User manual for IR3899A evaluation board

9 A single-phase buck regulator with 1.2 V output

About this document

Scope and purpose

The IR3899A is a synchronous buck converter, providing a compact, high-performance and flexible solution in a small 4 mm x 5 mm power QFN package.

Key features offered by the IR3899A include internal digital soft-start, precision 0.6 V reference voltage, power good (P_{good}), thermal protection, programmable switching frequency in the range of 600 kHz to 2 MHz, 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_3899A_1.2Vout engineering evaluation board. The manual describes operation and use of the evaluation board itself. Detailed application information for IR3899A is available in the IR3899A datasheet.

Intended audience

This document is intended as a guide for design engineers evaluating IR3899A performance with the engineering EVAL_3899A_1.2Vout evaluation board.

Table of contents

1 Board information

1.1 Board features

V_{in} = +12 V, V_{out} = +1.2 V at 0 A to 9 A

F_{sw} = 600 kHz to 2000 kHz

L = 470 nH (11.15 mm x 10.0 mm x 3.8 mm, DCR = 1.3 mΩ)

C_{in} = 1 x 1 nF (50 V, ceramic 0402) + 1 x 4.7 nF (25 V, ceramic 0603) + 4 x 22 µF (25 V, ceramic 0805) + 2 x 100 µF (25 V, polymer, optional)

C_{out} = 3 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)

1.2 Connections and operating instructions

The IR3899A evaluation board requires a single +12 V for the input power and can deliver up to 9 A load current. The operation mode and switching frequency can be selected through a jumper configuration. Figure 1 highlights the demo board I/O connections and jumper configurations for power-up.

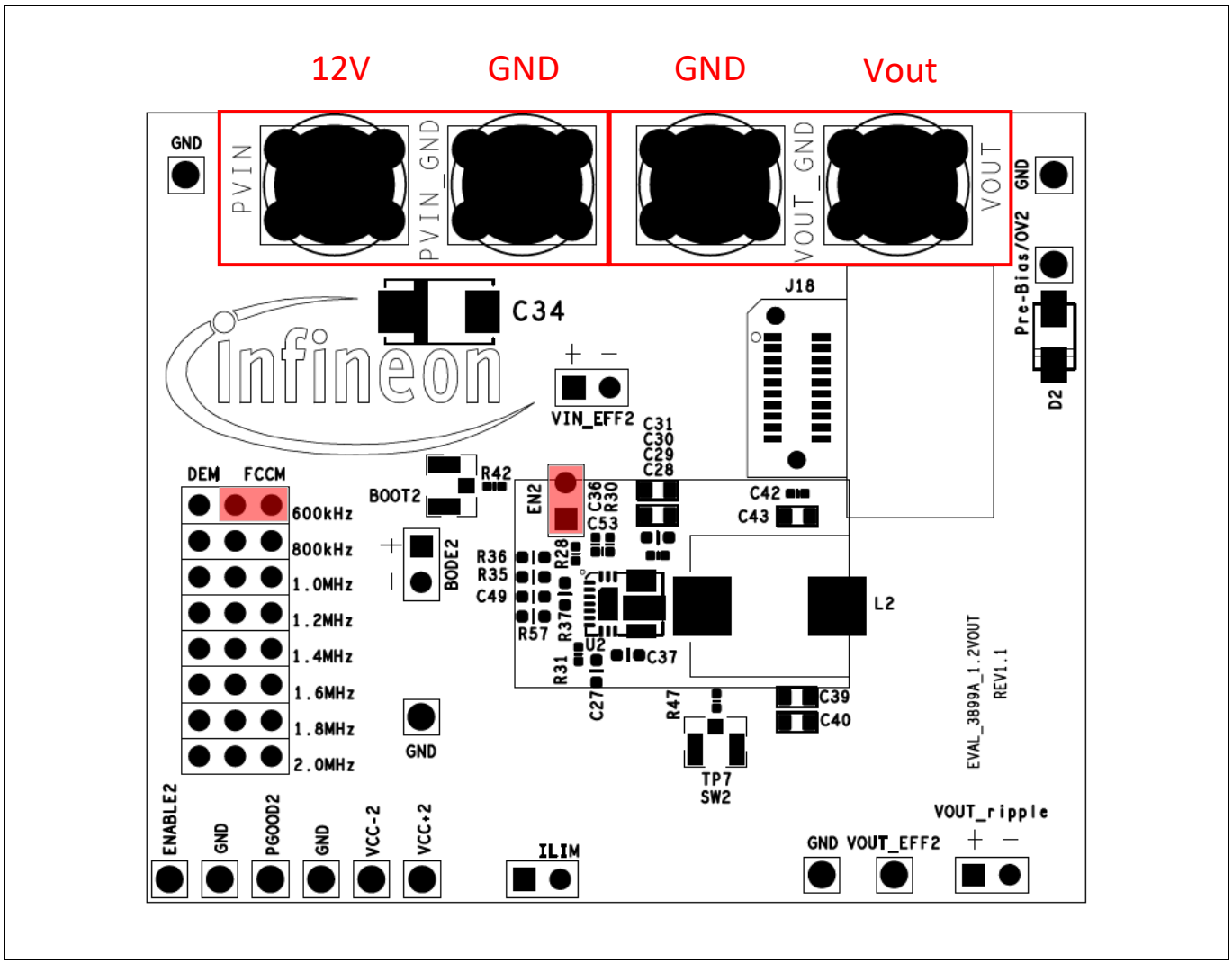

Figure 1 IR3899A evaluation board connections

Table 1 Connections

Label		Description
Input	PVIN	Connect input power (+12 V) to this pin
	PVIN_GND	Return of input power
	VIN_EFF2	Sense pins for the input voltage
Output	VOUT	Connect a load (9 A max.) to this pin
	VOUT_GND	Return of V_{out}
	VOUT_EFF2, GND	Sense pins for the output voltage, output voltage ripple
	VOUT_ripple	
Enable	ENABLE2	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	
	EN2	Use a jumper to use P_{Vin} for enable. Remove jumper if using an external enable.
Bode	BODE2	For bode plot measurement
OCP limit	ILIM	Use a jumper to make one of two OCP limit selections: short – 9 A and open – 12.7 A
T_{on}/Mode	FCCM	Use a jumper to select FCCM or DEM, and switching frequency. Eight preset switching frequencies are 600 kHz, 800 kHz, 1000 kHz, 1200 kHz, 1400 kHz, 1600 kHz, 1800 kHz and 2000 kHz.
	DEM	
P_{good}	PGOOD2	Connect a scope probe to this pin to monitor the power good signal
	GND	GND
V_{CC}	VCC+ 2	Connect a scope probe to this pin to monitor the output of the internal LDO
	VCC- 2	
Switch node	SW2	Use a UMCC cable to monitor the switch node on a scope
Boot	BOOT2	Use a UMCC cable to monitor the BOOT-to-GND voltage on a scope
Pre-bias	Pre-bias/OV2, GND	Use to apply an external pre-bias voltage on the output

1.3 Layout

The PCB is a four-layer board (2.6 in. x 2.2 in.) using FR4 material. The top, bottom and inner layers use 2 oz. copper. The PCB thickness is 0.062 in. The IR3899A and other major power components are mounted on the top side of the board.

