# AN4687
# Application note

# PoE synchronous flyback, IEEE802.3at compliant, 3.3 V - 6 A PD converter based on the PM8803 controller

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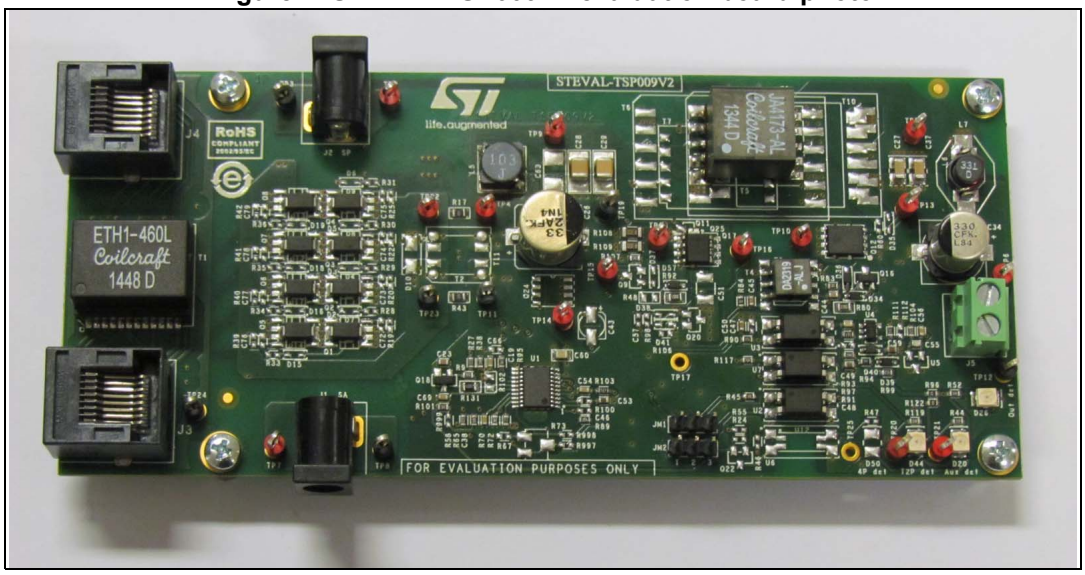
## Introduction

This document describes a reference design for a PoE+, high efficiency, 3.3 V - 6 A flyback converter based on the PM8803 PoE controller.

The PM8803 is highly integrated device embedding an IEEE802.3at compliant “Powered Device” (PD) interface together with a PWM controller and support for auxiliary sources.

The STEVAL-TSP009V2 reference design is based on an isolated flyback topology CCM converter with synchronous rectification and gate driver transformer. The same PCB can be populated in different ways to support various configurations and topologies (flyback with diode rectification, synchronous flyback with or without active clamp, self-driven synchronous flyback).

**Figure 1. STEVAL-TSP009V2 evaluation board photo**



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# 1 Main characteristics and circuit description

The main characteristics (reference and electrical specifications) of the converter are listed in *Table 1* and *Table 2*.

**Table 1. Reference**

| Reference code | |
|---|---|
| **Device** | PM8803 |
| **Evaluation board** | STEVAL-TSP009V2 |

**Table 2. Electrical specification**

| Parameter | Specifications |
|---|---|
| Input voltage supplies $V_{IN}$ [$V_{DC}$] | From 40 to 60 V |
| Auxiliary input voltage range | From 30 to 60 V |
| Output voltage $V_{OUT}$ [$V_{DC}$] | 3.3 $V_{DC}$ ±5% at 6 A |
| Peak to peak output ripple | < 25 $mV_{PP}$ |
| Efficiency DC-DC at full-load | > 90% |
| Efficiency overall at full load | > 87% |
| Transient response $\Delta V_{OUTPK}$ to 50% load step | < 250 mV |
| $\Delta V_{OUT}$ in load line case | < 0.5% |
| GLOOP bandwidth | > 4 kHz |
| GLOOP phase margin at 0 dB | > 60 deg. |
| GLOOP dB margin at 0 deg. | > 10 dB |

This document details the characteristics and performances of the PM8803 evaluation kit STEVAL-TSP009V2, which has been designed to cover a broad range of Power over Ethernet (PoE) applications.

