EVAL_TDA38826_1VOUT user guide

User guide for TDA38826 evaluation board

About this document

Scope and purpose

The TDA38826 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 TDA38826 include internal soft-start, precision 0.9 V reference voltage, Power Good, thermal protection, programmable switching frequency in the range of 600 kHz to 1 MHz, enable input, input undervoltage lockout (UVLO) for proper start-up, latched-off overvoltage protection (OVP), latched off overcurrent protection (OCP), and pre-bias start-up.

This user guide contains the schematic and bill of materials for the EVAL_TDA38826_1VOUT engineering evaluation board. It describes operation and use of the evaluation board itself. Detailed application information for TDA38826 is available in the TDA38826 datasheet.

Intended audience

This document is intended as a guide for design engineers evaluating TDA38826 performance with the engineering EVAL_TDA38826_1VOUT demo board.

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Safety precautions

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

Table 1 **Safety precautions**

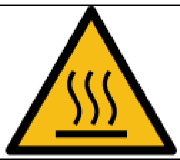
	**Caution:** *The heat sink and device surfaces of the evaluation or reference board may become hot during testing. Hence, necessary precautions are required while handling the board. Failure to comply may cause injury.*
	**Caution:** *The evaluation or reference board contains parts and assemblies sensitive 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.*

Table of contents

1 TDA38826 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 (0.9 V ± 0.5 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 1.5 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, UVP, thermal shutdown, and latch-off OVP
- Operating temperature: -40°C less than or equal to ≤ T_J ≤ 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

2 Board information

2.1 Evaluation board

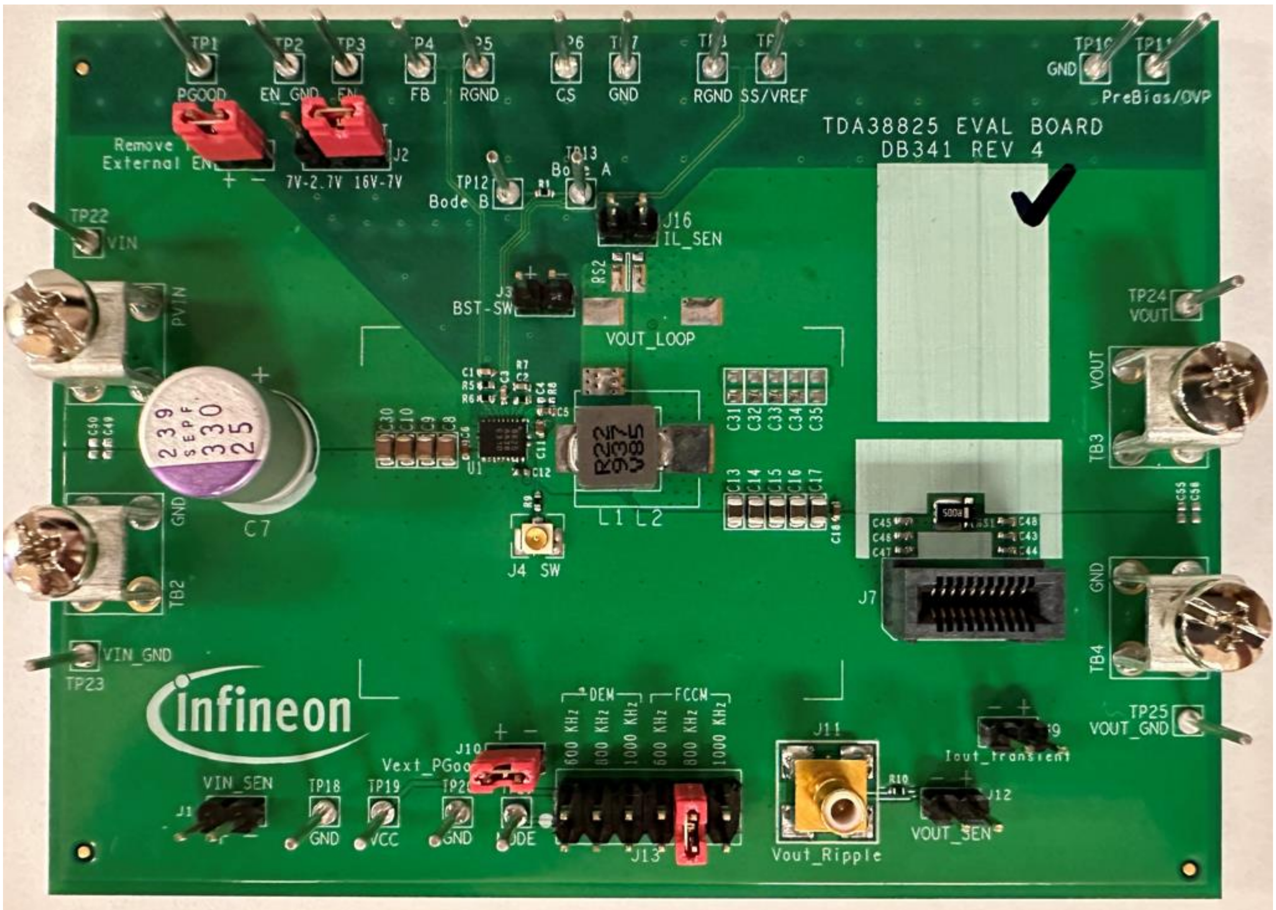


Figure 1 Evaluation board

2.2 Board features

V_{IN} = +12 V, V_{OUT} = +1 V at 0 to20 A

F_{SW} = 600 kHz/800 kHz/1000 kHz

L = 220 nH

C_{IN} = 10 x 22 µF (25 V, ceramic 0805) + 1 x 2.2 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 2.2 µF (6.3 V, ceramic 0805)

2.3 Connections and operating instructions

The TDA38826 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		Description
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} (+1V), 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 onboard 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
R_{GND}	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 TDA38826 and other major power components are mounted on the top side of the board.

