User manual for IR3889 evaluation board

30 A single-phase buck regulator with 3.3 V output

About this document

Scope and purpose

The IR3889 is a synchronous buck converter, providing a compact, high-performance and flexible solution in a small 5 mm x 6 mm power QFN package.

Key features offered by the IR3889 include internal digital soft-start, precision 0.8 V reference voltage, Power Good (P_{Good}), thermal protection, programmable switching frequency, enable input, input Under-Voltage Lockout (UVLO) for proper start-up, latched off or unlatched overvoltage Protection (OVP) and pre-bias start-up.

The 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 guide contains the schematic and bill of materials (BOM) for the EVAL_3889_3.3Vout engineering evaluation board. The guide describes operation and use of the evaluation board itself. Detailed application information for IR3889 is available in the IR3889 datasheet.

Intended audience

This document is intended as a guide for design engineers evaluating IR3889 performance with the engineering EVAL_3889_3.3Vout demo board.

Table of contents

1 Board information

1.1 Board features

V_{in} = +12 V

V_{out} = +3.3 V at 0 to 30 A

F_s = 600 kHz/800 kHz

L = 470 nH (12.5 mm x 13 mm x 9 mm, DCR = 0.165 mΩ)

C_{in} = 10 x 22 µF (25 V, ceramic 0805) + 1 x 330 µF (25 V, electrolytic, optional)

C_{out} =10 x 47 µF (6.3 V, ceramic 0805)

1.2 Connections and operating instructions

The IR3889 demo board requires a single +12 V for the input power and can deliver up to 30 A load current. The operation modes and OCP limits can be selected through jumpers.

Table 1 Connections

Label		Description
Input	PV_{in}	Connect input power (+12 V) to this pin
	GND	Return of input power
	PV_{in}, GND	Sense pins for the input voltage
Output	V_{out}	V_{out} (+5 V), connect a load (30 A max.) to this pin
	GND	Return of V_{out}
	V_{out}, GND	Sense pins for the output voltage
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 over-drive the on-board enable signal
	GND	
Bode	A	For bode plot measurement
	B	
SS/Latch	OVP latch	Use a jumper to select one of four soft-start time selections (1 ms, 2 ms, 4 ms and 8 ms), and latched OVP or unlatched OVP
	OVP no latch	
Ton/Mode	FCCM	Use a jumper to select FCCM or DEM, and switching frequency. The available switching frequencies are 600 kHz, 800 kHz, 1000 kHz and 1200 kHz
	DEM	
ILIM		Use a jumper to select one of four OCP limits. OCP1 is the lowest OCP limit and OCP4 is the highest OCP limit
P_{Good}	P_{Good}	Connect a scope probe to this pin to monitor Power Good signal
	GND	GND
	EPGb	External P_{Good} pull-up bias pin. P_{Good} pin is pulled up to V_{CC} through R4 on the standard demo board. By removing R4 and populating R42 with 49.9 kΩ, an external P_{Good} pull-up bias can be applied to the EPGb pin
V_{CC}	V_{CC}	Standard demo board is configured to use the internal LDO. Connect a scope probe to this pin to monitor the output of the internal LDO
	GND	

1.3 Layout

The PCB is a six-layer board (3.0" x 3.75") using FR4 material. Top and bottom layers use 1.5 oz. copper and inner layers use 2 oz. copper. The PCB thickness is 0.062". The IR3889 and other major power components are mounted on the top side of the board.

