12 V/8 A, active clamp forward converter, Power Over Ethernet (PoE) IEEE 802.3bt compliant reference design

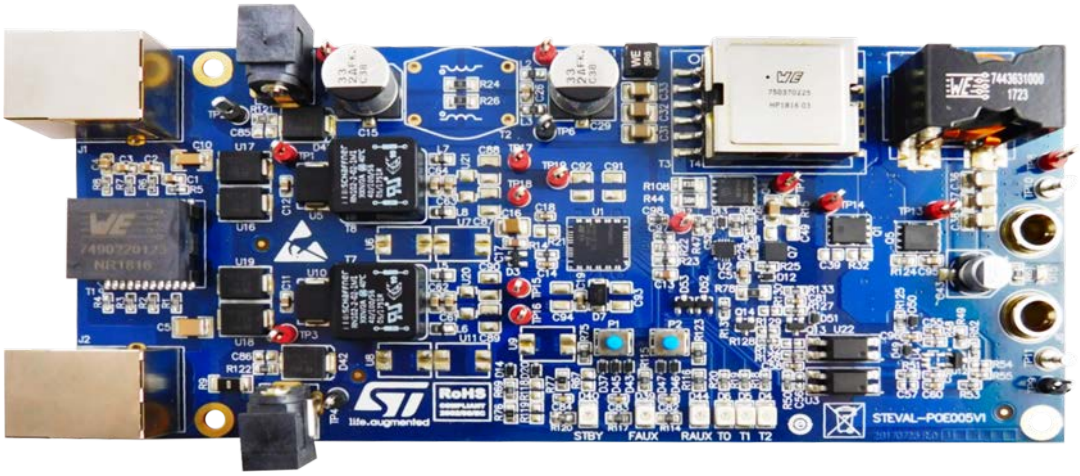
Introduction

This reference design represents a 3.3 V, 20 converter solution ideal for various applications including wireless access points, supplied with a PoE-PD interface and a DC-DC active clamp forward converter.

The PoE-PD interface is based on the PM8805 system in package device with two active bridges and an IEEE 802.3bt compliant Powered Device (PD) interface. It can be used in all medium-to-high power 2P and 4P high efficiency PoE and PoE+ applications.

The DC-DC active clamp forward converter is designed around the PM8804 PWM controller, which is an integrated solution for smart and efficient 48 V converters, featuring a programmable oscillator for the switching frequency, adjustable slope compensation, dual complementary low-side drivers with programmable dead time, programmable soft start, soft turn off and a programmable current sense blanking time.

Figure 1. STEVAL-POE005V1 reference design



1 STEVAL-POE005V1 reference design overview

1.1 Specifications, connectors and LEDs

Table 1. STEVAL-POE005V1 specifications

Parameter	Specs
V_{IN} at RJ45 connector	From 41.2 to 57 V
I_{IN} at RJ45 connector	1.0 A max. each pair
V_{OUT}	12 V ± 2%
I_{OUT}	8 A total max.(1)
Max. ouput power	100 W(2)
Efficiency overall peak	>92% at 5.5 A >90% at 8 A
V_{IN} at Frontal Jack connector (J9)	48 V ±2 V
I_{IN} at Frontal Jack connector (J9)	2.0 A total max.
V_{IN} at Rear Jack connector (J10)	48 V ±2 V
I_{IN} at Rear Jack connector (J10)	2.5 A total max.
Operating temperature	0°C - 50°C 8 A full load 50°C - 85°C linearly decrease to 5.5 A

1. *There are two limits to play with: the power limits specified in the BT standard→ Class 8 means 71 W min. available at PD interface with the specified efficiency of about 5.5 A at the output; the PM8805 current limit → 2 amp min., about 2.5 A typical, that is, to reach 8 amps on the output the PoE input voltage must be of at least 56 V or an auxiliary rear input source must be capable of about 110 W. In fact, the max. power can be reached using the rear input, to bypass the PM8805 current limit circuit.*
2. *The max. power cannot be maintained at a high ambient temperature (T_{amb} > 50°C) for a long time.*

Table 2. STEVAL-POE005V1 connectors

Reference	Type	Specs
J1	RJ45 connector	Data and power input
J2	RJ45 connector	Data output
J9	Power jack	Front Aux
J10	Power jack	Rear Aux
J4, TP10	Banana jack/turret	Positive of V_{OUT}
J6, TP11	Banana jack/turret	Negative of V_{OUT} (Sec GND)
TP8	Test point	Monitor of V_{OUT}
TP9	Test point	Monitor of Sec GND
P1	Push button	SLEEP/WKUP
P2	Push button	SHDN

Table 3. STEVAL-POE005V1 LEDs

Reference	Type	Function	Logic
D4	Green LED	Monitor of T2 signal	LED on when T2 is low
D5	Green LED	Monitor of T1 signal	LED on when T1 is low
D6	Green LED	Monitor of T0 signal	LED on when T0 is low
D15	Green LED	Monitor of V_{OUT}	LED on when V_{OUT} is present
D39	Green LED	Monitor of FAUX signal	LED on when frontal aux is present
D40	Green LED	Monitor of STBY signal	LED on when STBY is high
D44	Green LED	Monitor of RAUX signal	LED on when rear aux is present

Table 4. Tx signal possible configurations

Classification	T0	T1	T2	Bridges	Finger number	Notes
Type 1 (13 W)	1	1	1	1	0 or 1	Legacy type
Type 2 (25.5 W)	0	1	1	1	2, 3	Legacy type
Type 3 (51 W)	1	0	0	2	4	New PD type
Type 4 (71 W)	0	0	0	2	≥ 5	New PD type
Type 3 on 4 pairs (13 W), or legacy 4 pairs (type 1 class)	1	1	0	2	0 or 1	New PD type
Type 3 on 4 pairs (25.5 W), or legacy 4 pairs (type 2 class)	0	1	0	2	2, 3	New PD type
Rear AUX	0	0	1	any	N.A.	Aux present
Front AUX				0		

The STEVAL-POE005V1 reference design is classified as type 4 and class 8. The default status of Tx signal is 000.

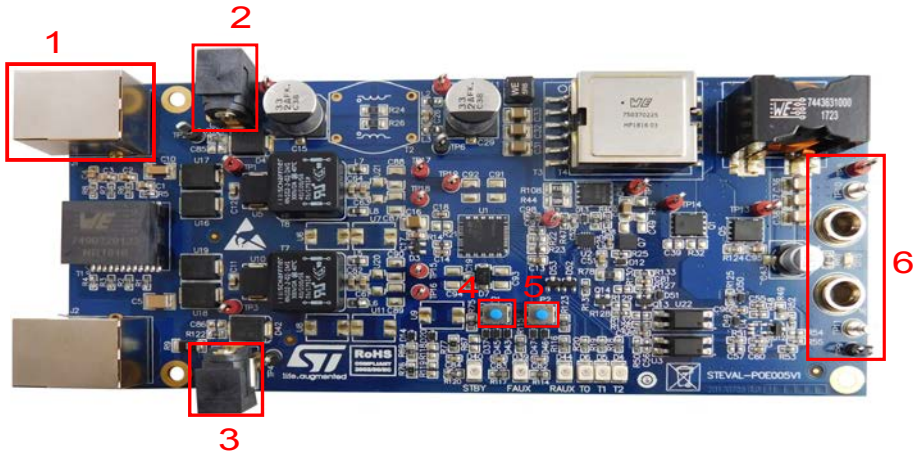
Note: Level 0 or low means the corresponding LED is on; level 1 or high means the LED is off.

1.2 Board setup

The STEVAL-POE005V1 reference design combines the PM8805 PD interface, compliant with the IEEE 802.3bt PoE standard, and the PM8804 PWM controller for an active clamp forward.

Figure 2. STEVAL-POE005V1 reference design: component view

- 1. POE IN
- 2. RAUX IN
- 3. FAUX IN
- 4.SLEEP and WAKEUP
- 5.SHUTDOWN
- 6.OUTPUT



When you use a bench power supply, follow the steps below.

Step 1. Set the power supply current limit to 0.2 A

Step 2. Apply 10 V and check the input current is 350-400 µA

Step 3. Apply 20 V and check the input current is within the selected Class range (the default is Class 8, 39 mA)

Step 4. Apply 48 V and check the input current is <60 mA and the output voltage is 12 V (without load)

Step 5. Change the current limit to 3 A

Step 6. Connect an electronic load between V_{OUT} and the secondary GND

Step 7. Turn the power supply on (48 V) and check the input current is coherent with the load current setting and the converter expected efficiency.

For example, 12 V x 5.5 A = 66 W→expected efficiency is 92% so P_{IN} = 66/0.92=71.74 W, which, with 48 V as input voltage, gives I_{input} =71.74/48 =1.5 A

Step 8. Change the load current as needed

2 Configurations

2.1 PM8805 configurations

Table 5. PM8805 control signal description

PM8805 behavior,standard operations	INPUTS			OUTPUTS				
	FAUX	RAUX	STBY	PGD	Hot swap	Charge pump	Active bridge	MPS
Normal POE operation	0	0	0	1 after 85ms hot swap enabled	Closes at UVLO	On @ UVLO	Enabled	Off
Stby PoE operation	0	0	1	1 when hot swap closed	Closes at UVLO	Off	LS enabled HS OFF	On
Front Aux operation	1	0	x	1 when hot swap closed	Closed	On	Enabled	Off
Rear Aux operation	0	1	0	1	Open	Off	Off	Off
Additional non standard operations								
Sleep mode/Wake up	1	1	1	0	Open	Off	LS enabled HS OFF	On
Rear Aux with MPS	0	1	1	1	Open	Off	LS enabled HS OFF	On
Shutdown/ reboot	1	1	0	0	Open	Off	Off	Off

2.2 PoE

The STEVAL-POE005V1 reference design default operation mode is the PoE (0,0,0). The selected class resistors are 36.5 ohm for CLS1 and 51.1 ohm for CLS2, so the board is class 8; that is, the Tx LED configuration is 000 or all LEDs on.

The other classes can be adjusted using the following table.

Table 6. PM8805 class description

PD class	CLS1 resistor (Ω)	CLS2 resistor (Ω)	Min. (mA)	Max. (mA)
Class 0	2 K	2 K	0	4.0
Class 1	150	150	9.0	12.0
Class 2	80.6	80.6	17.0	20.0
Class 3	51.1	51.1	26.0	30.0
Class 4	36.5	36.5	36.0	44.0
Class 5	36.5	2 K	36/0	44/4
Class 6	36.5	150	36/9	44/12
Class 7	36.5	80.6	36/17	44/20

PD class	CLS1 resistor (Ω)	CLS2 resistor (Ω)	Min. (mA)	Max. (mA)
Class 8	36.5	51.1	36/26	44/30

Classification phase is valid only for PoE devices, so it is not required when connected to any non-PoE power source such as a wall adapter: in those cases, the CLS buffers are never turned on.

Depending on the PD type and class, the relevant PD electrical parameters are summarized in the table below.

Table 7. PM8805 PD main parameters

PD type	Class	CLS1 sign.	CLS2 sign.	Pin (W)	Vin min. (V)	Vin max. (V)	I_{IN} max. (mA)	P_{peak} (W) for 50 ms
1	0	0	0	13.0	37.0	57	350	14.4
	1	1	1	3.84	42.1		90	5.00
	2	2	2	6.49	40.8		160	8.36
	3	3	3	13.0	37.0		350	14.4
2	4	4	4	25.5	42.5		600	28.05
3	1	1	1	3.84	42.1		90	5.00
	2	2	2	6.49	40.8		160	8.36
	3	3	3	13.0	37.0		350	14.4
	4	4	4	25.5	42.5		600	28.05
	5	4	0	40.0	44.3		900	42
	6	4	1	51.0	42.5		1200	53.55
4	7	4	2	62.0	42.9		1440	65.10
	8	4	3	71.3	41.2		1730	74.86

2.3 FAUX connector

A voltage applied at J9 connector (FAUX) sets automatically the correct input configuration (FAUX=1, RAUX=0, STBY=do not care).

If the STEVAL-POE005V1 reference design is already powered by a PSE, the following conditions apply:

1. FAUX voltage lower than PSE voltage: the board is still powered from PSE and T0,T1,T2 signal configuration remains the same according to Table 4
2. FAUX voltage is greater than PSE voltage, but the difference is less than 2 V: a current sharing occurs between PSE and FAUX to supply the board. T0,T1,T2 signal configuration remains unchanged as in the previous case
3. FAUX voltage is greater than PSE voltage and the difference is greater than 2 V: the board is powered by FAUX, PSE is disconnected as its load has significantly decreased (~3 mA) and PD does not ensure MPS condition.

   The PM8805 device works in Front aux mode (T0=0,T1=0,T2=1). When the FAUX connector (J9) is unplugged, PSE is not connected and the output voltage is interrupted as a new detection/classification procedure must be done before PSE powers the board again.

2.4 RAUX with MPS

A voltage applied at J10 connector (RAUX) sets automatically the correct input configuration (FAUX=0; RAUX=1; Stby=1).

The hot swap MOSFET is opened to give prevalence of the RAUX source over the PoE interface.

The STEVAL-POE005V1 reference design is configured to put the PSE in MPS mode triggering the STBY pin threshold by a proper divider (R69, R76 and R120) supplied by the RAUX input voltage. When STBY pin is pulled up, MPS current is enabled and drawn from the PSE.