The PM8803 is a highly integrated device embedding an IEEE802.3af/at compliant powered device (PD) interface together with a PWM controller and support for auxiliary sources.

Even though PM8803 device can be configured to work in several isolated topologies, self-driven or a transformer gate driven; this application note focuses on a high efficiency isolated flyback converter topology with synchronous rectification, 3.3 V output voltage with 6 A output current capability.

Auxiliary sources can be connected to the board on two different input connectors. One input (AUX II) allows prevalence of the auxiliary sources with respect to the PoE, while the other input ( AUX I ) allows the usage of a wall adaptor with voltage lower than the internal PoE UVLO threshold and still benefits from the inherent inrush and DC current limit.

The possible configurations supported by the PM8803 demonstration kit as options on the same PCB are:

- Alternative input bridge rectification: 4 possible options including standard diode bridges, discrete schottky diode bridges, half active bridges and full active bridges; schottky diode bridges are mounted on this eval board.
- Optional 4 pairs detection circuit, to detect if power is provided on 2 pairs or on 4 pairs by a high power PSE source; this circuit is not used on this eval board.
- Optional booster circuit, to increase the max. input current over 1A; this circuit is not used on this eval board.
- Diode or synchronous rectification; 4 package options for the diode and 2 package options for the MOSFET;
- Primary side snubber; 3 options included an active clamp; a simple R-C snubber is used on this eval board.
- Power transformer; 3 size options for transformer gate driven solutions and 2 size options for self-driven applications.

The bill of material (BOM) in *Table 3*, provides the list of components to be mounted to obtain a flyback CCM converter with gate transformer driven synchronous rectifier, with 3.3 V output at a 6 A evaluation board.

