User manual for IR3889 evaluation board

30 A single-phase buck regulator with 1.0 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 Over-Voltage Protection (OVP), and pre-bias start-up.

The output Over-Current 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_1Vout 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 the performance of IR3889 with the engineering EVAL_3889_1Vout demo board.

Table of contents

1 Board information

1.1 Board features

V_{in} = +12 V, V_{out} = +1 V at 0 to 30 A

F_s = 800 kHz/1000 kHz

L= 150 nH (12.4 mm x 8.3 mm x 8 mm, DCR = 0.15 mΩ)

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

C_{out} = 10 x 22 µF (6.3 V, ceramic 0805) + 4 x 47 µF (6.3 V, ceramic 0805) + 1 x 470 µF (2 V, 6 mΩ, SP-cap)

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
	GND	Or, an external enable signal can be applied to this pin to over-drive the on-board enable signal
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.

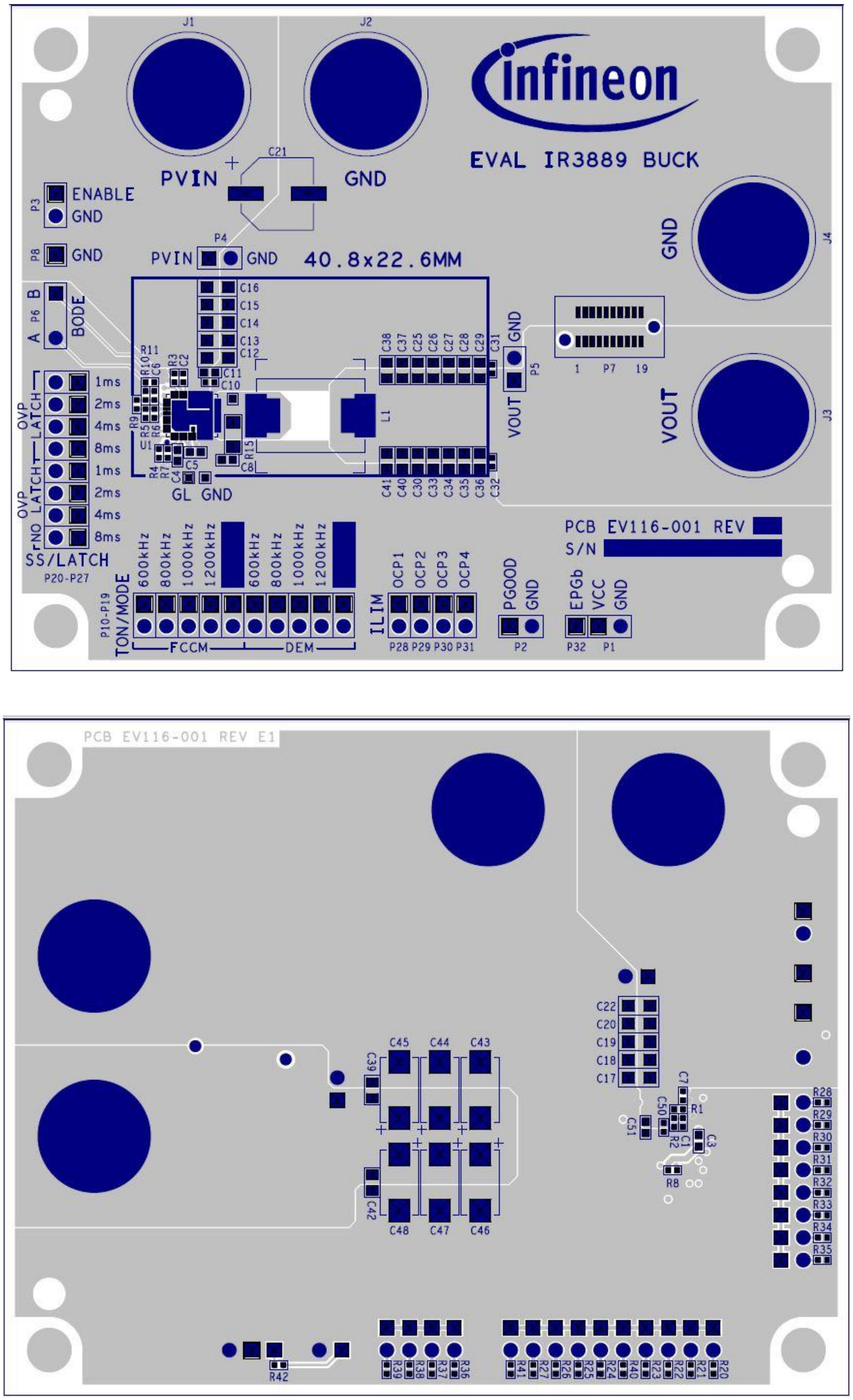


Figure 1 Top and bottom view of IR3889 evaluation board

1.4 PCB layout

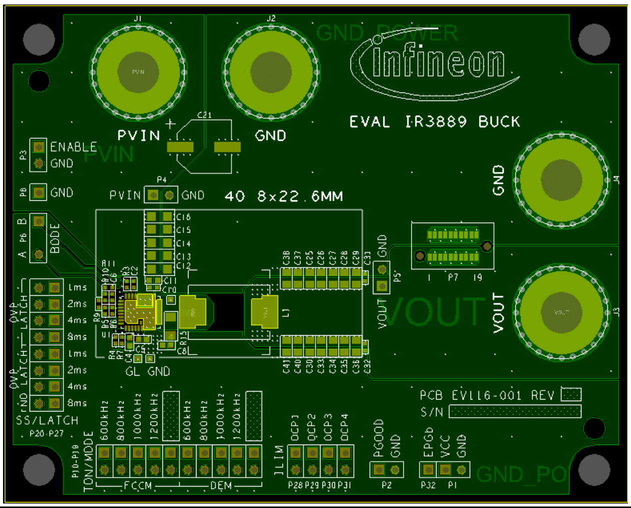


Figure 2 Top layer

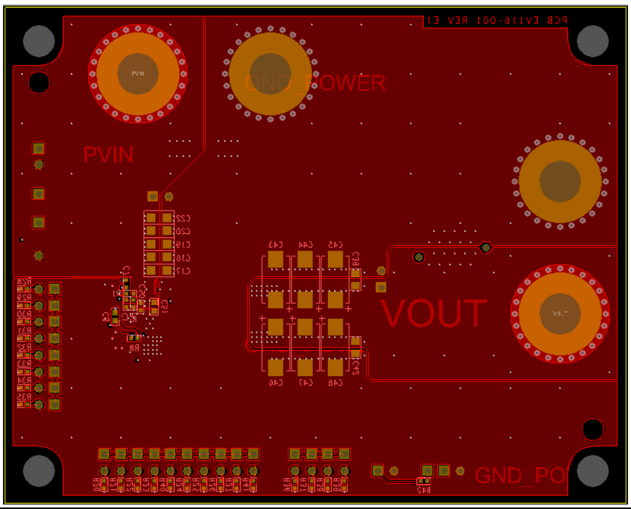


Figure 3 Bottom layer

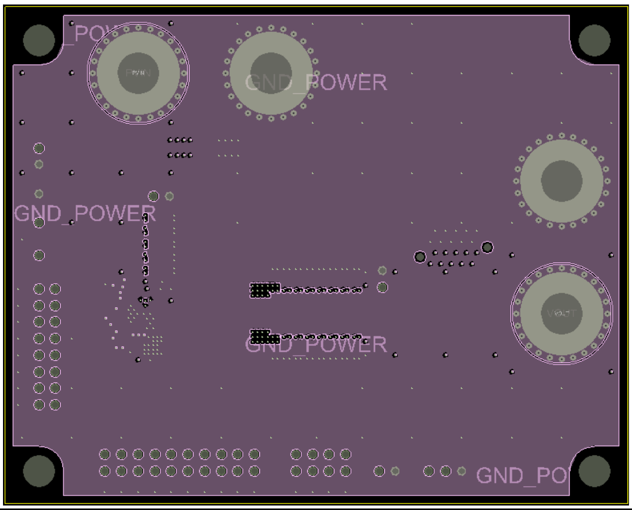


Figure 4 Mid layer 1

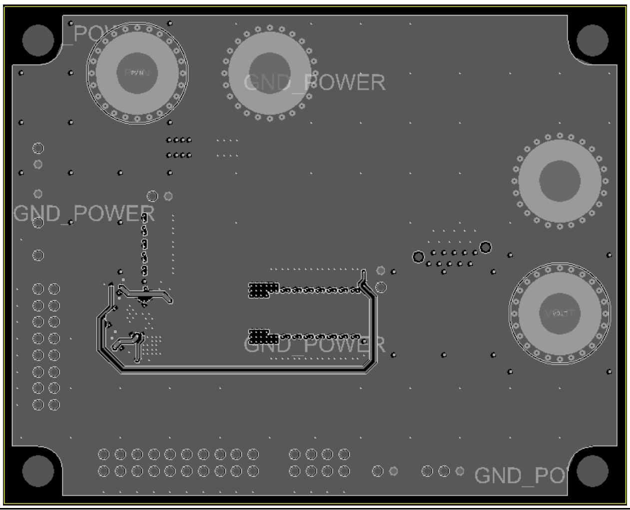


Figure 5 Mid layer 2

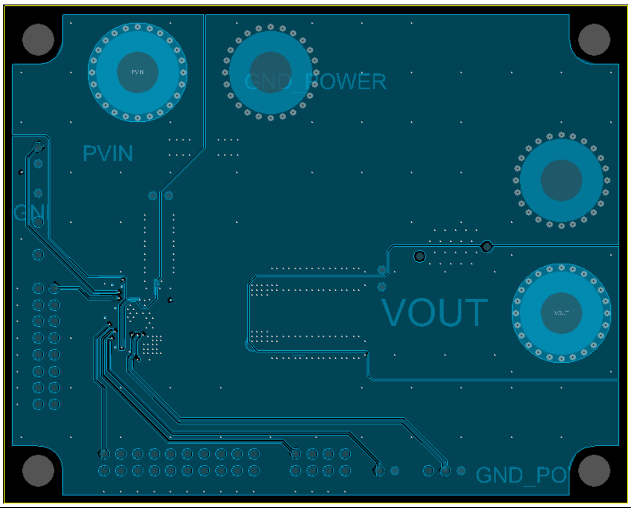


Figure 6 Mid layer 3

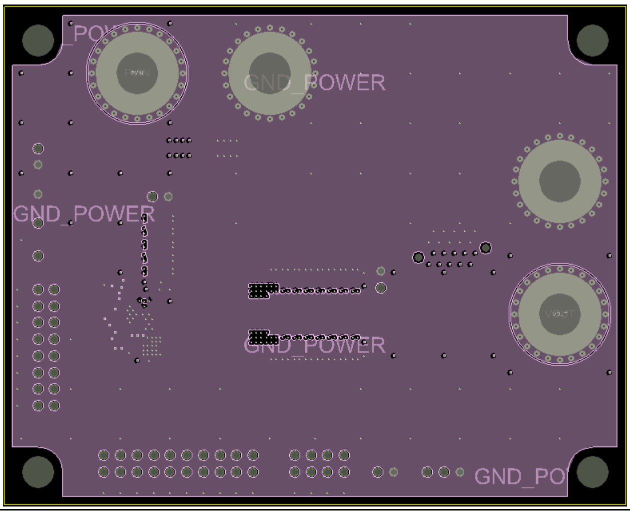


Figure 7 Mid layer 4

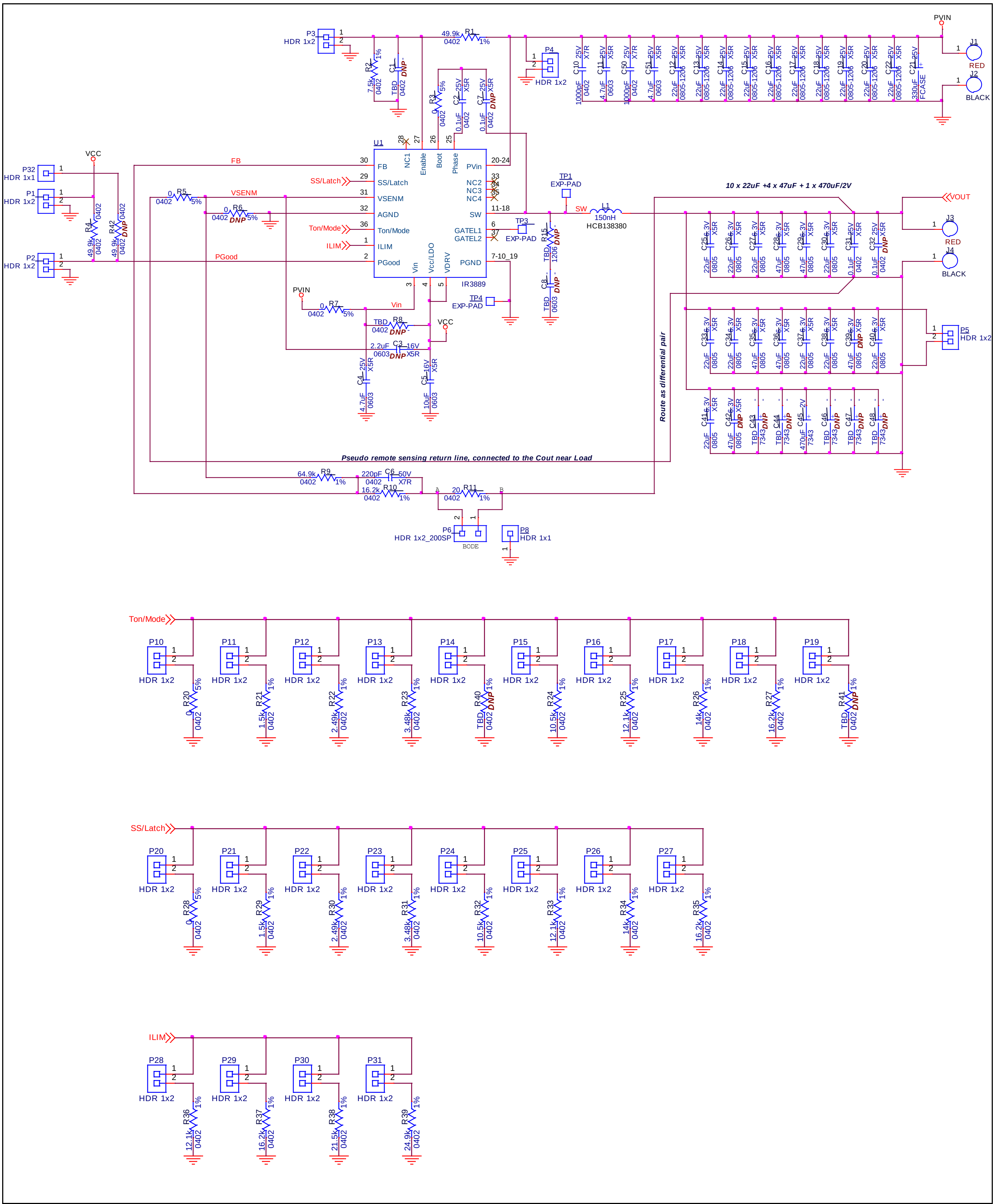


Figure 8 **Schematic of the IRDC3889 evaluation board V_{in} = 12 V, V_{out} = 1 V, I_{outmax} = 30 A, fsw = 800 kHz/1000 kHz**

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	10 µF	Murata	GRT188R61C106KE13D	Ceramic capacitor 10 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	EEV-FK1E331P	Aluminum capacitor 330 µF 20% 25 V SMD