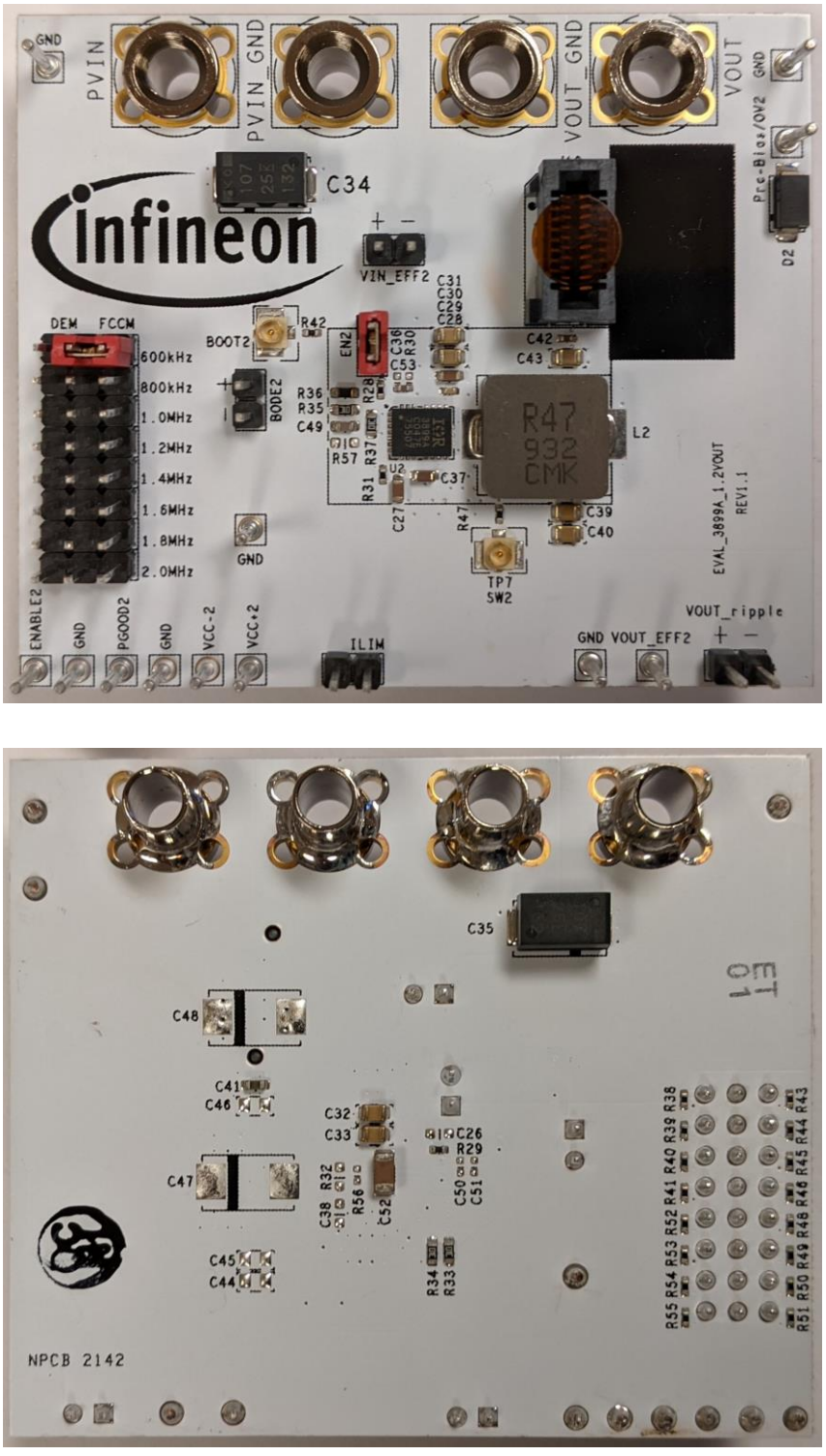

Figure 2 Top and bottom view of IR3899A evaluation board

1.4 PCB layout

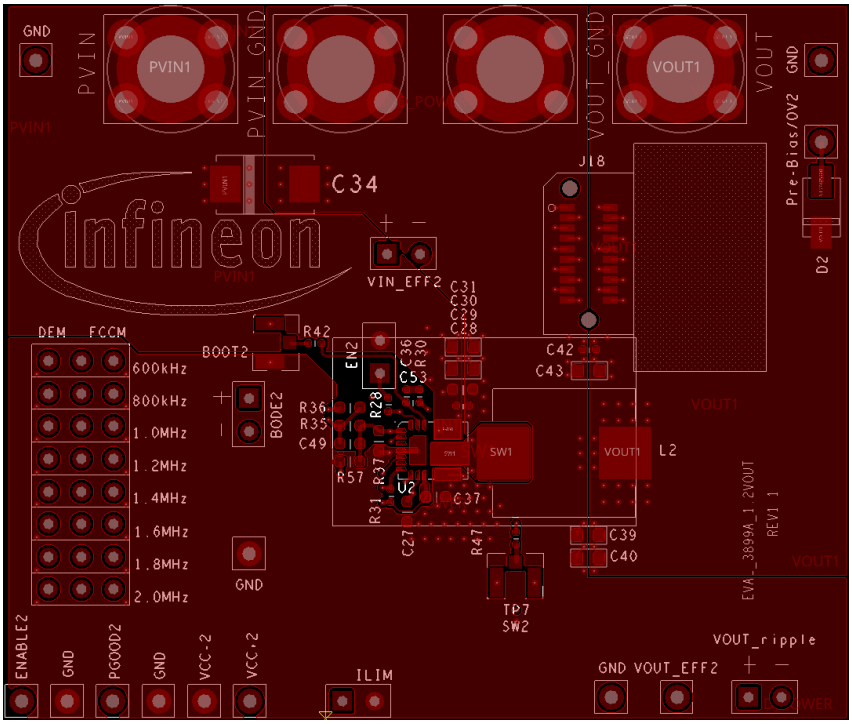

Figure 3 Top layer

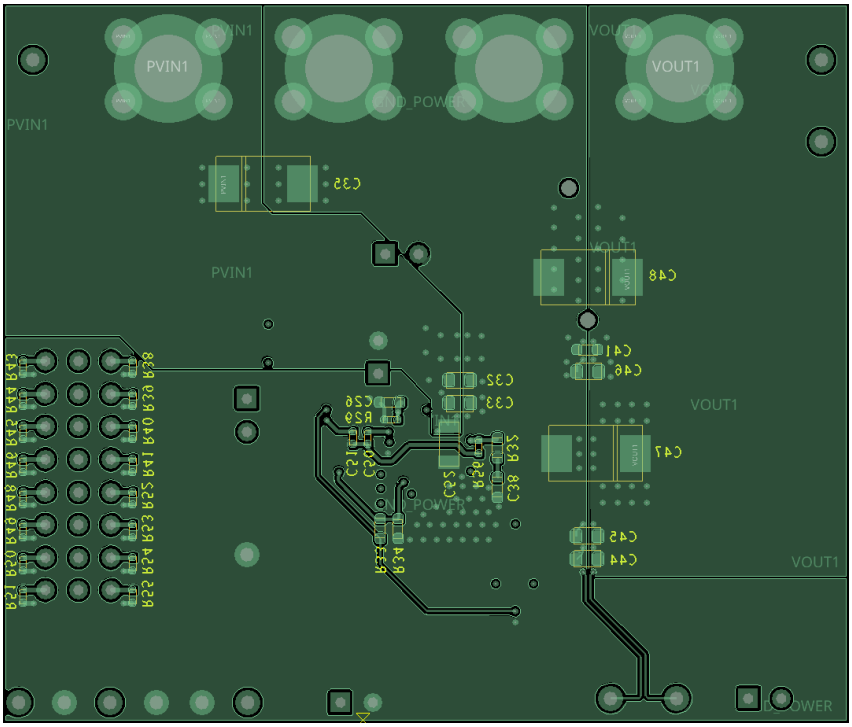

Figure 4 Bottom layer

