User manual for TDA38840 evaluation board

40 A single-phase buck regulator with 1.0 V output

About this document

Scope and purpose

The **TDA38840** 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 TDA38840 include internal digital soft-start, precision 0.6 V reference voltage, power good (PGood), 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_38840_1Vout engineering evaluation board. The manual describes operation and use of the evaluation board itself. Detailed application information for TDA38840 is available in the **TDA38840 datasheet**.

Intended audience

This document is intended as a guide for design engineers evaluating TDA38840 performance with the engineering EVAL_38840_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 40 A

F_s = 600 kHz/800 kHz/1000 kHz

L= 120 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

TDA38840 demo board requires a single +12 V for the input power and can deliver up to 40 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 (P4)	Sense pins for the input voltage
Output	V_{out}	Connect a load (40 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 eight-layer board (3.3 in. x 4.05 in.) using FR4 material. All layers use 2 oz. copper. The PCB thickness is 0.062 in. The TDA38840 and other major power components are mounted on the top side of the board.

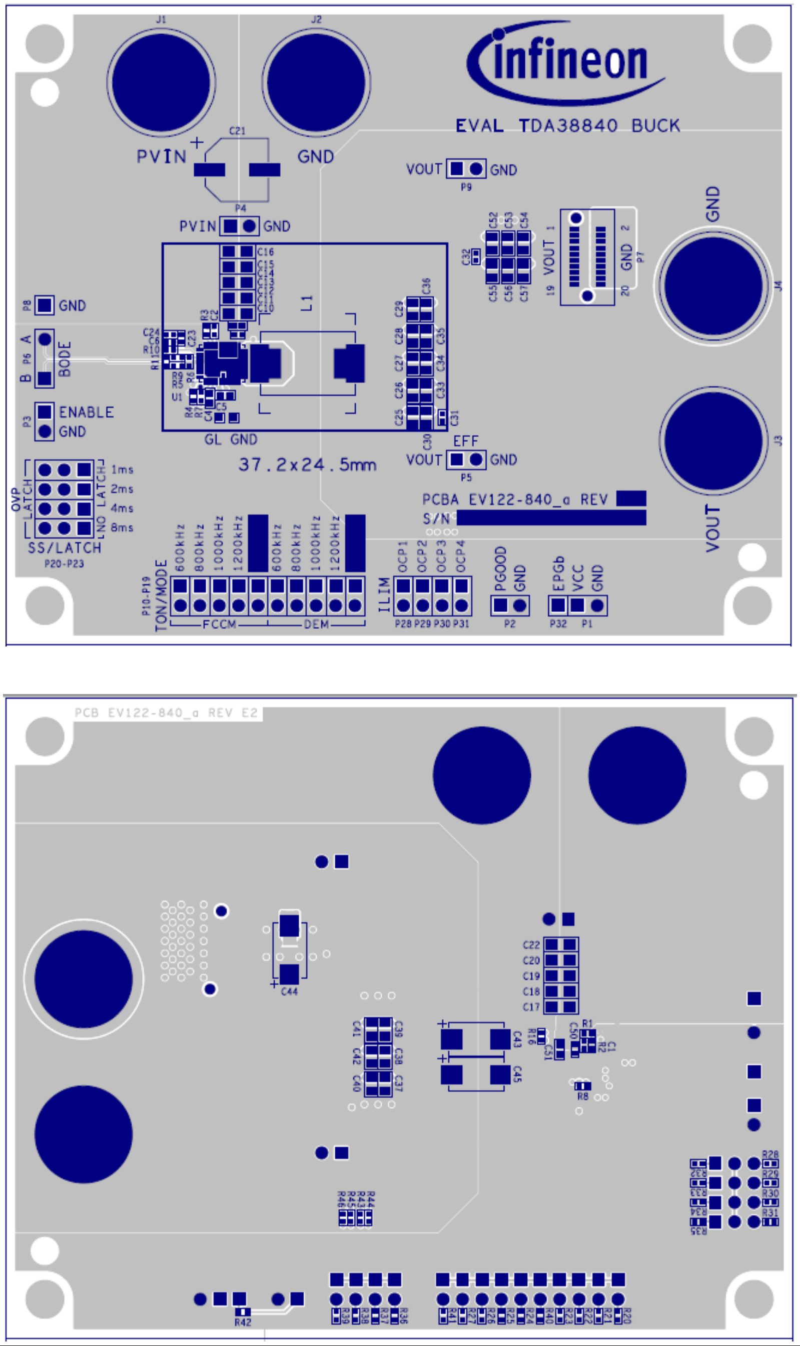


Figure 1 Top and bottom view of TDA38840 evaluation board

1.4 PCB layout

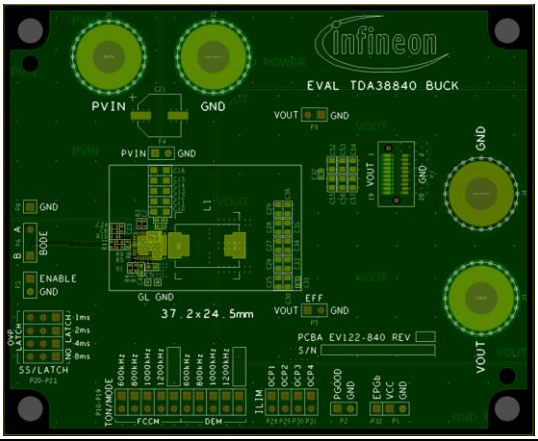


Figure 2 Top layer

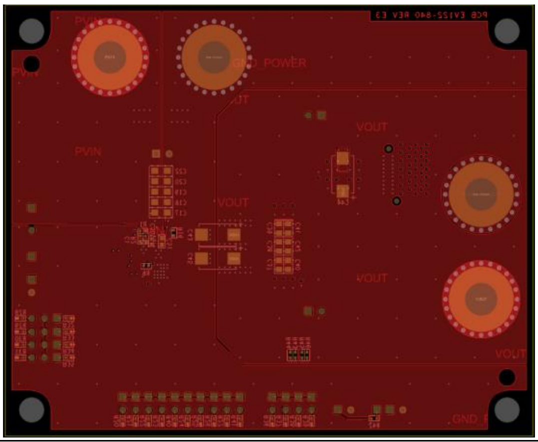


Figure 3 Bottom layer

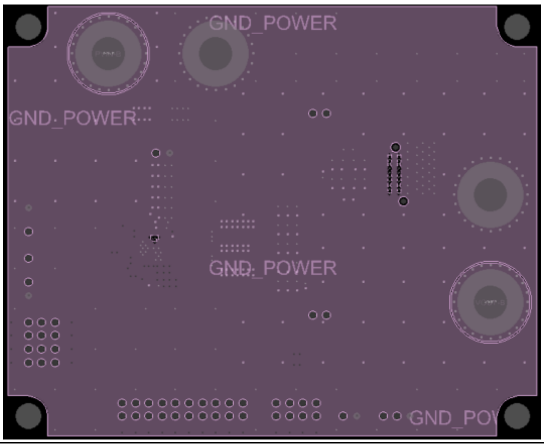


Figure 4 Mid layer 1

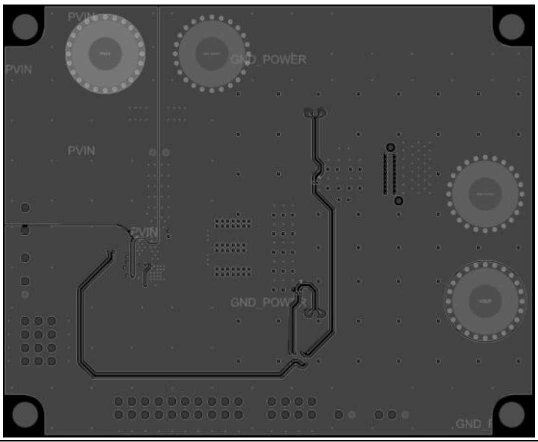


Figure 5 Mid layer 2

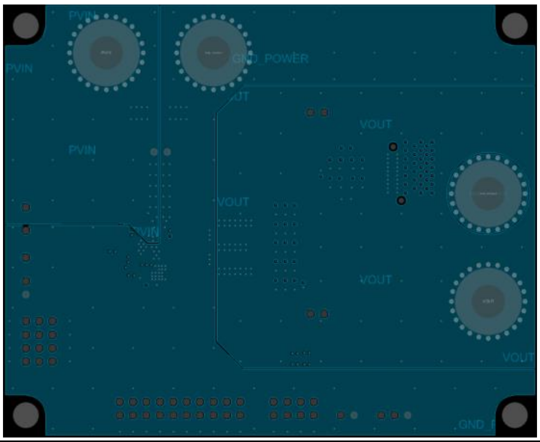


Figure 6 Mid layer 3

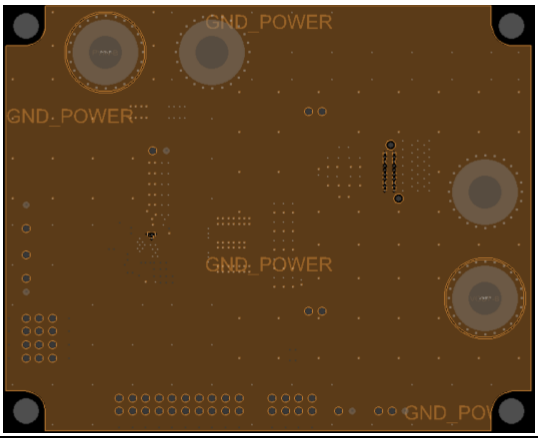


Figure 7 Mid layer 4

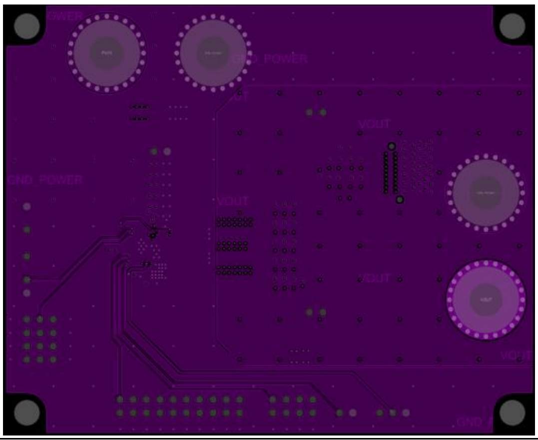


Figure 8 Mid layer 5

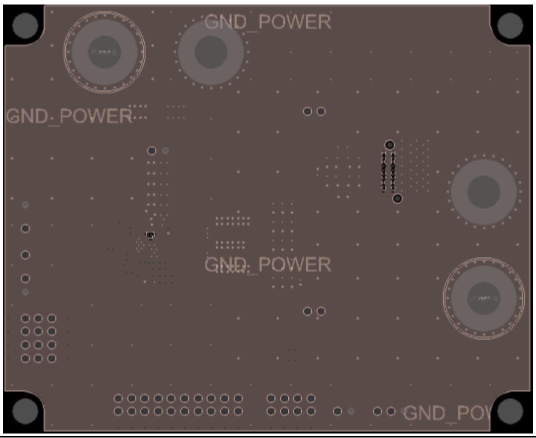


Figure 9 Mid layer 6

