User manual for TDA38725 evaluation board

25 A single-phase buck regulator

About this document

Scope and purpose

The TDA38725 is a synchronous buck converter with PMBus communication interface, providing a compact, high-performance and flexible solution in a small 5 mm x 6 mm power QFN package.

Key programmable features offered by the TDA38725 include soft-start, thermal protection, switching frequency, enable input, input undervoltage lockout (UVLO), overvoltage protection (OVP), overcurrent protection (OCP), output undervoltage, overtemperature protection (OTP), high-side short detection, load-line and pre-bias start-up. All faults have configurable responses via the XDP™ Designer GUI available from Infineon.

Output OCP function is implemented by sensing the voltage developed across the on-resistance of the synchronous (low-side) MOSFET for optimum cost and performance, and the current limit is thermally compensated.

This user manual contains the schematic and bill of materials (BOM) for the EVAL_TDA38725_1.2VOUT and EVAL_TDA38725_3.3VOUT evaluation boards. The manual describes operation and use of the evaluation board itself. Detailed application information for TDA38725 is available in the TDA38725 data sheet.

Intended audience

This document is intended as a guide for design engineers evaluating TDA38725 performance with the EVAL_TDA38725_1.2VOUT and EVAL_TDA38725_3.3VOUT demo boards.

Table of contents

1 Board information

1.1 Default board features

$P_{VIN} = V_{IN} = +12$ V

$f_{SW} = 800$ kHz (default, but it is configurable using the GUI)

C_{IN} = 8 x 22 µF (25 V, ceramic 0805) + 1 x 2.2 µF (25 V, ceramic 0402) + 1 x 4.7 µF (25 V, ceramic 0603) + 1 x 390 µF (20 V, electrolytic, optional)

Table 1 TDA38725 default output inductor and capacitor bank for each output voltage

Output voltage	Inductor	Output capacitors (C_{out})
1.2 V	150 nH	1410 µF (1 x 470 µF SP capacitor, 2.5 V rated + 20 x 47 µF ceramic)
3.3 V	470 nH	1410 µF (1 x 470 µF POSCAP, 6.3 V rated + 20 x 47 µF ceramic)

1.2 Connections and operating instructions

The EVAL_TDA38725_1.2VOUT and EVAL_TDA38725_3.3VOUT demo boards require a single +12 V for the input power and can deliver up to 25 A load current. The operation modes and OCP limits are programmable via the XDP™ Designer GUI.

Table 2 Connections

Label		Description
Input	PVIN	Connect input power (+12 V) to this pin
	GND	Return of input power
	VIN_Eff	Sense pins for the input voltage
	VIN_SEN	Sense pins for the input voltage
Output	VOUT	V_{OUT}, connect a load (25 A max.) to this pin
	GND	Return of V_{OUT}
	VOUT_Eff	Sense pins for efficiency
	VOUT_SEN	Sense pins for the output voltage
Enable	ENABLE	Connect a scope probe to this pin to monitor the enable signal. An external enable signal can be applied to this pin to overdrive the onboard enable signal by connecting a jumper on EXT-EN header J740 Alternatively, the enable signal can be generated using P_{VIN} using a resistor divider by connecting a jumper on PVIN-EN header J740.
	GND	
BODE	A	For bode plot measurement
	B	
SM_ADDR/PROG	I^2C slave address offset	Use this jumper to add an offset to the I^2C slave base address of 0x10h. By default, this is set to zero.
I^2C/PMBus	J745	This is used to establish communication with the Infineon XDP™ Designer GUI, which is used to change the default configuration of the part. The USB005 dongle is used for communication.

VRRDY	TP166	This signal is used to indicate that the V_{out} has reached a threshold set by POWER_GOOD_ON PMBus command
SM_ADDR/PROG	J717	This jumper is used to select between 16 programmed files stored in the part. By default, it is set to accept the most recent programmed config file into the part.
ILIM	J728	This jumper is used to select the resistor-programmable current limit
TON/MODE	J729	This jumper is used to select the resistor-programmable switching frequency and FCCM or DCM mode
VBT	J727	This jumper is used to set the resistor-programmable boot voltage
VIN-PVIN	VCC	Connecting a jumper to J751 generates the V_{CC} on board, but removing this jumper and connecting a 5 V external supply to TP169 will also work
EN ON/OFF	SW4	This switch is used to enable the part on and off. The switch is pulled up to an onboard 3.3 V regulator.

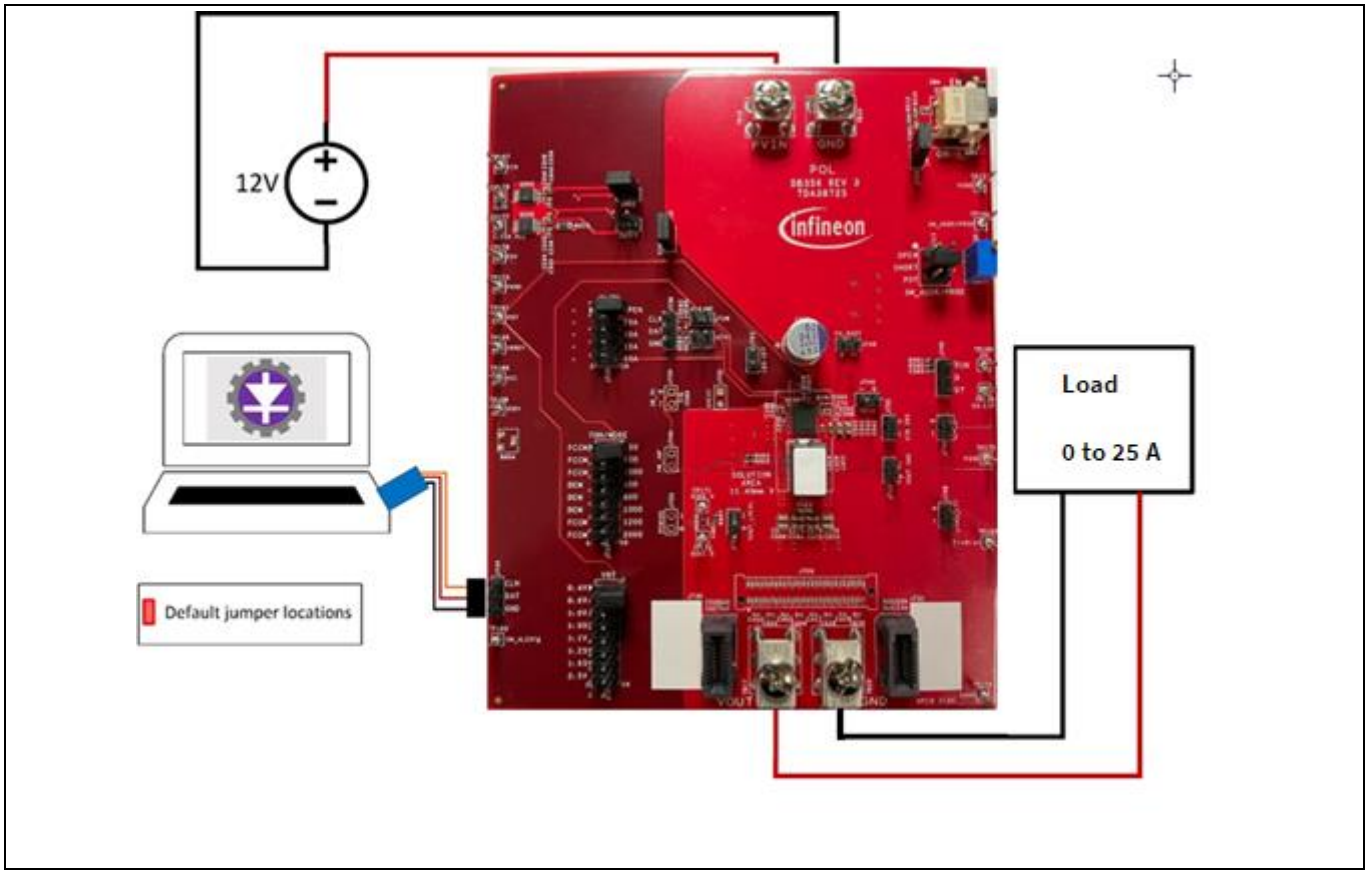

Figure 1 Default bench setup block diagram

Figure 1 depicts a default bench setup to start the demo board. The 12 V input voltage and USB dongle connected to a computer running the XDP™ Designer GUI are necessary to begin to communicate with the part. Section **1.6** covers installing and starting the GUI. A load may then be connected to the output terminals.

1.3 Layout

The PCB is an eight-layer board (5.25 in. x 4.1 in.) using FR4 material. The PCB thickness is 0.062 in. The TDA38725 and other major power components are mounted on the top side of the board. **Table 2** details the layer stack-up order and copper weight for each layer.

Table 3 PCB layer stack-up

Layer	Layer description	Trace material
1	Top	0.5 oz. copper + 1.5 oz. plating
2	Ground 1	2 oz. copper
3	Signal 1	2 oz. copper
4	Power 1	2 oz. copper
5	Power ground	2 oz. copper
6	Signal 2	2 oz. copper
7	Ground 2	2 oz. copper
8	Bottom	0.5 oz. copper + 1.5 oz. plating

