

EVAL_TDA38825_1VOUT user guide

User guide for TDA38825 evaluation board

About this document

Scope and purpose

The TDA38825 is a synchronous buck regulator, providing a compact, high-performance and flexible solution in a small 3 mm x 4 mm QFN package.

Key features offered by the TDA38825 include internal soft-start, precision 0.6 V reference voltage, Power Good, thermal protection, programmable switching frequency in the range of 600 kHz to 1 MHz, programmable soft-start, enable input, input undervoltage lockout (UVLO) for proper start-up, latched-off output overvoltage protection (OVP), overcurrent protection (OCP) limit, and pre-bias start-up.

This user guide contains the schematic and bill of materials for the EVAL_TDA38825_1VOUT engineering evaluation board. It describes operation and use of the evaluation board itself. Detailed application information for TDA38825 is available in the TDA38825 datasheet.

Intended audience

This document is intended as a guide for design engineers evaluating TDA38825 performance with the engineering EVAL_TDA38825_1VOUT demo board.

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Important notice

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Safety precautions

Safety precautions

Note: Please note the following warnings regarding the hazards associated with development systems

Table 1 Safety precautions

	Caution: The heat sink and device surfaces of the evaluation or reference board may become hot during testing. Hence, necessary precautions are required while handling the board. Failure to comply may cause injury.
	Caution: The evaluation or reference board contains parts and assemblies sensitive to electrostatic discharge (ESD). Electrostatic control precautions are required when installing, testing, servicing or repairing the assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with electrostatic control procedures, refer to the applicable ESD protection handbooks and guidelines.

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1 TDA38825 features

Features

- Wide input voltage range: 4 V to 16 V with internal bias and 2.7 V to 16 V with external V_{CC} (3.3 V)
- Precision reference voltage ($0.6\text{ V} \pm 0.5\text{ percent}$)
- Stable with ceramic output capacitors
- No external compensation
- Optional forced continuous conduction mode and diode emulation for enhanced light load efficiency
- Selectable switching frequency from 600 kHz, 800 kHz, and 1 MHz
- Programmable soft-start time with a minimum of 1 ms and enhanced pre-bias start-up
- Voltage tracking with external reference input
- Programmable OCP Limit with internal thermal compensation
- Enable input with voltage monitoring capability
- Power Good output
- Latch-off OCP, undervoltage protection (UVP), thermal shutdown, and latch-off OVP
- Operating temperature: -40°C less than or equal to $\leq T_J \leq$ less than or equal to 125°C
- Small size: 3 mm x 4 mm QFN-21
- Lead-free, halogen-free, and RoHS compliant

Potential applications

- Server applications
- Storage applications
- Telecom and datacom applications
- Distributed point-of-load (PoL) power architectures

Board information

2 Board information

2.1 Evaluation board



Figure 1 Evaluation board

2.2 Board features

$V_{IN} = +12\text{ V}$, $V_{OUT} = +1\text{ V}$ at 0 to 20 A

$F_s = 600\text{ kHz}/800\text{ kHz}/1000\text{ kHz}$

$L = 220\text{ nH}$

$C_{IN} = 10 \times 22\text{ }\mu\text{F}$ (25 V, ceramic 0805) + 1 x 2.2 μF (25 V, ceramic 0805) + 1 x 330 μF (25 V, electrolytic, optional)

$C_{OUT} = 10 \times 47\text{ }\mu\text{F}$ (6.3 V, ceramic 0805) + 1 x 2.2 μF (6.3 V, ceramic 0805)

Board information

2.3 Connections and operating instructions

The TDA38825 demo board requires a single +12 V for the input power and can deliver up to 20 A load current. The operation modes and OCP limits can be selected through jumpers.

Table 2 Connections

Label		Descriptions
Input	PVIN	Connect input power (+12 V) to this pin
	GND	Return of input power
	PVIN, PGND_SNS	Sense pins for the input voltage
Output	VOUT	V _{OUT} (+1 V), connect a DC load (20 A max.) to this pin
	PGND	Return of V _{OUT}
	VOUT, PGND_SNS	Sense pins for the output voltage
Enable	EN	Connect a scope probe to this pin to monitor enable signal
	GND	Or, an external enable signal can be applied to this pin to overdrive the on-board enable signal
Bode	BODE_A	For bode plot measurement
	BODE_B	
Soft-start	SS/VREF	Connect a capacitor to this pin to get different soft-start times
Mode	FCCM	Use a jumper to select FCCM or DEM, and switching frequency. Three preset switching frequencies are: 600 kHz, 800 kHz, 1000 kHz.
	DEM	
CS		Use a resistor to connect to CS to configure the current limit
P _{GOOD}	PGOOD	Connect a scope probe to this pin to monitor Power Good signal
	GND	GND
RGND	RGND	Differential remote sense negative input. Connect this pin directly to the negative side of the voltage sense point. Short to GND if remote sense is not used.
V _{CC}	VCC	Standard demo board is configured to use the internal low-dropout regulator (LDO). Connect a scope probe to this pin to monitor the output of the internal LDO.
	GND	

2.4 Layout

The PCB is a six-layer board using FR4 material. Top and bottom layers use 2 oz. copper and inner layers use 1 oz. copper. The PCB thickness is 1.6 mm. The TDA38825 and other major power components are mounted on the top side of the board.