2.5 PCB layout

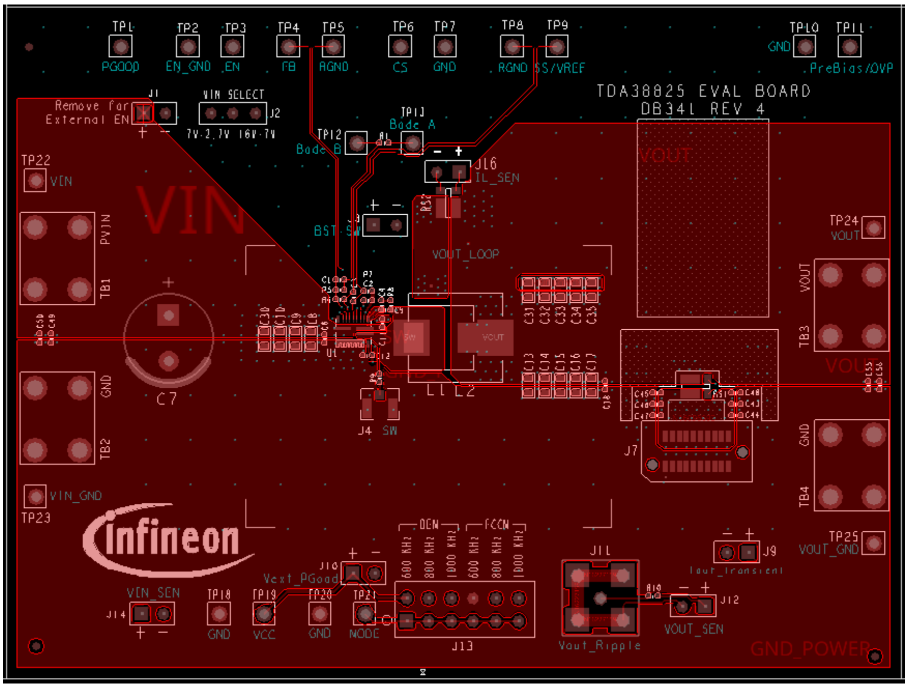


Figure 2 Top layer

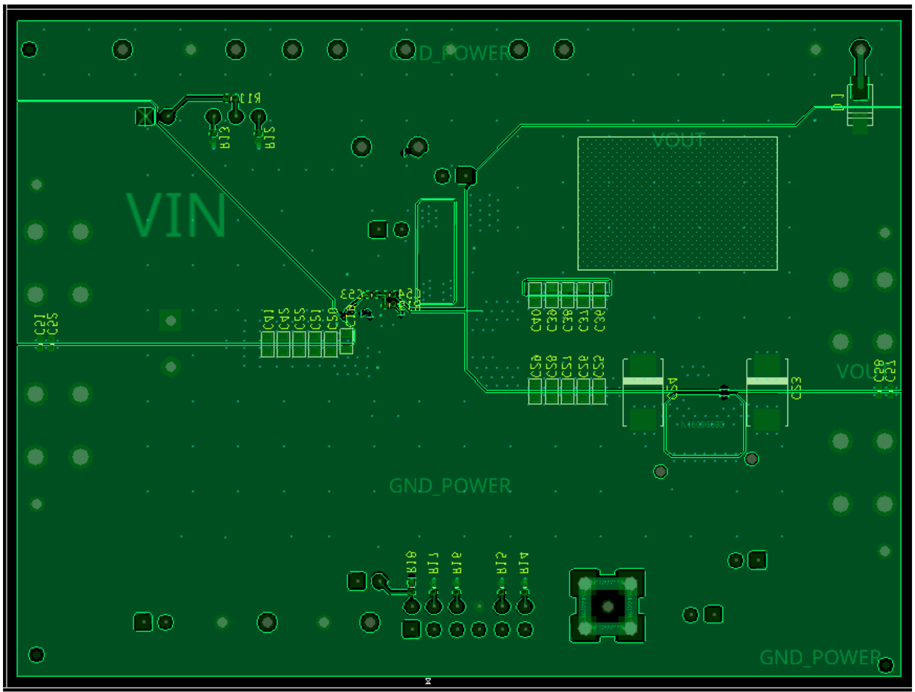


Figure 3 Bottom layer

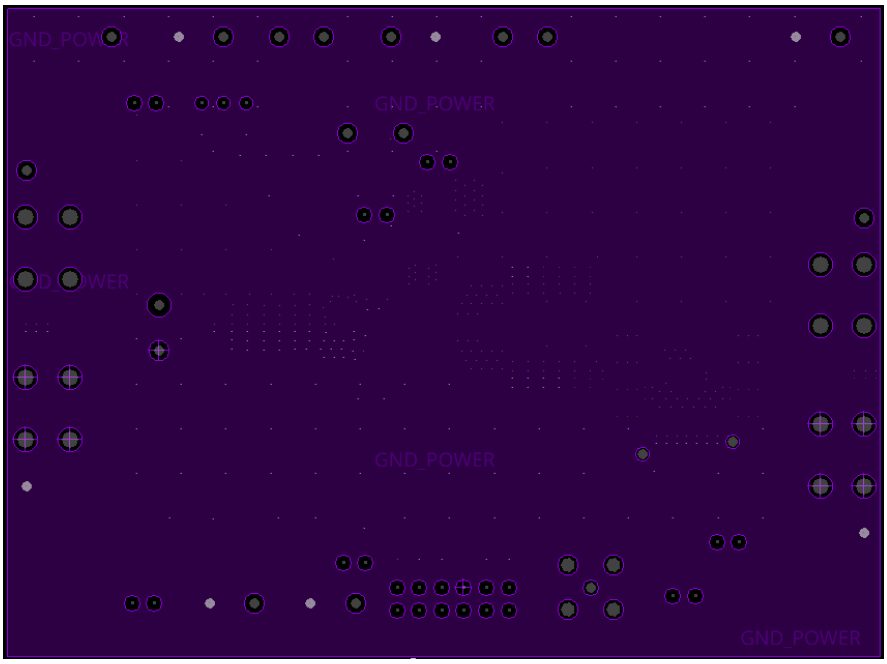


Figure 4 Inner layer 1

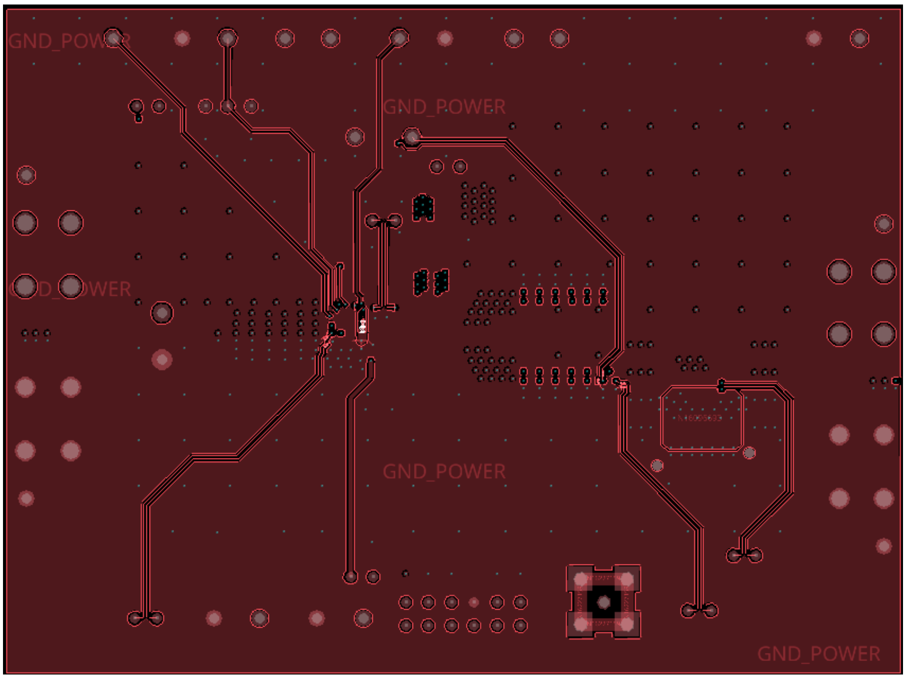


Figure 5 Inner layer 2

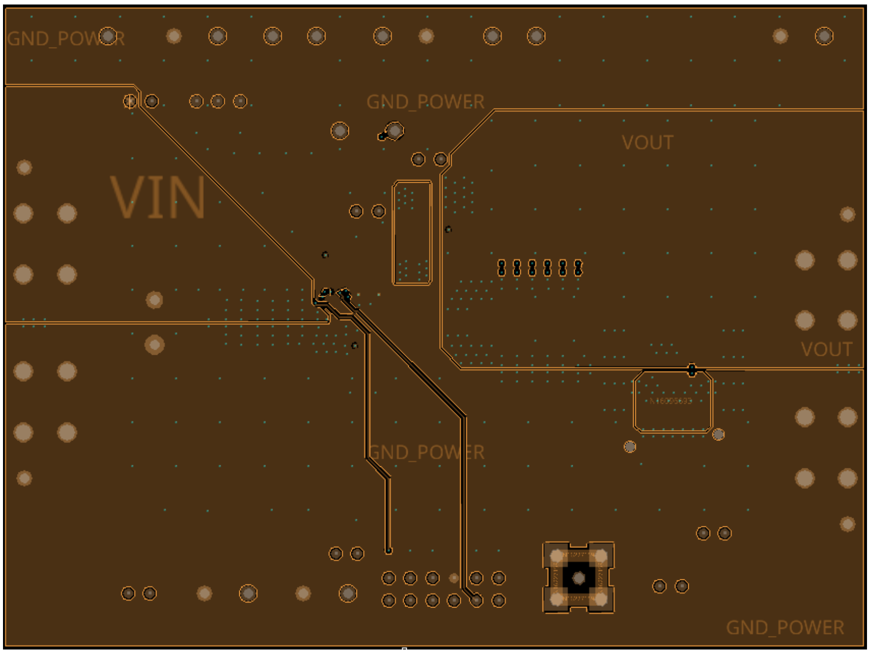


Figure 6 Inner layer 3

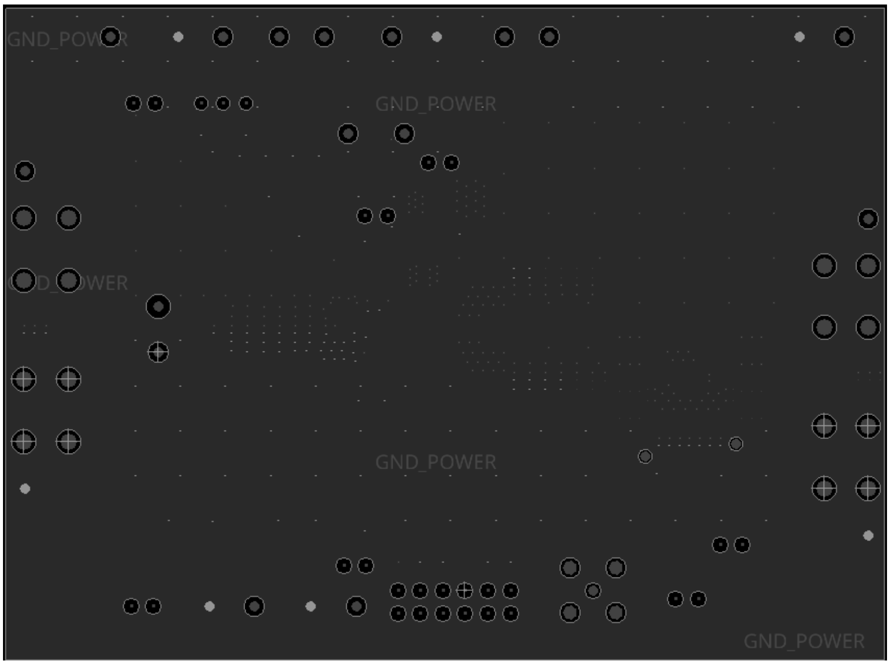


Figure 7 Inner layer 4

2.6 Schematic

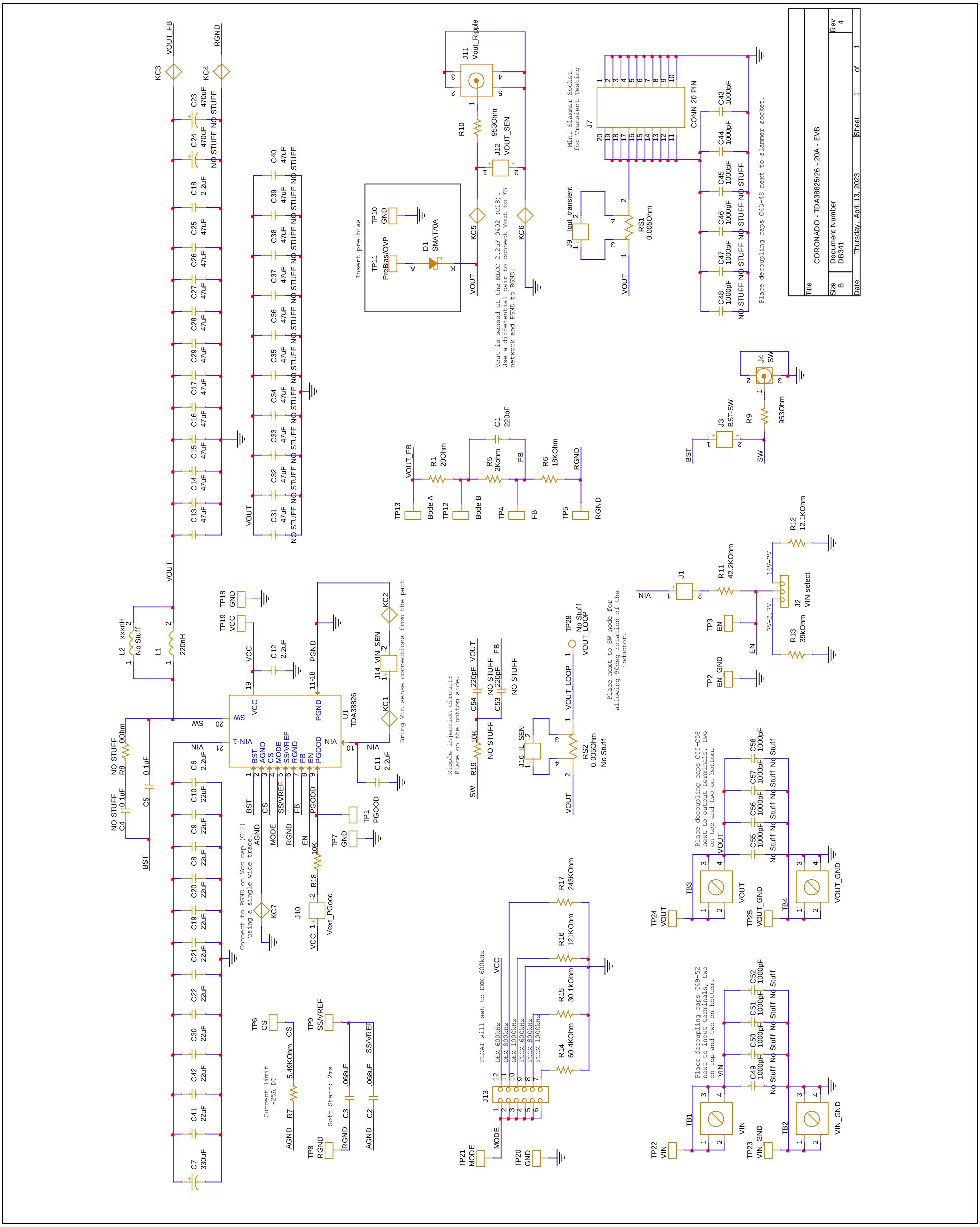


Figure 8 Schematic of the TDA38826 evaluation board V_{IN} = 12 V, V_{OUT} = 1 V, I_{OUTmax} = 20 A

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	C1005X7R1H221K050BA
2	1	C12	2.2 µF	Ceramic capacitor 2.2 µF 16 V X5R 0402 10%	TDK Corporation	C1005X5R1C225K050BC
3	10	C13, C14, C15, C16, C17, C25, C26, C27, C28, C29	47 µF	Ceramic capacitor 47 µF 6.3 V X5R 0805 20%	TDK Corporation	C2012X5R0J476M
4	2	C2, C3	.068 µF	Ceramic capacitor .068 µF 16 V X7R 0402 10%	Yageo	CC0402KRX7R7BB683
5	10	C22, C30, C41, C42, C8, C9, C10, C19, C20, C21	22 µF	Ceramic capacitor 22 µF 25 V X5R 0805 20%	Murata	GRM21BR61E226ME44L
6	2	C43, C44	1000 pF	Ceramic capacitor 1000 pF 50 V X7R 0402 10%	Kemet	C0402C102K5RAC7867
7	1	C5	0.1 µF	Ceramic capacitor 0.1 µF 16 V X7R 0402 10%	Murata	GRM155R71C104KA88D
8	3	C6, C11, C18	2.2 µF	Ceramic capacitor 2.2 µF 25 V X5R 0402 10%	Murata	GRM155R61E225KE11D
9	1	C7	330 µF	Aluminum polyester capacitor 330 µF 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

13	1	J13	–	Vertical header connector 12-position 2.54 mm	Adam Tech	PH2-12-UA
14	1	J2	–	Header connector R/A 3-2.54MM	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 connector	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 mΩ SMD	Delta Electronics/ Cyntec	CMLE063T-R22MS0R667
18	1	R1	20 Ω	Thick film resistor 20.0 Ω 1/16 W 1% SMD 0402	Yageo	RE0402FRE0720RL