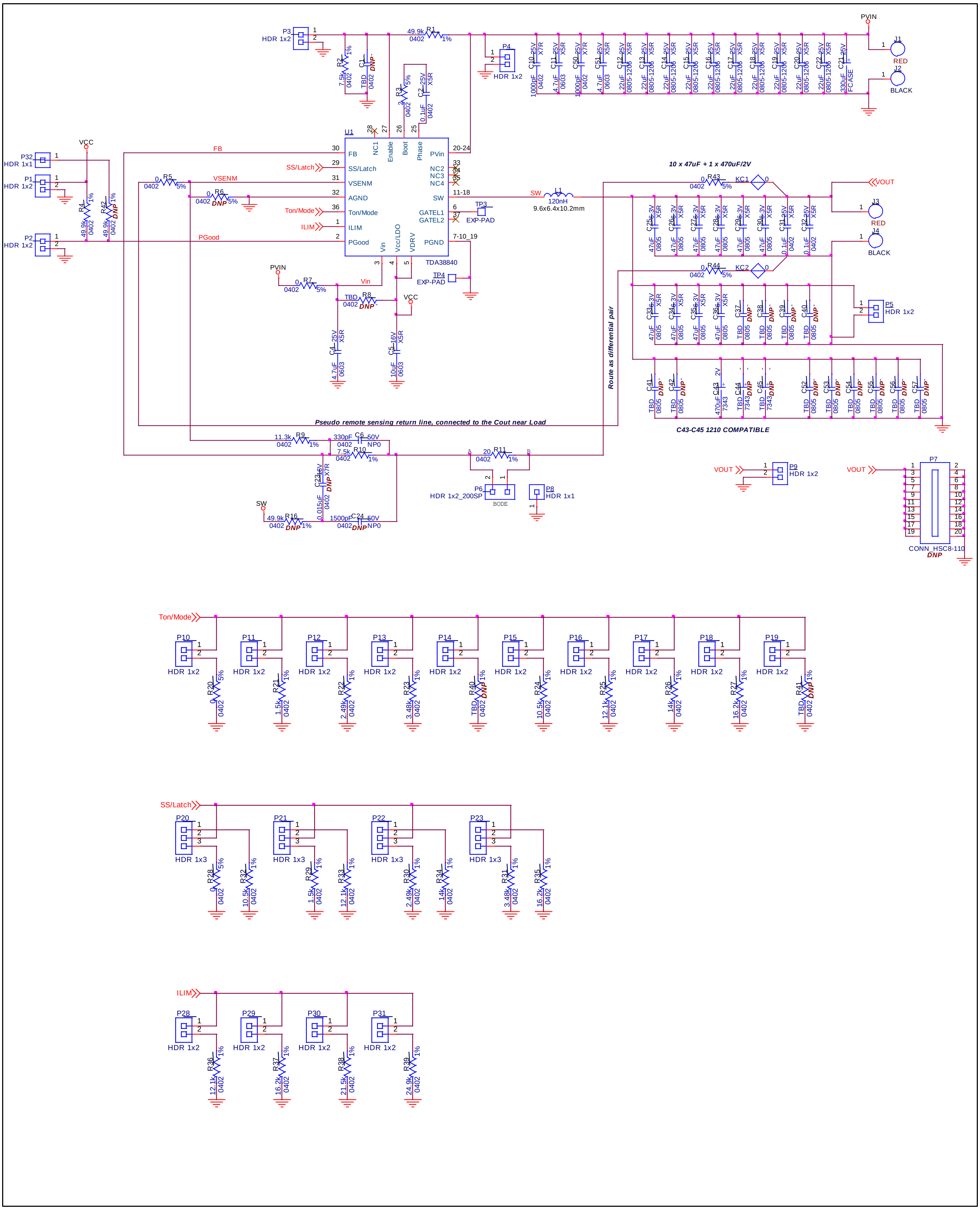


Figure 10 Schematic of the EVAL_38840_1Vout board V_{in} = 12 V, V_{out} = 1.0 V, I_{outmax} = 40 A

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	GRM188R61C106MA73D	Ceramic capacitor, 10 µF, 16 V, 20%, X5R, 0603
1	C6	330 pF	Murata	GRM1555C1H331JA01D	Ceramic capacitor, 330 pF, 50 V, 5%, NP0, 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, C30, C33, C34, C35, C36	47 µF	Murata	GRM21BR60J476ME11#	Ceramic capacitor, 47 µF, 6.3 V, 20%, X5R, 0805
1	C43	470 µF	Panasonic	EEF-SX0D471XE	Aluminum capacitor, 470 µF, 20%, 2 V, 6 mΩ
1	L1	120 nH	ITG	AH3740A-120K	INDUCTOR ,120 nH,9.6x6.4 x10 mm,0.145 mΩ, SMD
2	R1, R4	49.9 kΩ	Panasonic	ERJ-2RKF4992X	Resistor, 49.9 kΩ, 1/10 W, 1%, 0402, SMD
2	R2, R10	7.5 kΩ	Panasonic	ERJ-2RKF7501X	Resistor, 7.50 kΩ, 1/10W, 1%, 0402, SMD
1	R3	2 Ω	Panasonic	ERJ-U02F2R00X	Resistor, 2.0 Ω, 1/10W, 1%, 0402, SMD
6	R5, R7, R20, R28, R43, R44	0	Panasonic	ERJ-2GE0R00X	Resistor, 0.0 Ω, 1/10W, 0402, SMD
1	R9	11.3 kΩ	Panasonic	ERJ-2RKF1132X	Resistor, 11.3 kΩ, 1/10W, 1%, 0402, SMD
1	R11	20 Ω	Vishay Dale	CRCW040220R0FKED	Resistor 20.0 Ω, 1/16W, 1%, 0402, SMD
2	R21, R29	1.5 kΩ	Panasonic	ERJ-2RKF1501X	Resistor 1.5 kΩ, 1/10W, 1%, 0402, SMD
2	R22, R30	2.49 kΩ	Vishay Dale	CRCW04022K49FKED	Resistor 2.49 kΩ, 1/16W, 1%, 0402, SMD

2	R23, R31	3.48 kΩ	Vishay Dale	CRCW04023K48FKED	Resistor 3.48 kΩ, 1/16W, 1%, 0402, SMD
2	R24, R32	10.5 kΩ	Panasonic	ERJ-2RKF1052X	Resistor 10.5 kΩ, 1/10W, 1%, 0402, SMD
3	R25, R33, R36	12.1 kΩ	Panasonic	ERJ-2RKF1212X	Resistor 12.1 kΩ, 1/10W, 1%, 0402, SMD
2	R26, R34	14 kΩ	Panasonic	ERJ-2RKF1402X	Resistor 14.0 kΩ, 1/10W, 1%, 0402, SMD
3	R27, R35, R37	16.2 kΩ	Panasonic	ERJ-2RKF1622X	Resistor 16.2 kΩ, 1/10W, 1%, 0402, SMD
1	R38	21.5 kΩ	Panasonic	ERJ-2RKF2152X	Resistor 21.5 kΩ, 1/10W, 1%, 0402, SMD
1	R39	24.9 kΩ	Panasonic	ERJ-2RKF2492X	Resistor 24.9 kΩ, 1/10W, 1%, 0402, SMD
1	U1	TDA38840	Infineon	TDA38840	40 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 40 A, room temperature with no airflow.