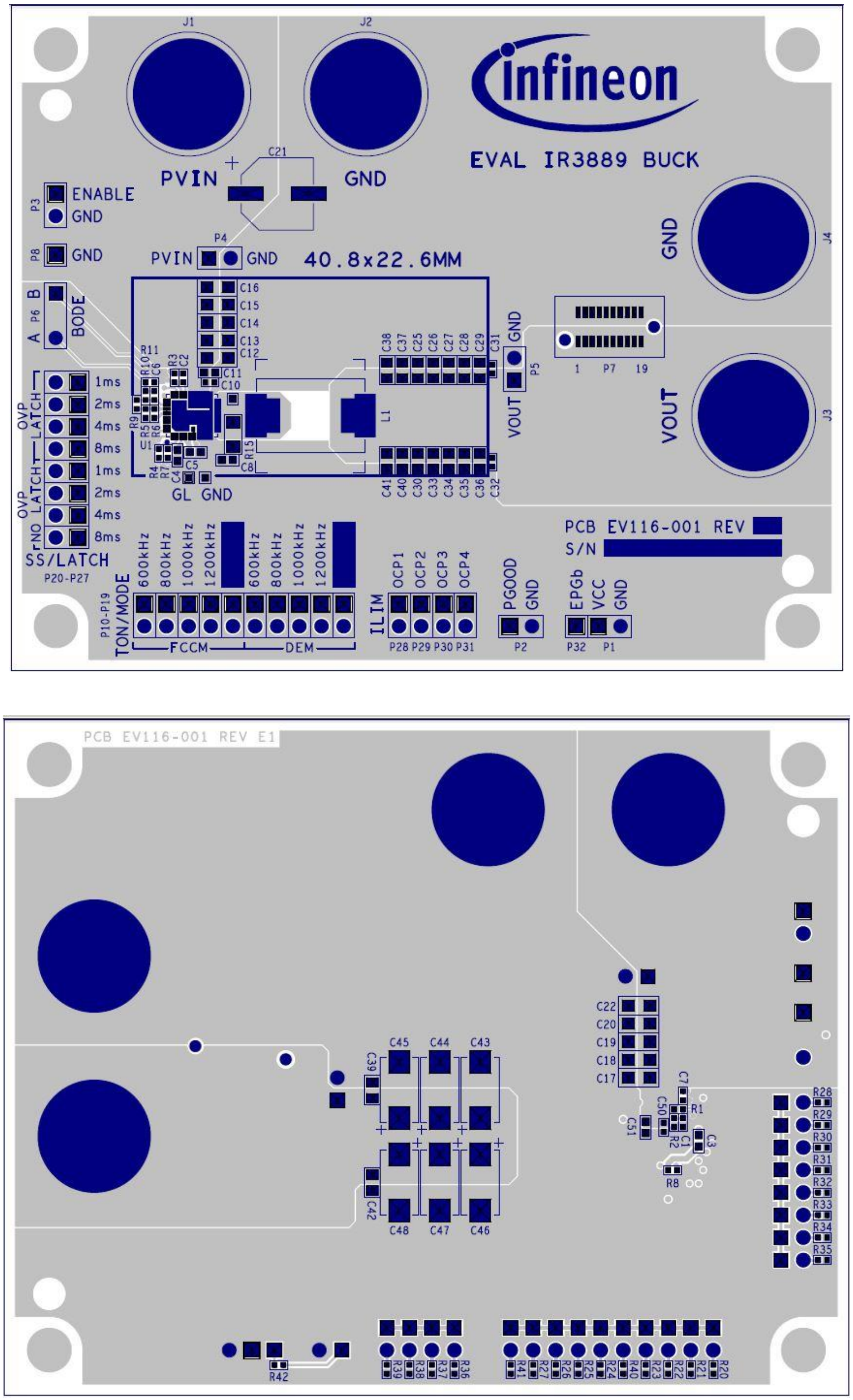


Figure 1 Top and bottom view of the IR3889 evaluation board

1.4 PCB layout

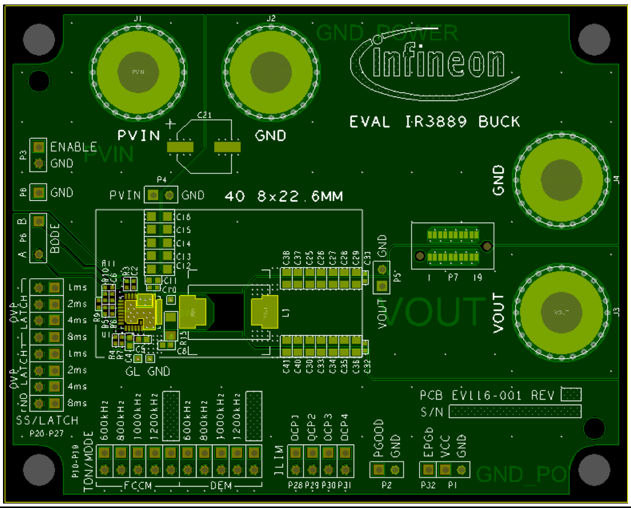


Figure 2 **Top layer**

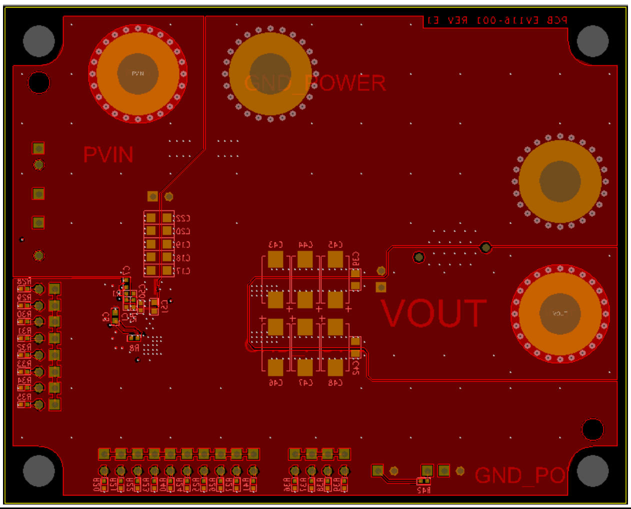


Figure 3 **Bottom layer**

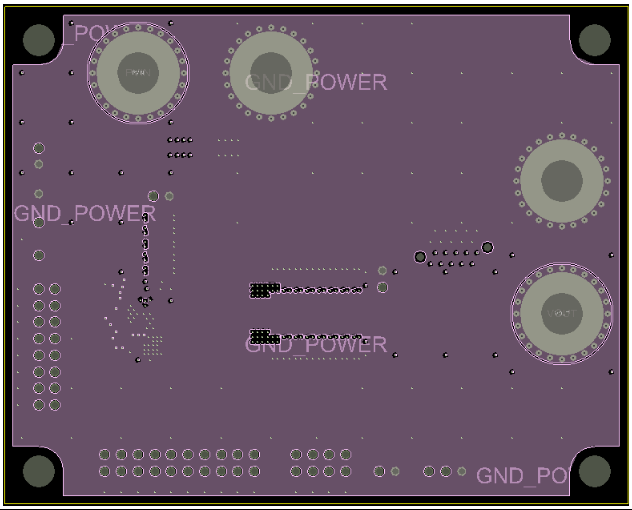


Figure 4 **Mid layer 1**

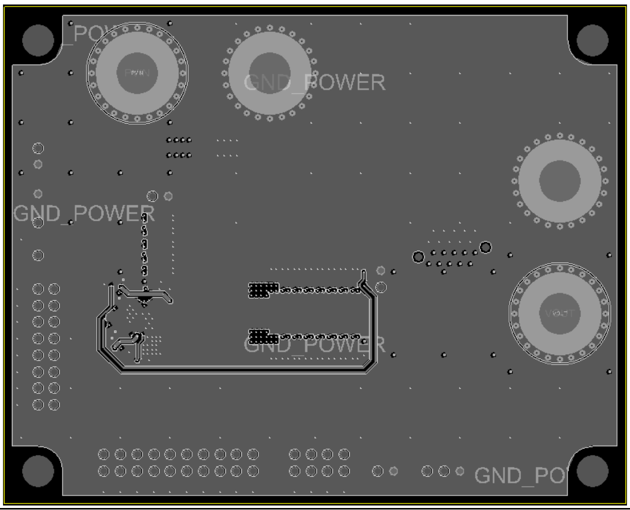


Figure 5 Mid layer 2

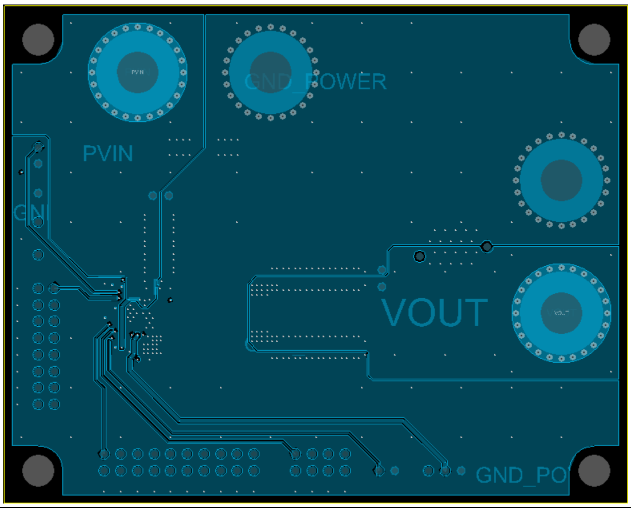


Figure 6 Mid layer 3

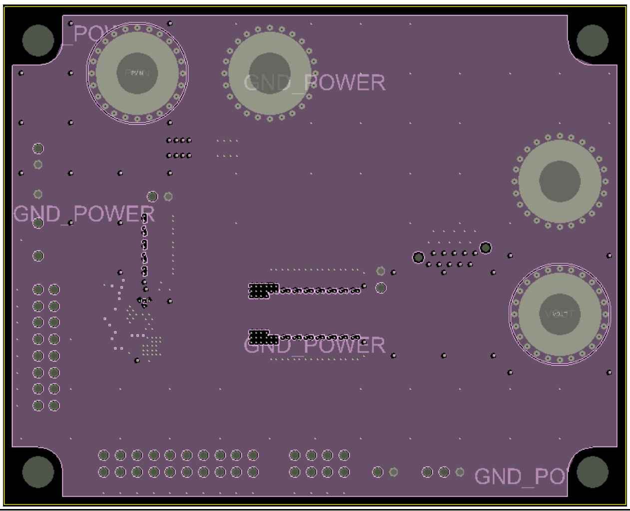


Figure 7 Mid layer 4

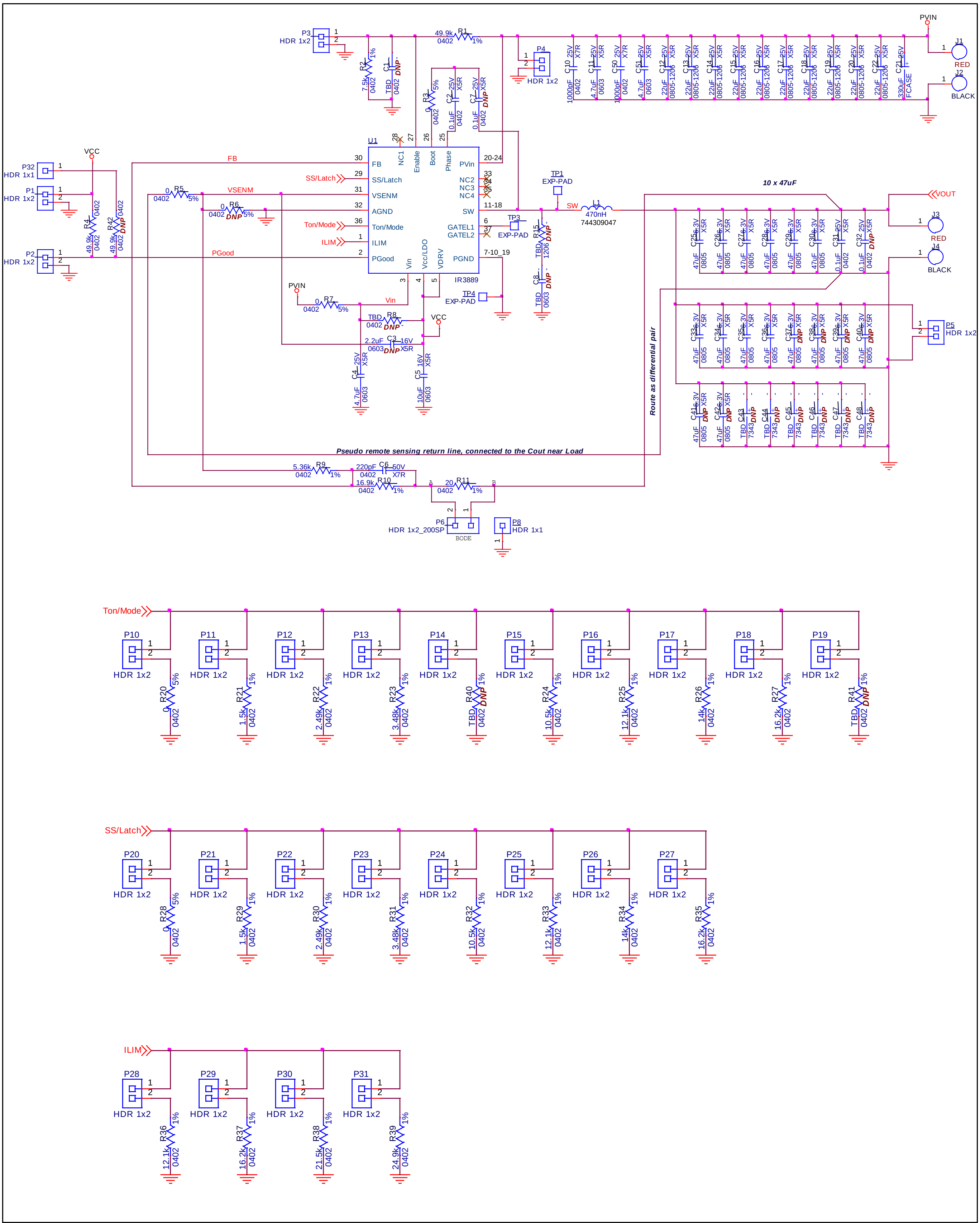


Figure 8 **Schematic of the IRDC3889 evaluation board V_{in} = 12 V, V_{out} = 3.3 V, I_{outmax} = 30 A, fsw = 600 kHz/800 kHz**

1.5 Bill of materials (BOM)

Table 2 BOM

Item	Qty.	Reference	Value	Manufacturer	Part number	Description
1	3	C2, C31, C32	0.1 µF	Murata	GRM155R71E104KE14J	Ceramic capacitor 0.1 µF 25 V 10% X7R 0402
2	3	C4, C11, C51	4.7 µF	Murata	GRM188R61E475KE15D	Ceramic capacitor 4.7 µF 25 V 10% X5R 0603
3	1	C5	2.2 µF	Murata	GRM188R61C225KE15D	Ceramic capacitor 2.2 µF 16 V 10% X5R 0603
4	1	C6	220 pF	Murata	GRM155R71H221KA01D	Ceramic capacitor 220 pF 50 V 10% X7R 0402
5	2	C10, C50	1000 pF	Murata	GRM155R61E102KA01D	Ceramic capacitor 1000 pF 25 V 10% X5R 0402
6	10	C12, C13, C14, C15, C16, C17, C18, C19, C20, C22	22 µF	Murata	GRM21BR61E226ME44L	Ceramic capacitor 22 µF 25 V 20% X5R 0805
7	1	C21	330 µF	Panasonic	PCE3410CT-ND	Aluminum capacitor 330 µF 20% 25 V SMD
8	10	C25, C26, C27, C28, C29, C36, C30, C33, C34, C35	47 µF	TDK	C2012X5R0J476M125AC	Ceramic capacitor 47 µF 6.3 V 20% X5R 0805
9	1	L1	470 nH	Wurth	744309047	Inductor 470 nH I_{sat} = 40.5 A 12.5 mm x 13 mm x 9 mm DCR = 0.165 mΩ SMD
10	2	R1, R4	49.9 k	Panasonic	ERJ-2RKF4992X	RES 49.9 kΩ 1/10 W 1% 0402 SMD
11	1	R2	7.5 k	Panasonic	ERJ-2RKF7501X	RES 7.50 kΩ 1/10 W 1% 0402 SMD
12	1	R38	21.5 k	Panasonic	ERJ-2RKF2152X	RES 21.5 kΩ 1/10 W 1% 0402 SMD