19	1	R11	42.2 kΩ	Thick film resistor 42.2 kΩ 1/16 W 1% 0402	Yageo	RC0402FR-0742K2L
20	1	R12	12.1 kΩ	Thick film resistor 12.1 kΩ 1/10 W 1% 0402	Panasonic	ERJ-2RKF1212X
21	1	R13	39 kΩ	Thick film resistor 39 kΩ 5.0 % 1/16 W SMD 0402	Panasonic	ERJ-2GEJ393X
22	1	R14	60.4 kΩ	Thick film resistor 60.4 kΩ 1/10 W 1% 0402	Yageo	RC0402FR-0760K4L
23	1	R15	30.1 kΩ	Thick film resistor 30.1 kΩ 1.0 % 1/16 W SMD 0402	Vishay	CRCW040230K1FKED
24	1	R16	121 kΩ	Thick film resistor 121 kΩ 1/10 W 1% 0402	Yageo	RC0402FR-07121KL
25	1	R17	243 kΩ	Thick film resistor 243 kΩ 1/16 W 1% 0402	Yageo	RC0402FR-07243KL
26	1	R18	10 k	SMD resistor 10 k Ω 1% 1/16 W 0402	YAGEO	AC0402FR-0710KL
27	1	R5	2 k	Thick film resistor 2 kΩ 1/16 W 1% 0402	Yageo	AC0402FR-072KL

28	1	R6	18 kΩ	Thick film resistor 18 kΩ 1/16 W 1% 0402	Yageo	AC0402FR-0718KL
29	1	R7	5.49 kΩ	Thick film resistor 5.49 kΩ 1/10 W 1% 0402	Panasonic	ERJ-2RKF5491X
30	2	R9, R10	953 Ω	Thick film resistor 953 Ω 1/10 W 1% 0402	Yageo	RC0402FR-07953RL
31	1	RS1	0.005 Ω	Thick film resistor 0.005 Ω 1W 1% SMD 1632	Delta Electronics	RL1632T4F-R005-FNH
32	4	TB1, TB2, TB3, TB4	–	Terminal screw 6-32 4-pin PCB	Keystone Electronics	7693
33	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" hole 1000/PKG	Vector Electronics	K30C/M
34	1	U1	TDA38826	TDA38826 20 A single-voltage synchronous buck regulator	Infineon	TDA38826

3 Evaluation board test results

3.1 Typical efficiency and power loss curves

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

V_{IN} = 12 V, V_{CC} = internal LDO, I_{OUT} = 0 A – 20 A, F_{SW} = 800 kHz, room temperature, natural convection. Note that the efficiency and power loss curves include losses of the TDA38826, inductor losses, losses of the input and output capacitors, and PCB trace losses. The **Table 4** below shows the inductors used for each of the output voltages in the efficiency measurement.