Board information

2.5 PCB Layout

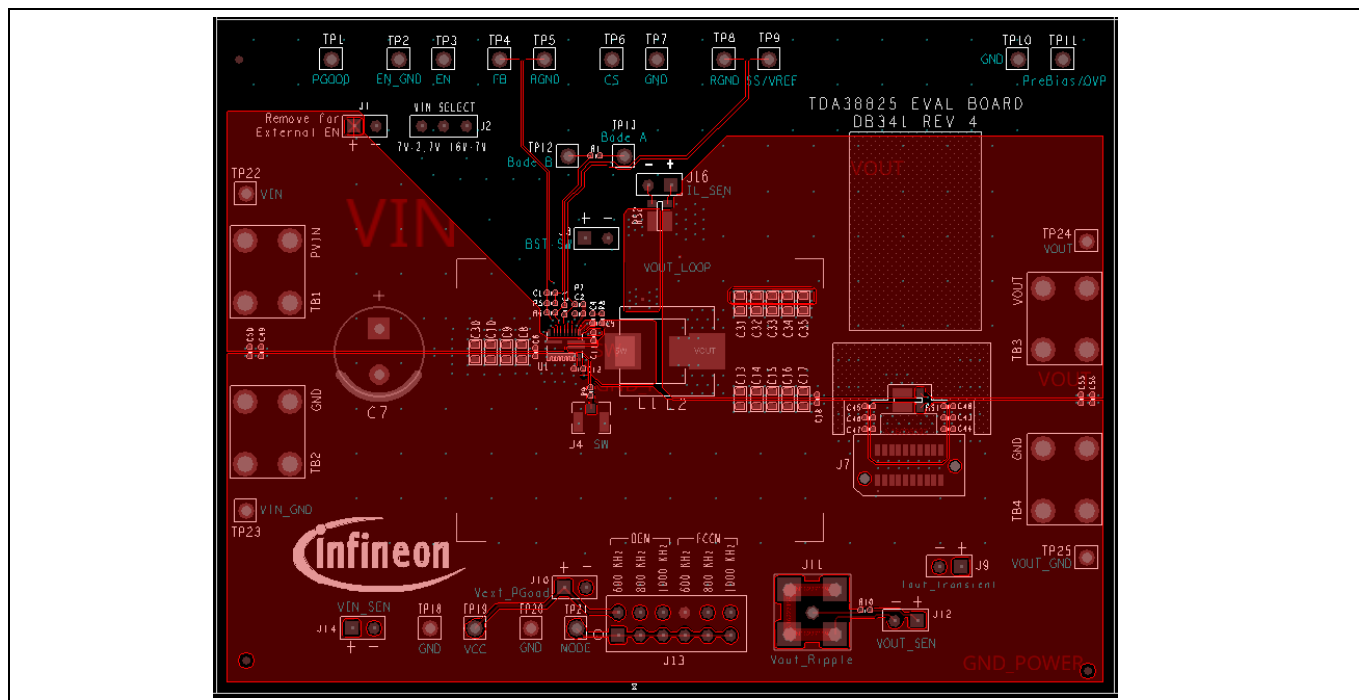


Figure 2 Top layer

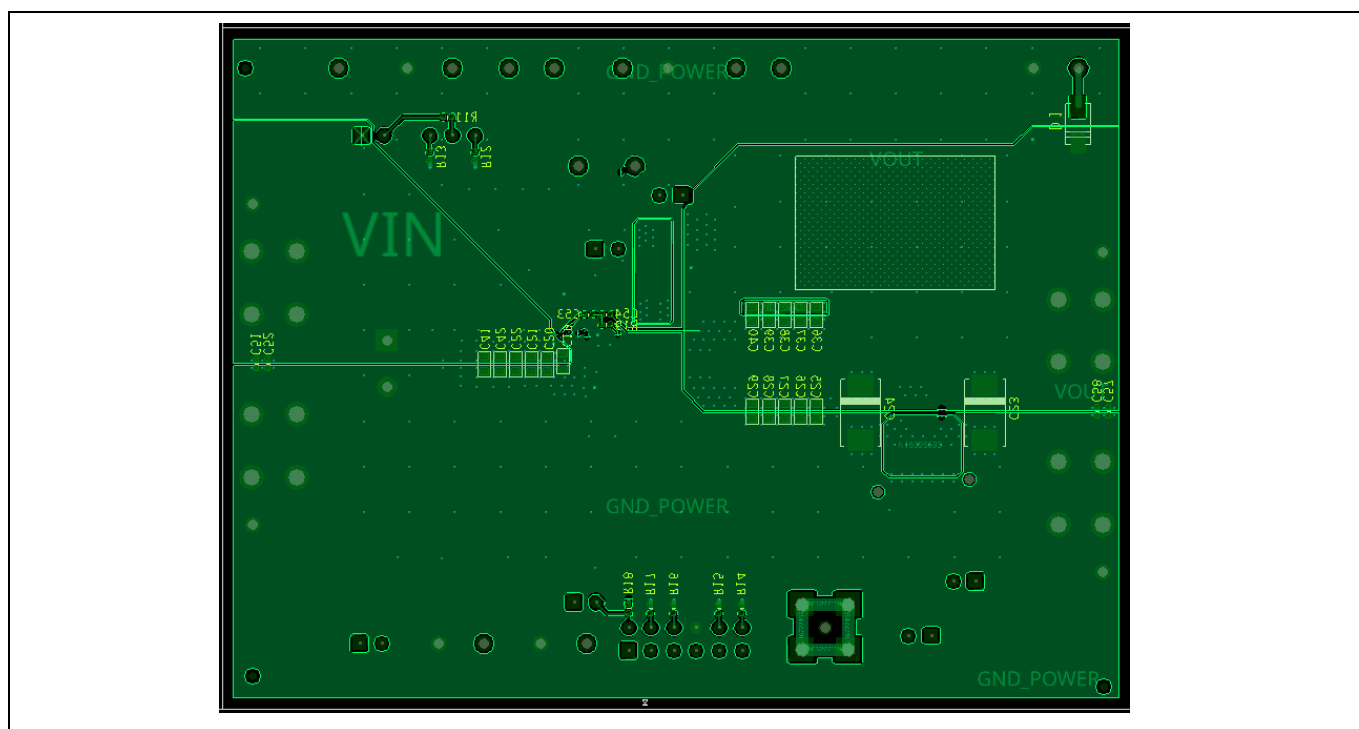


Figure 3 Bottom layer

Board information

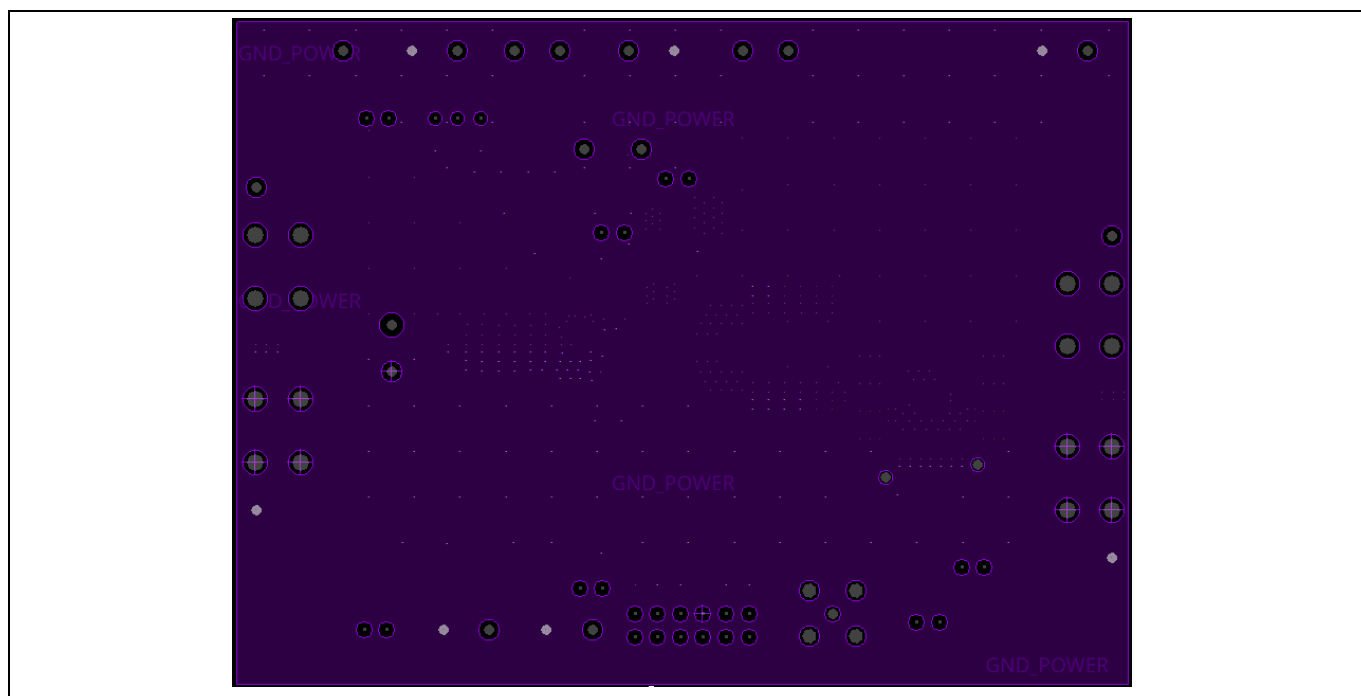


Figure 4 Inner layer 1

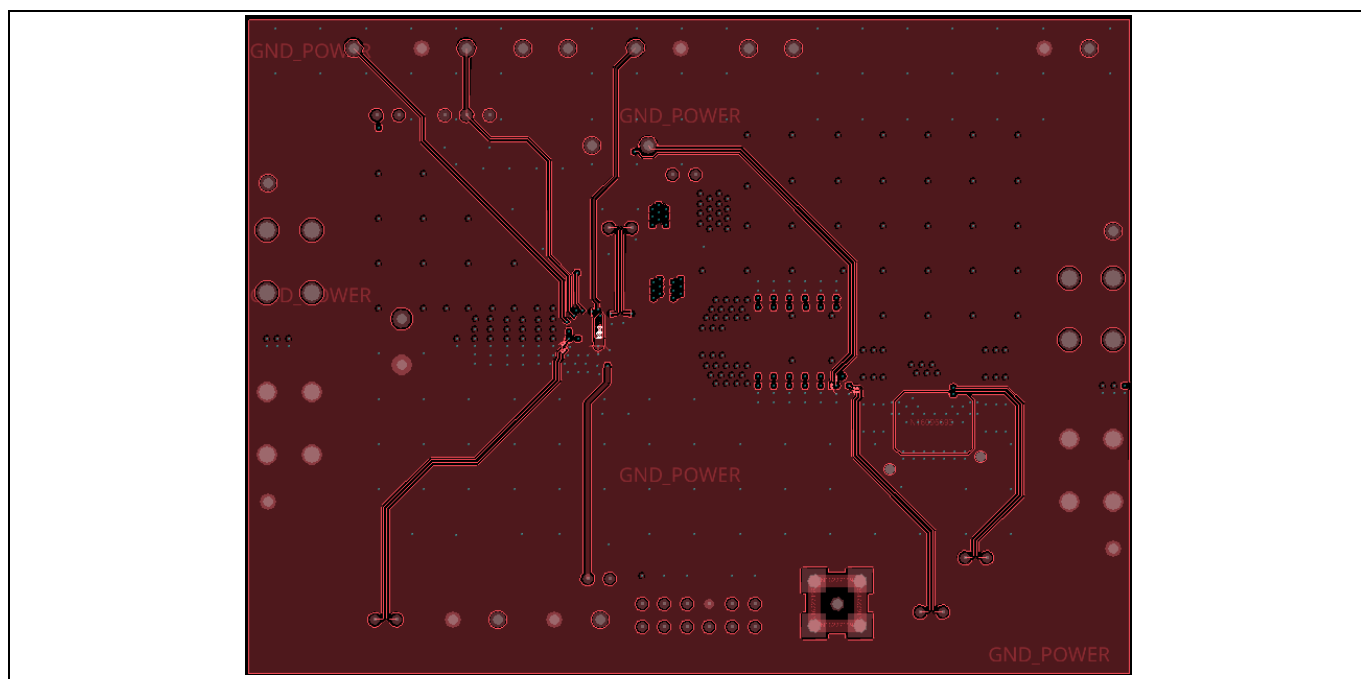


Figure 5 Inner layer 2

Board information

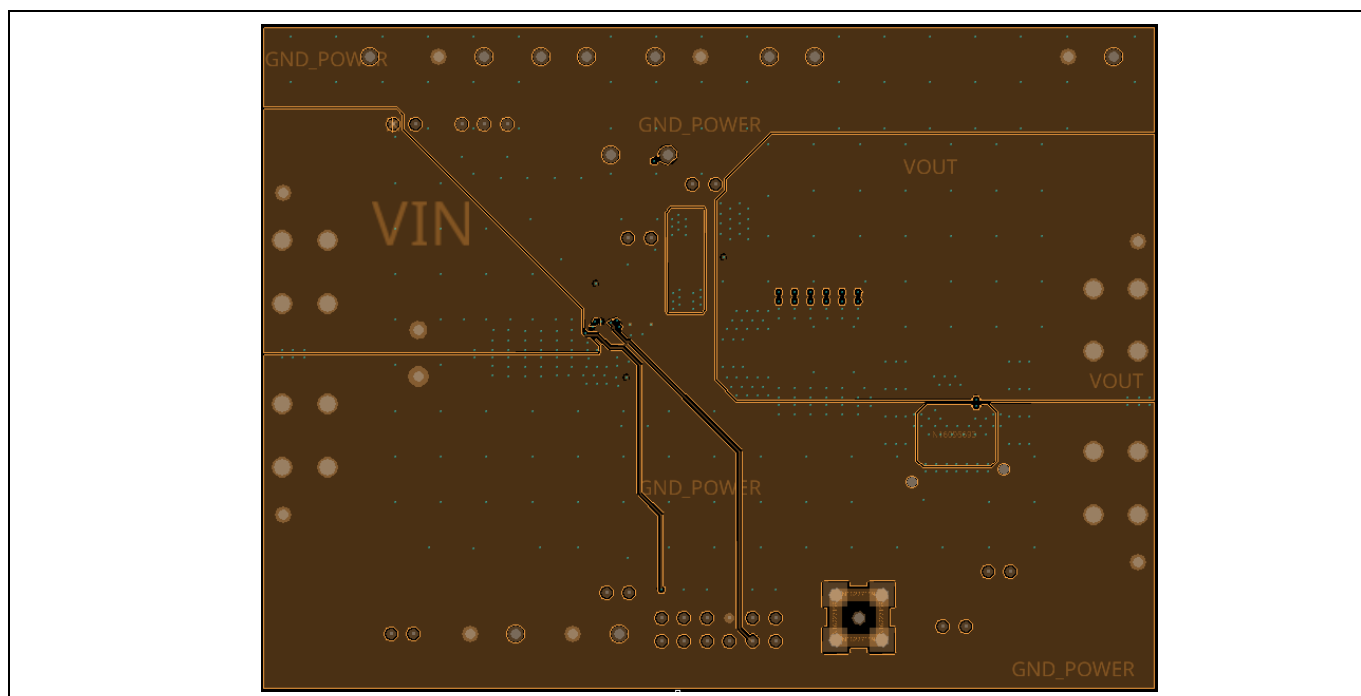


Figure 6 Inner layer 3

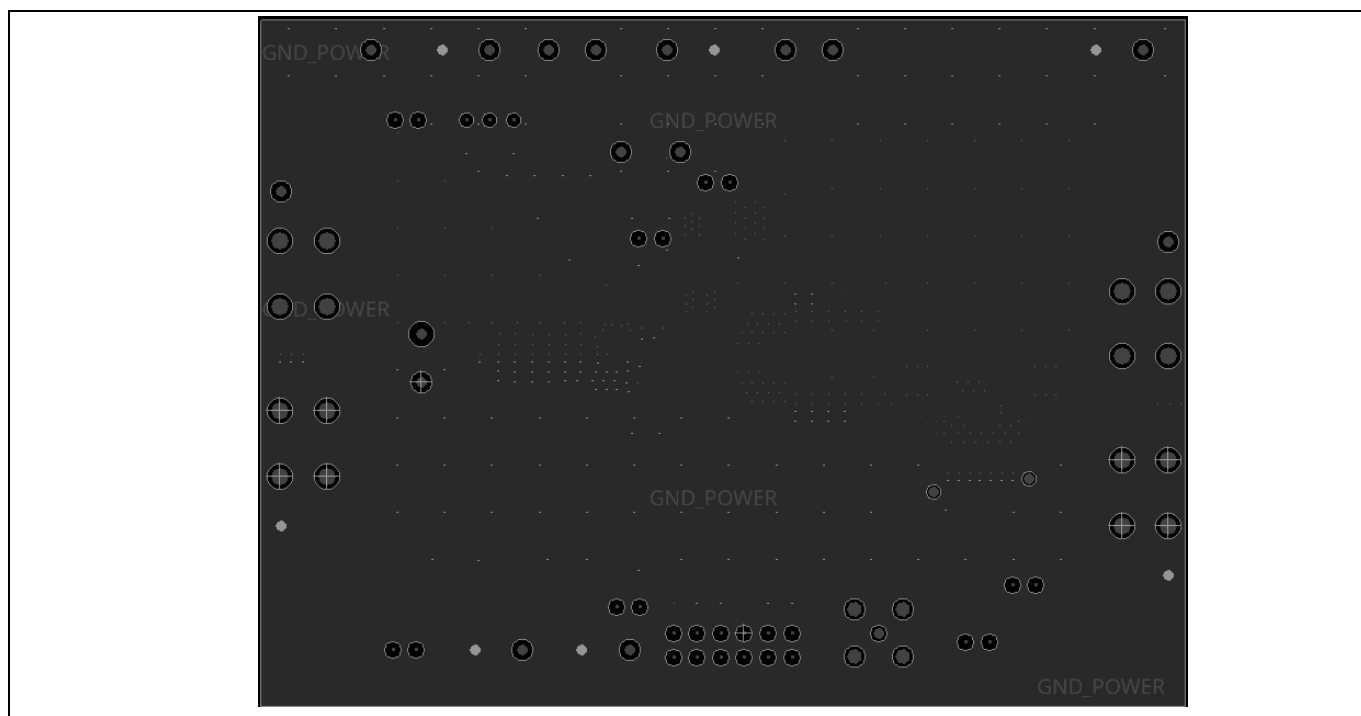


Figure 7 Inner layer 4

2.6 Schematic

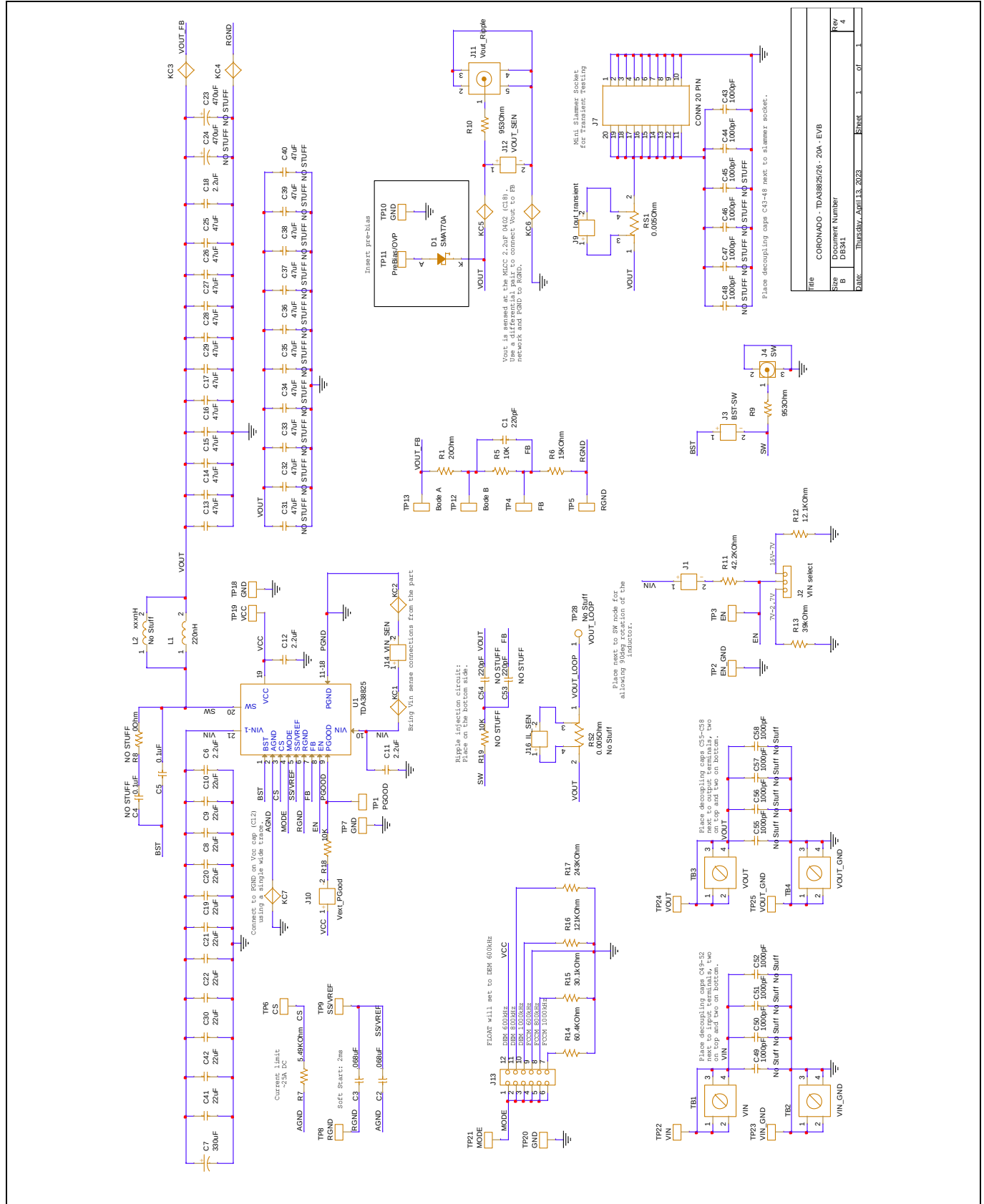


Figure 8 Schematic of the TDA38825 evaluation board $V_{IN} = 12\text{ V}$, $V_{OUT} = 1\text{ V}$, $I_{OUTmax} = 20\text{ A}$

Board information

2.7 Bill of materials

Table 3 Bill of materials

Item no.	Qty	Part reference	Value	Description	Manufacturer	Part number
1	1	C1	220 pF	Ceramic capacitor 220 pF 50 V X7R 0402 10%	TDK Corporation	C1005X7R1H 221K050BA
2	1	C12	2.2 μ F	Ceramic capacitor 2.2 μ F 16 V X5R 0402 10%	TDK Corporation	C1005X5R1C 225K050BC