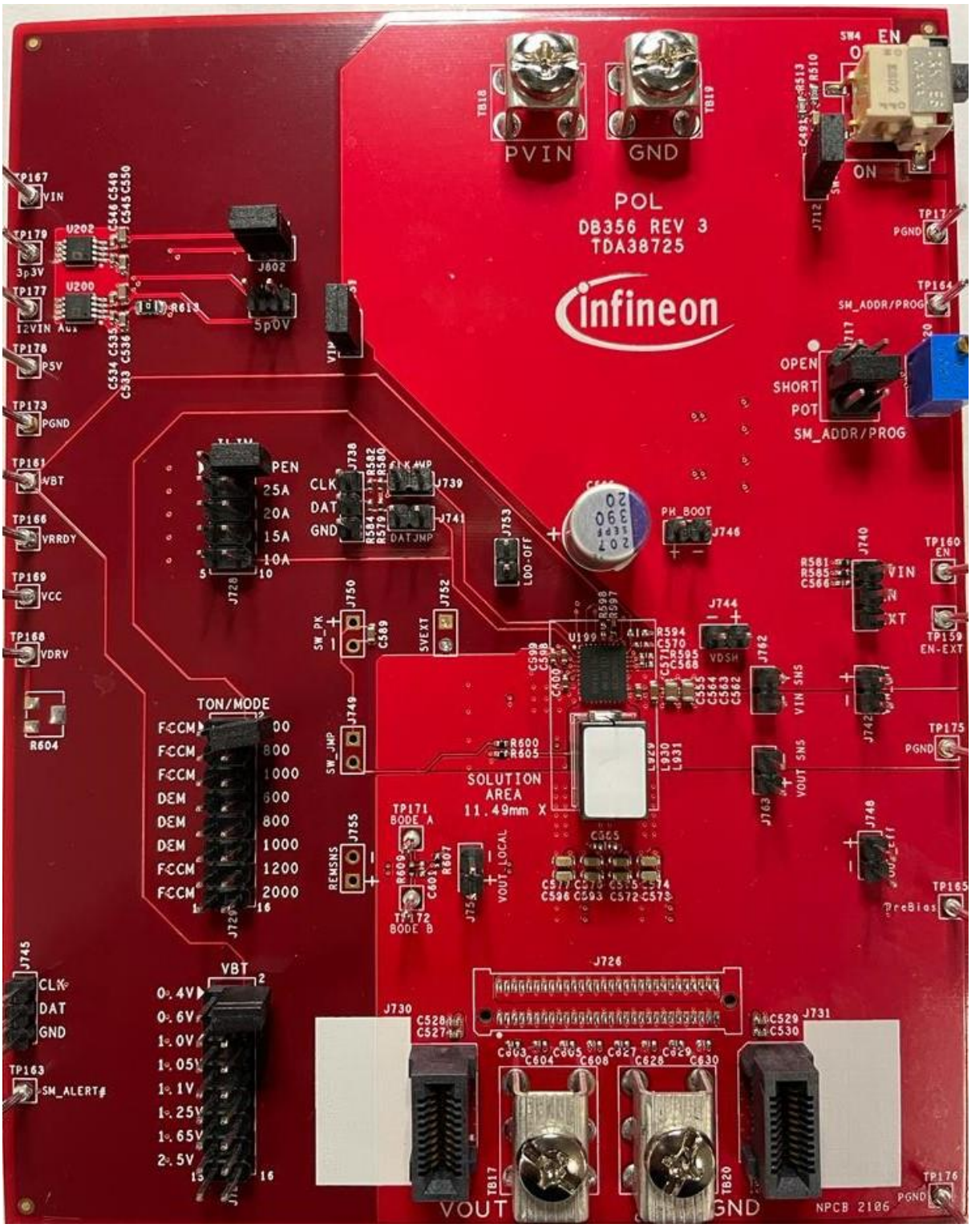

Figure 2 Top view of TDA38725 evaluation board

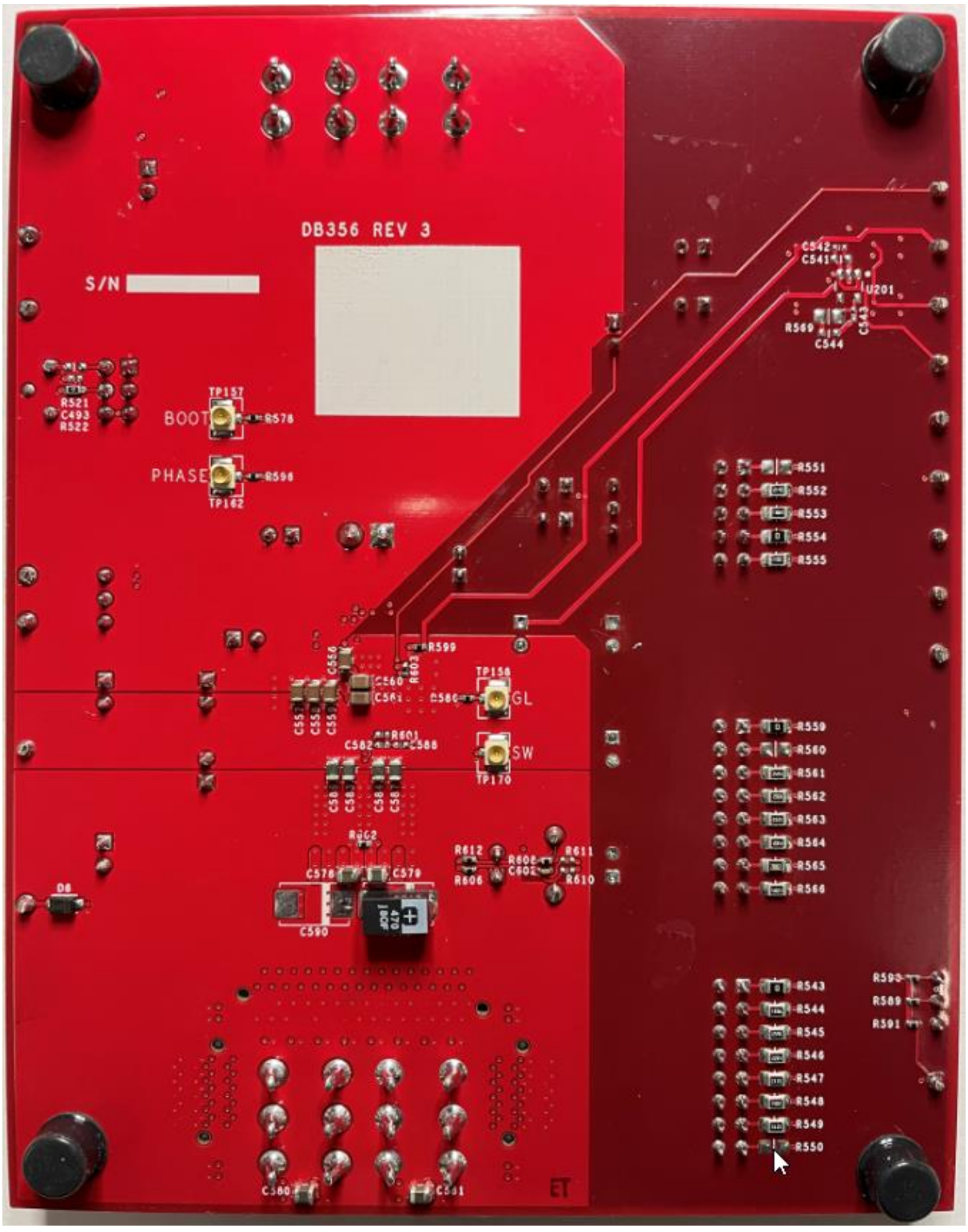

Figure 3 Bottom view of TDA38725 evaluation board

1.4 PCB layout

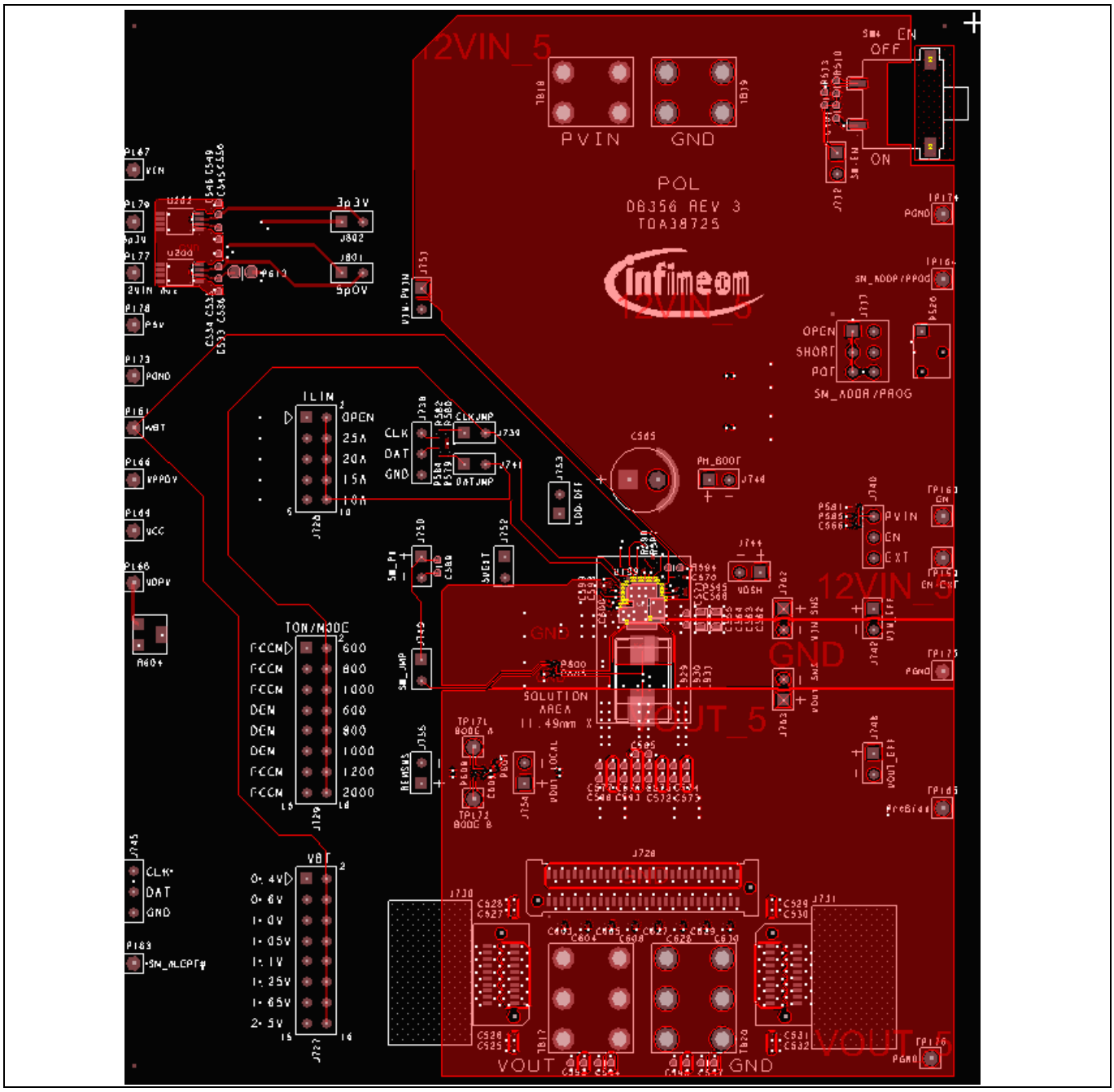

Figure 4 Top layer TDA38725

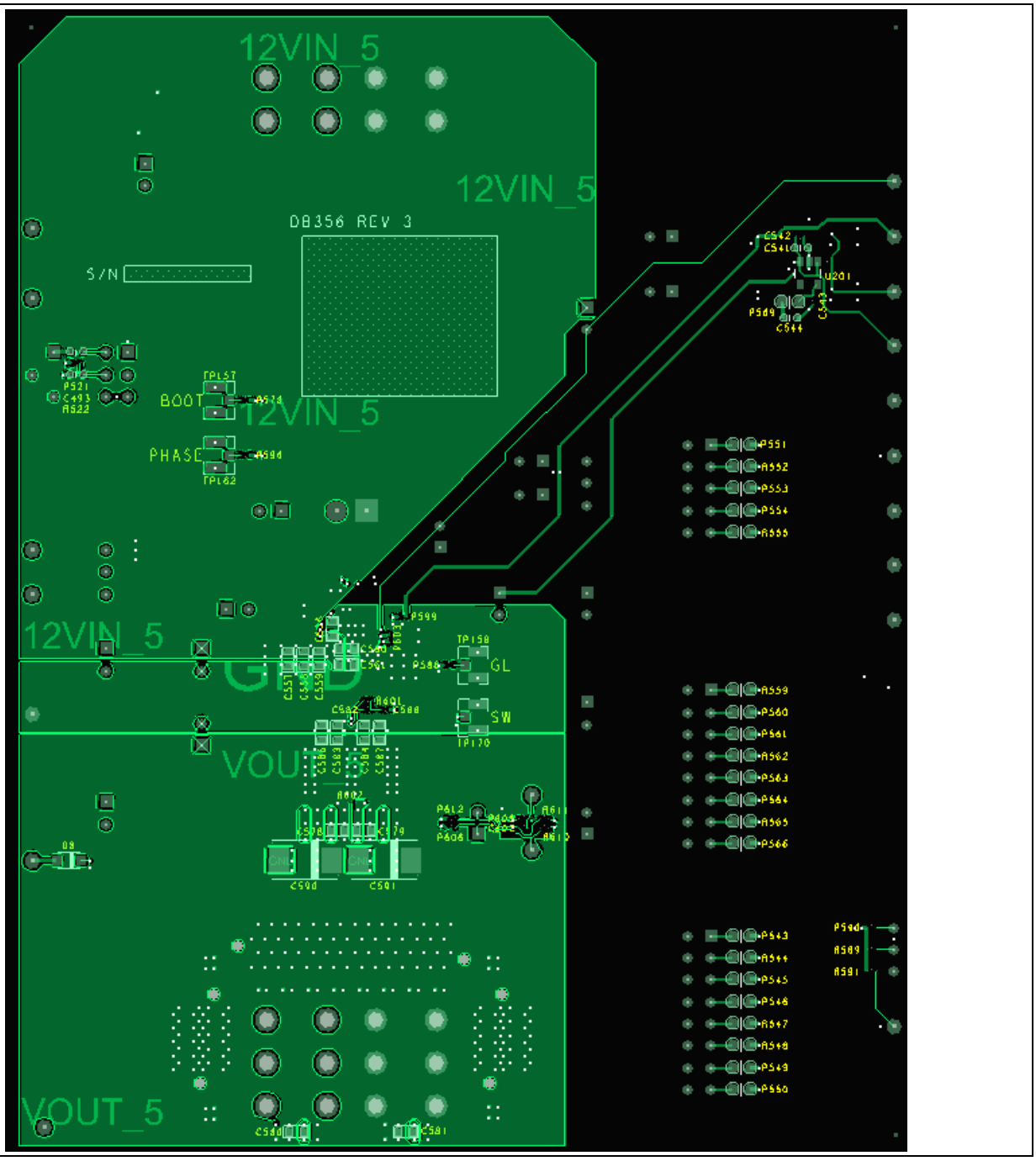

Figure 5 Bottom layer TDA38725

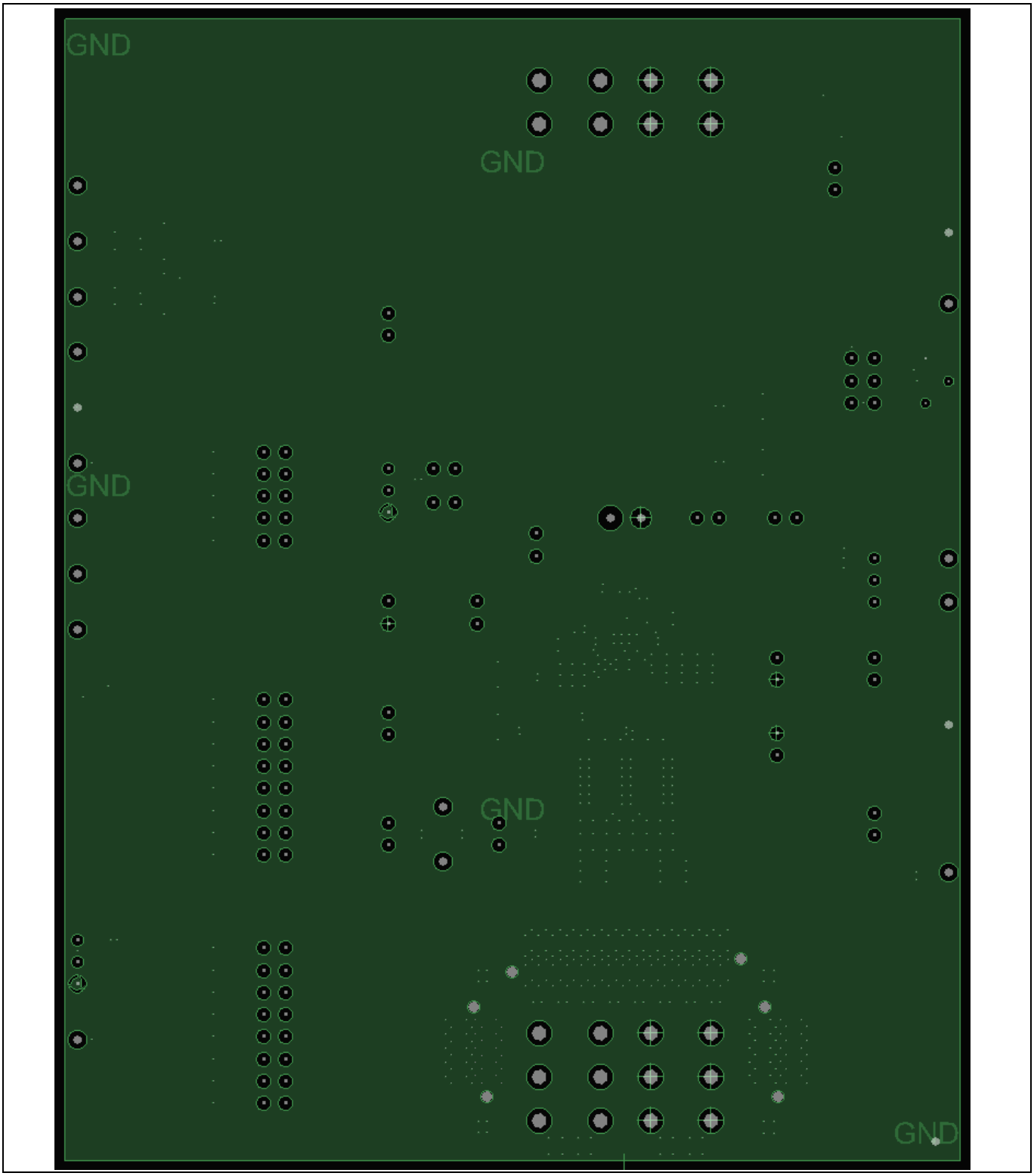

Figure 6 Mid layer 1 (ground 1) for TDA38725

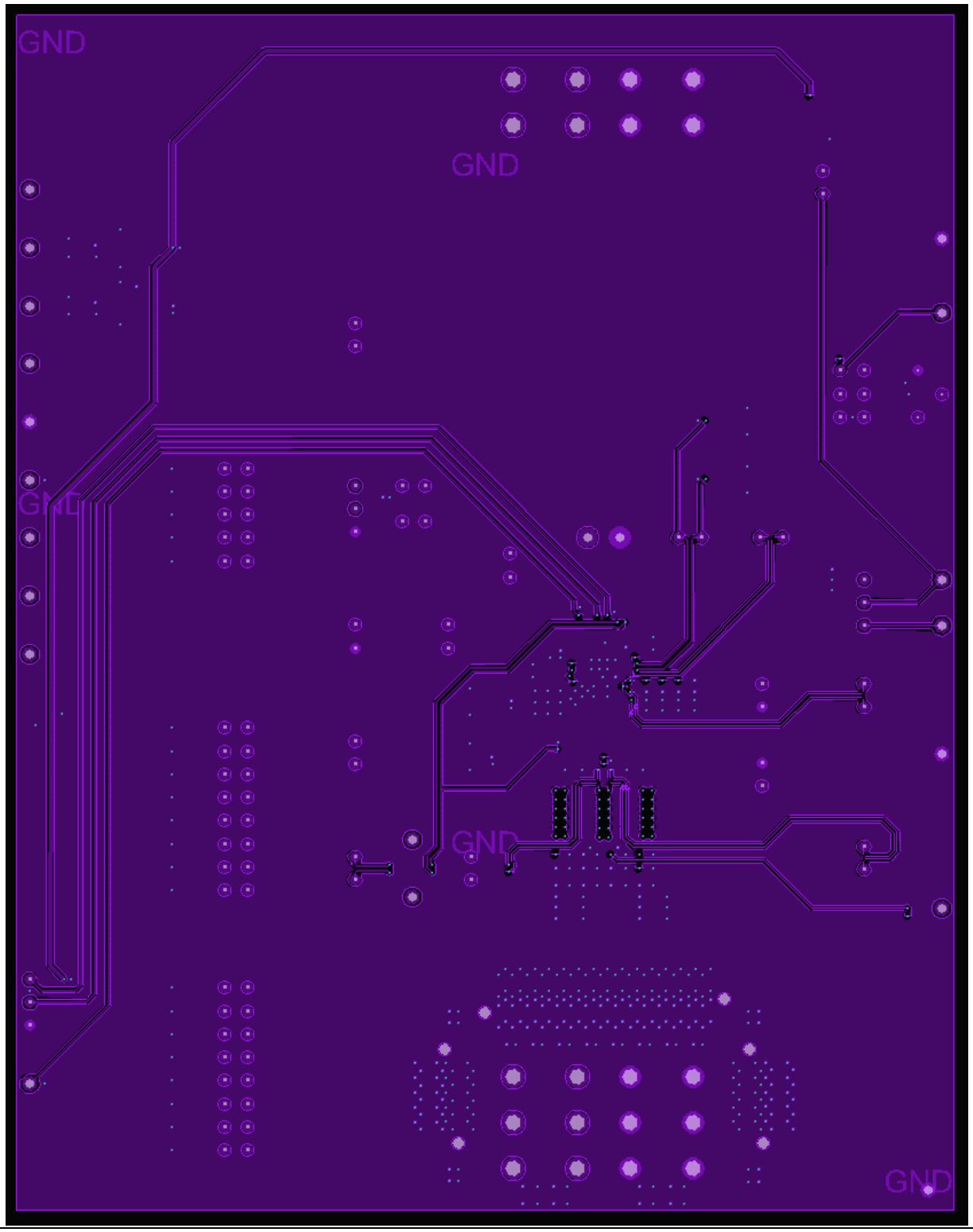

Figure 7 Mid layer 2 (signal 1) for TDA38725

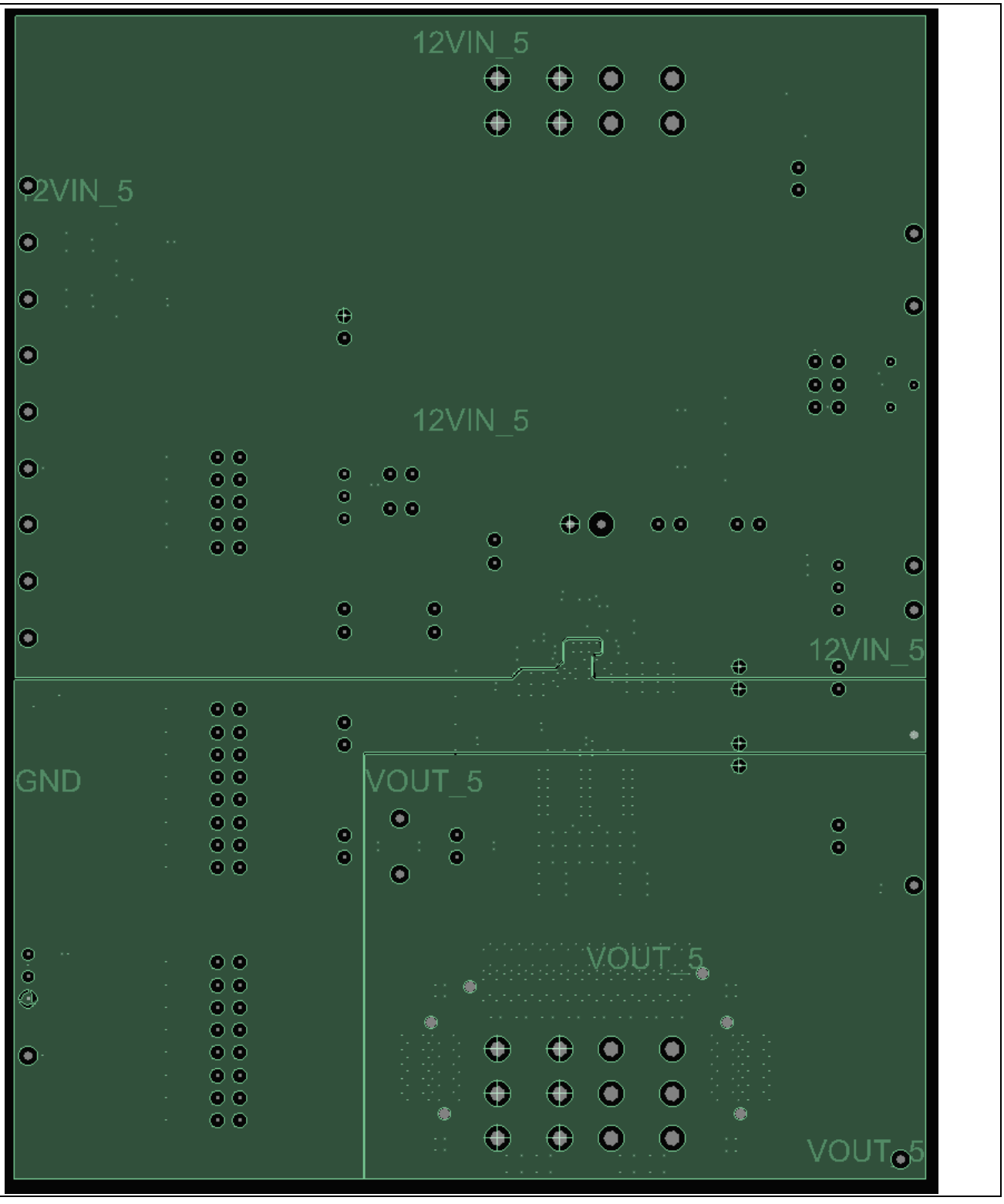

Figure 8 Mid layer 3 (power 1) for TDA38725

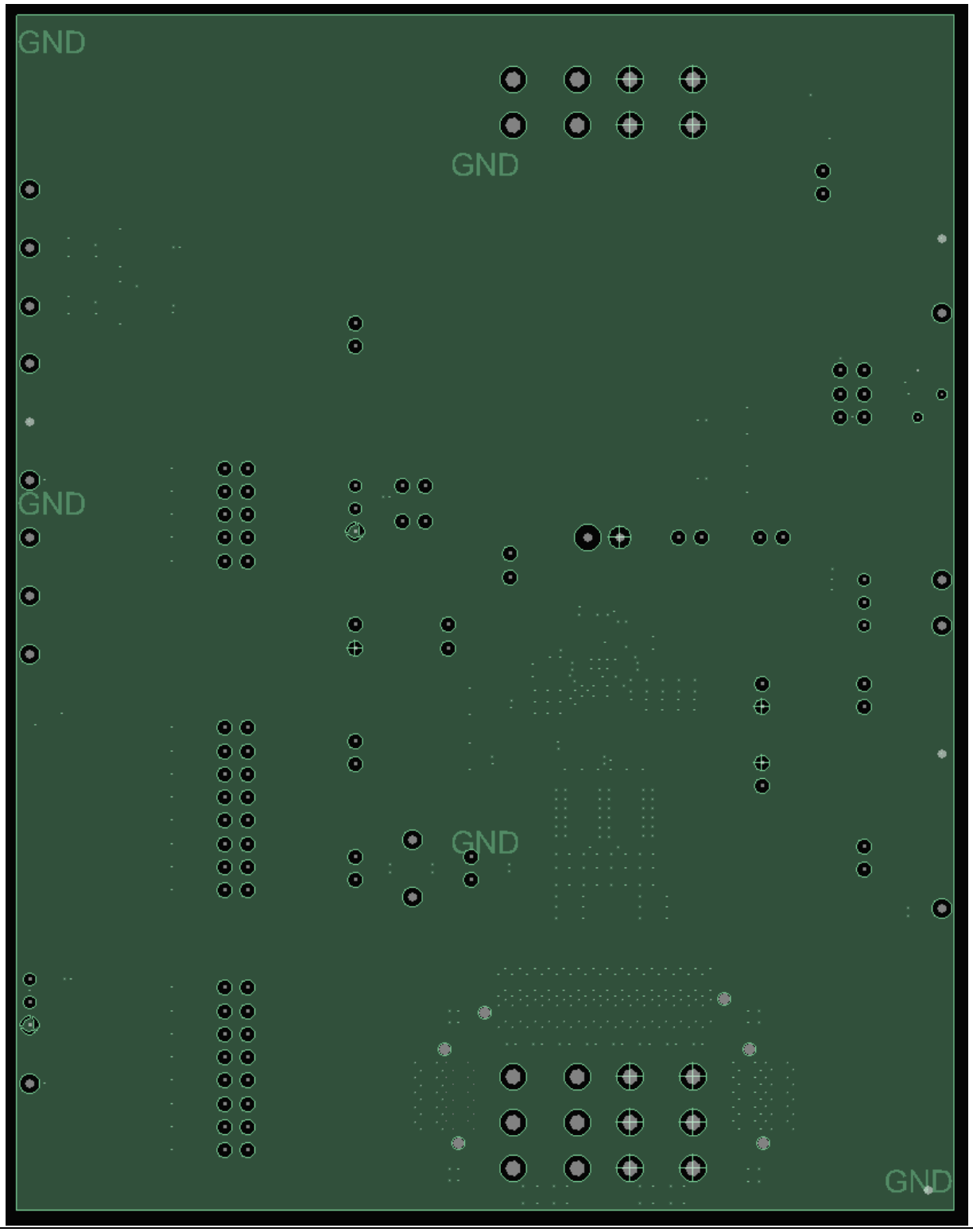

Figure 9 Mid layer 4 (power 2) for TDA38725

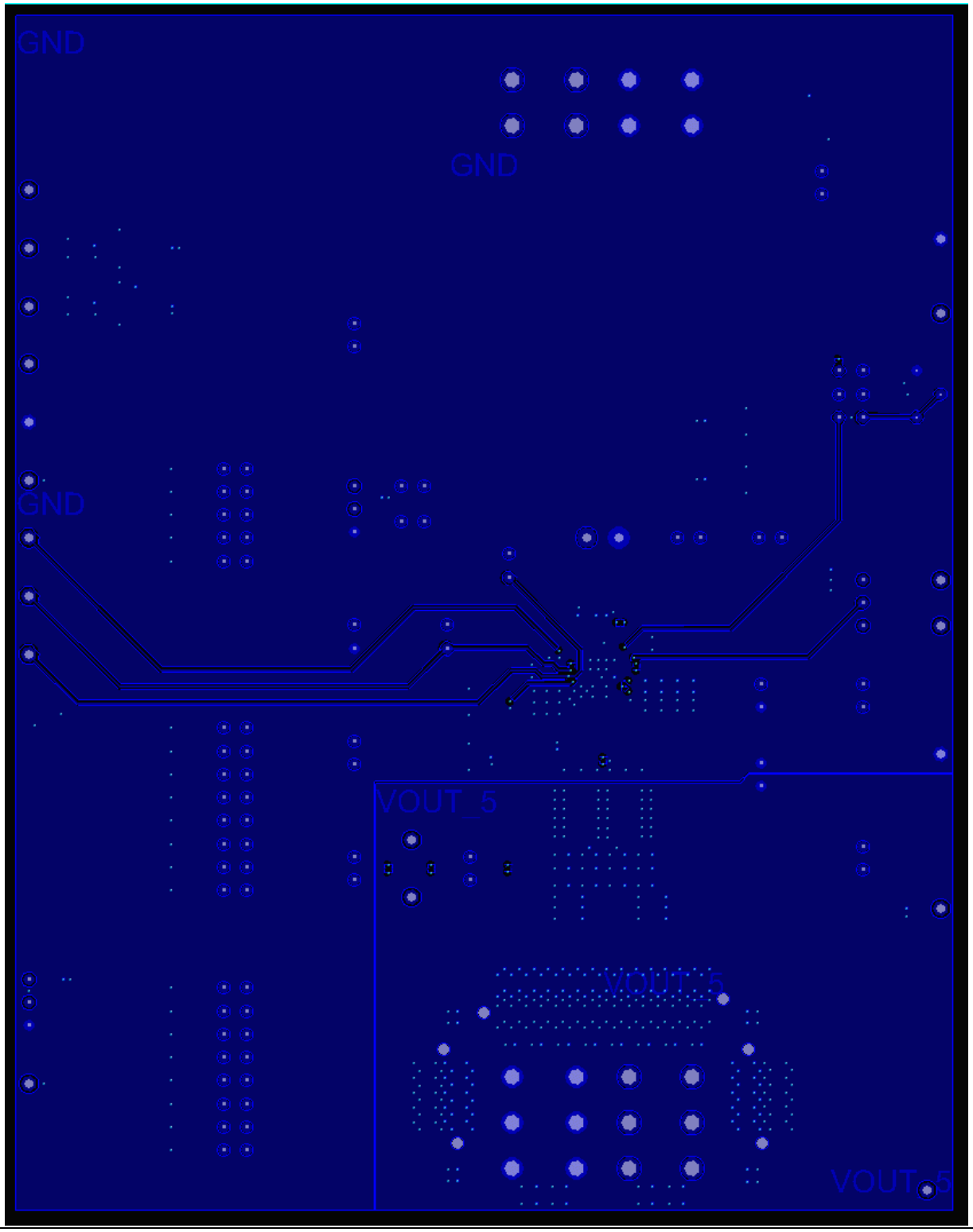

Figure 10 Mid layer 5 (signal 2) for TDA38725

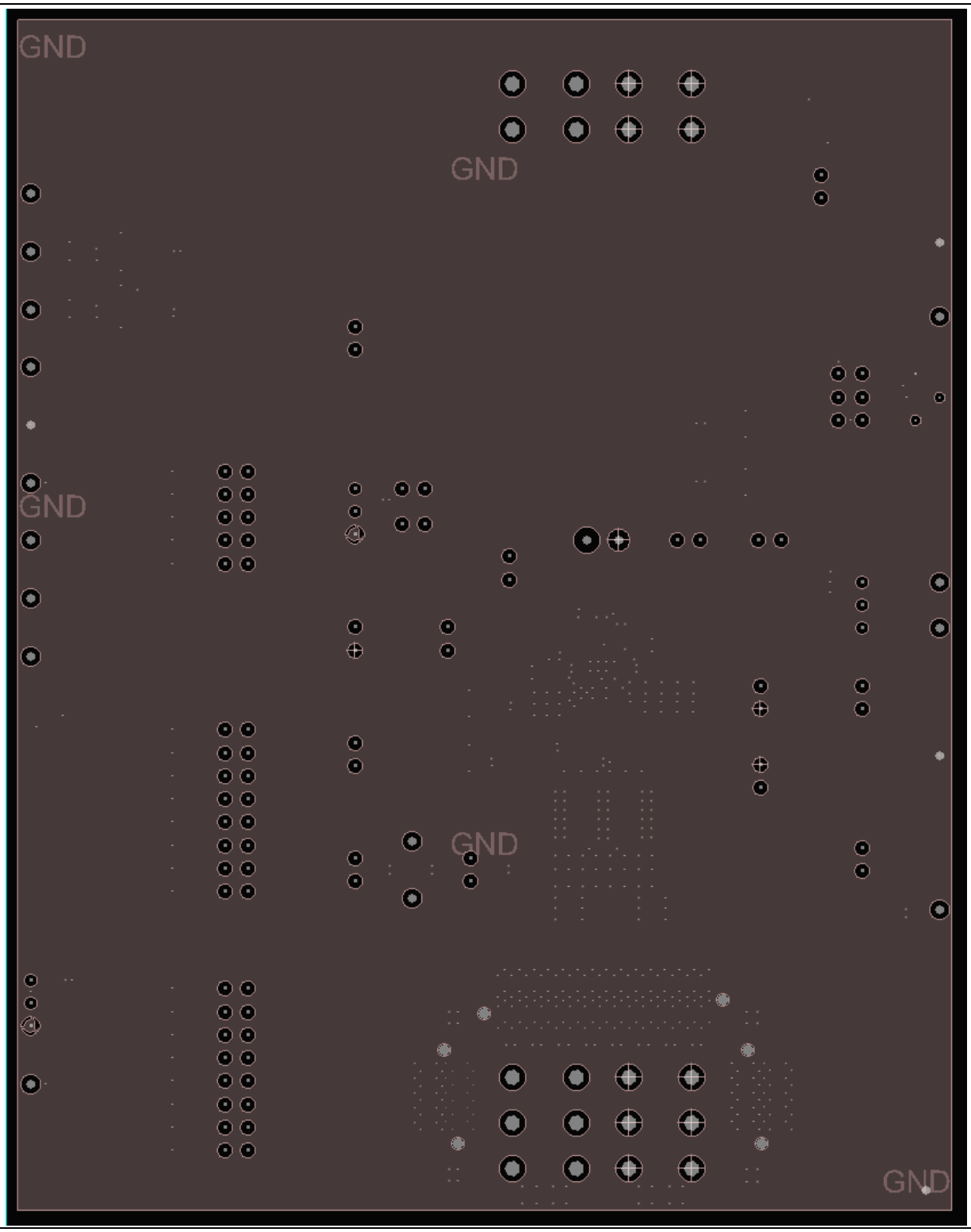

Figure 11 Mid layer 6 (ground 2) for TDA38725

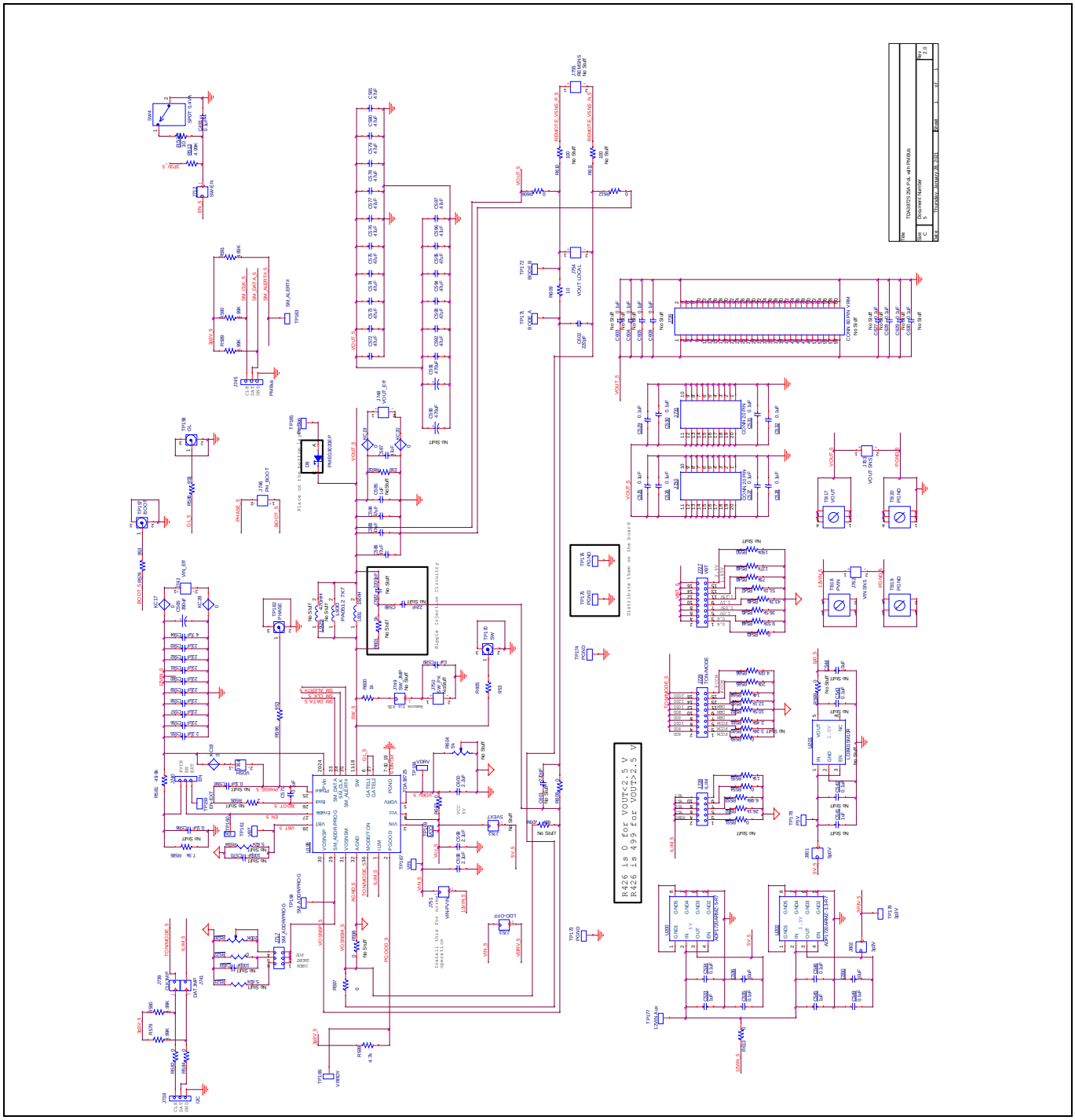

Figure 12 Schematic of the EVAL_TDA38725_1.2VOUT and EVAL_TDA38725_3.3VOUT evaluation board

1.5 Bill of materials

Table 4 Optimized BOM, with components necessary for point-of-load (POL) function

Item	Qty.	Reference	Value	Description	Manufacturer	Part number
1	1	C571	0.1 µF	0.1 µF 0402 25 V X7R 10%	TDK	C1005X7R1E104K
2	1	C493	–	100 pF 0402 50 V C0G 5%	JDI	500R07N101JV4T
3	1	C585	–	1 µF 0603 25 V X5R 10%	Samsung	CL10A105KA8NNNC
4	3	C598, C599, C600	2.2 µF	2.2 µF 0402 16 V X6S 10%	TDK	C1005X6S1C225K050BC
5	1	C555	2.2 µF	2.2 µF 0402 25 V X5R 10%	Murata	GRT155R61E225KE13D
6	8	C556, C557, C558, C559, C560, C561, C562, C563	22 µF	22 µF 0805 25 V X5R 20%	Murata	GRM21BR61E226ME44L
7	1	C564	4.7 µF	4.7 µF 0603 25 V X6S 20%	Murata	GRM188C81E475KE11
8	1	C565	390 µF	Capacitor, 8 mm, 20 V, 20%	Panasonic	20SEPF390M
9	12	C572, C573 C574, C575 C576, C577 C592, C593 C594, C595 C596, C597	47 µF	47 µF 0603 6.3 V X5R 10%	Murata	GRM188R60J476ME15D
