User manual for TDA38827 evaluation board

25 A single-phase buck regulator with 1.0 V output

About this document

Scope and purpose

The TDA38827 is a synchronous buck converter, providing a compact, high-performance and flexible solution in a small 6 mm x 5 mm power QFN package.

Key features offered by the IR38827 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 or unlatched 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 thermaly compensated.

This user manual contains the schematic and bill of materials for the EVAL_38827_1Vout engineering evaluation board. The manual describes operation and use of the evaluation board itself. Detailed application information for TDA38827 is available in the TDA38827 datasheet.

Intended audience

This document is intended as a guide for design engineers evaluating TDA38827 performance with the engineering EVAL_38827_1Vout demo board.

Table of contents

1 Board information

1.1 Board features

V_{in} = +12 V, V_{out} = +1.0 V at 0 to 25 A

F_s = 600 kHz/800 kHz/1000 kHz

L= 150 nH (9.6 mm x 6.4 mm x 10 mm, DCR = 0.145 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 x 470 µF (2 V, 6 mΩ, SP-cap)

1.2 Connections and operating instructions

TDA38827 demo board requires a single +12 V for the input power and can deliver up to 25 A load current. The operation modes and OCP limits can be selected through jumpers.

Table 1 Connections

Label		Descriptions
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}	Connect a load (25 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 onboard enable signal
	GND	
Bode	A	For bode plot measurement
	B	
SS/Latch	OVP latch	Use a jumper to make 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. Four preset switching frequencies are 600 kHz, 800 kHz, 1000 kHz and 1200 kHz. One additional jumper is a placeholder for user-selected switching frequency.
	DEM	
ILIM		Use a jumper to select one of four OCP limits. OCP4 is the highest OCP limit and OCP1 is the lowest OCP limit.
PGood	PGood	Connect a scope probe to this pin to monitor power good signal
	GND	GND
	EPGb	External PGood pull-up bias pin. The PGood 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 PGood pull-up bias can be applied to the EPGb pin.
V_{CC}	V_{CC}	The 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 (3.75 in. x 3.0 in.) using FR4 material. The top and bottom layers use 1.5 oz. copper and the inner layers use 2 oz. copper. The PCB thickness is 0.062 in. The TDA38827 and other major power components are mounted on the top side of the board.