13	5	R3, R5, R7, R20, R28	0	Panasonic	ERJ-2GE0R00X	RES 0.0 Ω 1/10 W 0402 SMD
14	3	R27, R35, R37	16.2 k	Panasonic	ERJ-2RKF1622X	RES 16.2 kΩ 1/10 W 1% 0402 SMD
15	1	R9	5.36 k	Panasonic	ERJ-2RKF5361X	RES SMD 5.36 kΩ 1/10 W 1% 0402
16	1	R10	16.9 k	Panasonic	ERJ-2RKF1692X	RES 16.9 kΩ 1/10 W 1% 0402 SMD
17	1	R11	20	Vishay Dale	CRCW040220R0FKED	RES 20.0 Ω 1/16 W 1% 0402 SMD
18	2	R21, R29	1.5 k	Panasonic	ERJ-2GEJ152X	RES SMD 1.5 kΩ 1/10 W 5% 0402
19	2	R22, R30	2.49 k	Vishay Dale	CRCW04022K49FKED	RES 2.49K OHM 1/16W 1% 0402 SMD
20	2	R23,R31	3.48 k	Vishay Dale	CRCW04023K48FKED	RES 3.48 kΩ 1/16 W 1% 0402 SMD
21	2	R24, R32	10.5 k	Panasonic	ERJ-2RKF1052X	RES 10.5 kΩ 1/10 W 1% 0402 SMD
22	3	R25, R33, R36	12.1k	Panasonic	ERJ-2RKF1212X	RES 12.1 kΩ 1/10 W 1% 0402 SMD
23	2	R26, R34	14k	Panasonic	ERJ-2RKF1402X	RES 14.0 kΩ 1/10 W 1% 0402 SMD
24	1	R39	24.9 k	Panasonic	ERJ-2RKF2492X	RES 24.9 kΩ 1/10 W 1% 0402 SMD
25	1	U1	IR3889	Infineon	IR3889	30 A single-input voltage, synchronous buck regulator

2 Typical operating waveforms

V_{in} = 12.0 V, V_{out} = 3.3V, I_{out} = 0 to 30 A, room temperature, no air-flow.

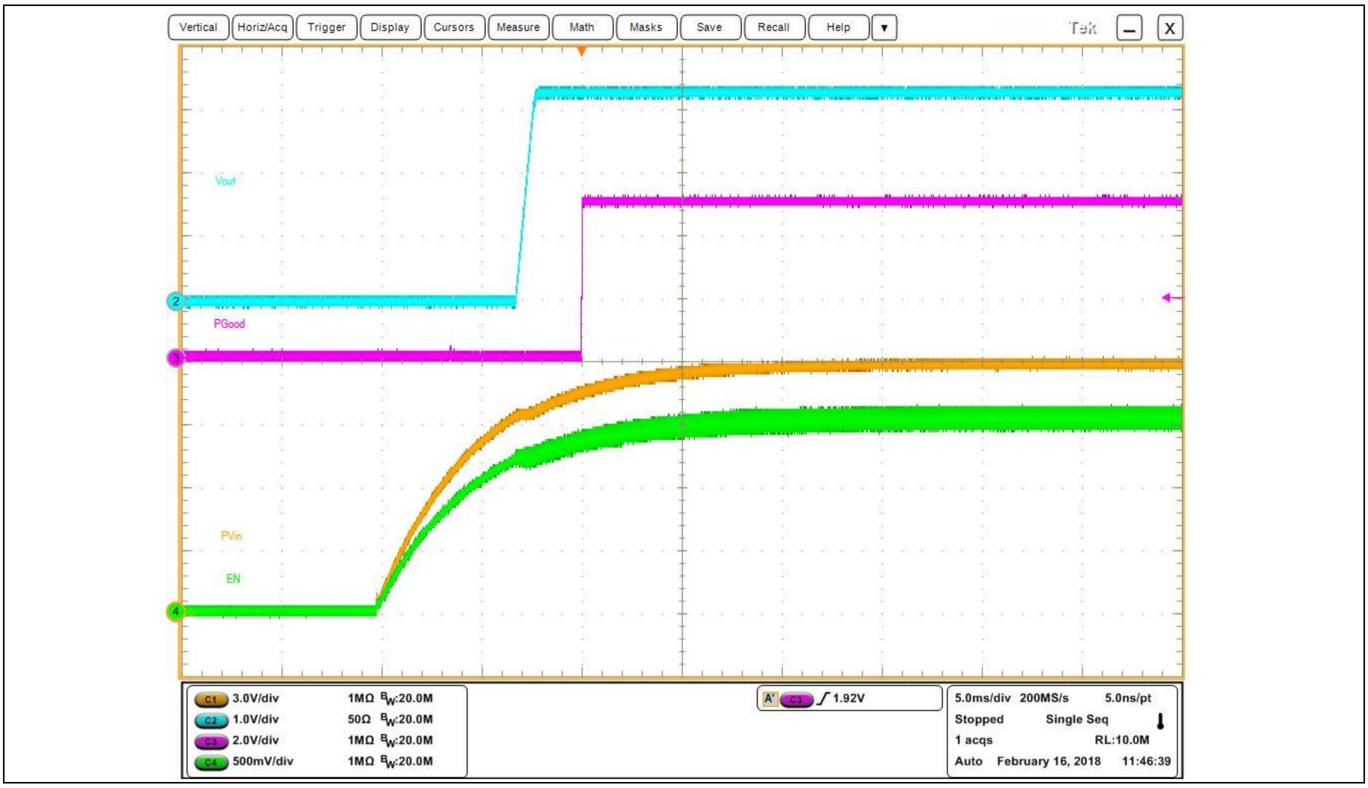


Figure 9 Start-up at 30 A load, (Ch1: PV_{in}, Ch2: V_{out}, Ch3: P_{Good} , Ch4: enable)

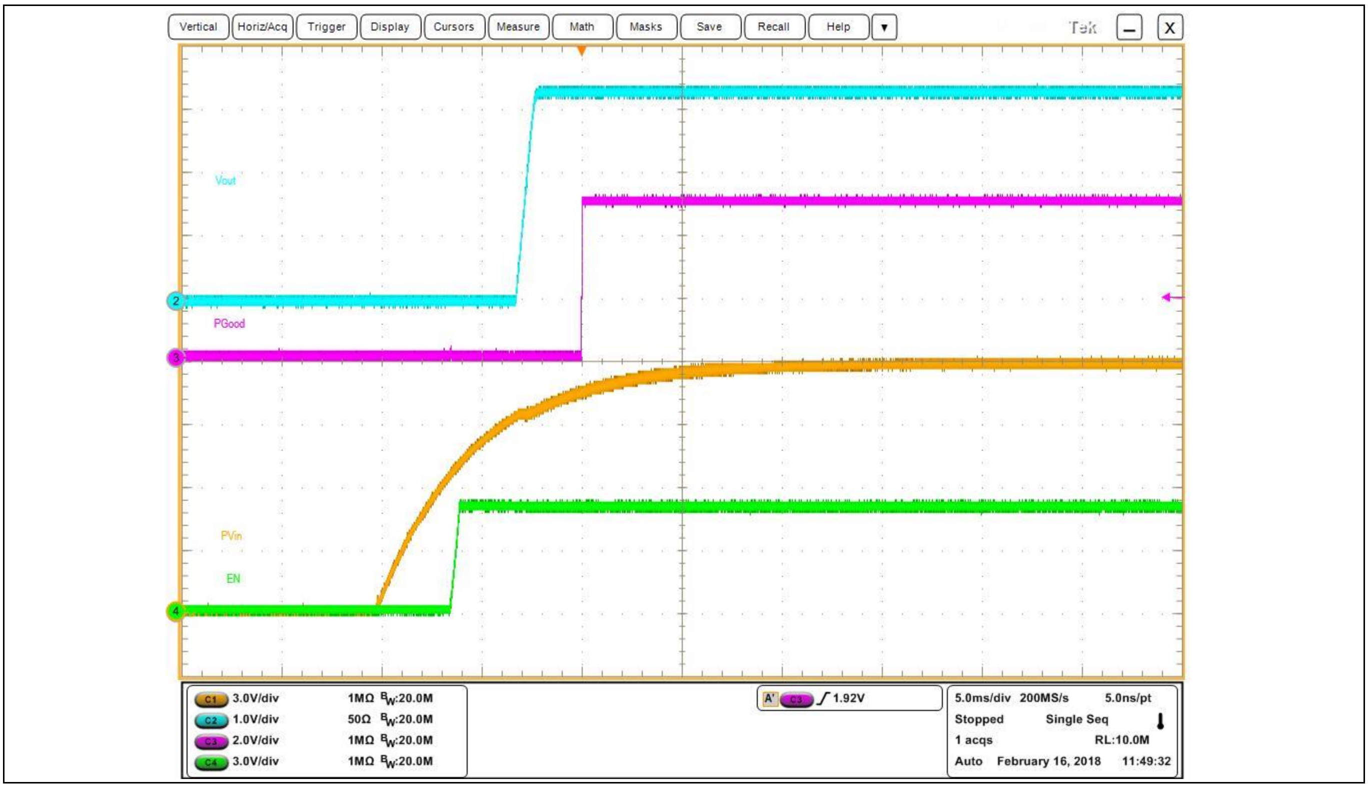


Figure 10 Start-up at 30 A load (Ch1: PV_{in}, Ch2: V_{out}, Ch3: P_{Good}, Ch4: V_{cc})