# 2 Schematic and BOM for 3.3 V at 6 A

## 2.1 Schematic

**Figure 2. STEVAL-TSP009V2 circuit schematic (1 of 2)**

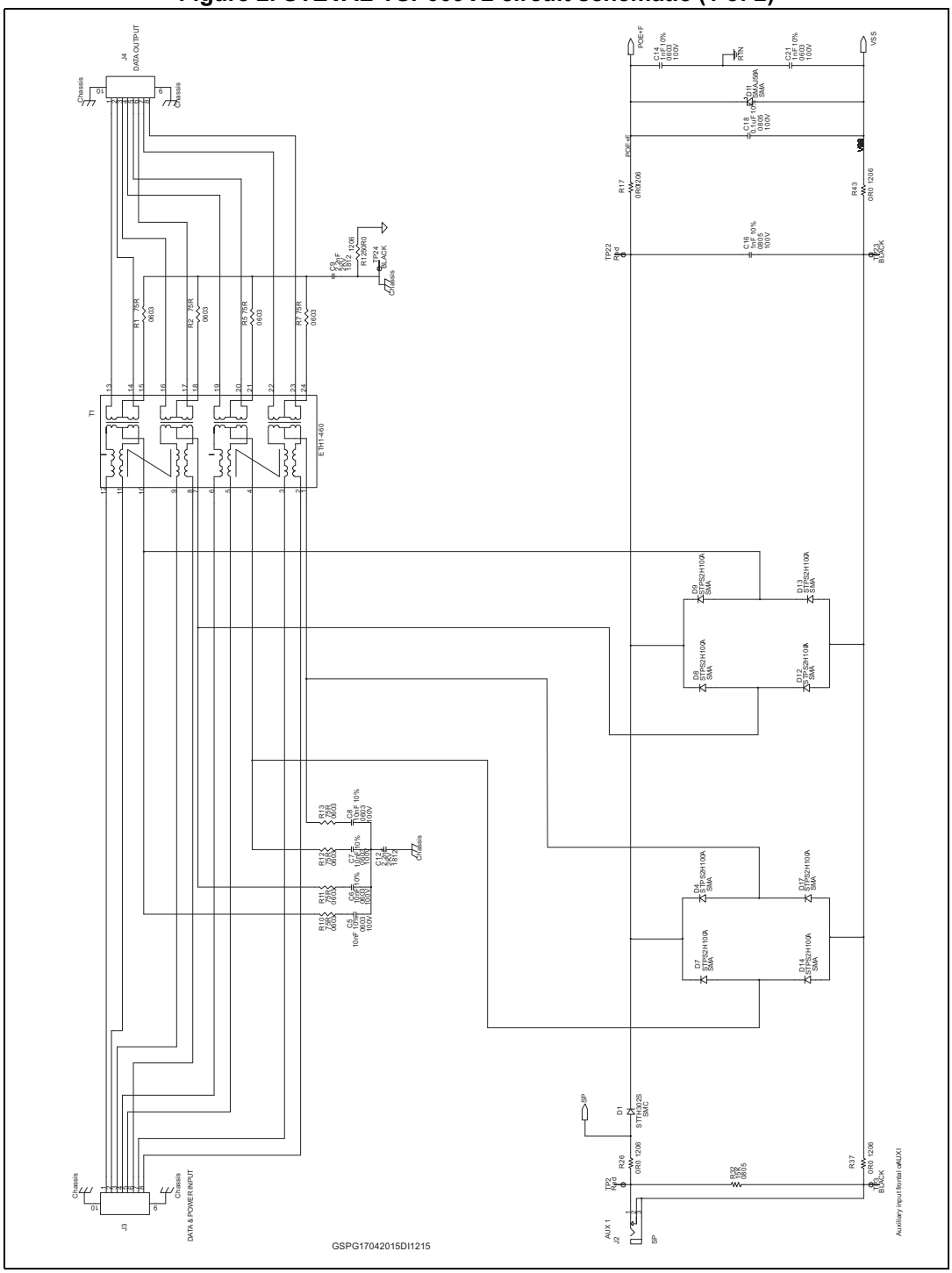
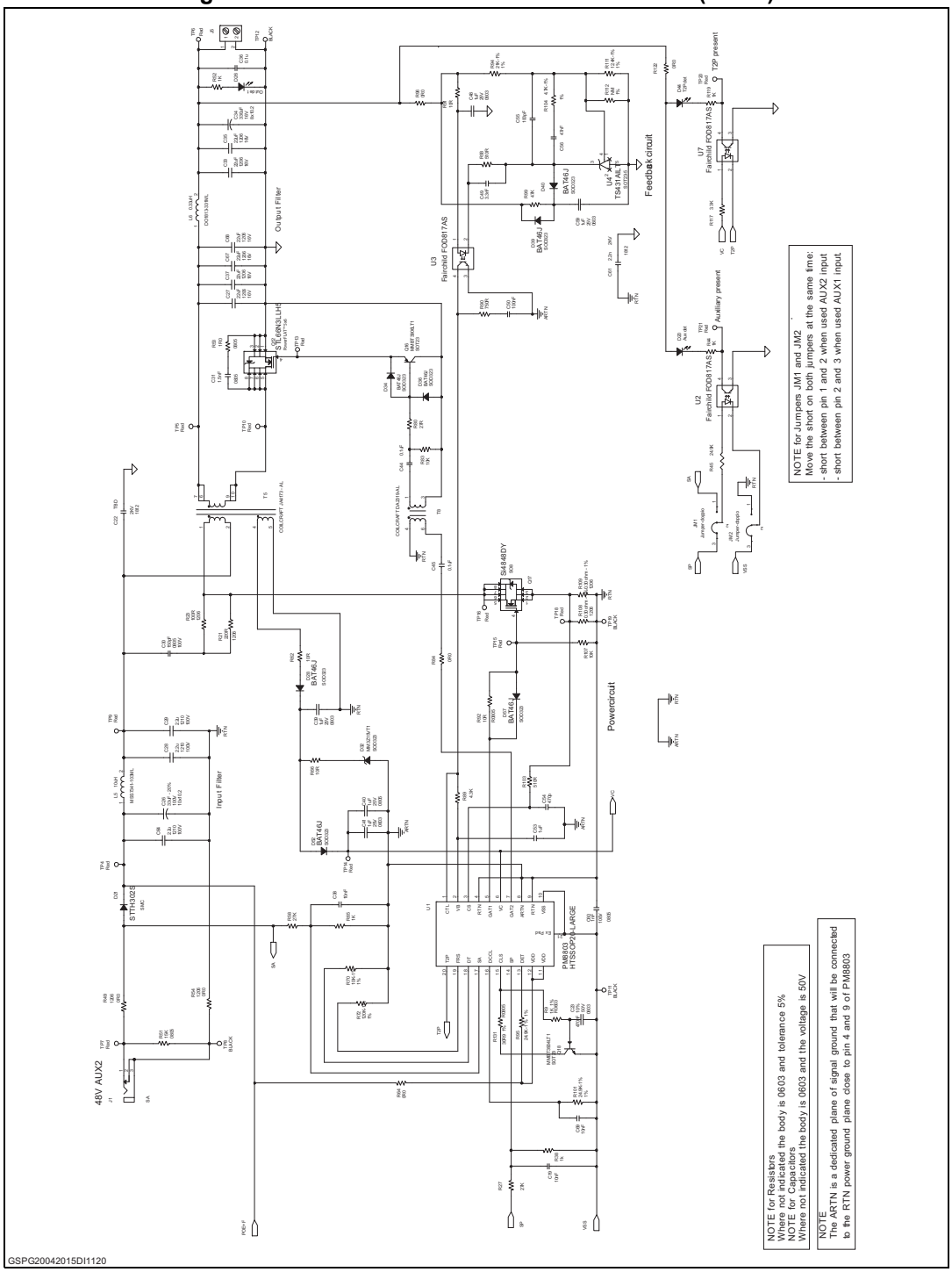