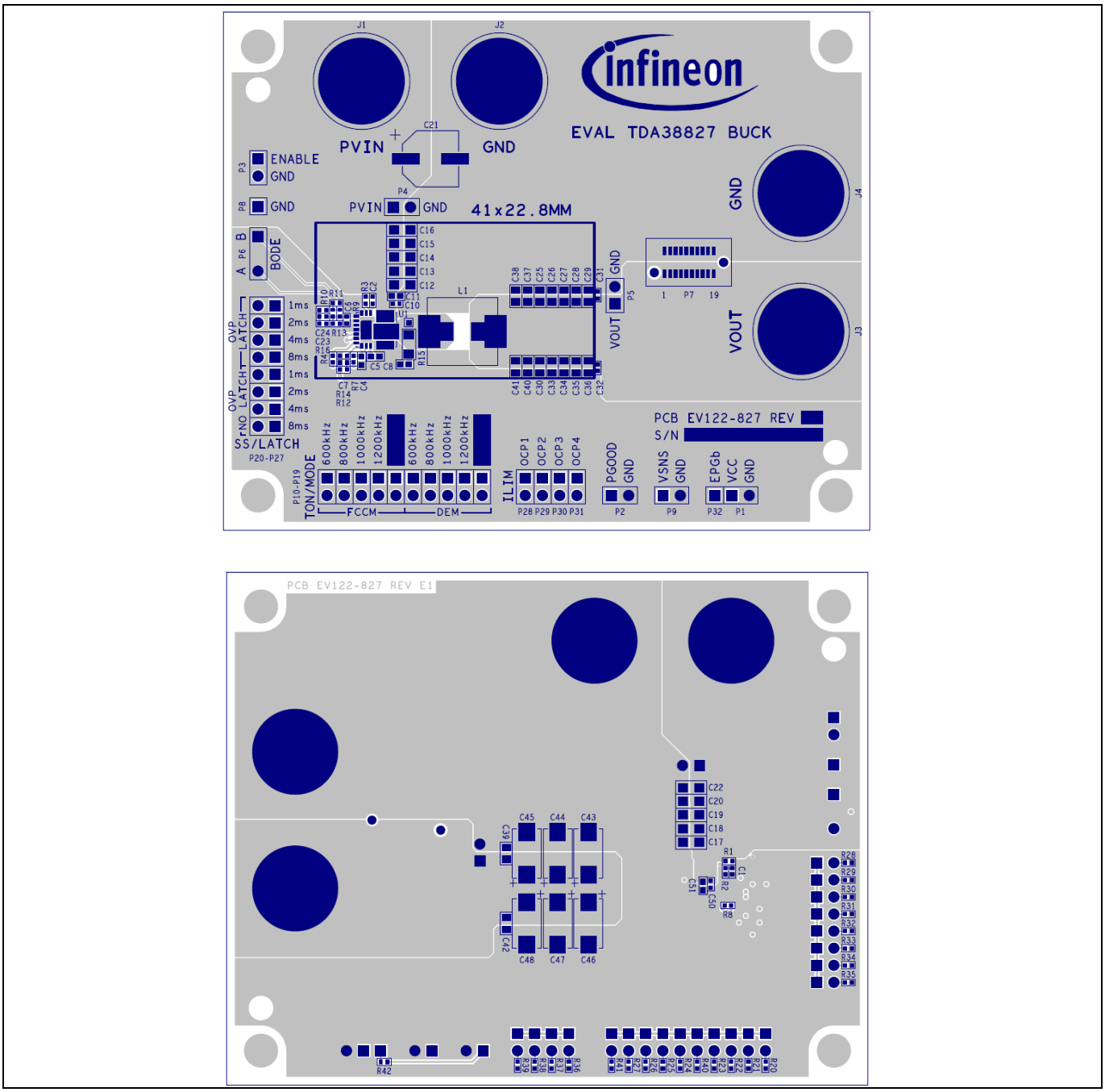

Figure 1 Top and bottom view of TDA38827 evaluation board

1.4 PCB layout

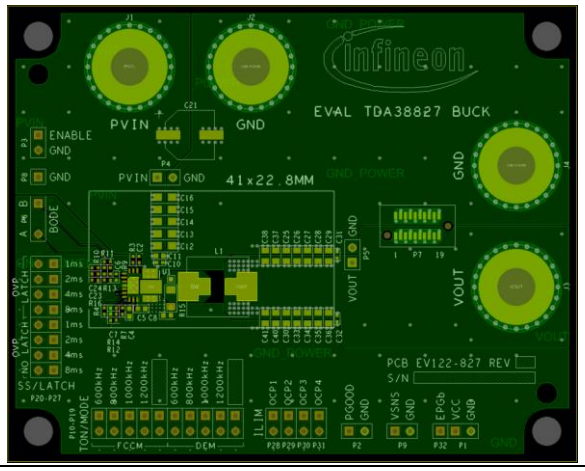

Figure 2 Top layer

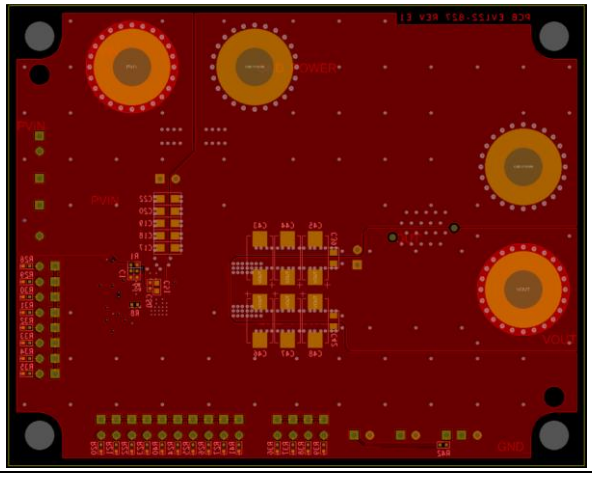

Figure 3 Bottom layer

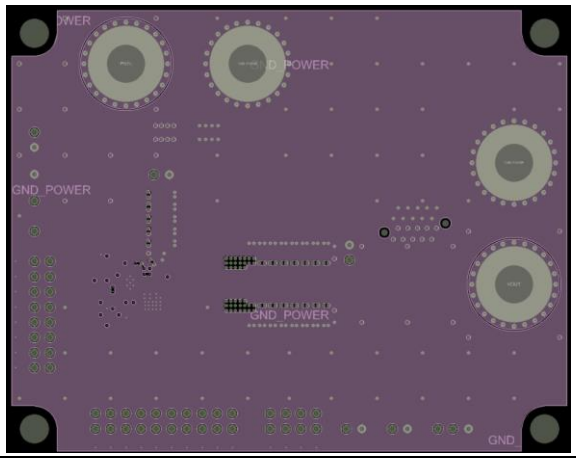

Figure 4 Mid layer 1

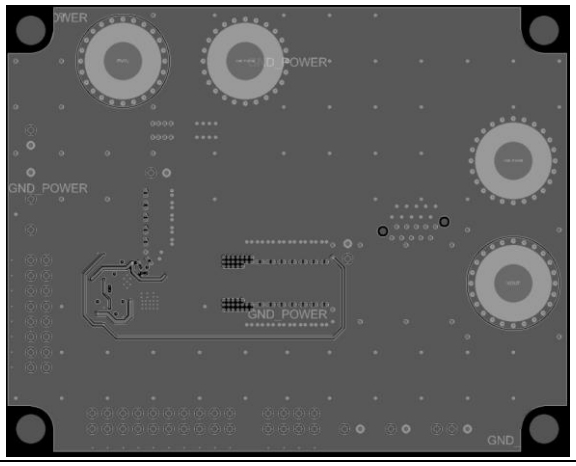

Figure 5 Mid layer 2

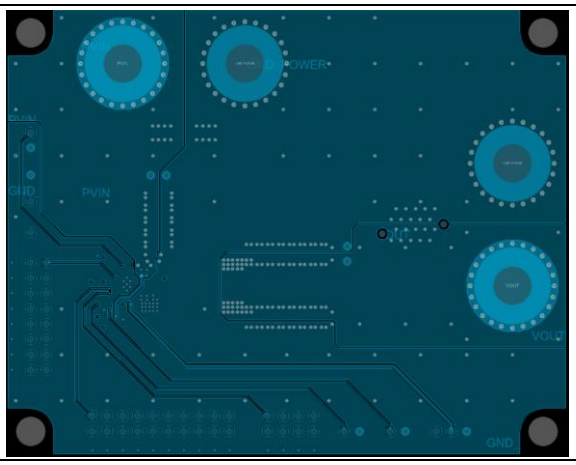

Figure 6 Mid layer 3

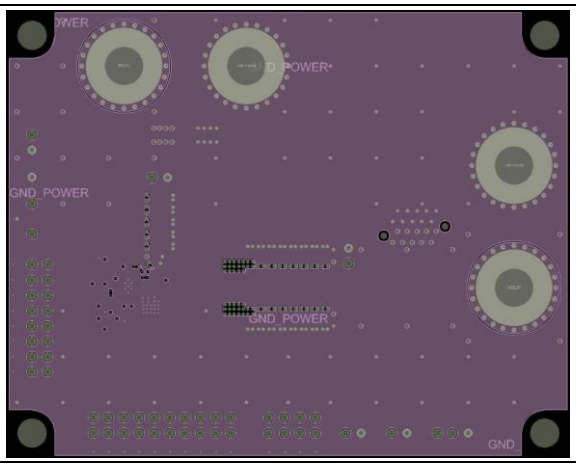

Figure 7 Mid layer 4

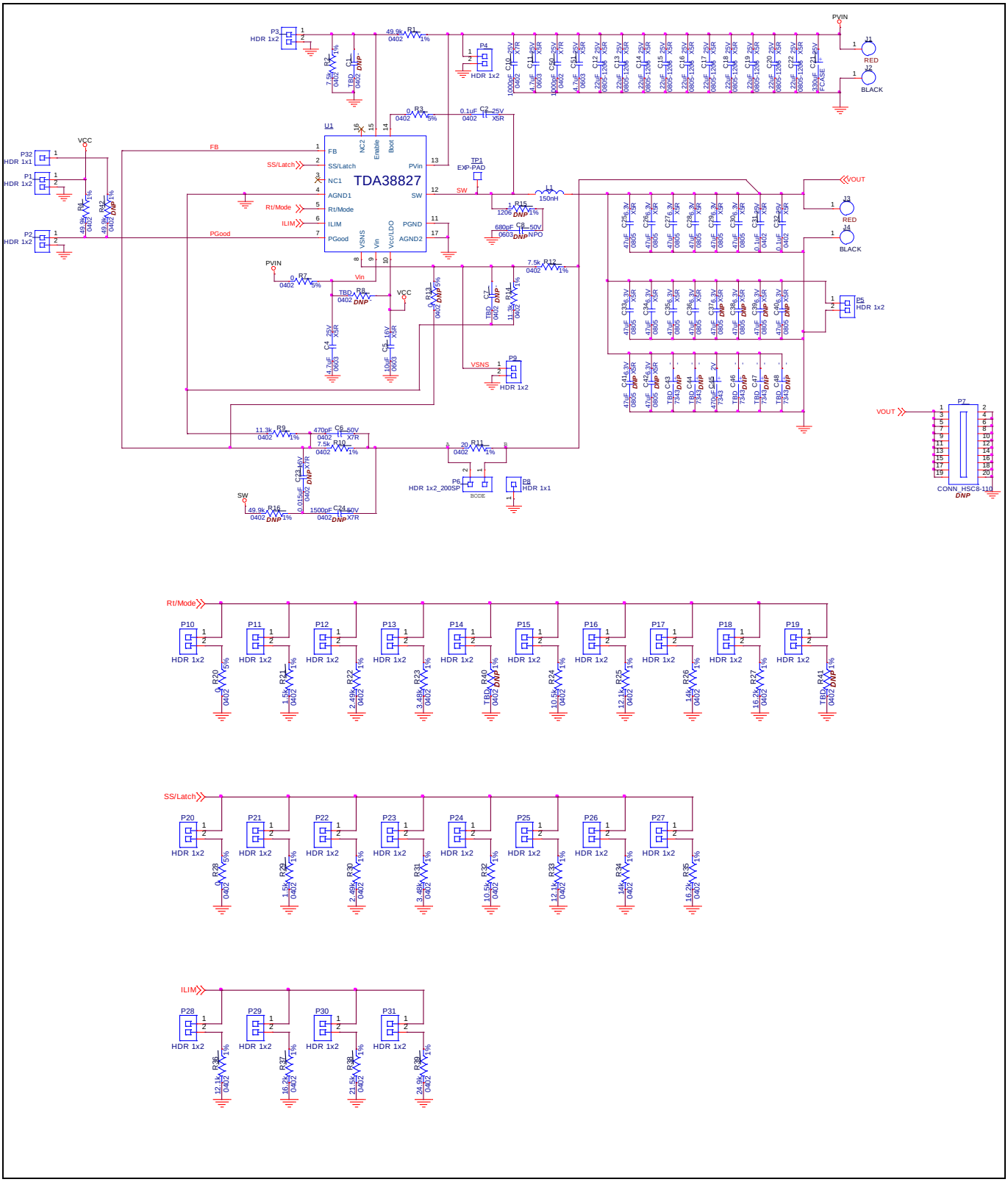

Figure 8 Schematic of the EVAL_38827_1Vout board V_{in} = 12 V, V_{out} = 1.0 V, I_{outmax} = 25 A

1.5 Bill of materials

Table 2 Bill of materials

Qty	Reference	Value	Manufacturer	Part number	Description
3	C2, C31, C32	0.1 µF	Murata	GRM155R71E104KE14J	Ceramic capacitor, 0.1 µF, 25 V, 10%, X7R, 0402
3	C4, C11, C51	4.7 µF	Murata	GRM188R61E475KE15D	Ceramic capacitor, 4.7 µF, 25 V, 10%, X5R, 0603
1	C5	10 µF	Murata	GRM188C81C106MA73D	Ceramic capacitor, 10 µF, 16 V, X6S, 0603
1	C6	470 pF	Murata	GCM155R71H471KA37D	Ceramic capacitor, 470 pF, 50 V, 10%, X7R, 0402
2	C10, C50	1000 pF	Murata	GRM155R61E102KA01D	Ceramic capacitor, 1000 pF, 25 V, 10%, X5R, 0402
10	C12, C13, C14, C15, C16, C17, C18, C19, C20, C22	22 µF	Murata	GRM21BR61E226ME44L	Ceramic capacitor, 22 µF, 25 V, 20%, X5R, 0805
1	C21	330 µF	Panasonic	PCE3410CT-ND	Aluminum capacitor, 330 µF, 20%, 25 V, SMD
10	C25, C26, C27, C28, C29, C36, C30, C33, C34, C35	47 µF	Murata	GRM21BR60J476ME11	Ceramic capacitor, 47 µF, 6.3 V, 20%, X5R, 0805
1	C45	470 µF	Panasonic	EEF-SX0D471XE	Polymer aluminum capacitor, 470 µF, 20%, 2 V, SMD