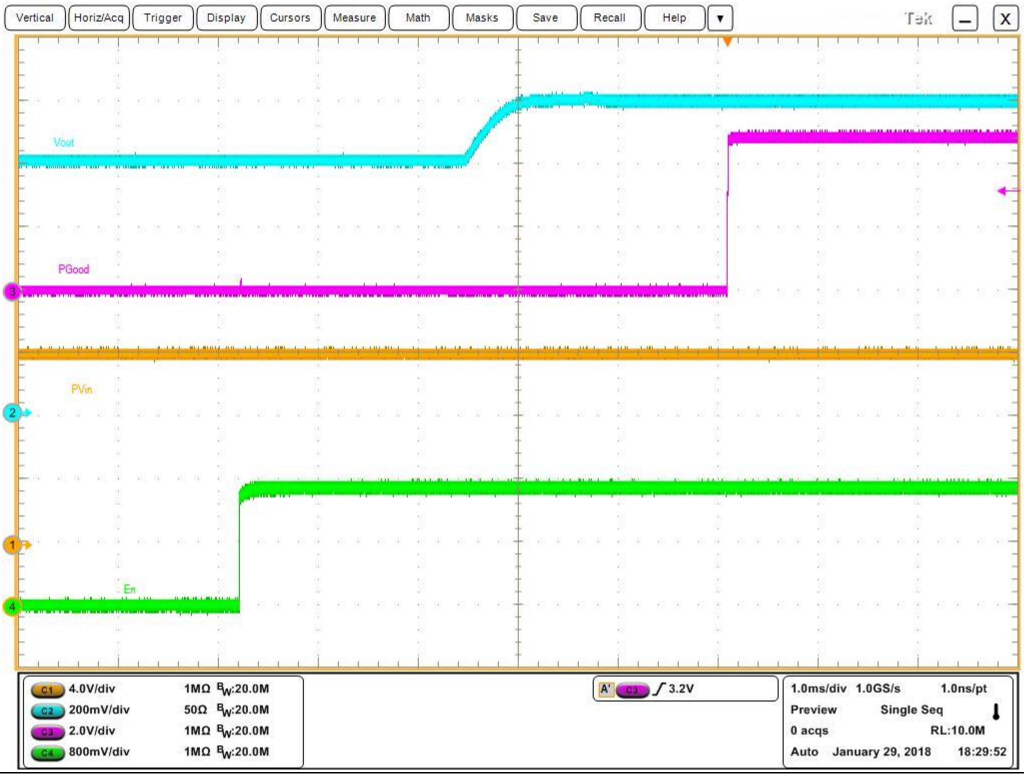
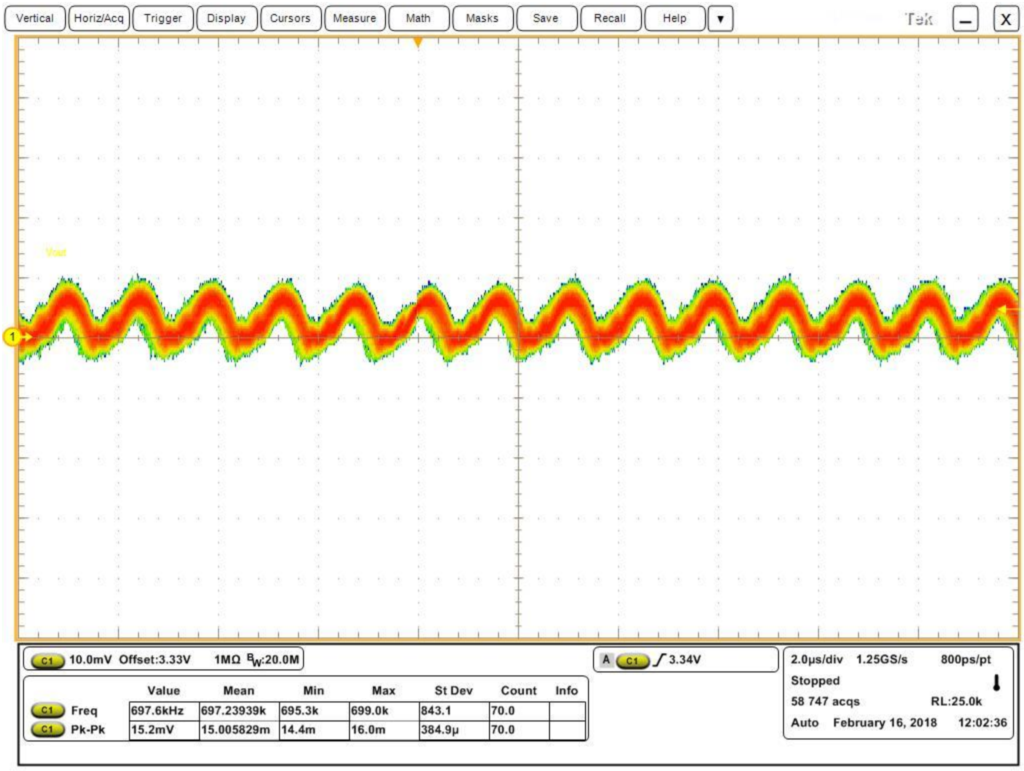
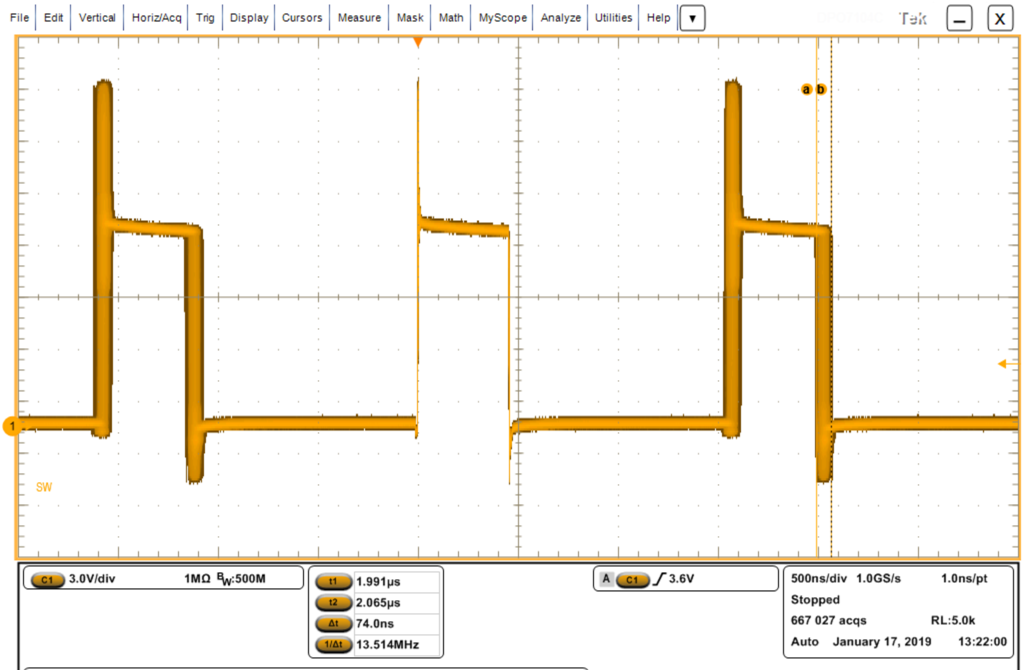


Figure 11 Pre-bias start-up at 0 A load (Ch_1: PV_{in}, Ch_2: V_{out}, Ch_3: P_{Good}, Ch_4: enable)



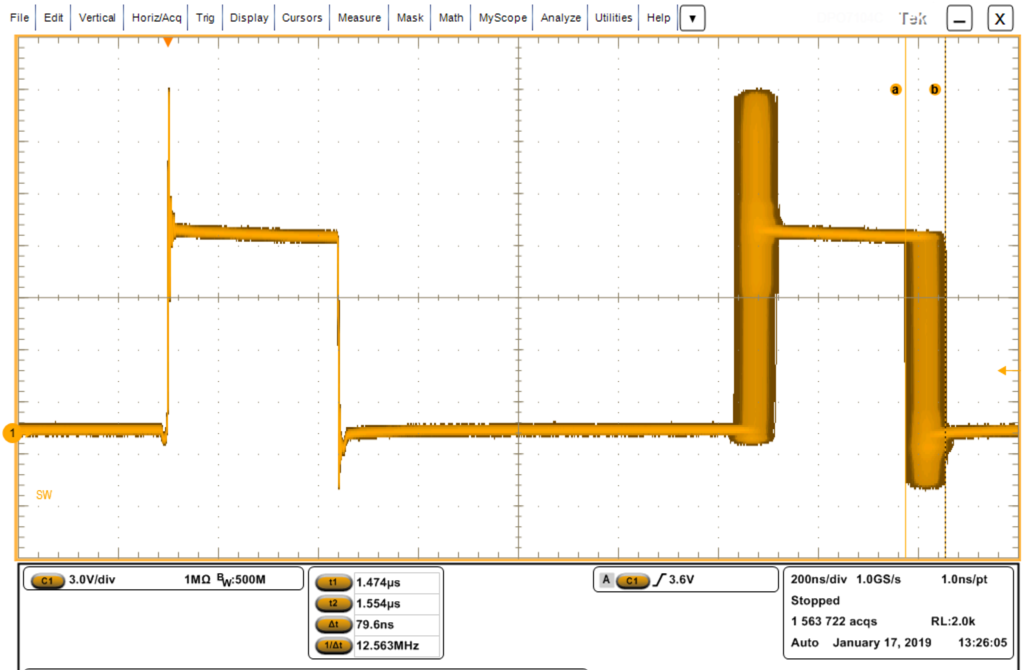
	Value	Mean	Min	Max	St Dev	Count	Info
C1 Freq	697.6kHz	697.23939k	695.3k	699.0k	843.1	70.0	
C1 Pk-Pk	15.2mV	15.005829m	14.4m	16.0m	384.9µ	70.0	

Figure 12 V_{out} ripple at 30 A load, fsw = 600 kHz (Ch_1: V_{out})



	Value	Mean	Min	Max	St Dev	Count	Info
C1 Min	-3.36V	-3.3480343	-5.76	1.2	300.6m	182.0	
C1 Max	20.04V	19.869161	8.16	20.16	925.6m	182.0	
C1 Freq	627.4kHz	627.16262k	333.9k	631.2k	7.086k	182.0	