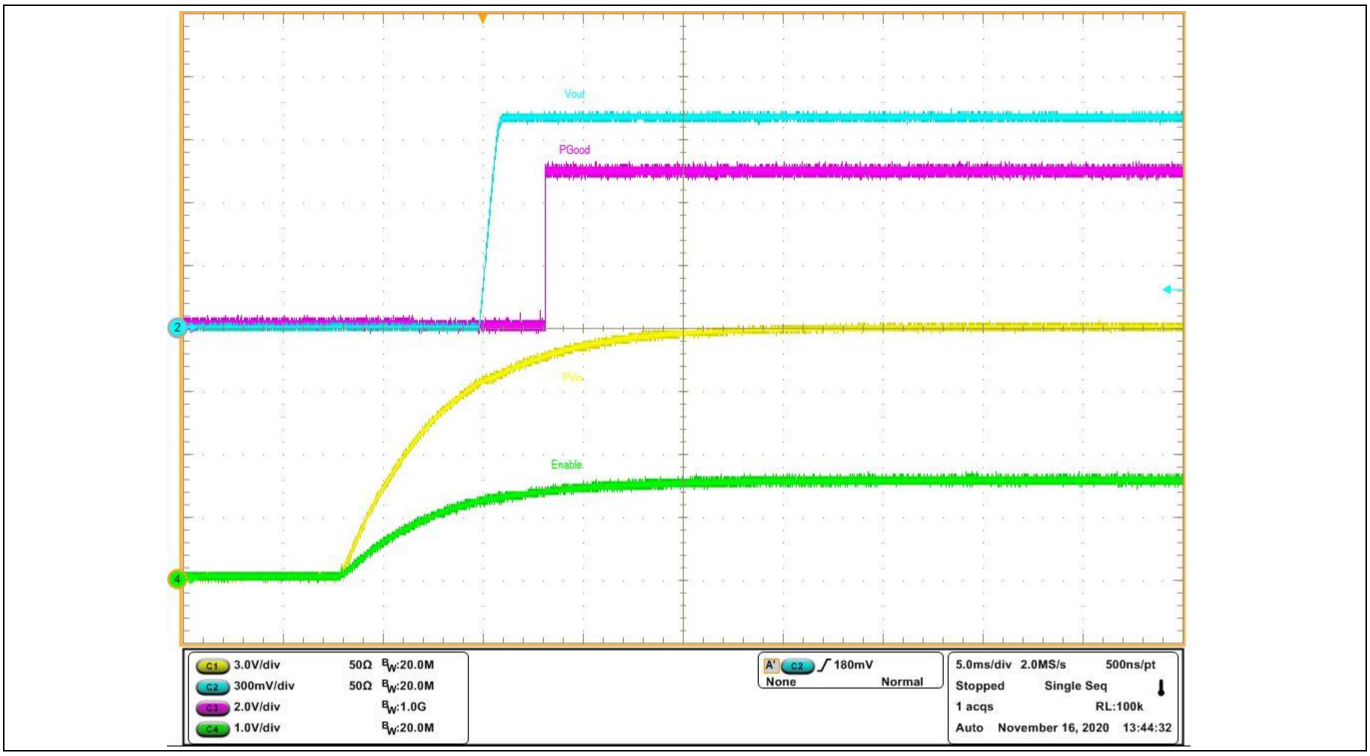


Figure 11 Start-up at 40 A load (Ch_1: PV_{in}, Ch_4: Enable, Ch_3: P_{Good}, Ch_2: V_{out})

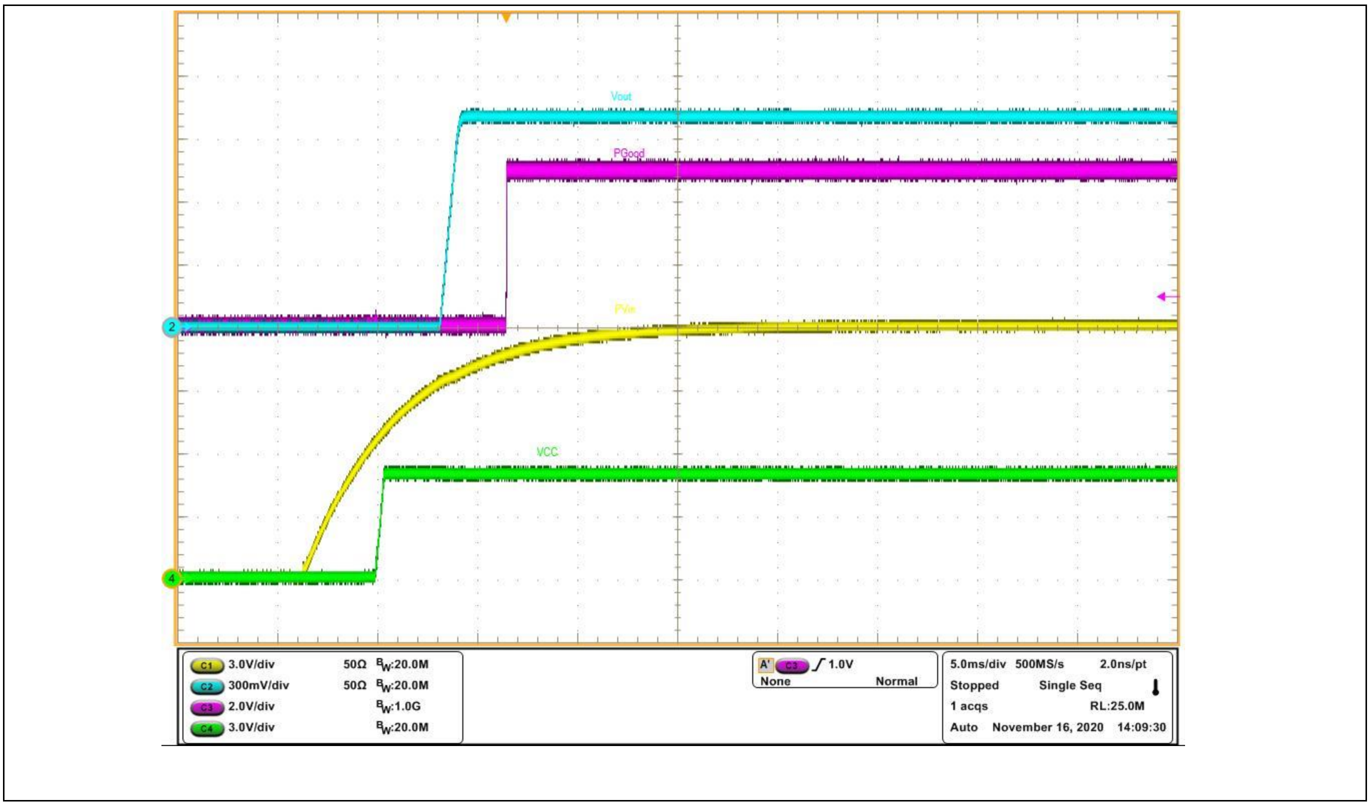


Figure 12 Start-up at 40 A load (Ch_1: PV_{in}, Ch_2: V_{out}, Ch_3: P_{Good}, Ch_4: V_{CC})

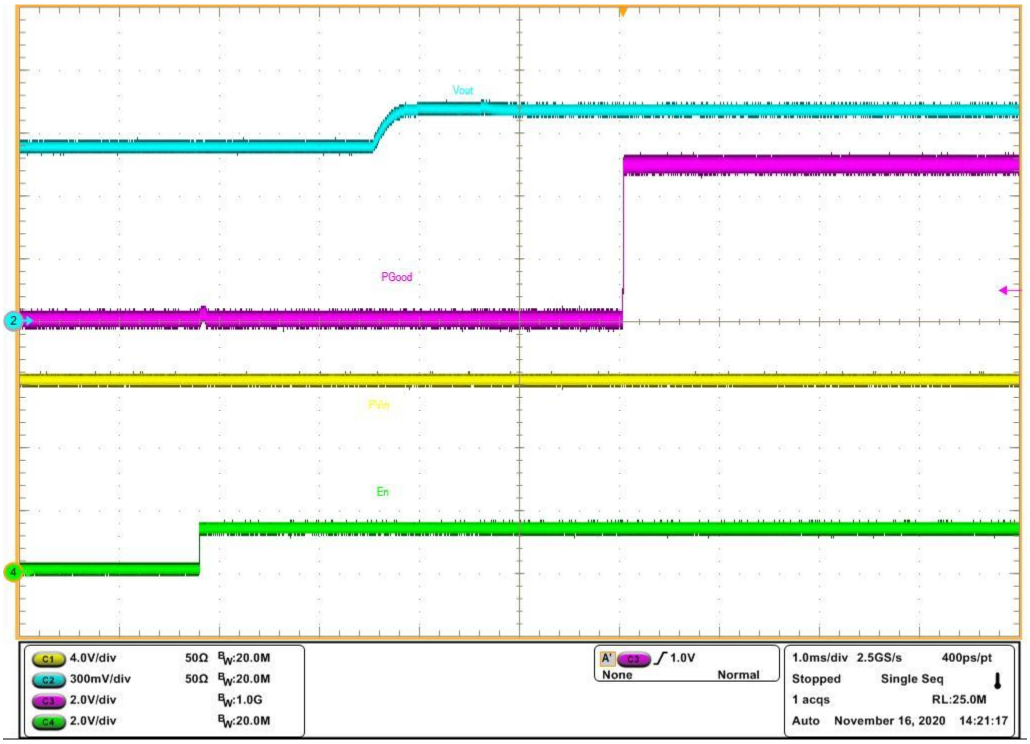


Figure 13 Pre-bias start-up at 0 A load (Ch_1: PV_{in}, Ch_4: V_{out}, Ch_3: P_{Good}, Ch_4: Enable)