The RAUX voltage can be in one of the following ranges, depending on the PSE voltage available at RJ45 connector (J1):

- RAUX voltage lower than PSE input voltage of less than 10 V: when RAUX voltage is applied and the board is already powered by PSE, switching between the two power supply sources works properly. The PM8805 device goes in Rear auxiliary with MPS mode and PSE remains connected to the board (T0=0,T1=0, T2=1)

Figure 3. PSE to RAUX switchover at VPSE=55 V, VRAUX=48 V, I_{OUT}=5.5 A

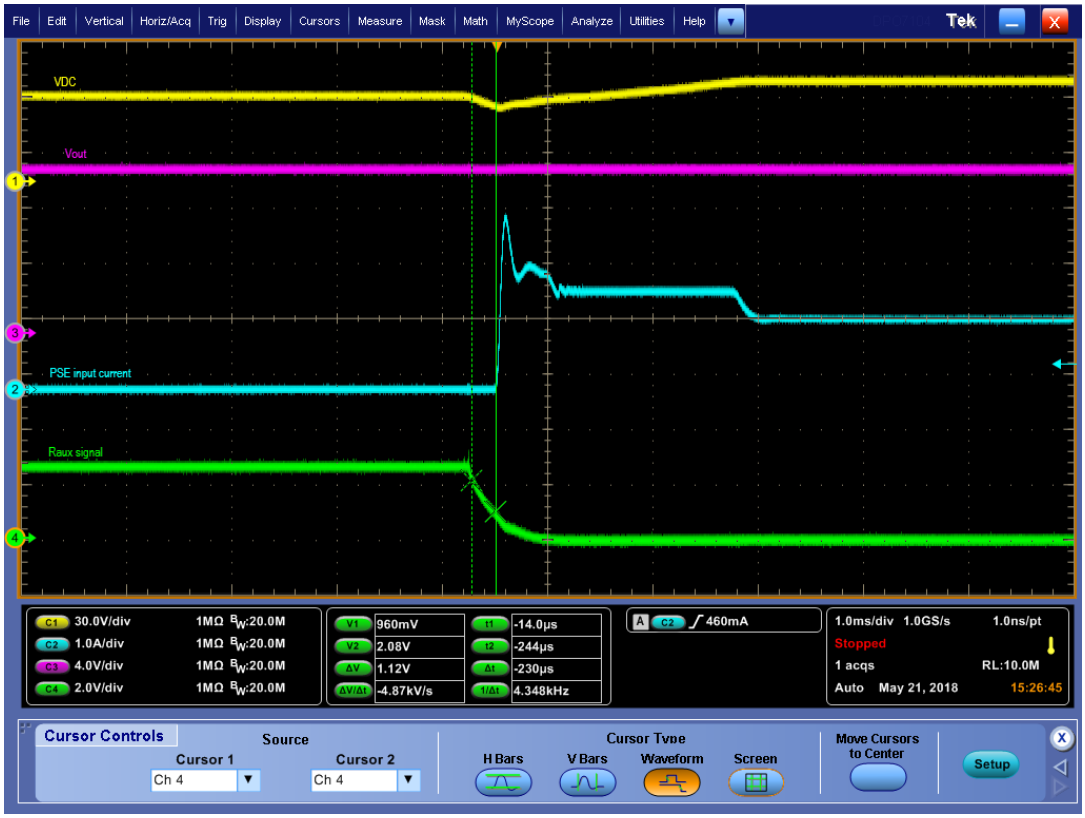
  – Ch1: VDC input voltage (TP5); Ch2: PSE input current (J1 twisted pairs)
  – Ch3: RAUX signal (pin 11 U1 - PM8805); Ch4: RAUX input current (J10)

When RAUX power supply is unplugged from J10, PSE is immediately available to supply the board, without causing output voltage interruptions, and the PM8805 device goes back to normal operating mode.

As shown in the figure below, there is a delay of about 200 µs between the time the RAUX source is unplugged and the hot swap MOSFET of PM8805 is turned on again, during which the forward converter is supplied only by input capacitors C29 and C15.

Figure 4. RAUX to PSE switchover at I_{OUT}=5.5 A, VRAUX=48 V, PSE voltage=55 V

– Ch1: VDC input voltage (TP5); Ch2: PSE input current (J1 twisted pairs)
– Ch3: Vout output voltage (TP8); Ch4: RAUX signal (pin 11 U1 - PM8805)

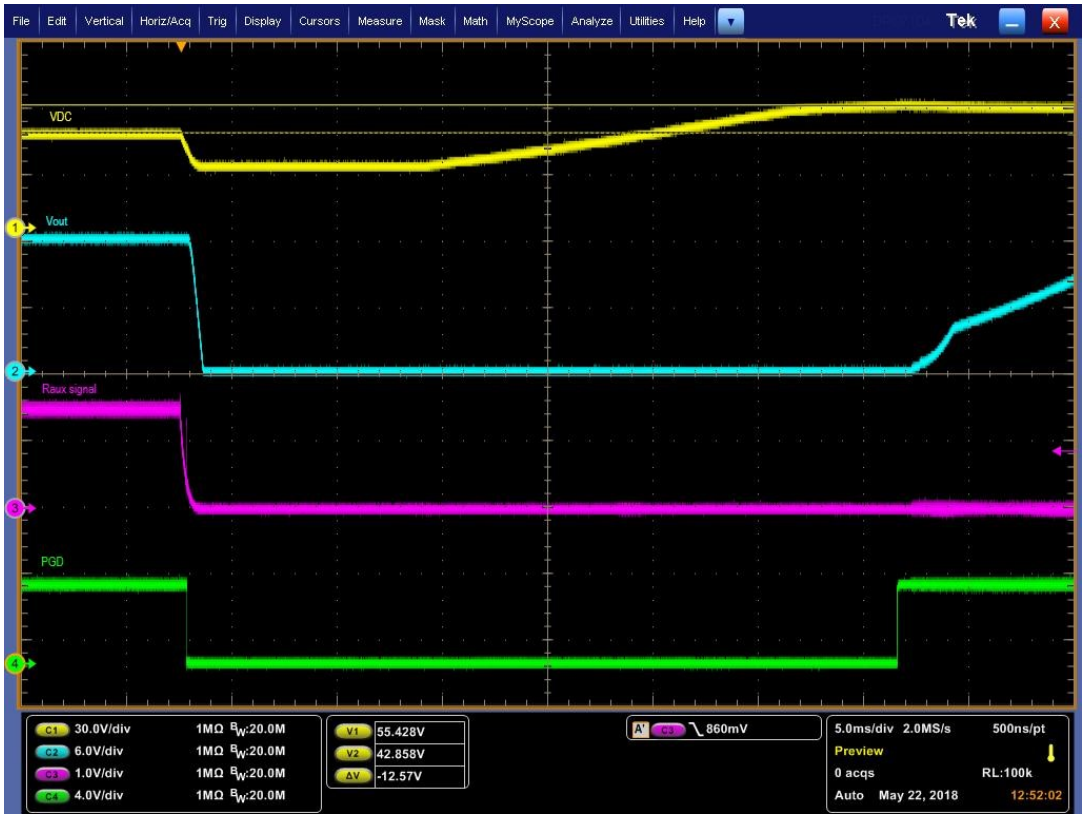


- RAUX voltage lower than PSE input voltage of more than 10 V: when RAUX voltage is applied and the board is already powered by PSE, switching between the two power supply sources works properly as in the previous case. When RAUX power supply is unplugged from J10, during the switchover, the PM8805 hot swap MOSFET drop between drain and source might be greater than the datasheet parameter **Vds_fail** (12 V min./16 V max.).

  If this failure occurs, the power good signal is forced to low level according to the datasheet parameter **Tretry** (9 min./11 max. msec), stopping the forward converter switching, then it is released causing an output voltage interruption as shown in the following figure.

Figure 5. RAUX to PSE switchover at I_{OUT}=5.5 A, Aux Rear = 44 V, PD voltage = 55 V

– Ch1: VDC input voltage (TP5); Ch2: Vout output voltage (TP8)
– Ch3: RAUX signal (pin 11 U1-PM8805); Ch4: PGD signal (TP19)



- RAUX voltage is greater than PSE input voltage of at least a diode forward voltage: when RAUX voltage is applied and the board is already powered by PSE, switching between the two power supply sources works properly as reported in the previous cases, but in this condition MPS current is drawn by RAUX source, then PSE is no more able to stay connected to the board. In this case, when RAUX source is removed, the output voltage goes to zero until PSE has successfully completed detection and classification phases, and the voltage is reapplied to the PD interface.

2.5 Soft stop

An important feature of the PM8804 is the soft stop that can be controlled via the MODE pin, used to select the converter operation mode.

By connecting this pin to AGND, you can turn GATE2 off when not used and disable the soft stop feature.

Pull up MODE pin if GATE2 is used and soft stop desired. Leave this pin open when not used.

In case of normal shutdown or thermal fault, the device features a soft stop procedure which helps to reduce the stress and the overvoltage on the power MOSFET and it is achieved discharging slowly the soft start capacitor with a 10 µA current sink. On the STEVAL-POE005V1 reference design the MODE pin is left open, as GATE2 must be available to implement the active clamp forward converter and, during normal shutdown, the soft stop procedure is implemented.

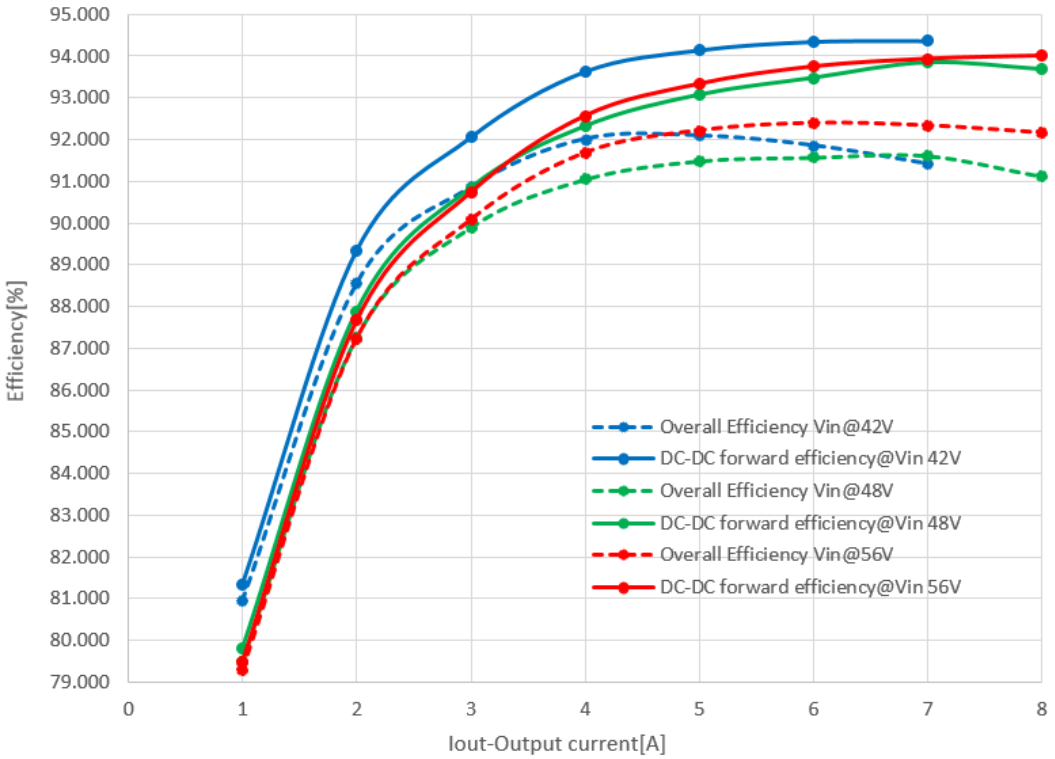
3 Measurements

3.1 Efficiency

The STEVAL-POE005V1 reference design consists of a PoE interface compliant with the IEEE 802.3bt standard and a forward active clamp DC-DC converter that receives DC voltage from the PoE interface.

The figure below shows the efficiency of a single forward converter and the overall efficiency including the PoE interface power losses.

Figure 6. STEVAL-POE005V1 overall and DC-DC forward efficiency



The dotted lines indicate the STEVAL-POE005V1 efficiency at different DC input voltages applied to RJ45 connector J1. The continuous line indicates the DC-DC forward efficiency, which does not include the following losses associated with the PoE interface section:

- RJ45 connector J1
- PoE data transformer T1
- common chokes T7 and T8 placed on the two power supply pairs
- PM8805 interface that integrates the dual power MOS bridges and a hot swap MOSFET
- Forward converter input filter

This efficiency is measured between output test points TP8/TP9 and input test points TP5/TP6 of the forward converter.