8	10	C25, C26, C27, C30, C33, C34, C35, C38, C40, C41	22 µF	TDK	C2012X5R0J226M	Ceramic capacitor 22 µF 6.3 V X5R 0805
9	4	C28, C29, C36, C37	47 µF	TDK	C2012X5R0J476M125AC	Ceramic capacitor 47 µF 6.3 V 20% X5R 0805
10	1	C45	470 µF	Panasonic	EEF-SX0D471XE	Aluminum capacitor poly 470 µF 2 V 20% SMD
11	1	L1	150 nH	Delta	HCB138380D-151	Inductor 150 nH, I_{sat} = 80 A 12.4 mm x 8.3 mm x 8 mm DCR = 0.15 mΩ SMD
12	2	R1, R4	49.9 k	Panasonic	ERJ-2RKF4992X	RES 49.9 kΩ 1/10 W 1% 0402 SMD
13	1	R2	7.5 k	Panasonic	ERJ-2RKF7501X	RES 7.50 kΩ 1/10 W 1% 0402 SMD

14	1	R38	21.5 k	Panasonic	ERJ-2RKF2152X	RES 21.5 kΩ 1/10 W 1% 0402 SMD
15	5	R3, R5, R7, R20, R28	0	Panasonic	ERJ-2GE0R00X	RES 0.0 Ω 1/10 W 0402 SMD
16	2	R27, R35	16.2 k	Panasonic	ERJ-2RKF1622X	RES 16.2 kΩ 1/10 W 1% 0402 SMD
17	1	R9	64.9 k	Panasonic	ERJ-2RKF6492X	RES SMD 64.9 kΩ 1% 1/10 W 0402
18	2	R10, R37	16.2 k	Panasonic	ERJ-2RKF1622X	RES 16.2 kΩ 1/10 W 1% 0402 SMD
19	1	R11	20	Vishay Dale	CRCW040220R0FKED	RES 20.0 Ω 1/16 W 1% 0402 SMD
20	2	R21, R29	1.5 k	Panasonic	ERJ-2GEJ152X	RES SMD 1.5 kΩ 5% 1/10 W 0402
21	2	R22, R30	2.49 k	Vishay Dale	CRCW04022K49FKED	RES 2.49 kΩ 1/16 W 1% 0402 SMD
22	2	R23, R31	3.48 k	Vishay Dale	CRCW04023K48FKED	RES 3.48 kΩ 1/16 W 1% 0402 SMD
23	3	R24, R32, R36	10.5 k	Panasonic	ERJ-2RKF1052X	RES 10.5 kΩ 1/10 W 1% 0402 SMD
24	2	R25, R33	12.1 k	Panasonic	ERJ-2RKF1212X	RES 12.1 kΩ 1/10 W 1% 0402 SMD
25	2	R26, R34	14 k	Panasonic	ERJ-2RKF1402X	RES 14.0 kΩ 1/10 W 1% 0402 SMD
26	1	R39	24.9 k	Panasonic	ERJ-2RKF2492X	RES 24.9 kΩ 1/10 W 1% 0402 SMD
27	1	U1	IR3889	Infineon	IR3889	30 A single-input voltage, synchronous buck regulator

2 Typical operating waveforms

V_{in} = 12.0 V, V_{out} = 1V, I_{out} = 0 to 30 A, room temperature, no air-flow.