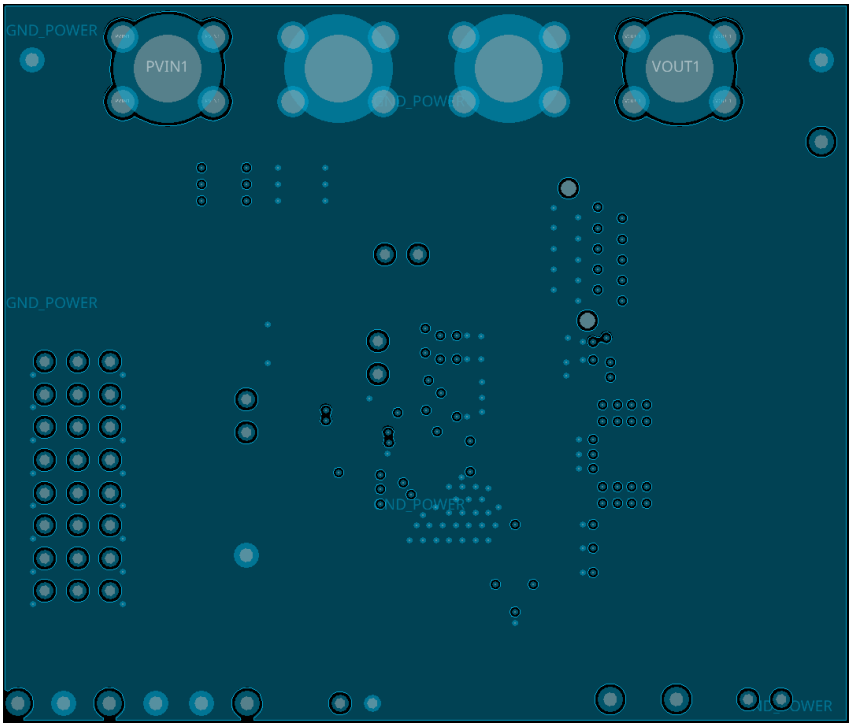

Figure 5 Mid layer 1

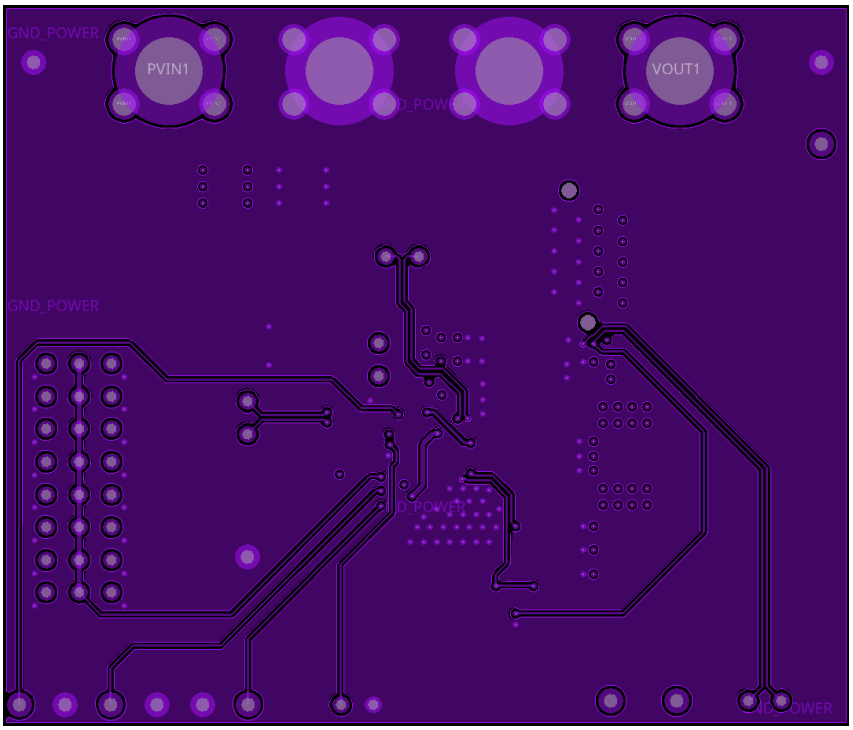

Figure 6 Mid layer 2

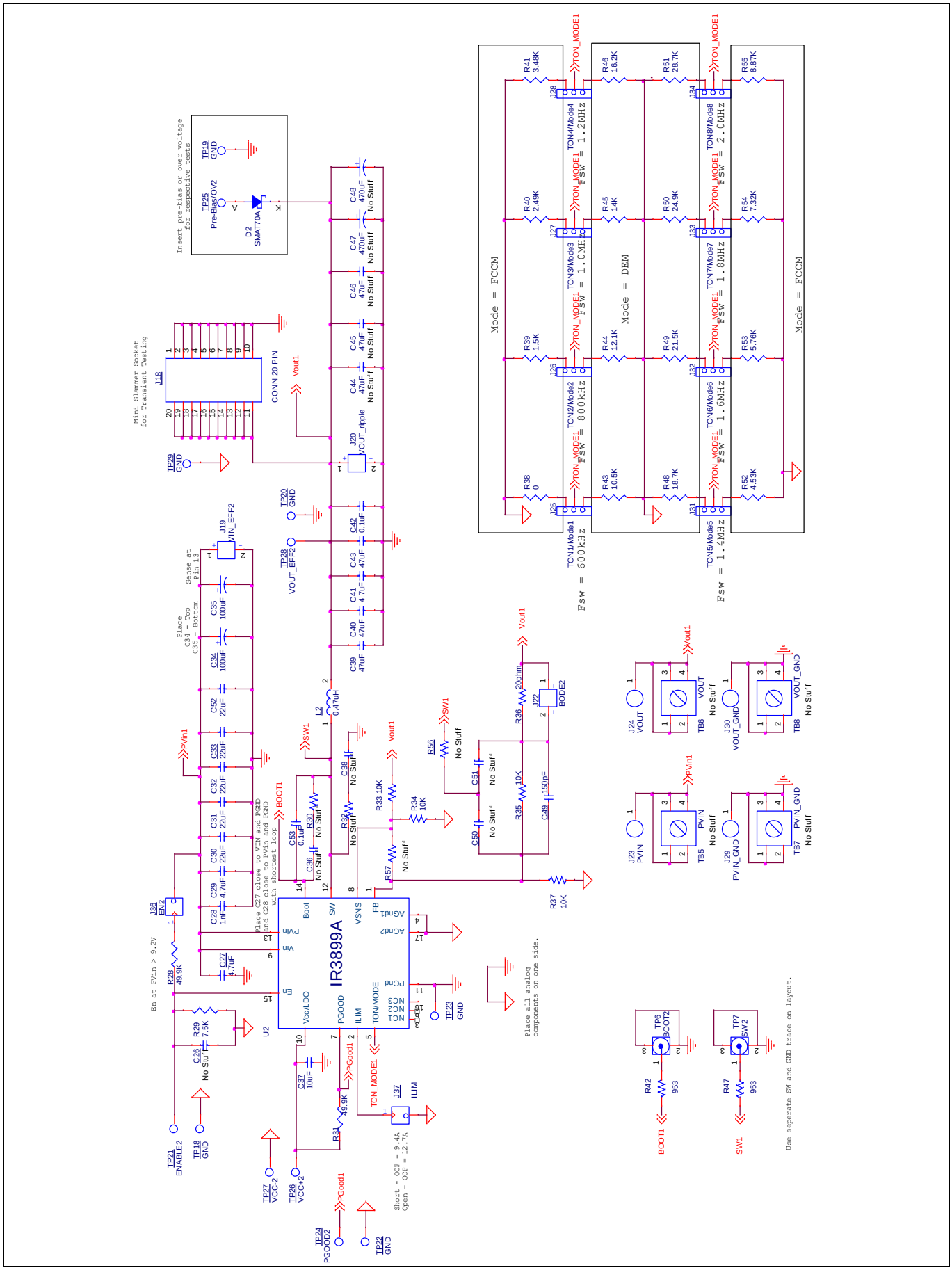

Figure 7 Schematic of the EVAL_3899A_1.2Vout board – V_{in} = 12 V, V_{out} = 1.2 V, I_{outmax} = 9 A