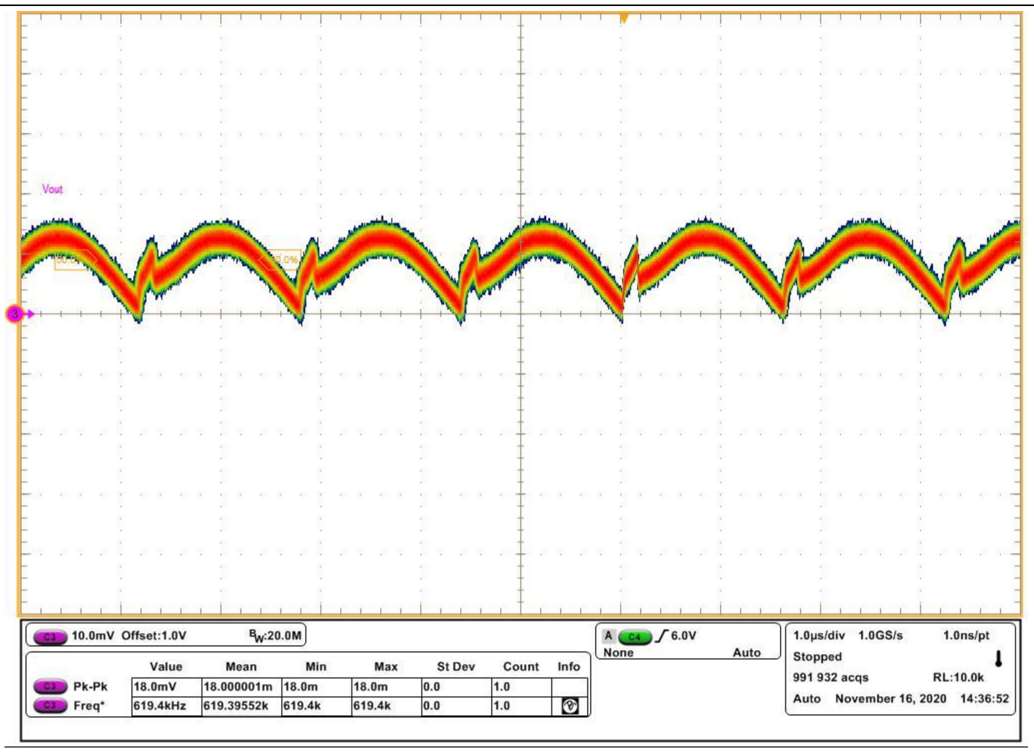


Figure 14 V_{out} ripple at 40 A load, f_{sw} = 600 kHz (Ch_3: V_{out}), peak to peak V_{out} ripple = 18 mV

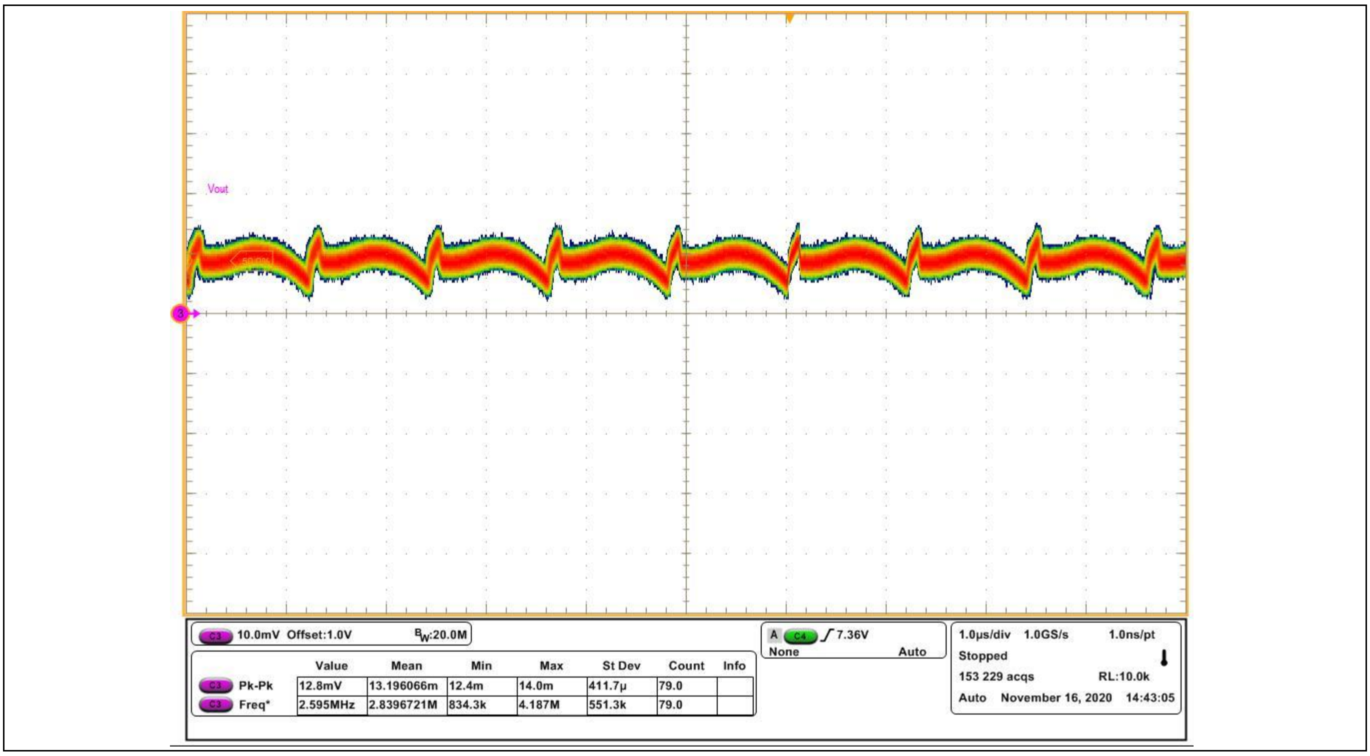


Figure 15 V_{out} ripple at 40 A load, f_{sw} = 800 kHz (Ch3: V_{out}), peak to peak V_{out} ripple = 12.8 mV

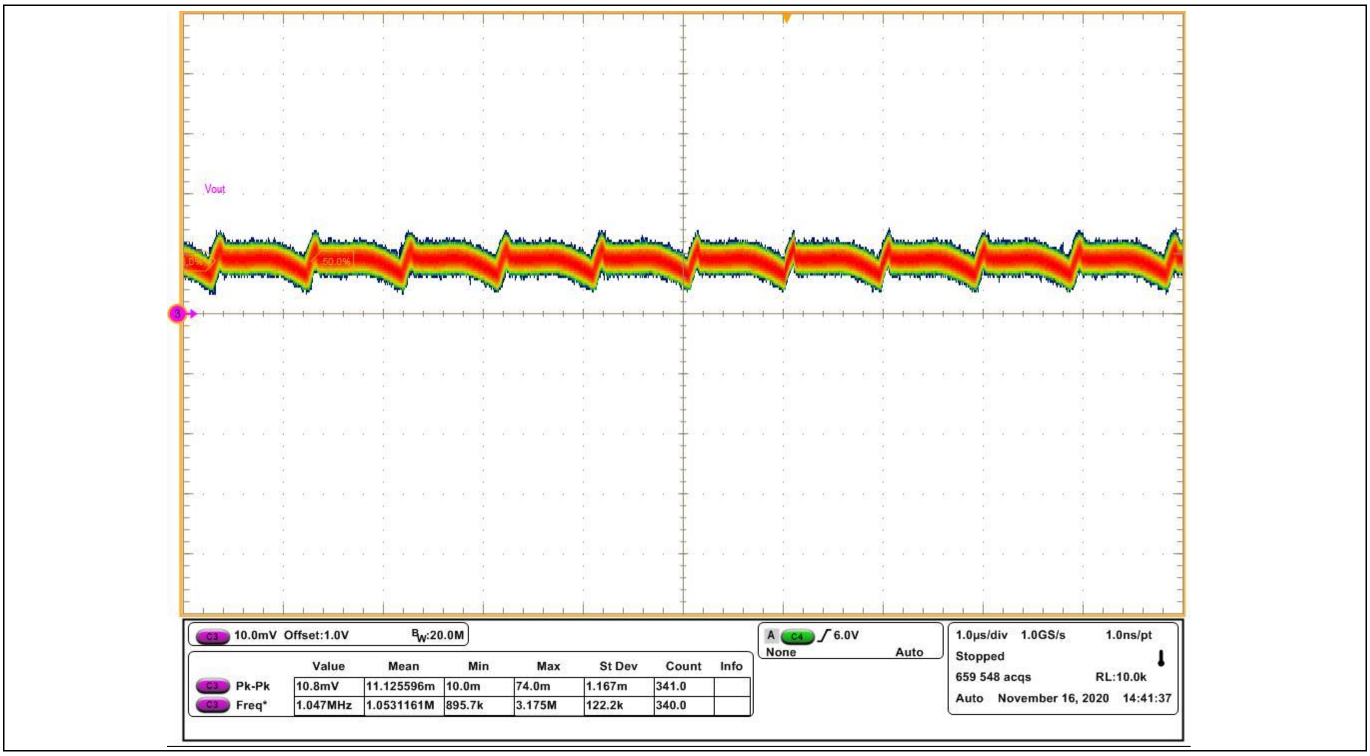


Figure 16 V_{out} ripple at 40 A load, f_{sw} = 1000 kHz (Ch3: V_{out}), peak to peak V_{out} ripple = 10.8 mV