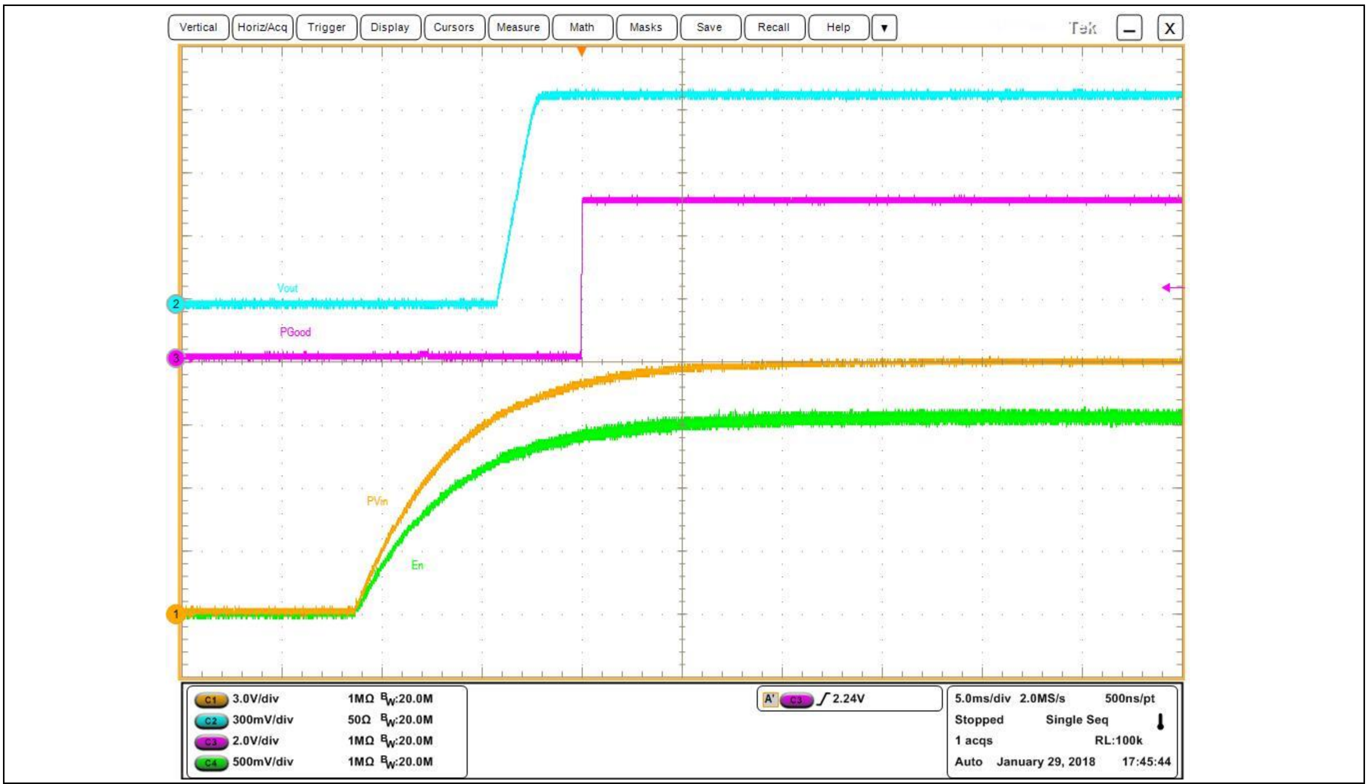


Figure 9 Start-up at 30 A load (Ch_1: PV_{in}, Ch_2: V_{out}, Ch_3: P_{Good}, Ch_4: enable)

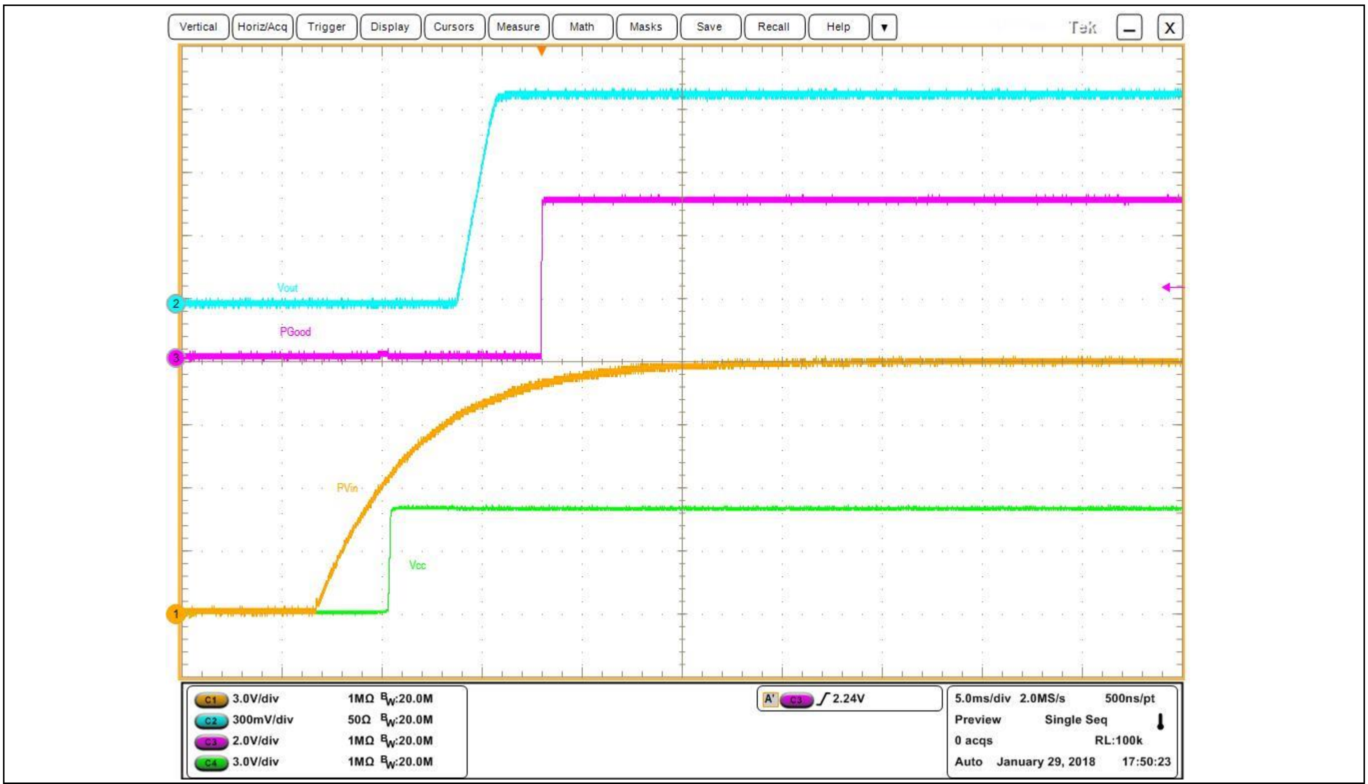


Figure 10 Start-up at 30 A load (Ch_1: PV_{in}, Ch_2: V_{out}, Ch_3: P_{Good}, Ch_4: V_{cc})

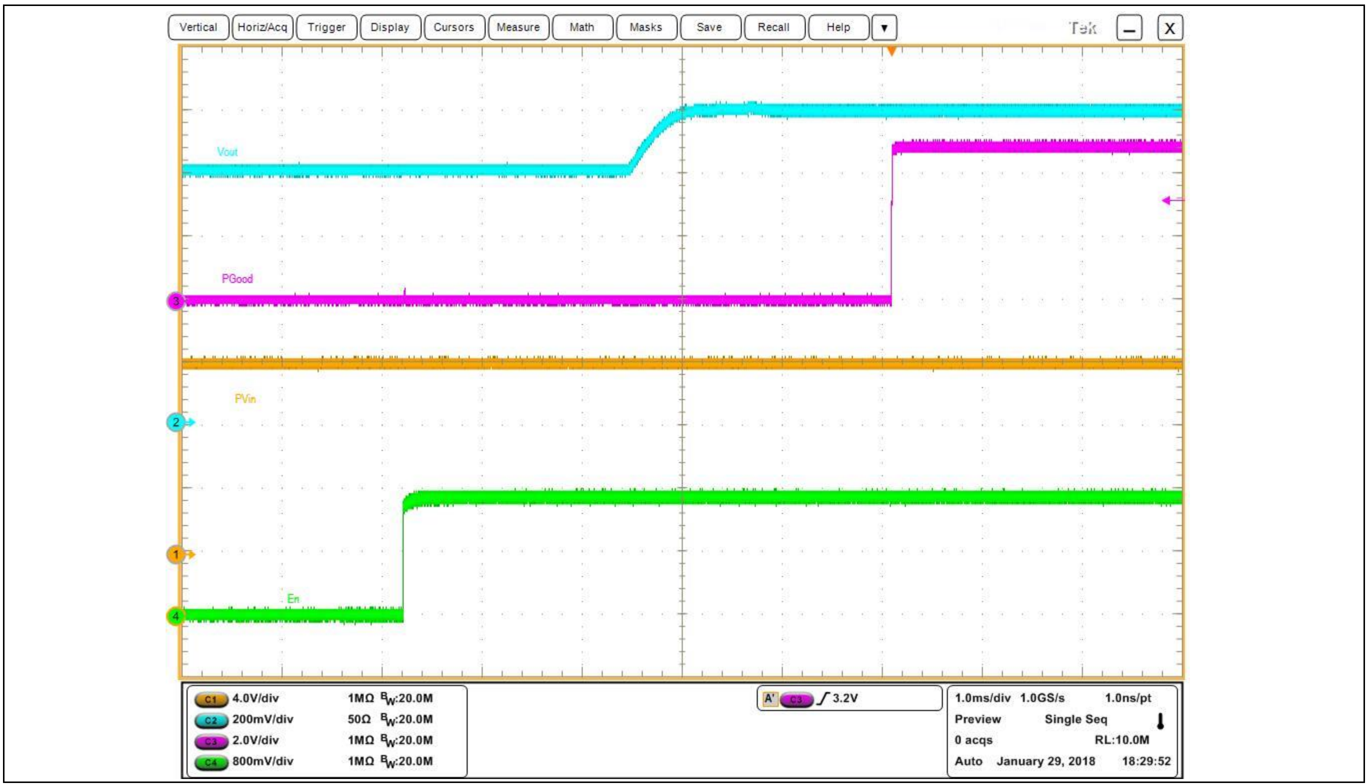


Figure 11 **Pre-bias start-up at 0 A load (Ch1: PV_{in}, Ch2: V_{out}, Ch3: P_{Good}, Ch4: enable)**