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

V_{OUT} (V)	L_{OUT} (nH)	P/N	DCR (mΩ)	Size (mm)
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

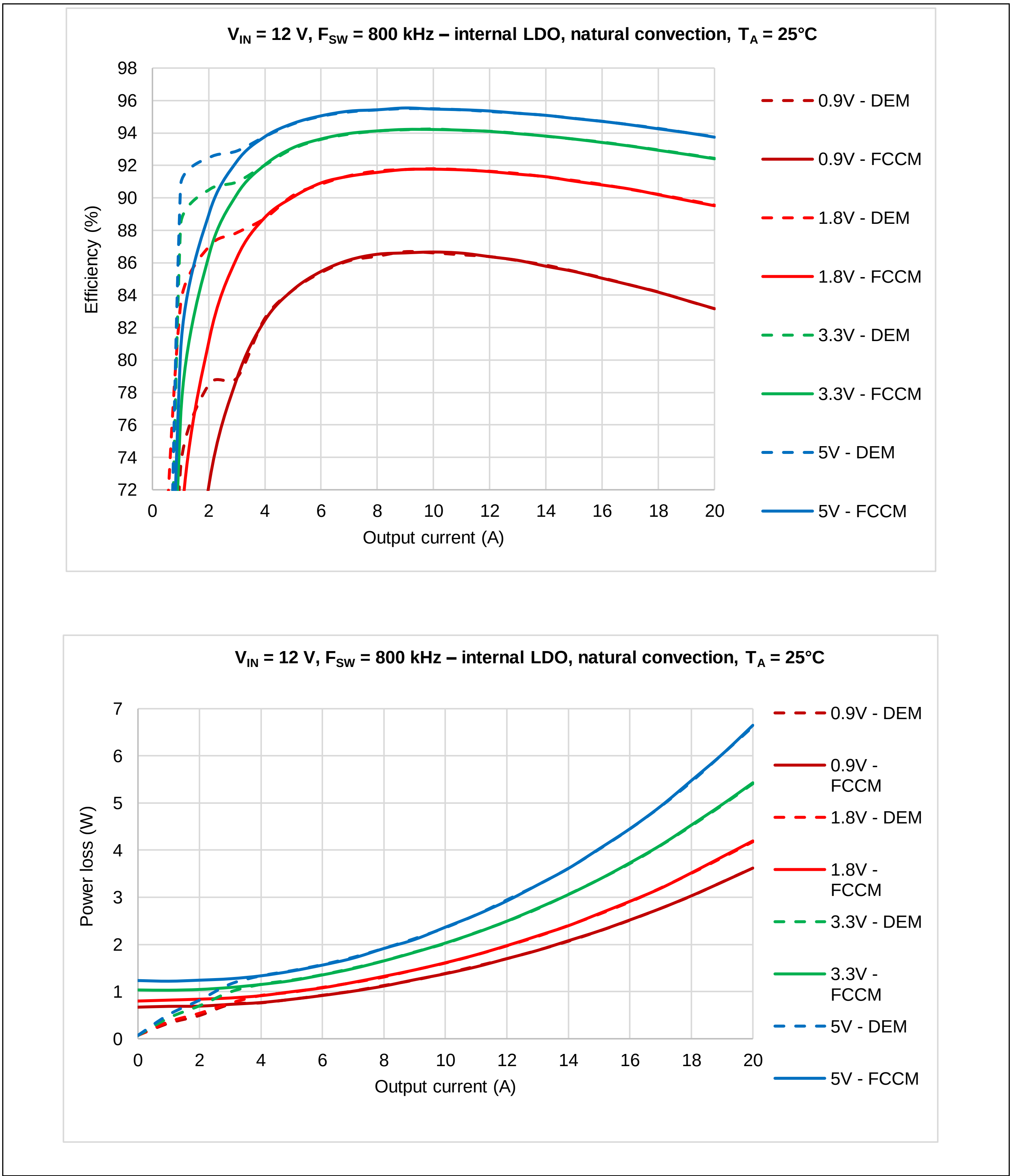


Figure 9 Efficiency and power loss

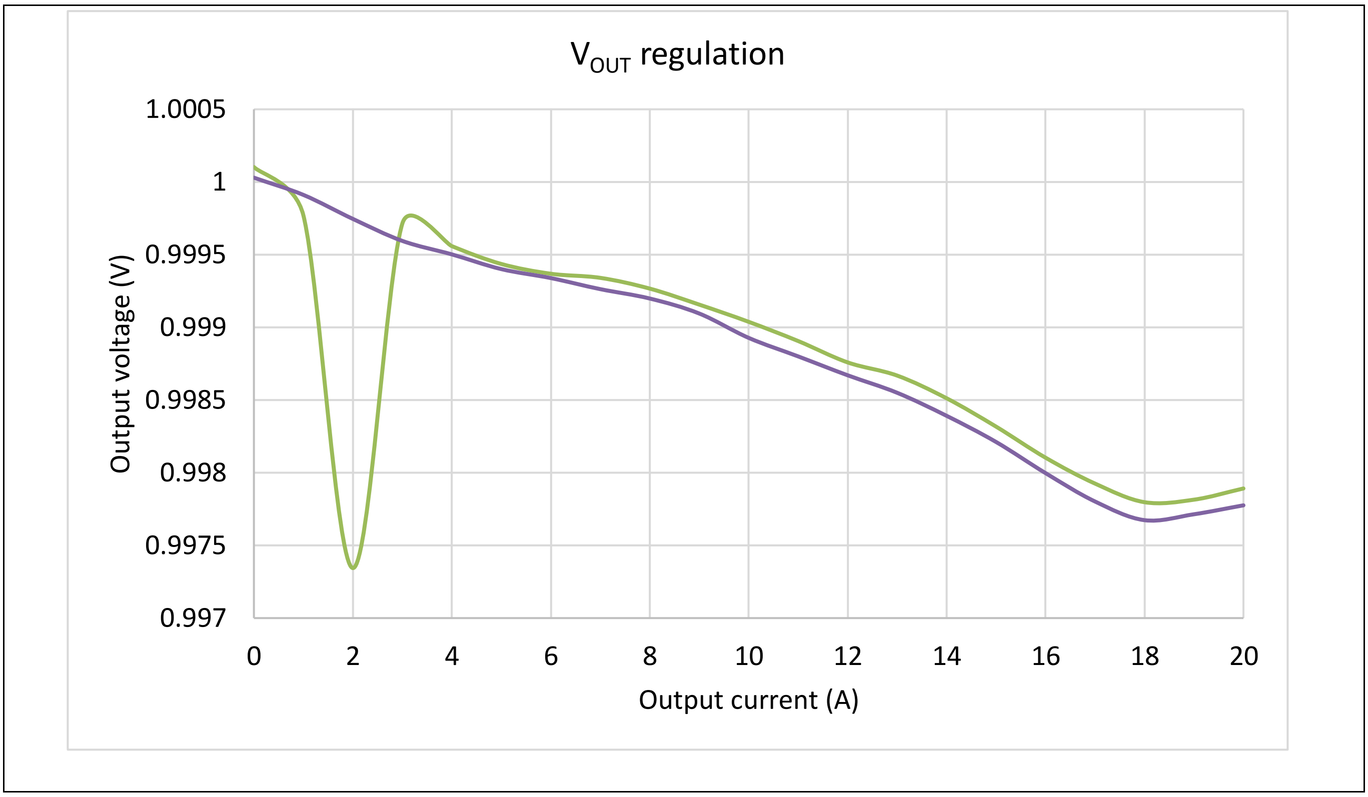


Figure 10 Output voltage regulation

3.2 Typical operating waveforms

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

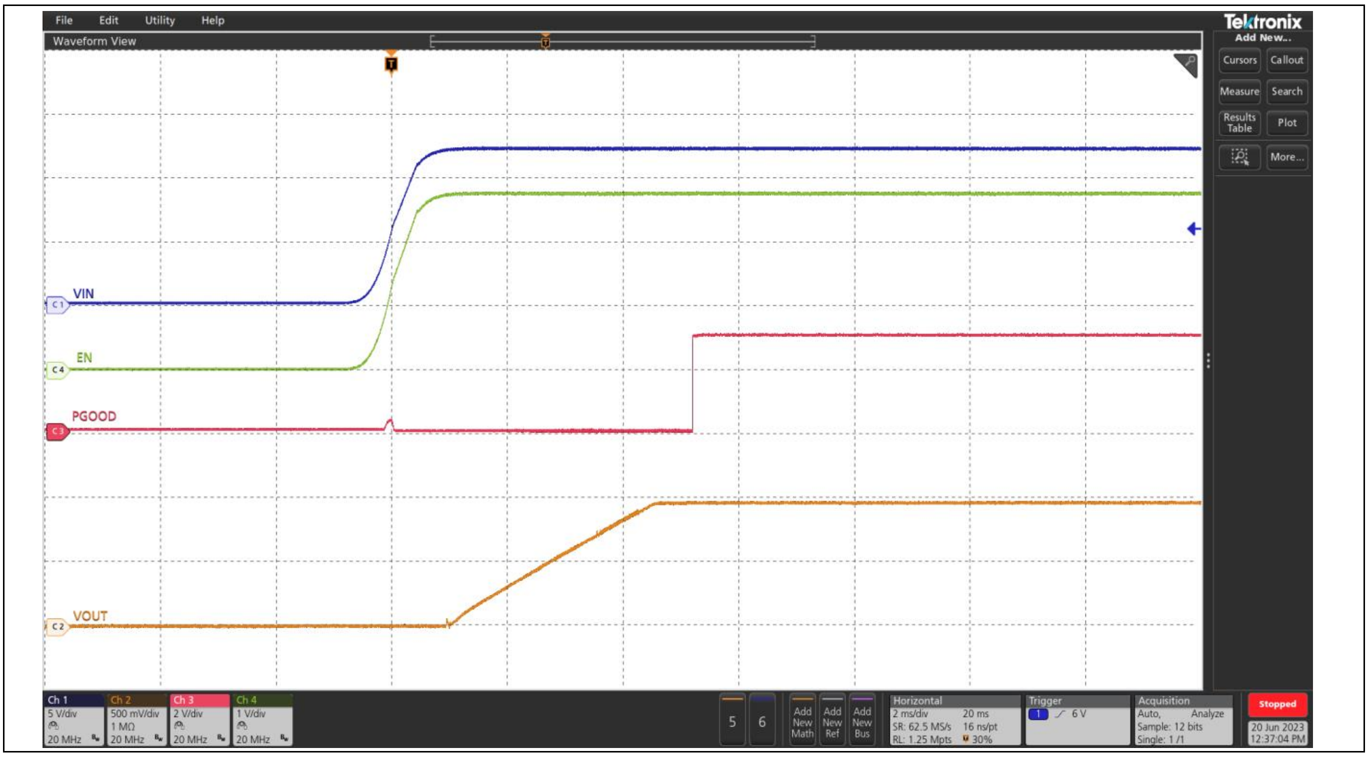


Figure 11 Start up at 20 A load, (Ch1: V_{IN}, Ch2: V_{OUT}, Ch3: P_{GOOD} ,Ch4: enable)