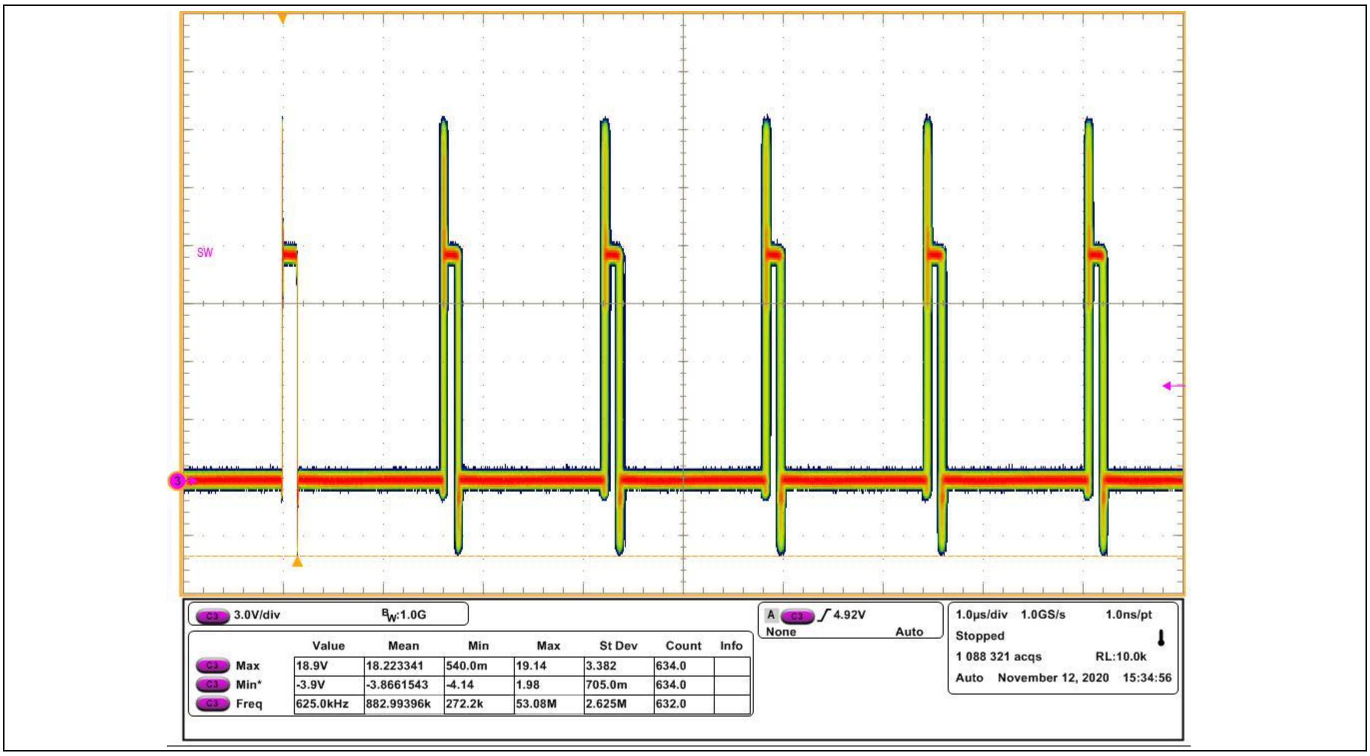


Figure 17 SW node, 40 A load, f_{sw} = 600 kHz

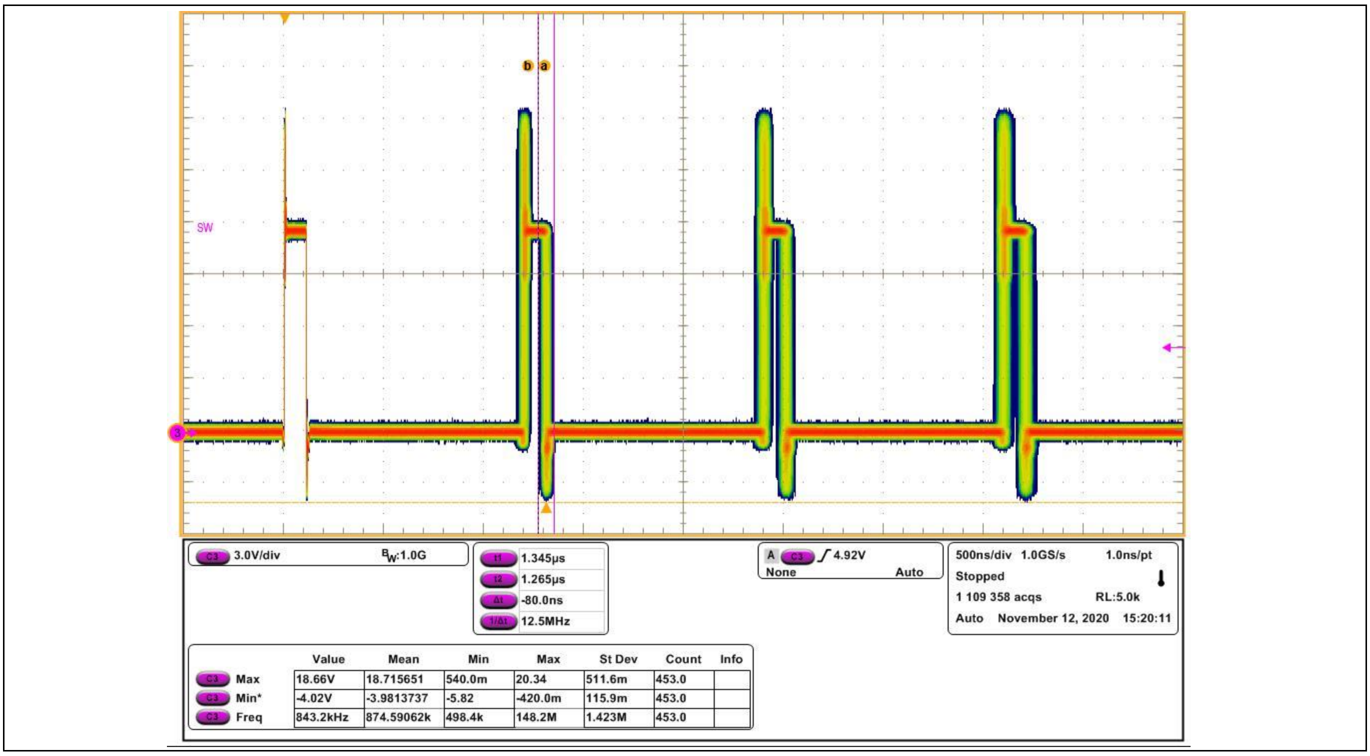
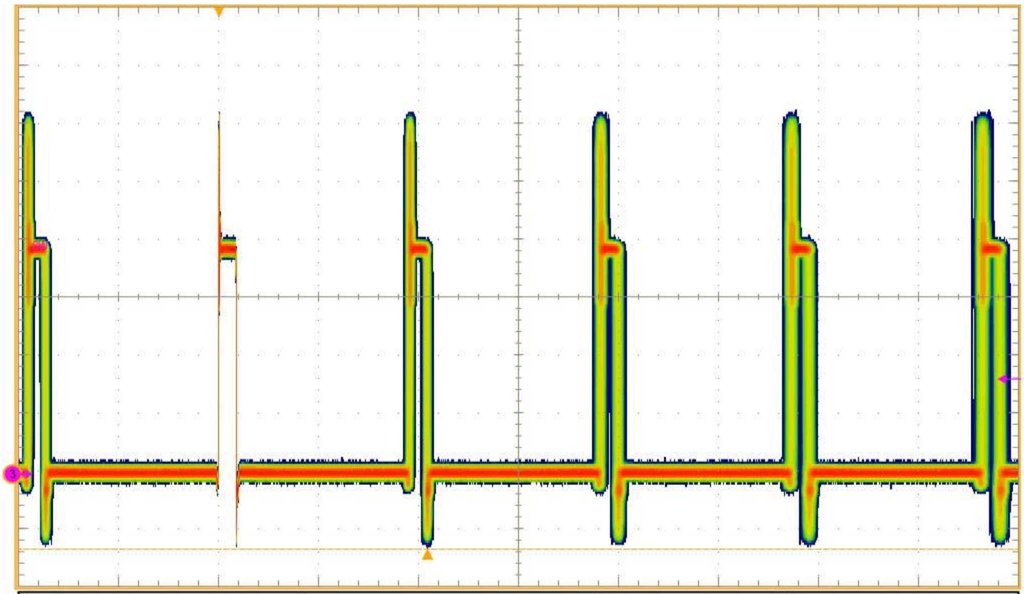
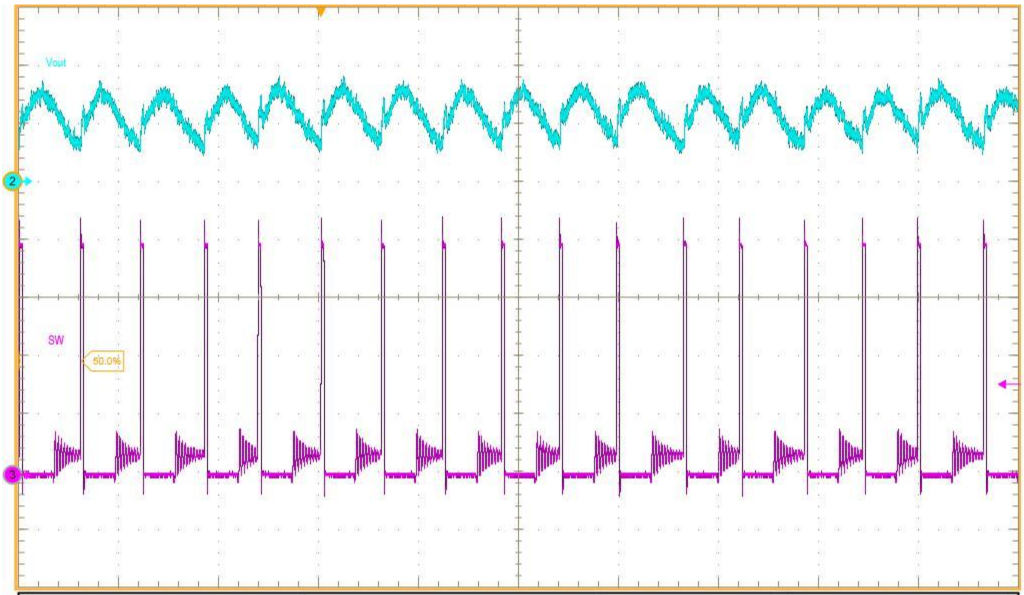