3	10	C13, C14, C15, C16, C17, C25, C26, C27, C28, C29	47 μ F	Ceramic capacitor 47 μ F 6.3 V X5R 0805 20%	TDK Corporation	C2012X5R0J4 76M
4	2	C2, C3	.068 μ F	Ceramic capacitor .068 μ F 16 V X7R 0402 10%	Yageo	CC0402KRX7 R7BB683
5	10	C22, C30, C41, C42, C8, C9, C10, C19, C20, C21	22 μ F	Ceramic capacitor 22 μ F 25 V X5R 0805 20%	Murata	GRM21BR61 E226ME44L
6	2	C43, C44	1000 pF	Ceramic capacitor 1000 pF 50 V X7R 0402 10%	Kemet	C0402C102K5 RAC7867
7	1	C5	0.1 μ F	Ceramic capacitor 0.1 μ F 16 V X7R 0402 10%	Murata	GRM155R71C 104KA88D
8	3	C6, C11, C18	2.2 μ F	Ceramic capacitor 2.2 μ F 25 V X5R 0402 10%	Murata	GRM155R61E 225KE11D
9	1	C7	330 μ F	Aluminum polyester capacitor 330 μ F 20% 25 V T/H	Panasonic Electronic Components	25SEPF330M
10	1	D1	SMAT 70 A	TVS diode 70 VWM 100VC SMA	Diodes Incorporated	SMAT70A-13
11	7	J1, J3, J9, J10, J12, J14, J16	–	Vertical header connector 2-position 2.54 mm	Harwin Inc.	M20-9990246
12	1	J11	–	SMB straight jack connector 50 Ω PCB	Cinch Connectivity Solutions/ Johnson	131-3701-261