1	L1	150 nH	ITG	AH3740-150k	150 nH, I_{sat} = 60 A, 9.6 mm x 6.4 mm x 10 mm, DCR = 0.145 mΩ, SMD
2	R1, R4	49.9 k	Panasonic	ERJ-2RKF4992X	Resistor, 49.9 kΩ, 1/10 W, 1%, 0402, SMD
3	R2, R10, R12	7.5 k	Panasonic	ERJ-2RKF7501X	Resistor, 7.50 kΩ, 1/10 W, 1%, 0402, SMD
4	R3, R7, R20, R28	0	Panasonic	ERJ-2GE0R00X	Resistor, 0.0 Ω, 1/10 W, 0402, SMD
3	R27, R35, R37	16.2 k	Panasonic	ERJ-2RKF1622X	Resistor, 16.2 kΩ, 1/10 W, 1%, 0402, SMD
1	R11	20	Vishay Dale	CRCW040220R0FKED	Resistor, 20.0 Ω, 1/16 W, 1%, 0402, SMD
2	R21, R29	1.5 k	Panasonic	ERJ-2GEJ152X	Resistor, 1.5 kΩ, 5%, 1/10 W, 0402, SMD
2	R22, R30	2.49 k	Vishay Dale	CRCW04022K49FKED	Resistor, 2.49 kΩ, 1/16 W, 1%, 0402, SMD
2	R23, R31	3.48 k	Vishay Dale	CRCW04023K48FKED	Resistor, 3.48 kΩ, 1/16 W, 1%,

					0402, SMD
2	R24, R32	10.5 k	Panasonic	ERJ-2RKF1052X	Resistor, 10.5 kΩ, 1/10 W, 1%, 0402, SMD
3	R25,R33, R36	12.1 k	Panasonic	ERJ-2RKF1212X	Resistor, 12.1 kΩ, 1/10 W, 1%, 0402, SMD
1	R38	21.5k	Panasonic	ERJ-2RKF2152X	Resistor, 21.5 kΩ, 1/10W 1% 0402, SMD
1	R39	24.9k	Panasonic	ERJ-2RKF2492X	Resistor, 24.9 kΩ, 1/10W 1% 0402, SMD
2	R9, R14	11.3k	Panasonic	ERJ-2RKF1132X	Resistor, 11.3 kΩ, 1/10W 1% 0402, SMD
2	R26, R34	14 k	Panasonic	ERJ-2RKF1402X	Resistor, 14.0 kΩ, 1/10 W, 1%, 0402, SMD
1	U1	TDA38827	Infineon	TDA38827	25 A single input voltage, synchronous buck regulator

2 Typical operating waveforms

V_{in} = 12.0 V, V_{out} = 1.0 V, I_{out} = 0 to 25 A, room temperature with no airflow.

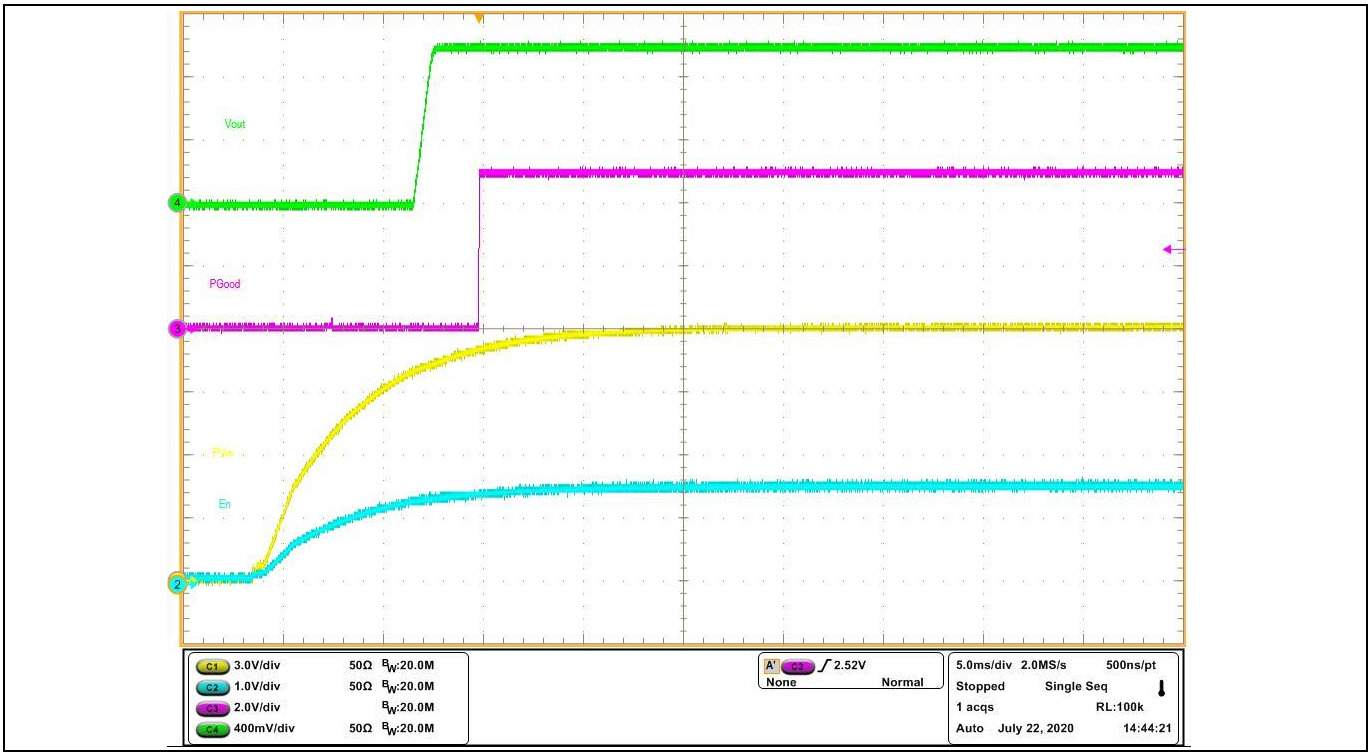

Figure 9 Start-up at 25 A load (Ch_1: PV_{in}, Ch_4: V_{out}, Ch_3: P_{Good}, Ch_2: enable)