Figure 18 SW node, 40 A load, f_{sw} = 800 kHz



	Value	Mean	Min	Max	St Dev	Count	Info
Max	18.78V	18.721935	13.74	19.14	692.9m	195.0	
Min*	-3.9V	-3.8220826	-4.02	-1.14	370.3m	195.0	
Freq	1.036MHz	1.0320197M	903.3k	1.036M	17.76k	195.0	

Figure 19 SW node, 40 A load, f_{sw} = 1000 kHz



	Value	Mean	Min	Max	St Dev	Count	Info
Pk-Pk	27.36mV	27.226044m	25.79m	28.84m	897.4µ	21.0	
Freq*	325.7kHz	336.94527k	307.3k	364.6k	16.97k	21.0	

Figure 20 SW node, 4 A load, f_{sw} = 600 kHz, DEM

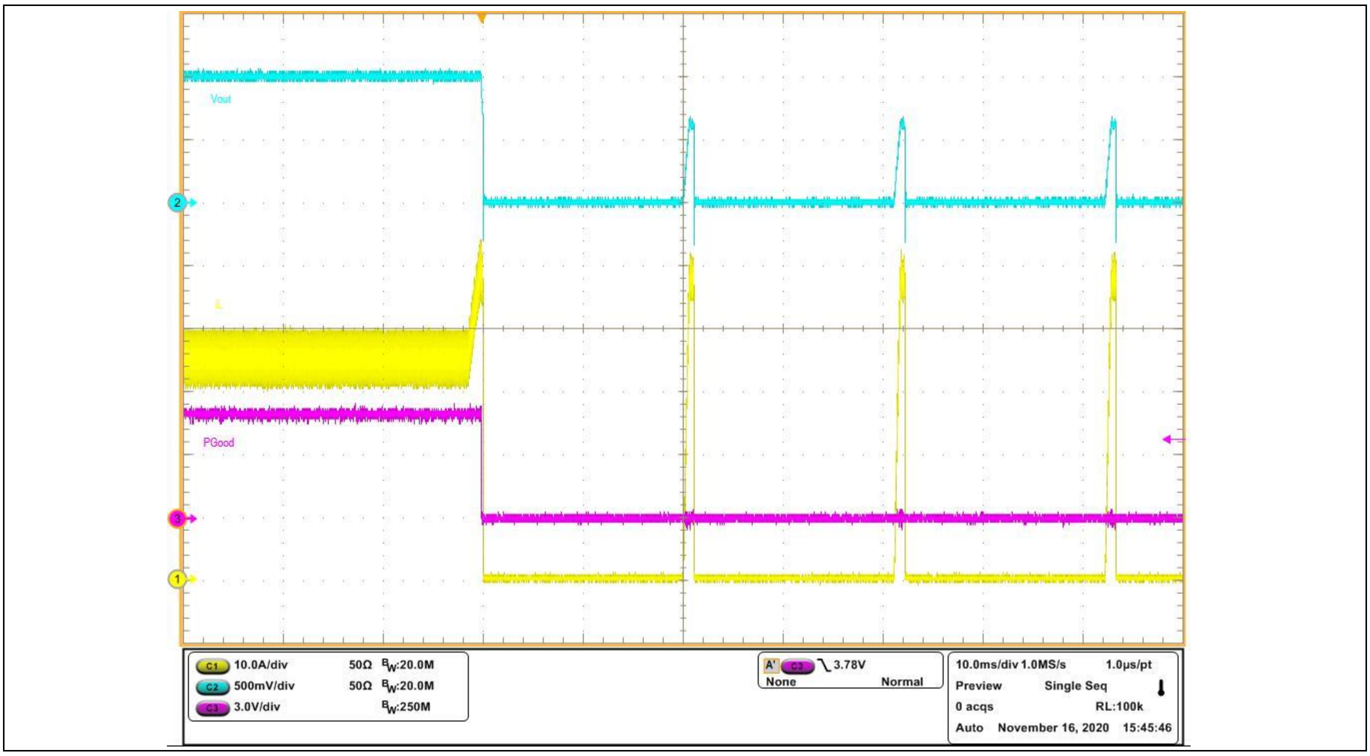


Figure 21 Short-circuit and UVP (hiccup), (Ch_1: iL, Ch_2: V_{out}, Ch_3: P_{Good})

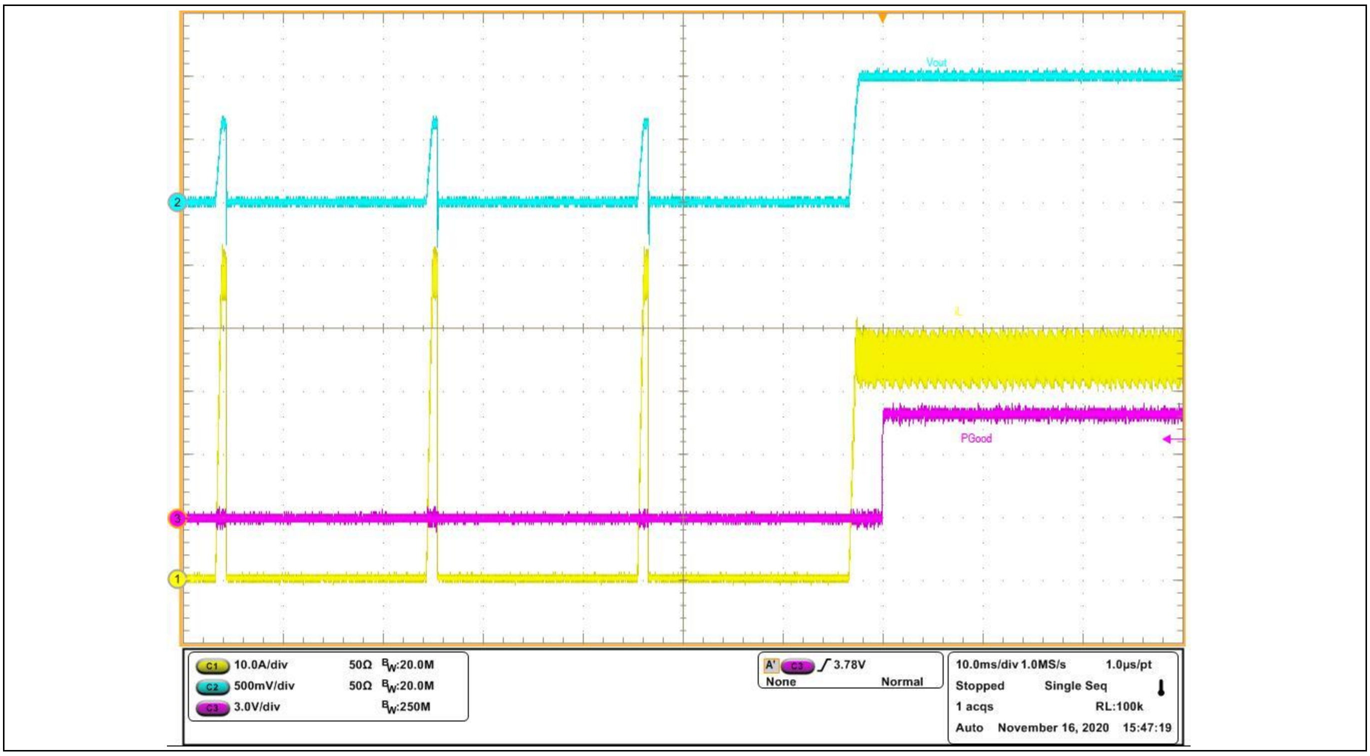


Figure 22 Short-circuit and UVP (hiccup) recover (Ch_1: iL, Ch_2: V_{out}, Ch_3: P_{Good})