Board information

13	1	J13	–	Vertical header connector 12-position 2.54 mm	Adam Tech	PH2-12-UA
14	1	J2	–	Header connector R/A 3- position 2.54 mm	Harwin Inc.	M20-9960345
15	1	J4	–	UMCC straight jack connector 50 Ω SMD	TE Connectivity/ AMP Connectors	1909763-1
16	1	J7	20- Pin conne ctor	Dual female edge connector 20-position 0.031	Samtec Inc.	HSEC8-110- 01-S-DV-A-K- TR
17	1	L1	220 nH	Fixed inductor 220 nH 37 A 0.667 m Ω SMD	Delta Electronics/ Cyntec	CMLE063T- R22MS0R667
18	1	R1	20 Ω	Thick film resistor 20.0 Ω 1/16 W 1% SMD 0402	Yageo	RE0402FRE0 720RL
19	1	R11	42.2 k Ω	Thick film resistor 42.2 k Ω 1/16 W 1% 0402	Yageo	RC0402FR- 0742K2L
20	1	R12	12.1 k Ω	Thick film resistor 12.1 k Ω 1/10 W 1% 0402	Panasonic	ERJ- 2RKF1212X
21	1	R13	39 k Ω	Thick film resistor 39 k Ω 5.0 % 1/16 W SMD 0402	Panasonic	ERJ- 2GEJ393X
22	1	R14	60.4 k Ω	Thick film resistor 60.4 k Ω 1/10 W 1% 0402	Yageo	RC0402FR- 0760K4L
23	1	R15	30.1 k Ω	Thick film resistor 30.1 k Ω 1.0 % 1/16 W SMD 0402	Vishay	CRCW040230 K1FKED
24	1	R16	121 k Ω	Thick film resistor 121 k Ω 1/10 W 1% 0402	Yageo	RC0402FR- 07121KL
25	1	R17	243 k Ω	Thick film resistor 243 k Ω 1/16 W 1% 0402	Yageo	RC0402FR- 07243KL
26	2	R5, R18	10 k	SMD resistor 10 k Ω 1% 1/16 W 0402	Yageo	AC0402FR- 0710KL
27	1	R6	15 k Ω	Thick film resistor 15.0 k Ω 1/16 W 1% 0402	Yageo	RC0402FR- 0715KL
28	1	R7	5.49 k Ω	Thick film resistor 5.49 k Ω 1/10 W 1% 0402	Panasonic	ERJ- 2RKF5491X

Board information

29	2	R9, R10	953 Ω	Thick film resistor 953 Ω 1/10 W 1% 0402	Yageo	RC0402FR-07953RL
30	1	RS1	0.005 Ω	Thick film resistor 0.005 Ω 1 W 1% SMD 1632	Delta Electronics	RL1632T4F-R005-FNH
31	4	TB1, TB2, TB3, TB4	–	Terminal screw 6-32 4-pin PCB	Keystone Electronics	7693
32	21	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP18, TP19, TP20, TP21, TP22, TP23, TP24, TP25	–	Inboard pin .042" Hhole 1000/PKG	Vector Electronics	K30C/M
33	1	U1	TDA38825	TDA38825 20 A single-voltage synchronous buck regulator	Infineon	TDA38825

3 Evaluation board test results

3.1 Typical efficiency and power loss curves

$V_{IN} = 12\text{ V}$, $F_{SW} = 800\text{ kHz}$, Mode: DEM and FCCM

$V_{IN} = 12\text{ V}$, $V_{CC} = \text{internal LDO}$, $I_{OUT} = 0\text{ A} - 20\text{ A}$, $F_{SW} = 800\text{ kHz}$, room temperature, natural convection. Note that the efficiency and power loss curves include losses of the TDA38825, inductor losses, losses of the input and output capacitors, and PCB trace losses. [Table 4](#) below shows the inductors used for each of the output voltages in the efficiency measurement.

Table 4 Inductors for $V_{IN} = 12\text{ V}$, $F_{SW} = 800\text{ kHz}$

$V_{OUT}\text{ (V)}$	$L_{OUT}\text{ (nH)}$	P/N	DCR (m Ω)	Size (mm)
0.6	100 nH	CMLB063T-R10MS	0.81	7.25 x 6.6 x 2.8
1.0	220 nH	CMLE063T-R22MS	1.15	7.25 x 6.6 x 2.8
1.8	240 nH	CMLE063T-R24MS	1.19	7.25 x 6.6 x 2.8
3.3	360 nH	CMLE063T-R36MS	2.3	6.95 x 6.6 x 2.8
5.0	470 nH	CMLE063T-R47MS	2.9	6.95 x 6.6 x 2.8

Evaluation board test results

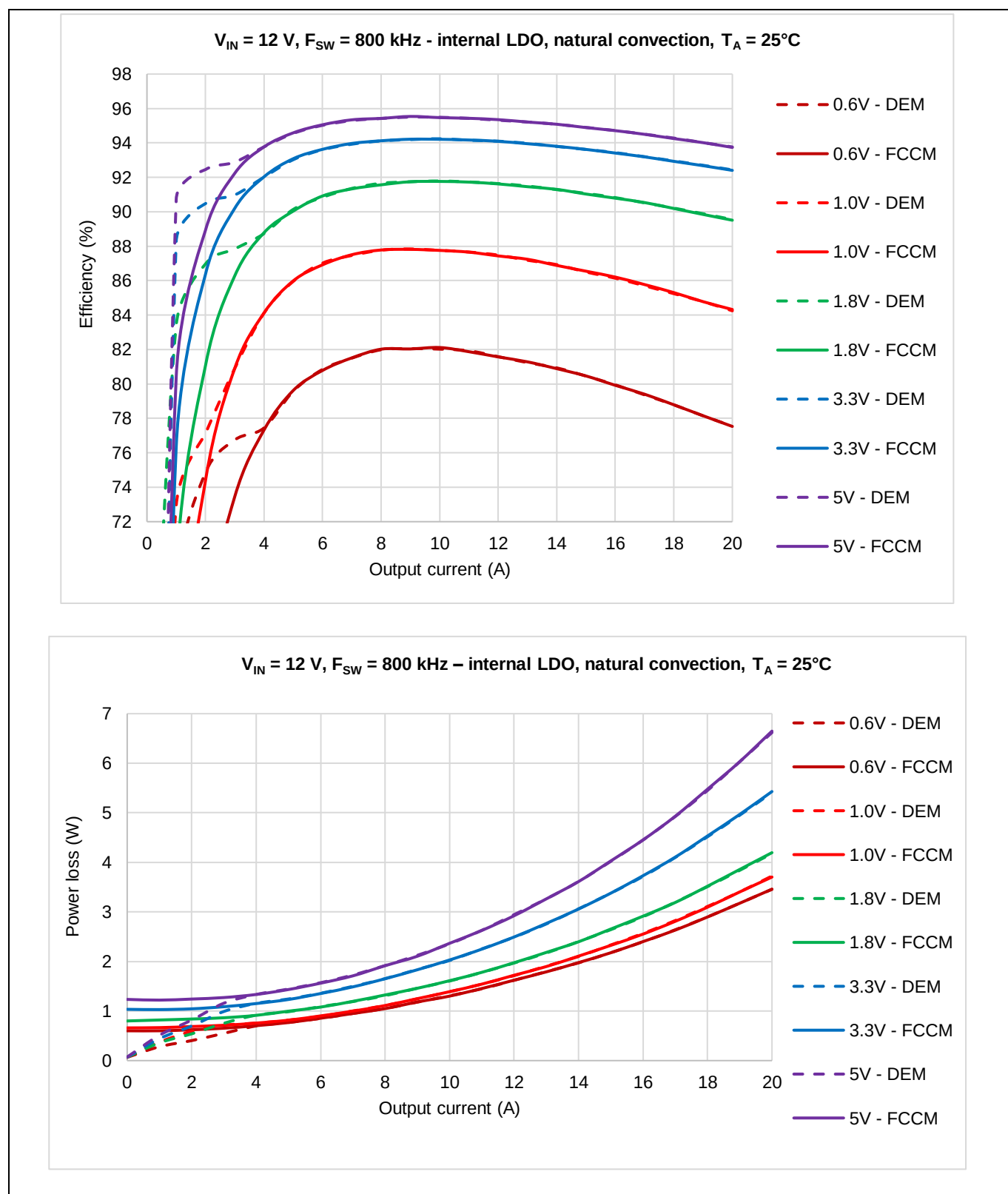


Figure 9 Efficiency and power loss

Evaluation board test results

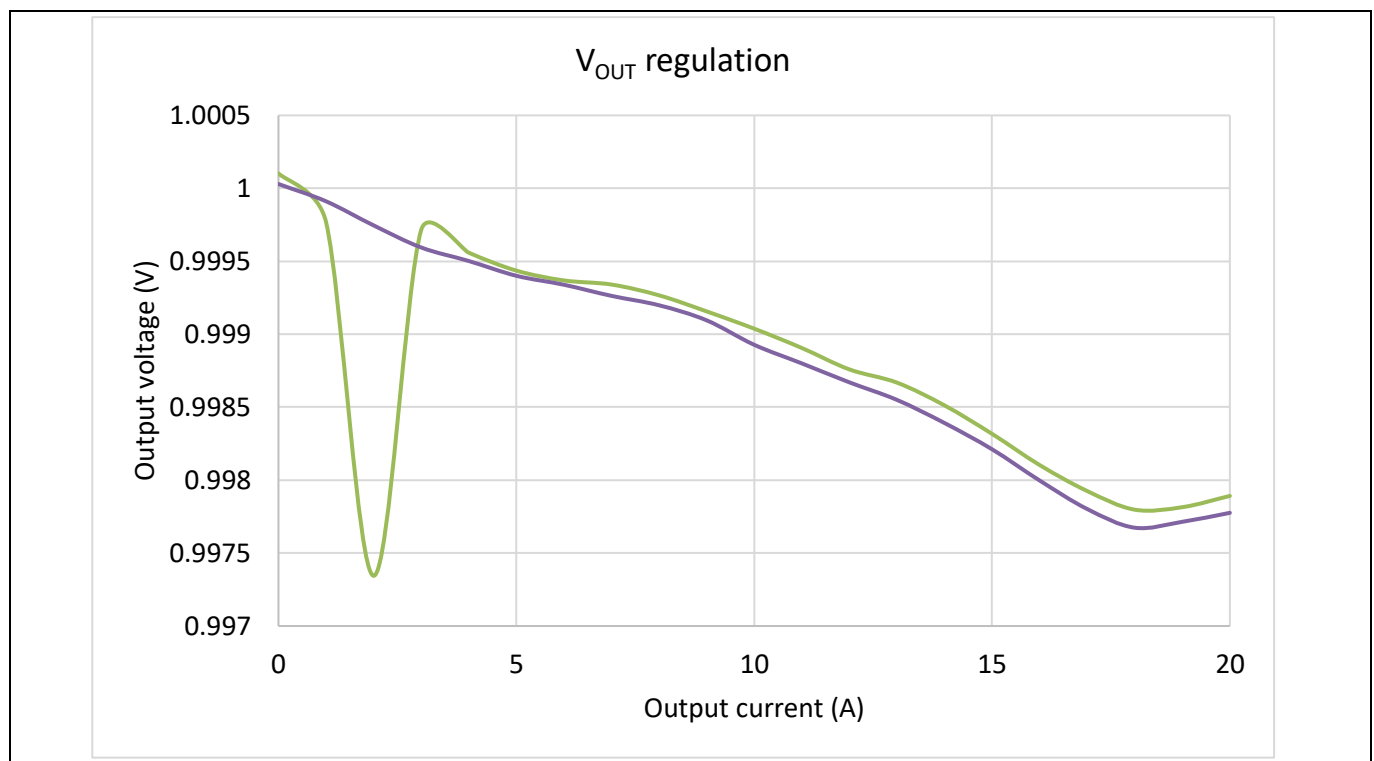


Figure 10 Output voltage regulation

3.2 Typical operating waveforms

$PV_{IN} = V_{IN} = 12.0\text{ V}$, $V_{OUT} = 1\text{ V}$, $I_{OUT} = 20\text{ A}$, $F_{SW} = 800\text{ kHz}$, room temperature, no airflow