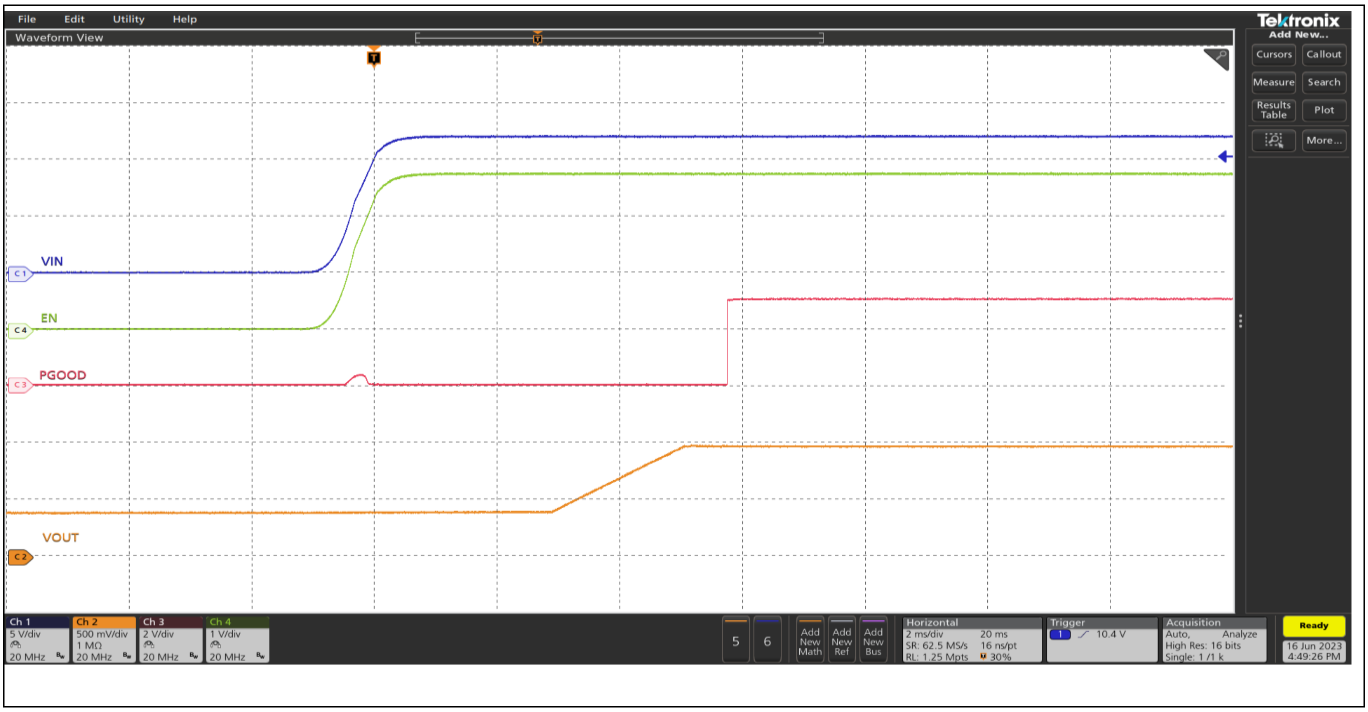


Figure 12 Pre-bias start-up at 0 A load, (Ch1: V_{IN}, Ch2: V_{OUT}, Ch3: P_{GOOD} ,Ch4: enable)

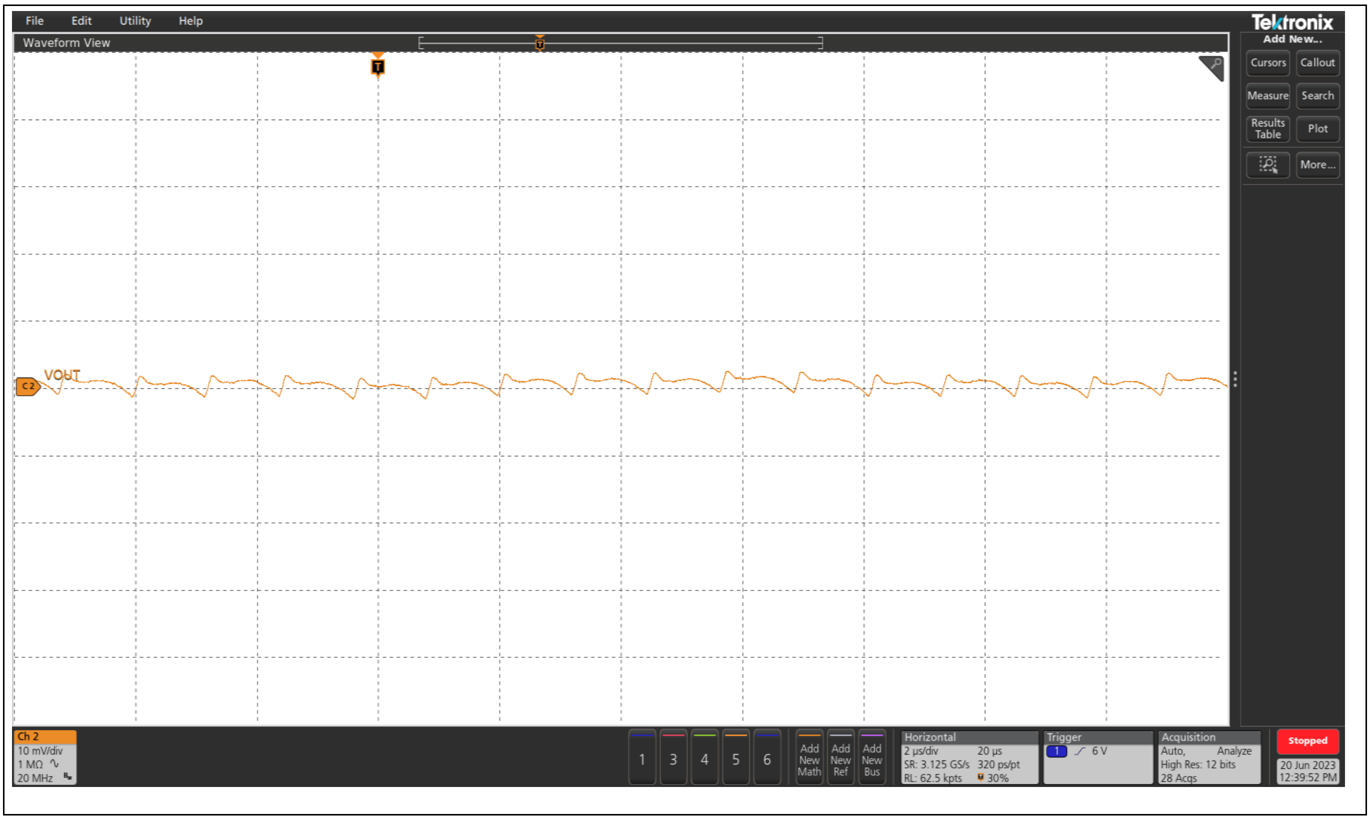


Figure 13 V_{OUT} ripple at 20 A load, F_{SW} = 800 kHz, (Ch2: V_{OUT})

