TDA38825 P5V0 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 3mm X 4mm QFN package.

Key features offered by the TDA38825 include internal Soft Start, precision 0.6V reference voltage, Power Good, thermal protection, programmable switching frequency in the range of 600 kHz to 1 MHz, programmable softstart, Enable input, input under-voltage lockout for proper start-up, latched off output over voltage protection, over current limit protection and pre-bias start-up.

This user guide contains the schematic and bill of materials for the EVAL_TDA38825_5VOUT engineering evaluation board. The guide describes operation and use of the evaluation board itself. Detailed application information for TDA38825 is available in the TDA38825 data sheet.

Intended audience

This document is intended as a guide for design engineers evaluating TDA38825 performance with the engineering EVAL_TDA38825_5VOUT demo board.

Table of contents

1 TDA38825 Features

Features

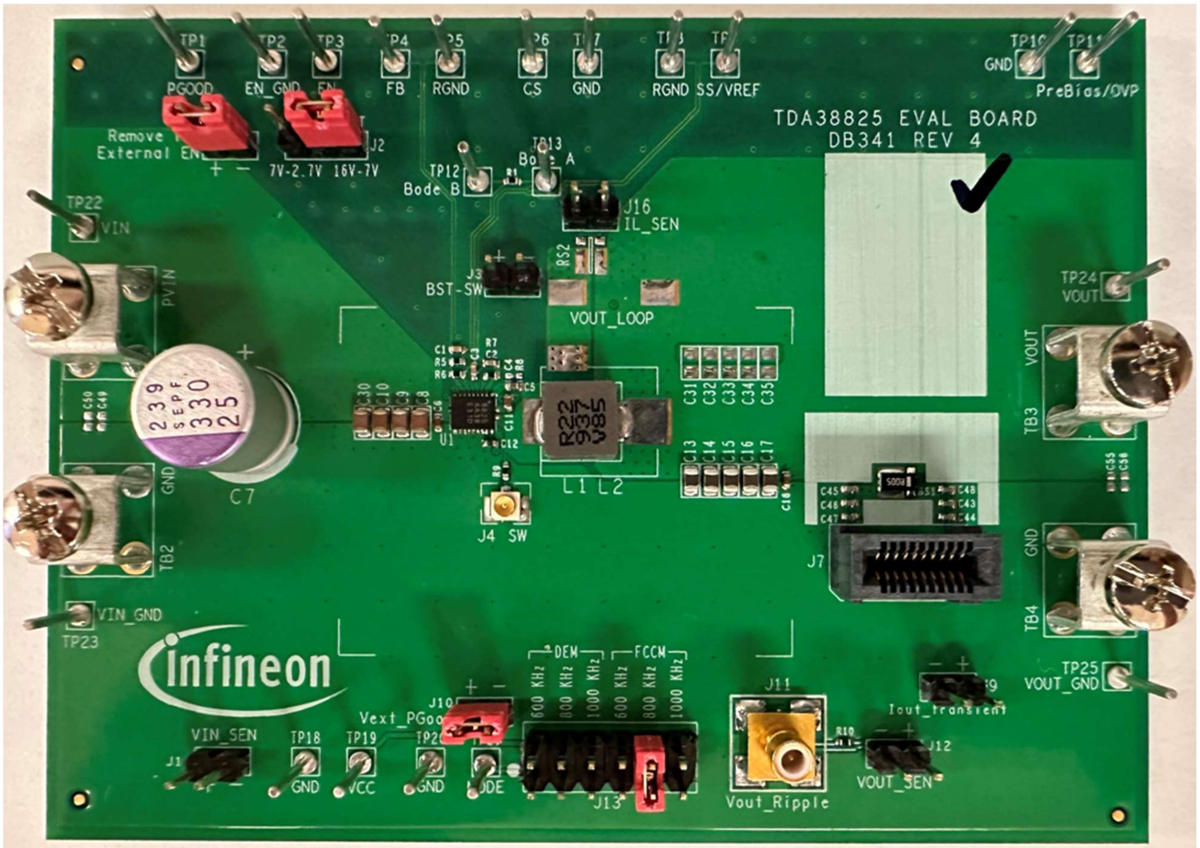
- Wide Input Voltage Range: 4 V to 16 V with internal bias and 2.7 V to 16 V with external VCC (3.3 V)
- Precision Reference Voltage (0.6V± 0.5%)
- Stable with Ceramic Output Capacitors
- No External Compensation
- Optional Forced Continuous Conduction Mode and Diode Emulation for Enhanced Light Load Efficiency
- Selectable Switching Frequency from 600 kHz, 800 kHz, and 1 MHz
- Programmable Soft-Start Time with a minimum of 1 ms & Enhanced Pre-Bias Start-Up
- Voltage Tracking with External Reference Input
- Programmable Over Current Protection 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 Temp: -40 °C < Tj < 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 & Datacom Applications
- Distributed Point of Load Power Architectures

2 Board information

2.1 Evaluation Board



2.2 Board features

V_{in} = +12 V, Vout = +5V @ 0- 20 A

F_s=600 kHz/800 kHz/1000 kHz

L= 470nH

C_{in}= 3x 10uF (25 V, ceramic 0805) + 2 x 1uF (25 V, ceramic 0805) + 1x100uF (25V, Electrolytic , optional)

C_{out}=10x 100 uF (6.3 V, ceramic 0805) + 1 x 2.2uF (6.3 V, ceramic 0805)

2.3 Connections and operating instructions

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

Table 1 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} (+5V), connect a DC load (20A max) to this pin
	PGND	Return of Vout
	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: 600kHz, 800kHz, 1000kHz.
	DEM	
CS		Use a resistor to connect to CS to configure the current limit
PGood	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.
Vcc	Vcc	Standard demo board is configured to use the internal LDO. Connect a scope probe to this pin to minitor the output of the internal LDO.
	GND	

2.4 Layout

The PCB is a 6-layer board using FR4 material. Top and bottom layers use 2Oz copper and inner layers use 1Oz. copper. The PCB thickness is 1.6 mm. The TDA38825 and other major power components are mounted on the top side of the board.