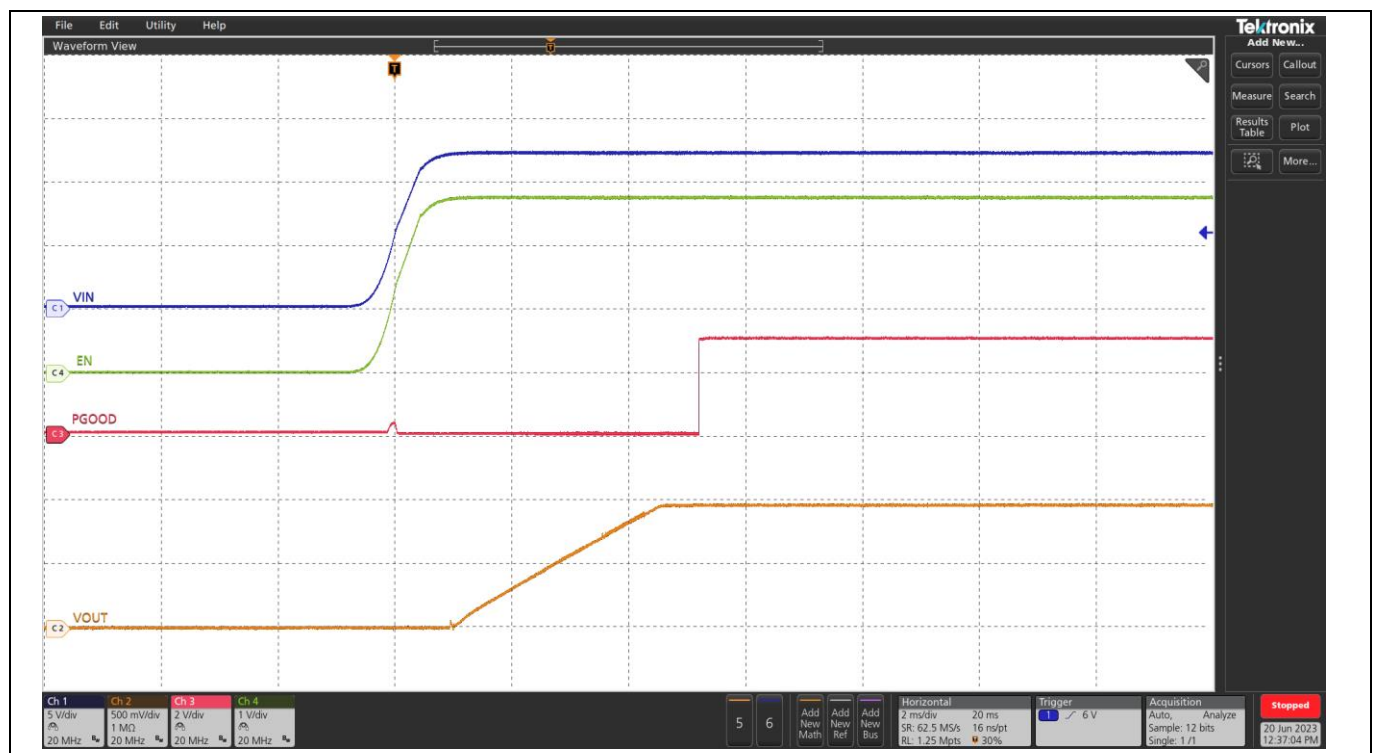


Figure 11 Start-up at 20 A load, (Ch1: V_{IN}, Ch2: V_{OUT}, Ch3: P_{GOOD}, Ch4: enable)

Evaluation board test results

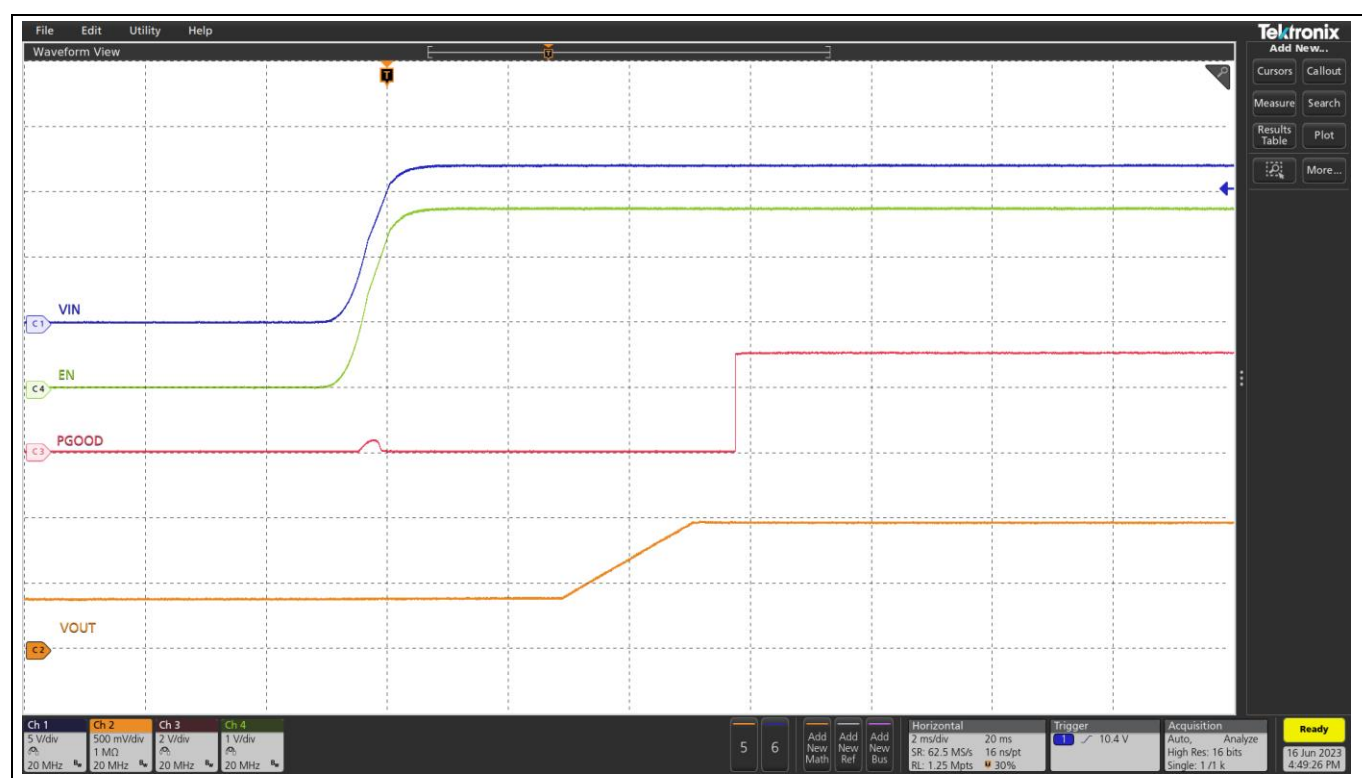


Figure 12 Pre-bias start-up at 0 A load, (Ch1: V_{IN} , Ch2: V_{OUT} , Ch3: P_{GOOD} , Ch4: enable)

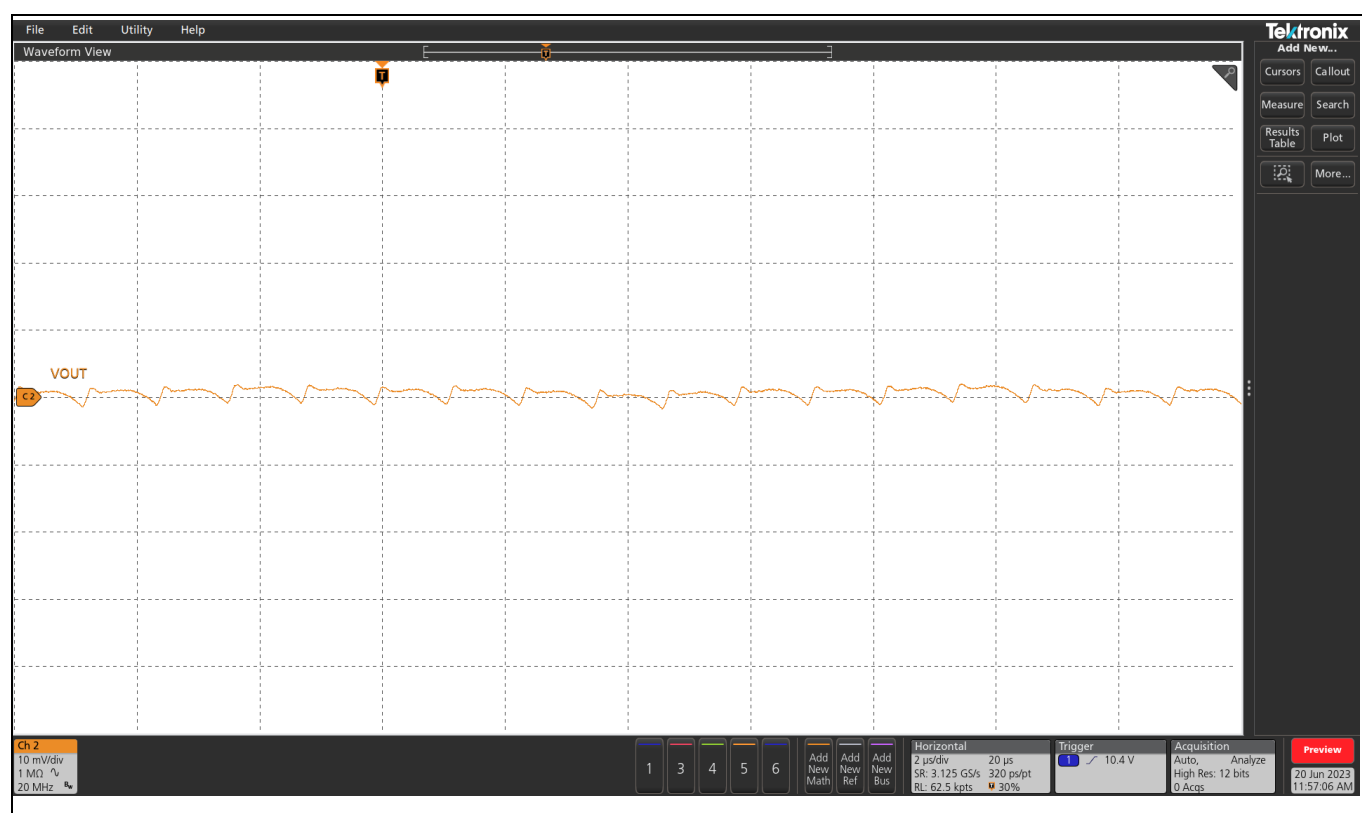


Figure 13 V_{OUT} ripple at 20 A Load, $F_{SW} = 800$ kHz, (Ch2: V_{OUT})