10	1	R581	49.9 k	Resistor 0402 1/16 W 1%	Yageo	RC0402FR-07####L
11	2	R603	0	Resistor 0402 1/16 W 1%	Yageo	RC0402FR-07####L
12	1	R585	7.5 k	Resistor 0402 1/16 W 1%	Yageo	RC0402FR-07####L
13	1	R521, R594	–	Resistor 0603 1/10 W 1%	Yageo	RC0603FR-07####L
14	1	R595	2	Resistor 0402 1/16 W 1%	Yageo	RC0402FR-07####L
15	1	R599	4.7 k	Resistor 0402 1/16 W 1%	Yageo	RC0402FR-07####L
16	1	R522	0	Resistor 0603 1/10 W 1%	Yageo	RC0603FR-07####L
17	1	R609	10	Resistor 0402 1/16 W 1%	Yageo	RC0402FR-07####L
18	1	R610, R611	100	Resistor 0402 1/16 W 1%	Yageo	RC0402FR-07####L
19	1	U199	TDA38725	TDA38725 25 A single-voltage synchronous buck regulator	Infineon	TDA38725-0000
20	8	C583, C584, C586, C587 C578, C579 C580, C581	47 µF	47 µF 0805 4 V X6S 20%	Murata	GRT21BC80G476ME13L
21	2	C591	470 µF	SP capacitor Dcase 2.5 V 20%	Panasonic	EEFGX0E471R
22	2	C590	–	SP Capacitor Dcase 2.5 V 20%	Panasonic	EEFGX0E471R
23	1	L931	150 nH	Inductor SMT 10 x 6.4 mm 78 A 0.125 mΩ	Inter-technical	L101247A-150L
24	1	R608	0	Resistor 0402 1/16 W 1%	Yageo	RC0402FR-07####L
25	1	R552	26.1 k	Resistor 0805 1/8 W 1%	Panasonic	ERJ6ENF####V
26	1	R607	–	Resistor 0402 1/16 W 1%	Yageo	RC0402FR-07####L

Table 5 Optimized BOM, with components that differ for different output voltages

V_{OUT}	Item	Qty.	Reference	Value	Description	Manufacturer	Part number
Less than 2.5 V	1	8	C583, C584, C586, C587 C578, C579 C580, C581	47 µF	47 µF 0805 4 V X6S 20%	Murata	GRT21BC80G476ME13L
	2	1	C591	470 µF	SP capacitor Dcase 2.5 V 20%	Panasonic	EEFGX0E471R
	3	1	C590	–	SP capacitor Dcase 2.5 V 20%	Panasonic	EEFGX0E471R
	4	1	L931	150 nH	Inductor SMT 10 x 6.4 mm 30 A 0.125 mΩ	Inter-technical	L101247A-x150L
	5	1	R608	0	Resistor 0402 1/16 W 1%	Yageo	RC0402FR-07####L
	6	1	R552	26.1 k	Resistor 0805 1/8 W 1%	Panasonic	ERJ6ENF####V