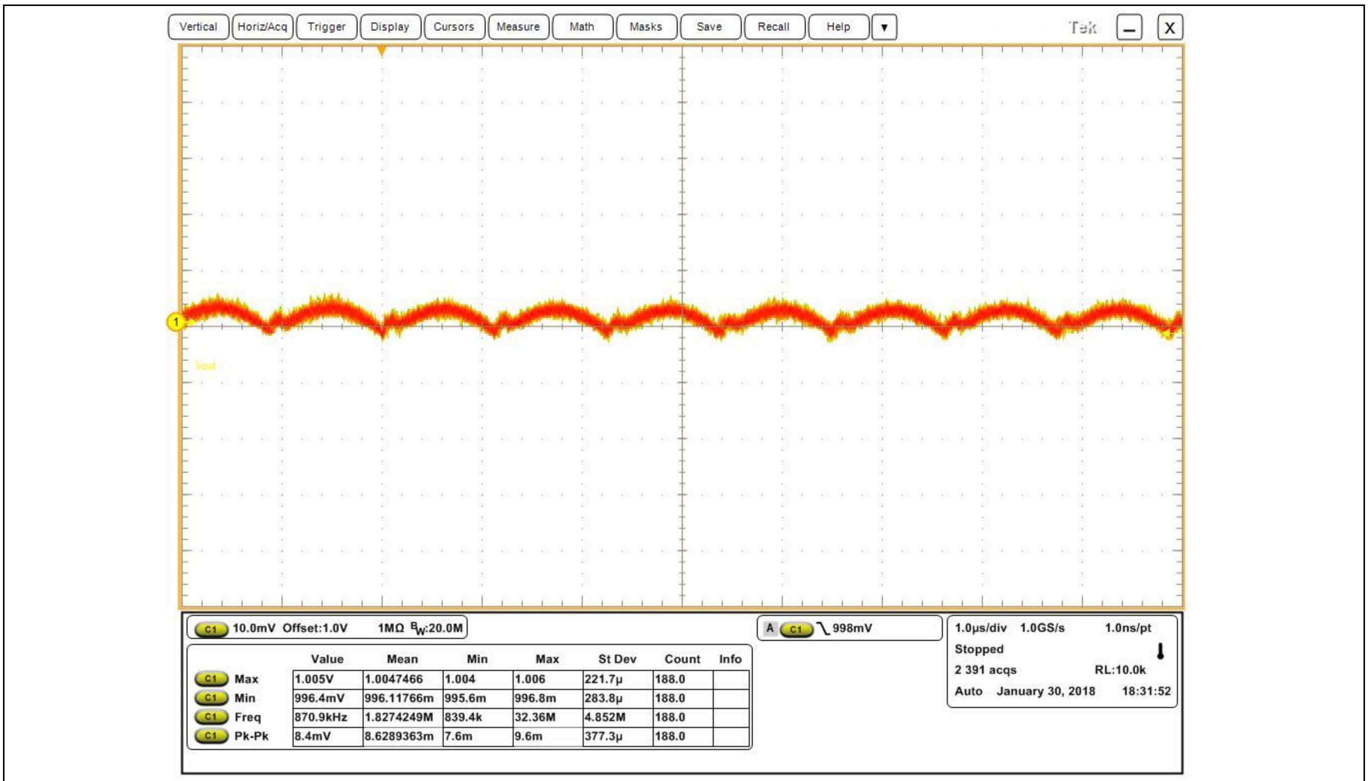
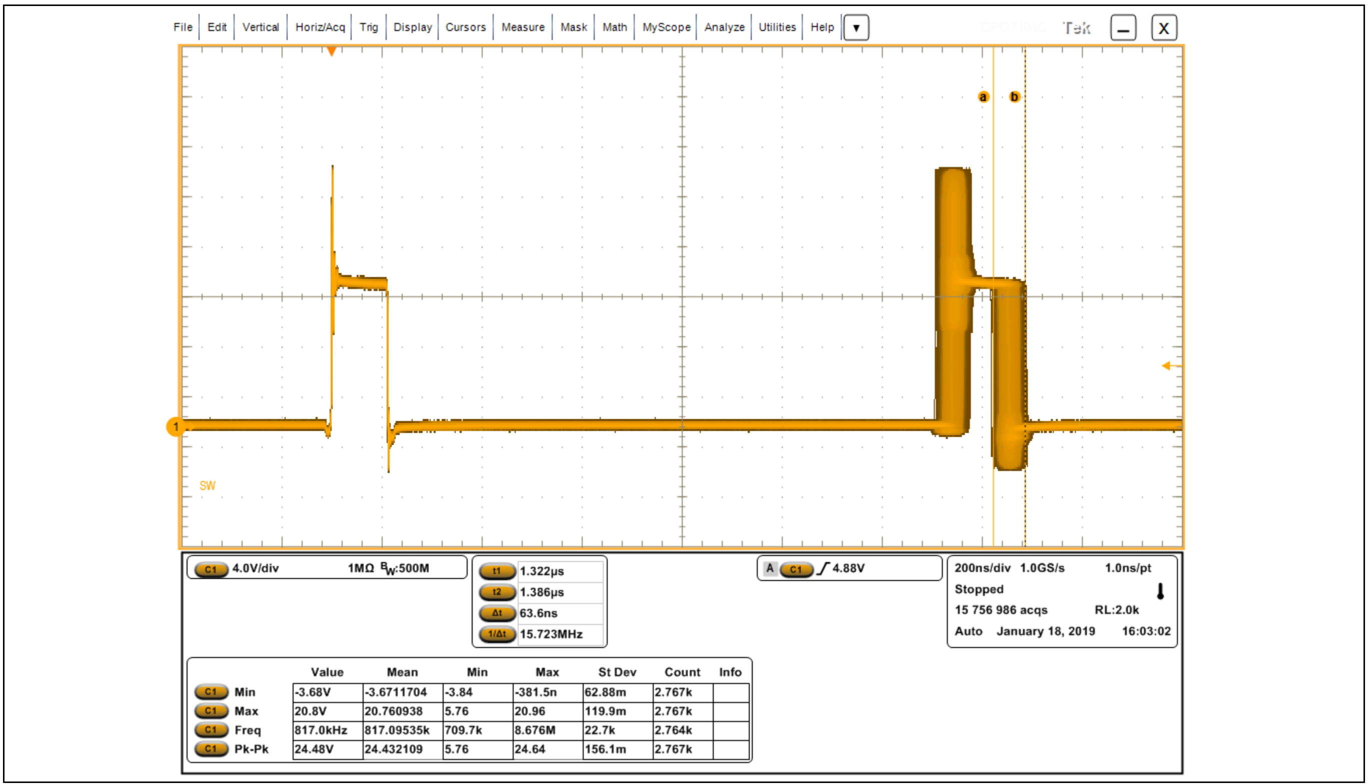
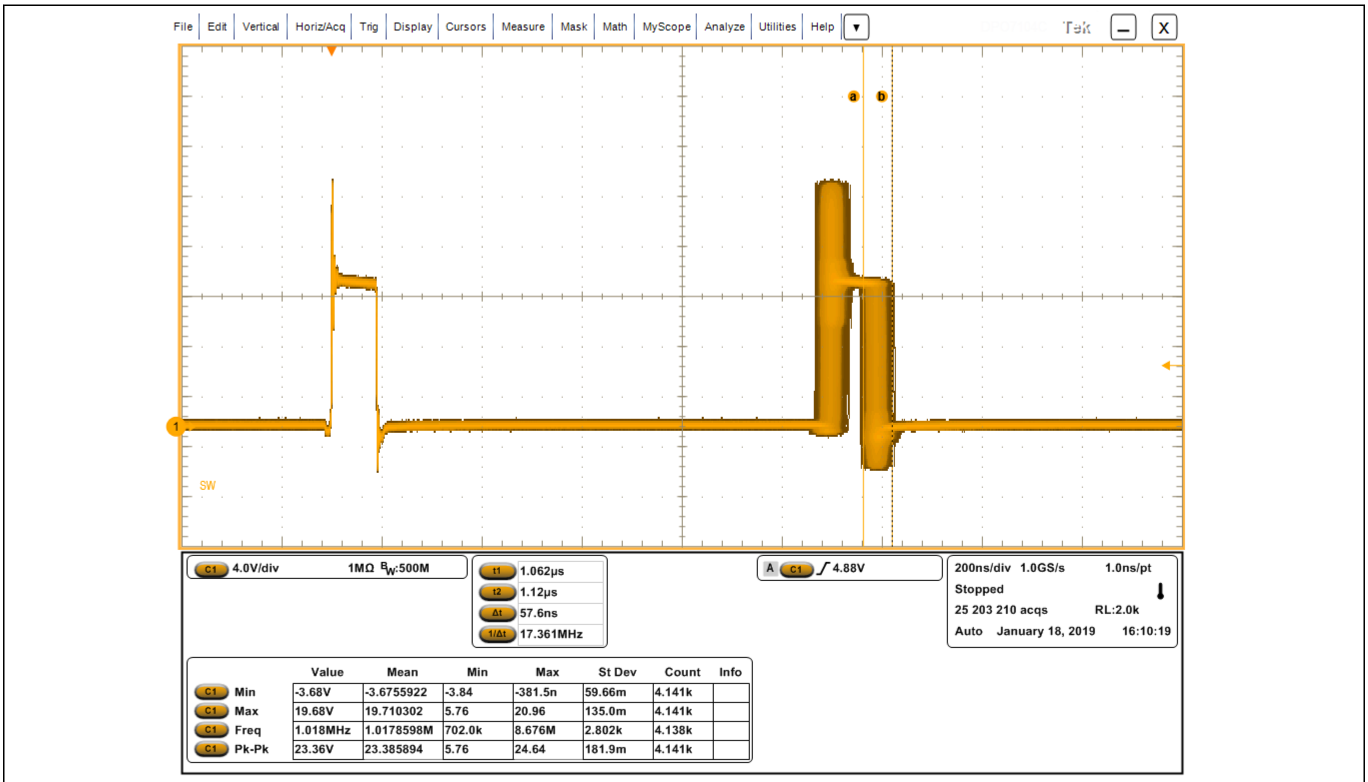