**Figure 3. STEVAL-TSP009V2 circuit schematic (2 of 2)**



## 2.2 Bill of material

**Table 3. STEVAL-TSP009V2 evaluation board BOM**

| Item | Ref. | Description | Value | PCB footprint | Supplier | Voltage |
|---|---|---|---|---|---|---|
| 1 | C5 | Ceramic Capacitor | 10 nF - 10% | C0603 | TDK | 100 V |
| 2 | C6 | Ceramic Capacitor | 10 nF - 10% | C0603 | TDK | 100 V |
| 3 | C7 | Ceramic Capacitor | 10 nF - 10% | C0603 | TDK | 100 V |
| 4 | C8 | Ceramic Capacitor | 10 nF - 10% | C0603 | TDK | 100 V |
| 5 | C9 | Ceramic Capacitor | 2.2 nF | C1812 | AVX | 2 kV |
| 6 | C12 | Ceramic Capacitor | 2.2 nF | C1812 | AVX | 2 kV |
| 7 | C14 | Ceramic Capacitor | 1 nF - 10% | C0603 | TDK | 100 V |
| 8 | C16 | Ceramic Capacitor | 1 nF - 10% | C0805 | TDK | 100 V |
| 9 | C18 | Ceramic Capacitor | 0.1 µF - 10% | C0805 | TDK | 100 V |
| 10 | C19 | Ceramic Capacitor | 10 nF | C0603 | Several | 50 V |
| 11 | C21 | Ceramic Capacitor | 1 nF - 10% | C0603 | TDK | 100 V |
| 12 | C22 | Ceramic Capacitor | TBD | C1812 | AVX | 2 kV |
| 13 | C23 | Ceramic Capacitor | 470 nF - 10% | C0603 | Several | 50 V |
| 14 | C26 | Aluminium Capacitor | 33 µF - 20% | C-POL8-10 | Panasonic EEEFK2A330P | 100 V |
| 15 | C27 | Ceramic Capacitor | 22 µF | C1206 | Murata - GRM31CR61C 226ME15L | 16 V |
| 16 | C28 | Ceramic Capacitor | 2.2 µF | C1210 | Murata - GRM32ER72A 225KA35L | 100 V |
| 17 | C29 | Ceramic Capacitor | 2.2 µF | C1210 | Murata - GRM32ER72A 225KA35L | 100 V |
| 18 | C30 | Ceramic Capacitor | 150 pF | C0805 | TDK | 100 V |
| 19 | C31 | Ceramic Capacitor | 1.5 nF | C0805 | Several | 50 V |
| 20 | C33 | Ceramic Capacitor | 22 µF | C1206 | Murata - GRM31CR61C 226ME15L | 16 V |
| 21 | C34 | Aluminium Capacitor | 330 µF | C-POL8-10 | Panasonic EEEFK1C331P | 16 V |
| 22 | C35 | Ceramic Capacitor | 22 µF | C1206 | Murata - GRM31CR61C 226ME15L | 16 V |
| 23 | C36 | Ceramic Capacitor | 0.1 µF | C0603 | Several | 50 V |
| 24 | C37 | Ceramic capacitor | 22 µF | C1206 | Murata - GRM31CR61C 226ME15L | 16 V |