2.5 PCB Layout

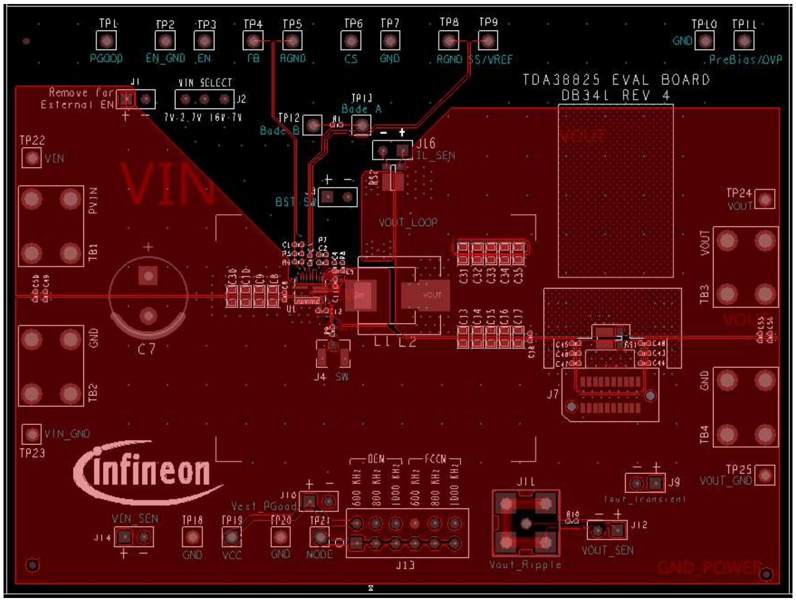


Figure 1 Top Layer

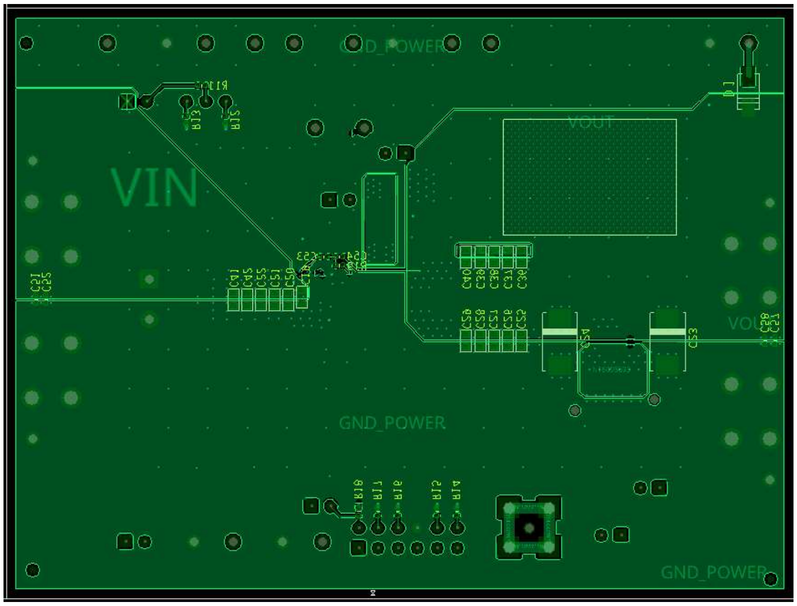


Figure 2 Bottom Layer

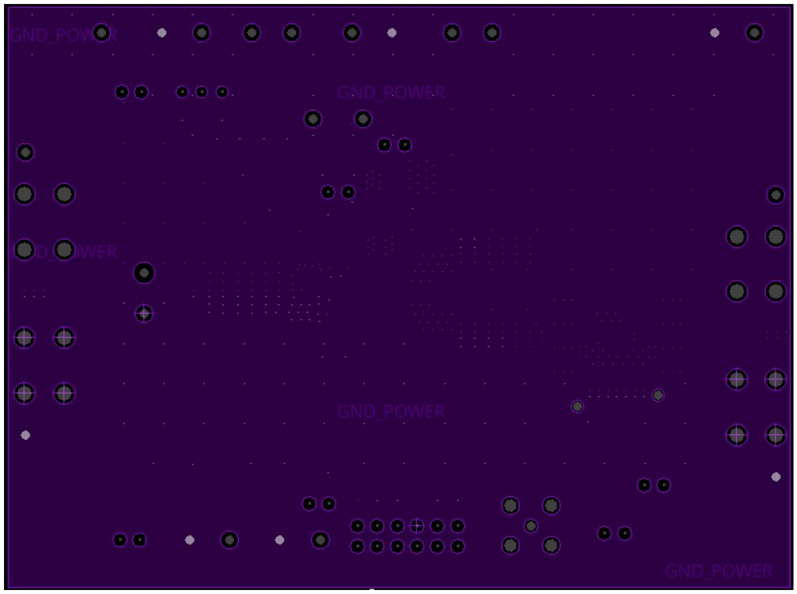


Figure 3 Inner Layer 1

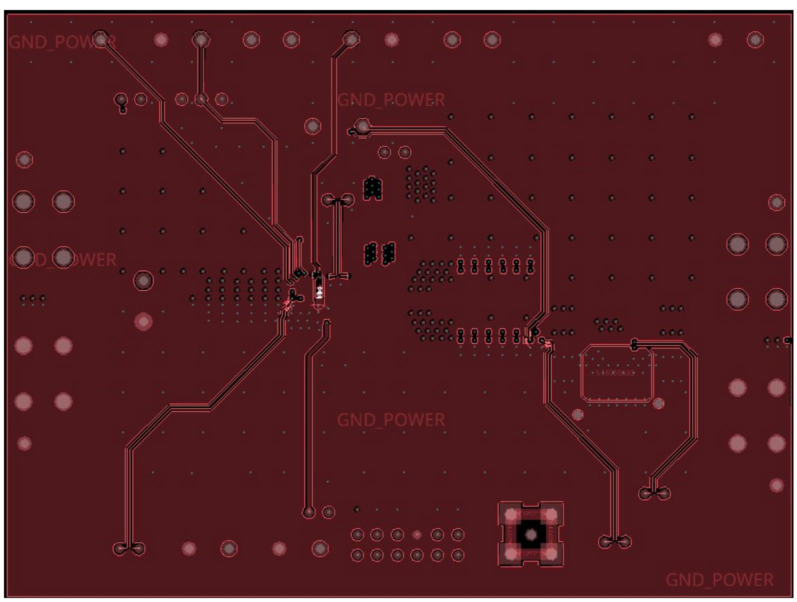


Figure 4 Inner Layer 2

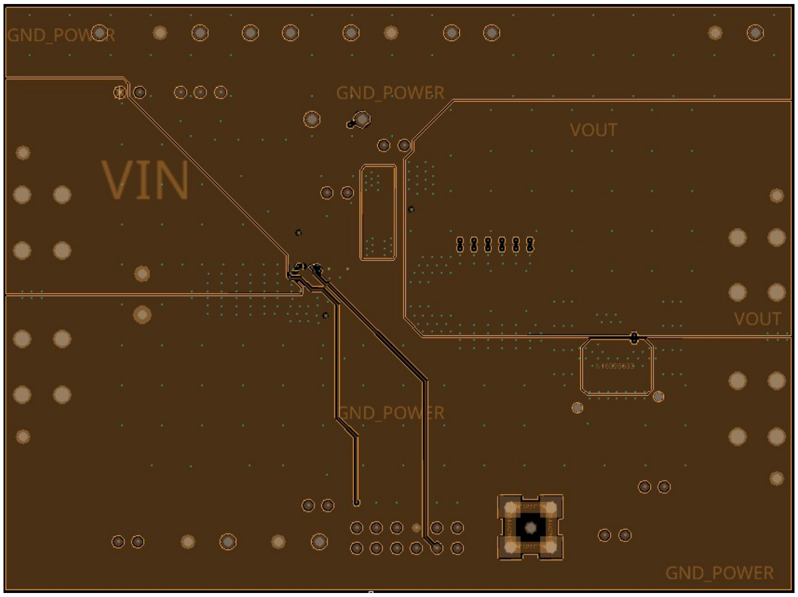


Figure 5 Inner Layer 3

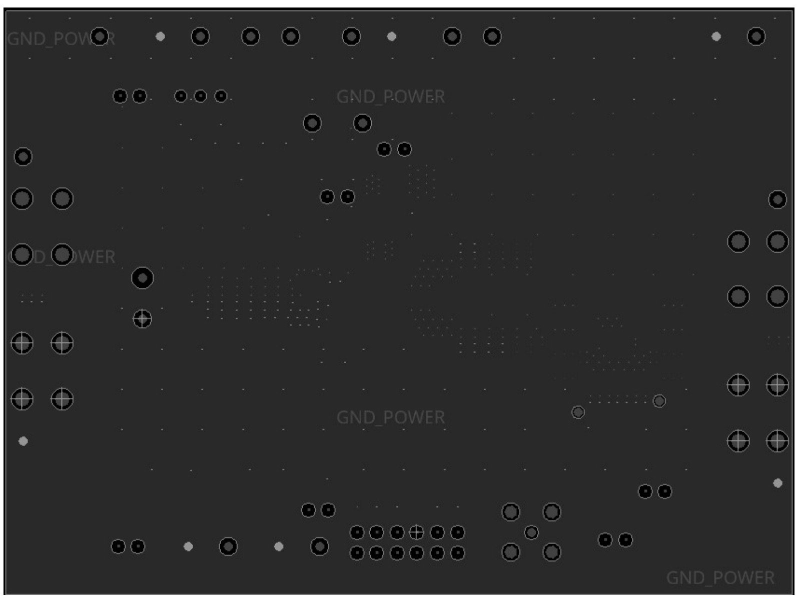


Figure 6 Inner Layer 4

2.6 Schematic

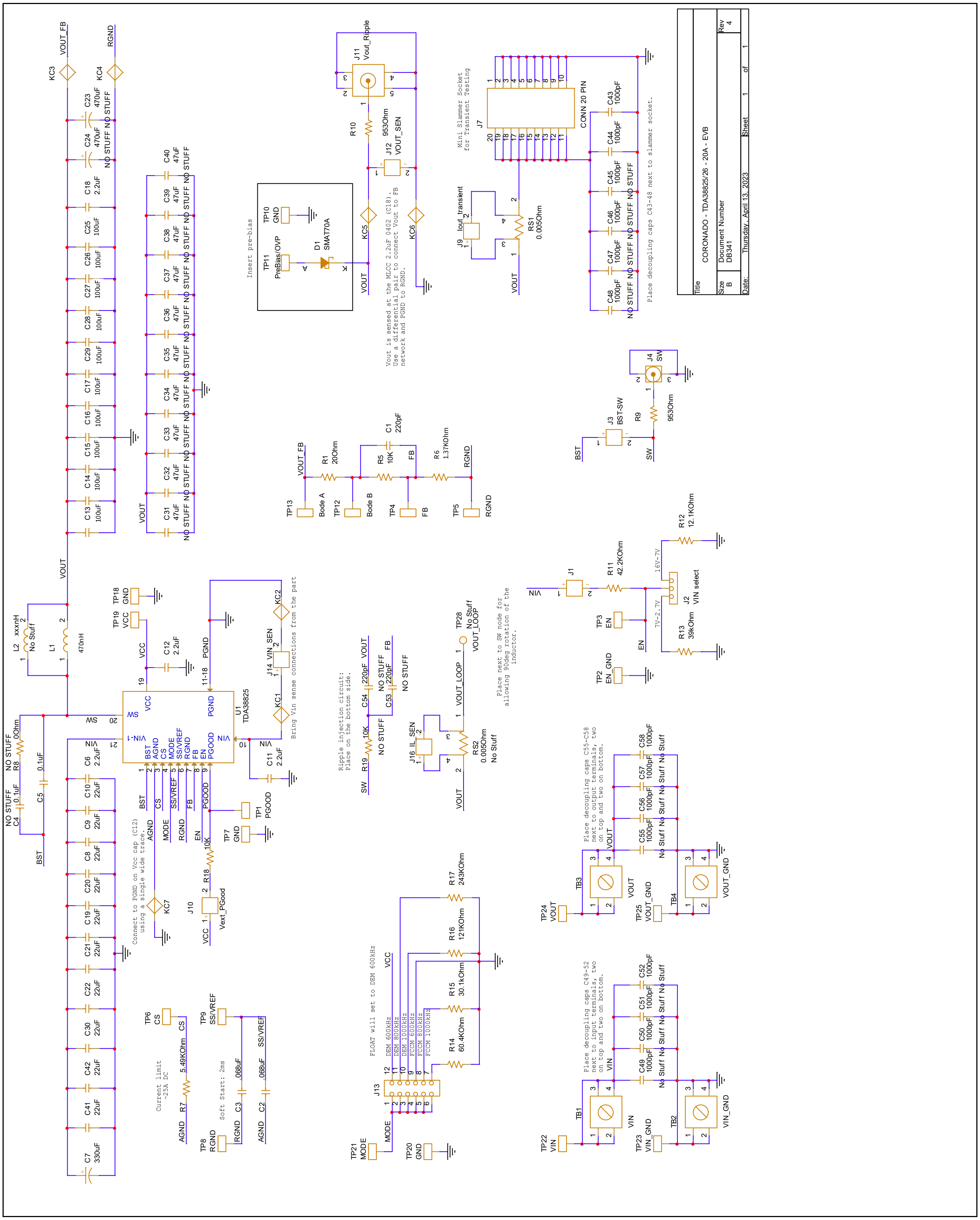


Figure 7 Schematic of the TDA38825 evaluation board Vin = 12 V, VO = 5V, IOmax = 20A

2.7 Bill of materials

Table 2 Bill of Materials

Item #	Qty	Part Referece	Value	Description	Manufacturer	PART_NUMBER
1	1	C1	220pF	CAP CER 220pF 50V X7R 0402 10%	TDK Corporation	C1005X7R1H221K050BA
2	1	C12	2.2uF	CAP CER 2.2uF 16V X5R 0402 10%	TDK	C1005X5R1C225K050BC
3	10	C13 C14 C15 C16 C17 C25 C26 C27 C28 C29	100uF	CAP CER 100uF 6.3V X5R 0805 20%	TDK	CM21X5R107M06AT
4	2	C2 C3	.068uF	CAP CER .068uF 16V X7R 0402 10%	Yageo	CC0402KRX7R7BB683
5	10	C22 C30 C41 C42 C8 C9 C10 C19 C20 C21	22uF	CAP CER 22uF 25V X5R 0805 20%	Murata	GRM21BR61E226ME44L
6	2	C43 C44	1000pF	CAP CER 1000pF 50V X7R 0402 10%	Kemet	C0402C102K5RAC7867
7	1	C5	0.1uF	CAP CER 0.1uF 16V X7R 0402 10%	Murata	GRM155R71C104KA88D
8	3	C6 C11 C18	2.2uF	CAP CER 2.2uF 25V X5R 0402 10%	Murata	GRM155R61E225KE11D
9	1	C7	330uF	CAP ALUM POLY 330UF 20% 25V T/H	Panasonic Electronic Components	25SEPF330M
10	1	D1	SMAT70A	TVS DIODE 70VWM 100VC SMA	Diodes Incorporated	SMAT70A-13
11	7	J1 J3 J9 J10 J12 J14 J16	-	CONN HEADER VERT 2POS 2.54MM	Harwin Inc.	M20-9990246

12	1	J11	-	CONN SMB JACK STR 50 OHM PCB	Cinch Connectivity Solutions Johnson	131-3701-261
13	1	J13	-	CONN HEADER VERT 12POS 2.54MM	Adam Tech	PH2-12-UA