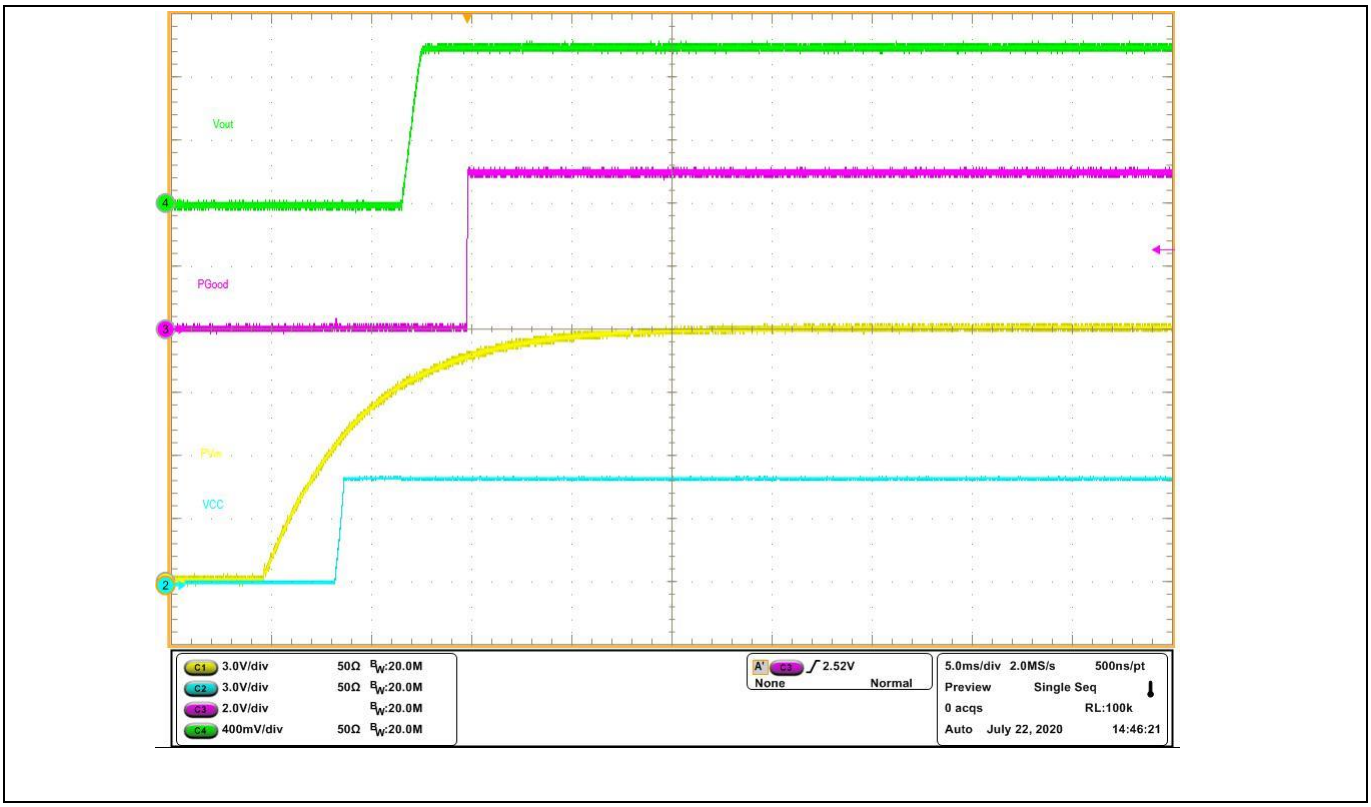

Figure 10 Start-up at 25 A load (Ch_1: PV_{in}, Ch_4: V_{out}, Ch_3: P_{Good}, Ch_2: V_{CC})

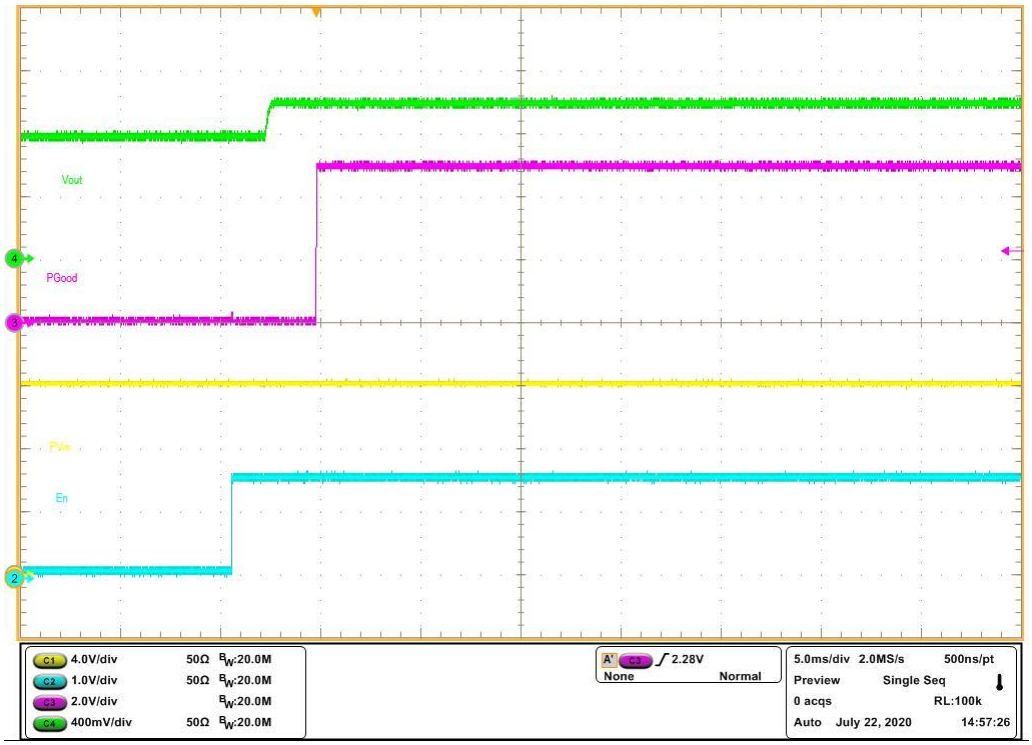

Figure 11 Pre-bias start-up at 0 A load (Ch_1: PV_{in}, Ch_4: V_{out}, Ch_3: P_{Good}, Ch_4: enable)

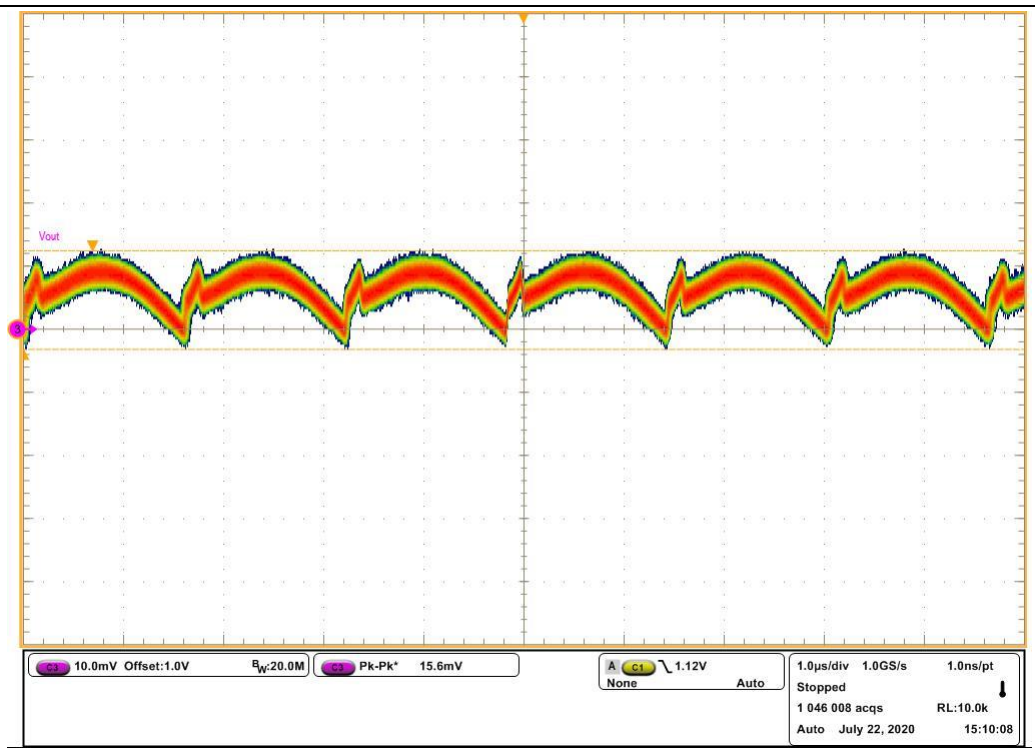

Figure 12 V_{out} ripple at 25 A load, f_{sw} = 600 kHz (Ch_1: V_{out})

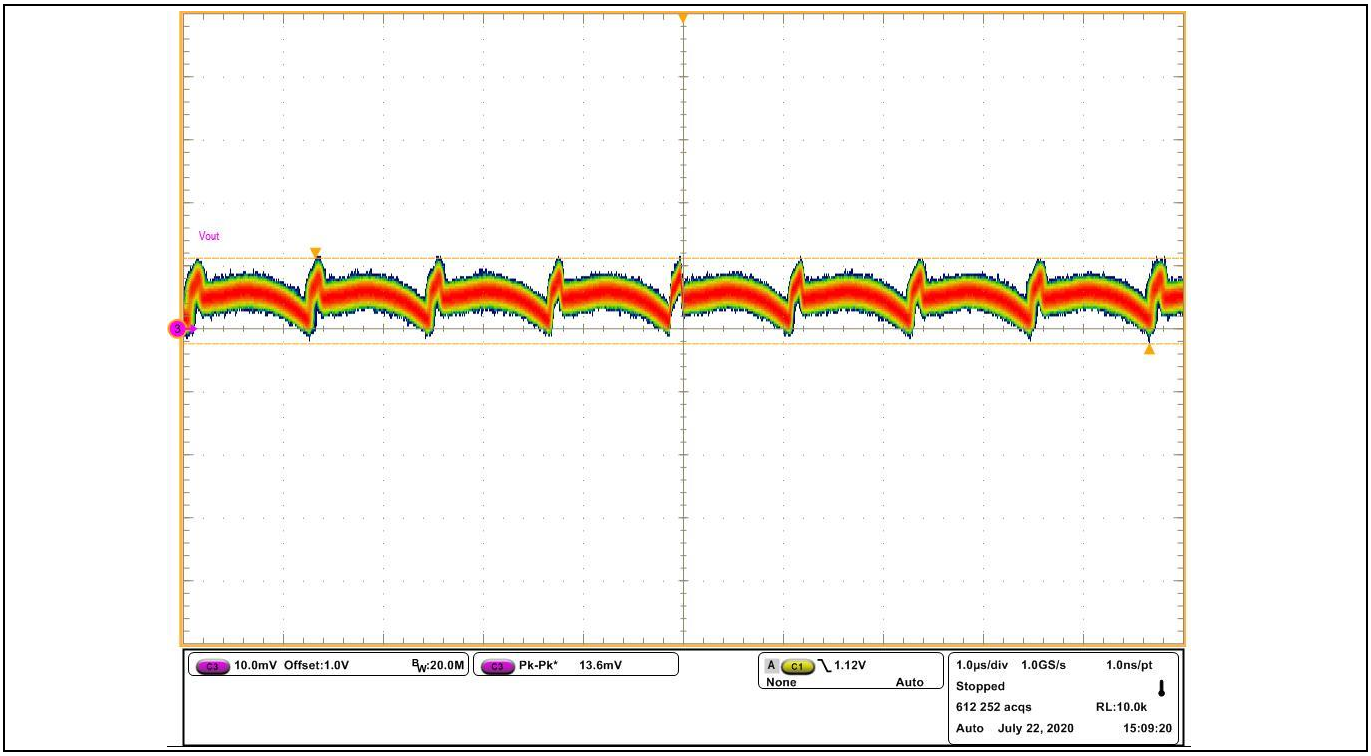

Figure 13 V_{out} ripple at 25 A load, f_{sw} = 800 kHz (Ch_1: V_{out})