Table 3. STEVAL-TSP009V2 evaluation board BOM (continued)

| Item | Ref. | Description | Value | PCB footprint | Supplier | Voltage |
|---|---|---|---|---|---|---|
| 25 | C38 | Ceramic capacitor | 10 nF | C0603 | Several | 50 V |
| 26 | C39 | Ceramic capacitor | 1 µF | C0603 | KEMET | 25 V |
| 27 | C40 | Ceramic capacitor | 1 µF | C1206 | KEMET | 25 V |
| 28 | C41 | Ceramic capacitor | 1 µF | C0603 | KEMET | 25 V |
| 29 | C44 | Ceramic capacitor | 0.1 µF | C0603 | Several | 50 V |
| 30 | C45 | Ceramic capacitor | 0.1 µF | C0603 | Several | 50 V |
| 31 | C48 | Ceramic capacitor | 1 µF | C0603 | KEMET | 25 V |
| 32 | C49 | Ceramic capacitor | 3.3 nF | C0603 | Several | 50V |
| 33 | C50 | Ceramic capacitor | 100 nF | C0603 | Several | 50 V |
| 34 | C53 | Ceramic capacitor | 1 µF | C0603 | KEMET | 25 V |
| 35 | C54 | Ceramic capacitor | 470 p | C0603 | Several | 50 V |
| 36 | C55 | Ceramic capacitor | 100 pF | C0603 | Several | 50 V |
| 37 | C56 | Ceramic capacitor | 47 nF | C0603 | Several | 50 V |
| 38 | C59 | Ceramic capacitor | 1 µF | C0603 | KEMET | 25 V |
| 39 | C60 | Ceramic capacitor | 1 nF | C0805 | TDK | 100 V |
| 40 | C61 | Ceramic capacitor | 2.2 nF | C1812 | AVX | 2 kV |
| 41 | C64 | Ceramic capacitor | 2.2 µF | C1210 | Murata - GRM32ER72A 225KA35L | 100 V |
| 42 | C67 | Ceramic capacitor | 22 µF | C1206 | Murata - GRM31CR61C 226ME15L | 16 V |
| 43 | C68 | Ceramic capacitor | 22 µF | C1206 | Murata - GRM31CR61C 226ME15L | 16 V |
| 44 | C69 | Ceramic capacitor | 10 nF | C0603 | Several | 50 V |
| 45 | D1 | Diode | STTH302S | SMC | STM | |
| 46 | D4 | Schottky diode | STPS2H100A | SMA | STM | |
| 47 | D7 | Schottky diode | STPS2H100A | SMA | STM | |
| 48 | D8 | Schottky diode | STPS2H100A | SMA | STM | |
| 49 | D9 | Schottky diode | STPS2H100A | SMA | STM | |
| 50 | D11 | TVS diode | SMAJ58A | SMA | STM | |
| 51 | D12 | Schottky diode | STPS2H100A | SMA | STM | |
| 52 | D13 | Schottky diode | STPS2H100A | SMA | STM | |
| 53 | D14 | Schottky diode | STPS2H100A | SMA | STM | |
| 54 | D17 | Schottky diode | STPS2H100A | SMA | STM | |
| 55 | D20 | Diode LED | Aux det | KA-3528SGT | Kingbright | |

