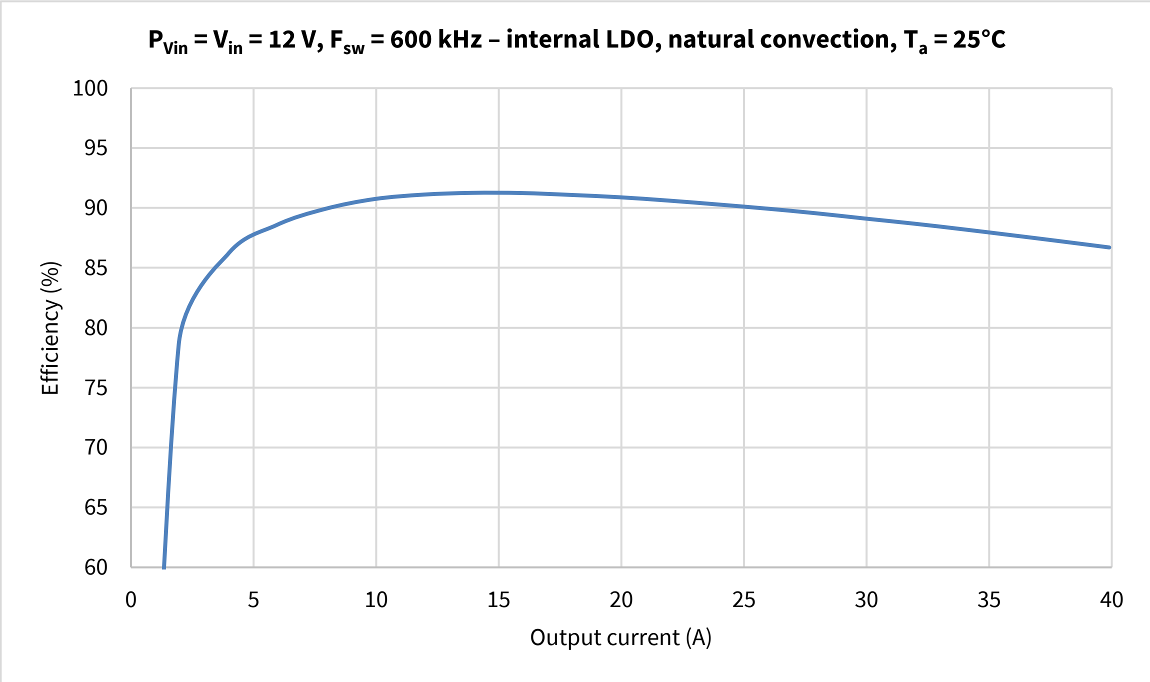


Figure 18 Efficiency vs. load current – natural convection (12 V_{in}, 1.2 V_{out}, 600 kHz, $T_a = 25°C$, FCCM)

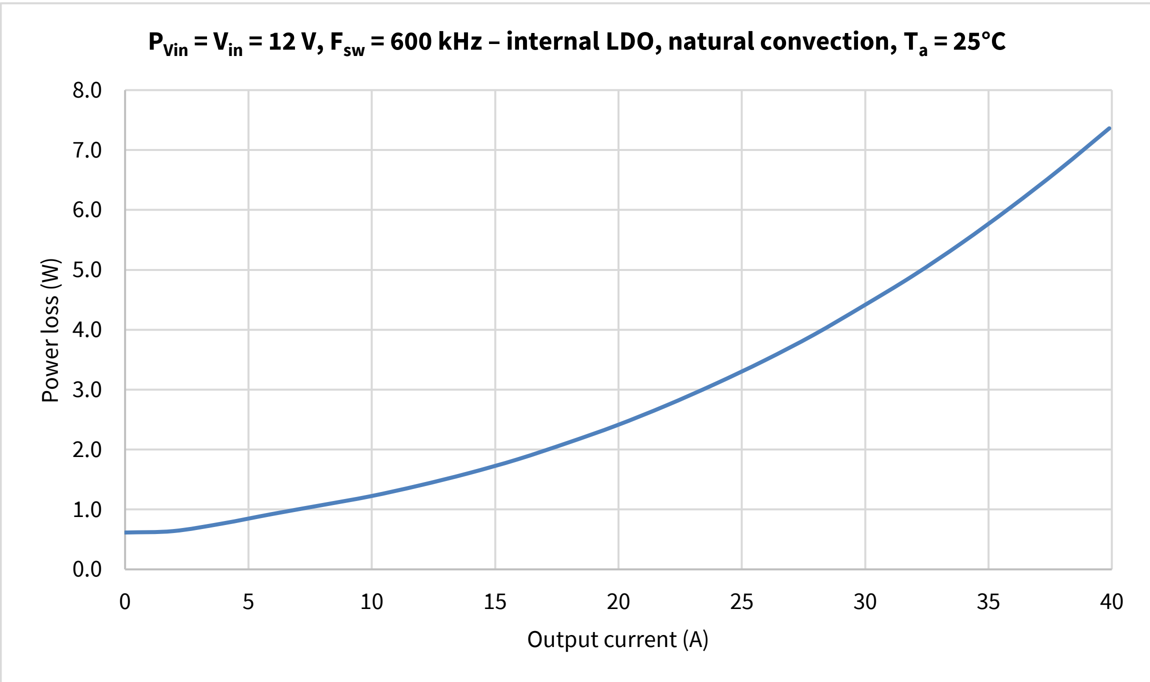


Figure 19 Power loss vs. load current – natural convection (12 V_{in}, 1.2 V_{out}, 600 kHz, $T_a = 25°C$, FCCM)