14	1	J2	-	CONN HEADER R/A 3POS 2.54MM	Harwin Inc.	M20-9960345
15	1	J4	-	CONN UMCC JACK STR 50OHM SMD	TE Connectivity AMP Connectors	1909763-1
16	1	J7	CONN 20 PIN	CONN EDGE DUAL FMALE 20POS 0.031	Samtec Inc.	HSEC8-110-01-S-DV-A-K-TR
17	1	L1	470nH	FIXED IND 470NH 23A 2.9MOHM SMD		CMLE063T-R47MS
18	1	R1	20Ohm	RES Thick Film 20.0 Ohm 1/16W 1% SMD 0402	Yageo	RE0402FRE0720RL
19	1	R11	42.2KOhm	RES Thick Film 42.2K Ohm 1/16W 1% 0402	Yageo	RC0402FR-0742K2L
20	1	R12	12.1KOhm	RES Thick Film 12.1K Ohm 1/10W 1% 0402	Panasonic	ERJ-2RKF1212X
21	1	R13	39kOhm	RES Thick Film 39 kOhm 5.0 % 1/16 W SMD 0402	Panasonic	ERJ-2GEJ393X
22	1	R14	60.4KOhm	RES Thick Film 60.4K Ohm 1/10W 1% 0402	Yageo	RC0402FR-0760K4L
23	1	R15	30.1kOhm	RES Thick Film 30.1 kOhm 1.0 % 1/16 W SMD 0402	Vishay	CRCW040230K1FKED
24	1	R16	121KOhm	RES Thick Film 121K Ohm 1/10W 1% 0402	Yageo	RC0402FR-07121KL

25	1	R17	243KOhm	RES Thick Film 243K Ohm 1/16W 1% 0402	Yageo	RC0402FR-07243KL
26	2	R5 R18	10K	RES SMD 10K OHM 1% 1/16W 0402	YAGEO	AC0402FR-0710KL
27	1	R6	1.37KOhm	RES Thick Film 1.37K Ohm 1/16W 1% 0402	Yageo	RC0402FR-071K37L
28	1	R7	5.49KOhm	RES Thick Film 5.49K Ohm 1/10W 1% 0402	Panasonic	ERJ-2RKF5491X
29	2	R9 R10	953Ohm	RES Thick Film 953 Ohm 1/10W 1% 0402	Yageo	RC0402FR-07953RL
30	1	RS1	0.005Ohm	RES Thick Film 0.005 Ohm 1W 1% SMD 1632	Delta Electronics	RL1632T4F-R005-FNH
31	4	TB1 TB2 TB3 TB4	-	TERM 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	-	PIN INBOARD .042" HOLE 1000/PKG	Vector Electronics	K30C/M
33	1	U1	TDA38825	TDA38825 20A Single-voltage Synchronous Buck Regulator	Infineon	TDA38825

3 Evaluation Board Test Results

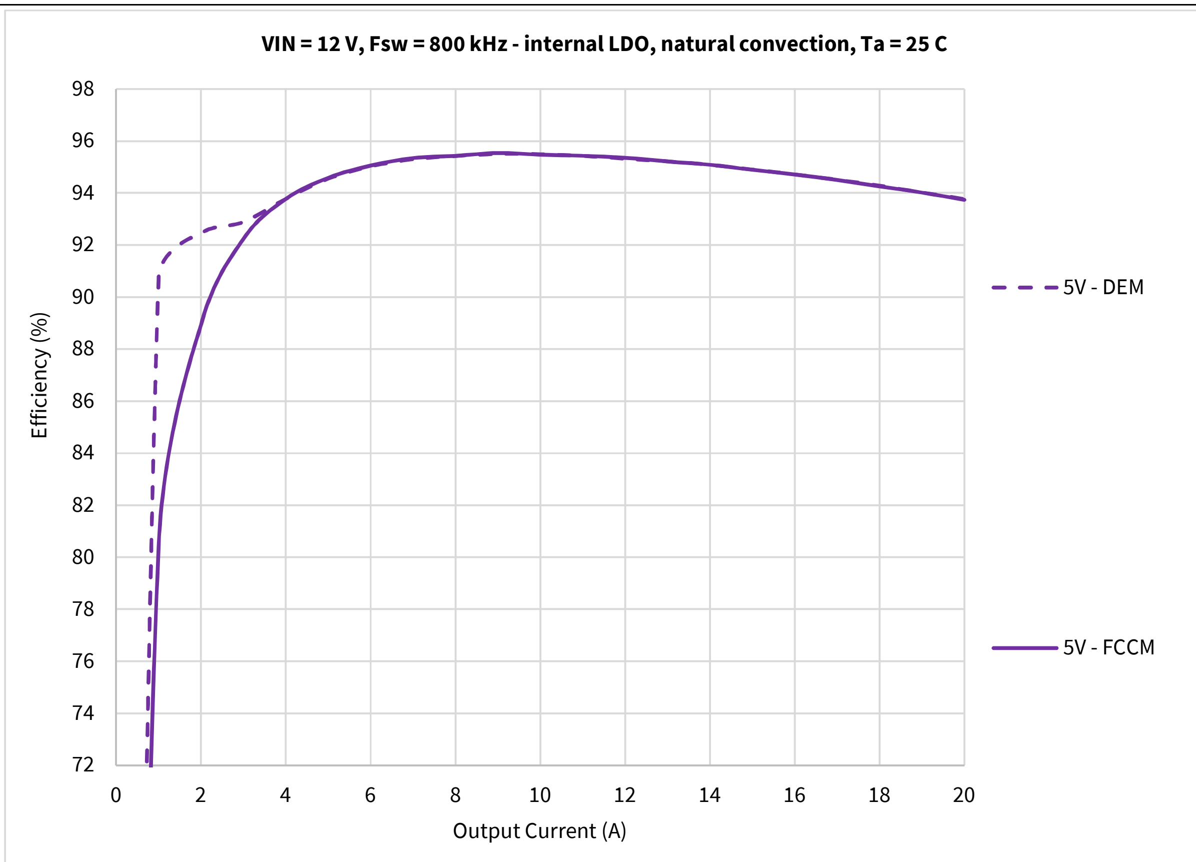
3.1 Typical Efficiency and Power loss curves