1.5 Bill of materials

Table 2 Bill of materials

Qty	Reference	Value	Manufacturer	Part number	Description
1	C28	1 nF	Samsung	CL05B102KB5NNNC	1 nF, 0402, 50 V, X7R, 10%
2	C42, C53	0.1 µF	TDK	C1005X7R1H104K050BB	0.1 µF, 0402, 50 V, X7R, 10%
2	C27, C29	4.7 µF	Murata	GRM188C81E475KE11D	4.7 µF, 0603, 25 V, X6S, 20%
1	C37	10 µF	Murata	GRM188C81C106MA73D	10 µF, 0603, 16 V, X6S, 20%
1	C41	4.7 µF	TDK	CGB3B3X5R0J475M055AB	4.7 µF, 0603, 6.3 V, X5R, 20%
1	C49	150 pF	Rohm	MCH185A151JK	150 pF, 0603, 50 V, C0G, 5%
4	C30, C31, C32, C33	22 µF	Murata	GRM21BR61E226ME44L	22 µF, 0805, 25 V, X5R, 20%
3	C39, C40, C43	47 µF	Samsung	CL21A476MQYNNNE	47 µF, 0805, 6.3 V, X5R, 20%
1	C52	22 µF	Samsung	CL31X226KAHN3NE	22 µF, 1206, 25 V, X6S, 10%
2	C34, C35	100 µF	Kemet	T521X107M025ATE030	Capacitor PolyTan 100 µF, 25 V, 20%, 2917
1	L2	0.47 µH	Delta	CMLS104T-R47MS	Inductor, SMT, 11p15x10 mm, 1.5 mΩ
2	R28, R31	49.9K	Yageo	RC0402FR-0749K9L	Resistor, 0402, 1/16 W, 0.1%
1	R29	7.5K	Yageo	RC0402FR-077K5L	Resistor, 0402, 1/16 W, 0.1%
1	R38	0	Yageo	RC0402FR-070RL	Resistor, 0402, 1/16 W, 0.1%
1	R39	1.5K	Yageo	RC0402FR-071K5L	Resistor, 0402, 1/16 W, 0.1%
1	R40	2.49K	Yageo	RC0402FR-072K49L	Resistor, 0402, 1/16 W, 0.1%
1	R41	3.48K	Yageo	RC0402FR-073K48L	Resistor, 0402, 1/16 W, 0.1%
2	R42, R47	953	Yageo	RC0402FR-07953RL	Resistor, 0402, 1/16 W, 1%
1	R43	10.5K	Yageo	RC0402FR-0710K5L	Resistor, 0402, 1/16 W, 0.1%
1	R44	12.1K	Yageo	RC0402FR-0712K1L	Resistor, 0402, 1/16 W, 0.1%
1	R45	14K	Yageo	RC0402FR-0714KL	Resistor, 0402, 1/16 W, 0.1%
1	R46	16.2K	Bourns Inc.	CR0402-FX-1622GLF	Resistor, 0402, 1/16 W, 0.1%
1	R48	18.7K	Yageo	RC0402FR-0718K7L	Resistor, 0402, 1/16 W, 0.1%

Qty	Reference	Value	Manufacturer	Part number	Description
1	R49	21.5K	Yageo	RC0402FR-0721K5L	Resistor, 0402, 1/16 W, 0.1%
1	R50	24.9K	Yageo	RC0402FR-0724K9L	Resistor, 0402, 1/16 W, 0.1%
1	R51	28.7K	Yageo	RC0402FR-0728K7L	Resistor, 0402, 1/16 W, 0.1%
1	R52	4.53K	Yageo	RC0402FR-074K53L	Resistor, 0402, 1/16 W, 0.1%
1	R53	5.76K	Yageo	RC0402FR-075K76L	Resistor, 0402, 1/16 W, 0.1%
1	R54	7.32K	Yageo	RC0402FR-077K32L	Resistor, 0402, 1/16 W, 0.1%
1	R55	8.87K	Yageo	RC0402FR-078K87L	Resistor, 0402, 1/16 W, 0.1%
4	R33, R34, R35, R37	10K	Yageo	RC0603FR-0710KL	Resistor, 0603, 1/10 W, 1%
1	R36	20 Ω	Yageo	RC0603FR-0720RL	Resistor, 0603, 1/10 W, 1%
8	J25, J26, J27, J28, J31, J32, J33, J34	–	Harwin	M20-9990346	Header, 1x3, TH, 0.025 sq, 0.1 inch space
5	J36, J37, J19, J20, J22	–	Harwin	M20-9990246	Header, 1x2, TH, 0.025 sq, 0.1 inch space
2	TP6, TP7	–	TE Conn./Amp	1909763-1	UMCC receptor style A
1	J18	Connector 20-pin	3M	HSEC8-110-01-S-DV-A-K-TR	3M edge connector SPD08
1	D2	SMAT70A	Diodes, Inc.	SMAT70A	Transient voltage suppressor, SMA, 3.5 V,40 A
12	TP18, TP19, TP20, TP22, TP23, TP29, TP21, TP24, TP25, TP26, TP27, TP28	–	Vector	K24C/M	Test point V1055_ND
4	J23, J24, J29, J30	–	Keystone Electronics	575-8	Connector banana jack solder
1	U2	IR3899A	Infineon	IR3899A	IR3899A PQFN 4x5 mm

2 Typical operating waveforms

V_{in} = 12.0 V, V_{out} = 1.2 V, I_{out} = 0 A to 9 A, room temperature with no airflow.