Figure 13 SW node, 30 A load, fsw = 600 kHz



	Value	Mean	Min	Max	St Dev	Count	Info
C1 Min	-3.36V	-3.2854166	-3.48	-960.0m	395.2m	223.0	
C1 Max	19.8V	19.638452	13.2	20.04	1.082	223.0	
C1 Freq	866.5kHz	864.64436k	812.9k	868.5k	8.684k	223.0	

Figure 14 SW node, 30 A load, fsw = 800 kHz

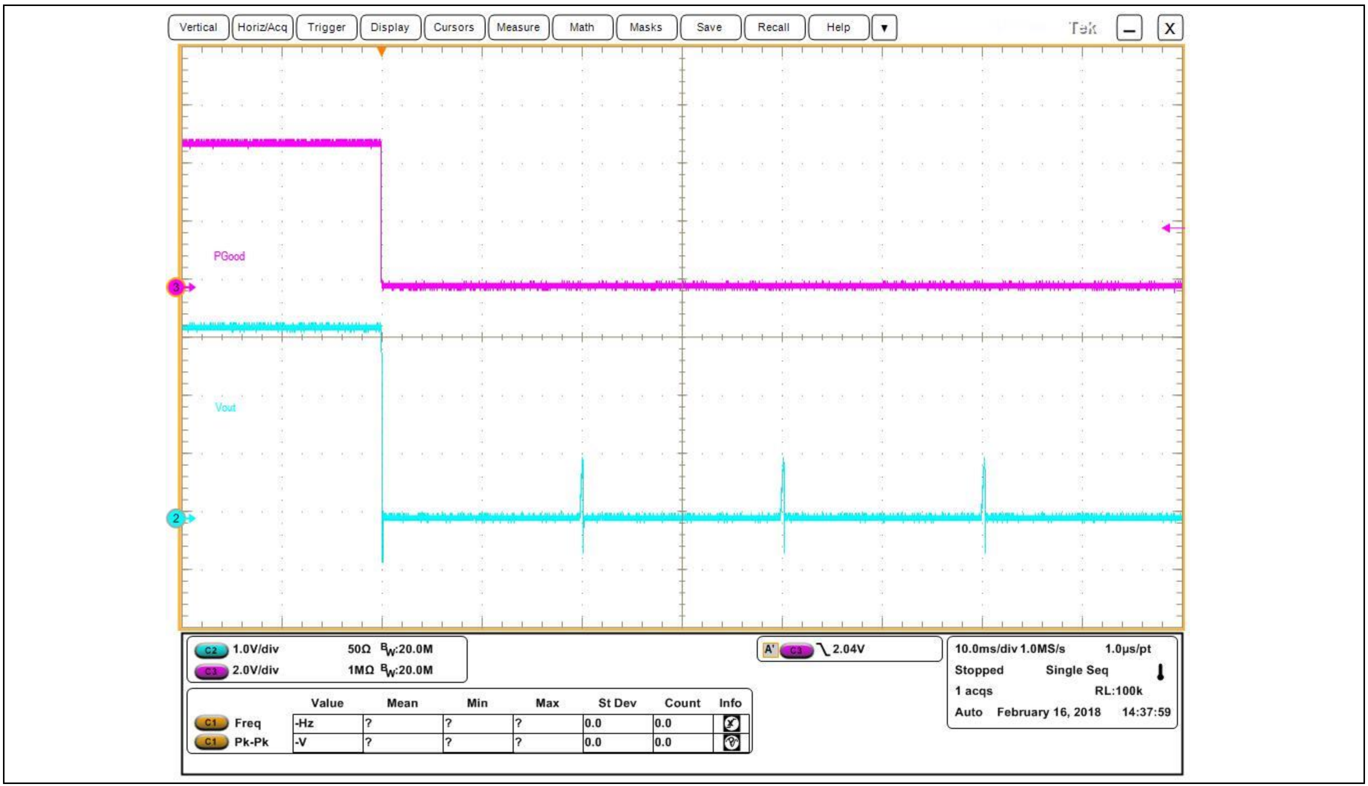


Figure 15 **Short-circuit and UVP (hiccup), (Ch_2: V_{out}, Ch_3: P_{Good})**

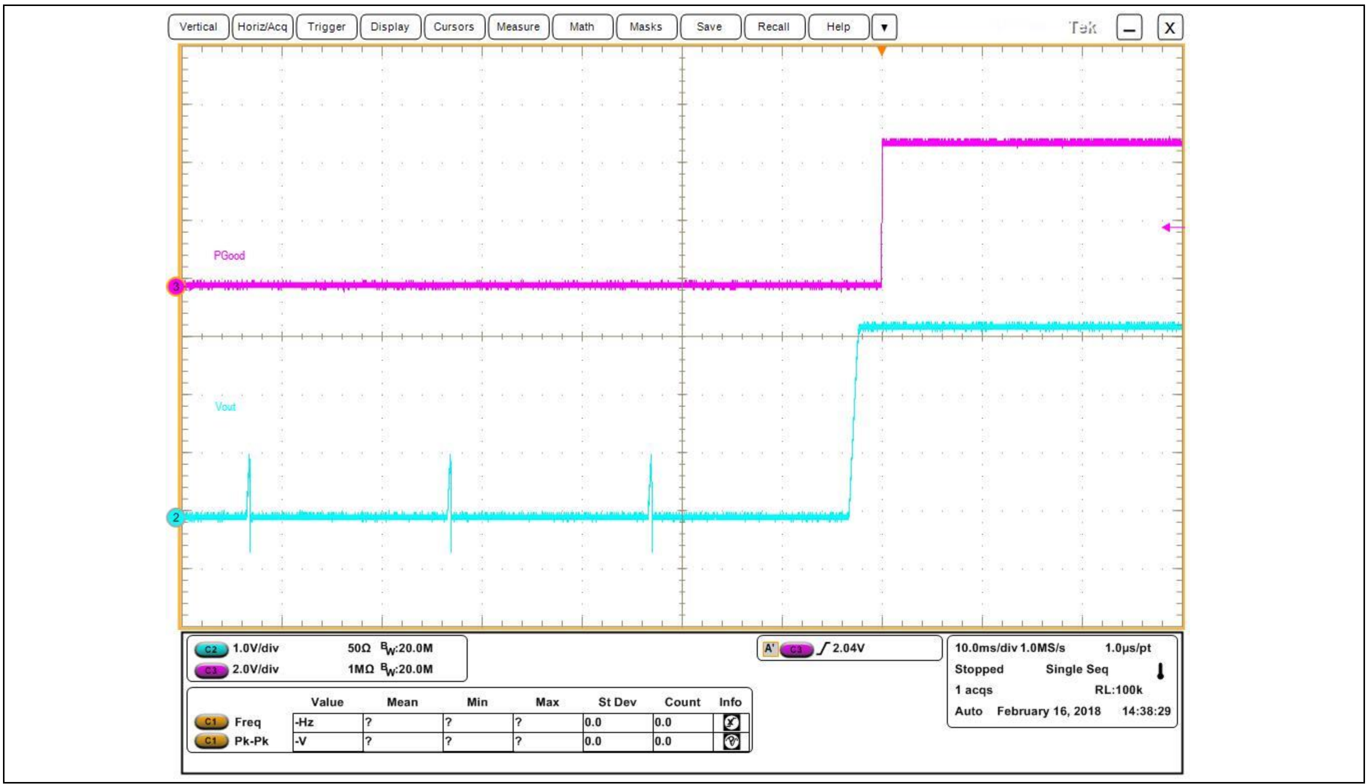


Figure 16 **Short-circuit and UVP (hiccup) recover, (Ch_2: V_{out}, Ch_3: P_{Good})**

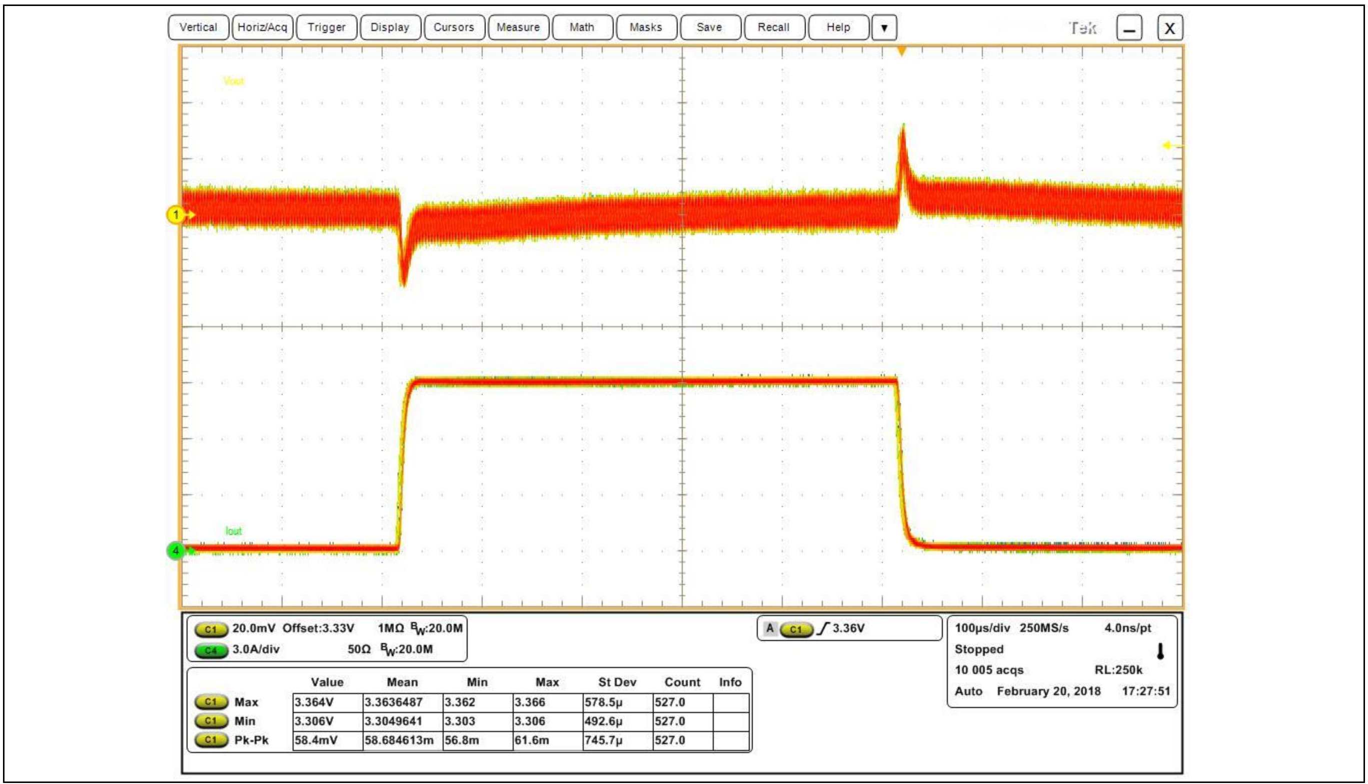


Figure 17 Transient response at 9 A step-load current at 2.5 A/µs slew rate: I_{out} = 0 A to 9 A, (Ch_1: V_{out}, Ch_4: I_{out}) pk-pk: 62 mV, fsw = 600 kHz