VIN = 12 V, Fsw = 800 kHz, Mode: DEM and FCCM

VIN = 12 V, VCC = internal LDO, Iout = 0 A – 20 A, Fsw = 800 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. The **Table 3** below shows the inductors used for each of the output voltages in the efficiency measurement.

Table 3 Inductors for VIN = 12 V, Fsw = 800 kHz

Vout (V)	Lout (nH)	P/N	DCR (mΩ)	Size (mm)
5.0	470 nH	CMLE063T-R47MS	2.9	6.95 x 6.6 x 2.8



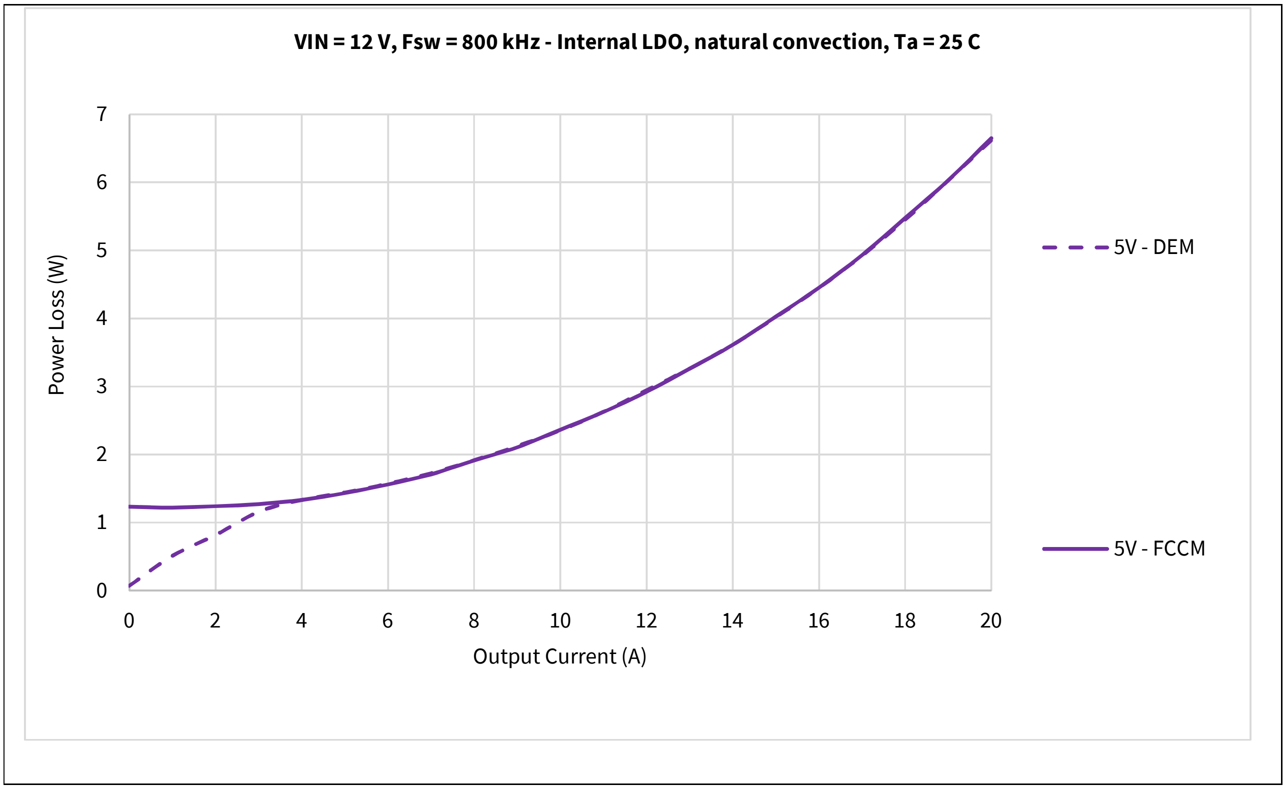


Figure 8 **Efficiency and Power Loss**

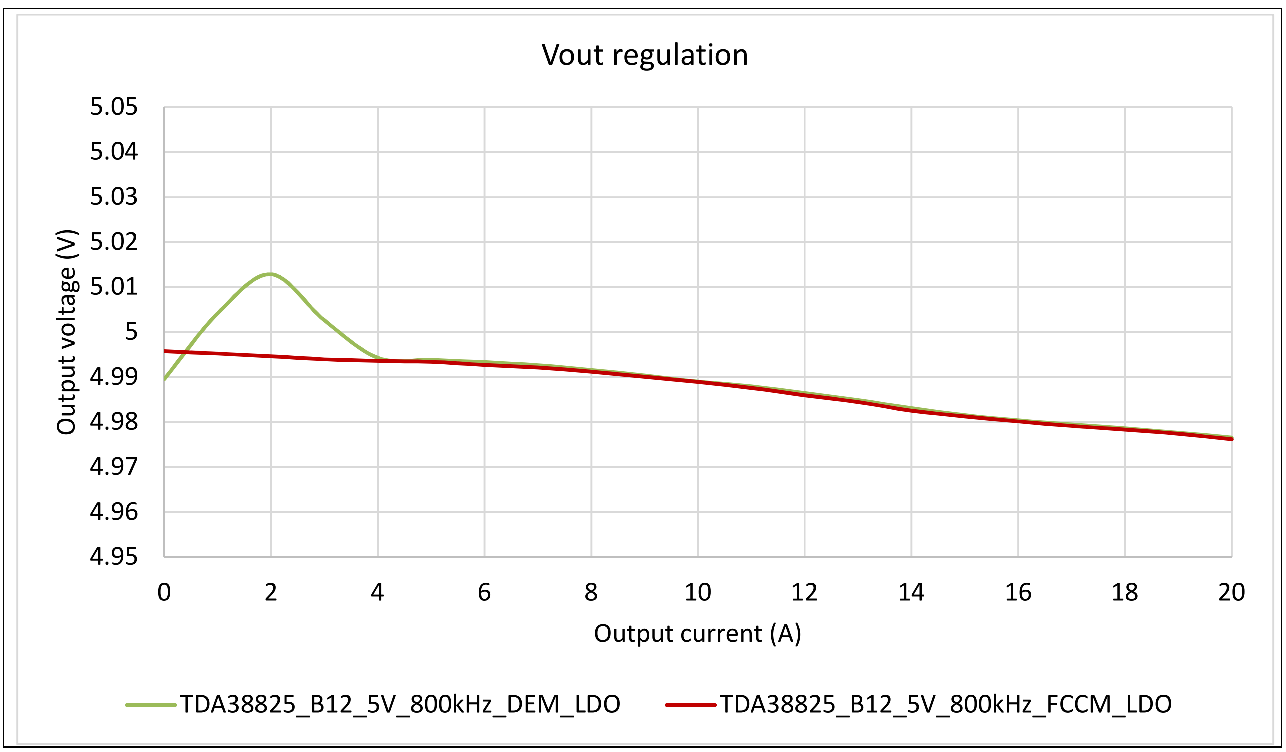


Figure 9 **Output Voltage Regulation**

3.2 Typical Operating Waveforms

$PV_{in} = V_{in} = 12.0$ V, Vo = 5 V, $I_o = 0$ A, $f_{sw} = 800$ kHz, Room Temperature, no airflow