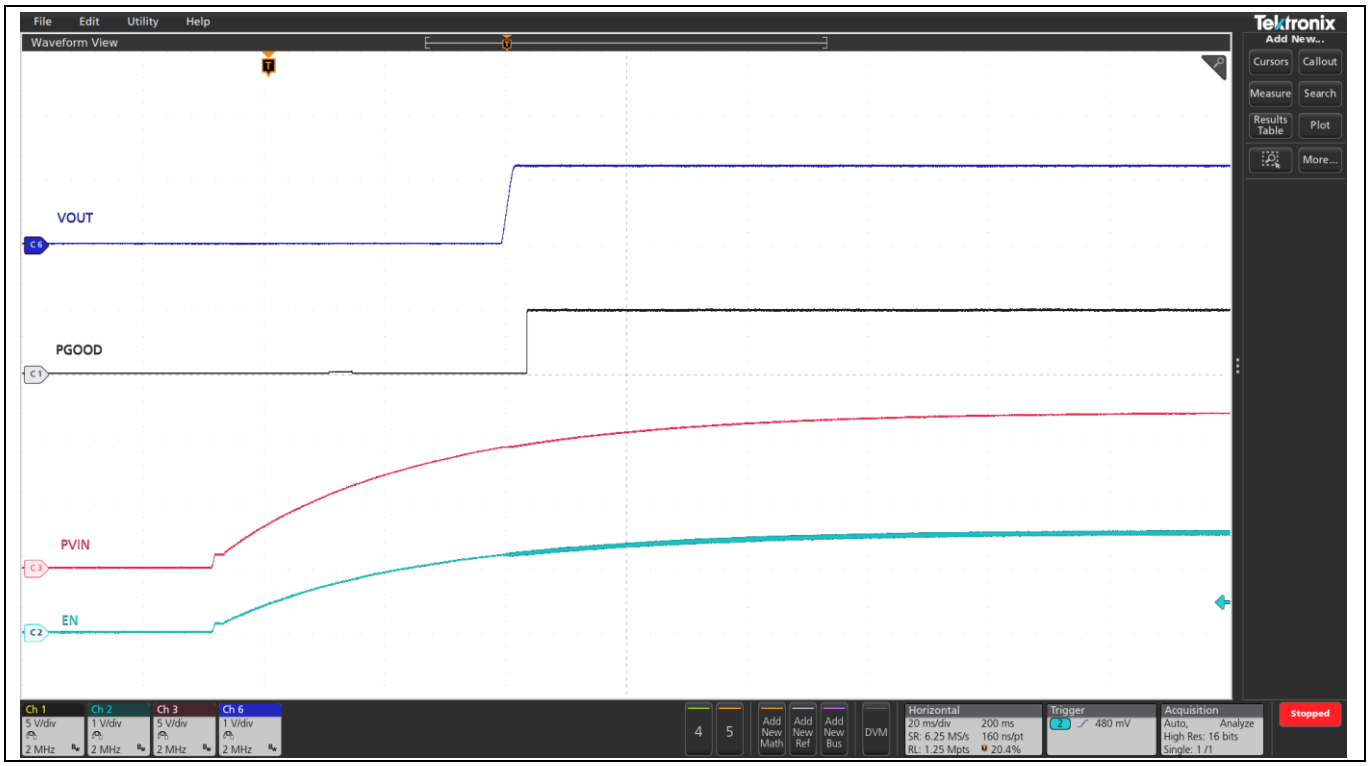

Figure 8 Start-up at 9 A load, (Ch1: P_{good}, Ch2: EN, Ch3: P_{Vin}, Ch6: V_{out})

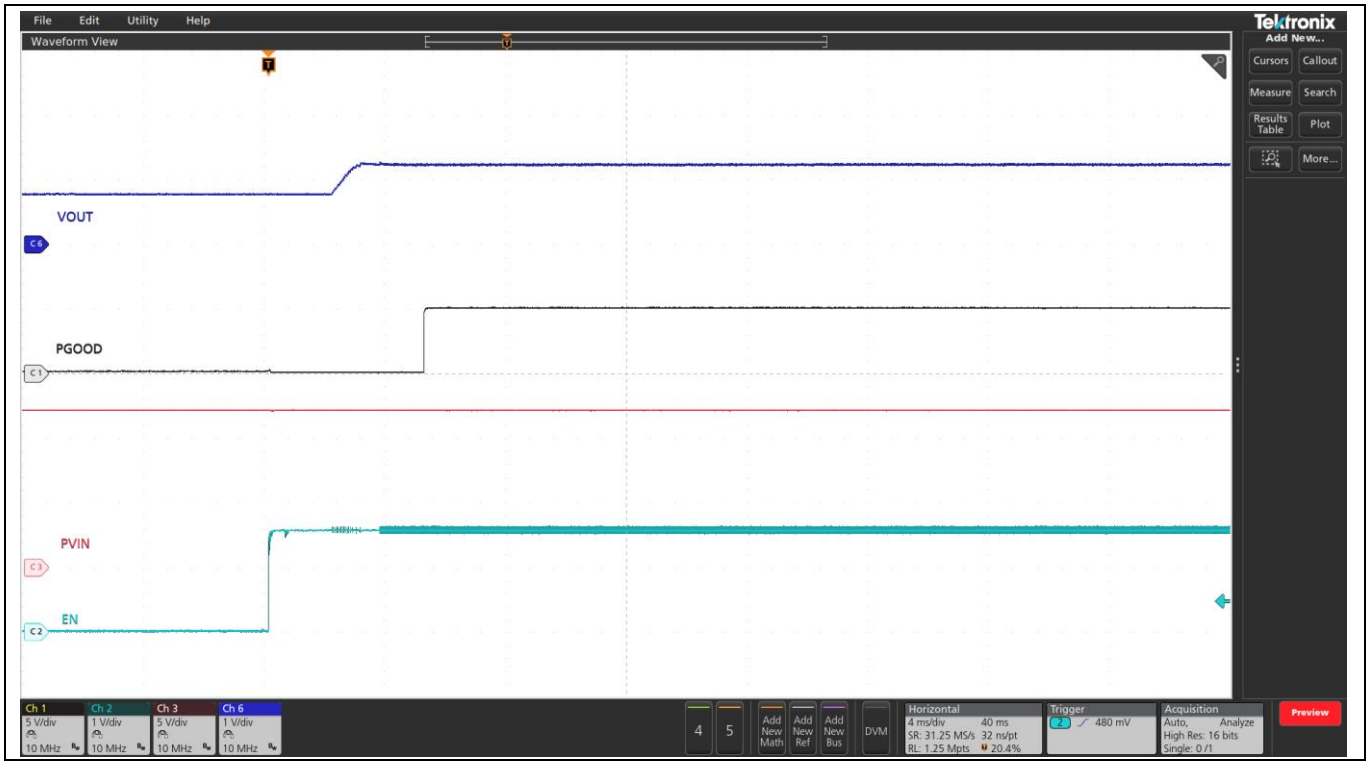

Figure 9 Pre-bias start-up at 0 A load, (Ch1: P_{good}, Ch2: EN, Ch3: P_{Vin}, Ch6: V_{out})