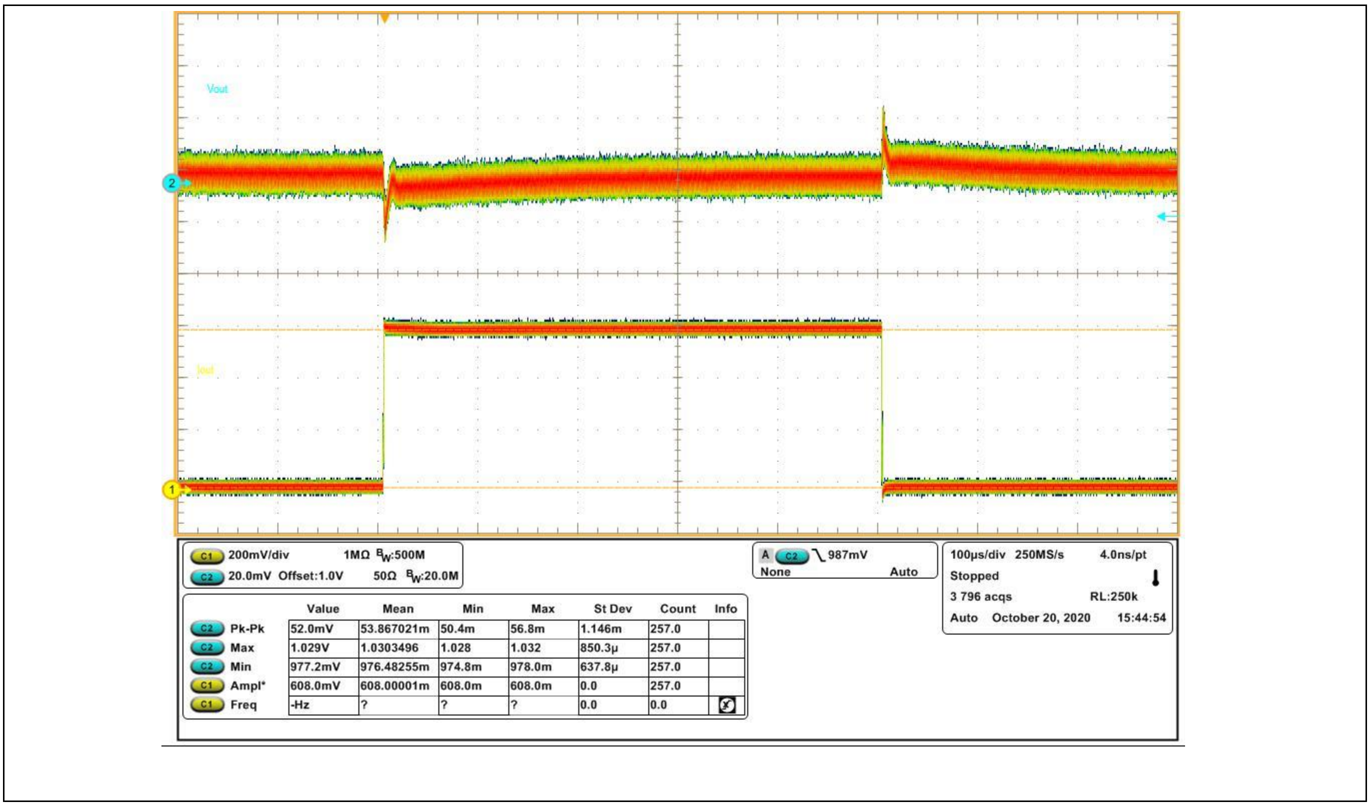


Figure 23 Transient response at 12 A step-load current at 10 A/µs slew rate: I_{out} = 0 A to 12 A (Ch_2: V_{out}, Ch_1: I_{out}) pk-pk: 52 mV, f_{sw} = 800 kHz

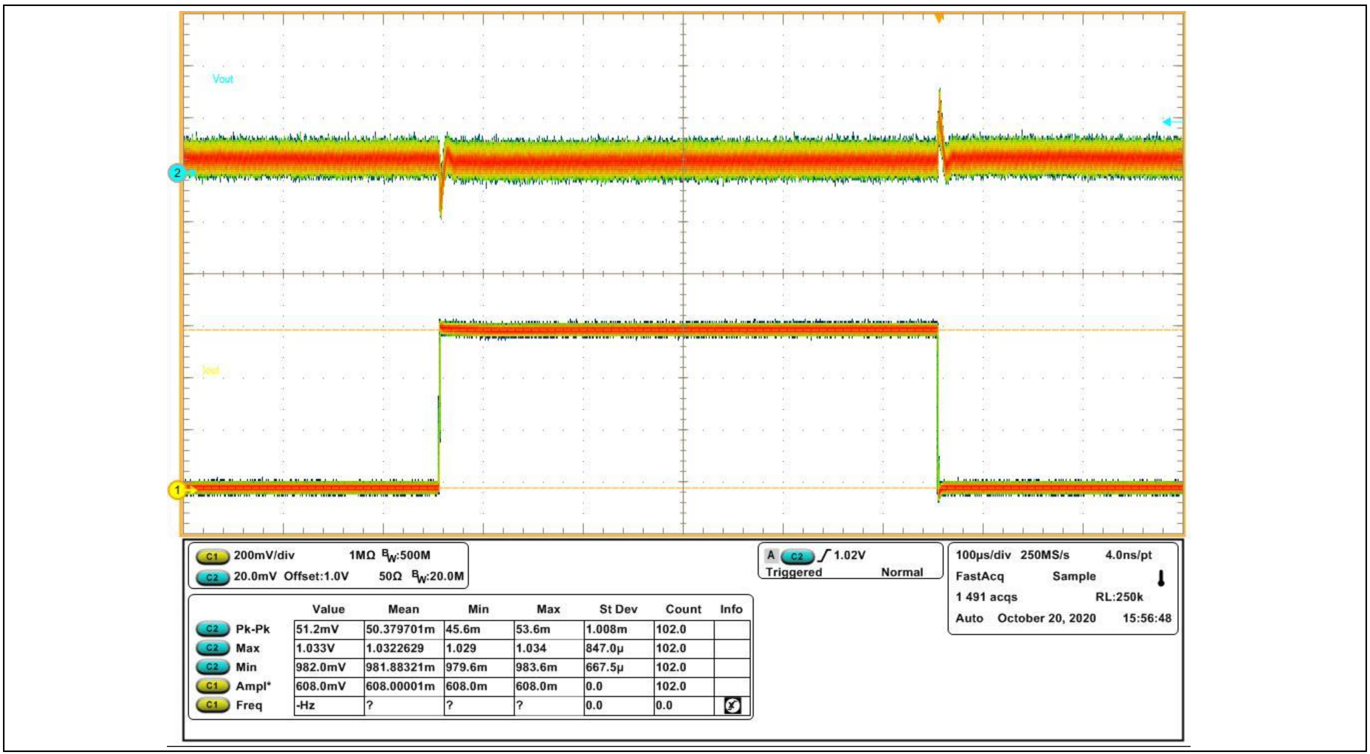


Figure 24 Transient response at 12 A step-load current at 10 A/µs slew rate: I_{out} = 28 A to 40 A (Ch_2: V_{out}, Ch_1: I_{out} exclude 28 A DC current), pk-pk: 51.2 mV, f_{sw} = 800 kHz

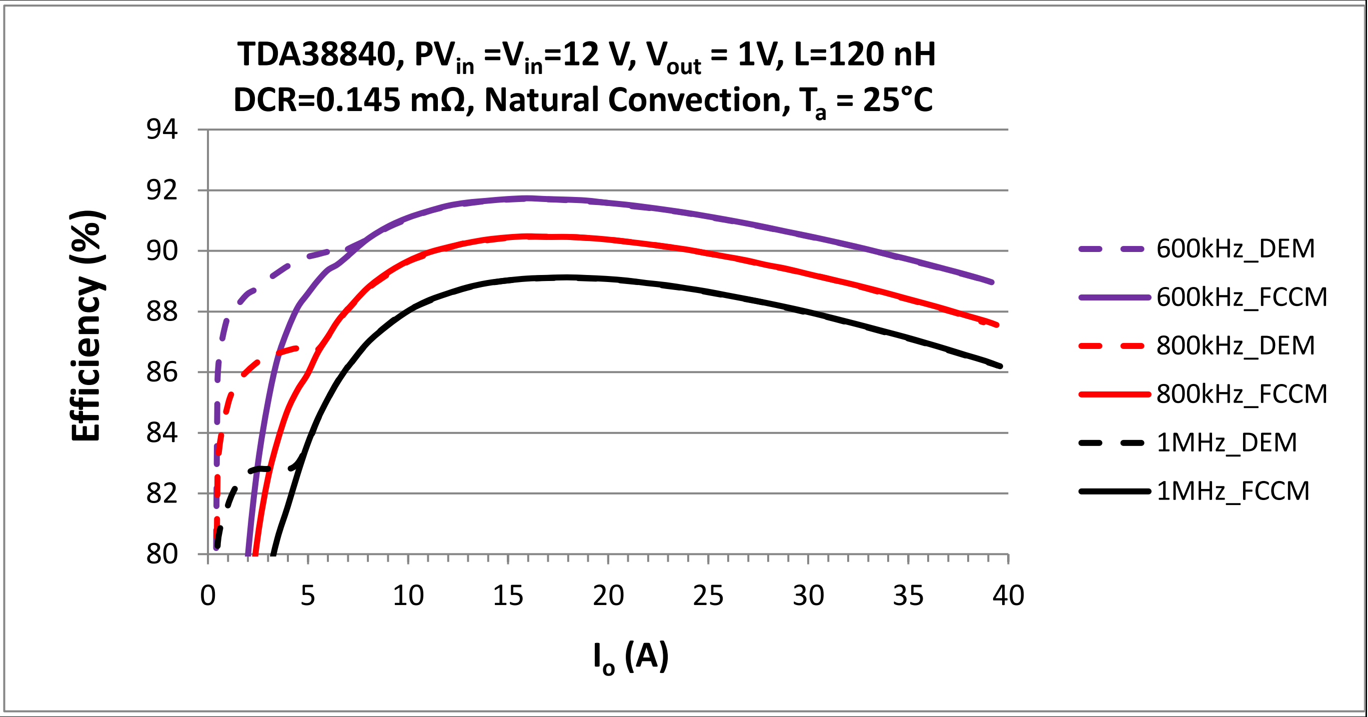


Figure 25 Efficiency vs. load current natural convection (12 V_{in}, 1 V_{out}, 120 nH, 600 kHz/800 kHz/1000 kHz, T_a = 25°C, FCCM: solid line, DEM: dashed line)