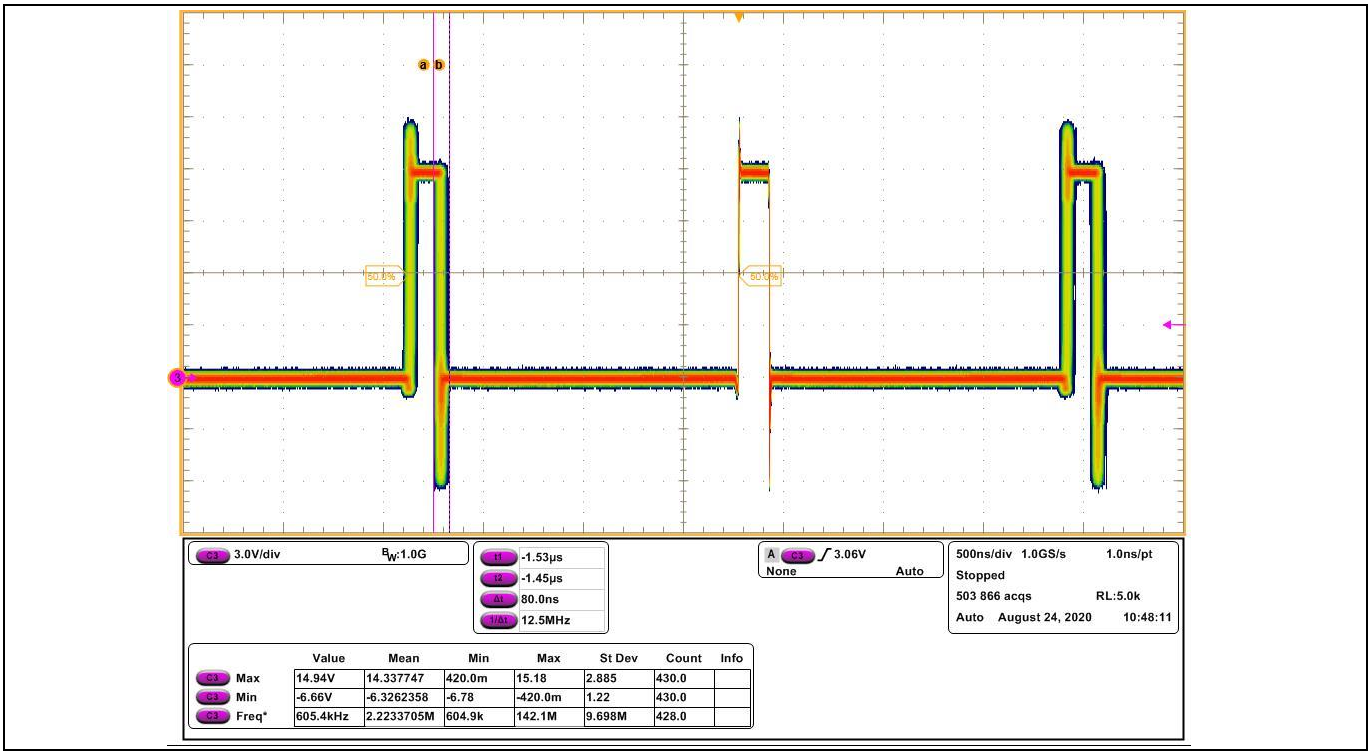

Figure 14 SW node, 25 A load, f_{sw} = 600 kHz

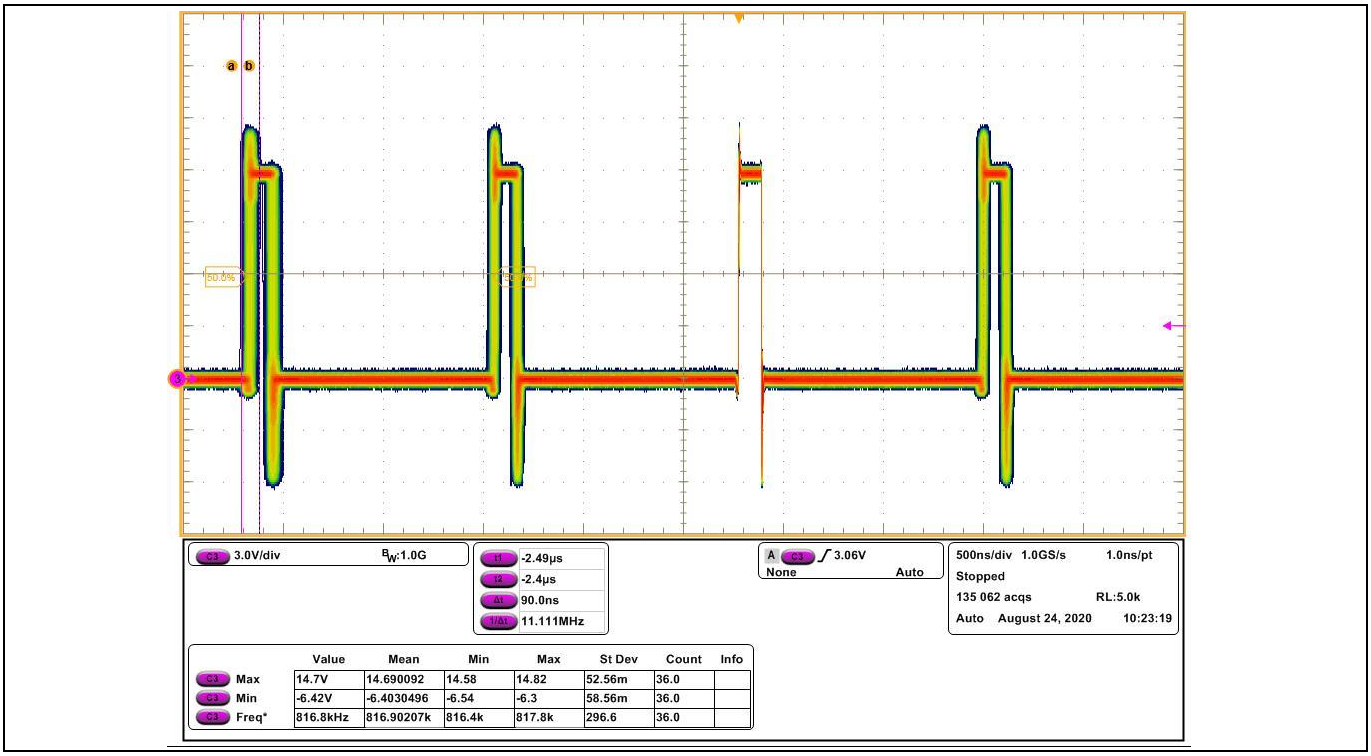

Figure 15 SW node, 25 A load, f_{sw} = 800 kHz

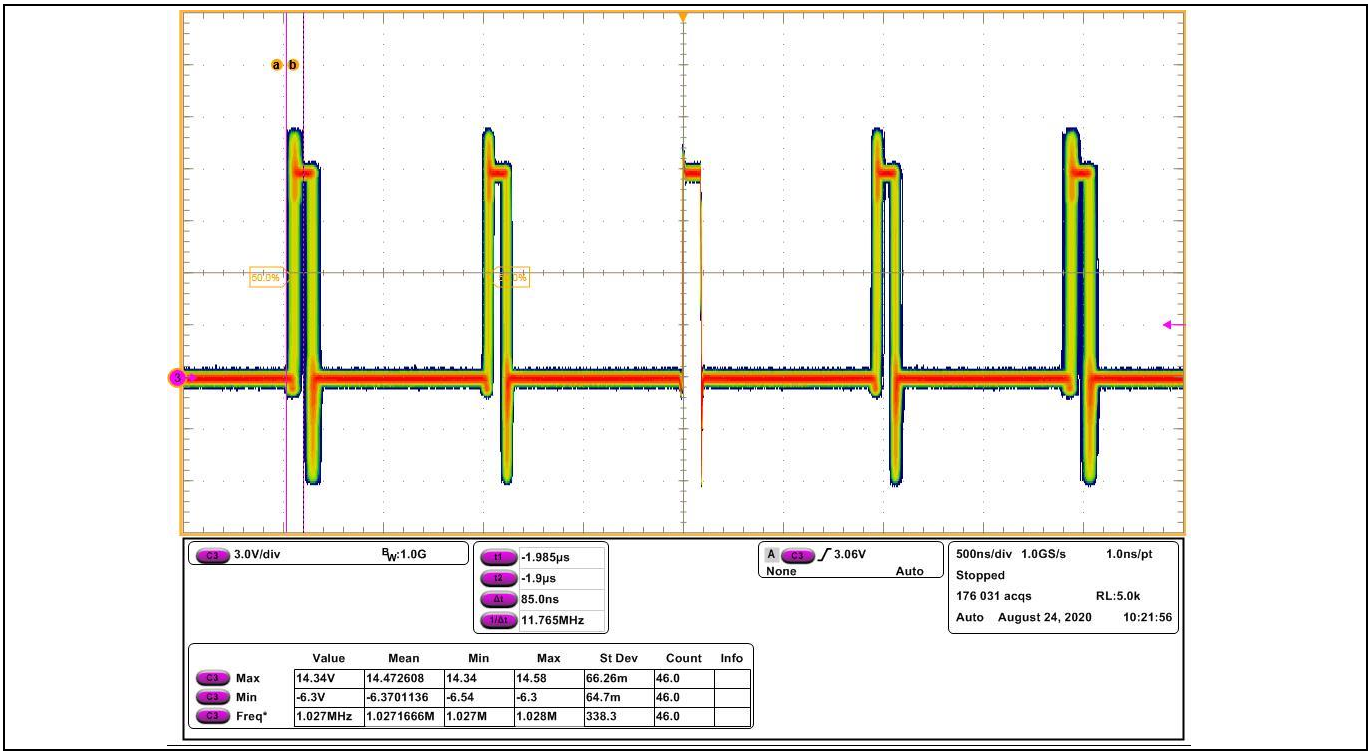

Figure 16 SW node, 25 A load, f_{sw} = 1000 kHz

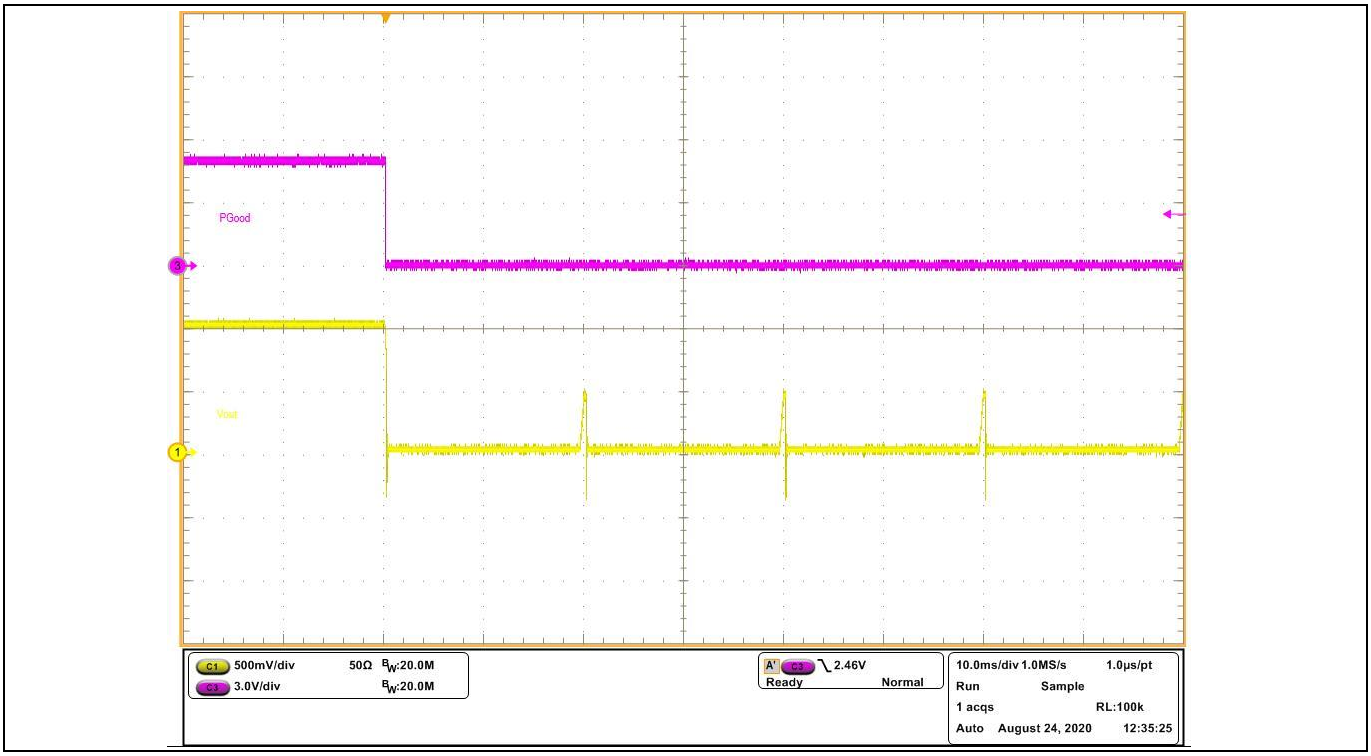

Figure 17 Short-circuit and UVP (hiccup), (Ch_1: V_{out}, Ch_3: P_{Good})

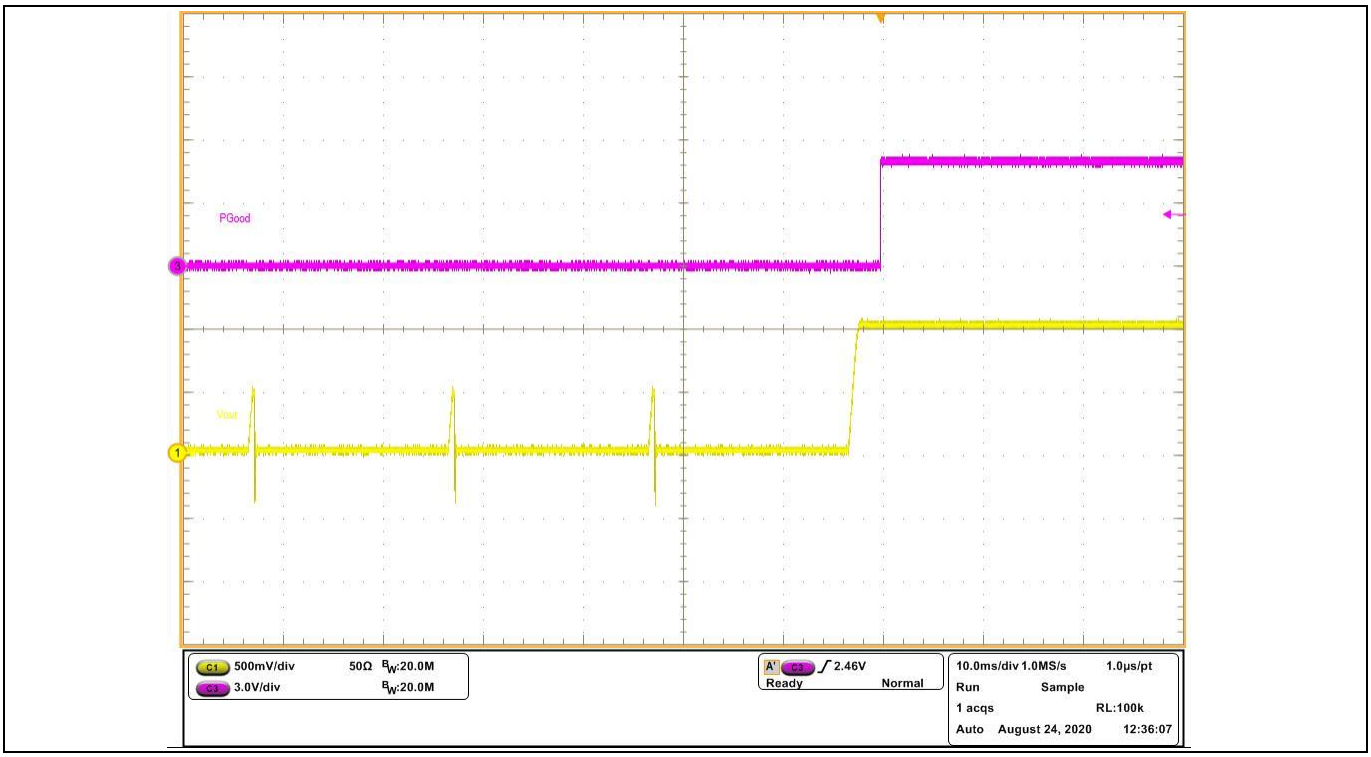

Figure 18 Short-circuit and UVP (hiccup) recover (Ch_1: V_{out}, Ch_3: P_{Good})

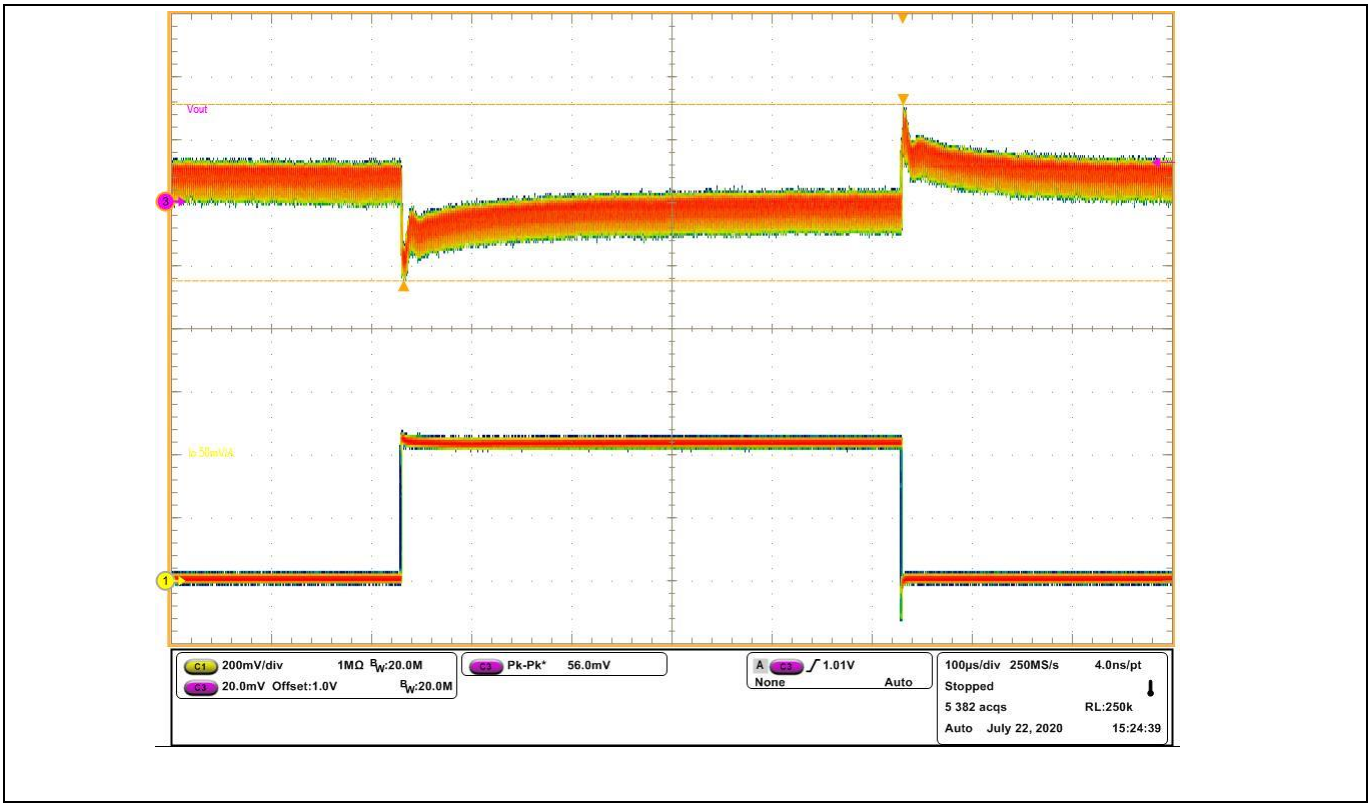

Figure 19 **Transient response at 9 A step-load current at 30 A/µs slew rate: I_{out} = 0 A to 9 A (Ch_3: V_{out}, Ch_1: I_{out}) pk-pk: 56 mV, f_{sw} = 600 kHz**