Evaluation board test results

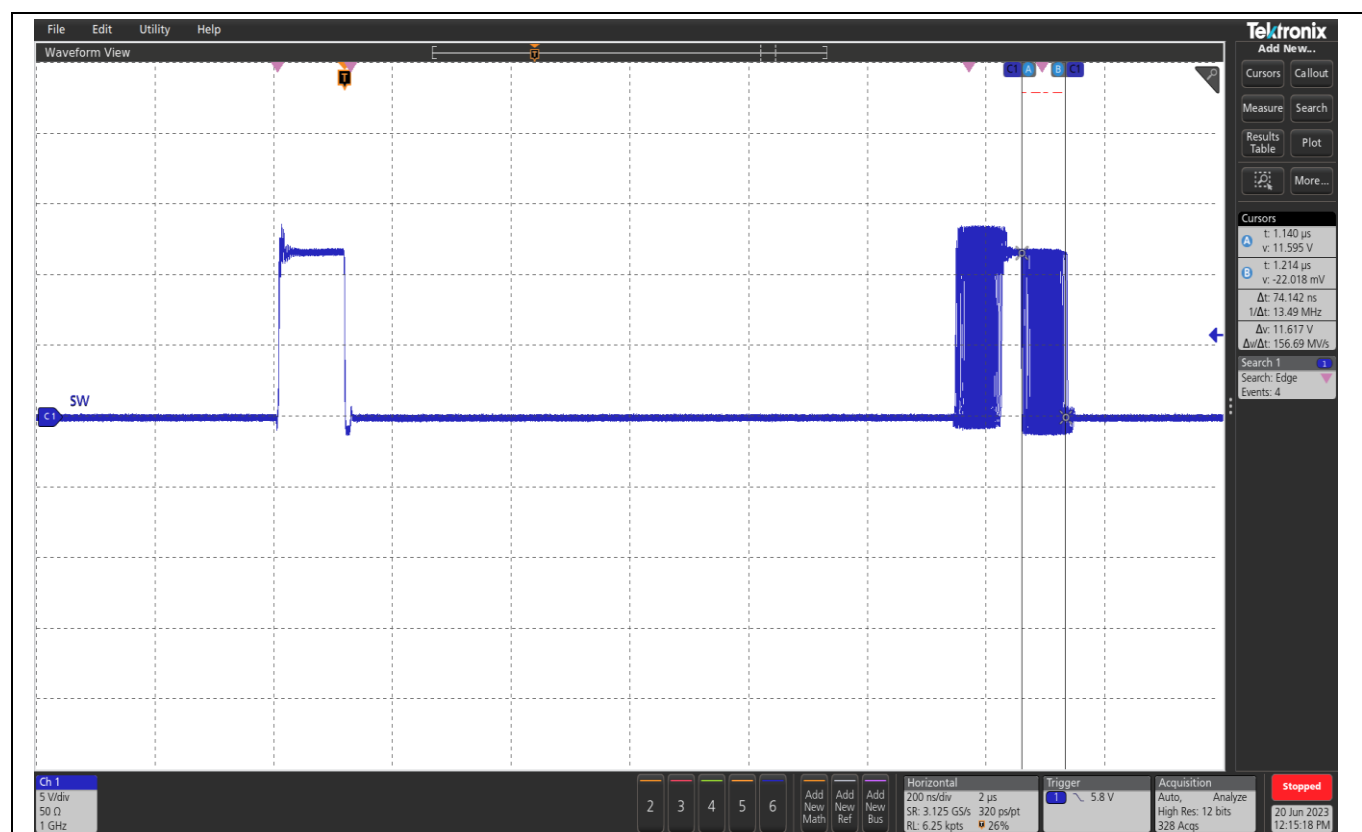


Figure 14 SW node jitter, 20 A load, $F_{sw} = 800$ kHz

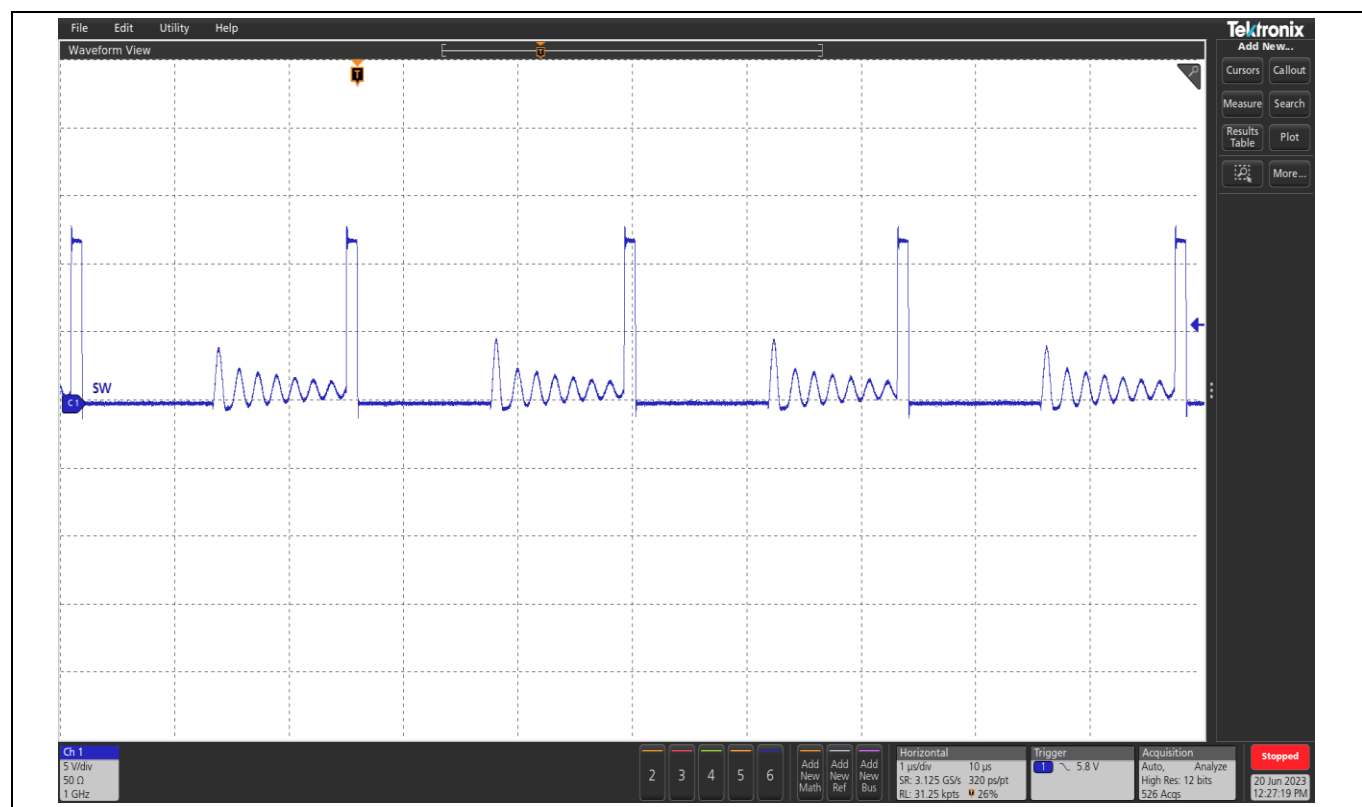


Figure 15 SW node (in DEM), 1 A load

Evaluation board test results

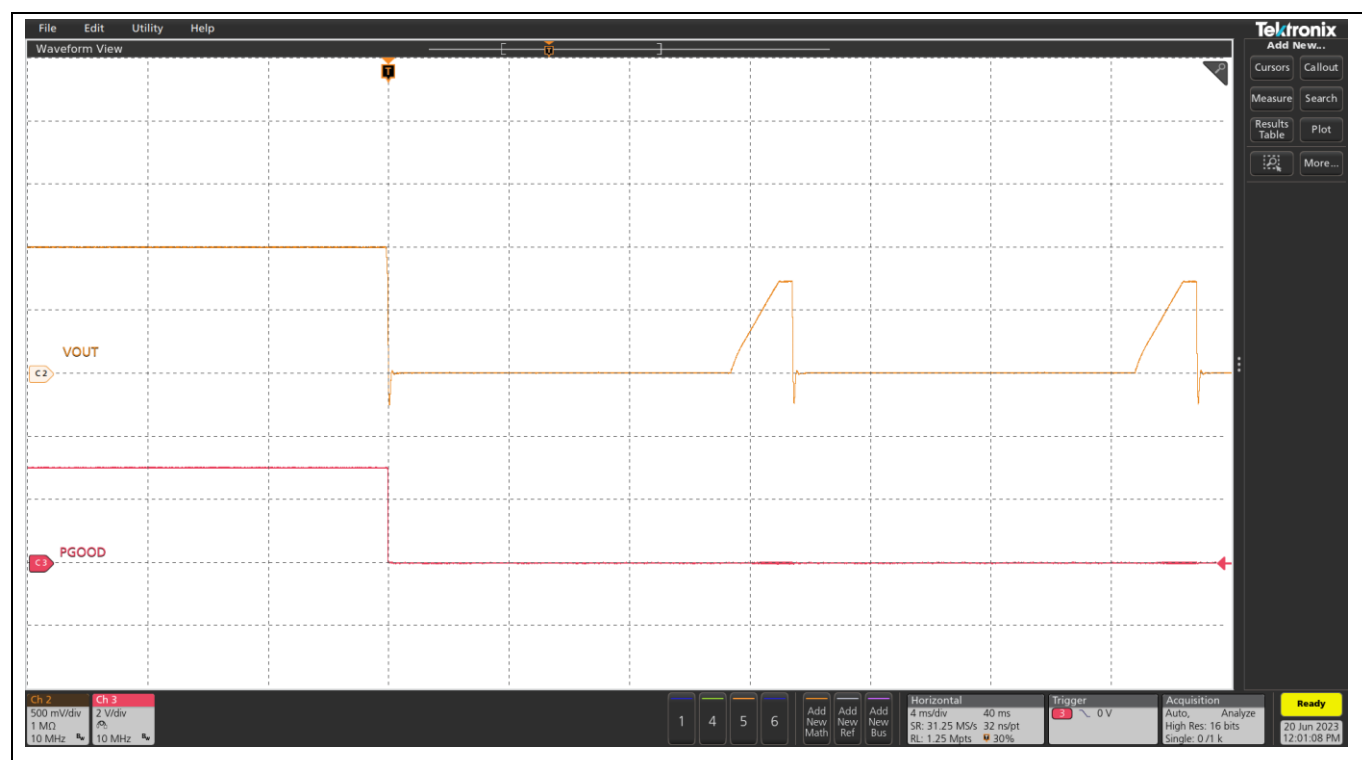


Figure 16 Short-circuit and UVP (Hiccup), (Ch2: V_{OUT} , Ch3: P_{GOOD})

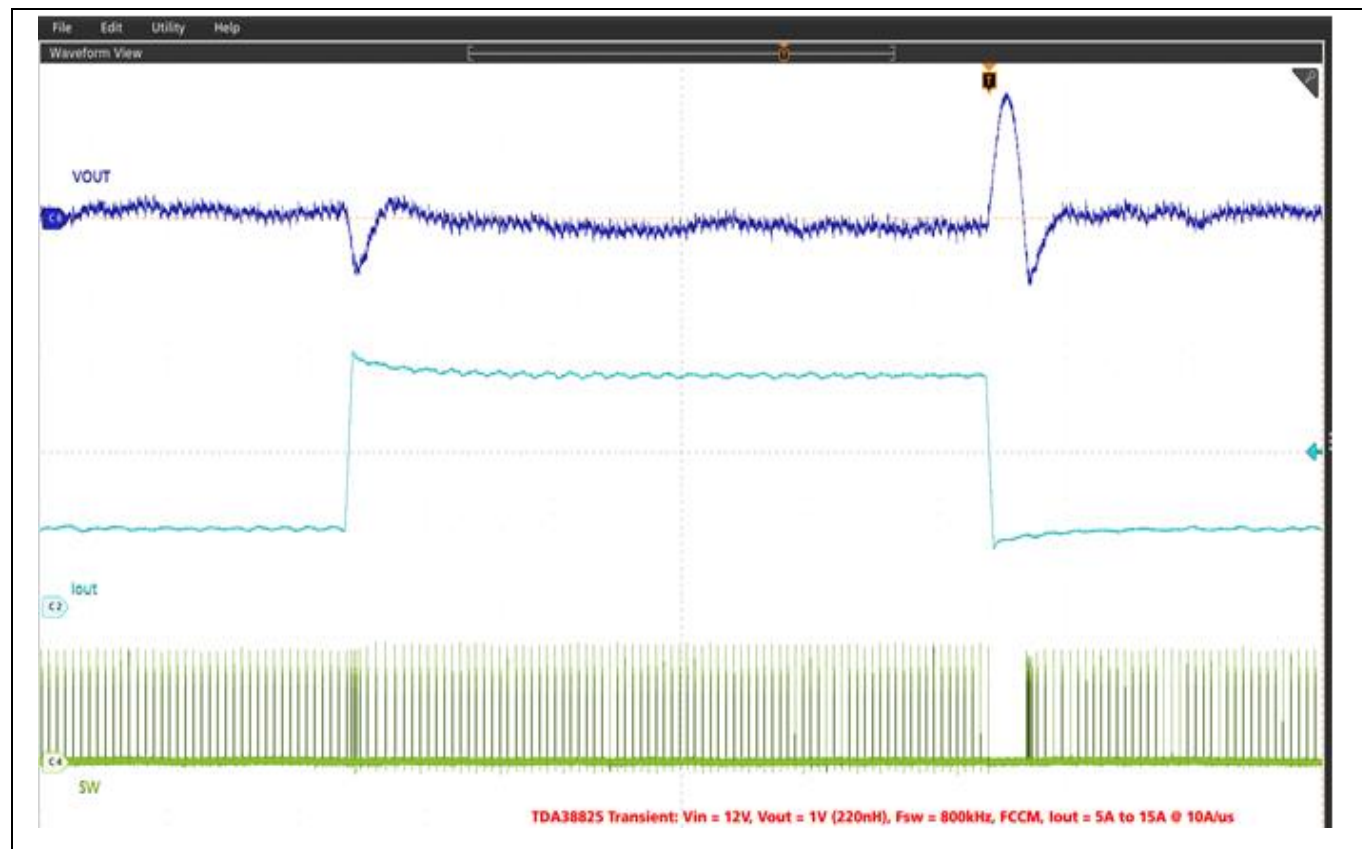


Figure 17 Transient response at 10 A step load current at 10 A/ μ s slew rate: I_{OUT} = 5 A – 15 A, (Ch6: V_{OUT} , Ch2: I_{OUT} , Ch4: SW), pk-pk: 55 mV, F_{SW} = 800 kHz