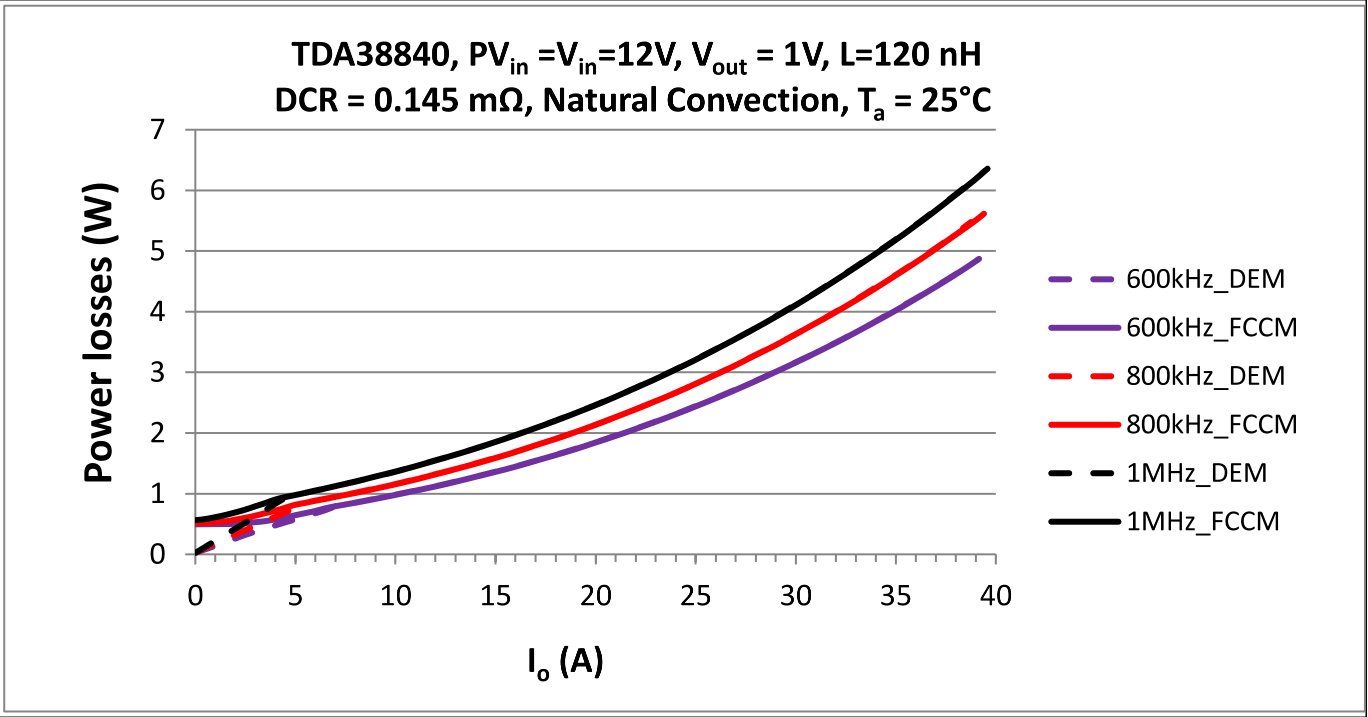


Figure 26 Power loss vs. load current natural convection (12 V_{in}, 1.0 V_{out}, 120 nH, 600 kHz/800 kHz/1000 kHz, T_a = 25°C, FCCM: solid line, DEM: dashed line)

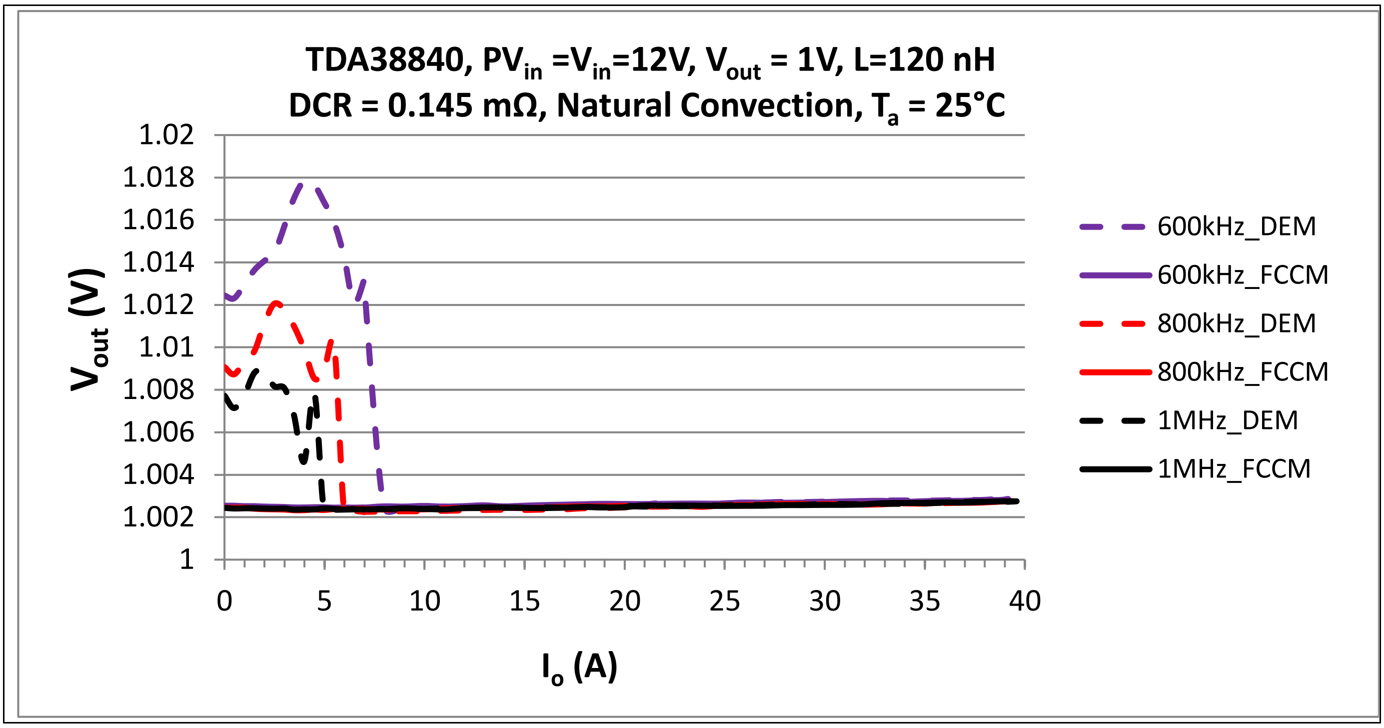


Figure 27 **TDA38840 V_{out} regulation (12 V_{in}, 1.0 V_{out}, 120 nH, 600 kHz/800 kHz/1 MHz, T_a = 25°C, FCCM: solid line, DEM: dashed line)**

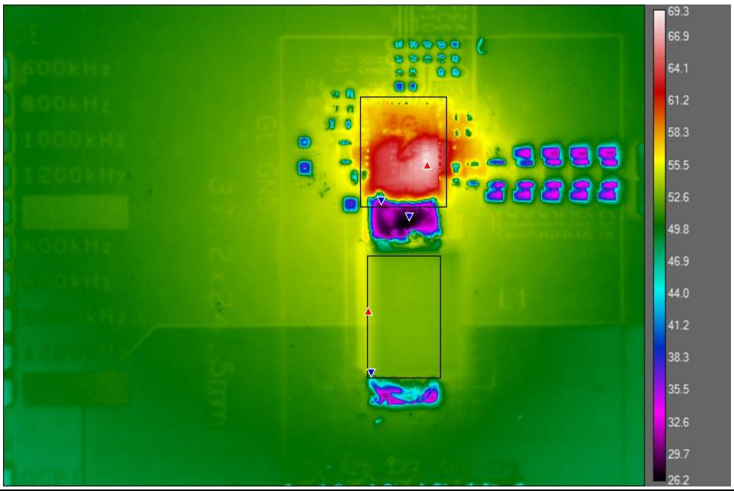


Figure 28 **Thermal image of the board at 40 A load TDA38840 = 69.3°C, L = 54.3°C, f_{sw} = 600 kHz, T_a = room temperature, natural convection**

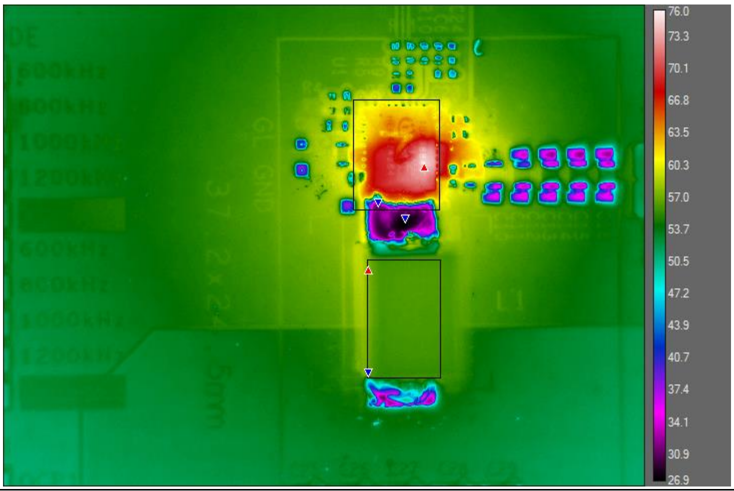


Figure 29 Thermal image of the board at 40 A load TDA38840 = 76°C, L = 57°C, f_{sw} = 800 kHz, T_a = room temperature, natural convection

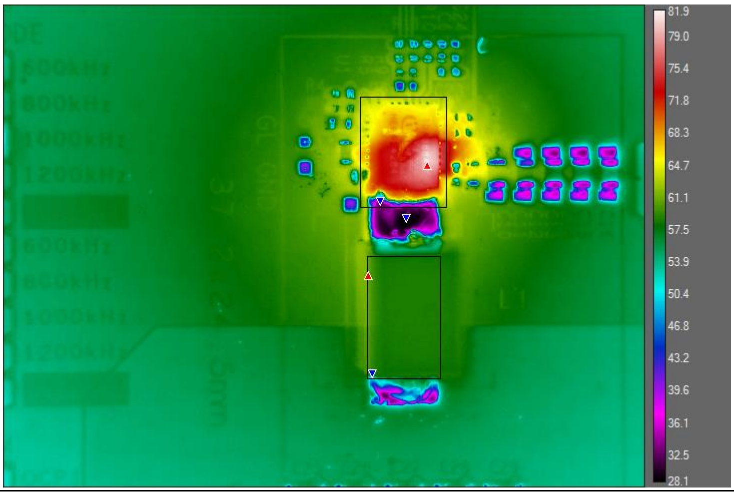


Figure 30 Thermal image of the board at 40 A load TDA38840 = 82°C, L = 60°C, f_{sw} = 1000 kHz, T_a = room temperature, natural convection

3 Revision history

Document version	Date of release	Description of changes
V 1.0	2022-06-28	First release

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