	7	1	R607	–	Resistor 0402 1/16 W 1%	Yageo	RC0402FR-07####L
More than 2.5 V	1	8	C583, C584, C586, C587 C578, C579 C580, C581	47 µF	47 µF 0805 6.3 V X5R 20%	TDK	C2012X5R0J476M
	2	1	C591	470 µF	POSCAP Dcase 6.3 V 20%	Panasonic	6TPF470MAH
	3	1	C590	–	POSCAP Dcase 6.3 V 20%	Panasonic	6TPF470MAH
	4	1	L931	470 nH	Inductor SMT 10 x 7.3 mm 30 A 0.81 mΩ	Inter-technical	L101158A-R47LH
	5	1	R608	499	Resistor 0402 1/16 W 1%	Yageo	RC0402FR-07####L
	6	1	R552	26.1 k	Resistor 0805 1/8 W 1%	Panasonic	ERJ6ENF####V
	7	1	R607	499	Resistor 0402 1/16 W 1%	Yageo	RC0402FR-07####L

1.6 XDP™ Designer GUI

Infineon's XDP™ Designer GUI is needed to communicate with the TDA38725 part via I²C. The GUI is part of the Infineon Toolbox. The **Toolbox** can be downloaded from Infineon's website by navigating to the "Tools/Utilities" tab, then scrolling to the "**Infineon Developer Center Launcher**" section. The page has more detailed instructions on how to install the Toolbox. Dongle driver v59.4 or higher is necessary to communicate with the TDA38725.

Once the Toolbox is installed the user must launch it and navigate to the "Manage tools" section. Search this section for "XDP™ Designer" and click to install. Launch XDP™ Designer, and with the evaluation board powered (+12 V V_{IN}) and connected via the USB005 dongle, click the "tuning and debugging" button. This should update the system section with this device and its configuration, or alternatively click the "scan devices" button. The device will show with the part number and I²C address, with green circles (if the connection is correct and there are no faults). Navigate the options on the toolbar to alter any system configurations or read the telemetry. See **Figure 13** for an annotated version of the XDP™ Designer home screen.