Evaluation board test results

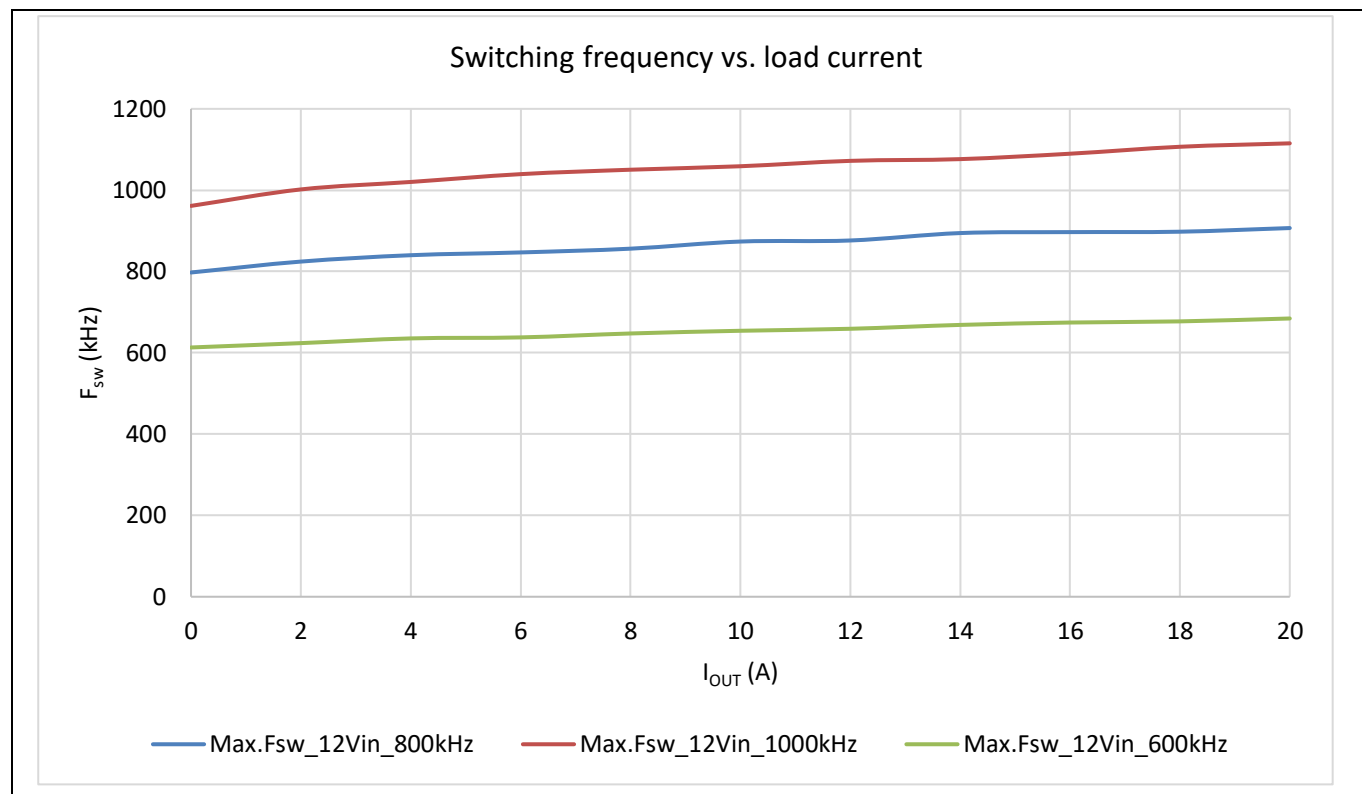


Figure 18 Switching frequency vs. load current

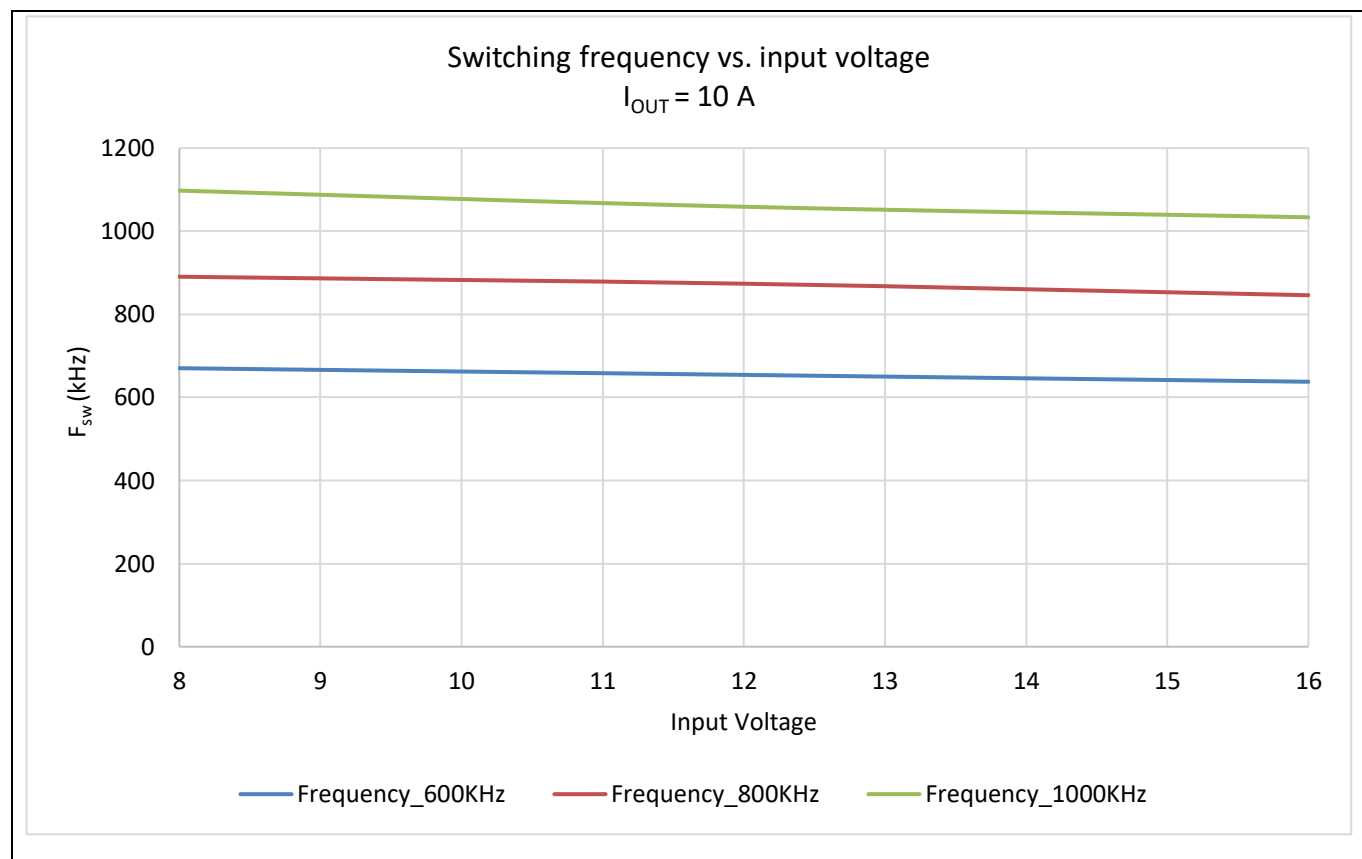


Figure 19 Switching frequency vs. input voltage

Evaluation board test results

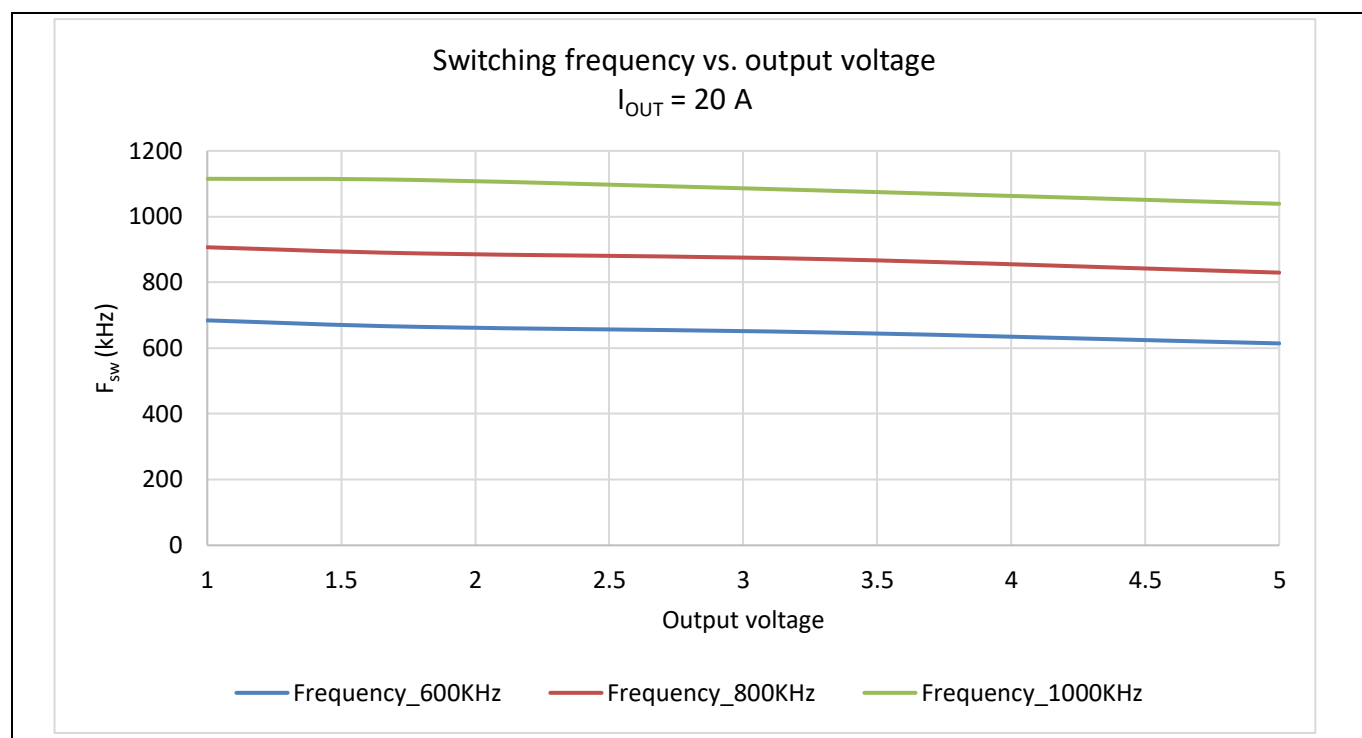


Figure 20 Switching frequency vs. output voltage

3.3 Thermal images with no air flow and 25°C ambient