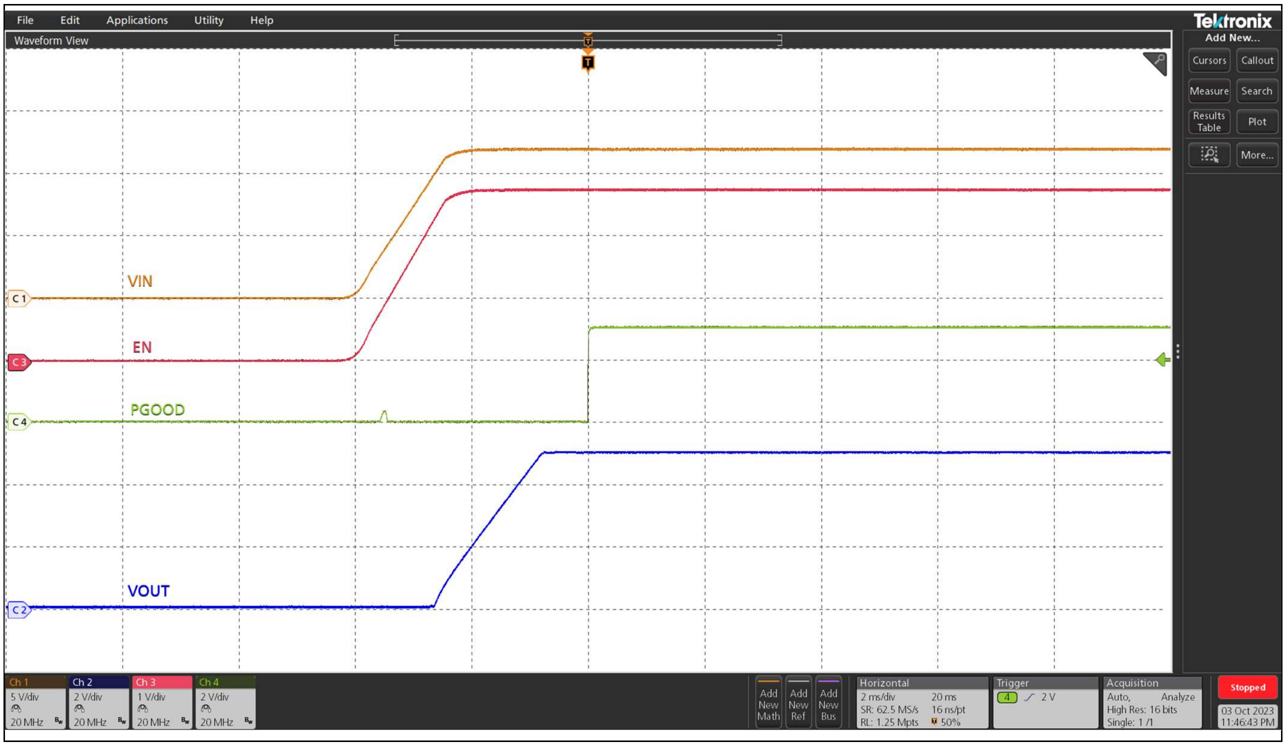


Figure 10 Start up at 0 A Load, (Ch1: Vin, Ch2: Vout, Ch3: Enable, Ch4: PGood)

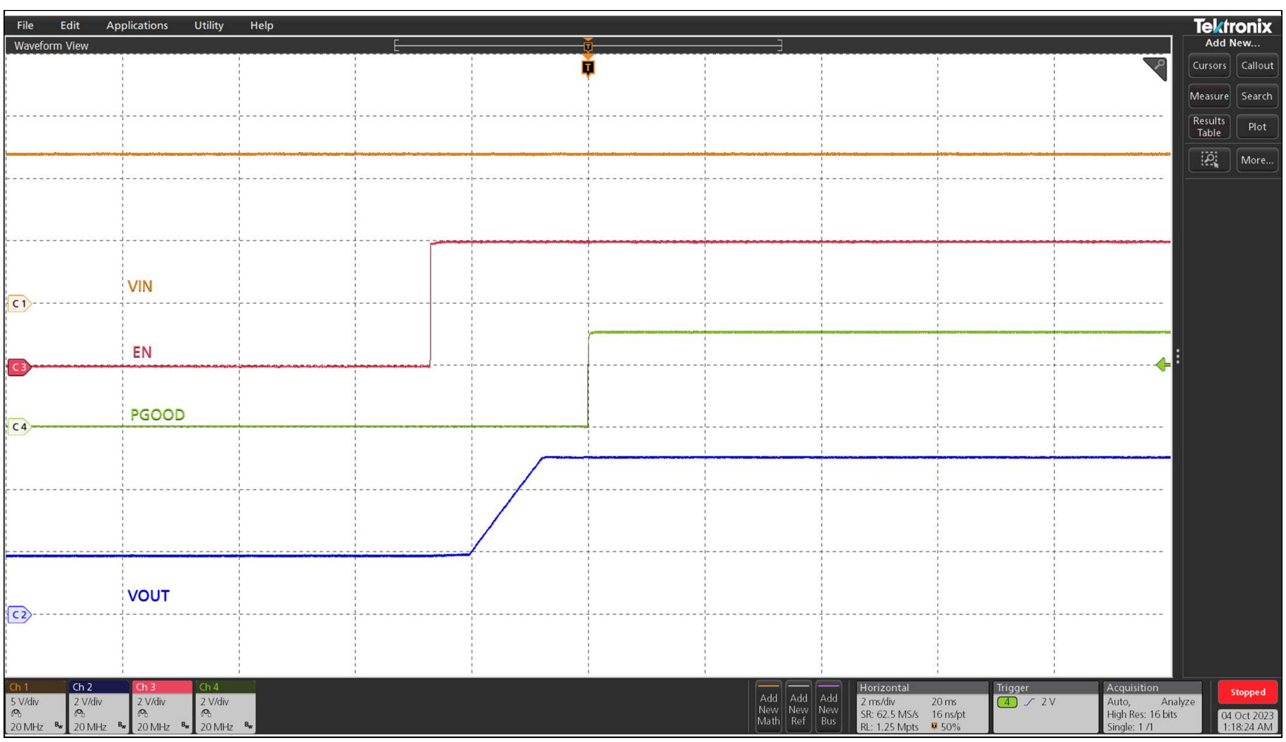


Figure 11 Pre-bias Start up at 0 A Load, (Ch1: Vin, Ch2: Vout, Ch3: Enable, Ch4: PGood)

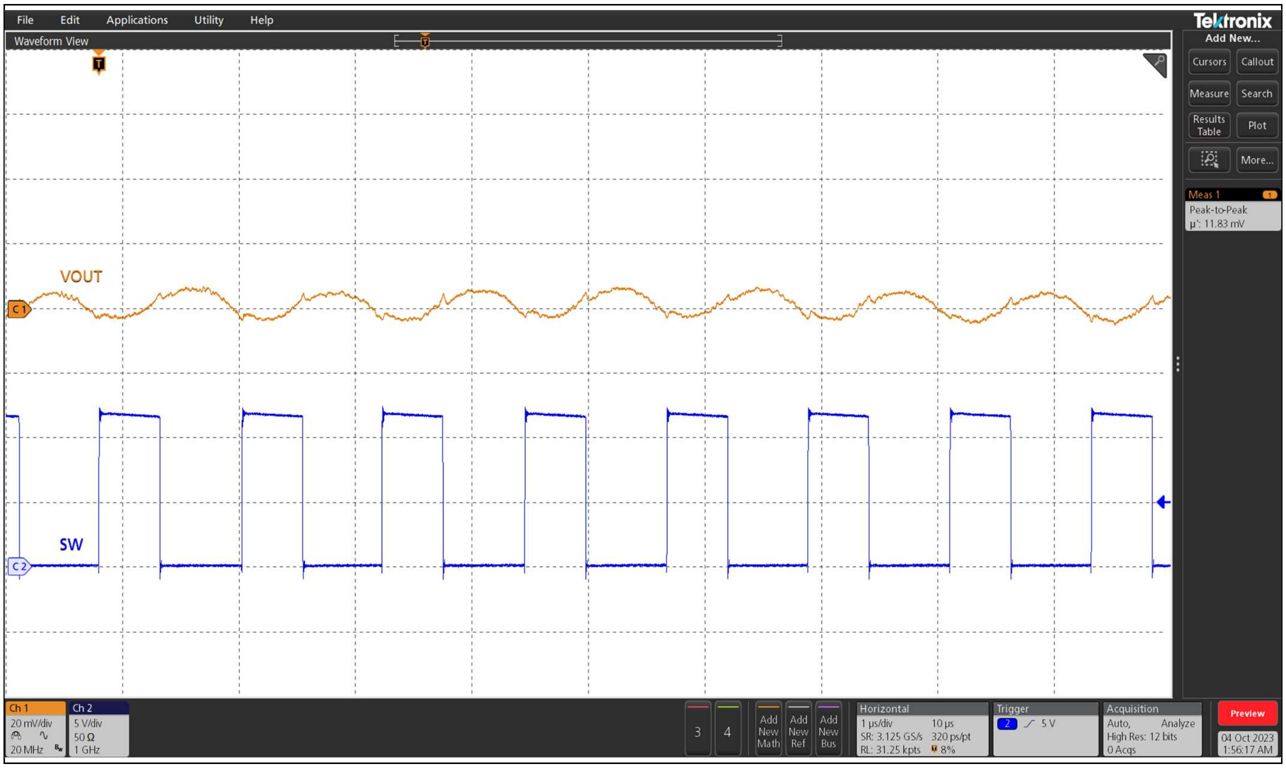


Figure 12 Vout ripple at 10A Load, fsw = 800 kHz, (Ch1: Vout, Ch2: SW)