3.2 Output voltage ripple

Figure 7. Output voltage ripple: I_{OUT}= 800 mA

- Ch1: Vout ripple; Ch2: Primary MOSFET gate voltage; Ch3: I_{OUT}

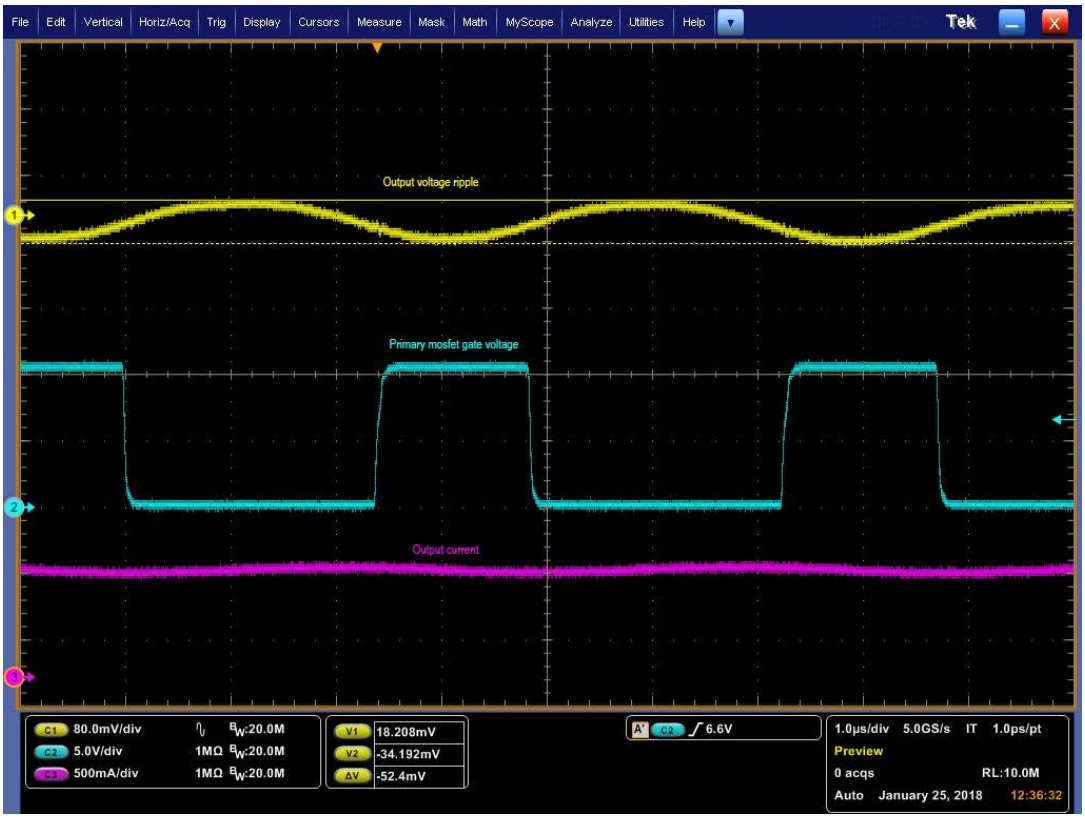
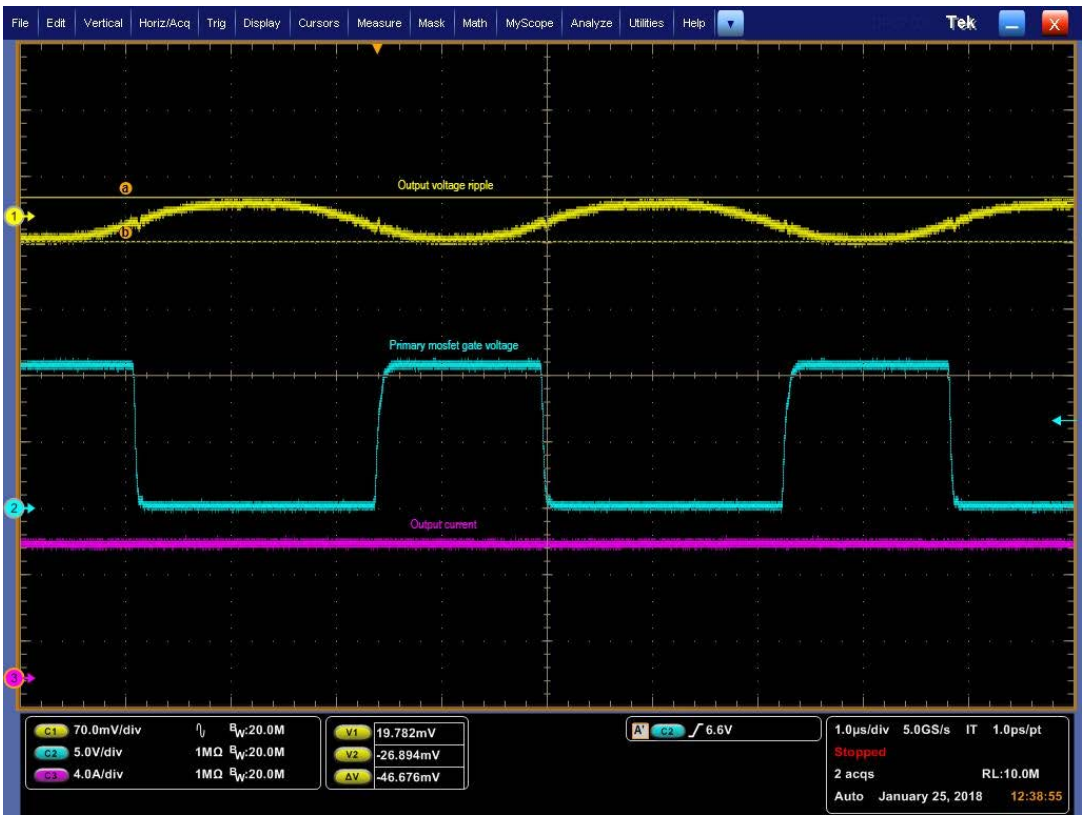


Figure 8. Output voltage ripple: I_{OUT}= 8 A

- Ch1: Vout ripple; Ch2: Primary MOSFET gate voltage; Ch3: I_{OUT}



3.3 Input voltage ripple

Figure 9. Input voltage ripple before and after forward input filter: V_{IN} = 48 V, I_{OUT} = 800 mA

- Ch1: Vin ripple before input filter (TP5); Ch2: Primary MOSFET gate voltage
- Ch4: Vin ripple after input filter (C33); Ch3: Input current (J1 connector pairs)

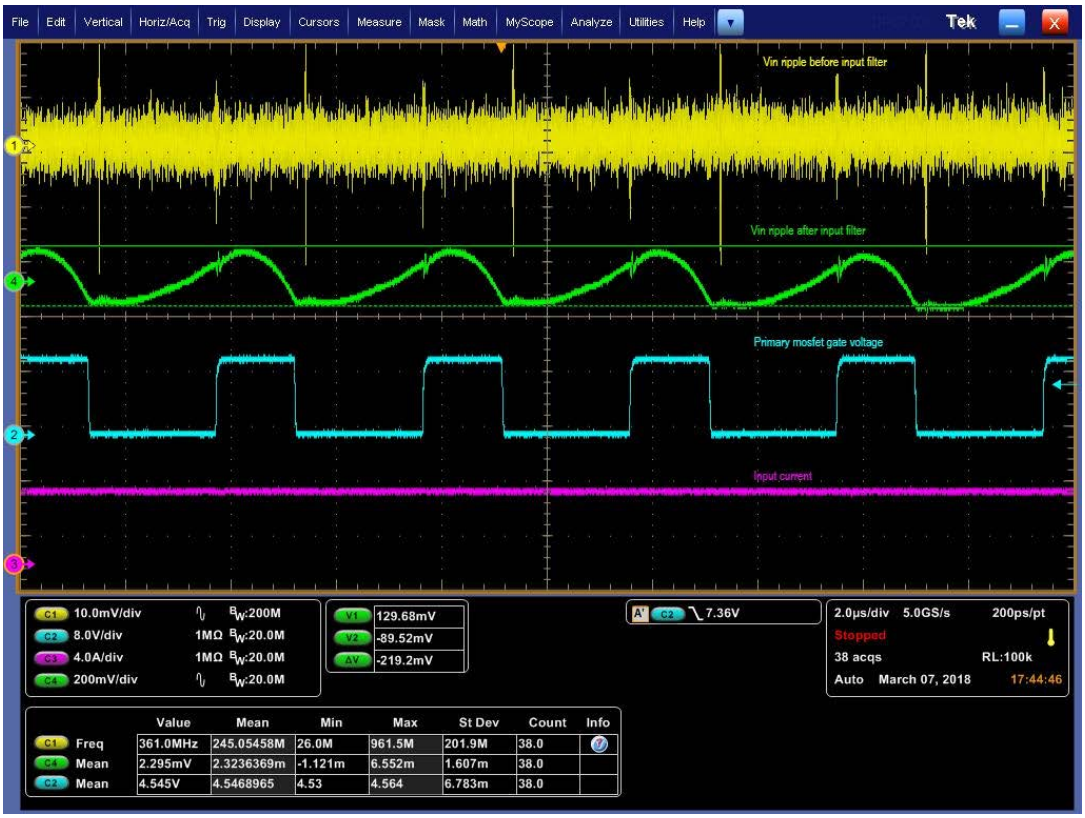
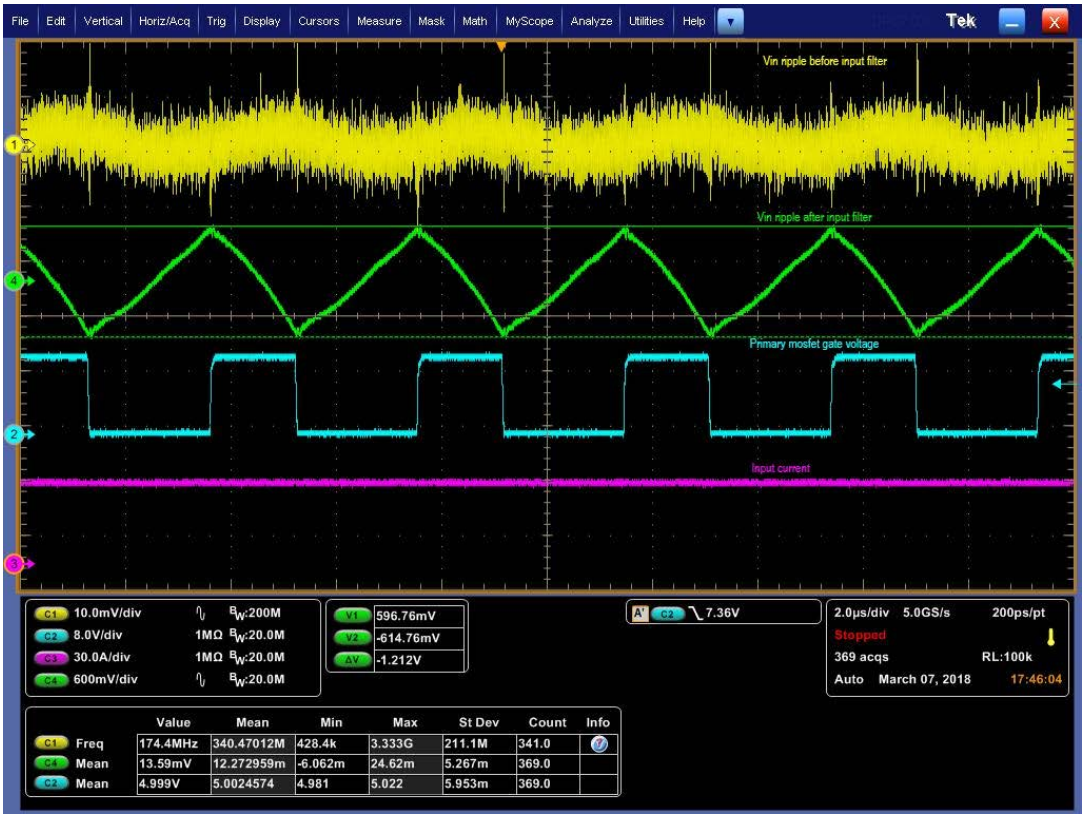


Figure 10. Input voltage ripple before and after forward input filter: V_{IN} = 48 V, I_{OUT} = 8 A

- Ch1: Vin ripple before input filter (TP5); Ch2: Primary MOSFET gate voltage
- Ch4: Vin ripple after input filter (C33); Ch3: Input current (J1 connector pairs)



3.4 Startup

Figure 11. Output voltage at startup: Iout at no load, Vin= 48 V

- Ch1: Vout; Ch2: Soft start voltage (C53); Ch4: primary MOSFET gate voltage

Figure 12. Output voltage at startup: Iout=8 A, Vin= 48 V

- Ch1: Output voltage; Ch2: Soft start voltage (C53);
  Ch4: Output current; Ch3: primary MOSFET gate voltage

3.5 PoE connector unplugged power off

Figure 13. Power off at primary side: Iout=8 A, Vin= 42 V

- Ch1: Primary Q4 MOSFET drain voltage; Ch2: Forward input voltage (TP5)
- Ch3: Soft start voltage (C53); Ch4: Power good (TP19)

Figure 14. Power off at secondary side (Q1): Iout=8 A, Vin= 42 V

- Ch1: Primary Q4 MOSFET drain voltage; Ch2: Secondary Q1 MOSFET gate voltage
- Ch3: Secondary Q1 MOSFET drain voltage; Ch4: Power good (TP19)