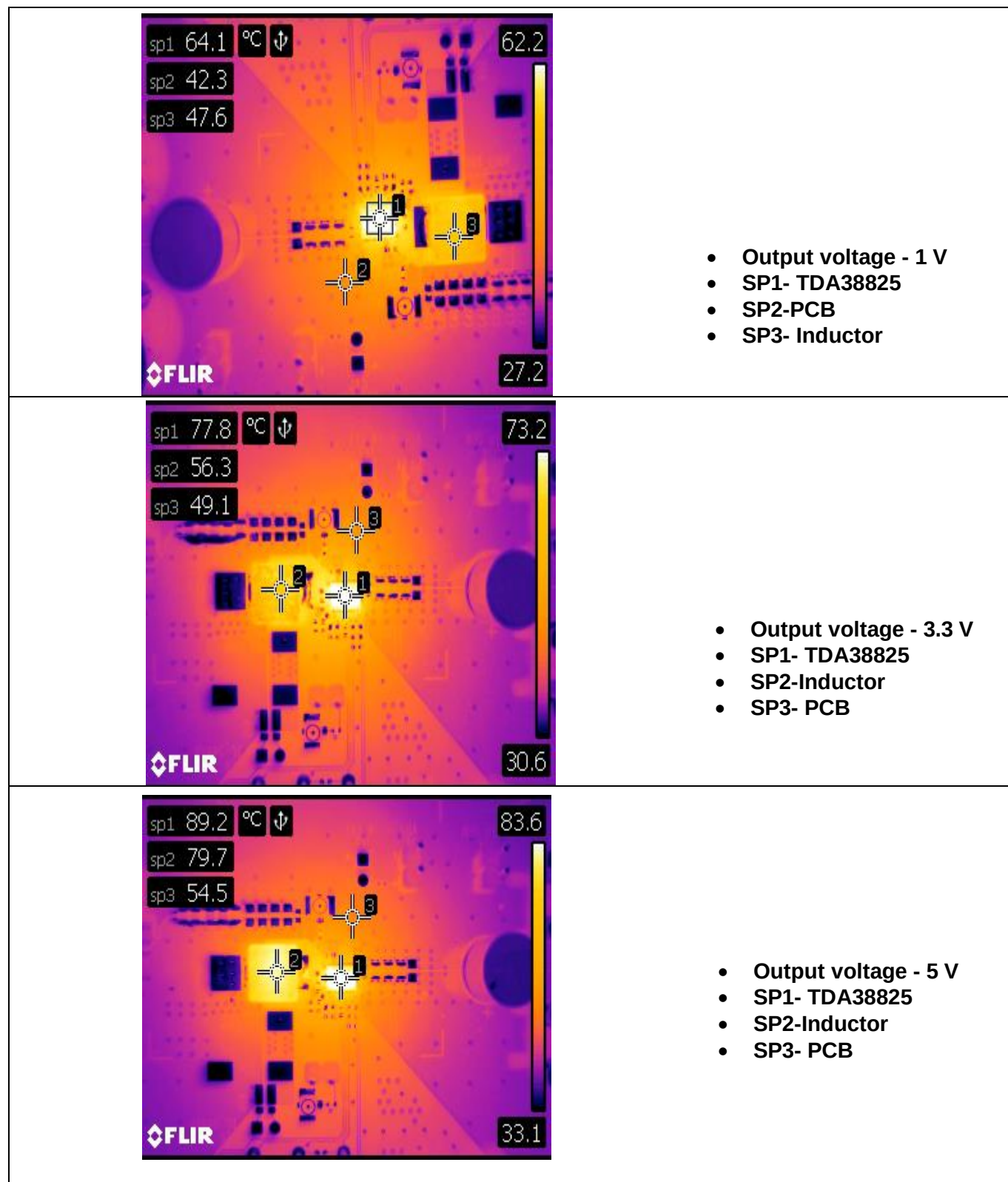


Figure 21 Thermal performance of TDA38825 for 1 V, 3.3 V, and 5 V output voltages, 20 A load, FCCM mode, 800 khz switching frequency, 12 V V_{IN}

Revision history

Revision history

Document version	Date of release	Description of changes
V 1.0	2023-07-21	Initial release

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