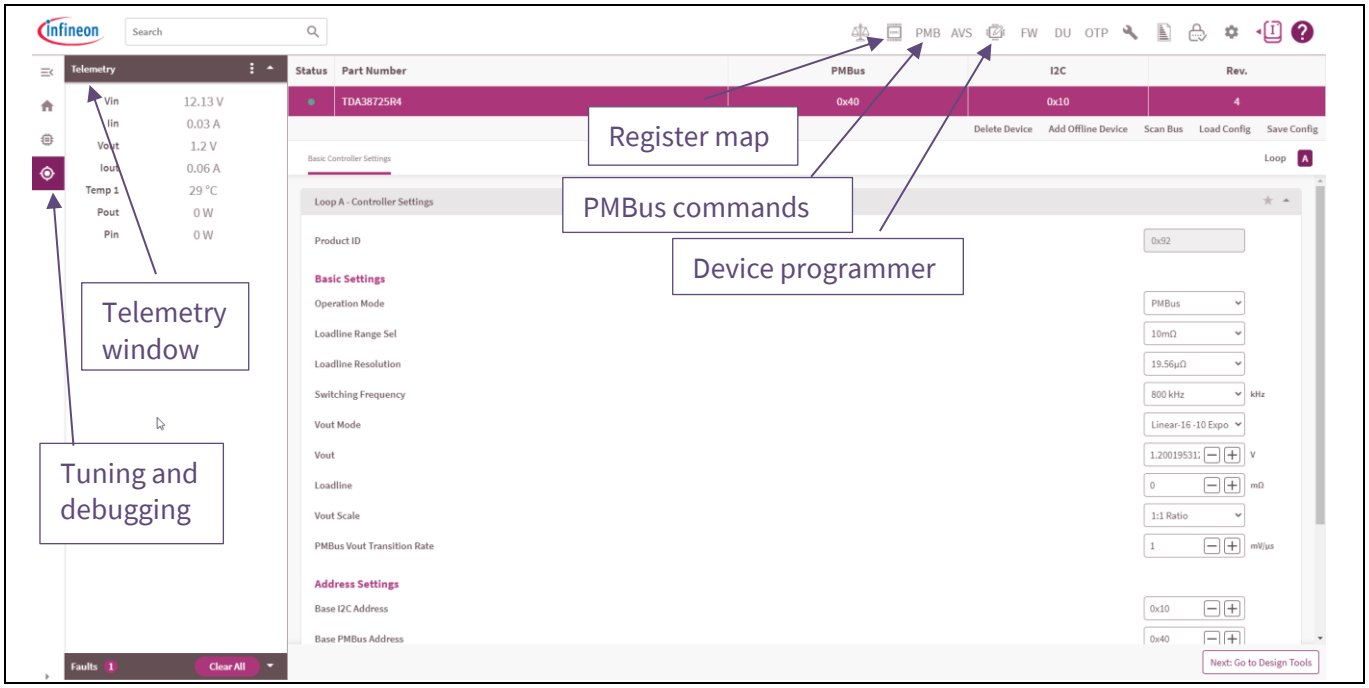

Figure 13 XDP™ Designer GUI

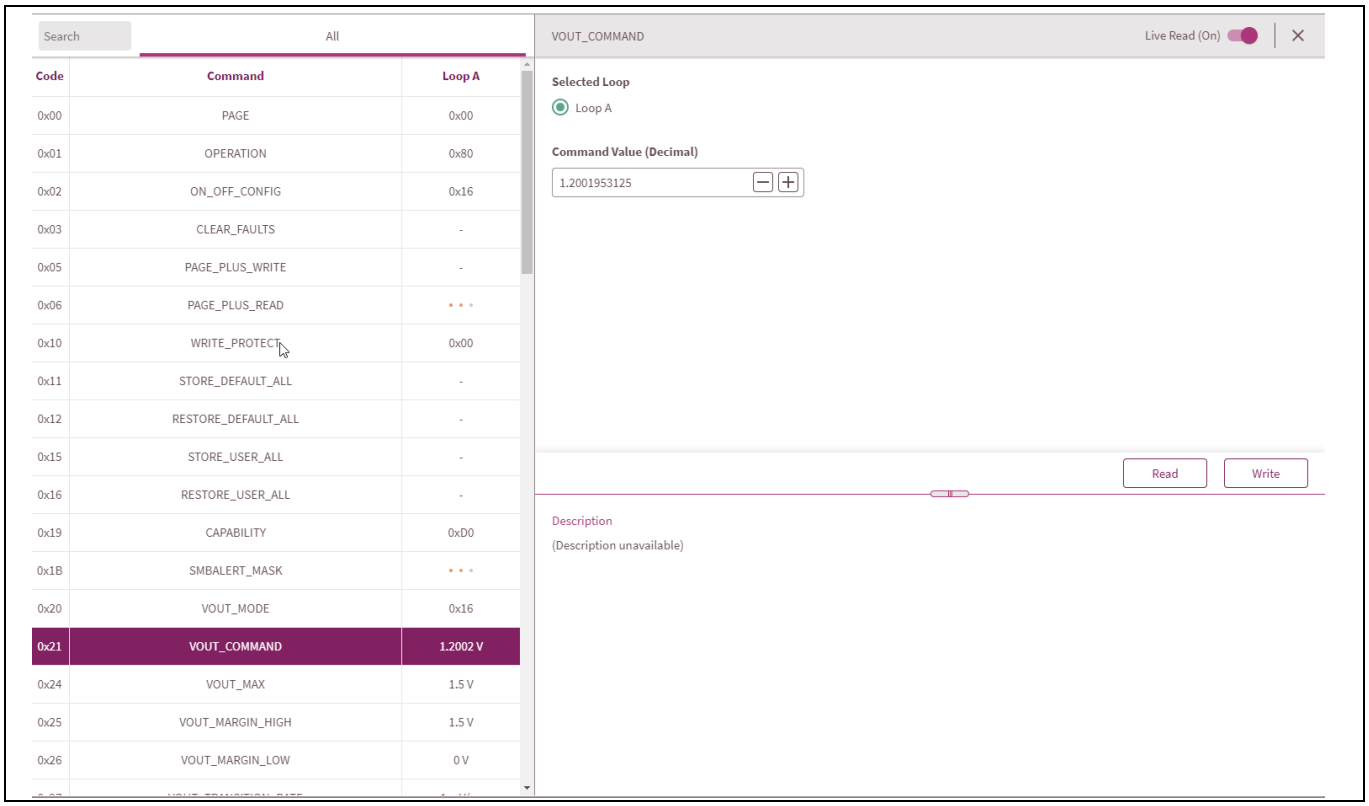

Figure 14 PMBus command window

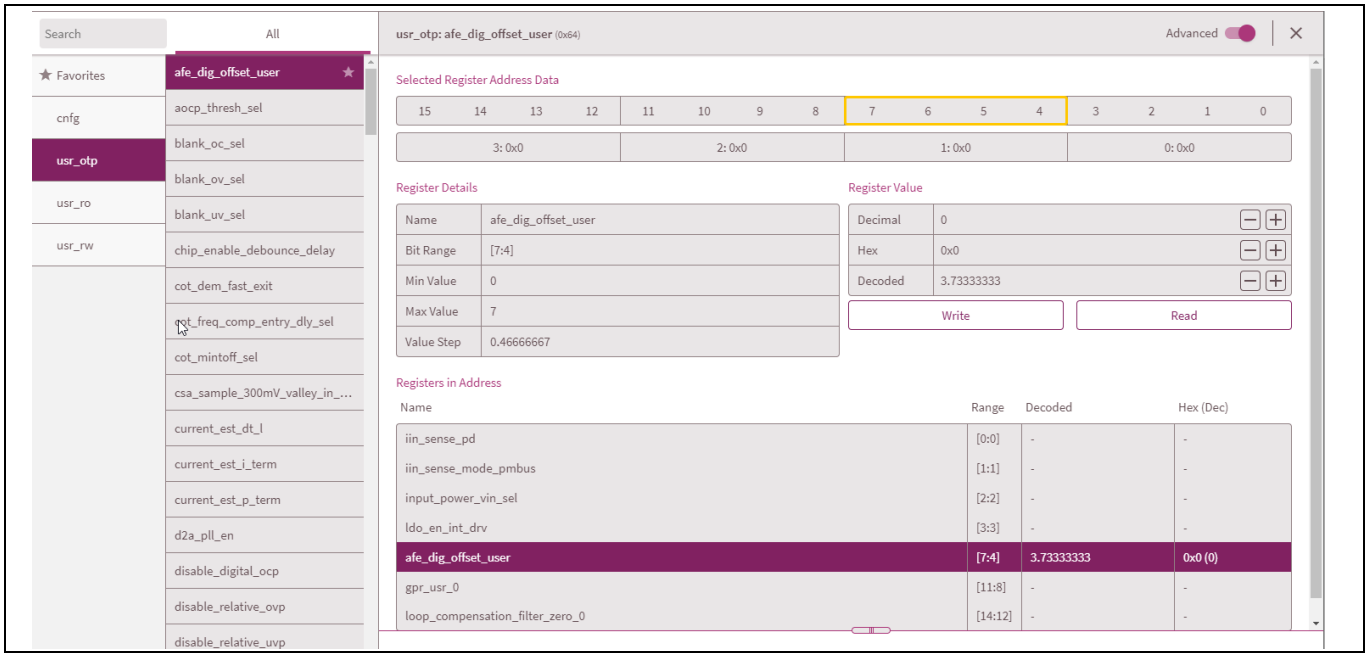

Figure 15 Register map window

2 Typical operating waveforms

2.1 P_{VIN} = 12.0 V, V_{OUT} = 1.2 V, I_{OUT} = 0 to 25 A, room temperature, no airflow

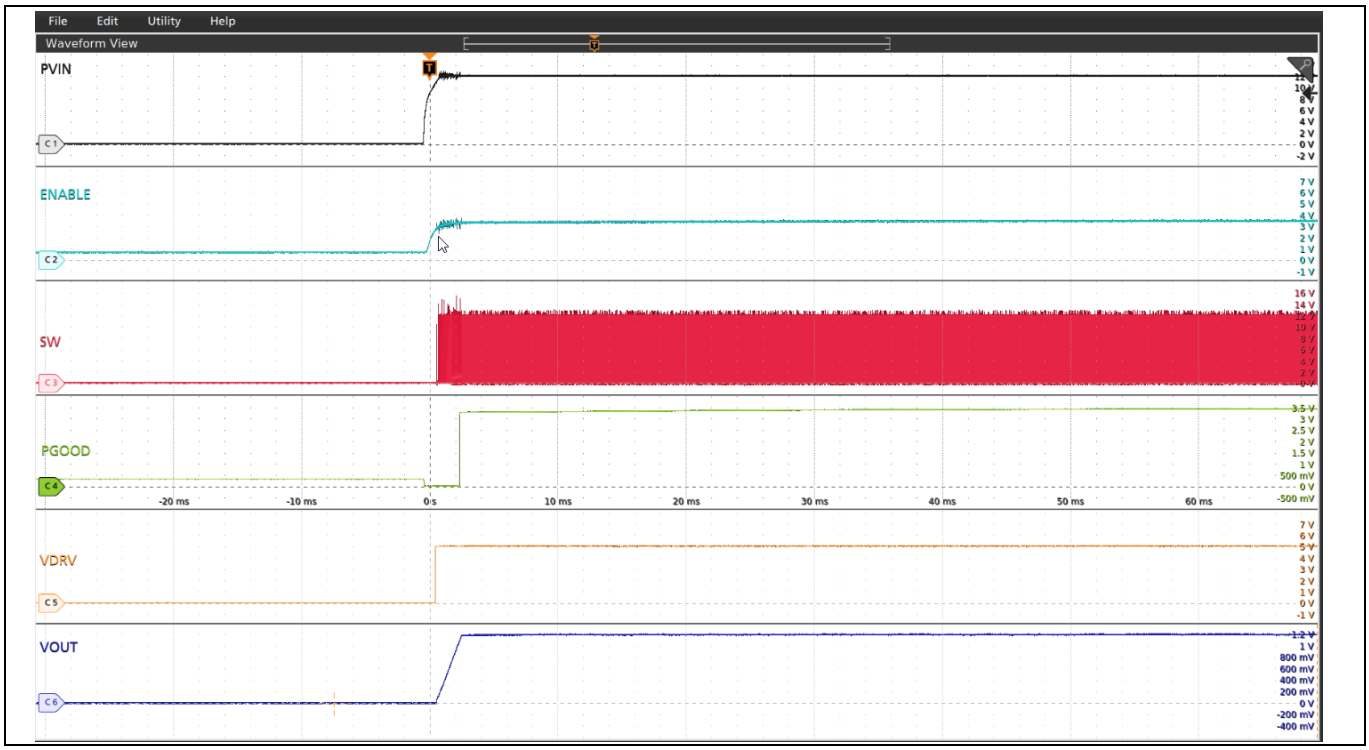

Figure 16 Start-up at 0 A load (Ch_1: P_{VIN}, Ch_2: enable, Ch_3: switch node, Ch_4: P_{GOOD}, Ch_5: V_{DRV}, Ch_6: V_{OUT})

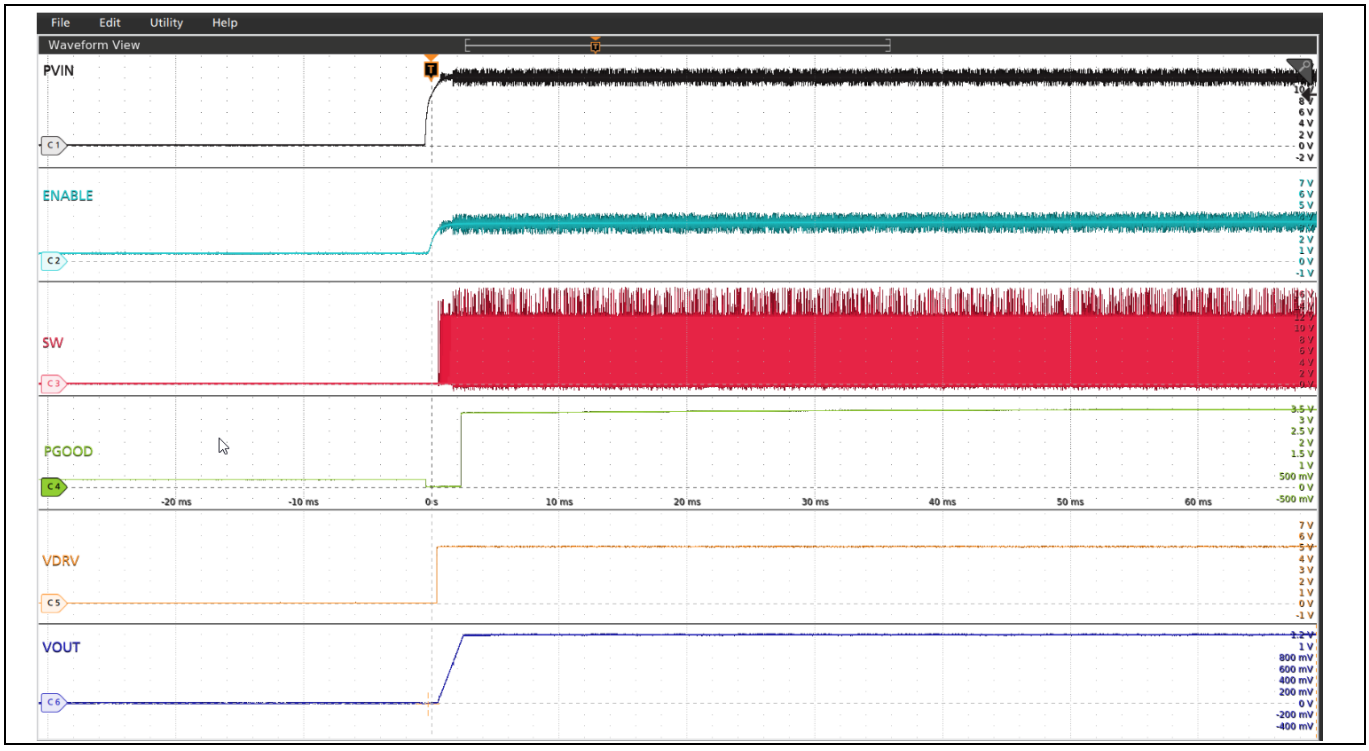

Figure 17 Start-up at 20 A load (Ch_1: P_{VIN}, Ch_2: enable, Ch_3: switch node, Ch_4: P_{GOOD}, Ch_5: V_{DRV}, Ch_6: V_{OUT})

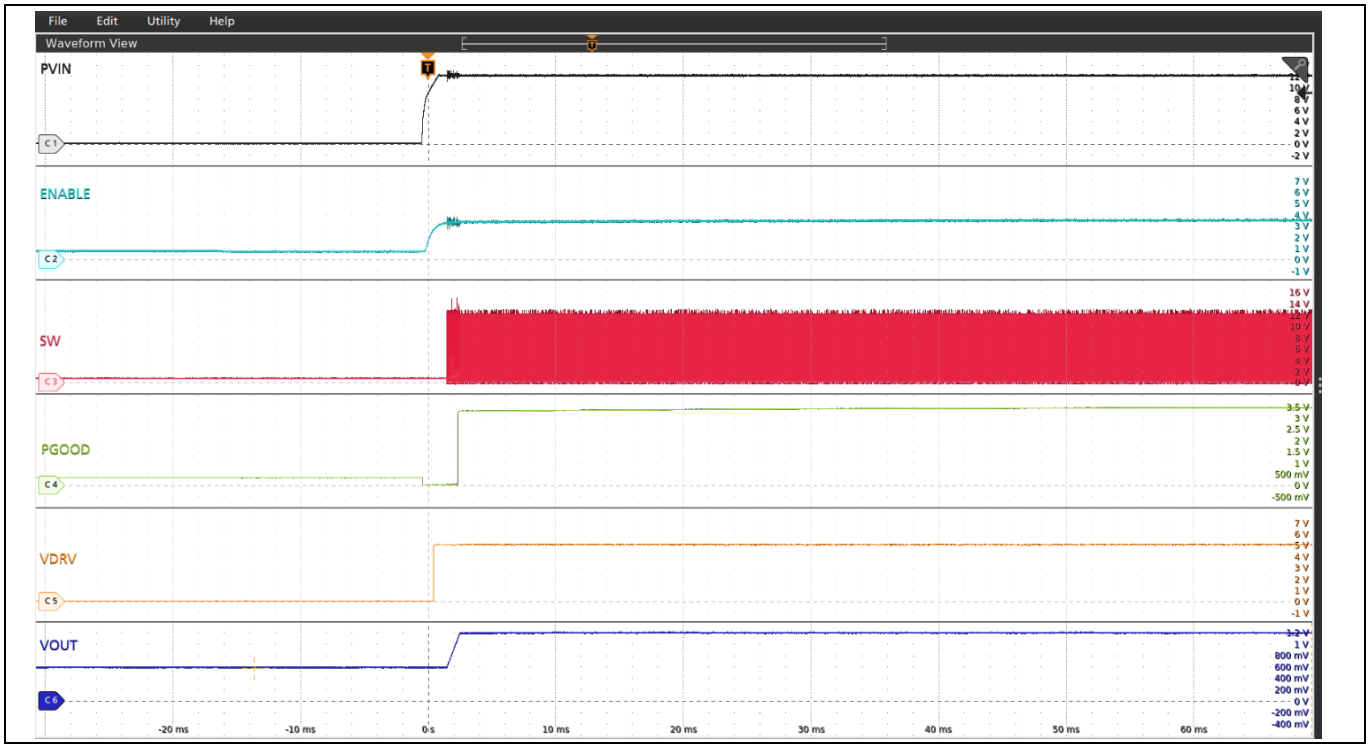

Figure 18 **Pre-bias start-up at 0 A, pre-bias voltage = 0.6 V (Ch_1: P_{VIN}, Ch_2: enable, Ch_3: switch node, Ch_4: P_{GOOD}, Ch_5: V_{DRV}, Ch_6: V_{OUT})**