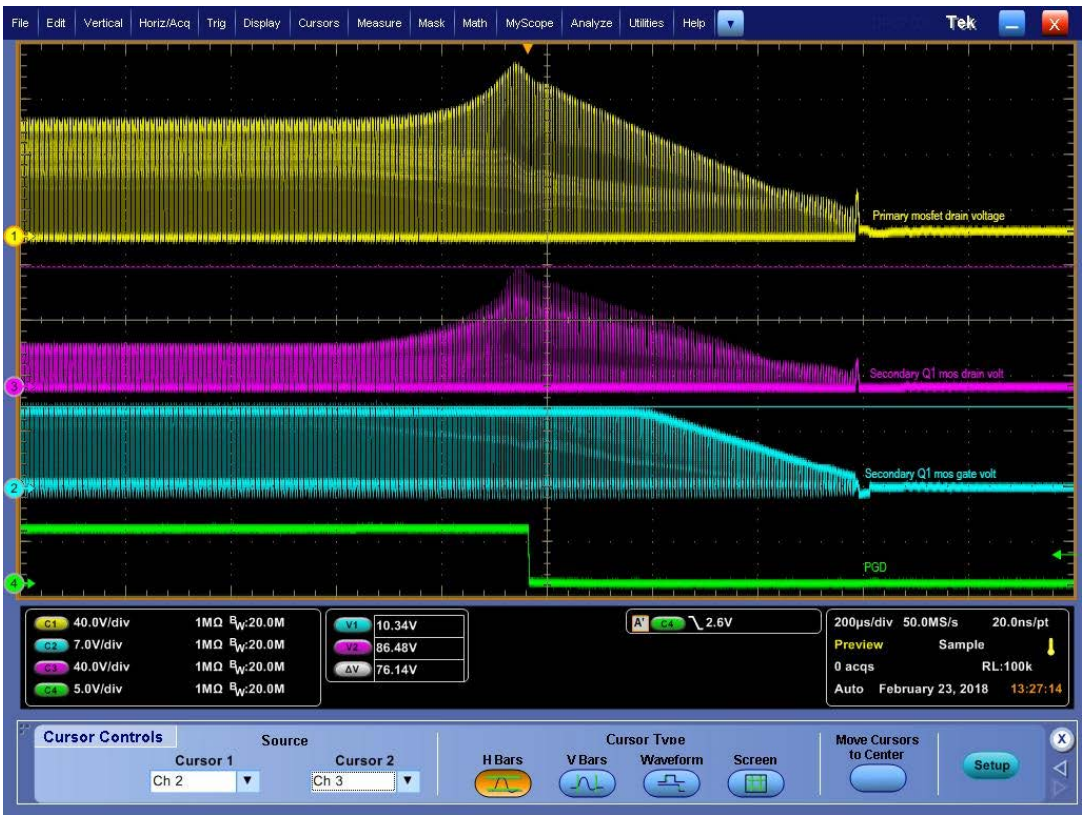
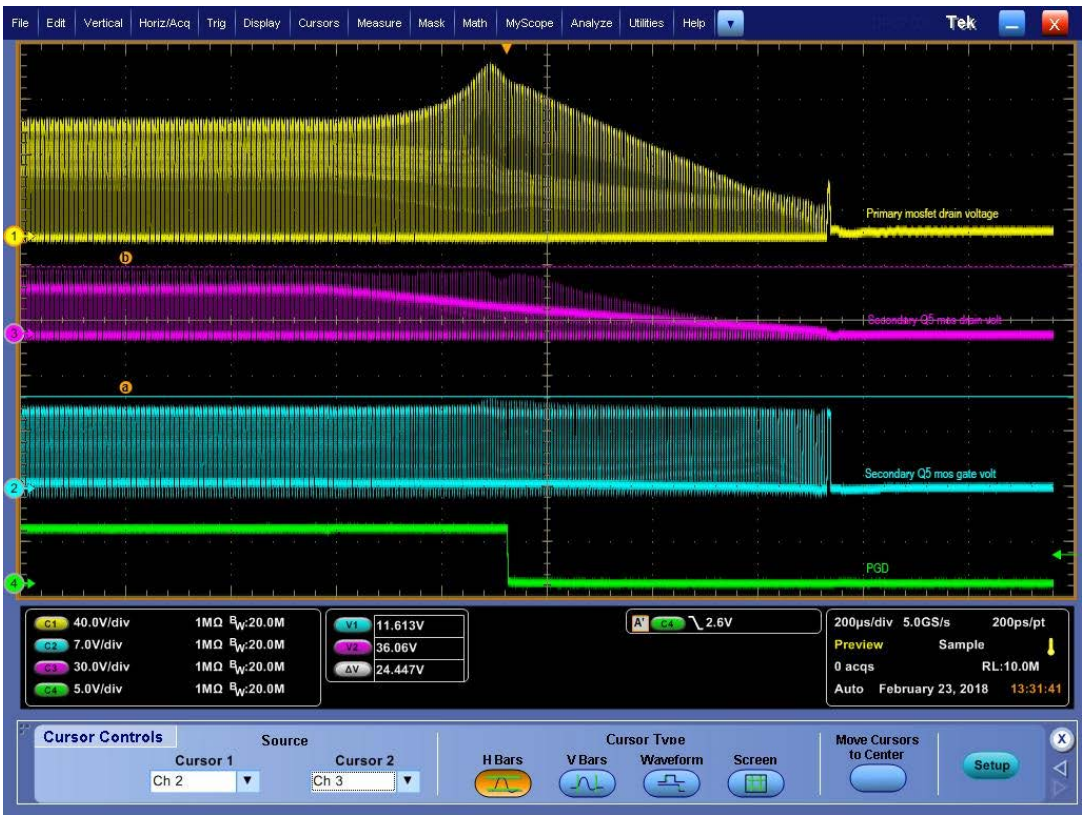


Figure 15. Power off at secondary side (Q5): Iout=8 A, Vin= 42 V

- Ch1: Primary Q4 MOSFET drain voltage; Ch2: Secondary Q5 MOSFET gate voltage
- Ch3: Secondary Q5 MOSFET drain voltage; Ch4: Power good (TP19)



3.6 Primary side waveforms

Figure 16. Primary steady state: Iout=800 mA, Vin= 48 V

- Ch1: Primary Q4 MOSFET drain voltage; Ch2: Primary current sense voltage
- Ch4: Primary MOSFET gate voltage

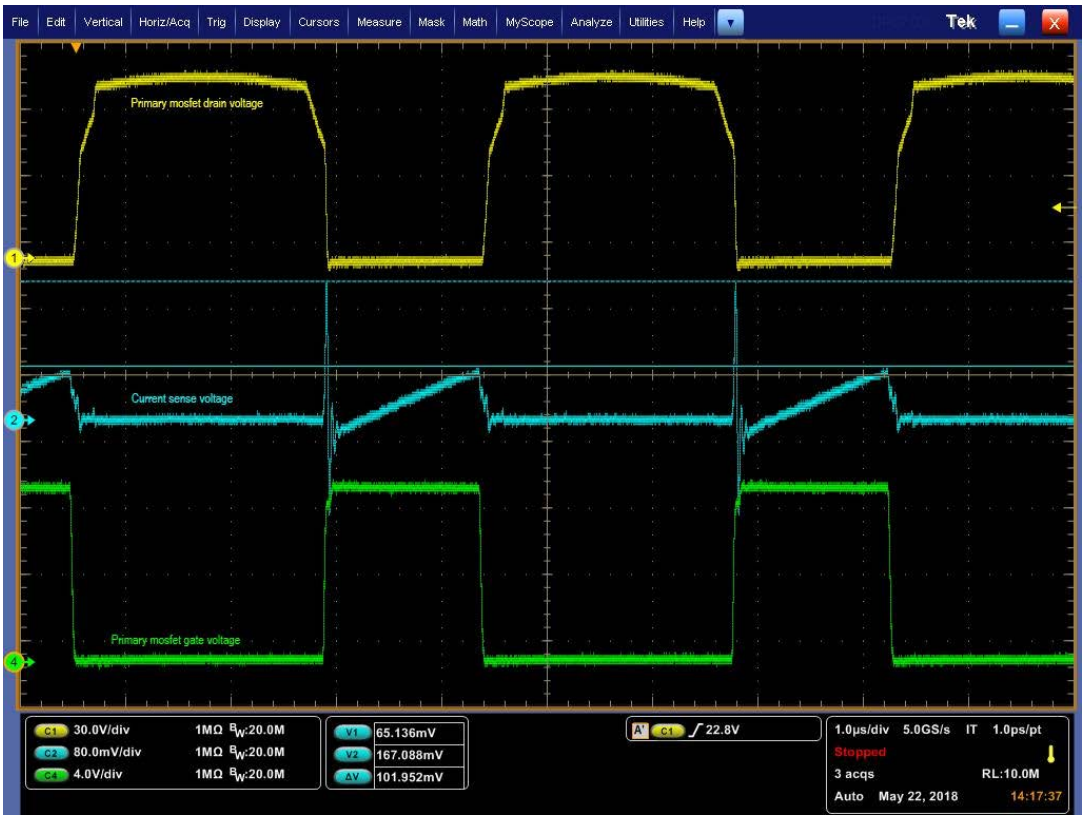
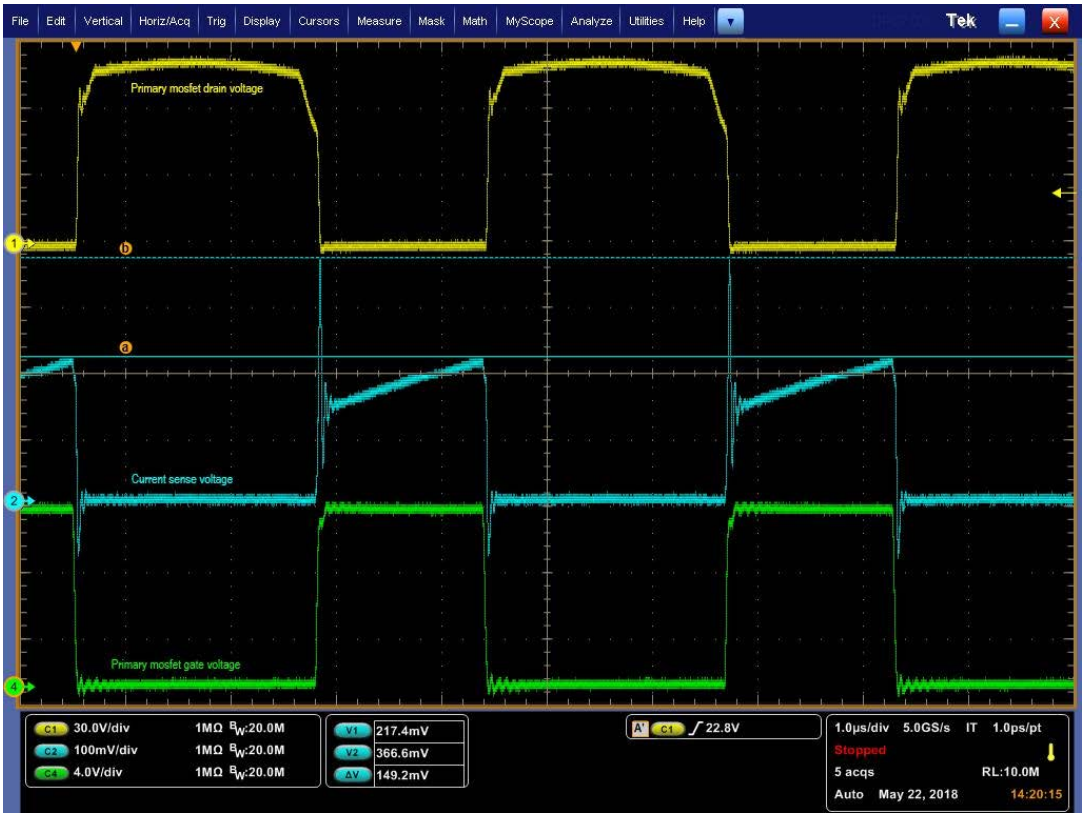


Figure 17. Primary steady state: Iout=8 A, Vin= 48 V

- Ch1: Primary Q4 MOSFET drain voltage; Ch2: Primary current sense voltage
- Ch4: Primary MOSFET gate voltage



3.7 Secondary side waveforms

Figure 18. Secondary steady state: Iout=800 mA, Vin= 48 V

- Ch1: Secondary Q1 MOSFET drain voltage; Ch3: Secondary Q5 MOSFET drain voltage
- Ch2: Secondary Q1 MOSFET gate voltage; Ch4: Secondary Q5 MOSFET gate voltage

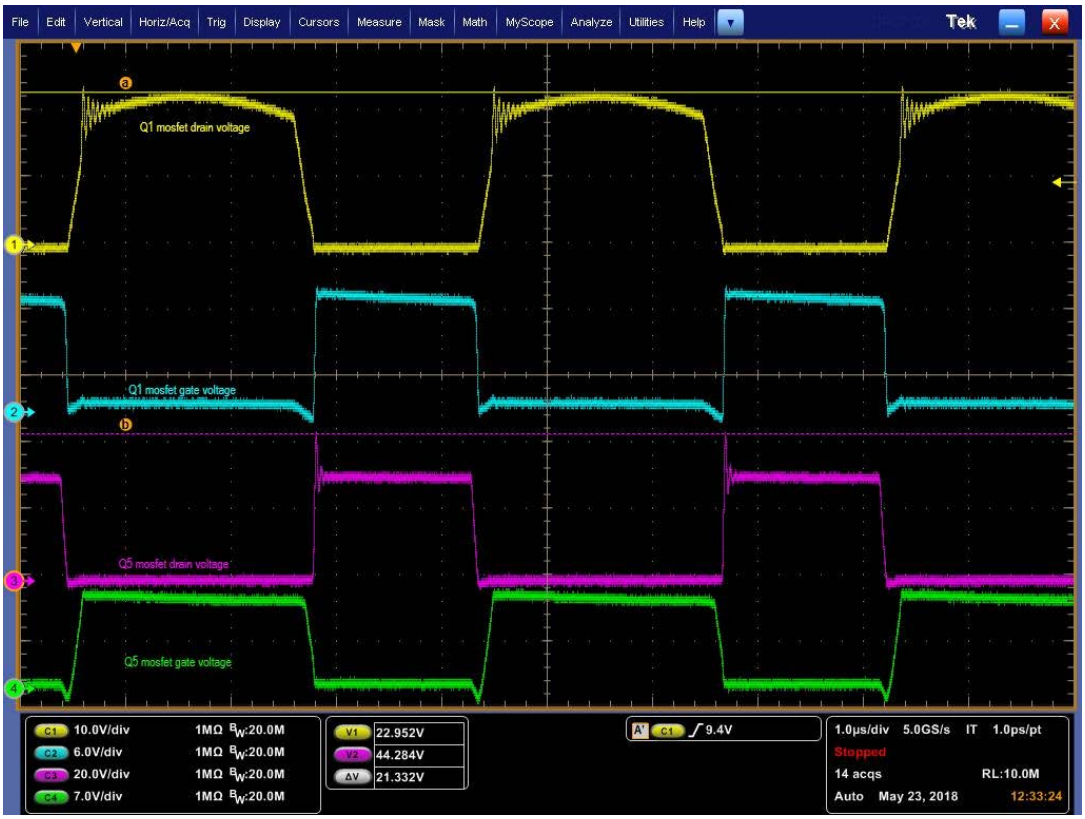


Figure 19. Secondary steady state: Iout=8 A, Vin= 48 V

- Ch1: Secondary Q1 MOSFET drain voltage; Ch3: Secondary Q5 MOSFET drain voltage
- Ch2: Secondary Q1 MOSFET gate voltage; Ch4: Secondary Q5 MOSFET gate voltage