Figure 12 **V_{out} ripple at 30 A load, fsw = 800 kHz (Ch1: V_{out})**



	Value	Mean	Min	Max	St Dev	Count	Info
C1 Min	-3.68V	-3.6711704	-3.84	-381.5n	62.88m	2.767k	
C1 Max	20.8V	20.760938	5.76	20.96	119.9m	2.767k	
C1 Freq	817.0kHz	817.09535k	709.7k	8.676M	22.7k	2.764k	
C1 Pk-Pk	24.48V	24.432109	5.76	24.64	156.1m	2.767k	

Figure 13 SW node, 30 A load, fsw = 800 kHz



	Value	Mean	Min	Max	St Dev	Count	Info
C1 Min	-3.68V	-3.6755922	-3.84	-381.5n	59.66m	4.141k	
C1 Max	19.68V	19.710302	5.76	20.96	135.0m	4.141k	
C1 Freq	1.018MHz	1.0178598M	702.0k	8.676M	2.802k	4.138k	
C1 Pk-Pk	23.36V	23.385894	5.76	24.64	181.9m	4.141k	

Figure 14 SW node, 30 A load, fsw = 1000 kHz

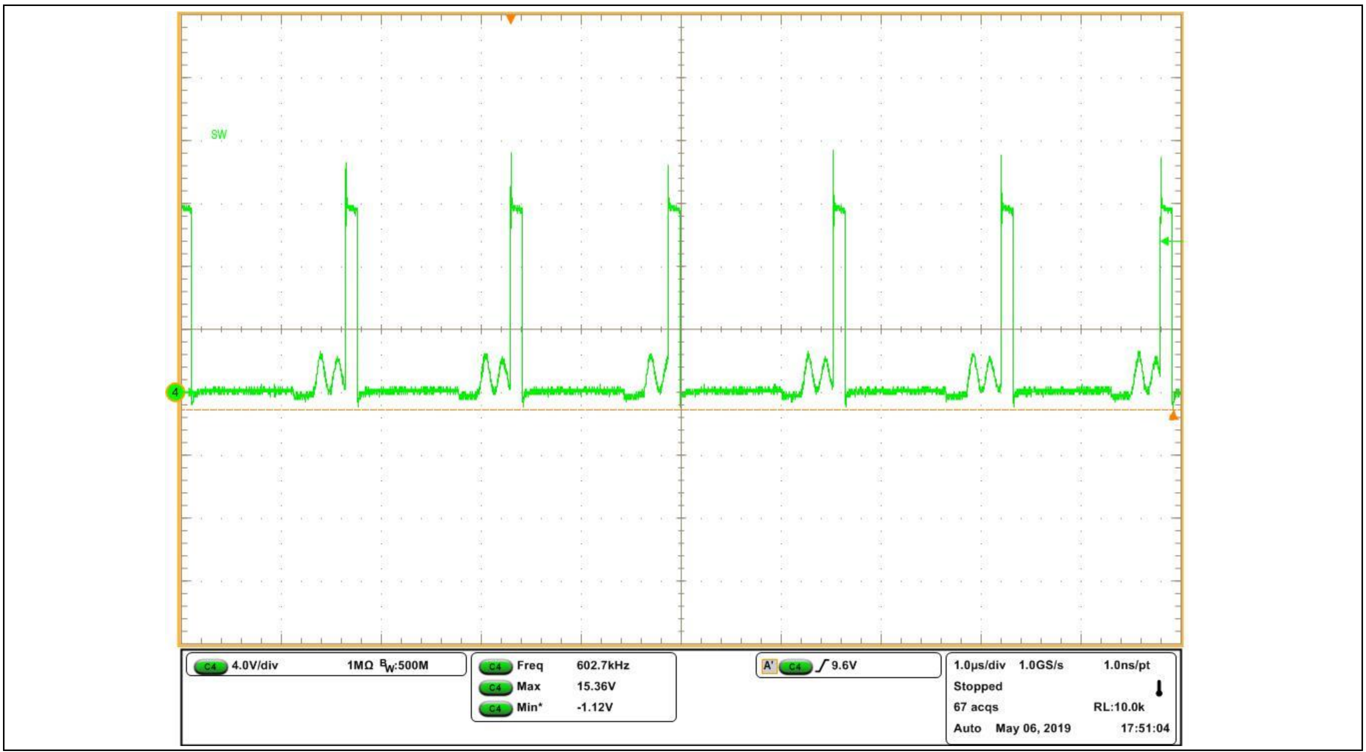


Figure 15 SW node (in DEM), 3.5 A load

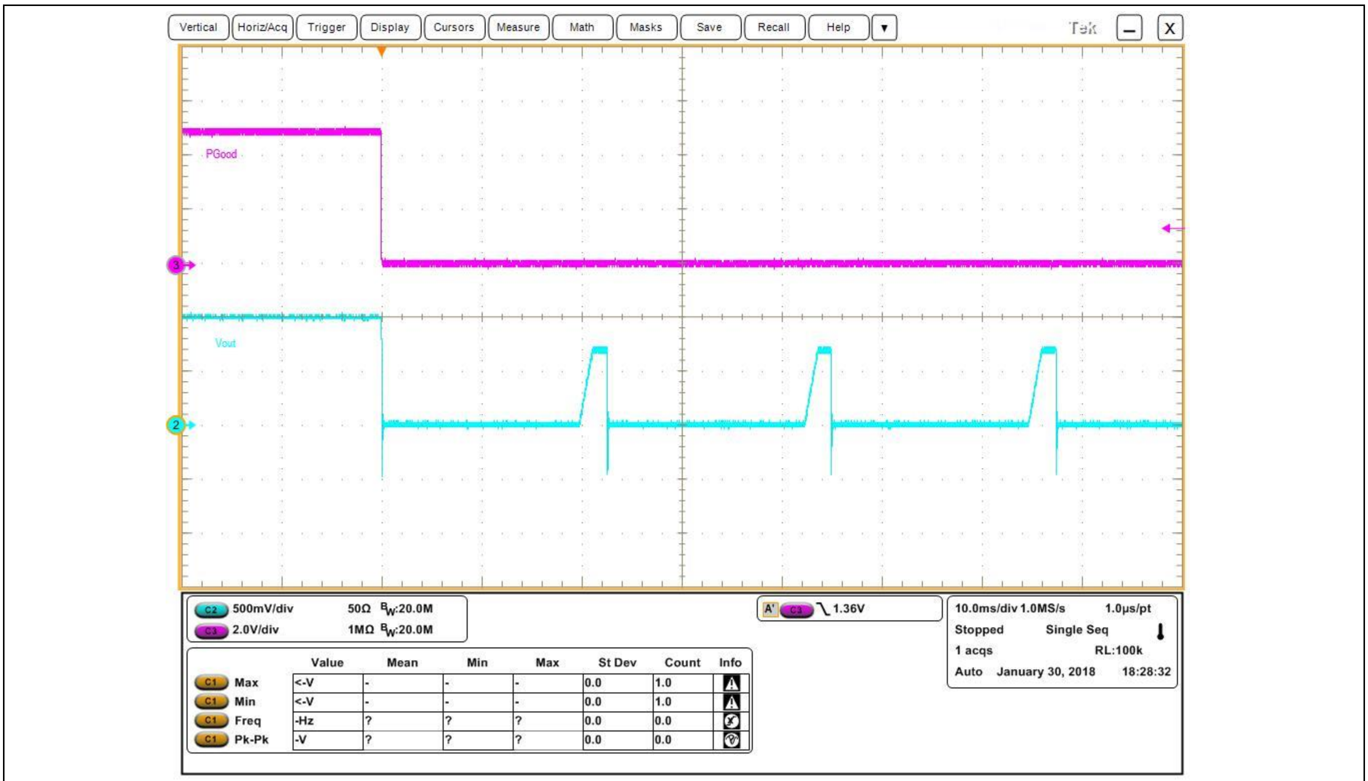


Figure 16 Short-circuit and UVP (hiccup), (Ch_2: V_{out}, Ch_3: P_{Good})