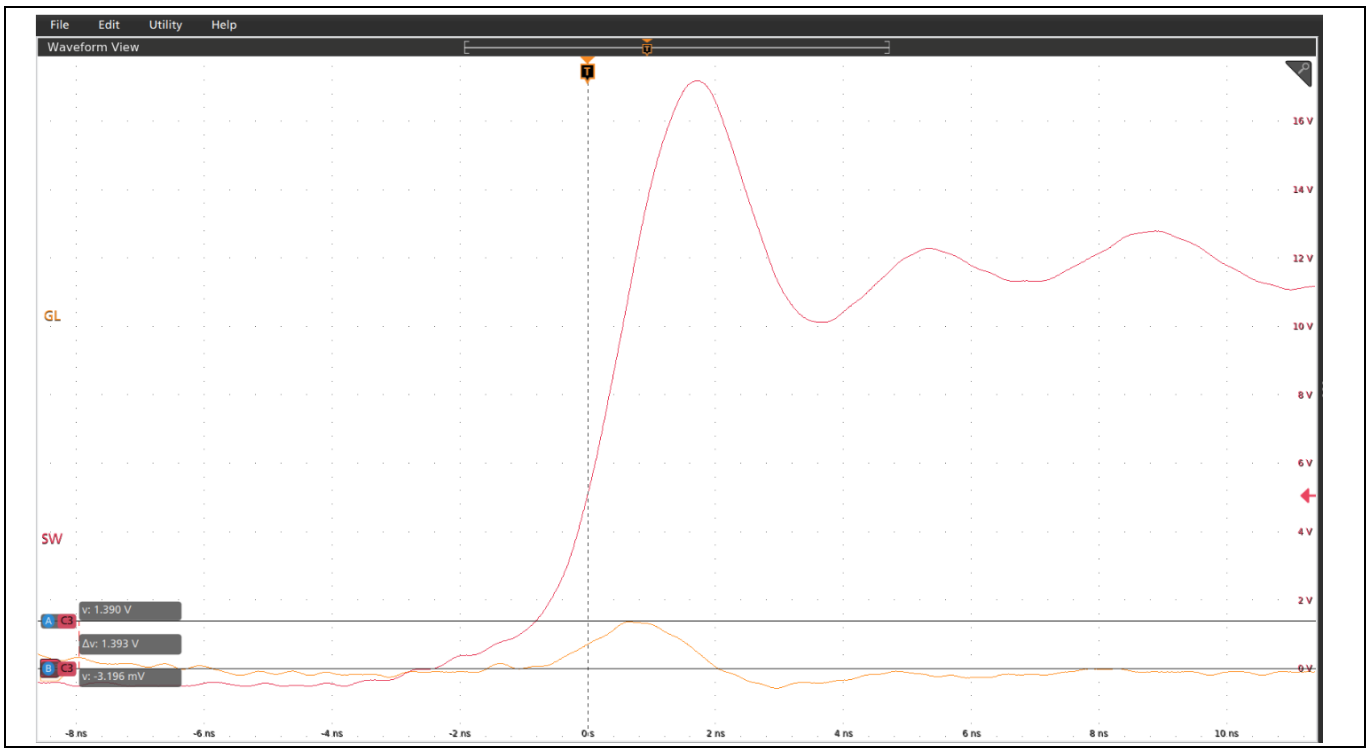

Figure 19 **SW and GL, 25 A load, f_{SW} = 800 kHz**

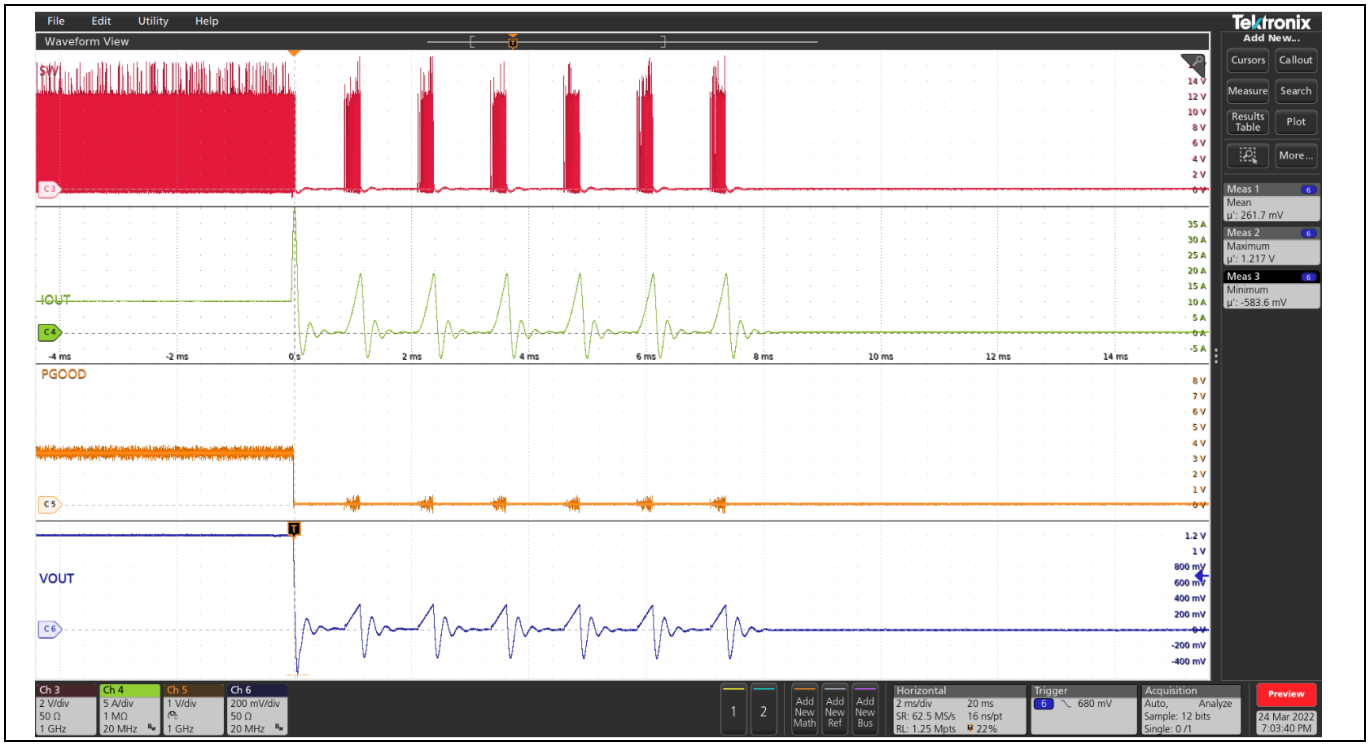

Figure 20 **Short-circuit and retry six times and shut down (Ch_3: SW, Ch_6: V_{OUT}, Ch_5: P_{GOOD}, Ch_4: output current)**

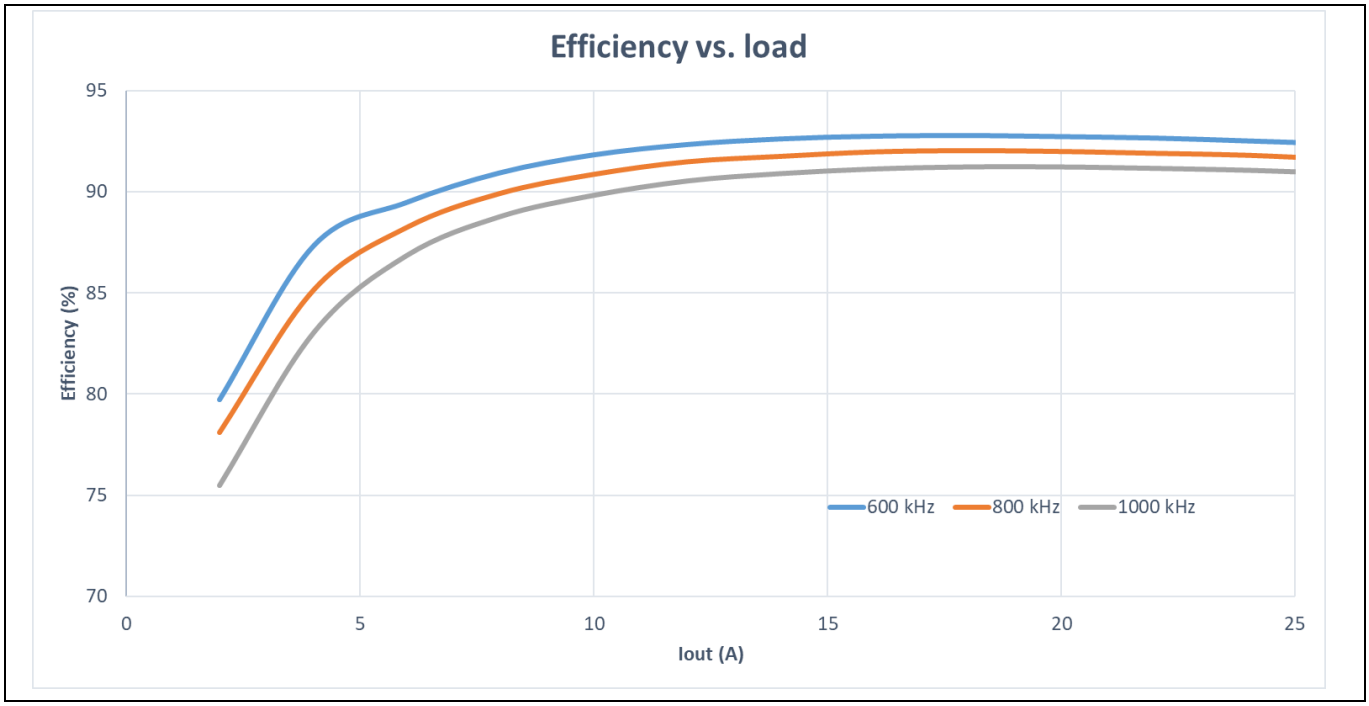

Figure 21 **TDA38725 efficiency vs. load current without airflow in FCCM with external V_{CC} (12 V_{IN}, 1.2 V_{OUT}, no airflow, 150 nH, 600/800 kHz/1000 kHz, T_a = 25°C)**

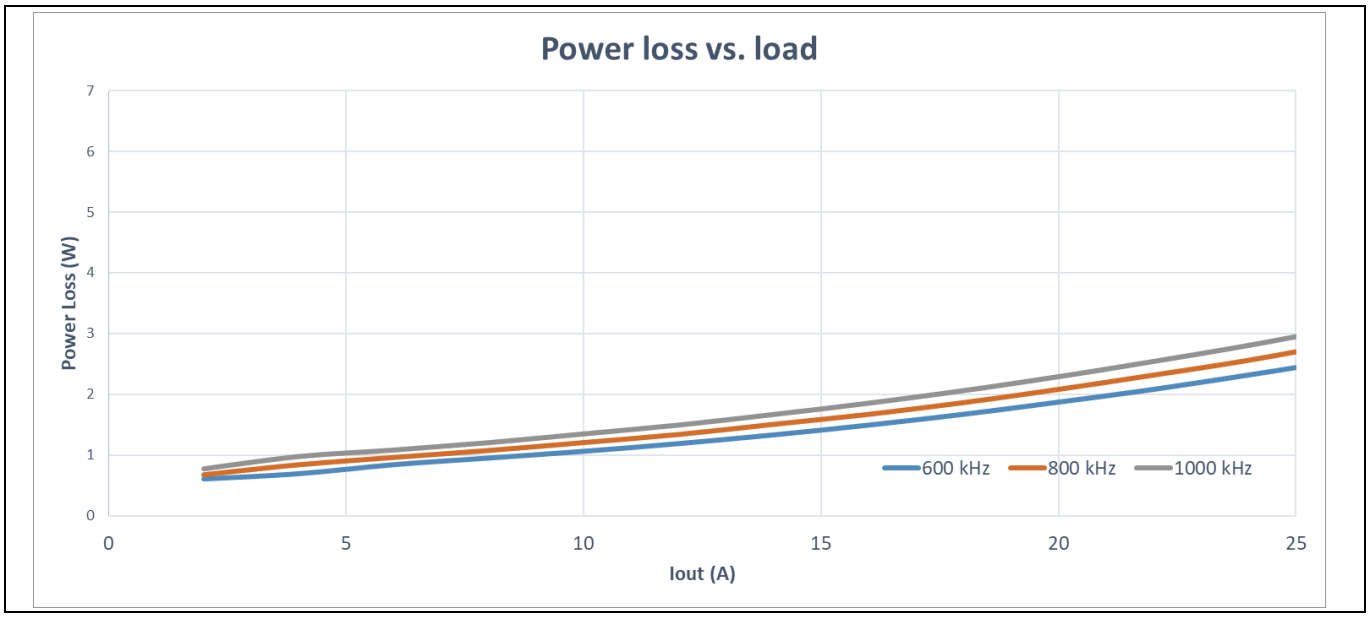

Figure 22 **Power loss vs. load current without airflow in FCCM with external V_{CC} (12 V_{IN}, 1.2 V_{OUT}, no airflow, 150 nH, 800 kHz/1000 kHz, T_a = 25°C)**

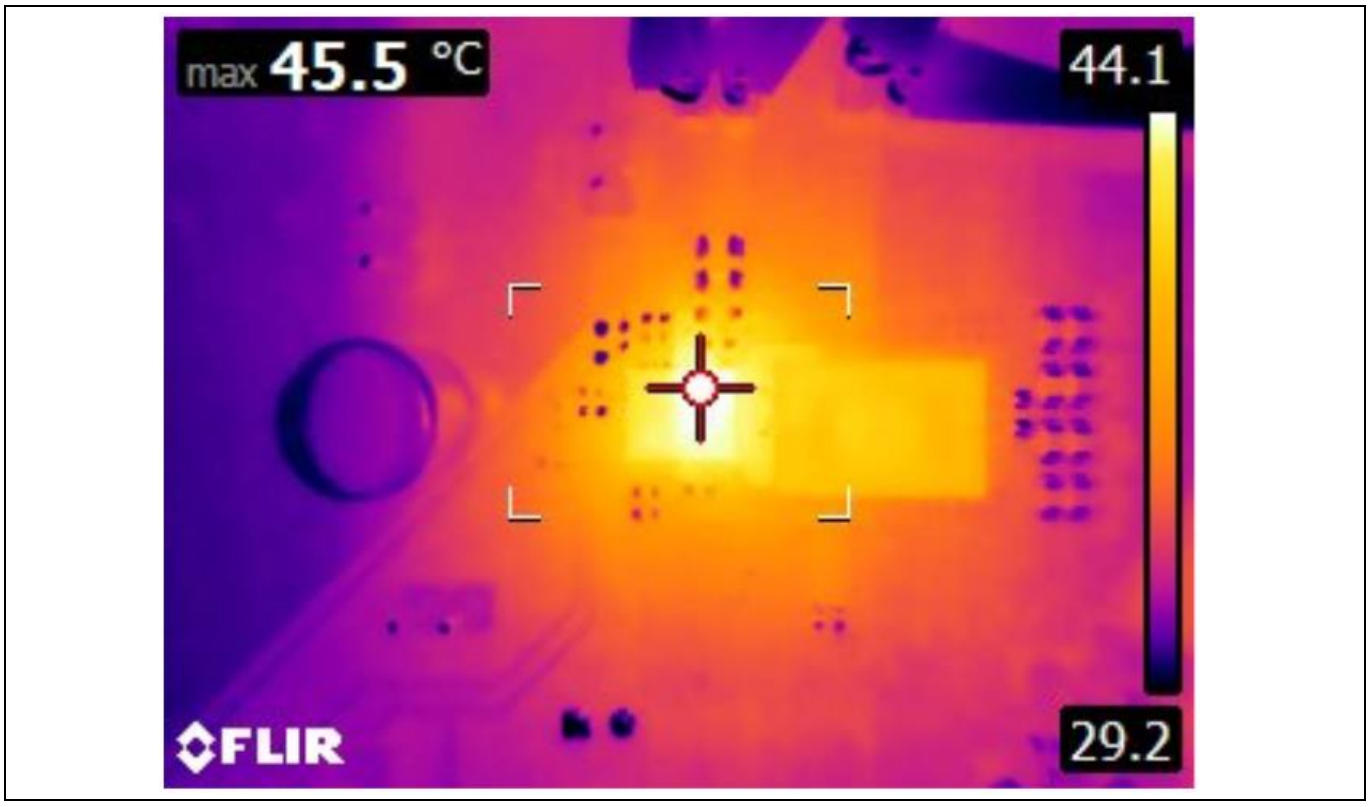

Figure 23 **Thermal image of the board at 25 A load TDA38725 = 45.5°C, L = 40.1°C, T_a = 25°C, natural convection, f_{SW} = 800 kHz**

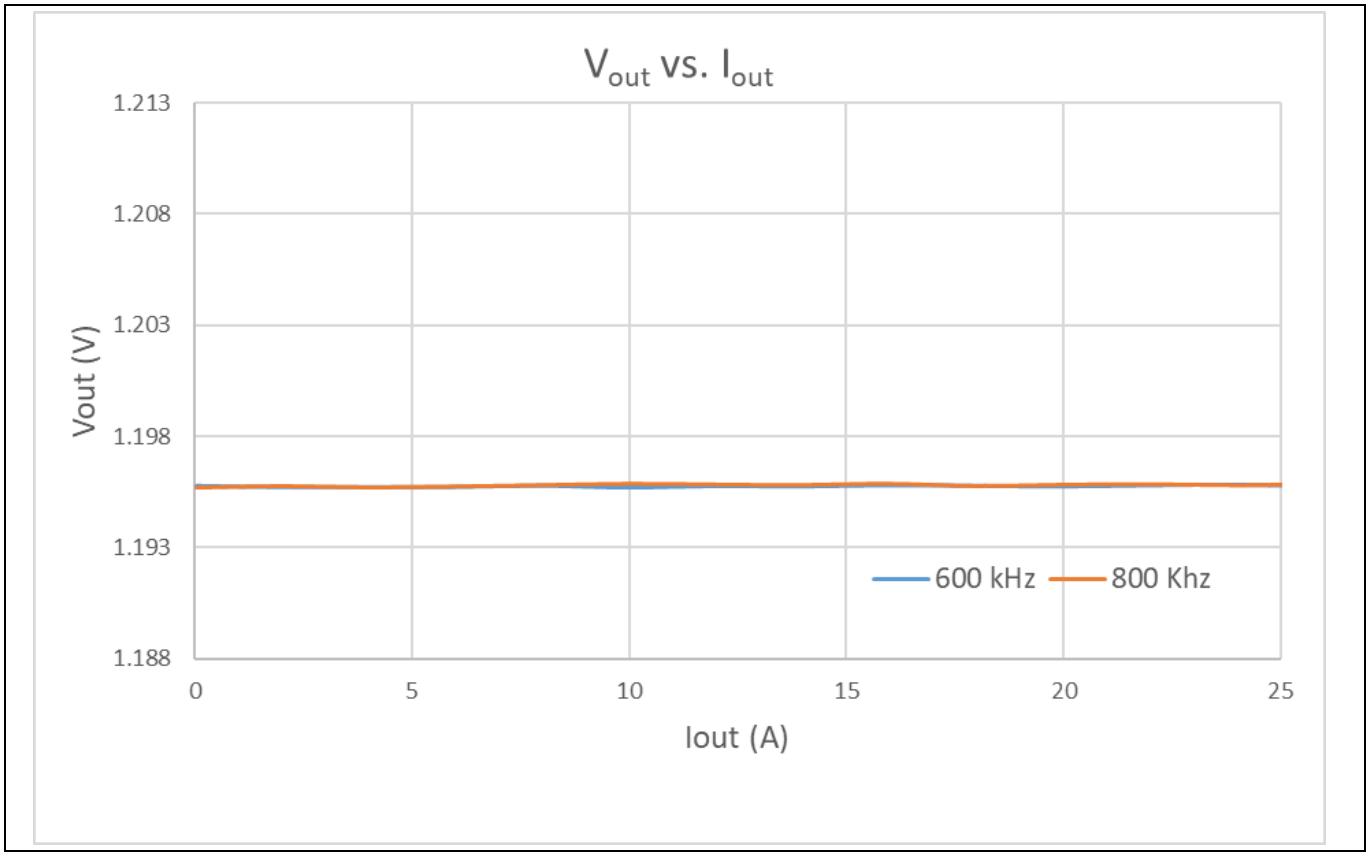

Figure 24 TDA38725 V_{OUT} regulation (12 V_{IN}, 1.2 V_{OUT}, no airflow, 150 nH, 600/800 kHz, T_a = 25°C)