3.8 Load transient side waveforms

Figure 20. Load transient: Iout=4 to 8 A, Vin= 48 V

- Ch1: Output voltage; Ch2: Output current

3.9 Gloop measurements

Figure 21. **Gloop plot (Vin= 48 V, Iout=6 A)**

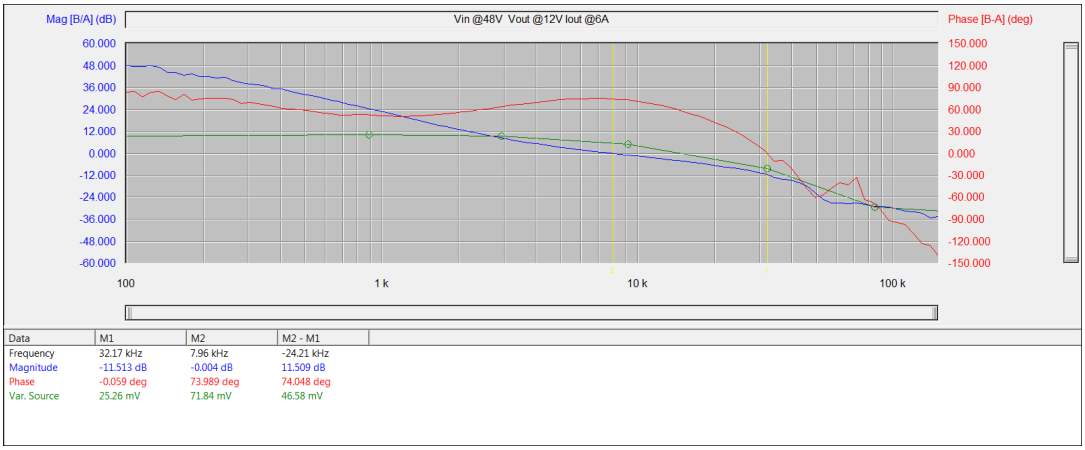


Figure 22. **Gloop plot (Vin= 48 V, Iout=0.8 A)**

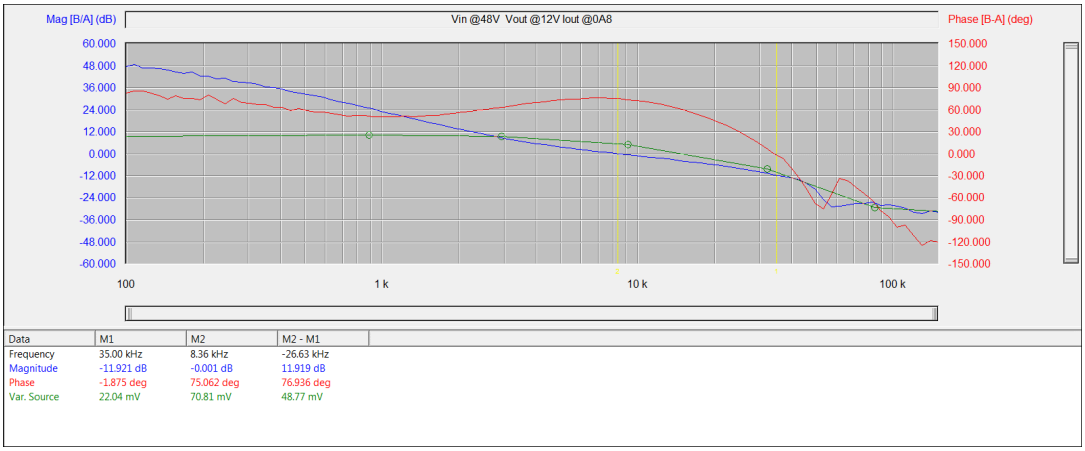


Figure 23. **Gloop plot (Vin= 42 V, Iout=6 A)**

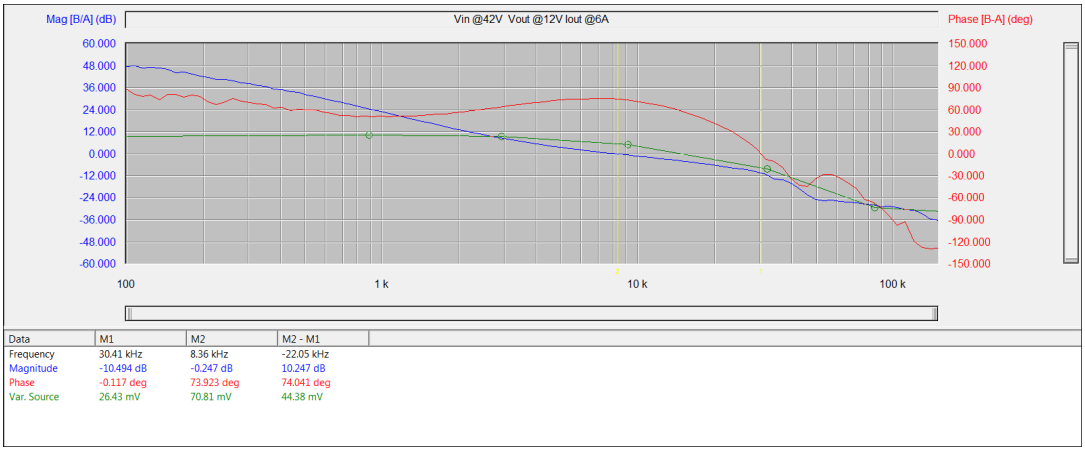
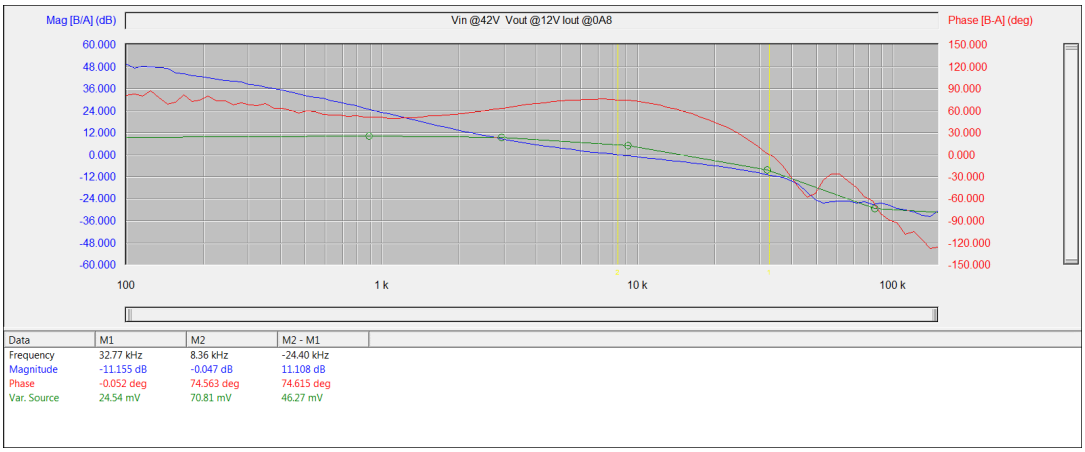


Figure 24. **Gloop plot (Vin= 42 V, Iout=0.8 A)**



3.10 Board thermography

Figure 25. **STEVAL-POE005V1 reference design thermography at 8 A, 56 V (emissivity = 0.95, reflected temperature = 20°C**

- SP1 (Q1 secondary rectifier MOSFET) = 78.4°C
- SP2 (Q5 secondary freewheeling MOSFET) = 77.3°C
- SP3 (Q4 primary main MOSFET) = 87.1°C
- SP4 (T3 forward transformer) = 85.4°C
- SP5 (L4 output inductor) = 80.3°C
- SP6 (U1 PM8805) = 66.2°C
- SP7 (Reference point) = 45.6°C

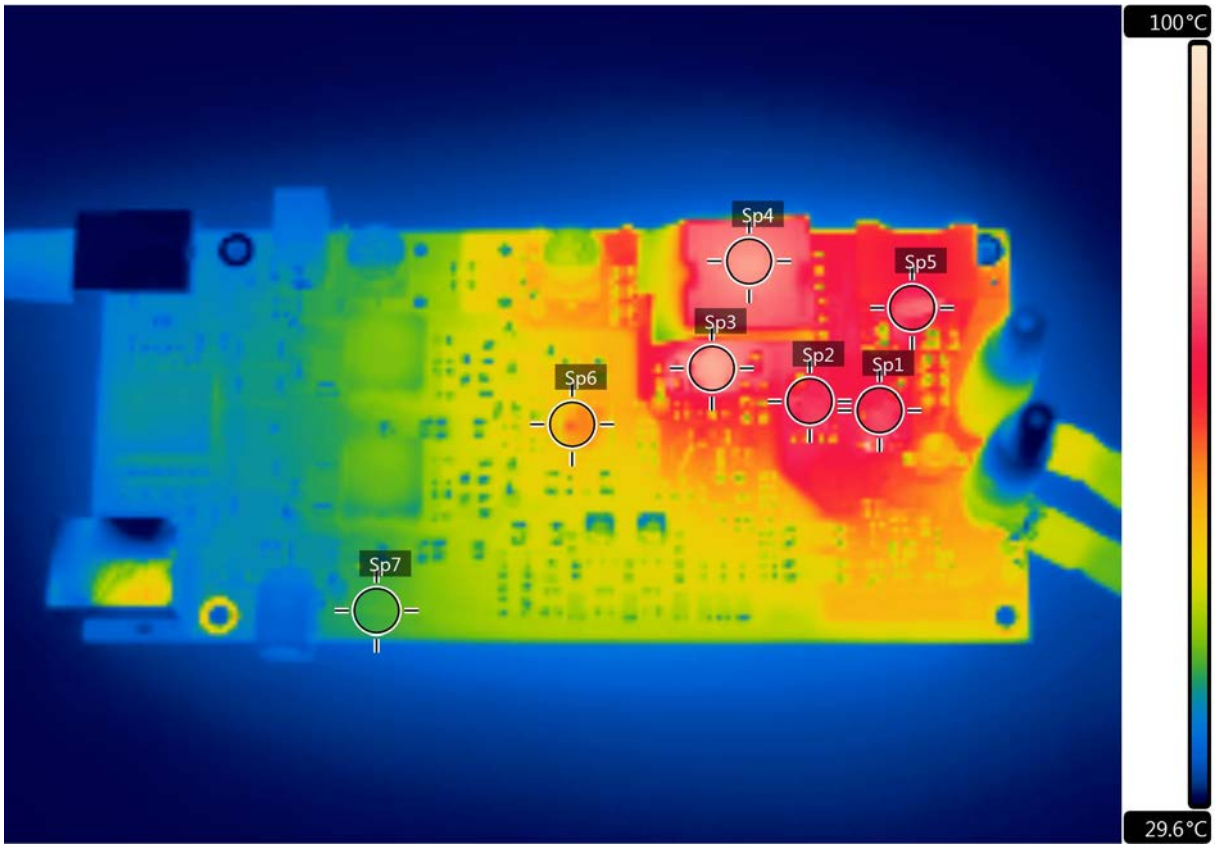
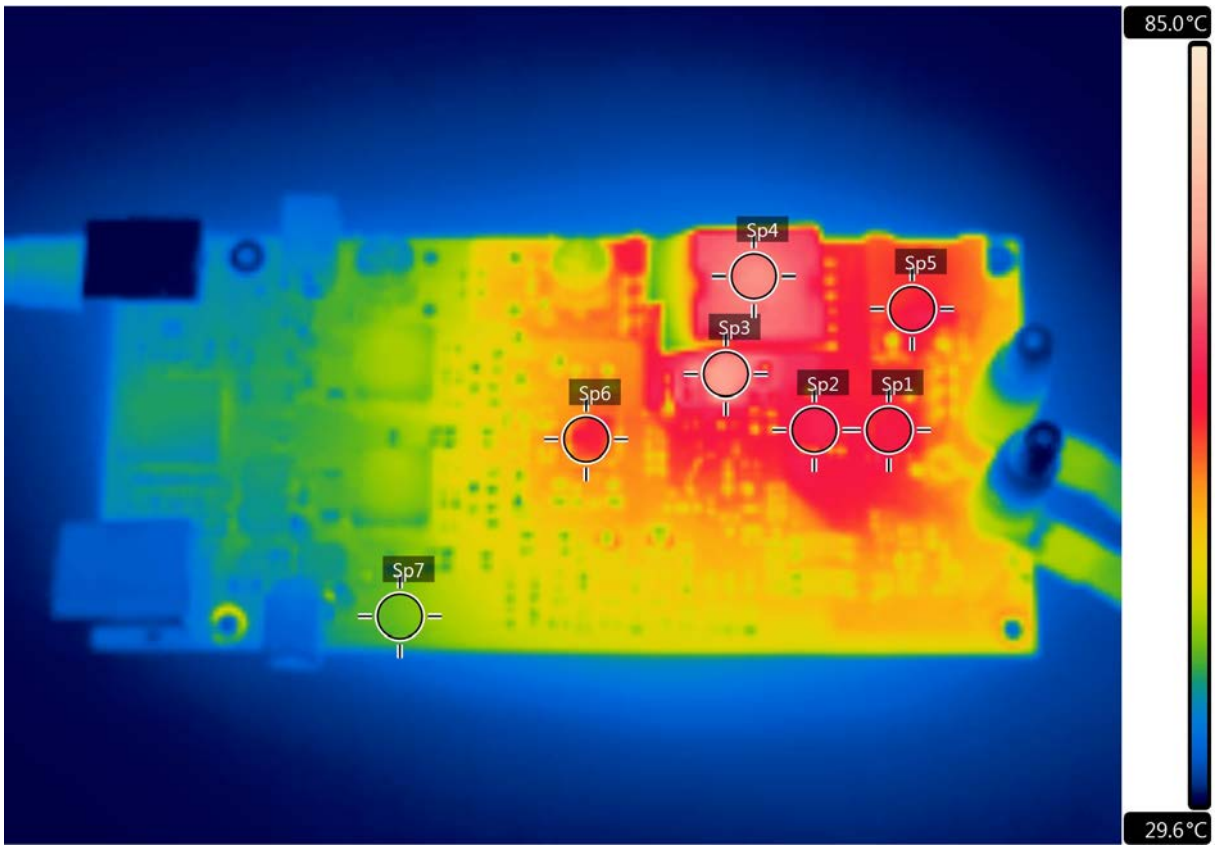