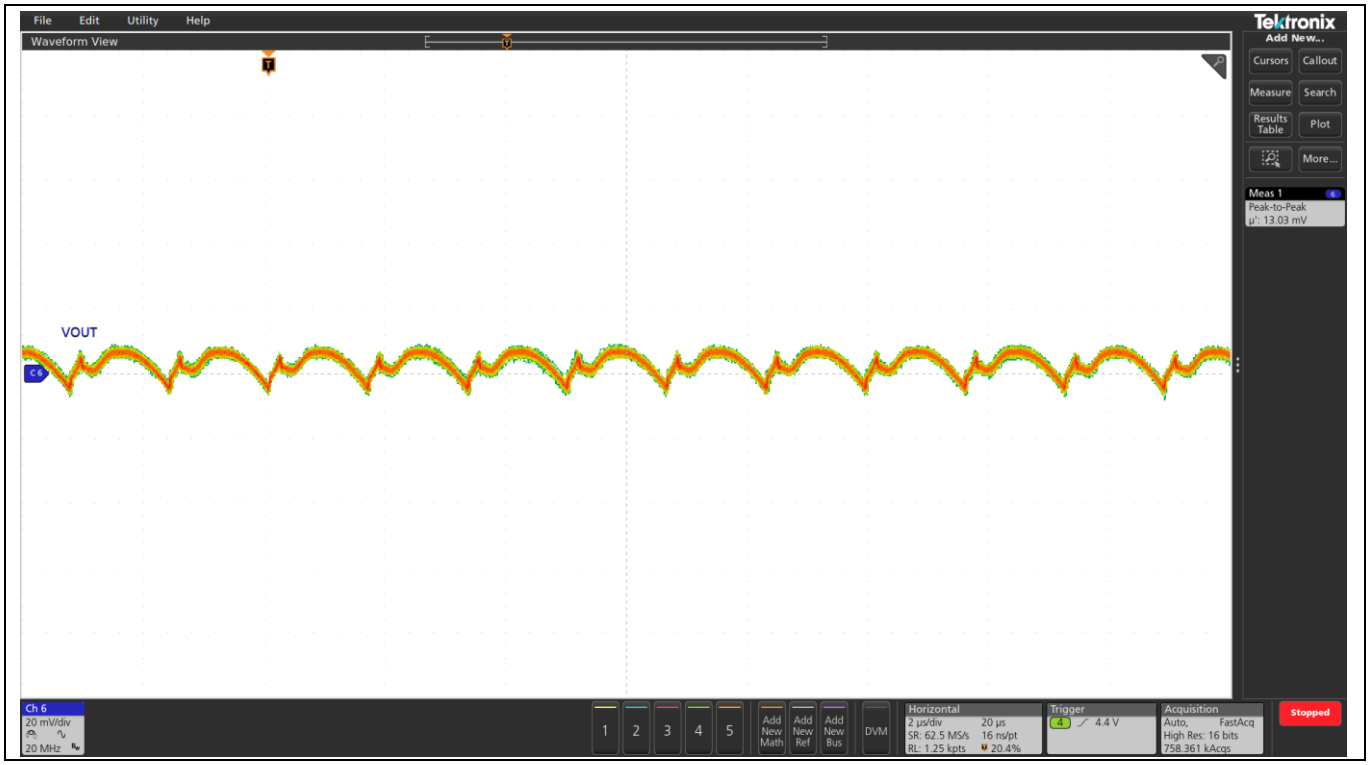

Figure 10 **V_{out} ripple at 9 A load, F_{sw} = 600 kHz, (Ch6: V_{out})**

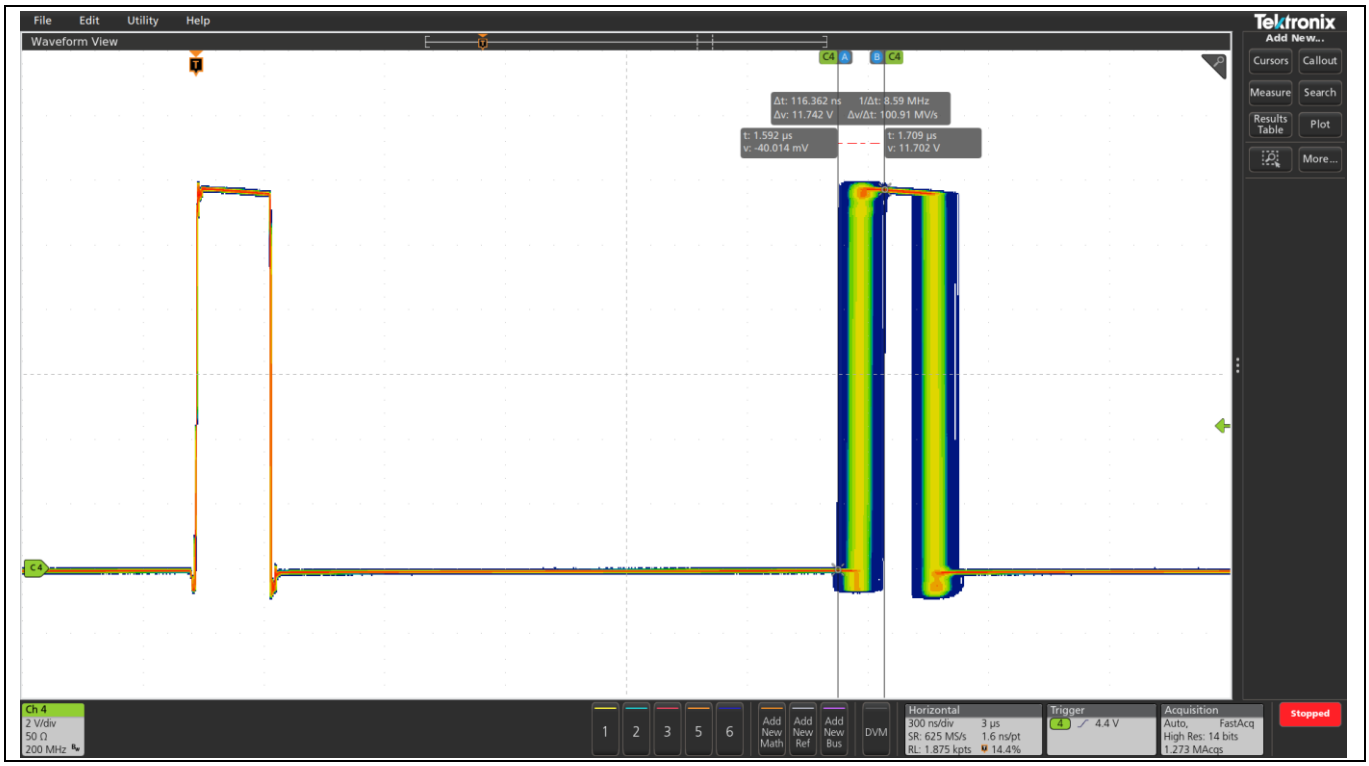

Figure 11 **SW node, 9 A load, F_{sw} = 600 kHz, (Ch4: SW)**

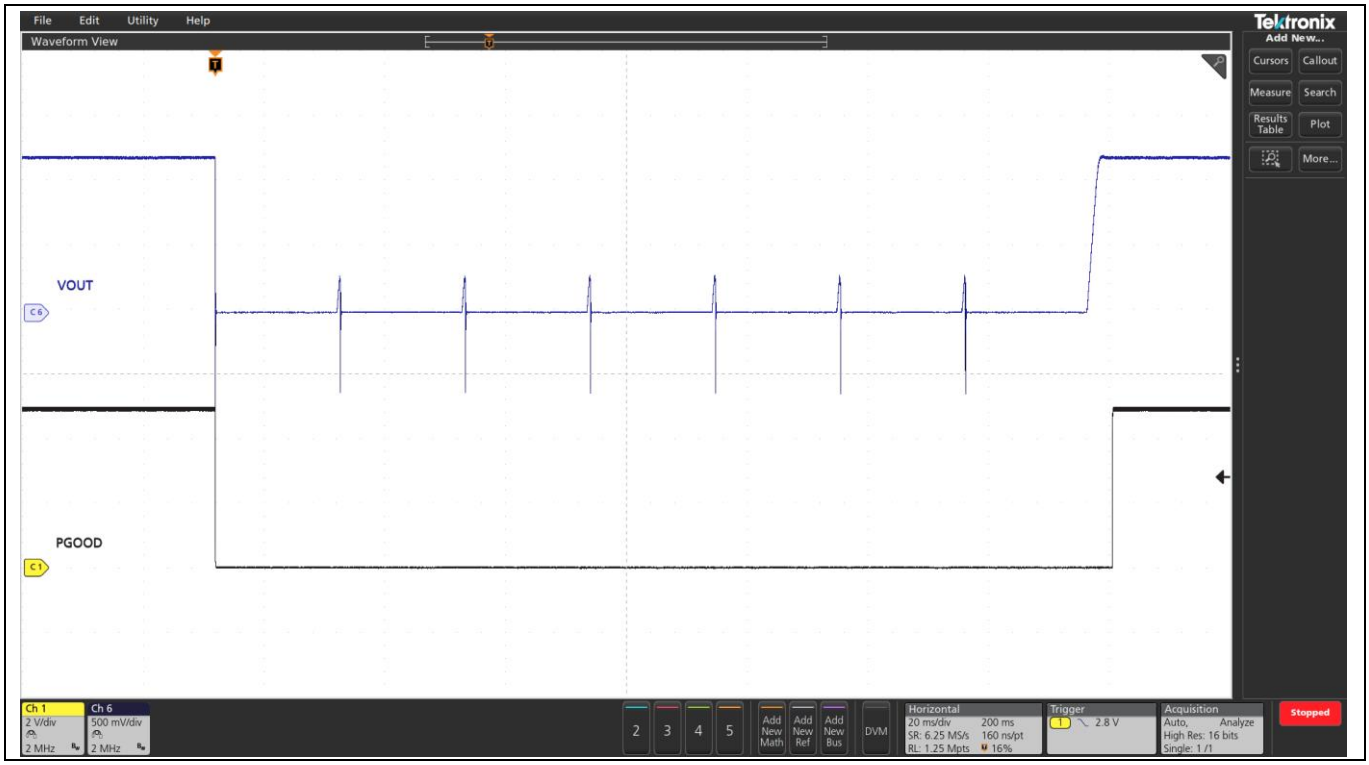

Figure 12 Short-circuit and UVP (hiccup and recovery, Ch1: P_{good}, Ch6: V_{out})