2.2 P_{VIN} = 12.0 V, V_{OUT} = 3.3 V, I_{OUT} = 0 to 25 A, room temperature, no airflow

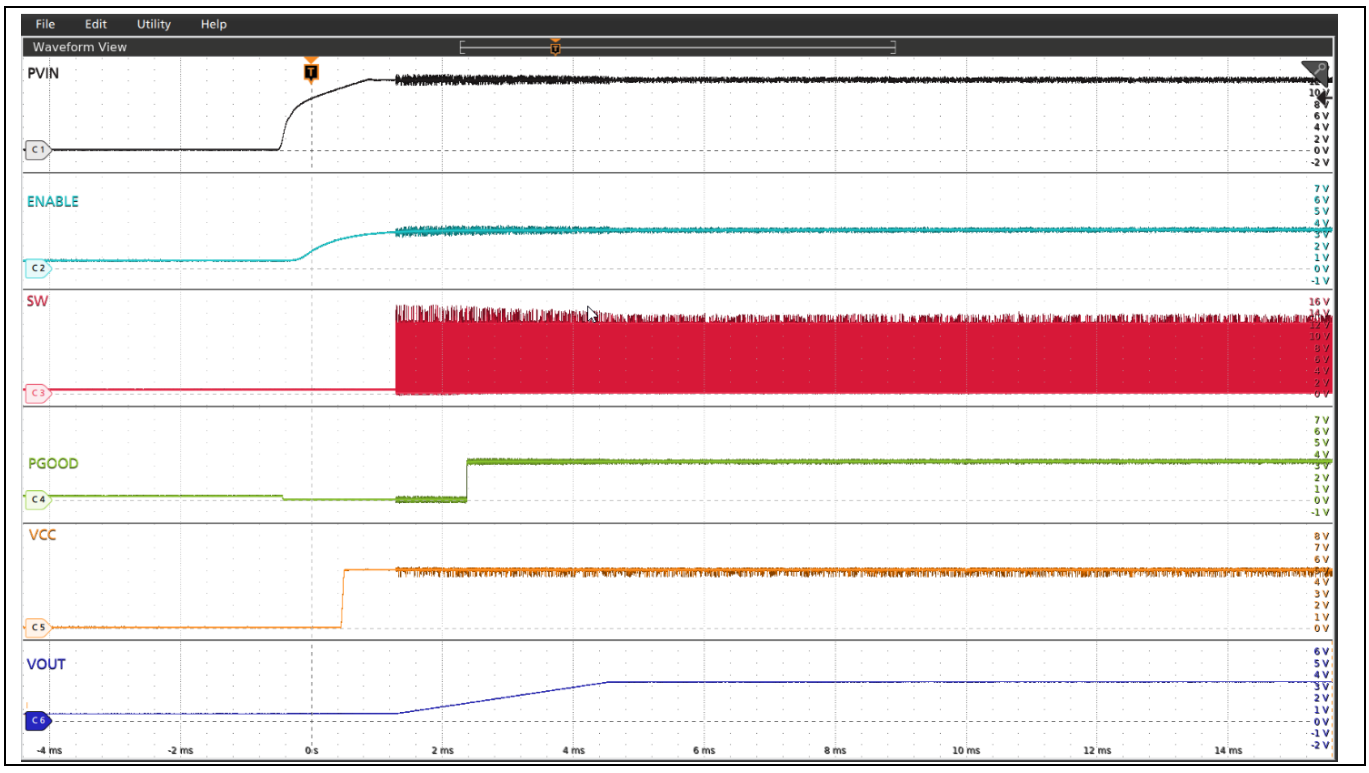

Figure 25 Start-up at 0 A load (Ch_1: P_{VIN}, Ch_2: enable, Ch_3: switch node, Ch_4: P_{GOOD}, Ch_5: V_{DRV}, Ch_6: V_{OUT})

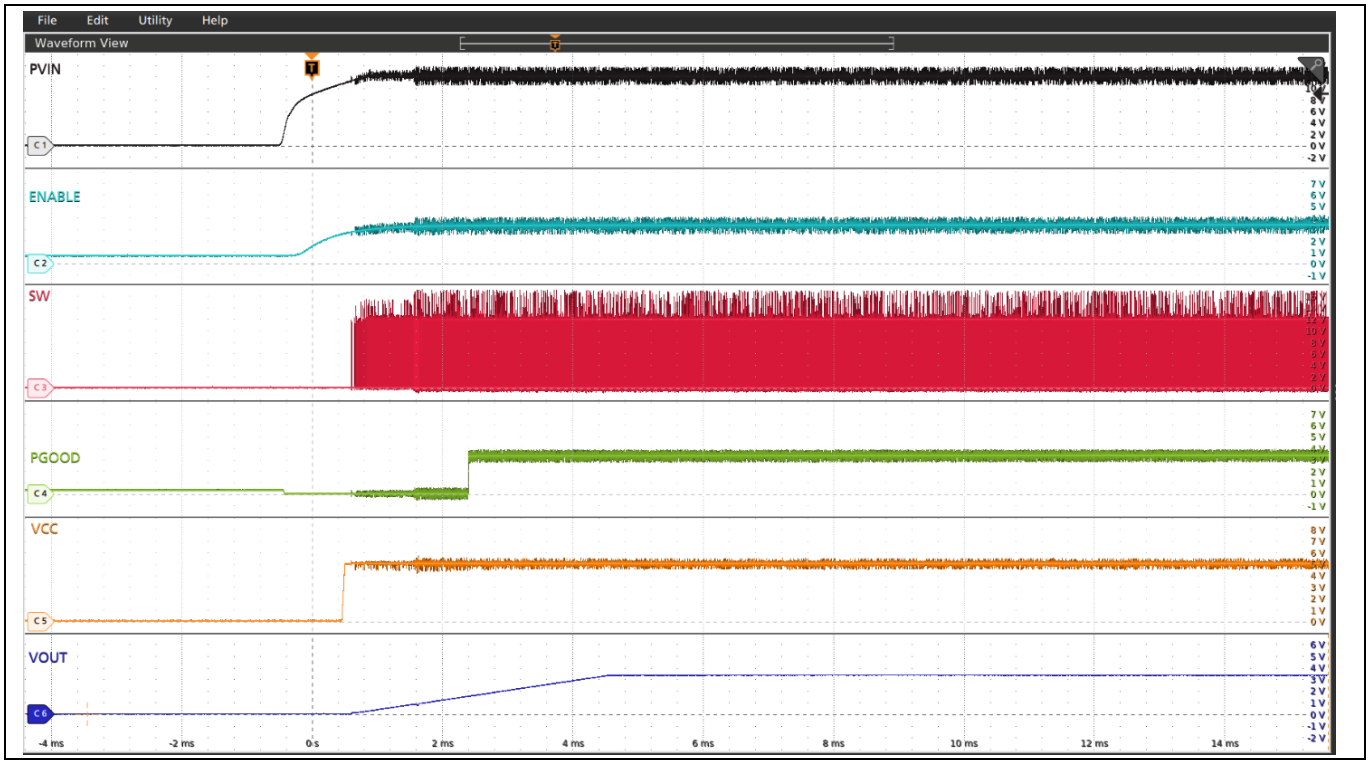

Figure 26 Start-up at 20 A load (Ch_1: P_{VIN}, Ch_2: enable, Ch_3: switch node, Ch_4: P_{GOOD}, Ch_5: V_{DRV}, Ch_6: V_{OUT})

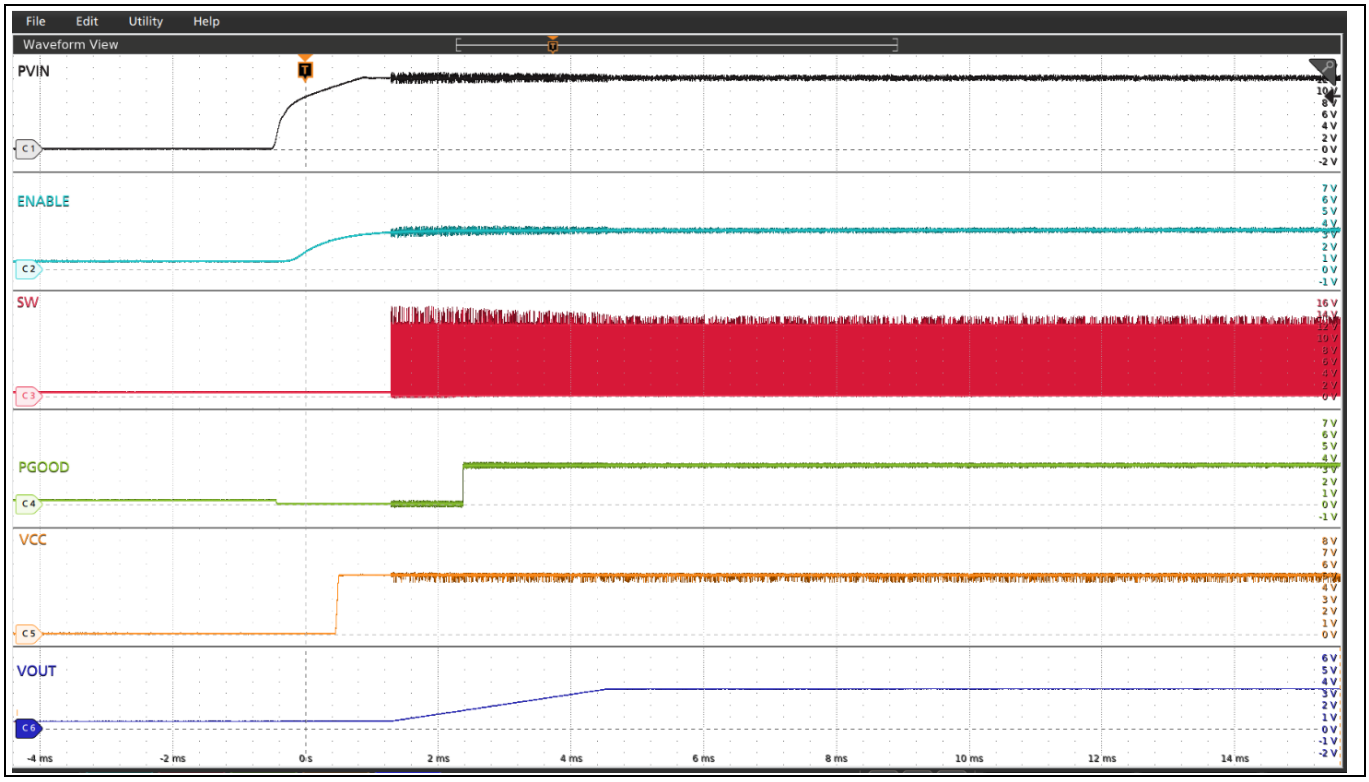

Figure 27 Pre-bias start-up at 0 A (Ch_1: P_{VIN}, Ch_2: enable, Ch_3: switch node, Ch_4: P_{GOOD}, Ch_5: V_{DRV}, Ch_6: V_{OUT})