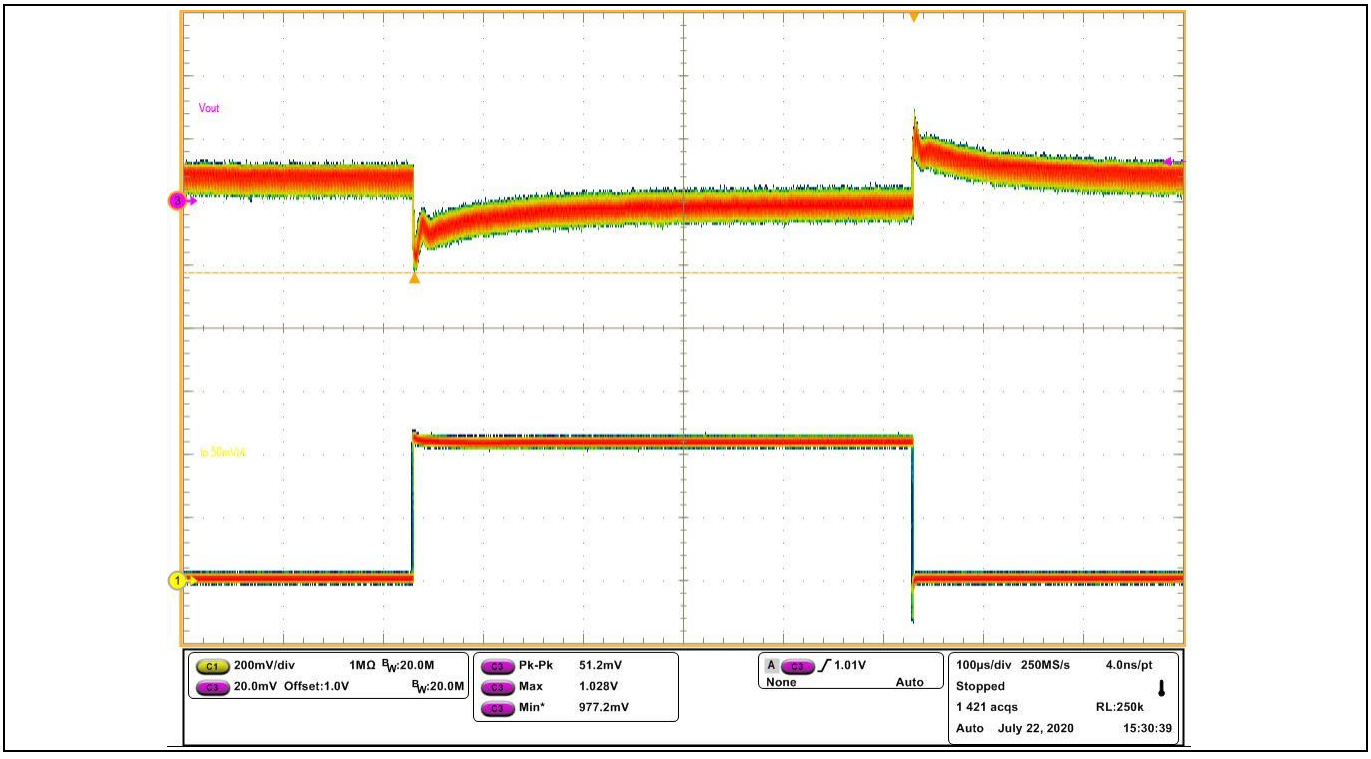

Figure 20 **Transient response at 9 A step-load current at 30 A/µs slew rate: I_{out} = 0 A to 9 A (Ch_3: V_{out}, Ch_1: I_{out}), pk-pk: 51.2 mV, f_{sw} = 800 kHz**

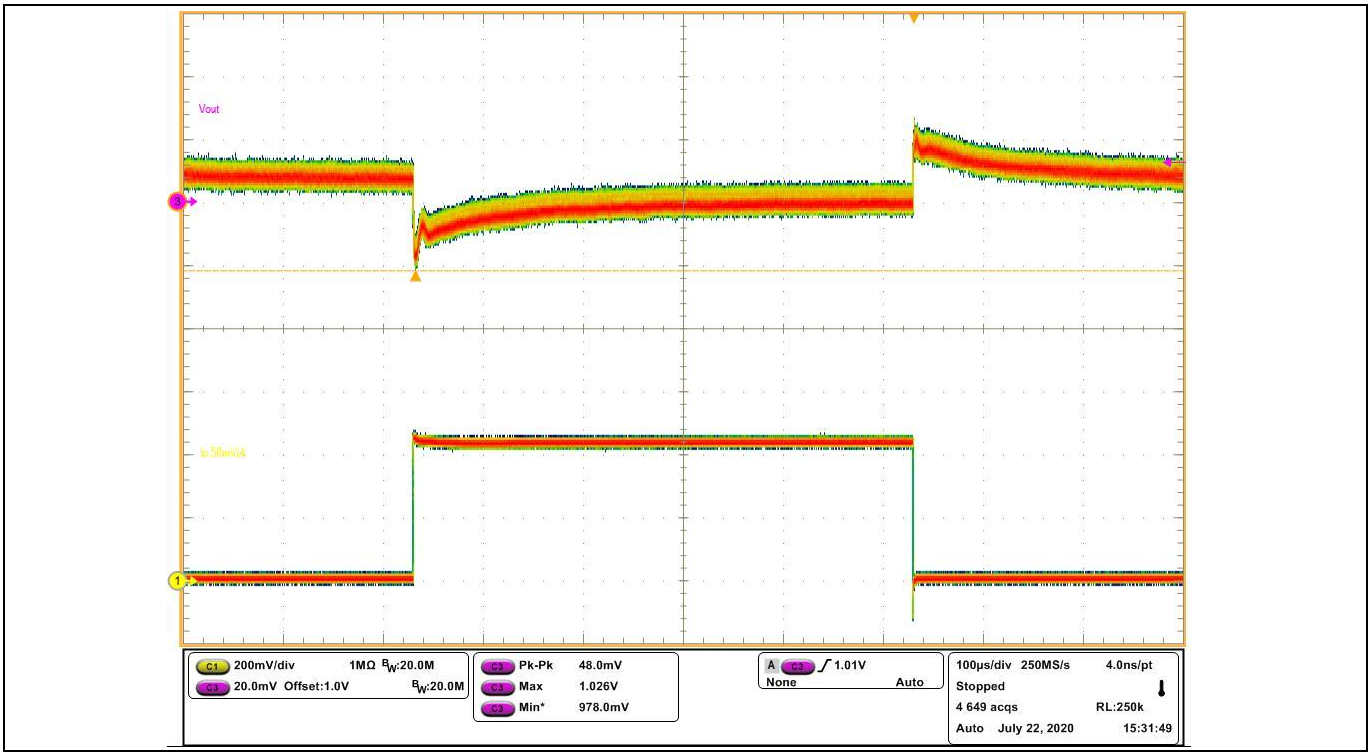

Figure 21 **Transient response at 9 A step-load current at 30 A/µs slew rate: I_{out} = 0 A to 9 A (Ch_3: V_{out}, Ch_1: I_{out}), pk-pk: 48 mV, f_{sw} = 1000 kHz**

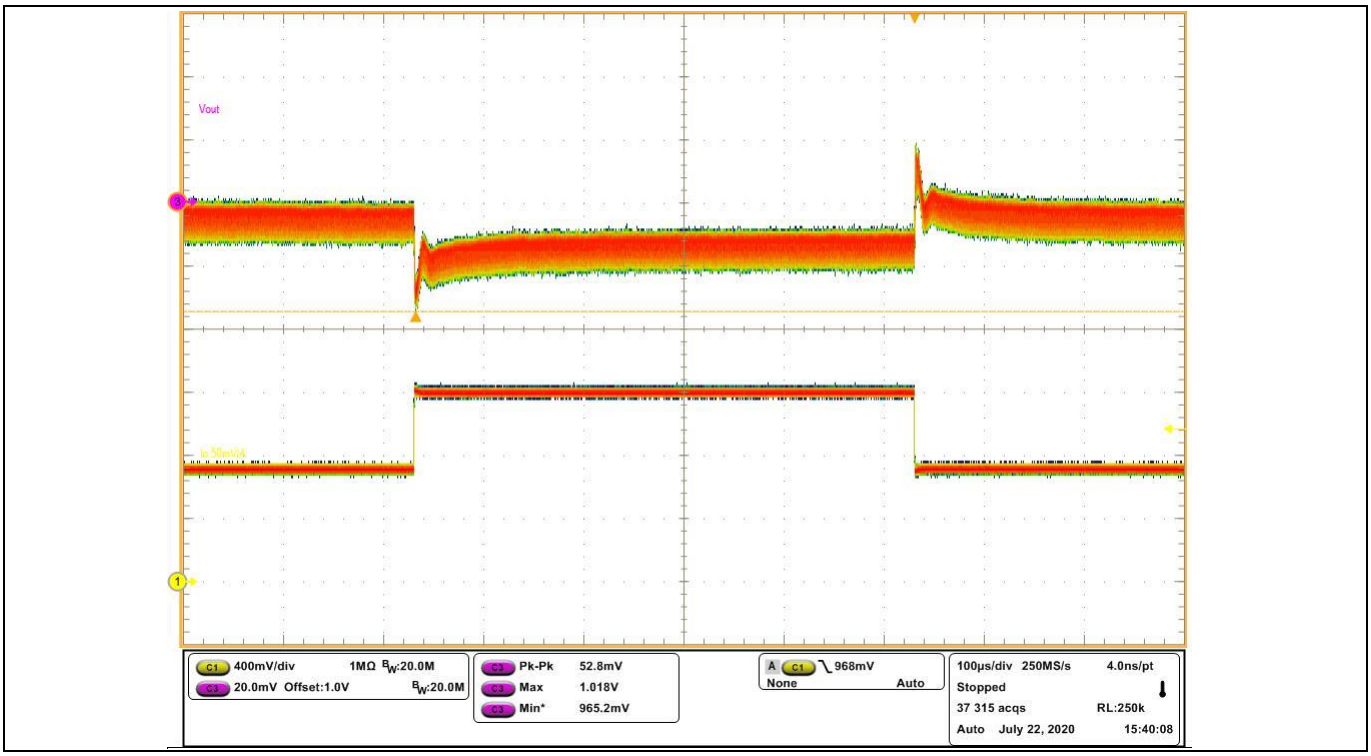

Figure 22 **Transient response at 9 A step-load current at 30 A/µs slew rate: I_{out} = 16 A to 25 A (Ch_3: V_{out}, Ch_1: I_{out}) pk-pk: 52.8 mV, f_{sw} = 600 kHz**

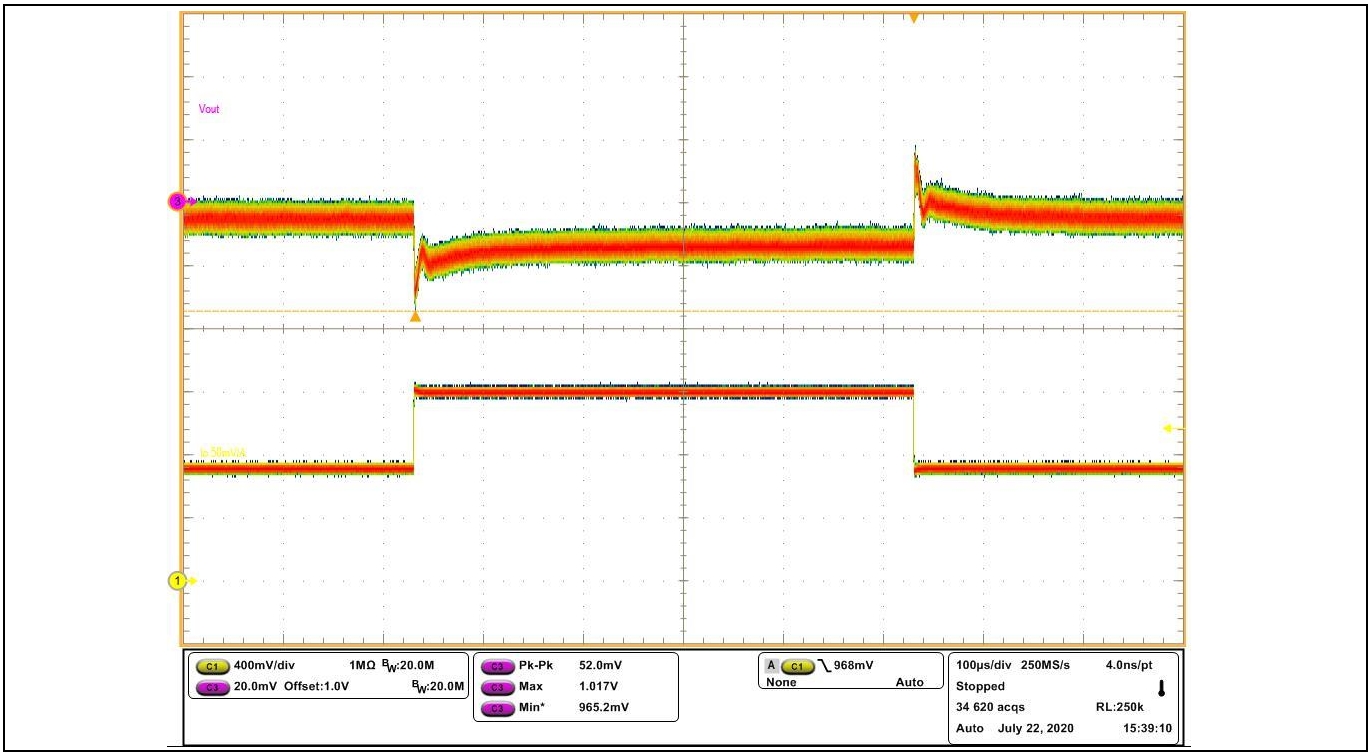

Figure 23 **Transient response at 9 A step-load current at 30 A/µs slew rate: I_{out} = 16 A to 25 A (Ch_3: V_{out}, Ch_1: I_{out}) pk-pk: 52 mV, f_{sw} = 800 kHz**