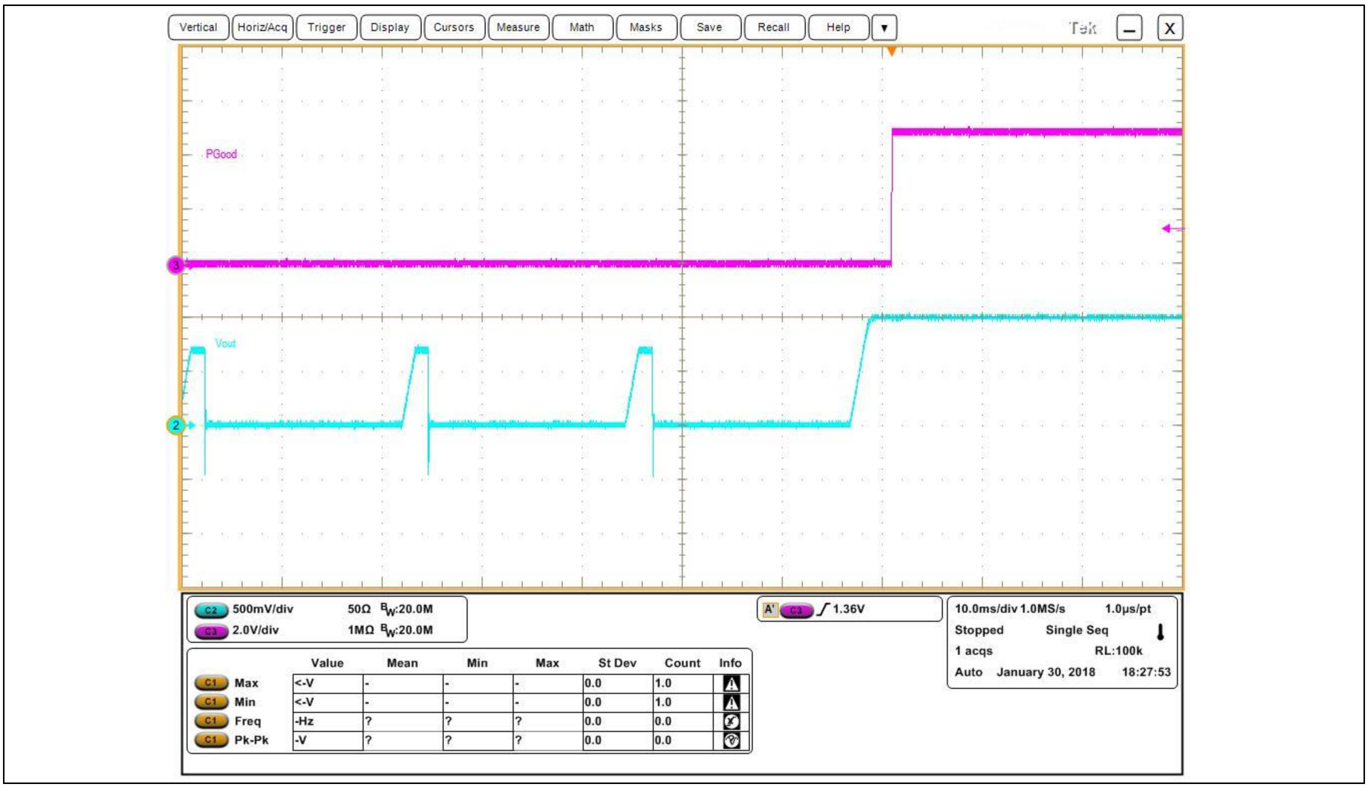


Figure 17 Short-circuit and UVP (hiccup) recover, (Ch_2: V_{out}, Ch_3: P_{Good})

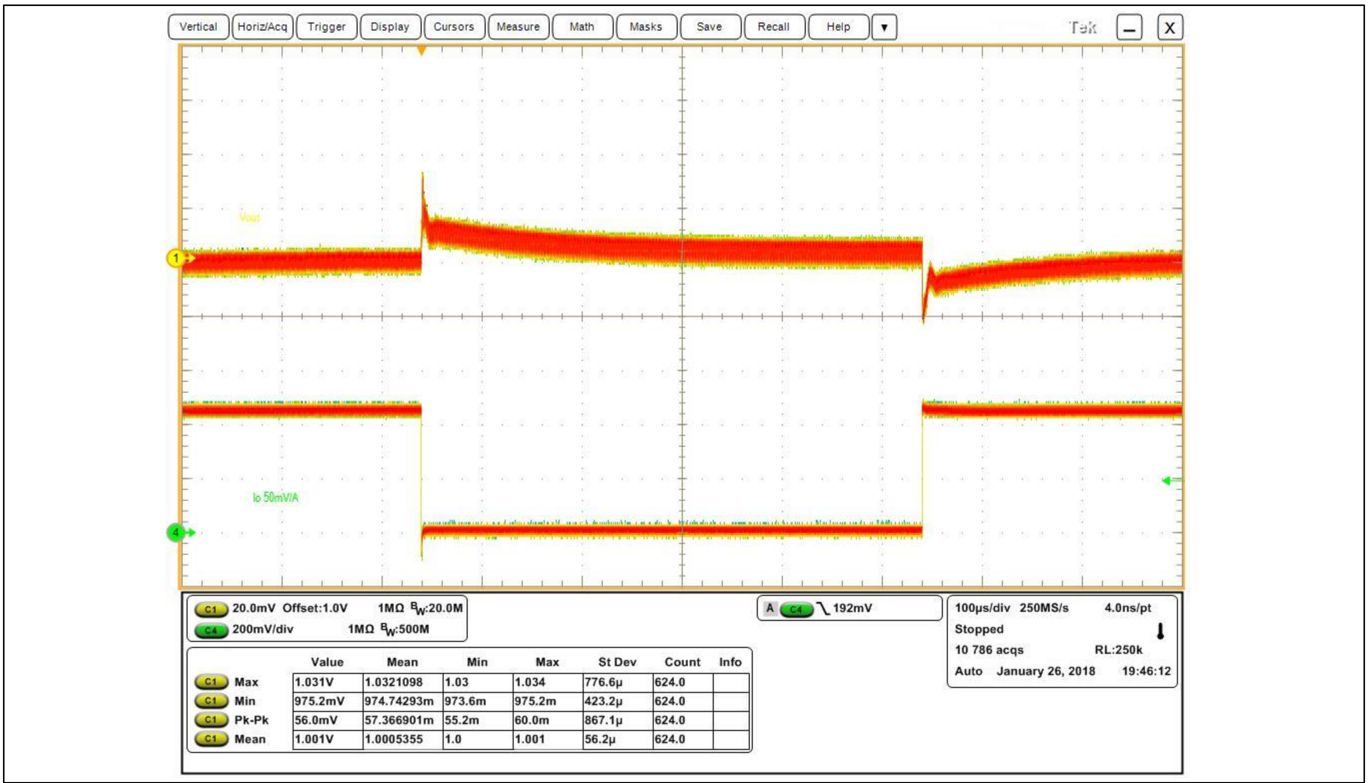


Figure 18 Transient response at 9 A step-load current at 30 A/µs slew rate: I_{out} = 0 A to 9 A, (Ch_1: V_{out}, Ch_4: I_{out}) pk-pk: 60 mV, fsw = 800 kHz

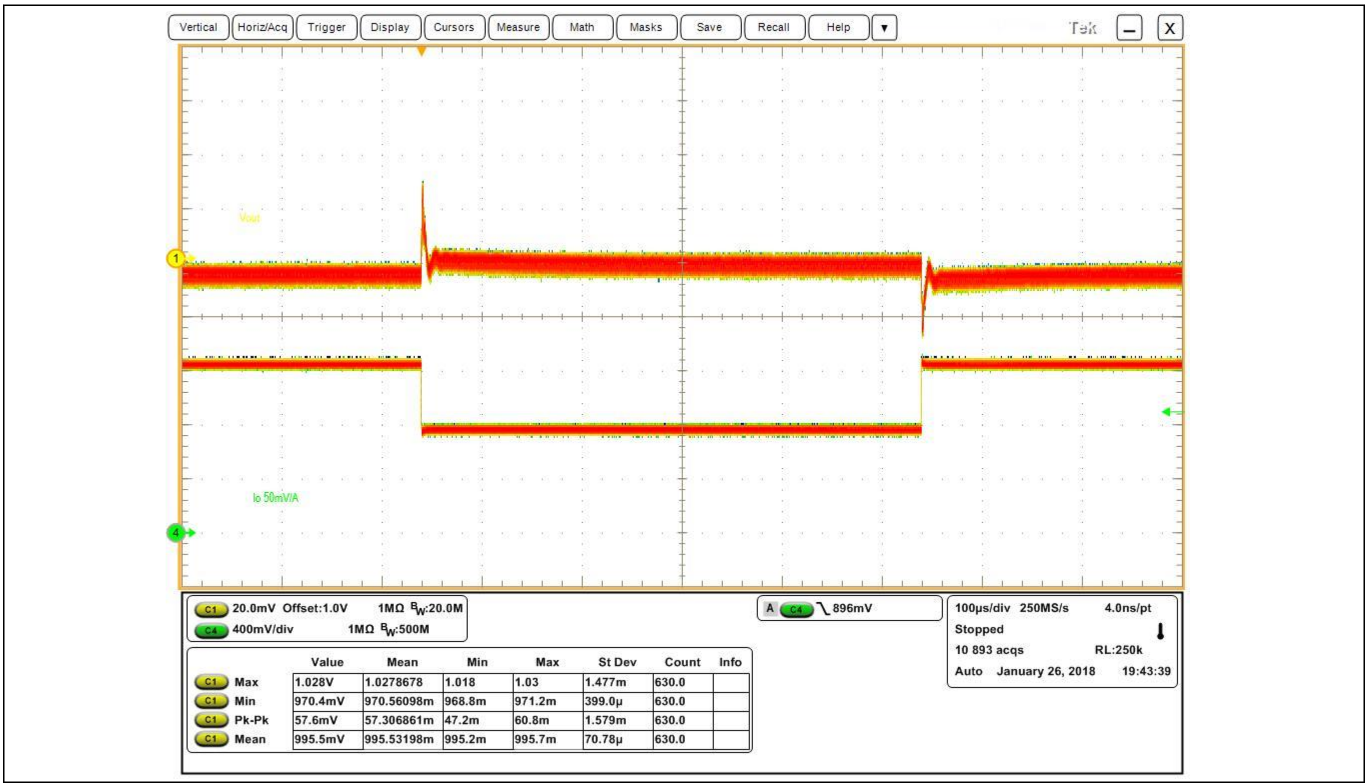


Figure 19 **Transient response at 9 A step-load current at 30 A/µs slew rate: I_{out} = 16 A to 25 A, (Ch_1: V_{out}, Ch_4: I_{out}), pk-pk: 60.8 mV, fsw = 800 kHz**