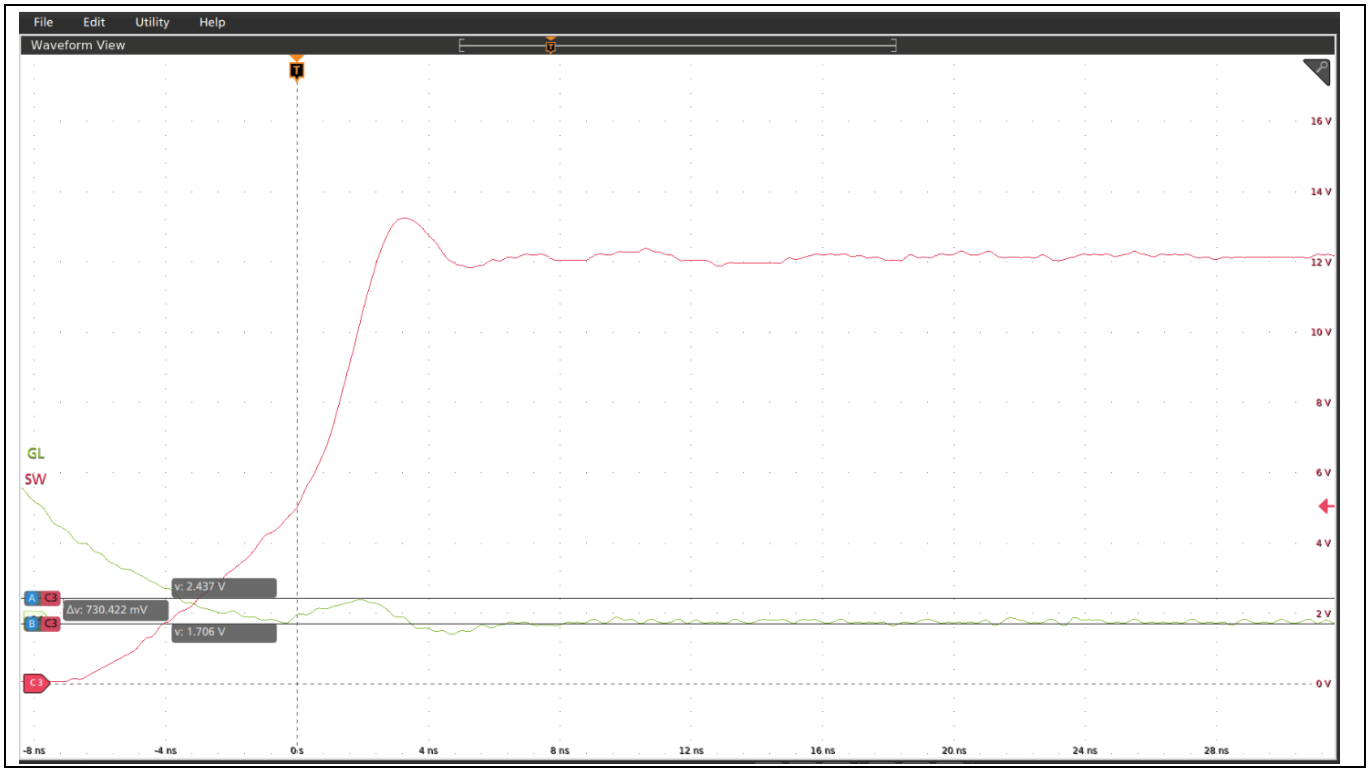

Figure 28 SW and GL, 25 A load, f_{SW} = 800 kHz

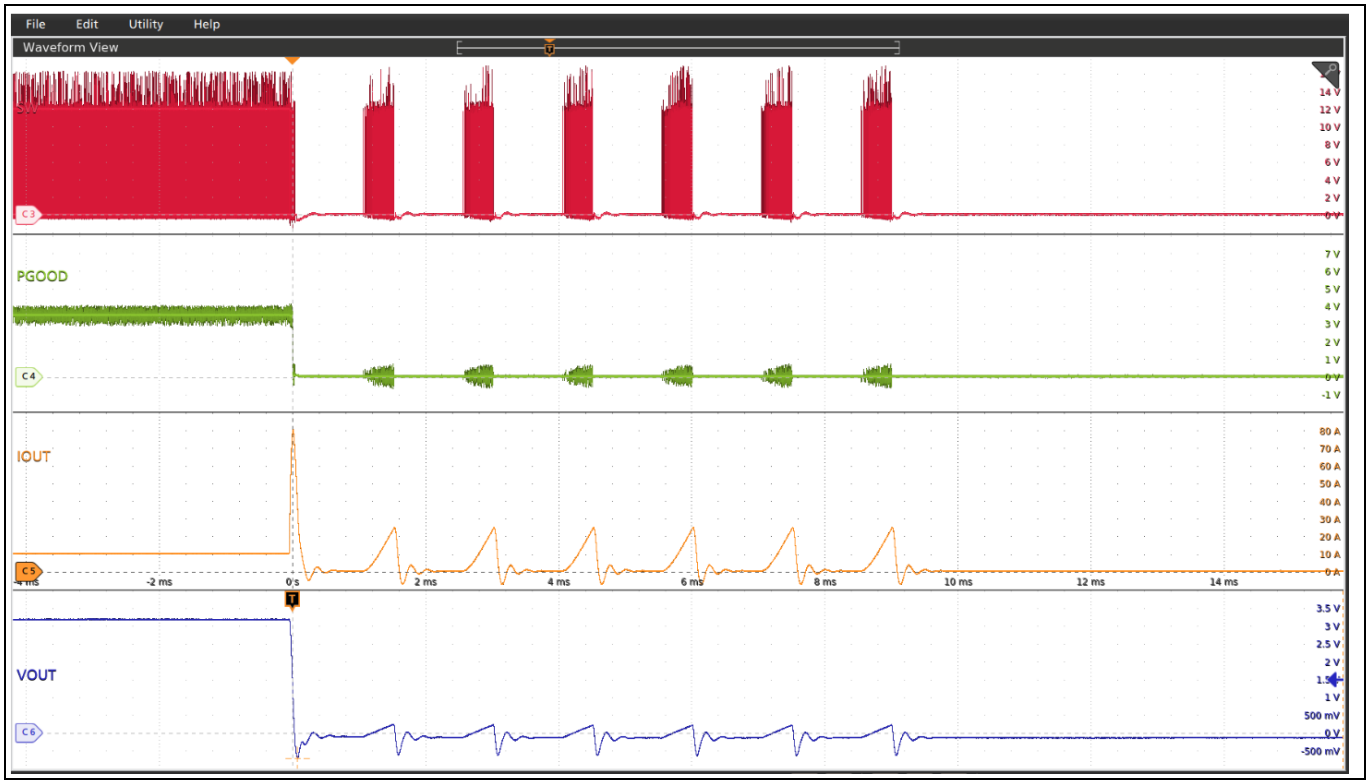

Figure 29 Short-circuit and retry six times and shut down (Ch_1: SW, Ch_2: V_{OUT}, Ch_3: P_{GOOD}, Ch_4: inductor current)

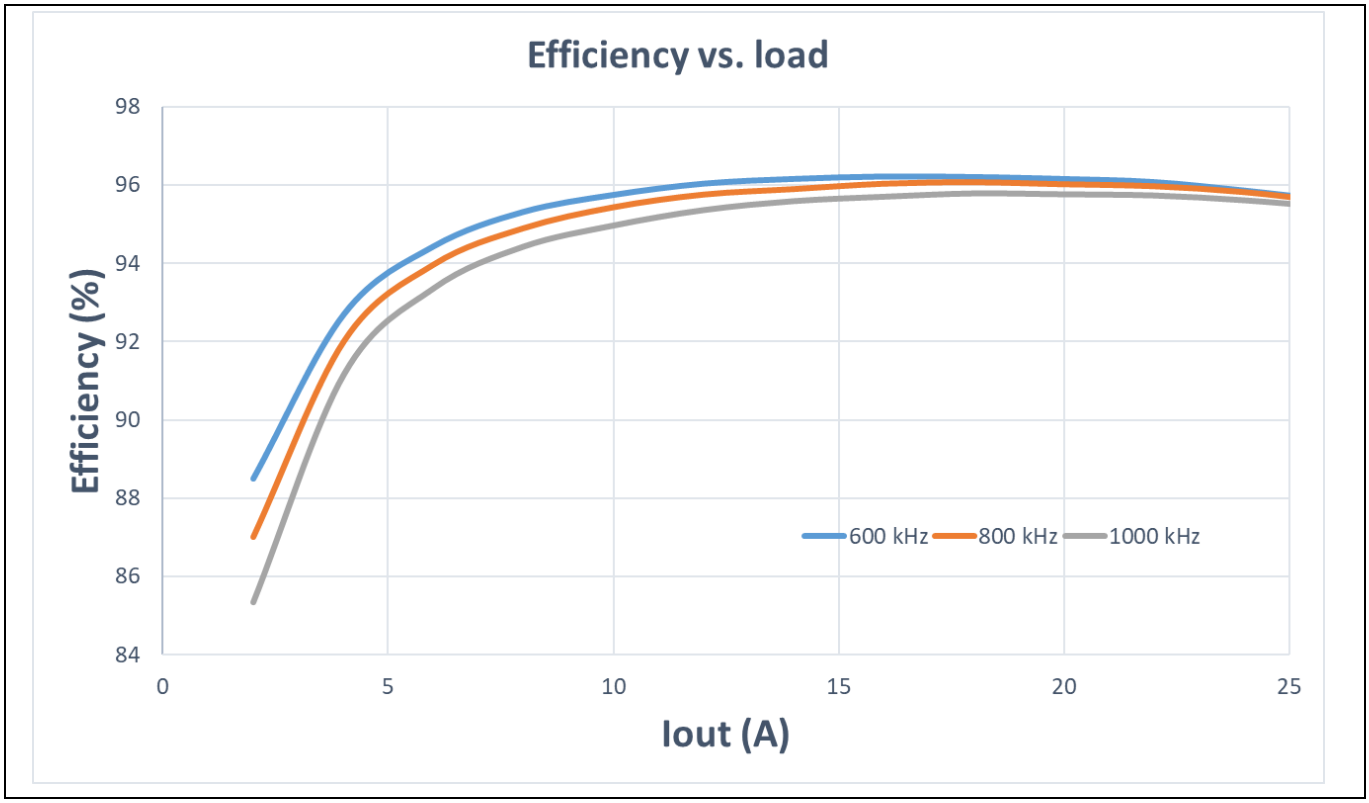

Figure 30 **Efficiency vs. load current without airflow in FCCM with external V_{CC} (12 V_{IN}, 3.3 V_{OUT}, no airflow, 470 nH, 800 kHz/1000 kHz, T_a = 25°C)**

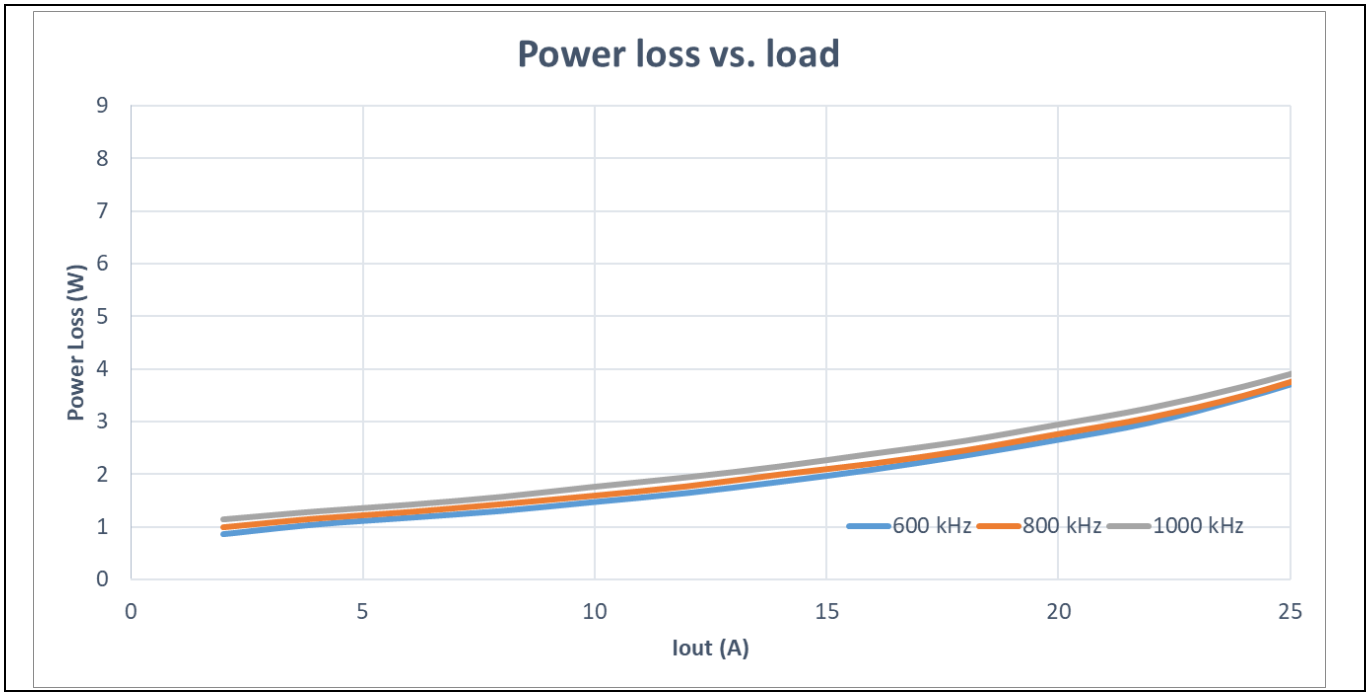

Figure 31 **Power loss vs. load current without airflow in FCCM with external V_{CC} (12 V_{IN}, 3.3 V_{OUT}, no airflow, 470 nH, 800 kHz/1000 kHz, T_a = 25°C)**

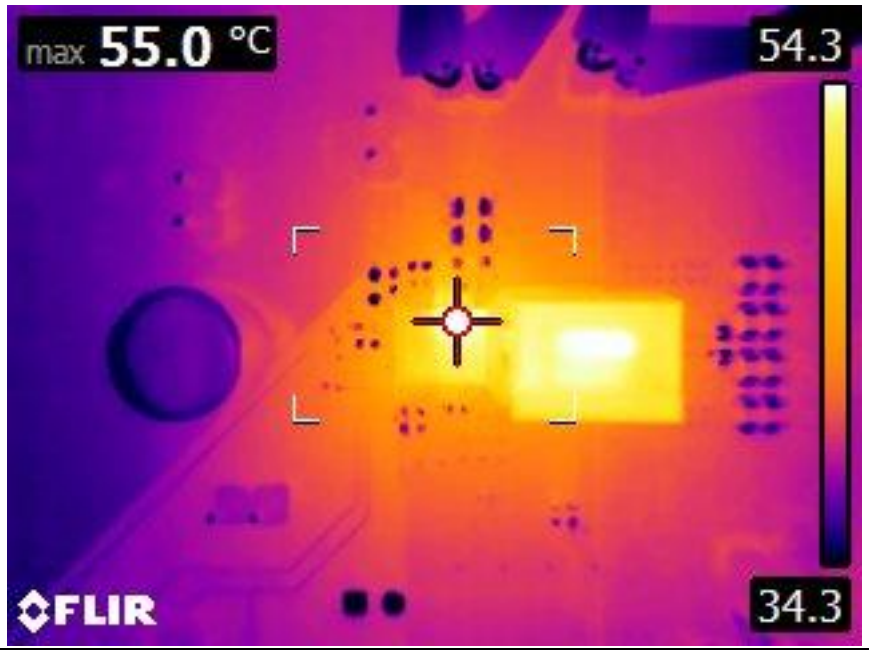

Figure 32 **Thermal image of the board at 25 A load TDA38725 = 55.0°C, L= 53.9°C, T_a = 25°C, natural convection, f_{sw} = 800 kHz**

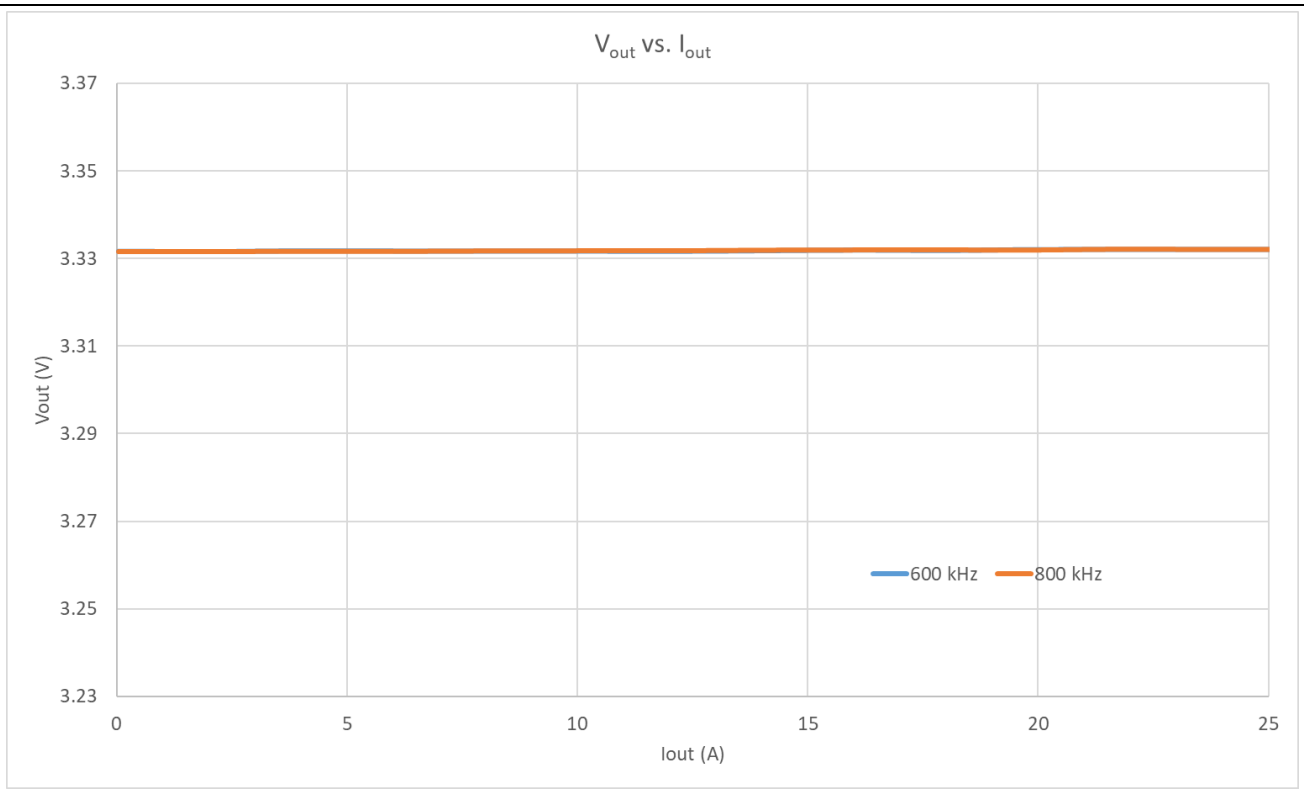

Figure 33 **TDA38725 V_{OUT} regulation (12 V_{IN}, 3.3 V_{OUT}, no airflow, 150 nH, 600/800 kHz, T_a = 25°C)**

Revision history

Document version	Date of release	Description of changes
V 1.0	2022-05-27	Initial release

Trademarks
All referenced product or service names and trademarks are the property of their respective owners.

Edition 2022-05-27

Published by

Infineon Technologies AG

81726 Munich, Germany

Do you have a question about this document?

Email: erratum@infineon.com

Document reference
UM_2204_PL12_2204_213232

IMPORTANT NOTICE

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics ("Beschaffenheitsgarantie").

With respect to any examples, hints or any typical values stated herein and/or any information regarding the application of the product, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

In addition, any information given in this document is subject to customer's compliance with its obligations stated in this document and any applicable legal requirements, norms and standards concerning customer's products and any use of the product of Infineon Technologies in customer's applications.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer's technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

For further information on the product, technology, delivery terms and conditions and prices please contact your nearest Infineon Technologies office (**www.infineon.com**).

WARNINGS

Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies' products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.