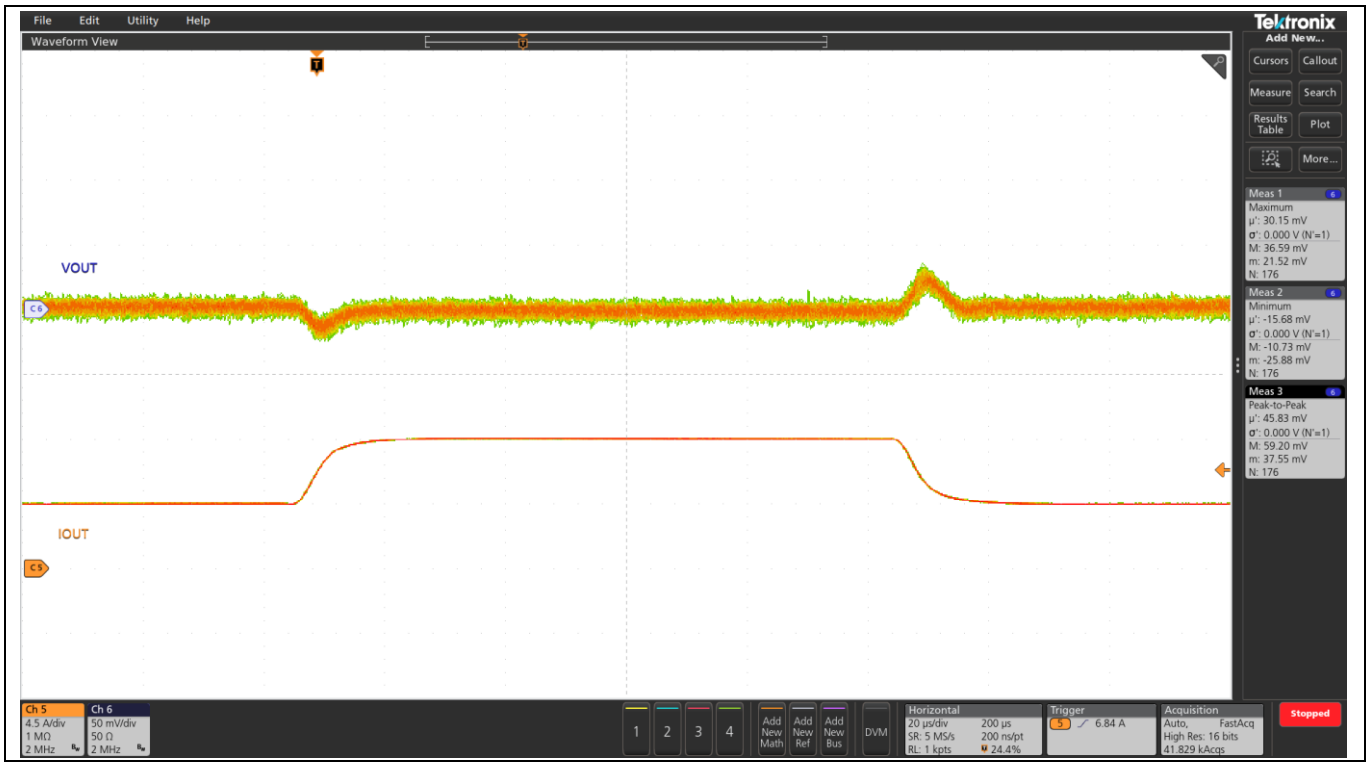

Figure 13 Transient response at 4.5 A step load current: I_{out} = 4.5 A to 9 A (Ch6: V_{out}, Ch5: I_{out}), pk-pk: 45.8 mV, F_{sw} = 600 kHz

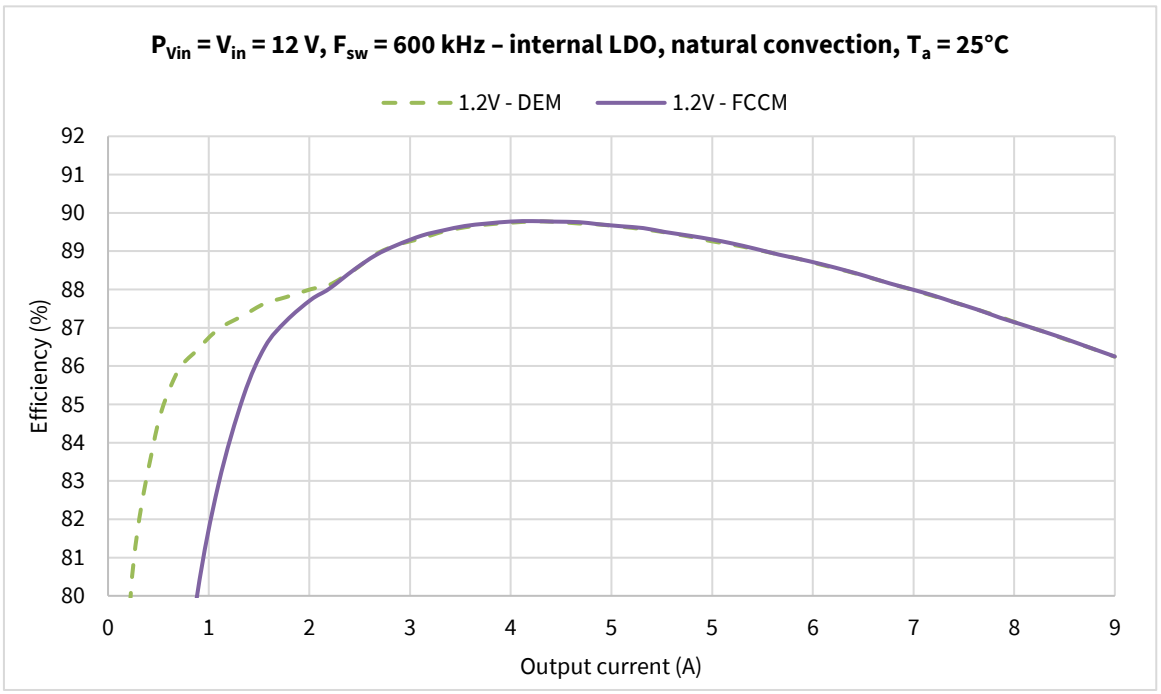

Figure 14 **Efficiency vs. load current natural convection (12 V_{in}, 1.2 V_{out}, 470 nH, 600 kHz, T_a = 25°C, FCCM: solid line, DEM: dashed line)**