Table 3. STEVAL-TSP009V2 evaluation board BOM (continued)

| Item | Ref. | Description | Value | PCB footprint | Supplier | Voltage |
|---|---|---|---|---|---|---|
| 56 | D21 | Diode | STTH302S | SMC | STM | |
| 57 | D26 | Diode LED | Out det | KA-3528SGT | Kingbright | |
| 58 | D28 | Schottky Diode | BAT46J | SOD323 | STM | |
| 59 | D32 | Zener diode | MM3Z15VT1 | SOD323 | Onsemi | |
| 60 | D34 | Schottky diode | BAT46J | SOD323 | STM | |
| 61 | D36 | Schottky diode | BAT46J | SOD323 | STM | |
| 62 | D39 | Schottky diode | BAT46J | SOD323 | STM | |
| 63 | D40 | Schottky diode | BAT46J | SOD323 | STM | |
| 64 | D44 | Diode LED | T2P det | KA-3528SGT | Kingbright | |
| 65 | D52 | Schottky diode | BAT46J | SOD323 | STM | |
| 66 | D57 | Schottky diode | BAT46J | SOD323 | STM | |
| 67 | JM1 | Connector | Jumper-doppio | 3PIN-P254 | Several | |
| 68 | JM2 | Connector | Jumper-doppio | 3PIN-P254 | Several | |
| 69 | J1 | Connector | SA | P-JACK-RAPC722 | Several | |
| 70 | J2 | Connector | SP | P-JACK-RAPC722 | Several | |
| 71 | J3 | Connector | Data & power input | RJ45-8PIN | Molex | |
| 72 | J4 | Connector | Data output | RJ45-8PIN | Molex | |
| 73 | J5 | Connector | MOR-10X10.5-P5-2PIN | MOR-2POLI-508 | Several | |
| 74 | L5 | Inductor | 10 µH | MSS7341-103ML | Coilcraft | |
| 75 | L6 | Inductor | 0.33 µH | DO1813H | Coilcraft | |
| 76 | Q12 | MOSFET | STL66N3LLH5 | PowerFLAT™ 5x6 | STM | |
| 77 | Q16 | MOSFET | MMBT3906LT1 | SOT23 | Several | |
| 78 | Q17 | MOSFET | Si4848DY | so8pwrpak-SO8 | VISHAY | |
| 79 | Q18 | MOSFET | MMBT3904LT1 | SOT23 | Several | |
| 80 | R1 | Resistor | 75 R | R0603 | Several | |
| 81 | R2 | Resistor | 75 R | R0603 | Several | |
| 82 | R5 | Resistor | 75 R | R0603 | Several | |
| 83 | R7 | Resistor | 75 R | R0603 | Several | |
| 84 | R9 | Resistor | 1K - 1% | R0603 | Several | |
| 85 | R10 | Resistor | 75 R | R0603 | Several | |
| 86 | R11 | Resistor | 75 R | R0603 | Several | |

Table 3. STEVAL-TSP009V2 evaluation board BOM (continued)