Figure 26. STEVAL-POE003V1 reference design thermography at 6 A, 41 V (emissivity = 0.95, reflected temperature = 20°C

- SP1 (Q1 secondary rectifier MOSFET) = 63.1°C
- SP2 (Q5 secondary freewheeling MOSFET) = 64.3°C
- SP3 (Q4 primary main MOSFET) = 73°C
- SP4 (T3 forward transformer) = 71.5°C
- SP5 (L4 output inductor) = 63°C
- SP6 (U1 PM8805) = 60.9°C
- SP7 (Reference point) = 43.4°C



4 STEVAL-POE005V1 schematic diagrams

Figure 27. **STEVAL-POE005V1 circuit schematic (1 of 3)**

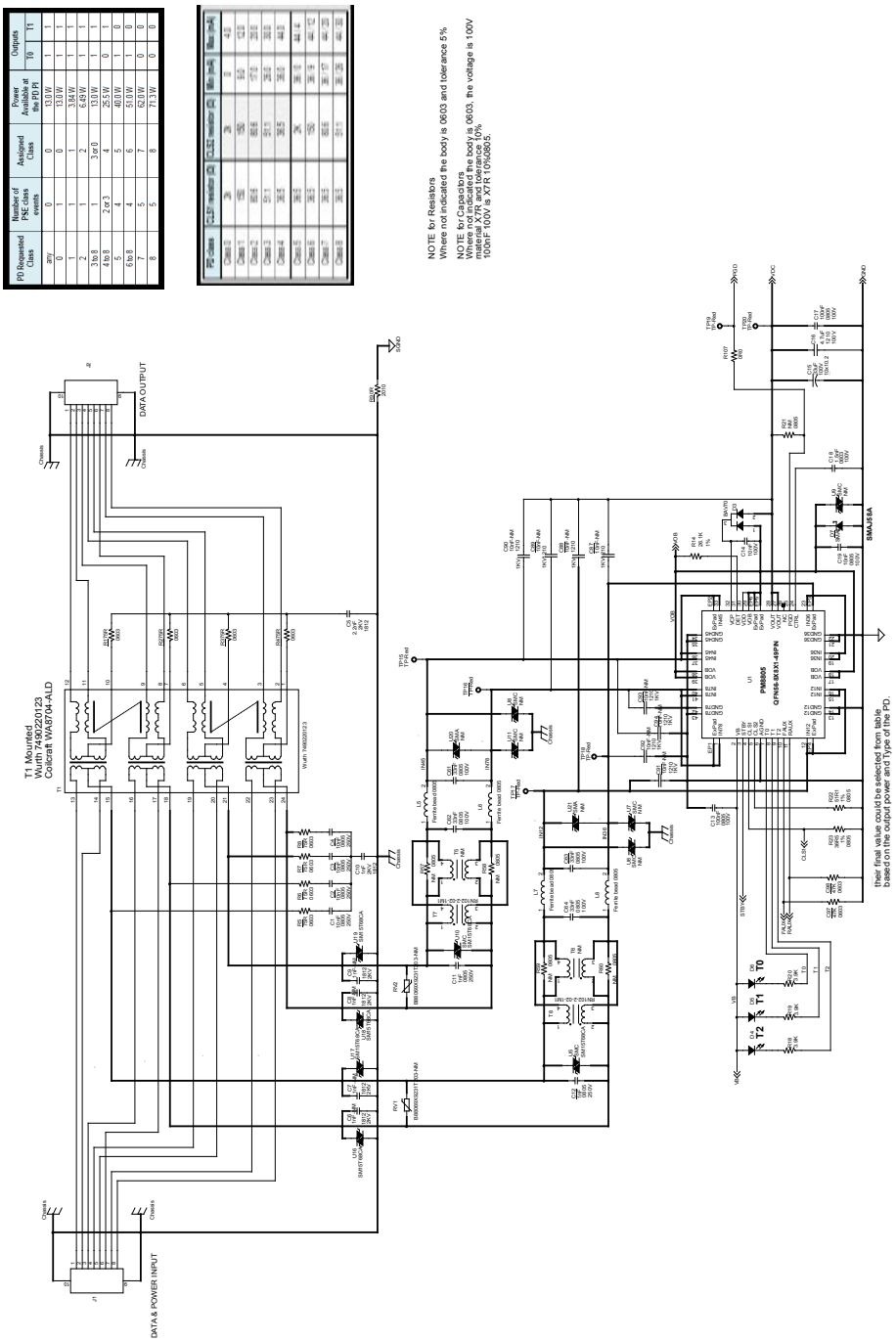


Figure 28. **STEVAL-POE005V1 circuit schematic (2 of 3)**

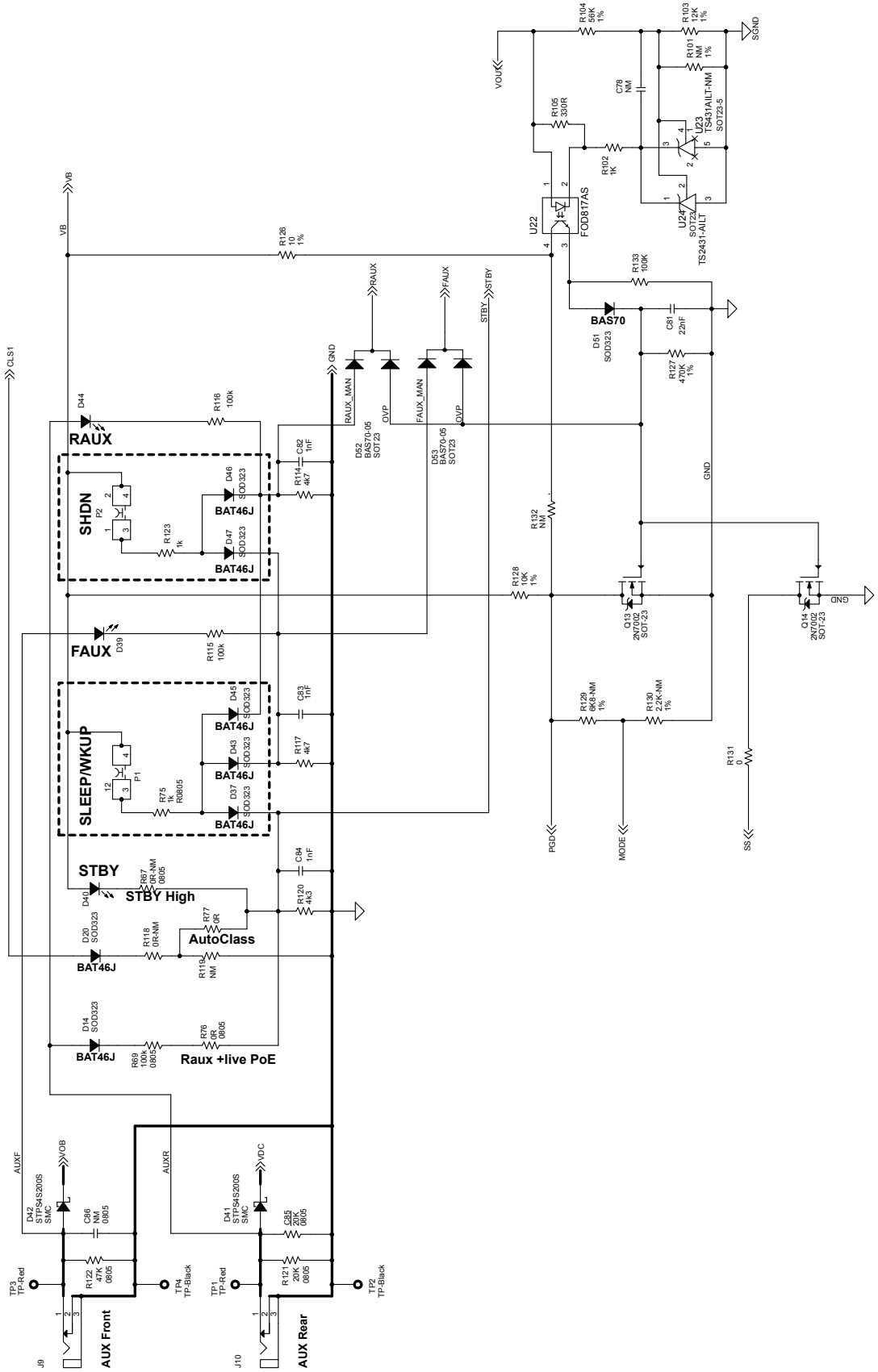
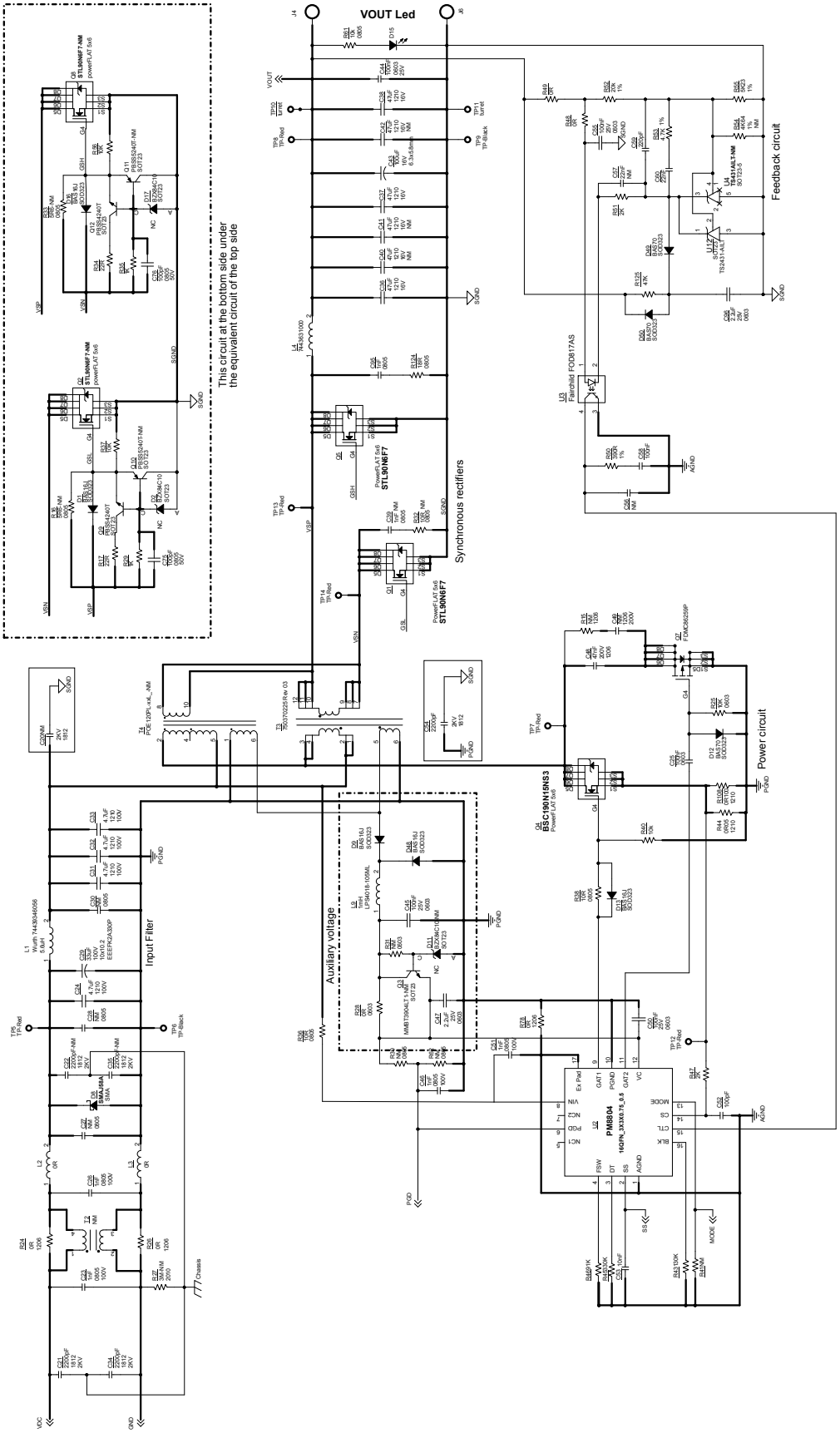