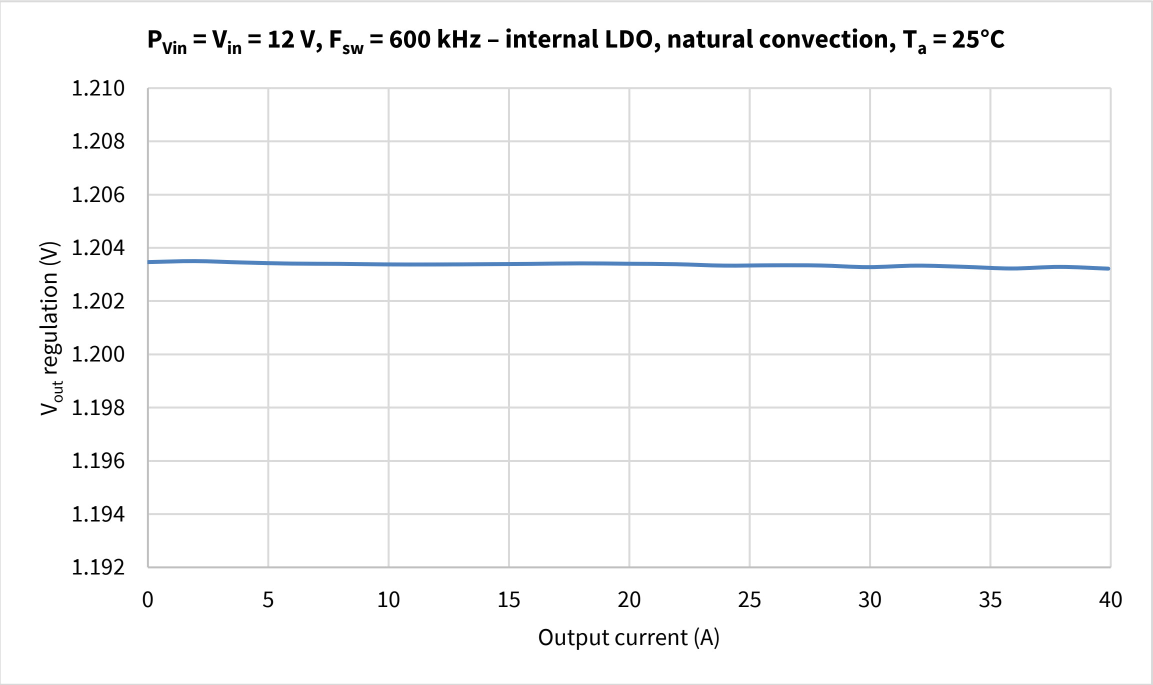


Figure 20 IR3846A V_{out} regulation (12 V_{in}, 1.2 V_{out}, 600 kHz, T_a = 25°C, FCCM)

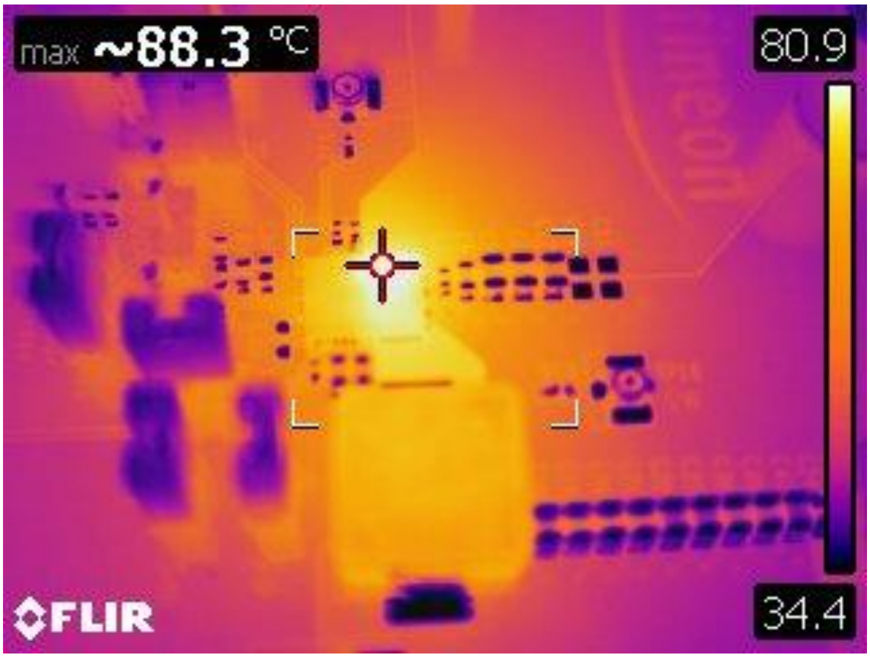


Figure 21 Thermal image of the board at 40 A load, IR3846A = 88.3°C, F_{sw} = 600 kHz, T_a = room temperature, natural convection

Revision history

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

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Edition 2022-07-28

Published by

Infineon Technologies AG

81726 Munich, Germany

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Email: erratum@infineon.com

Document reference
UM_2111_PL12_2112_225839