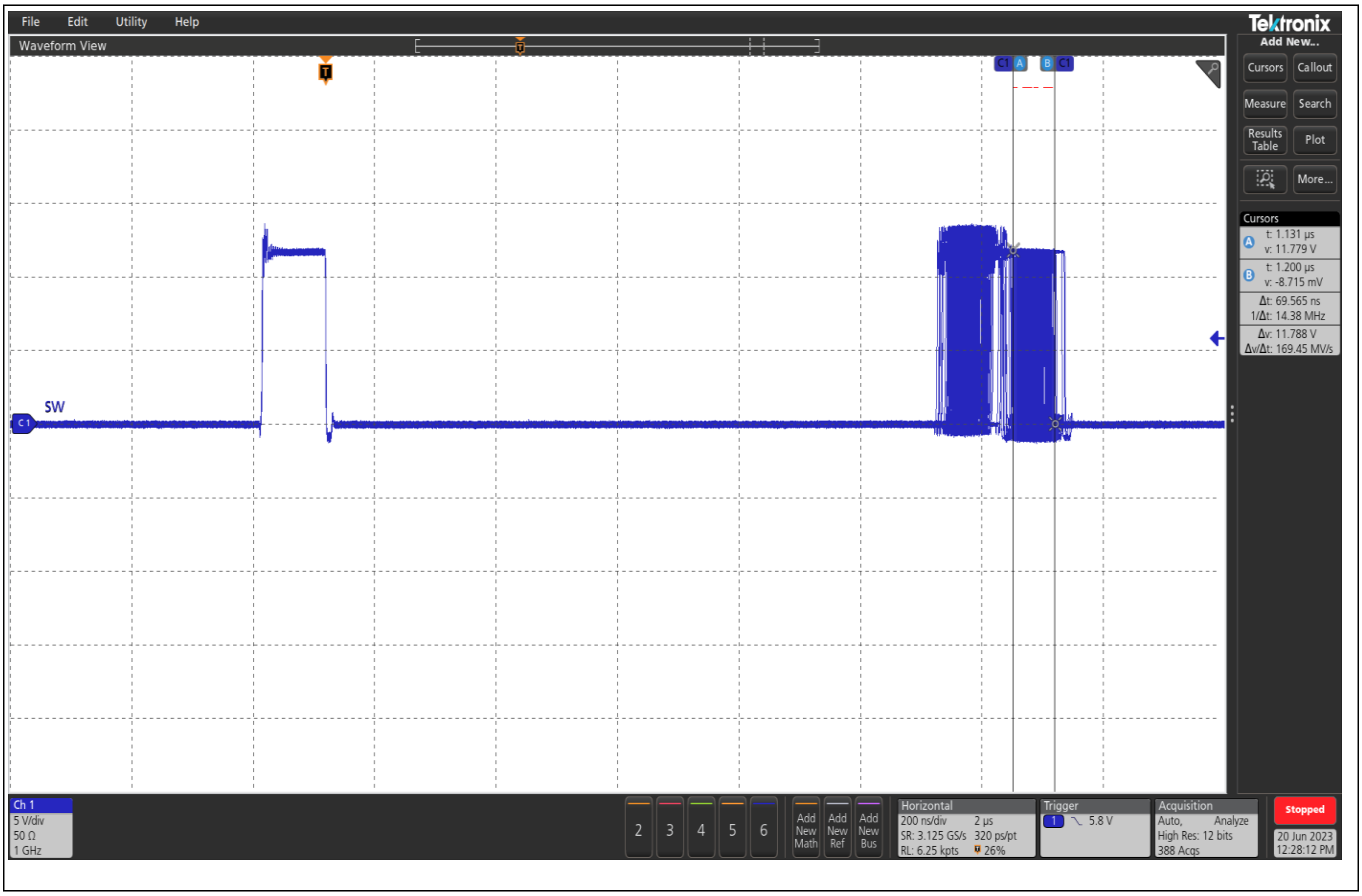


Figure 14 SW node jitter, 20 A load, F_{SW} = 800 kHz

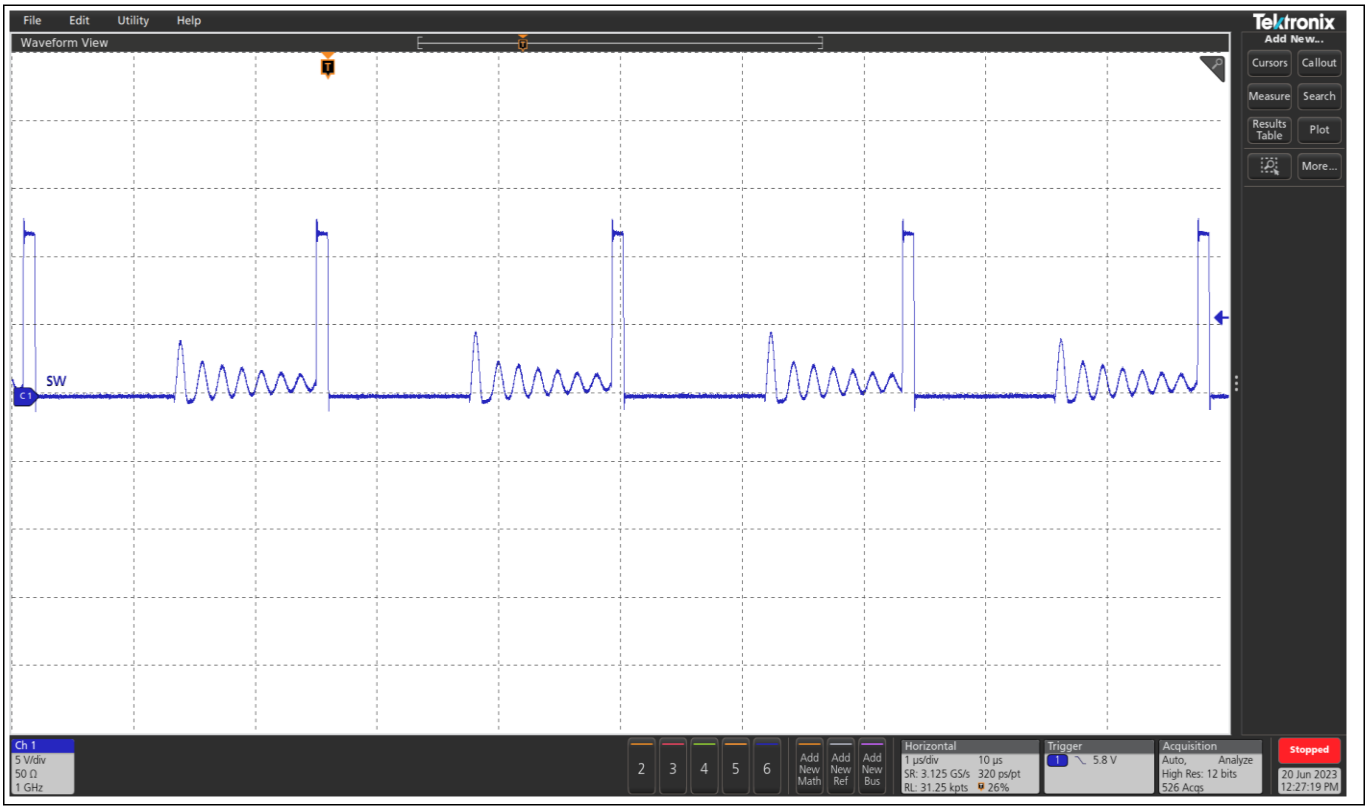


Figure 15 SW node (in DEM), 1 A load

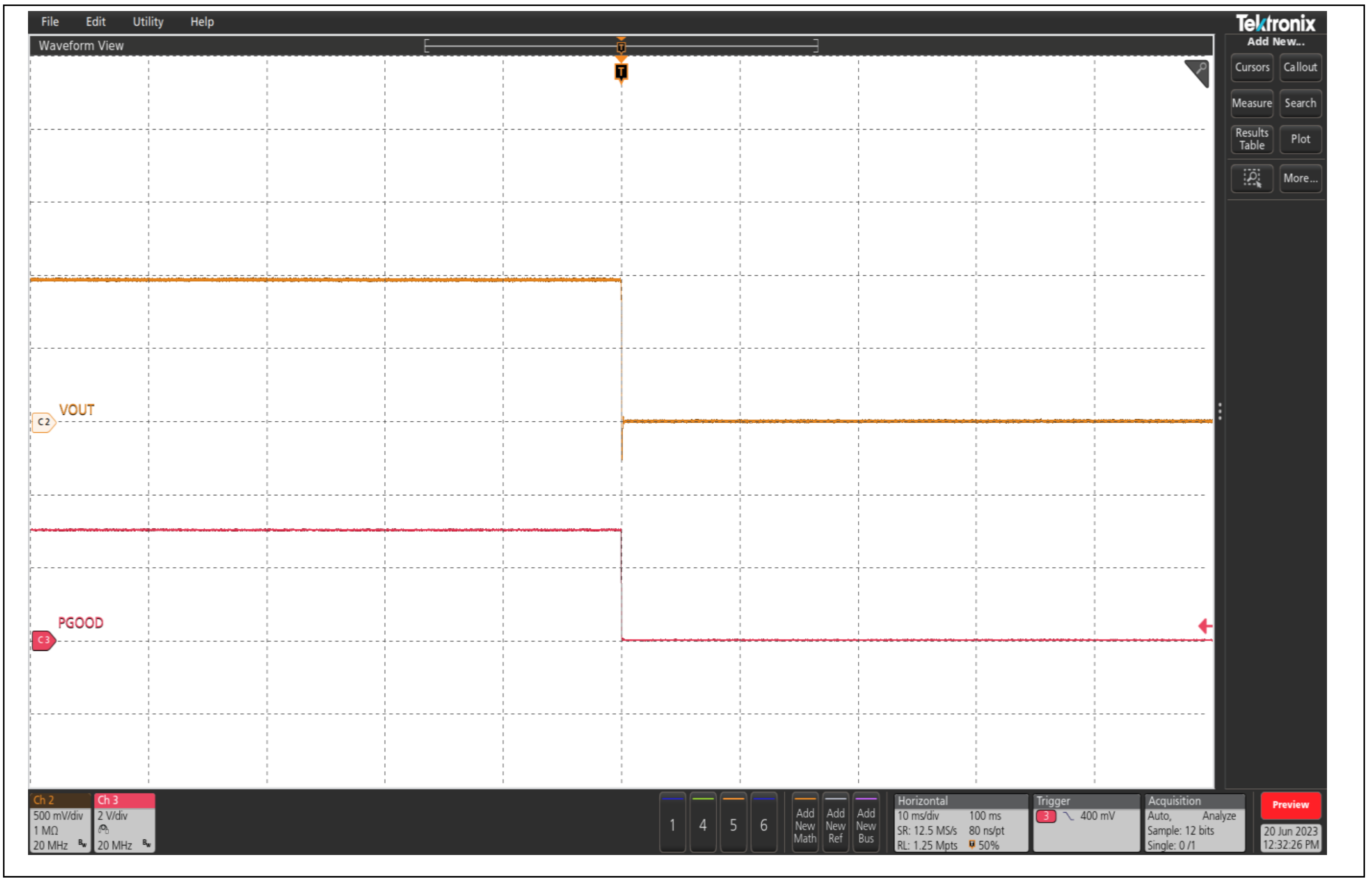


Figure 16 Short circuit and UVP (Shutdown), (Ch2: V_{OUT}, Ch3: P_{GOOD})