Figure 29. **STEVAL-POE005V1 circuit schematic (3 of 3)**



5 Bill of materials

Table 8. **STEVAL-POE005V1 bill of materials**

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
1	4	C1, C2, C3, C4	10 nF 250 V C0805	Capacitors	Wurth Elektronik	885342207010
2	1	C5	2.2 nF 2KV C1812	Capacitor	AVX	
3	4	C6, C7, C8, C9	1 nF 2KV C1812	Capacitors (not mounted)	TDK	
4	1	C10	1 nF 2KV C1812	Capacitor	AVX	
5	2	C11, C12	1 nF 250 V C0805	Capacitors	Wurth Elektronik	885342207008
6	2	C13, C17	100 nF 100 V C0805	Capacitor	Wurth Elektronik	885012207128
7	1	C14	10 nF 100 V C0603	Capacitor	Wurth Elektronik	885012206114
8	1	C15	33 µF 100 V C-POL8-10	Capacitor	Panasonic	EEEFK2A330P
9	2	C16, C24	4.7 µF 100 V C1210	Capacitor	TDK	
10	1	C18	1.5 nF 100 V C0603	Capacitor	Wurth Elektronik	885012206109
11	1	C19	10 nF 100 V C0805	Capacitor	Wurth Elektronik	885012207122
12	2	C20, C22	2200 pF 2KV C1812	Capacitors (not mounted)	AVX	
13	1	C21	2200 pF 2KV C1812	Capacitor	AVX	
14	5	C23, C26, C46, C51, C95	1 nF 100 V C0805	Capacitor	Wurth Elektronik	885012207116
15	1	C25	100nF 25V C0603	Capacitor	Wurth Elektronik	885012206071
16	3	C27, C28, C30	100 V C0805	Capacitors (not mounted)	Any	
17	1	C29	33 µF 100 V C-POL8-10	Aluminium Electrolytic capacitor	Panasonic	EEEFK2A330P
18	3	C31, C32, C33	4.7uF 100V C1210	Capacitors	TDK	
19	1	C34	2200 pF 2KV C1812	Capacitor	AVX	
20	1	C35	2200 pF 2KV C1812	Capacitor (not mounted)	AVX	
21	3	C36, C37, C38	47 µF 16 V C1210	Capacitor	Wurth Elektronik	885012109011
22	1	C39	1 nF 100 V C0805	Capacitor (not mounted)	Wurth Elektronik	885012207116

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
23	3	C40, C41, C42	47 µF 16 V C1210	Capacitor (not mounted)	Wurth Elektronik	885012109011
24	1	C43	100 ↕0F 16 V Case D	Aluminium Electrolytic capacitor	Panasonic	EEEFK1C101P
25	2	C44, C45	100 nF 25 V C0603	Capacitor	Wurth Elektronik	885012206071
27	1	C47	2.2 µF 25 V C0603	Capacitor	Any	
28	1	C48	47 nF 200 V C1206	Capacitor	Any	
29	1	C49	200 V C1206	Capacitor (not mounted)	Any	
30	3	C50, C55, C58	100 nF 25 V C0603	Capacitor	Wurth Elektronik	885012206071
31	1	C52	100 pF 25 V C0603	Capacitor	Any	
32	1	C53	10 nF 25 V C0603	Capacitor	Wurth Elektronik	885012206065
33	1	C54	2200 pF 2KV C1812	Capacitor	AVX	
34	1	C56	C0603	Capacitor (not mounted)	Any	
35	1	C57	22 nF COG 25 V C0603	Capacitor (not mounted)	Any	
36	1	C59	220 pF COG 25 V C0603	Capacitor	Wurth Elektronik	885012006040
37	1	C60	22 nF COG 25 V C0603	Capacitor	Any	
38	4	C61, C62, C63, C64	33 nF 100 V C0805	Capacitor	Wurth Elektronik	885012207125
39	2	C75, C76	100 pF 50 V C0805	Capacitor	Wurth Elektronik	885012007057
40	1	C78	25 V C0603	Capacitor (not mounted)	Any	
41	1	C81	22 nF 25 V C0603	Capacitor	Wurth Elektronik	885012206067
42	3	C82, C83, C84	1 nF 25 V C0603	Capacitor	Wurth Elektronik	885012206059
43	1	C85	20 K R0805	Resistor (not mounted)	Any	
44	1	C86	100 V C0805	Capacitor (not mounted)	Any	
45	8	C87, C88, C89, C90, C91, C92, C93, C94	10 nF 1KV C1210	Capacitor (not mounted)	AVX	1210AC103KAT 1A
46	1	C96	2.2 µF 25 V C0603	Capacitor	Any	
47	1	C97	47K R0603	Resistor	Any	
48	1	C98	47K R0603	Resistor	Any	

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
49	1	D1	SOD-323	Diode	Any	
50	1	D2	SOD-23	Diode	Any	
51	1	D3	SOT23	Diode	Any	
52	1	D4	T2	LED Diode	Kingbright	AA3528CGSK
53	1	D5	T1	LED Diode	Kingbright	AA3528CGSK
54	1	D6	T0	LED Diode	Kingbright	AA3528CGSK
55	1	D7	SMA	Diode TVS	ST	SMAJ58A
56	1	D8	SMA	Transil Diode	ST	
57	1	D9	SOD-323	Diode	Any	BAS16J
58	1	D11	SOT23-D	Zener diode (not mounted)	Any	BZX84C10
59	15	D12, D13, D14, D16, D17, D20, D37, D43, D45, D46, D47, D48, D49, D50, D51	SOD-323	Diode	Any	
60	1	D15	VOUT Led LED_SMD_0805	LED Diode	Several	
61	1	D39	FAUX	LED Diode	Kingbright	AA3528CGSK
62	1	D40	STBY	LED Diode	Kingbright	AA3528CGSK
63	2	D41, D42	SMC	Diode	ST	STPS4S200S
64	1	D44	RAUX	LED Diode	Kingbright	AA3528CGSK
65	2	D52, D53	SOT-23	Dual Diode Common Anodes	Any	BAS70-05
66	1	J1	DATA & POWER INPUT RJ45-8PIN	Connector	Bell Stewart	SS-7188S-A-NF
67	1	J2	DATA OUTPUT RJ45-8PIN	Connector	Bell Stewart	SS-7188S-A-NF
68	2	J4, J6	BANANA-JACK BOC_10A	Connector	Any	
69	1	J9	AUX Front	Power Jack	Switchcraft	P-JACK-RAPC722
70	1	J10	AUX Rear	Power Jack	Switchcraft	P-JACK-RAPC722
71	1	L1	POWER INDUCTOR, 5.6 µH	Inductor	Wurth Elektronik	744316560
					Coilcraft	XAL5050-562
72	2	L2, L3	220 R 805	Inductor (not mounted, mount ohm resistor)	TDK	MPZ2012S221AT000
73	1	L4	10 µH	Inductor	Wurth Elektronik	7443631000
74	4	L5, L6, L7, L8	220 R 805	Ferrite beads	TDK	MPZ2012S221AT000
75	1	L9		Low Profile Power inductor	Coilcraft	LPS4018-105ML

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
76	1	P1	SLEEP/WKUP	Push Button	Any	
77	1	P2	SHDN	Push Button	Any	
78	2	Q1, Q5	POWERFLAT_5X6_SGD	Power MOSFET	ST	STL90N6F7
79	1	Q2	POWERFLAT_5X6_SGD	Power MOSFET (not mounted)	ST	STL90N6F7
80	2	Q3, Q8	MMBT3904LT1 SOT23_BEC_T	Switching transistor NPN (not mounted)	Any	MMBT3904LT1
81	1	Q4	BSC190N15NS3 POWERFLAT_5X6_SGD	Power MOSFET	Infineon	BSC190N15NS3
82	1	Q7	POWERFLAT_3X3_SGD	Switching MOSFET P channel	Any	FDMC86259P
83	2	Q9, Q12	SOT23_BEC_T	Switching transistor NPN	Any	PBSS4240T
84	2	Q10, Q11	SOT23_BEC_T	Switching transistor PNP (not mounted)	Any	PBSS5240T
85	2	Q13, Q14	SOT23	N channel MOSFET	Any	2N7002
86	8	R1, R2, R3, R4, R5, R6, R7, R8	75 R R0603	Resistor	Any	
87	1	R9	0R0 R1210	Resistor	Any	
88	1	R14	26.1 K ±1% R0603	Resistor	Any	
89	1	R15	R1206	Resistor (not mounted)	Any	
90	1	R16	5R6 R0805	Resistor (not mounted)	Any	
91	1	R17	22 R R0805	Resistor	Any	
92	3	R18, R19, R20	3.9 K R0603	Resistor	Any	
93	2	R21, R30	10 K R0805	Resistor (not mounted)	Any	
94	1	R22	51R1 ±1% R0805	Resistor	Any	
95	1	R23	36R5 ±1% R0805	Resistor	Any	
96	2	R24, R26	0R0 R1206	Resistor	Any	
97	3	R25, R37, R40	10 K R0603	Resistor	Any	
98	1	R27	3Mega R2010	Resistor (not mounted)	Any	
99	1	R28	0R R0603	Resistor	Any	
100	1	R29	1 K R0805	Resistor	Any	
101	1	R31	R0603	Resistor (not mounted)	Any	

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
102	1	R32	10 R R0805	Resistor (not mounted)	Any	
103	1	R33	5R6 R0805	Resistor (not mounted)	Any	
104	1	R34	22 R R0805	Resistor	Any	
105	2	R35, R75	1 K R0805	Resistor	Any	
106	2	R36, R38	10 R R0805	Resistor	Any	
107	1	R41	R0603	Resistor (not mounted)	Any	
108	1	R43	130 K ±1% R0603	Resistor	Any	
109	1	R44	R050 ±1% R1210	Resistor	Any	
110	1	R45	330 K ±1% R0603	Resistor	Any	
111	1	R46	91 K ±1% R0603	Resistor	Any	
112	1	R47	2 K R0603	Resistor	Any	
113	1	R48	0R ±1% R0603	Resistor	Any	
114	1	R49	0R0 R0603	Resistor	Any	
115	1	R50	390 R ±1% R0603	Resistor	Any	
116	1	R51	2 K ±1% R0603	Resistor	Any	
117	1	R52	20 k ±1% R0603	Resistor	Any	
118	1	R53	4.7 K ±1% R0603	Resistor	Any	
119	1	R54	4K64 ±1% R0603	Resistor (not mounted)	Any	
120	1	R55	5K23 ±1% R0603	Resistor	Any	
121	1	R56	10 K R0603	Resistor	Any	
122	5	R57, R58, R59, R60, R67	0R0 R0805	Resistor (not mounted)	Any	
123	1	R61	10 K R0805	Resistor	Any	
124	1	R62	5K6 R0805	Resistor (not mounted)	Any	
125	1	R69	100 k R0805	Resistor	Any	
126	2	R76, R77	0R R0805	Resistor	Any	
127	1	R78	0R R1206	Resistor	Any	
128	1	R101	±1% R0603	Resistor (not mounted)	Any	
129	1	R102	1 K R0603	Resistor	Any	
130	1	R103	12k ±1% R0603	Resistor	Any	
131	1	R104	56K ±1% R0603	Resistor	Any	
132	1	R105	330 R R0603	Resistor	Any	

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
133	1	R107	0R0 R0805	Resistor	Any	
134	1	R108	R100 R1210	Resistor	Any	
135	1	R114	4K7 R0805	Resistor	Any	
136	2	R115, R116	100 k R0805	Resistor	Any	
137	1	R117	4k7 R0805	Resistor	Any	
138	1	R118	0 R R0805	Resistor (not mounted)	Any	
139	1	R119	100 k R0603	Resistor (not mounted)	Any	
140	1	R120	4k3 R0805	Resistor	Any	
141	1	R121	20 K R0805	Resistor	Any	
142	1	R122	47 K R0805	Resistor	Any	
143	1	R123	1 k R0805	Resistor	Any	
144	1	R124	18 R R0805	Resistor	Any	
145	1	R125	47 K R0603	Resistor	Any	
146	1	R126	10 R0603	Resistor	Any	
147	1	R127	470 K R0603	Resistor	Any	
148	1	R128	10 K R0603	Resistor	Any	
149	1	R129	6K8 R0603	Resistor (not mounted)	Any	
150	1	R130	2K2 R0603	Resistor (not mounted)	Any	
151	1	R131	0R0 R0603	Resistor	Any	
152	1	R132	0R0 R0603	Resistor (not mounted)	Any	
153	1	R133	100K R0603	Resistor	Any	
154	2	RV1, RV2	1812	Surge arrester (not mounted)	TDK	B88069X9231T 203
155	1	T1	POE Trafo	Data Trafo	Wurth Elektronik	7490220123
					Coilcraft	WA8704-ALD
156	1	T2	RN112	Common Choke (not mounted)	Schaffner	RN 112-4-02-0M7
157	1	T3	750370225 Rev 03	Power Trafo	Wurth Elektronik	
158	1	T4		Planar Power Trafo (not mounted)	Coilcraft	
159	2	T5, T6	WURTH_WE-SL5	Common Choke (not mounted)	Wurth Elektronik	744272471
160	2	T7, T8	RN102	Common Choke	Schaffner	RN 102-2-02-1M1