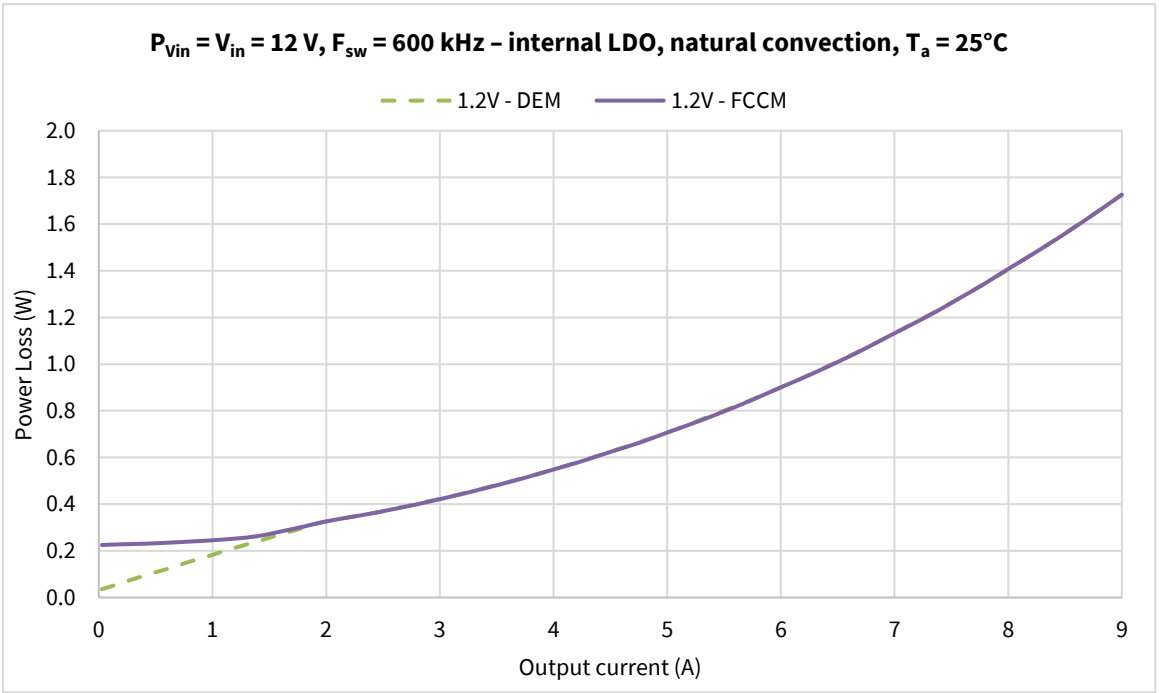

Figure 15 **Power loss vs. load current, natural convection (12 V_{in}, 1.2 V_{out}, 470 nH, 600 kHz, T_a = 25°C, FCCM: solid line, DEM: dashed line)**

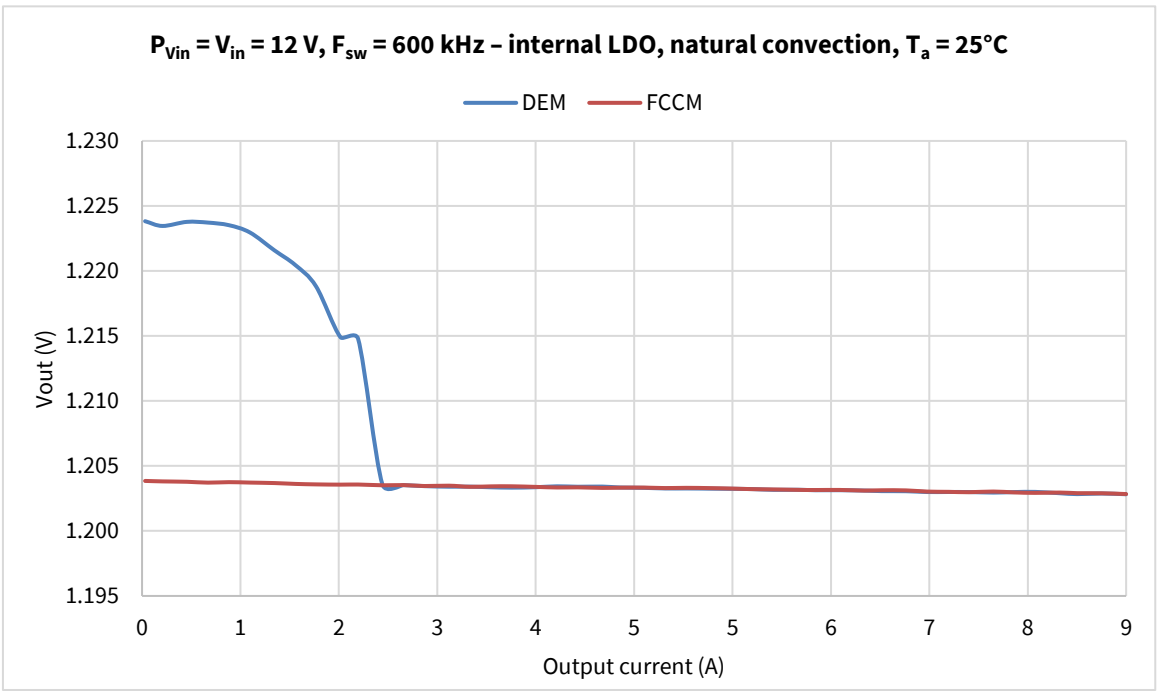

Figure 16 **IR3899A V_{out} regulation (12 V_{in}, 1.2 V_{out}, 470 nH, 600 kHz, T_a = 25°C, FCCM: solid line, DEM: dashed line)**

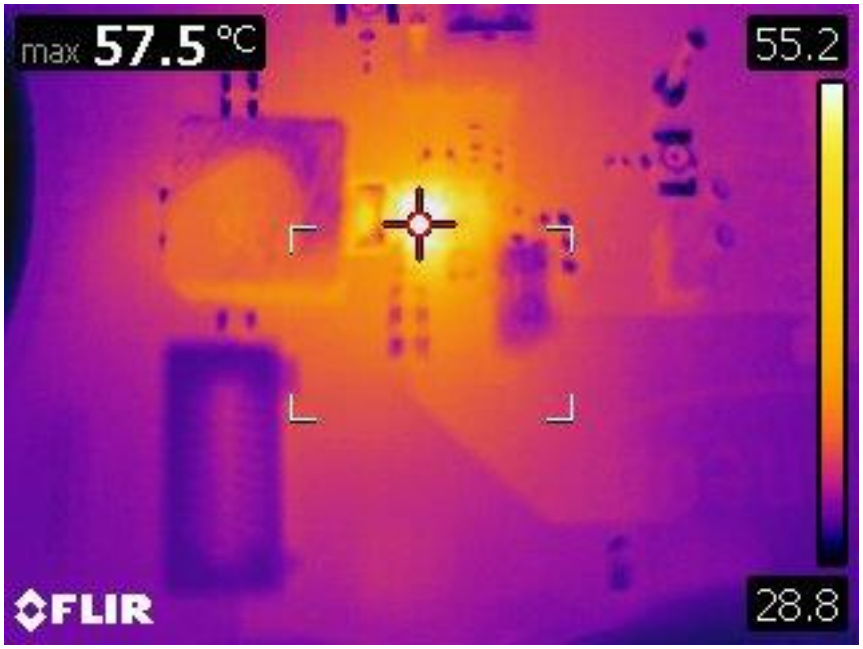

Figure 17 **Thermal image of the board at 9 A load IR3899A = 57.5°C, F_{sw} = 600 kHz, T_a = room temperature, natural convection**

Revision history

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

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