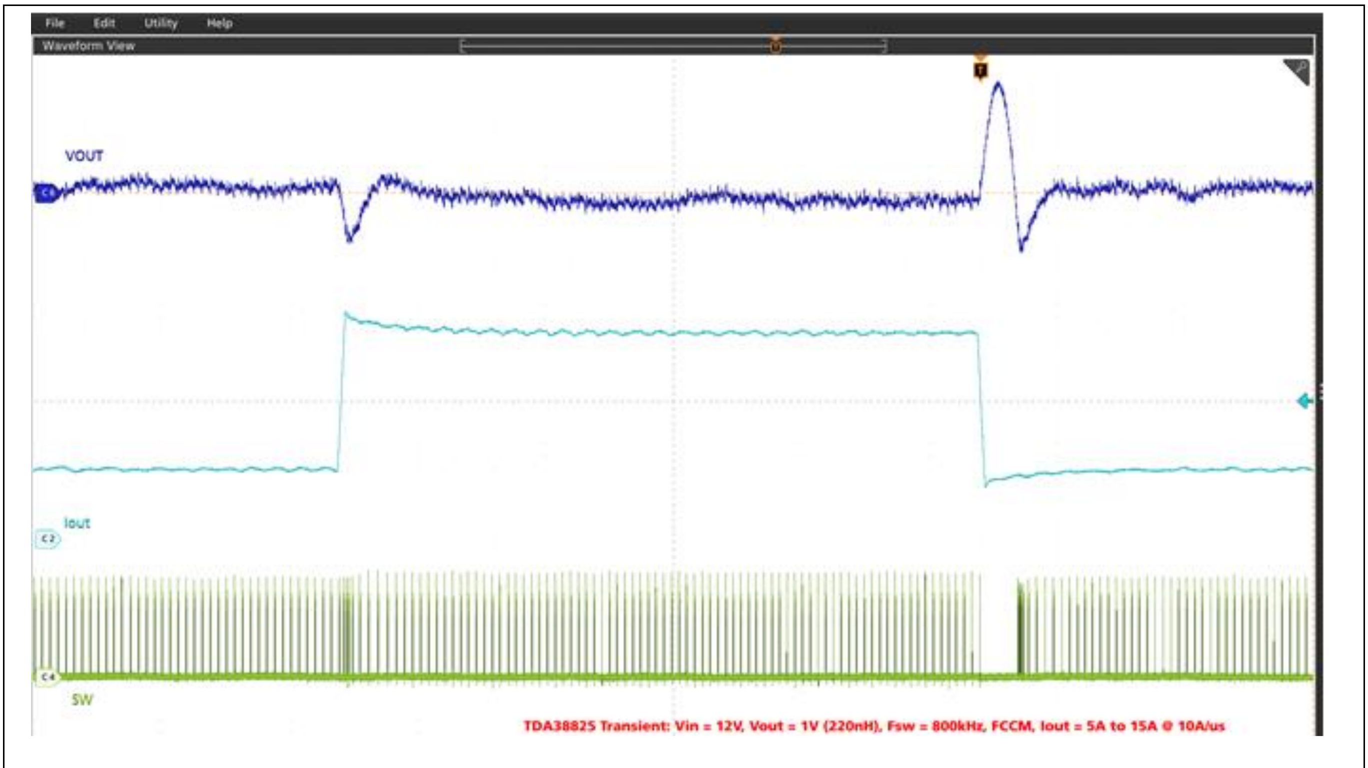


Figure 17 Transient response at 10 A step load current at 10 A/µs slew rate: I_{OUT} = 5 A – 15 A, (Ch6: V_{OUT}, Ch2: I_{OUT}, Ch4: Sw), pk-pk: 55 mV, F_{SW} = 800 kHz