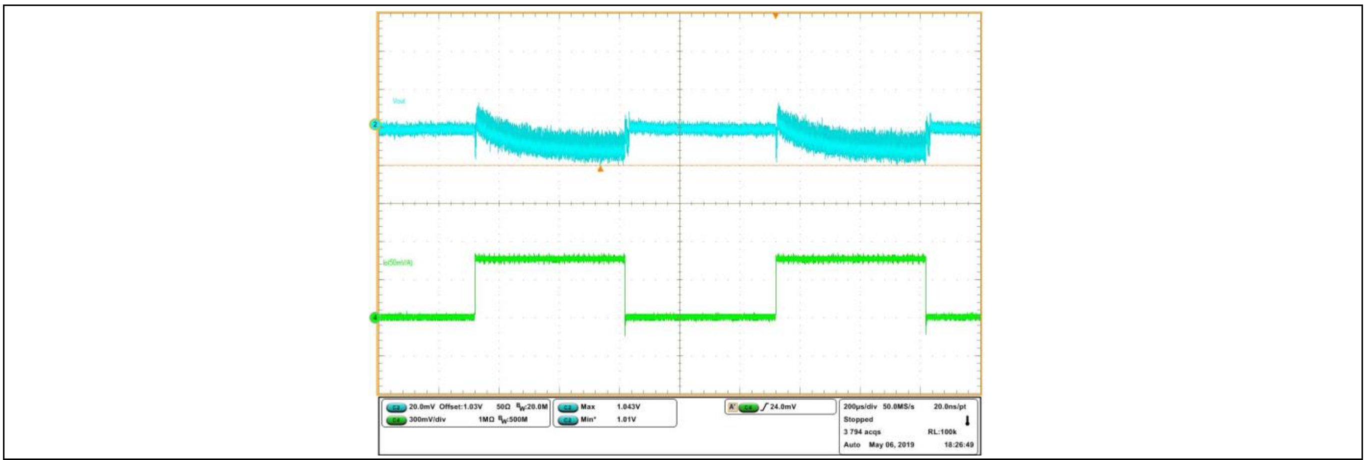


Figure 20 **In DEM, transient response at 9 A step-load current at 30 A/µs slew rate: I_{out} = 0 A to 9 A, (Ch2: V_{out}, Ch4: I_{out}) pk-pk: 42 mV, fsw = 800 kHz**

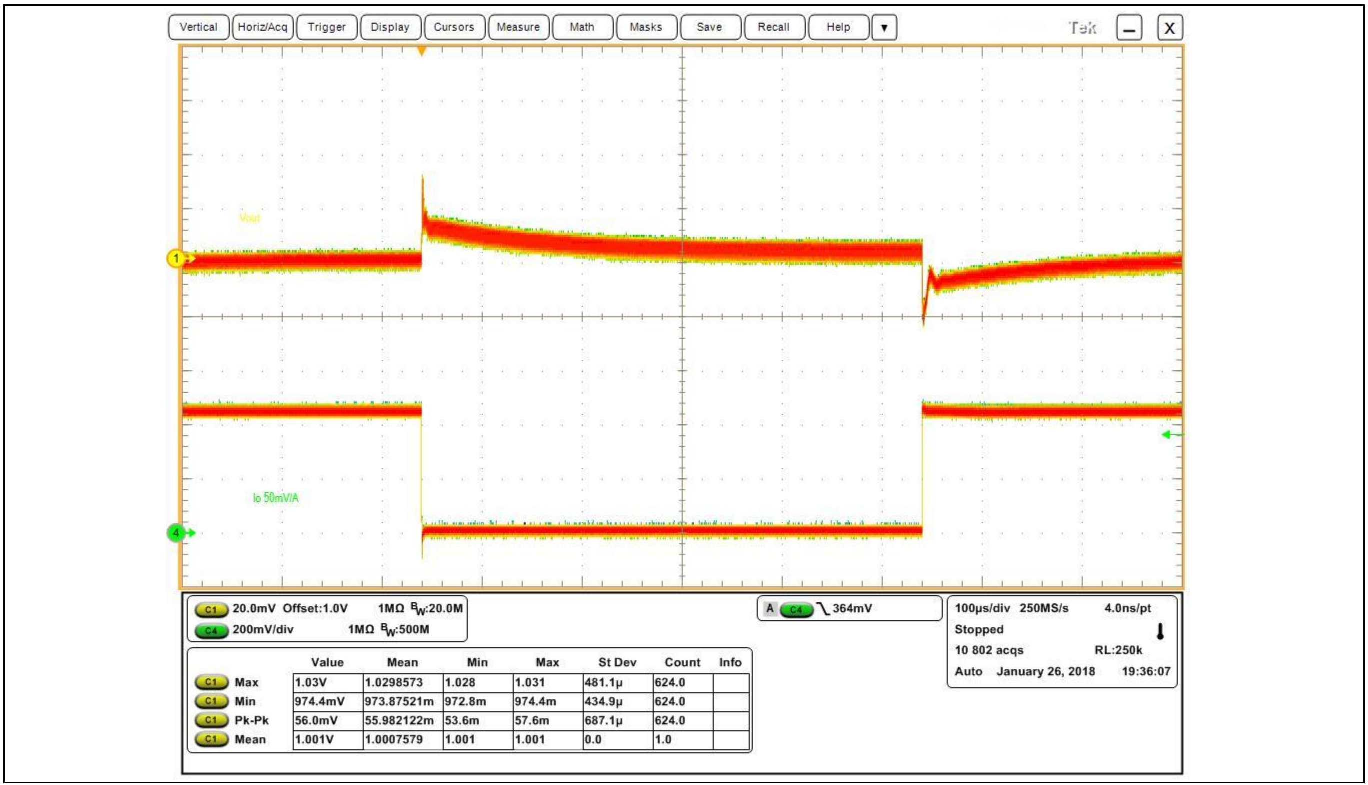


Figure 21 Transient response at 9 A step-load current at 30 A/µs slew rate: I_{out} = 0 A to 9 A, (Ch_1: V_{out}, Ch_4: I_{out}) pk-pk: 58 mV, fsw = 1000 kHz

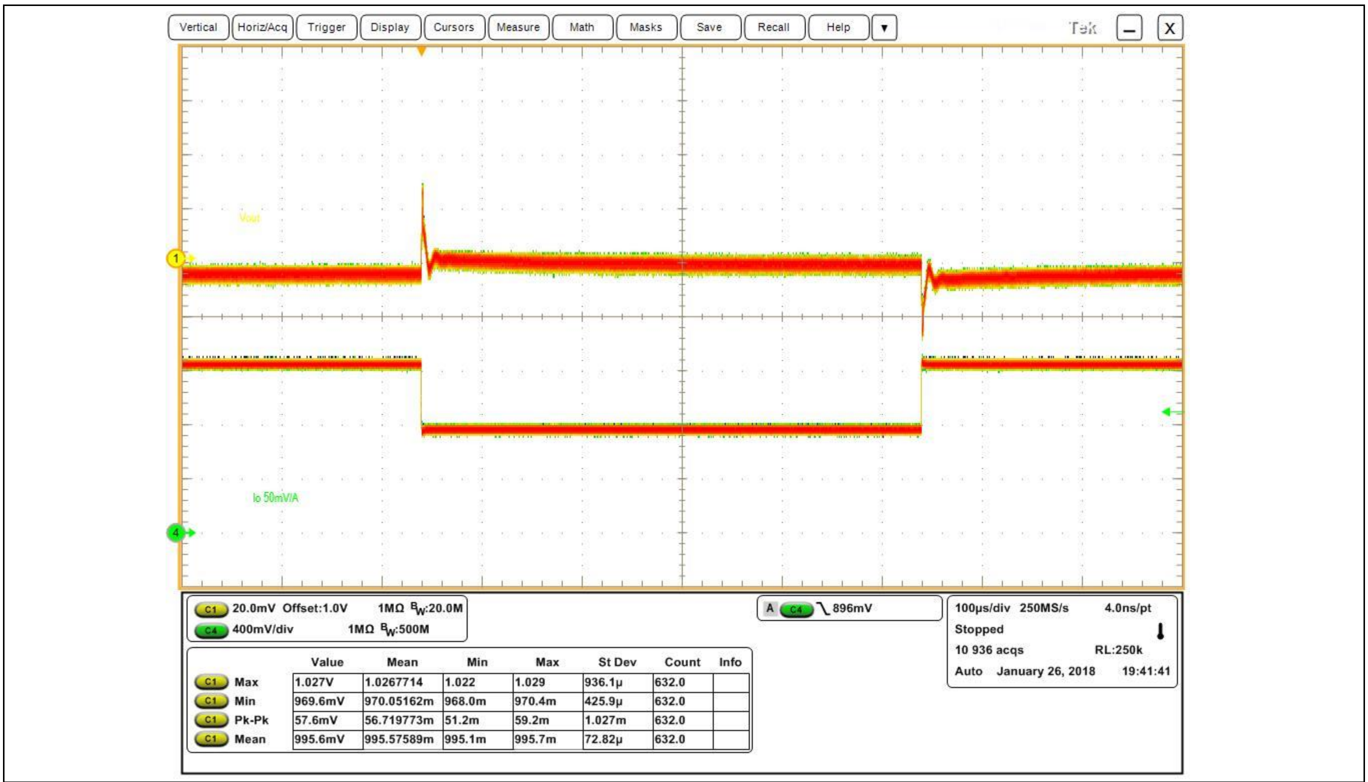


Figure 22 Transient response at 9 A step-load current at 30 A/µs slew rate: I_{out} = 16 A to 25 A, (Ch_1: V_{out}, Ch_4: I_{out}), pk-pk: 59.2 mV, fsw = 1000 kHz