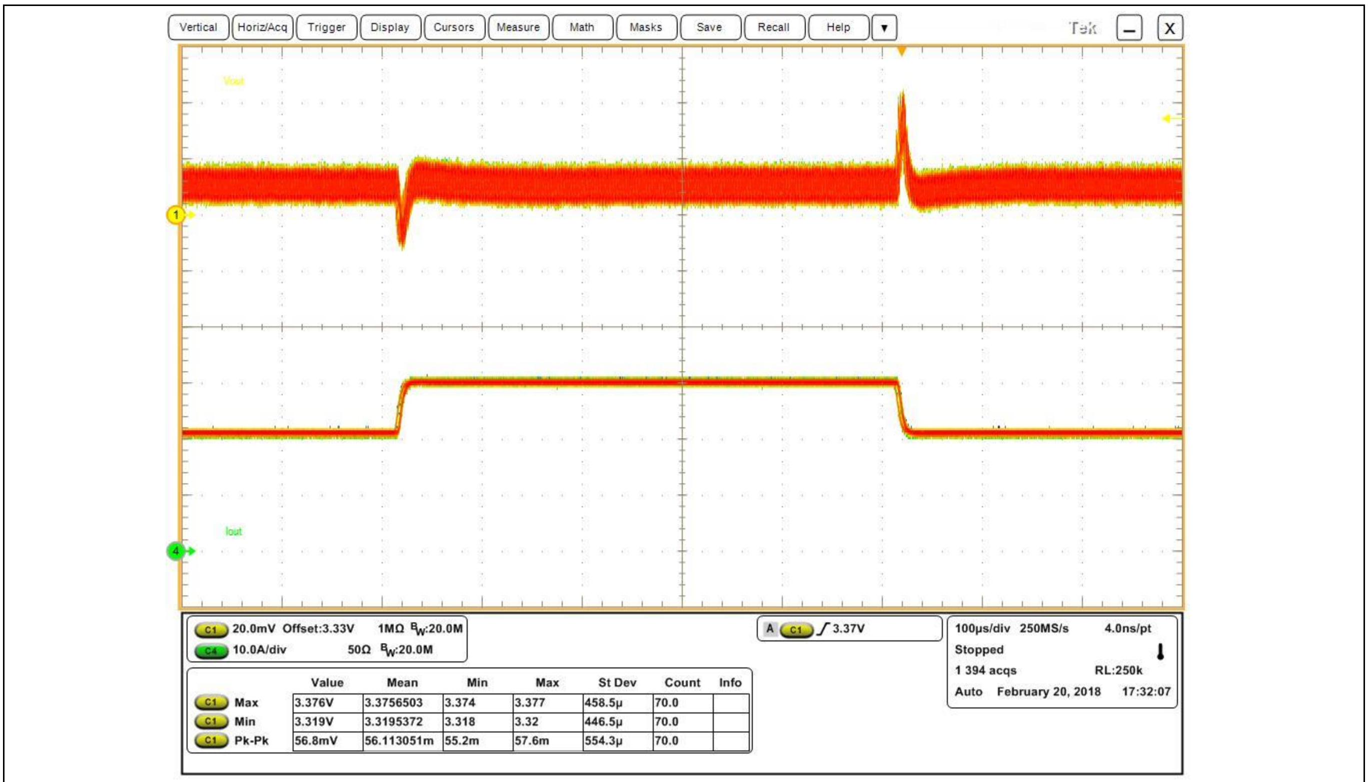


Figure 18 Transient response at 9 A step-load current at 2.5 A/µs slew rate: I_{out} = 21 A to 30 A, (Ch_1: V_{out}, Ch_4: I_{out}), pk-pk: 58 mV, fsw = 600 kHz

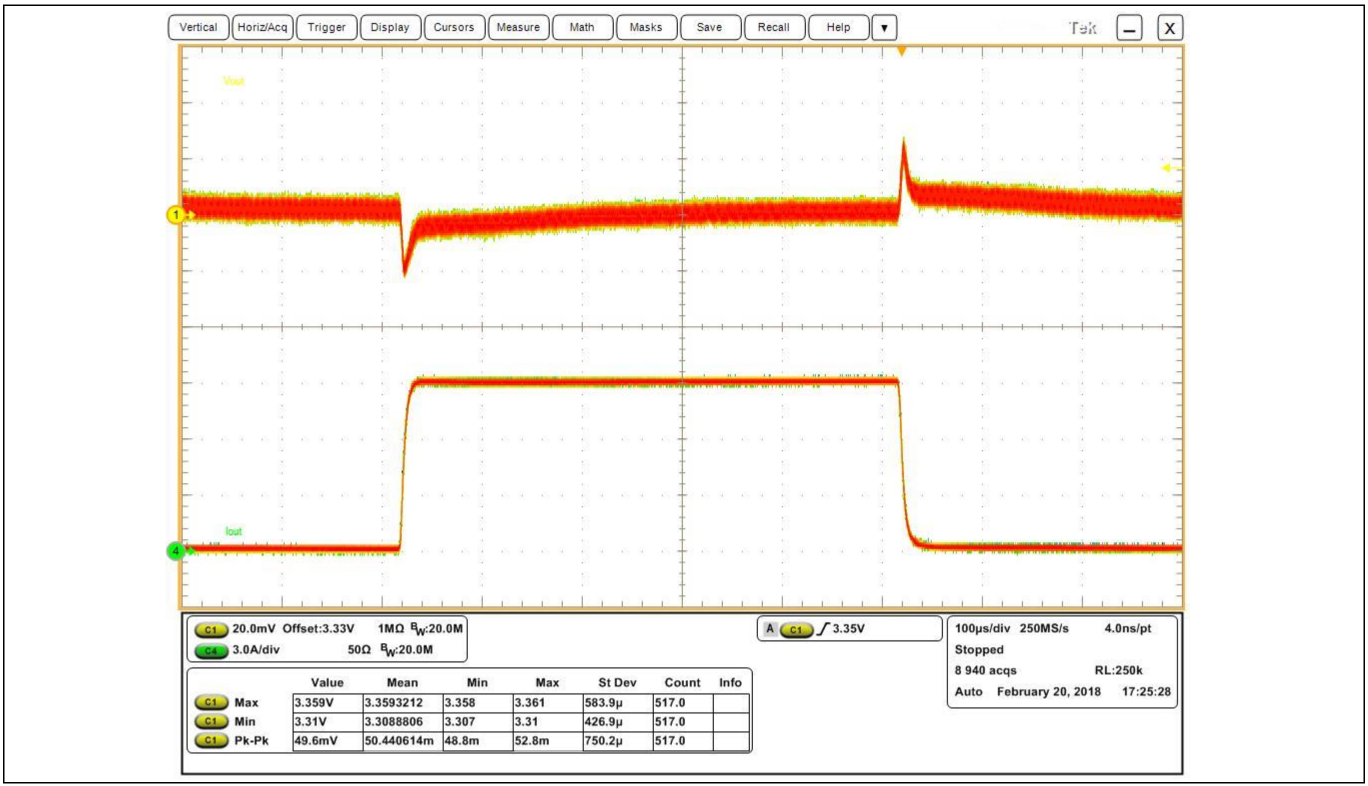


Figure 19 Transient response at 9 A step-load current at 2.5 A/µs slew rate: I_{out} = 0 A to 9 A, (Ch_1: V_{out}, Ch_4: I_{out}) pk-pk: 53 mV, fsw = 800 kHz