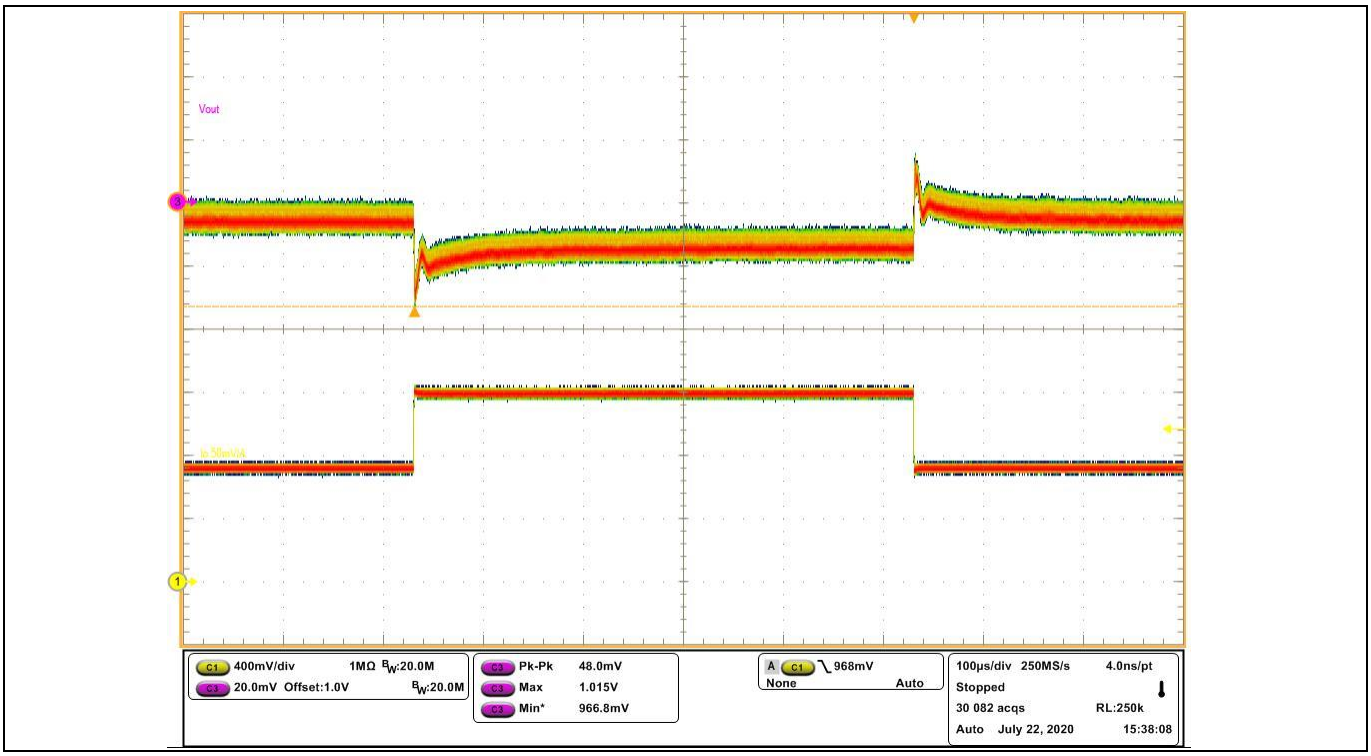

Figure 24 **Transient response at 9 A step-load current at 30 A/µs slew rate: I_{out} = 16 A to 25 A (Ch_3: V_{out}, Ch_1: I_{out}) pk-pk: 48 mV, f_{sw} = 1000 kHz**

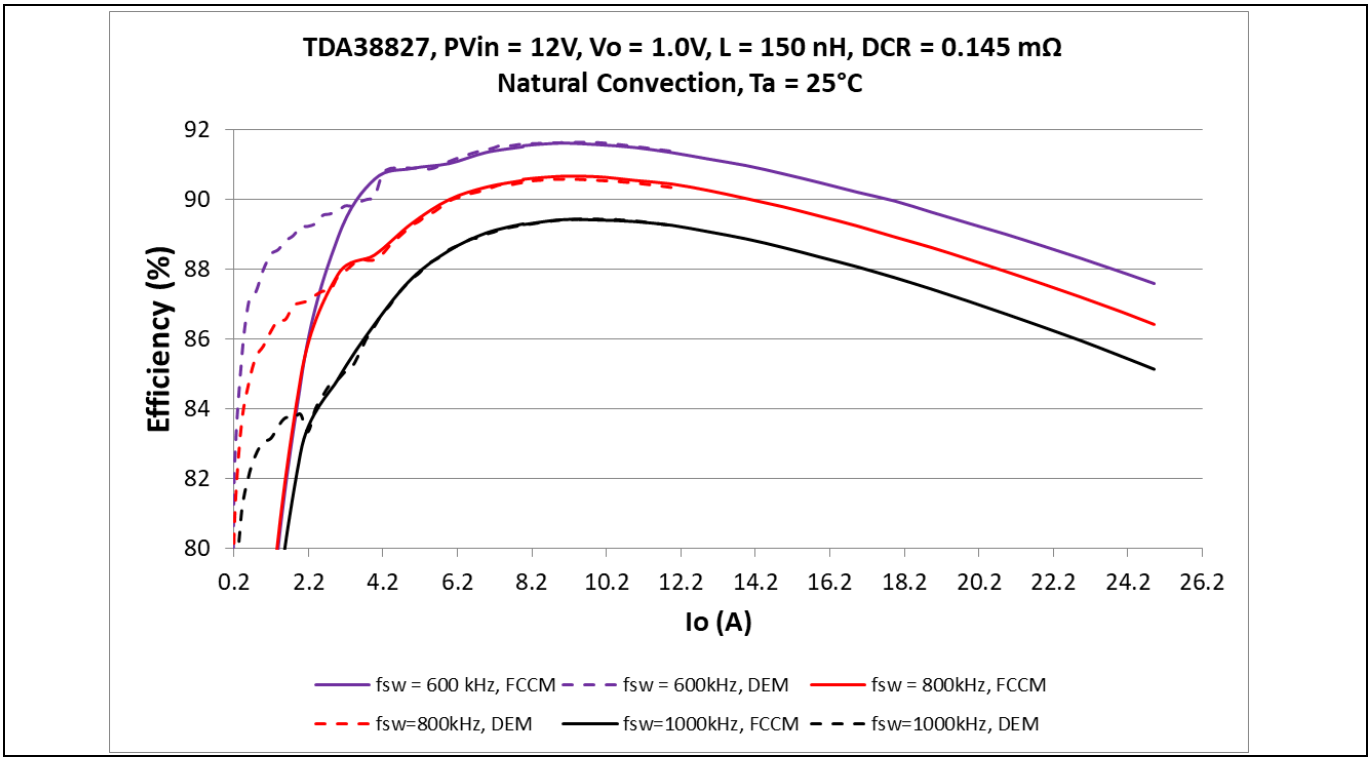

Figure 25 **Efficiency vs. load current natural convection (12 V_{in}, 1 V_{out}, 150 nH, 600 kHz/800 kHz/1000 kHz, T_a = 25°C, FCCM: solid line, DEM: dashed line)**

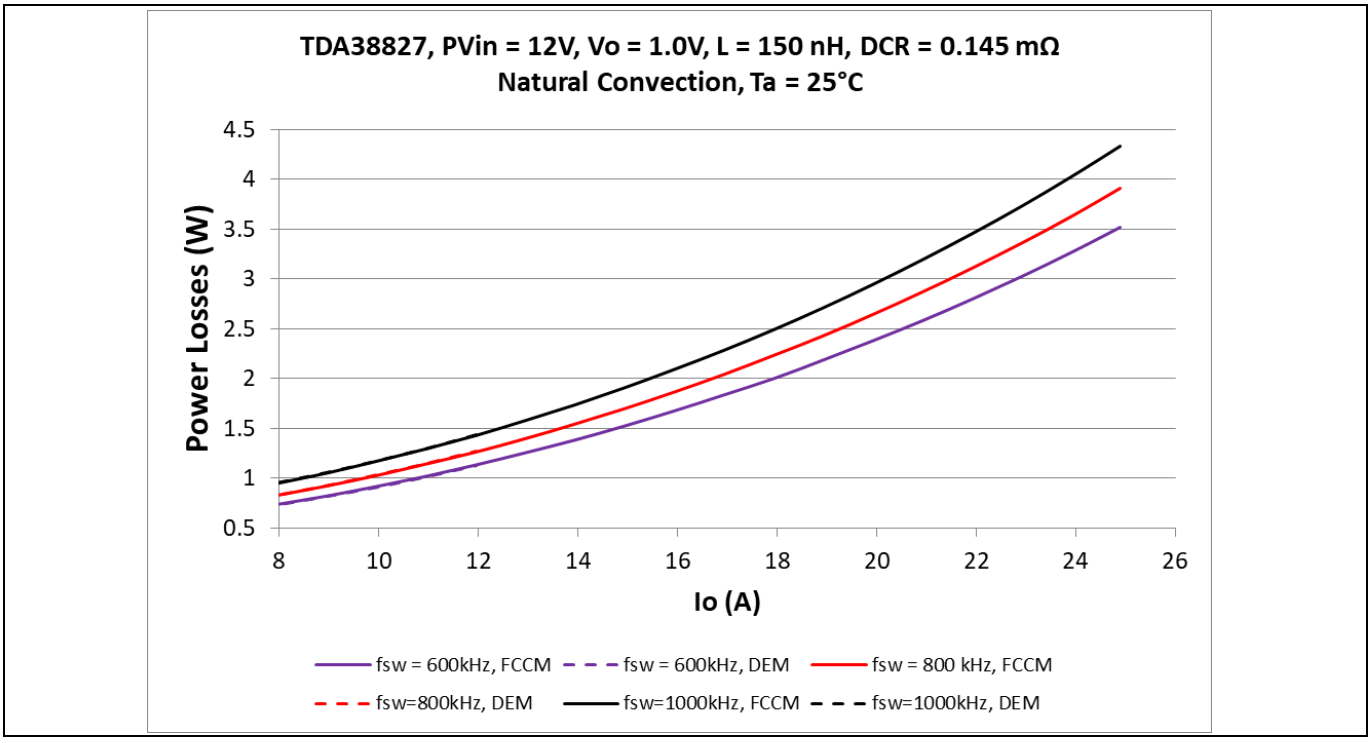

Figure 26 **Power loss vs. load current natural convection (12 V_{in}, 1.0 V_{out}, 150 nH, 600 kHz/800 kHz/1000 kHz, T_a = 25°C, FCCM: solid line, DEM: dashed line)**