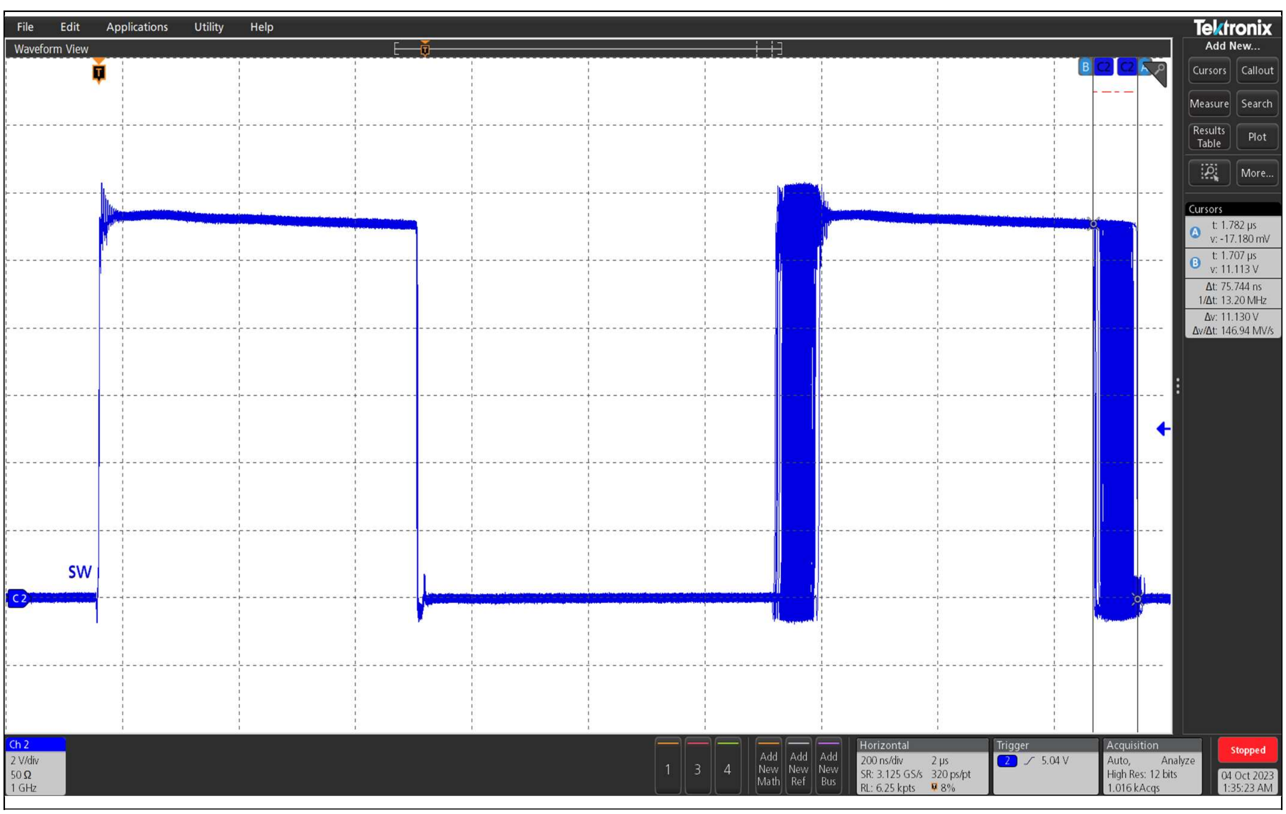


Figure 13 SW node Jitter, 20A load, fsw = 800 kHz

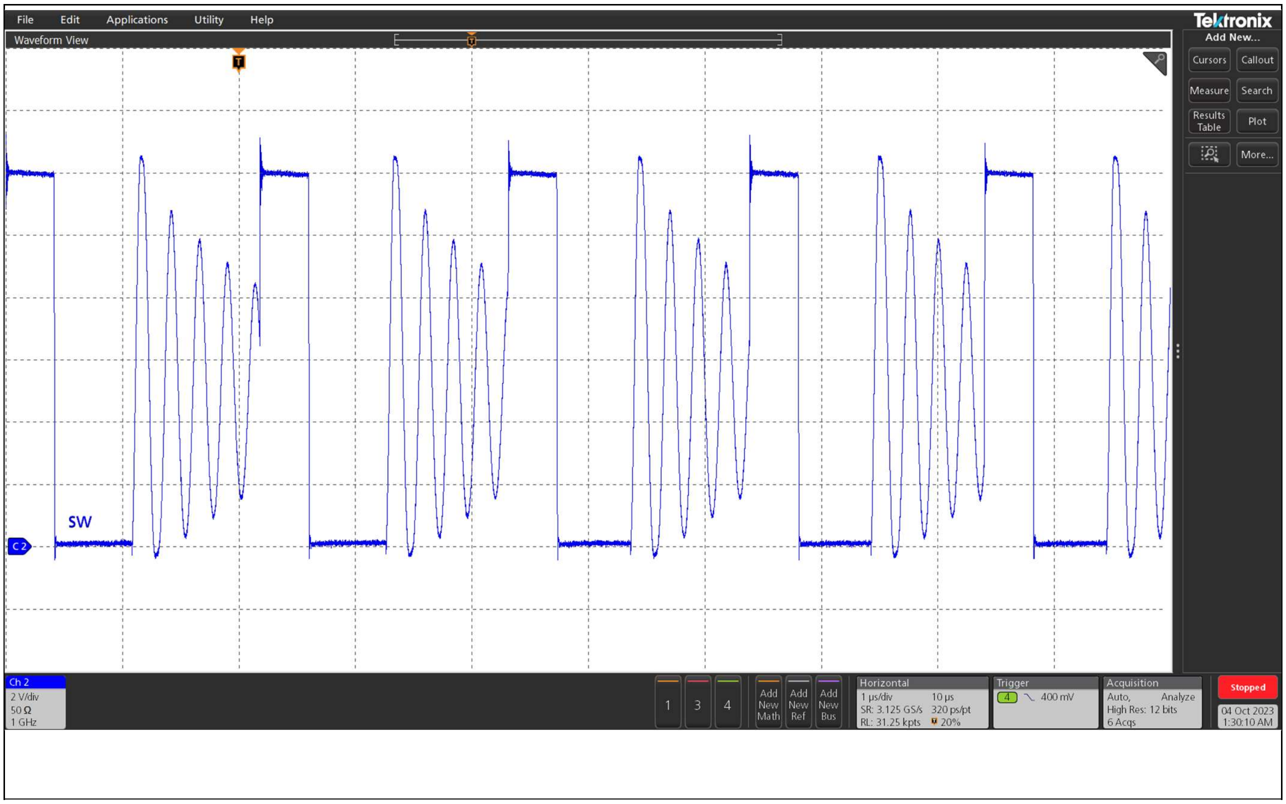


Figure 14 SW node (in DEM), 1 A load

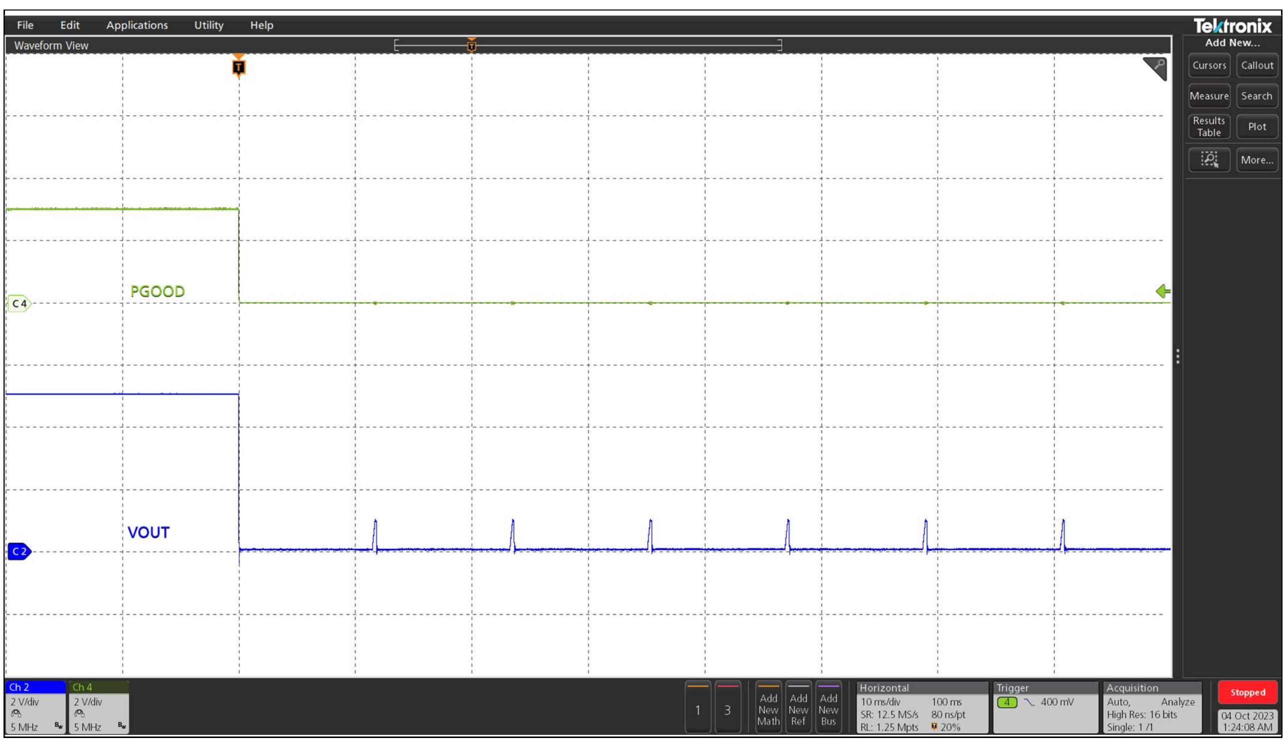