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
161	14	TP1, TP3, TP5, TP7, TP8, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20	KEYSTONE_5010	Test point red	Any	
162	4	TP2, TP4, TP6, TP9	KEYSTONE_5011	Test point black	Any	
163	2	TP10, TP11	MILLMAX_2501	Test point turret	Any	
164	1	U1	QFN56-8X8X1-49PIN	Controller	ST	PM8805
165	1	U2	16QFN_3X3X0.75_0.5	Controller	ST	PM8804
166	1	U3	FOD817	Optocoupler	Fairchild	FOD817AS
167	2	U4, U23	SOT-23-5LEAD	Voltage Reference (not mounted)	ST	TS431AILT
168	5	U5, U16, U17, U18, U19	Diode TVS SMC	Transil	Any	
169	5	U6, U7, U8, U9, U11	Diode TVS SMC	Transil (not mounted)	Any	
170	1	U10	Diode TVS SMC	Transil	ST	SM15T68CA
171	2	U12, U24	SOT-23-3L	Voltage Reference	ST	TS2431-AILT
172	2	U20, U21	Diode TVS SMC	Transil (not mounted)	Any	
173	1	U22	FOD817	Optocoupler	Fairchild	FOD817AS

6 Board layout

Figure 30. **STEVAL-POE005V1 reference design PCB top assembly**

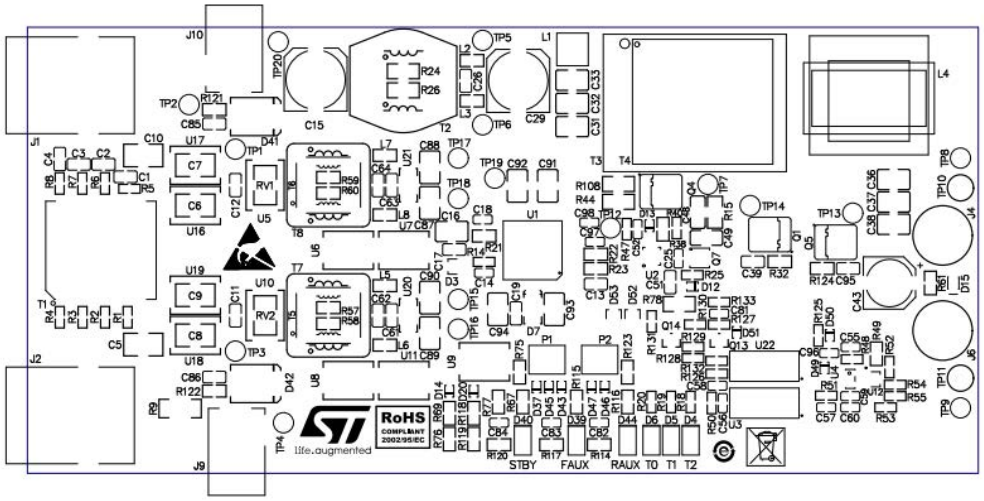


Figure 31. **STEVAL-POE005V1 reference design PCB bottom assembly**

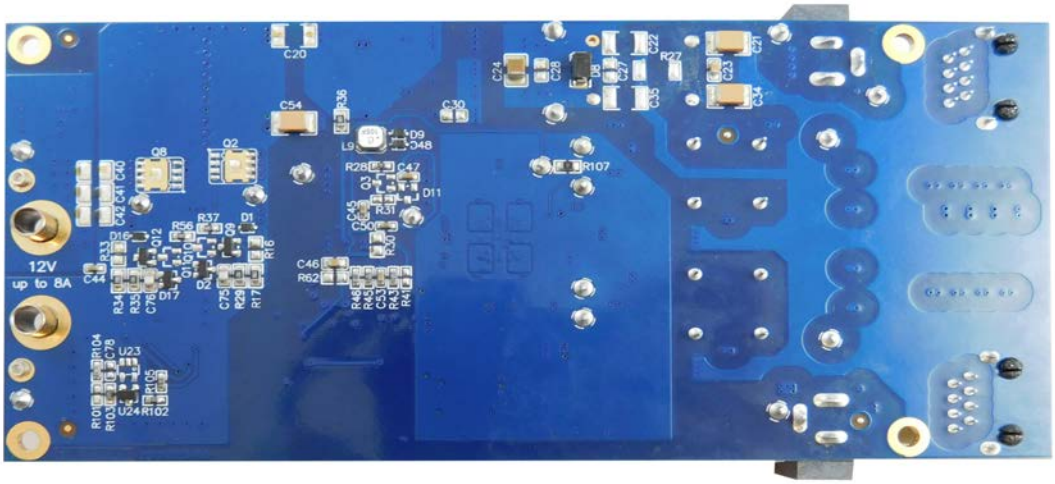


Figure 32. **STEVAL-POE005V1 reference design PCB layer 1 top**

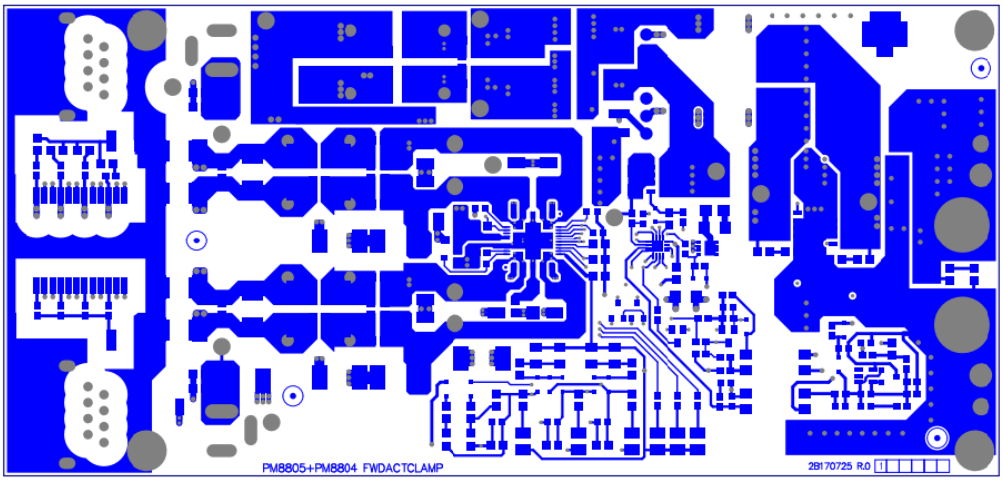


Figure 33. **STEVAL-POE005V1 reference design PCB layer 2**

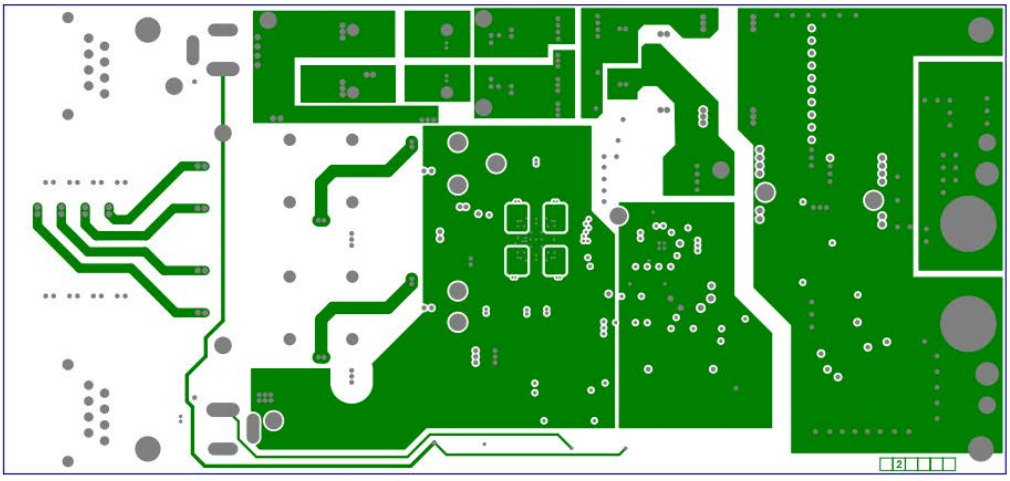


Figure 34. **STEVAL-POE005V1 reference design PCB layer 3**

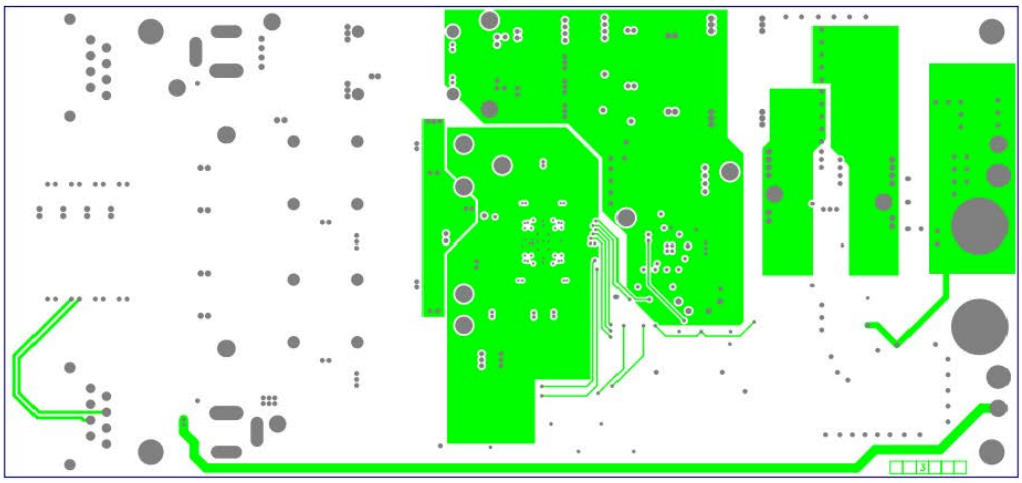


Figure 35. **STEVAL-POE005V1 reference design PCB layer 4**

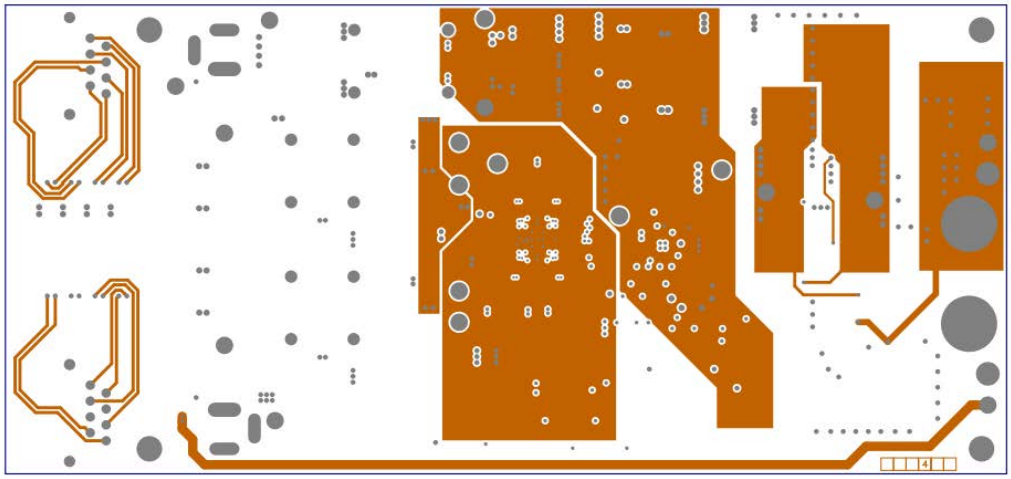


Figure 36. **STEVAL-POE005V1 reference design PCB layer 5**

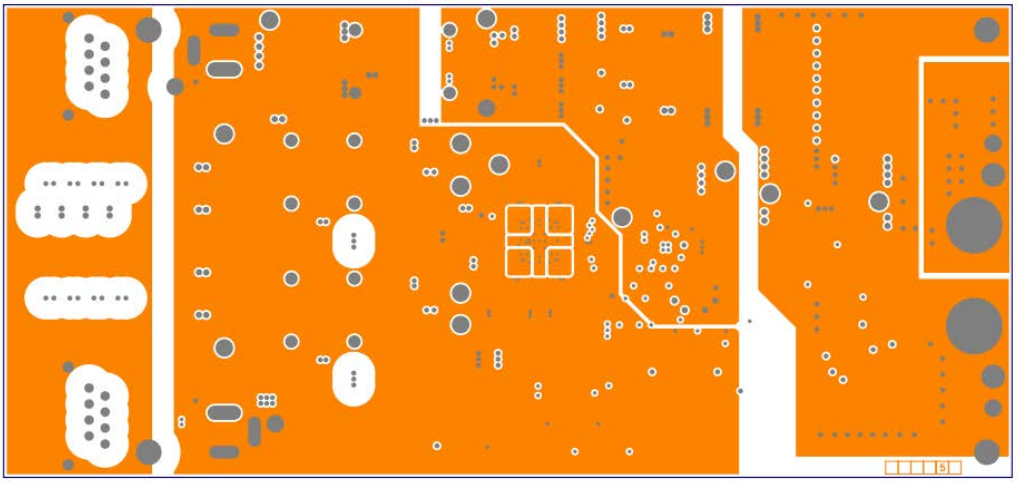


Figure 37. **STEVAL-POE005V1 reference design PCB layer 6**

A References

Freely available on www.st.com:

1. PM8804 datasheet
2. PM8805 datasheet

Revision history

Table 9. **Document revision history**

Date	Version	Changes
05-Oct-2018	1	Initial release.
09-May-2019	2	Updated title, Introduction, Figure 1. STEVAL-POE005V1 reference design and Figure 2. STEVAL-POE005V1 reference design: component view.

Contents

List of figures

List of tables