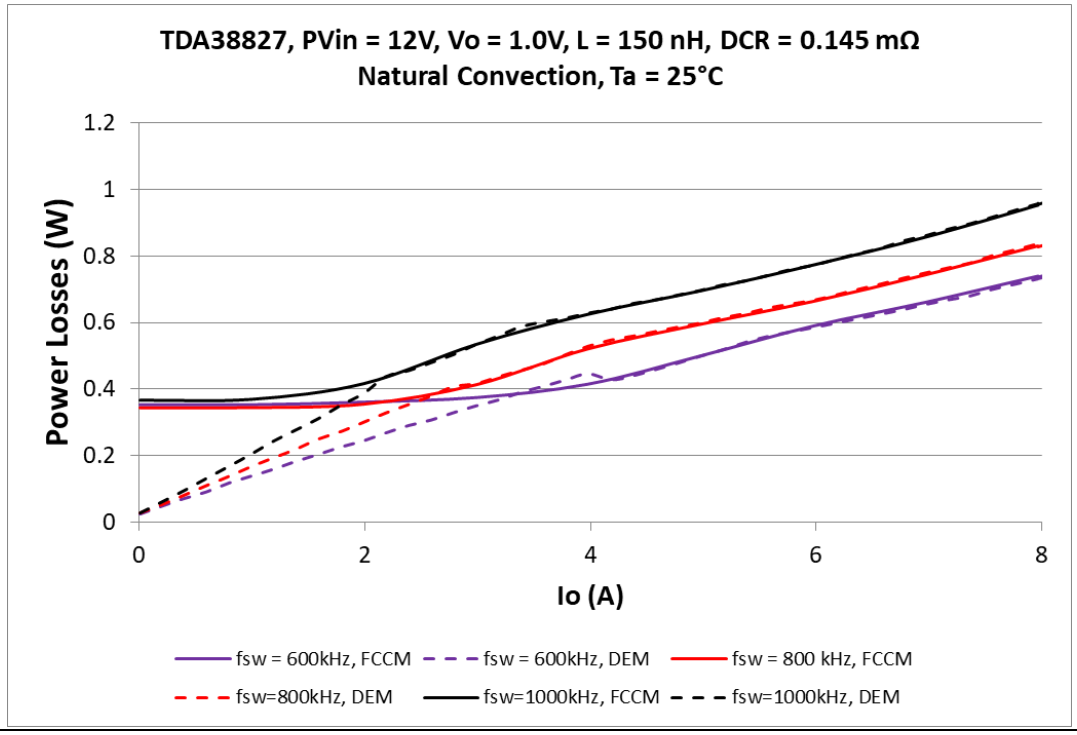

Figure 27 **Power loss vs. load current natural convection (12 V_{in}, 1.0 V_{out}, 150 nH, 600 kHz/800 kHz/1000 kHz, T_a = 25°C, FCCM: solid line, DEM: dashed line)**

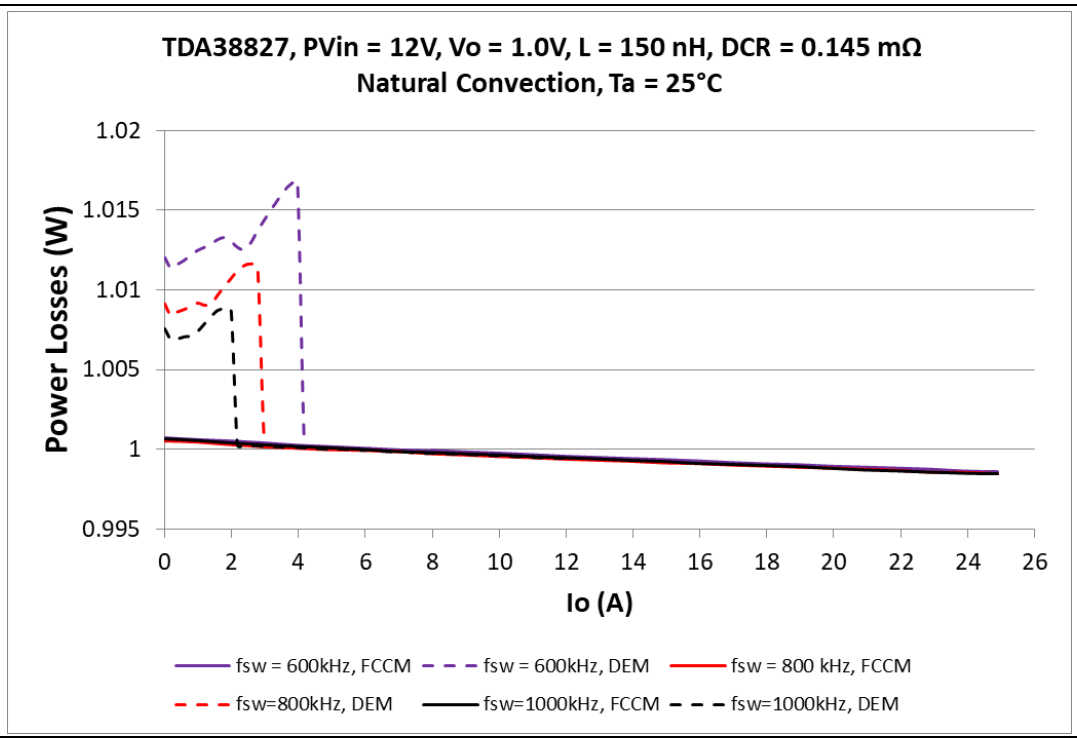

Figure 28 **TDA38827 V_{out} regulation (12 V_{in}, 1.0 V_{out}, 150 nH, 600 kHz/800 kHz/1 MHz,T_a = 25°C, FCCM: solid line, DEM: dashed line)**

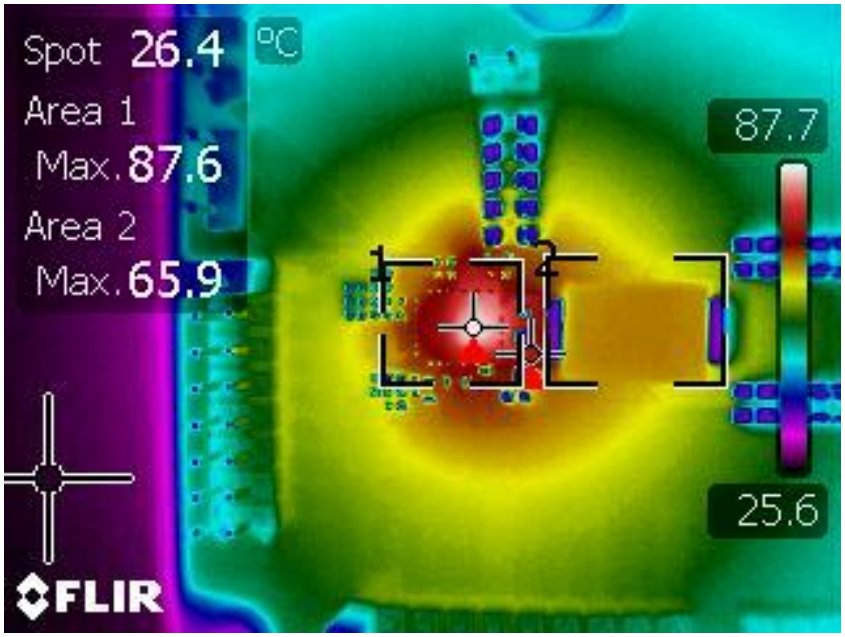

Figure 29 **Thermal image of the board at 25 A load TDA38827 = 87.6°C, L = 66°C, f_{sw} = 600 kHz, T_a = room temperature, natural convection**

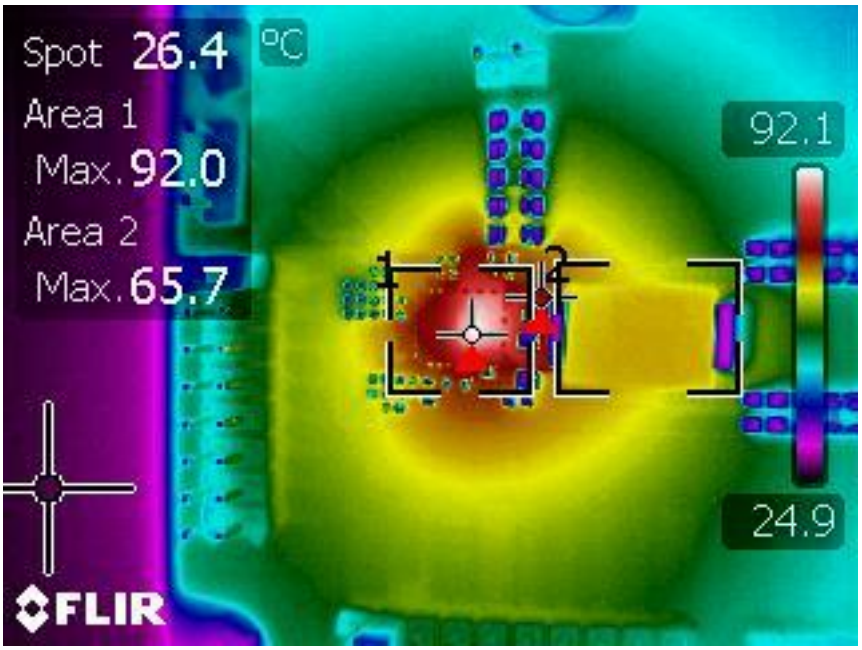

Figure 30 **Thermal image of the board at 25 A load TDA38827 = 92°C, L = 65.7°C, f_{sw} = 800 kHz, T_a = room temperature, natural convection**

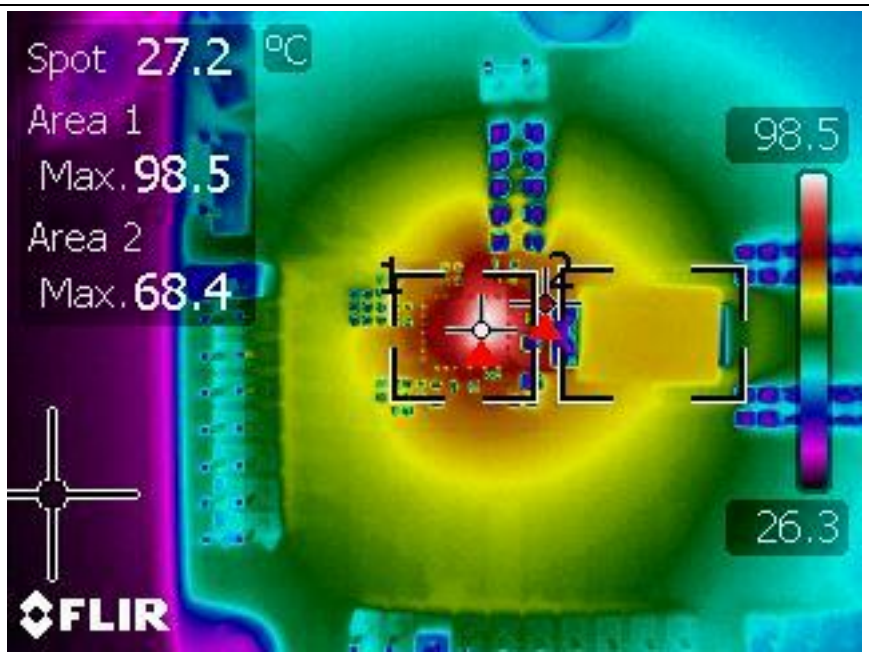

Figure 31 **Thermal image of the board at 25 A load TDA38827 = 98.5°C, L = 68.4°C, f_{sw} = 1000 kHz, T_a = room temperature, natural convection**

3 Revision history

Document version	Date of release	Description of changes
V 1.0	11-09-2020	First release
V 1.1	23-09-2020	Update pin numbers of TDA38827 in Figure 8
V 1.2	28-04-2022	Title and subtitle updated

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