Figure 15 Short circuit and UVP (Hiccup), (Ch2: Vo, Ch4:PGood)

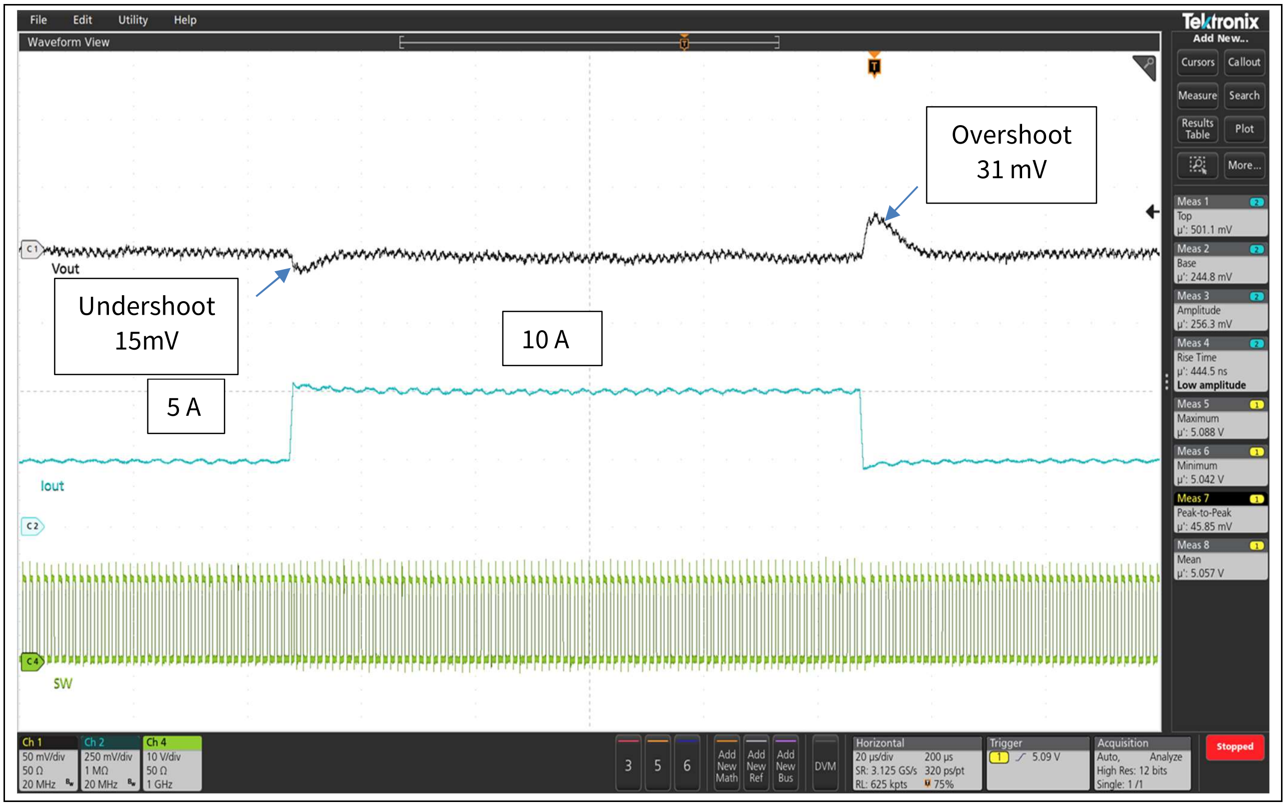


Figure 16 **Transient response at 5 A step load current @ 10 A/µs slew rate: Io= 5A – 10 A, (Ch1: Vo, Ch2: Io, Ch4: Sw), pk-pk: 45.85 mV, fsw = 800 kHz**