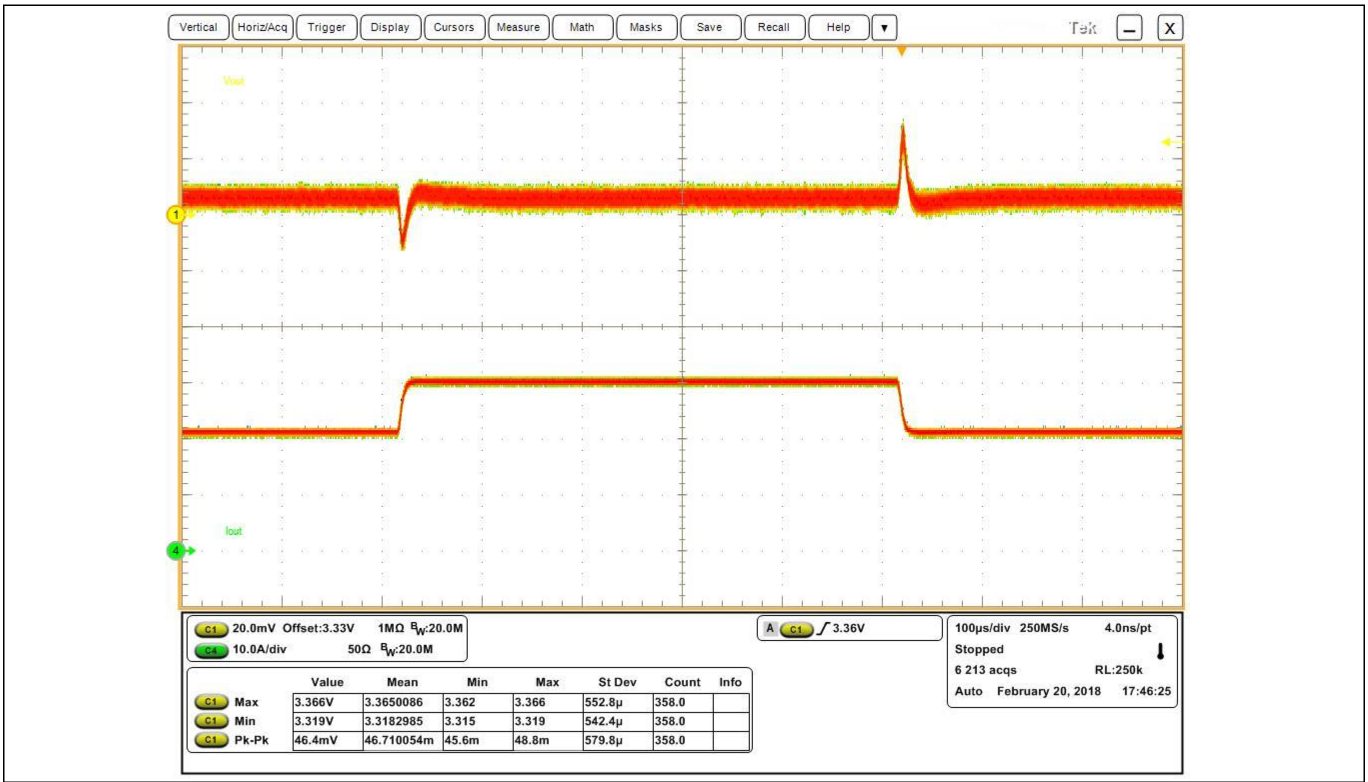


Figure 20 Transient response at 9 A step-load current at 2.5 A/µs slew rate: I_{out} = 21 A to 30 A, (Ch_1: V_{out}, Ch_4: I_{out}), pk-pk: 49 mV, fsw = 800 kHz