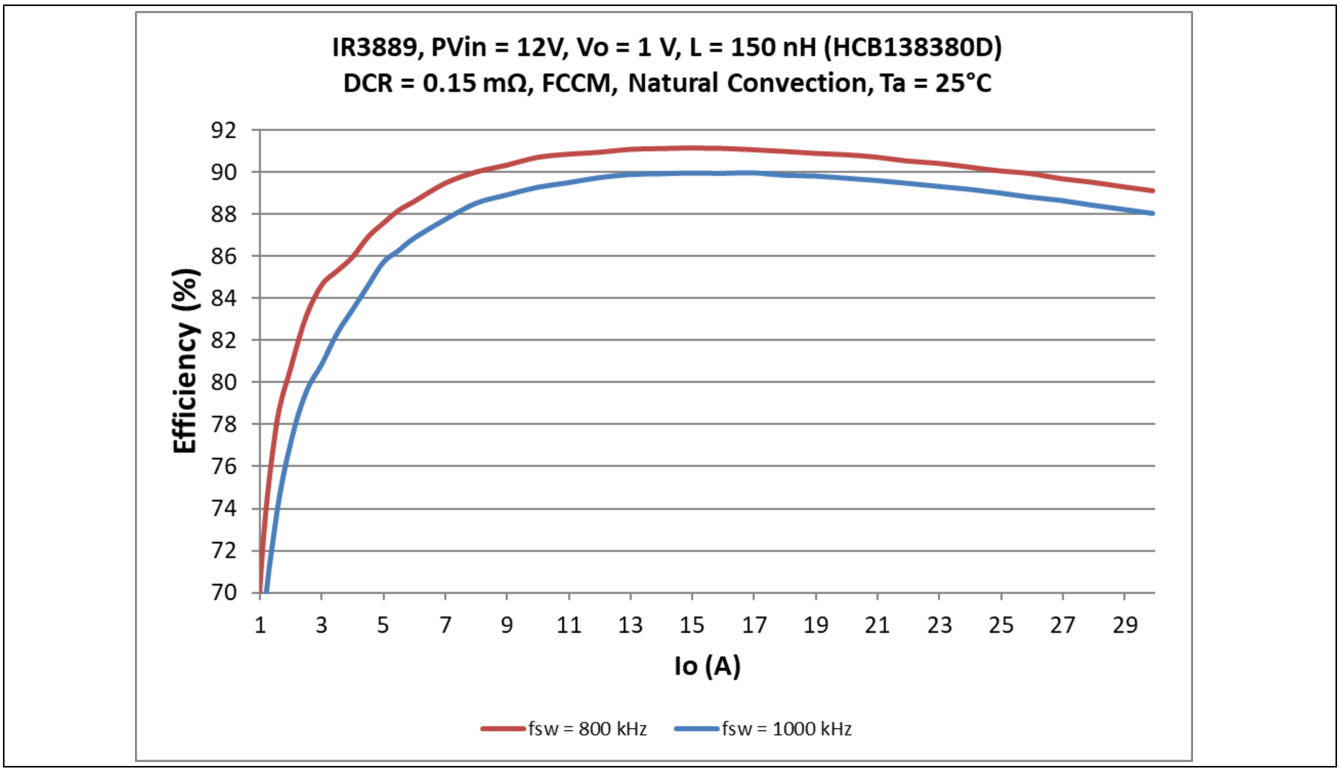


Figure 23 **Efficiency with natural convection (12 V_{in}, 1 V_{out}, 150 nH, 800 kHz/1000 kHz, T_a = 25°C)**

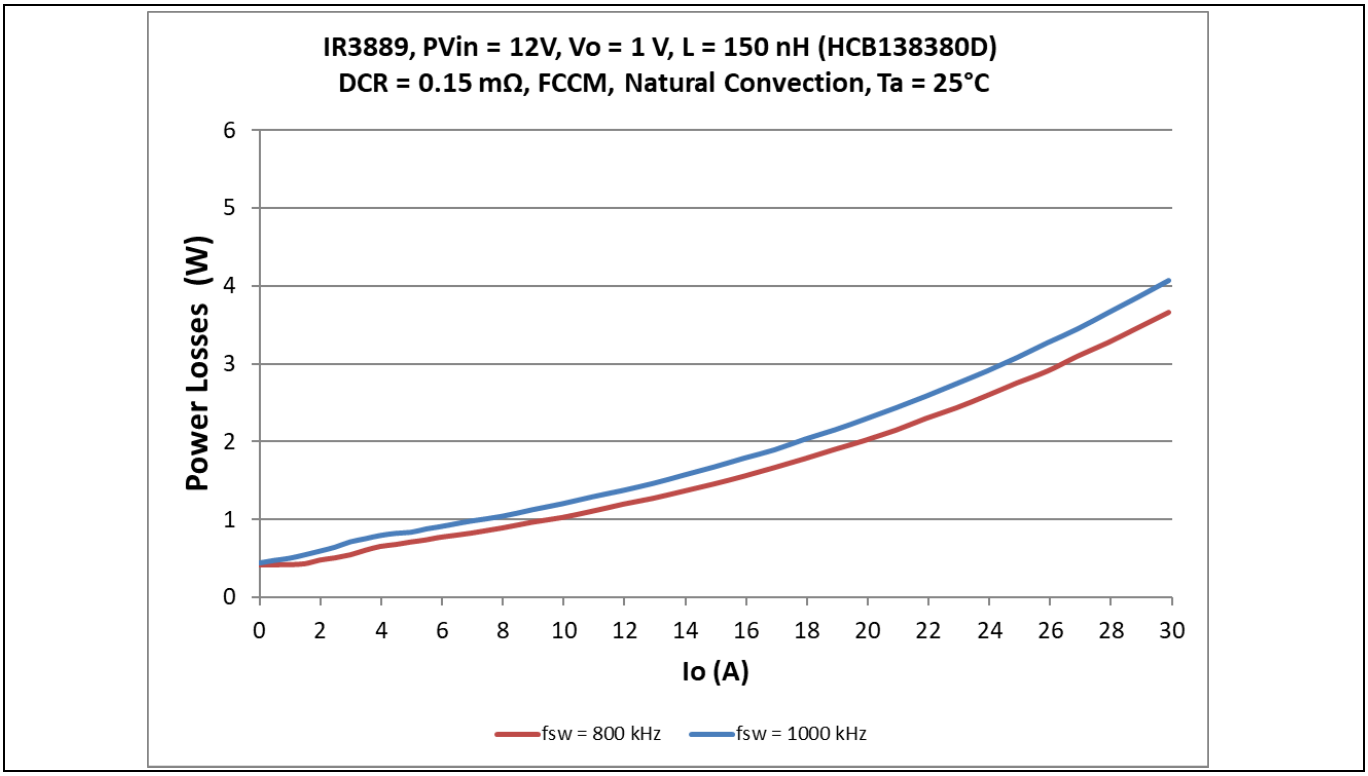


Figure 24 **Power loss with natural convection (12 V_{in}, 1 V_{out}, 150 nH, 800 kHz/1000 kHz, T_a = 25°C)**

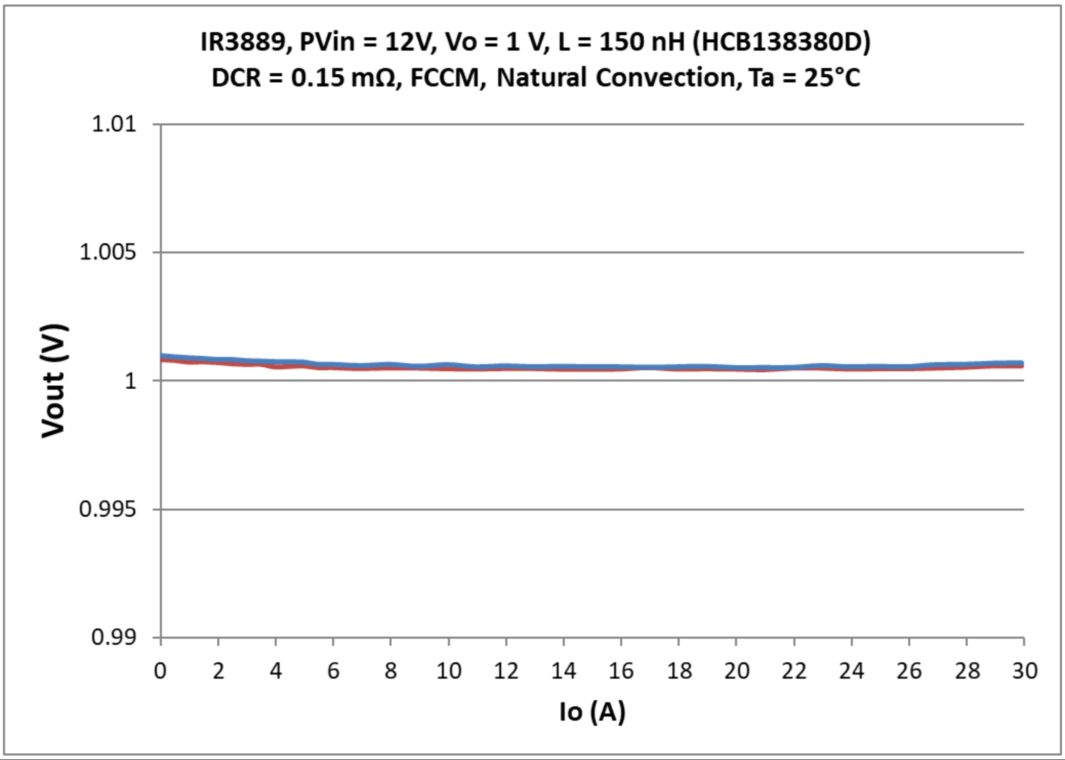


Figure 25 IR3889 V_{out} regulation (12 V_{in}, 1 V_{out}, 150 nH, 800 kHz/1000 kHz, T_a = 25°C)

Figure 26 Thermal image at 30 A load IR3889 = 75°C, L = 58°C, fsw = 800 kHz, T_a = 25°C, natural convection

Figure 27 Thermal image at 25 A load IR3889 = 60°C, L = 48°C, fsw = 800 kHz, T_a = 25°C, natural convection

Figure 28 Thermal image at 30 A load IR3889 = 80°C, L = 60°C, fsw = 1000 kHz, T_a = 25°C, natural convection

Figure 29 Thermal image at 25 A load IR3889 = 66°C, L = 50°C, fsw = 1000 kHz, T_a = 25°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	

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_022551