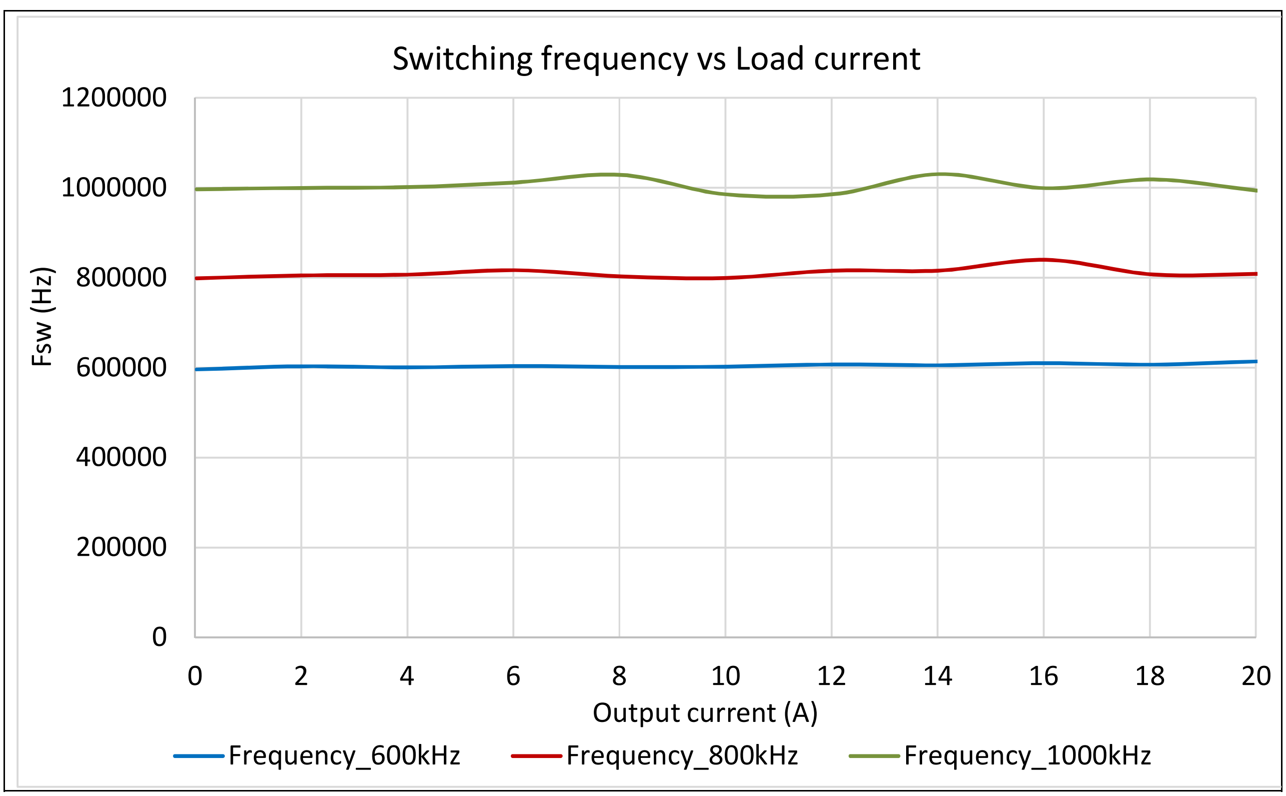


Figure 17 **Switching Frequency vs Load Current**

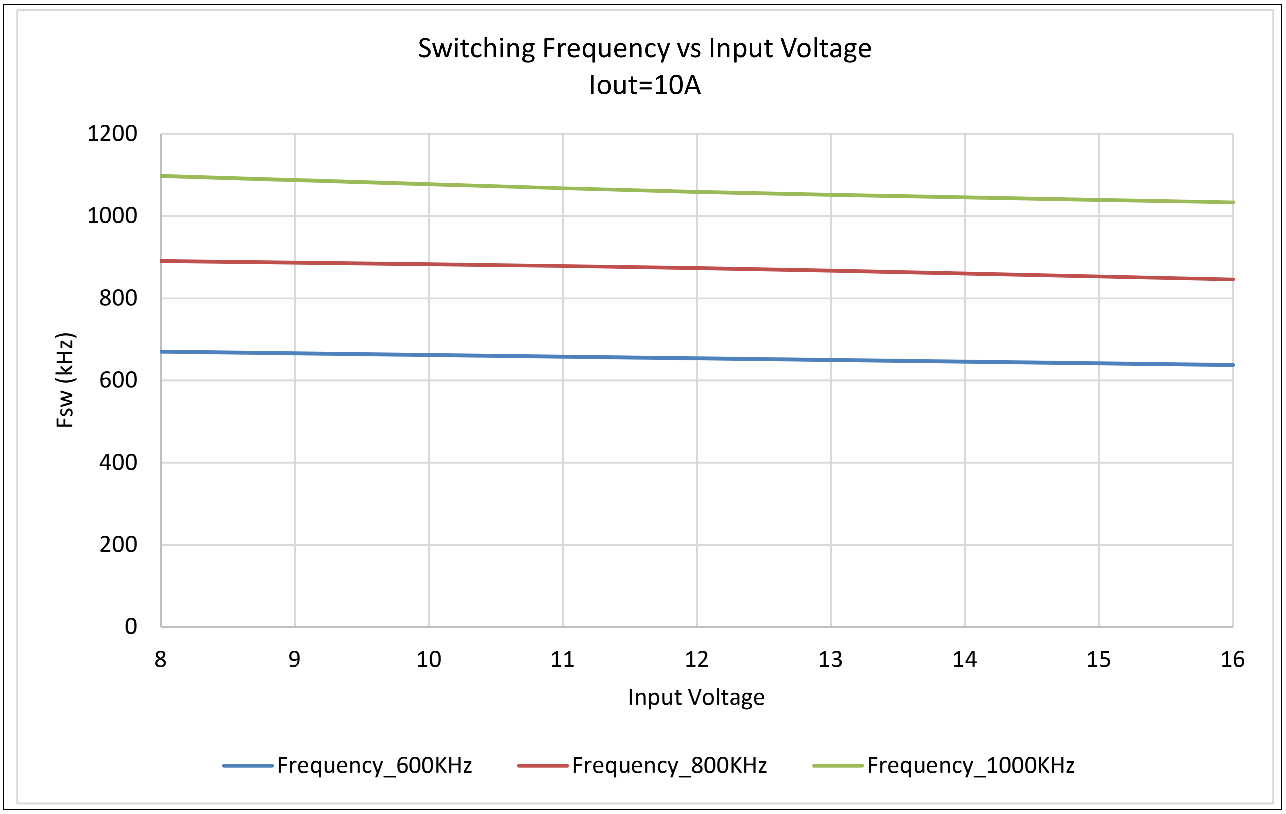


Figure 18 Switching Frequency vs Input Voltage

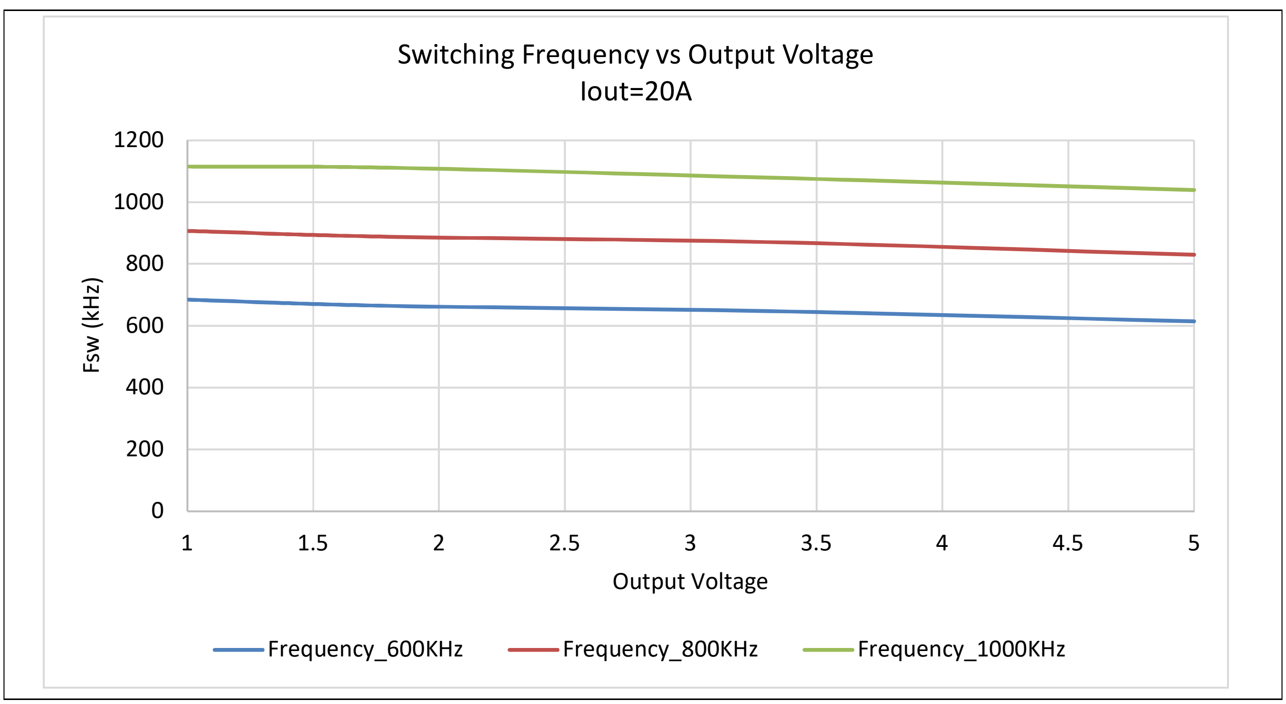
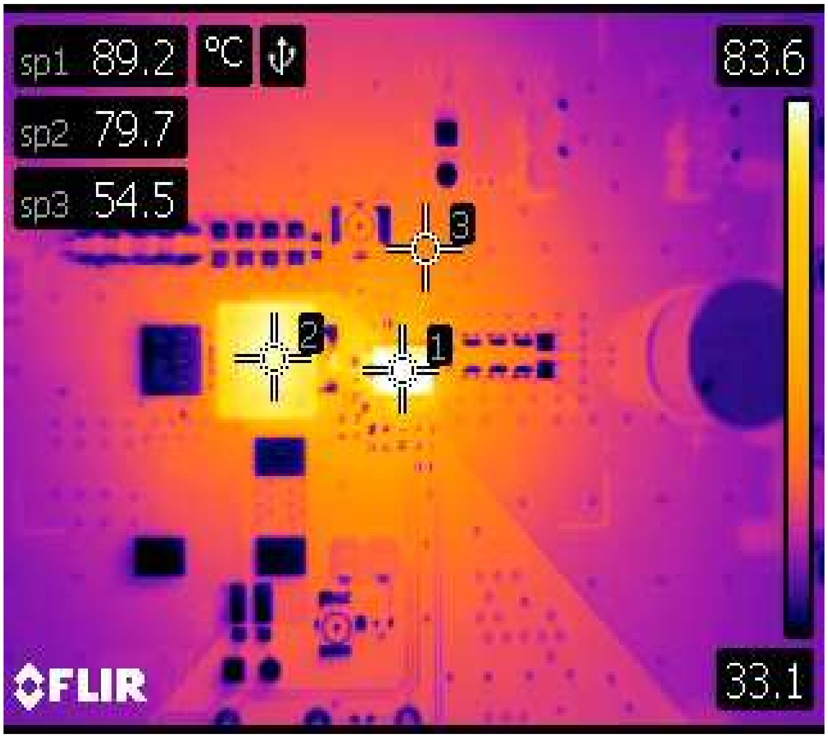


Figure 19 Switching Frequency vs Output Voltage

Thermal Images with no air flow and 25^{o}C ambient



- **Output Voltage-5V**
- **SP1- TDA38825**
- **SP2- Inductor**
- **SP3- PCB**

Figure 20 Thermal Performance of TDA38825 for 5V output voltage, 20A load, FCCM mode, 800Khz Switching Frequency, 12V Vin

Revision history

Document version	Date of release	Description of changes
1.0	10-04-2024	Final User Guide

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