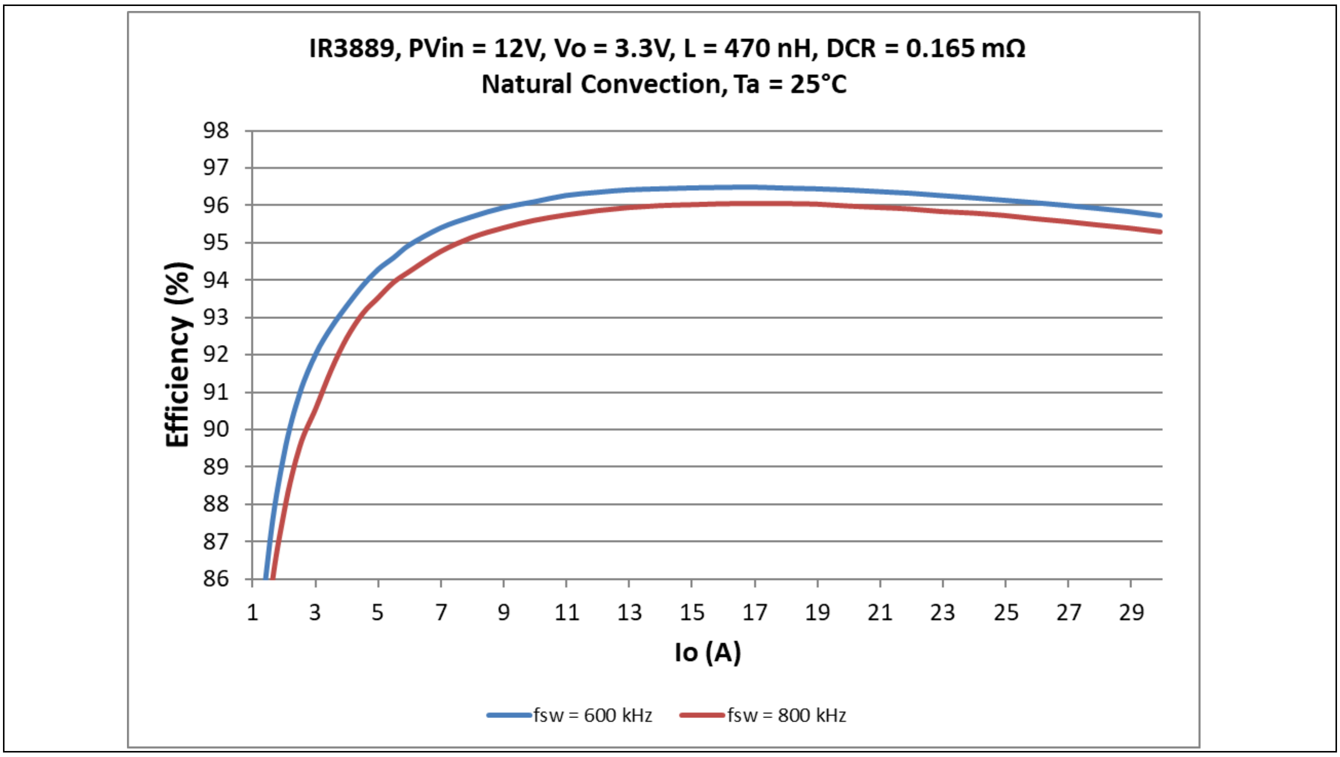


Figure 21 Efficiency vs. load current, natural convection, T_a = 25°C

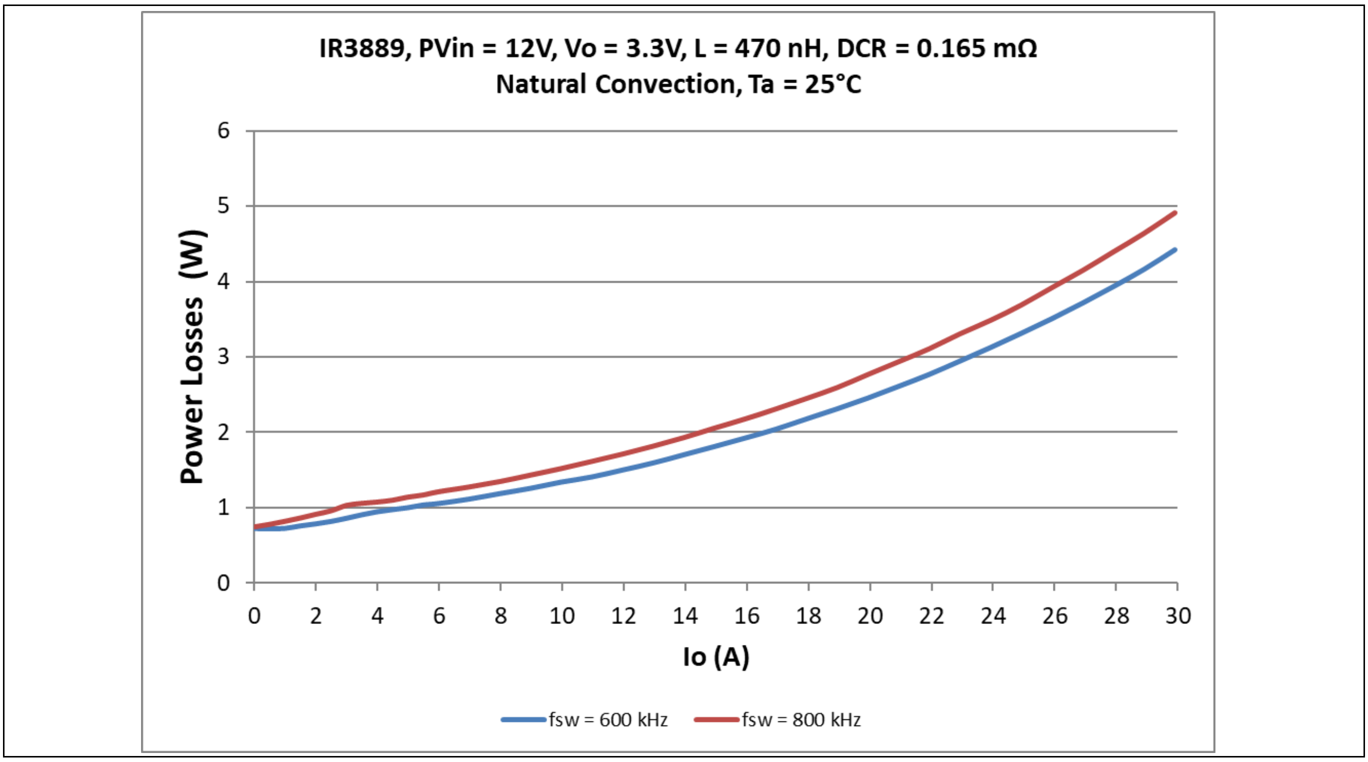


Figure 22 Power loss vs. load current, natural convection, T_a = 25°C

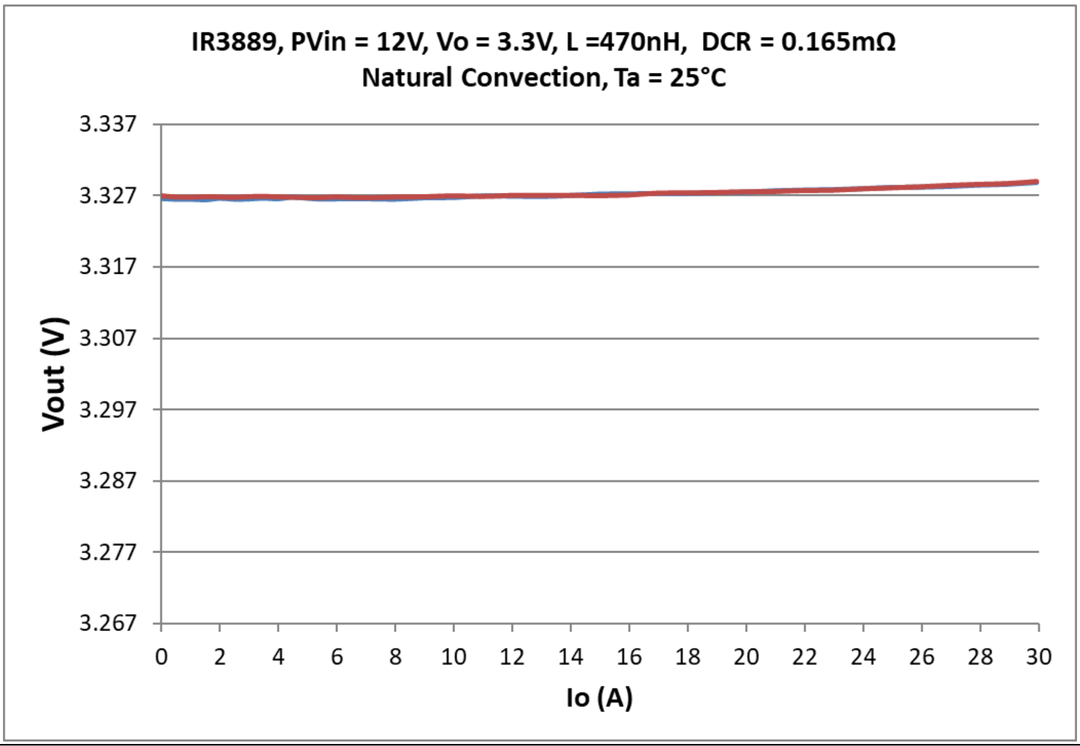


Figure 23 IR3889 V_{out} regulation, natural convection, T_a = 25°C

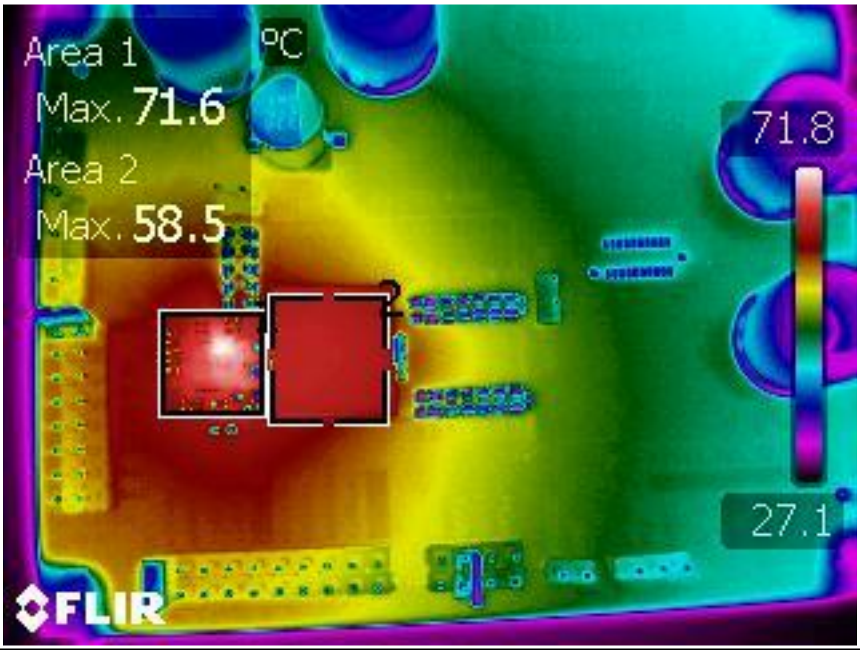


Figure 24 Thermal image of the board at 25 A load IR3889 = 72°C, L= 59°C, fsw = 600 kHz, T_a = 27°C, natural convection

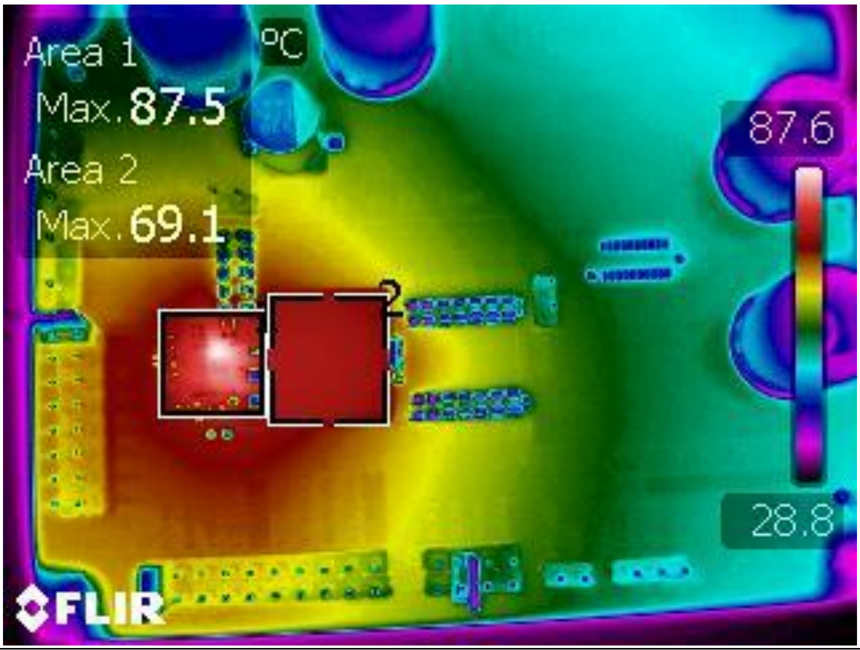


Figure 25 Thermal image of the board at 30 A load IR3889 = 88°C, L = 69°C, fsw = 600 kHz, T_a = 29°C, natural convection

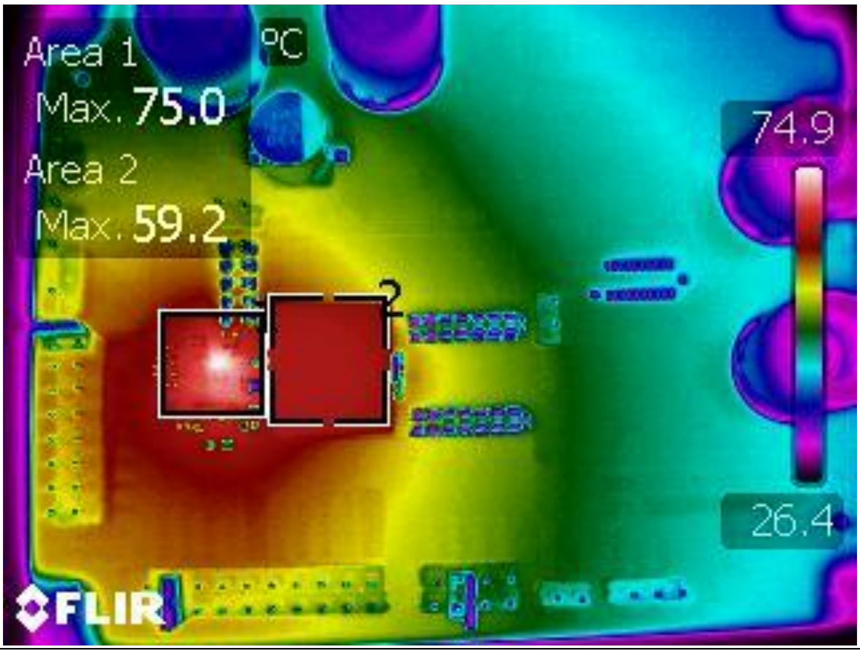


Figure 26 Thermal image of the board at 25 A load IR3889 = 75°C, L = 59°C, fsw = 800 kHz, T_a = 26°C, natural convection

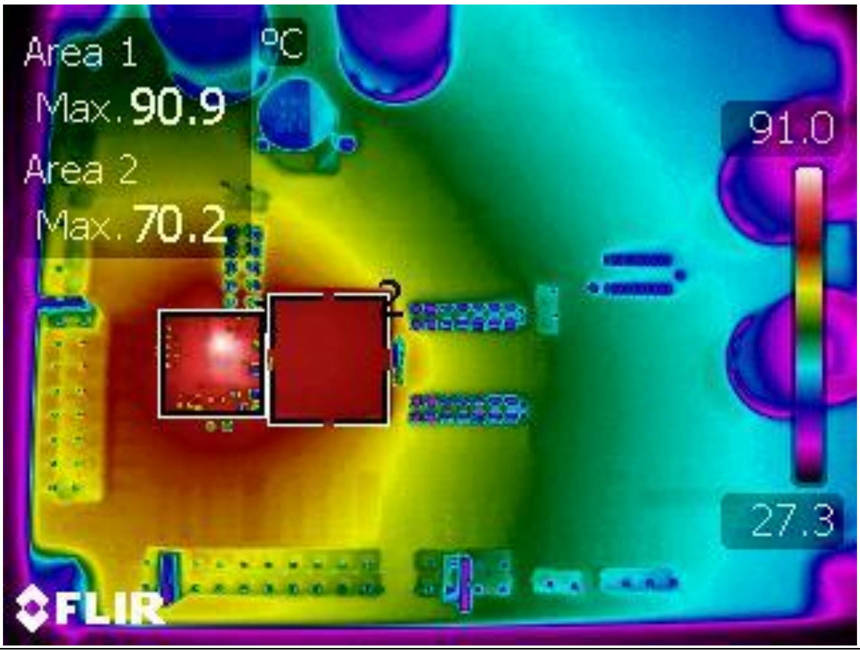


Figure 27 Thermal image of the board at 30 A load IR3889 = 91°C, L = 70°C, fsw = 800 kHz, T_a = 27°C, natural convection

Revision history

Document version	Date of release	Description of changes
V 1.0	2019-06-04	Initial release
V 1.1	2022-04-28	Title and subtitle updated

Trademarks
All referenced product or service names and trademarks are the property of their respective owners.

Edition 2022-04-28

Published by

Infineon Technologies AG

81726 Munich, Germany

Do you have a question about this document?

Email: erratum@infineon.com

Document reference
UM_1902_PL12_1902_022747