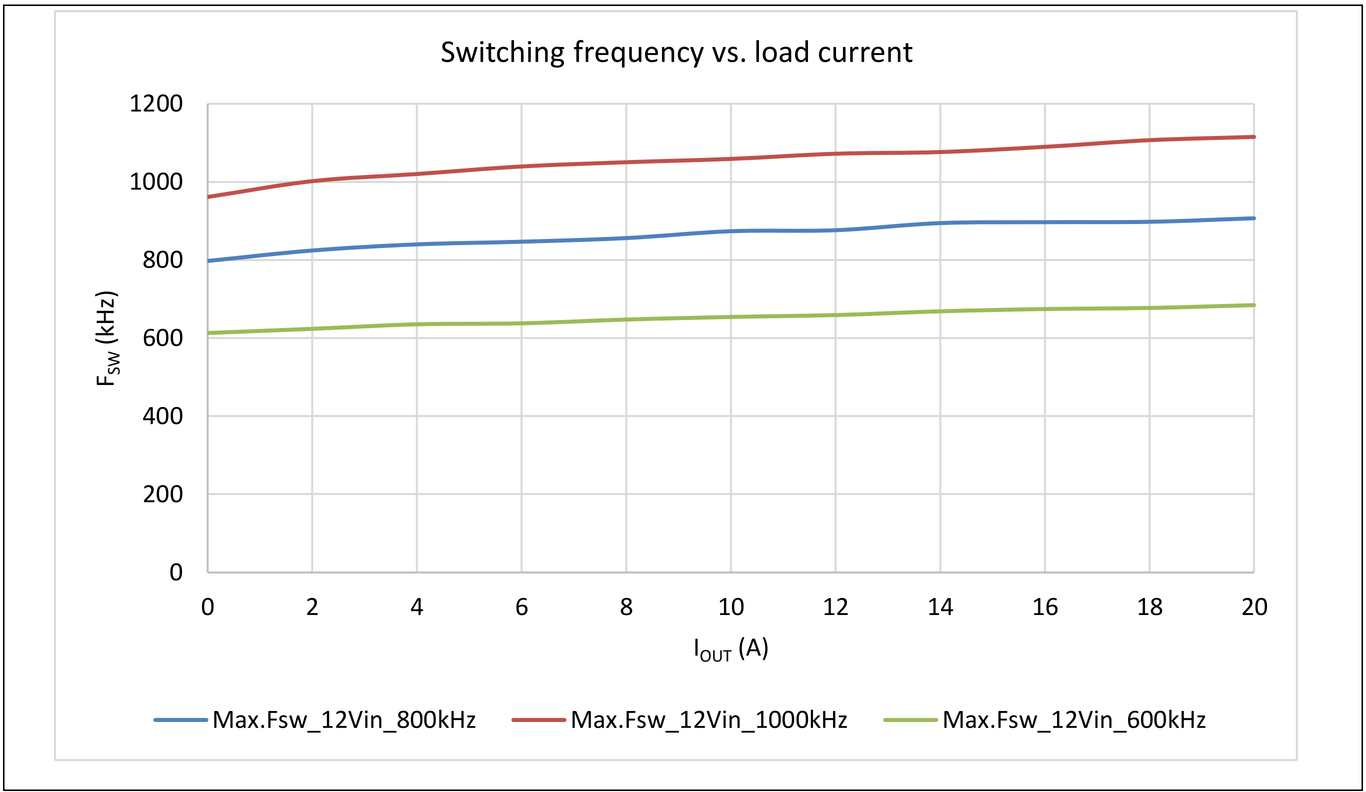


Figure 18 Switching frequency vs. load current

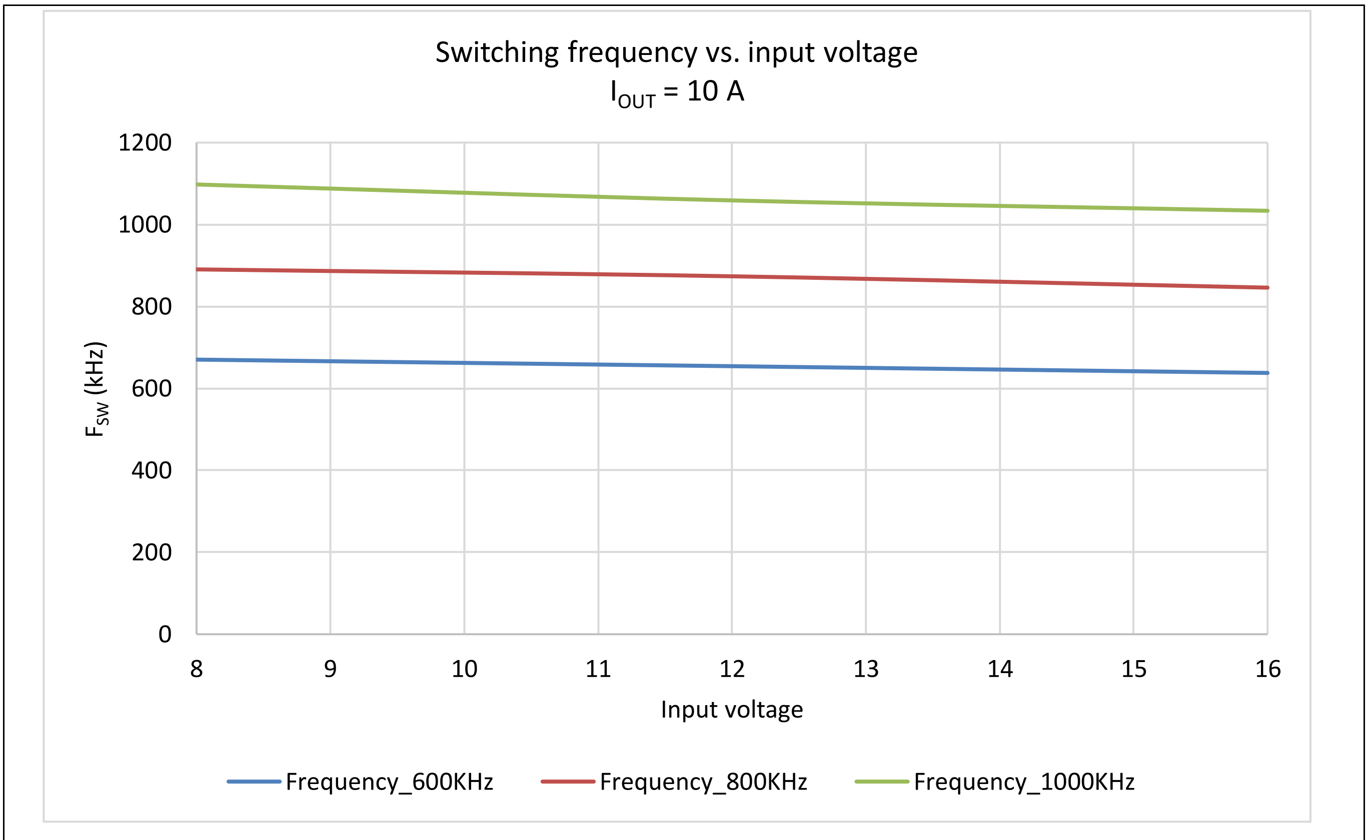


Figure 19 Switching frequency vs. input voltage

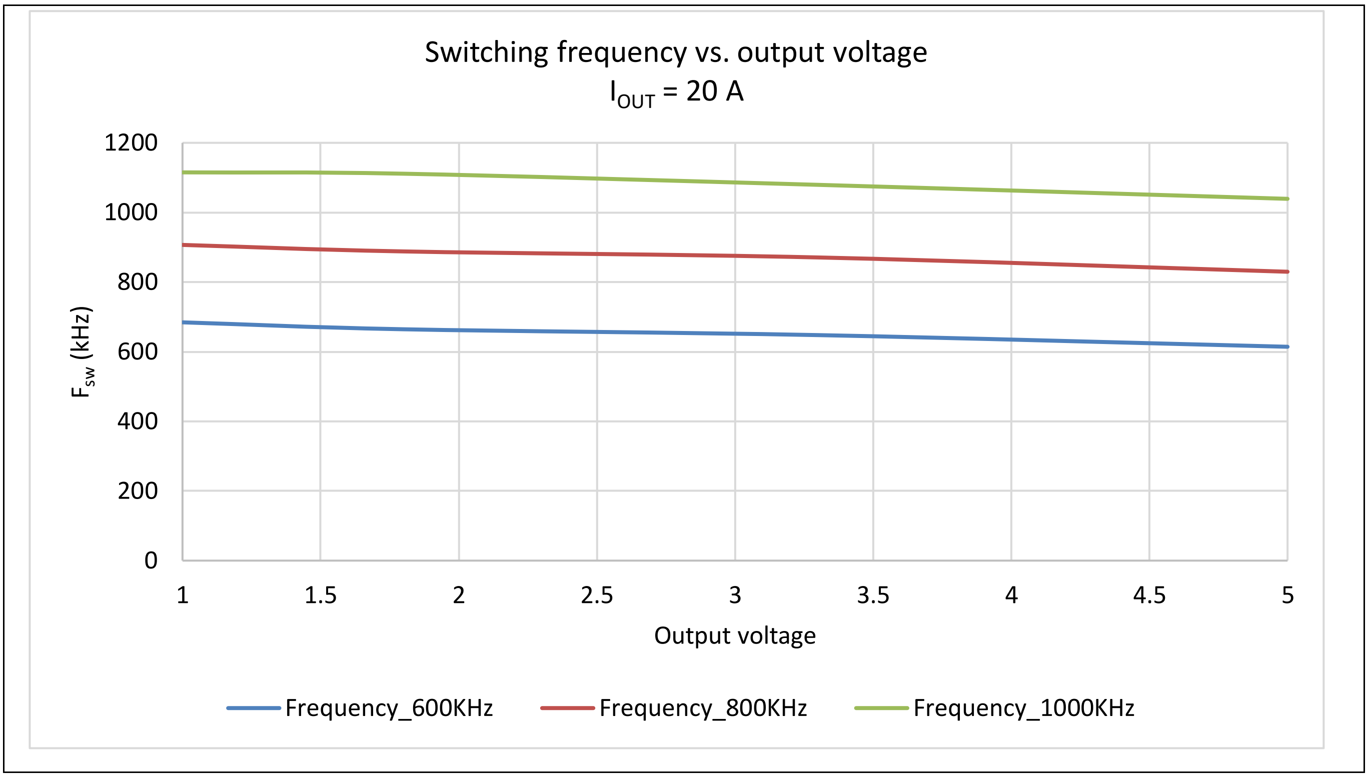
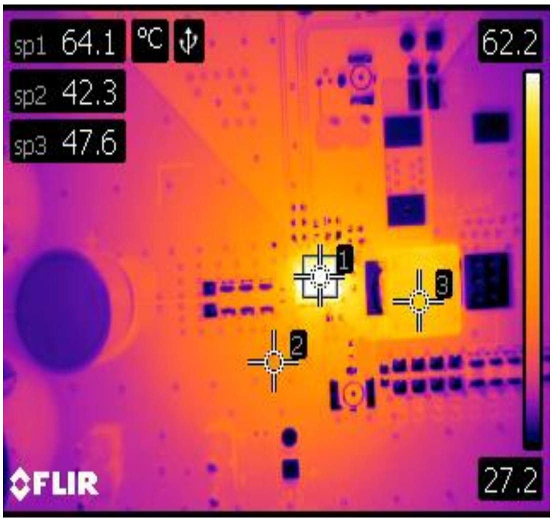
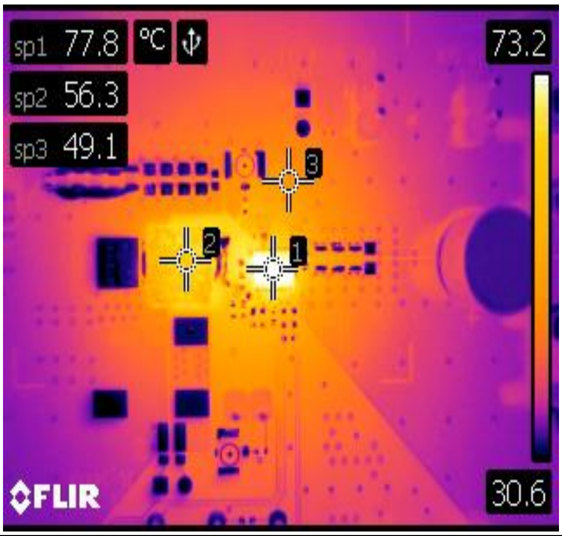


Figure 20 Switching frequency vs. output voltage

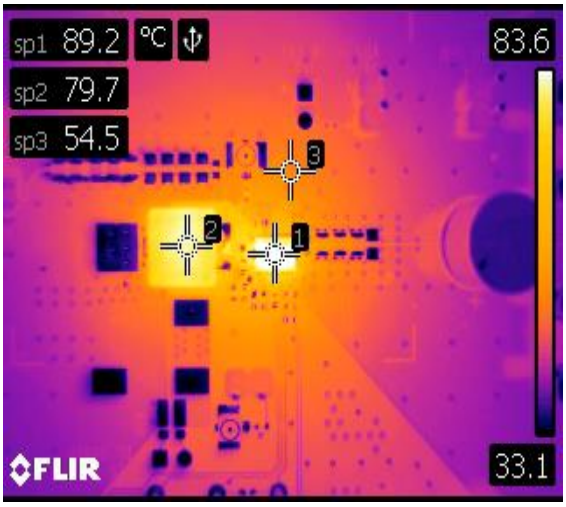
3.3 Thermal images with no air flow and 25°C ambient



- Output Voltage 1 V
- SP1- TDA38826
- SP2-PCB
- SP3- Inductor



- Output Voltage - 3.3 V
- SP1- TDA38826
- SP2-Inductor
- SP3- PCB



- Output Voltage-5V
- SP1- TDA38826
- SP2-Inductor
- SP3- PCB

Figure 21 Thermal performance of TDA38826 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

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

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