| Item | Ref. | Description | Value | PCB footprint | Supplier | Voltage |
|---|---|---|---|---|---|---|
| 87 | R12 | Resistor | 75 R | R0603 | Several | |
| 88 | R13 | Resistor | 75 R | R0603 | Several | |
| 89 | R17 | Resistor | 0R0 | R0805 | Several | |
| 90 | R21 | Resistor | 220 R | R1206 | Several | |
| 91 | R23 | Resistor | 100 R | R1206 | Several | |
| 92 | R26 | Resistor | 0R0 | R1206 | Several | |
| 93 | R27 | Resistor | 27 K | R0603 | Several | |
| 94 | R32 | Resistor | 15 K | R0805 | Several | |
| 95 | R37 | Resistor | 0R0 | R1206 | Several | |
| 96 | R38 | Resistor | 1 k | R0603 | Several | |
| 97 | R43 | Resistor | 0R0 | R0805 | Several | |
| 98 | R44 | Resistor | 1 k | R0603 | Several | |
| 99 | R45 | Resistor | 24.9 k | R0603 | Several | |
| 100 | R49 | Resistor | 0R0 | R1206 | Several | |
| 101 | R51 | Resistor | 15 K | R0805 | Several | |
| 102 | R52 | Resistor | 1 K | R0603 | Several | |
| 103 | R53 | Resistor | 1R0 | R1206 | Several | |
| 104 | R54 | Resistor | 0R0 | R1206 | Several | |
| 105 | R58 | Resistor | 27 K | R0603 | Several | |
| 106 | R62 | Resistor | 10 R | R0603 | Several | |
| 107 | R64 | Resistor | 0R0 | R0603 | Several | |
| 108 | R65 | Resistor | 1 K | R0603 | Several | |
| 109 | R66 | Resistor | 10 R | R0603 | Several | |
| 110 | R70 | Resistor | 10 K-1% | R0603 | Several | |
| 111 | R72 | Resistor | 120 K-1% | R0603 | Several | |
| 112 | R80 | Resistor | 27 R | R0805 | Several | |
| 113 | R83 | Resistor | 10 K | R0603 | Several | |
| 114 | R84 | Resistor | 0R0 | R0603 | Several | |
| 115 | R89 | Resistor | 4.3 K | R0603 | Several | |
| 116 | R90 | Resistor | 750 R | R0603 | Several | |
| 117 | R91 | Resistor | 10 R | R0603 | Several | |
| 118 | R92 | Resistor | 10 R | R0805 | Several | |
| 119 | R93 | Resistor | 510 R | R0603 | Several | |
| 120 | R94 | Resistor | 21 K-1% | R0603 | Several | |
| 121 | R95 | Resistor | 24.9 K-1% | R0603 | Several | |

Table 3. STEVAL-TSP009V2 evaluation board BOM (continued)

| Item | Ref. | Description | Value | PCB footprint | Supplier | Voltage |
|---|---|---|---|---|---|---|
| 122 | R96 | Resistor | 0R0 | R0603 | Several | |
| 123 | R99 | Resistor | 47 K | R0603 | Several | |
| 124 | R101 | Resistor | 24.9 K-1% | R0603 | Several | |
| 125 | R103 | Resistor | 510 R | R0603 | Several | |
| 126 | R104 | Resistor | 4.7 K-1% | R0603 | Several | |
| 127 | R107 | Resistor | 10 K | R0603 | Several | |
| 128 | R108 | Resistor | 0.30 Ω - 1% | R1206 | Bourns | |
| 129 | R109 | Resistor | 0.30 Ω - 1% | R1206 | Bourns | |
| 130 | R111 | Resistor | 12.4 K-1% | R0603 | Several | |
| 131 | R112 | Resistor | NM | R0603 | Several | |
| 132 | R117 | Resistor | 3.3 K | R0603 | Several | |
| 133 | R119 | Resistor | 1K | R0603 | Several | |
| 134 | R122 | Resistor | 0R0 | R0603 | Several | |
| 135 | R125 | Resistor | 0R0 | R1206 | Several | |
| 136 | R131 | Resistor | 30R9 -1% | R0805 | Several | |
| 137 | TP2 | Test point | Red | TH-5013 | Keystone | |
| 138 | TP3 | Test point | Black | TH-5013 | Keystone | |
| 139 | TP4 | Test point | Red | TH-5013 | Keystone | |
| 140 | TP5 | Test point | Red | TH-5013 | Keystone | |
| 141 | TP6 | Test point | Red | TH-5013 | Keystone | |
| 142 | TP7 | Test point | Red | TH-5013 | Keystone | |
| 143 | TP8 | Test point | Black | TH-5013 | Keystone | |
| 144 | TP9 | Test point | Red | TH-5013 | Keystone | |
| 145 | TP10 | Test point | Red | TH-5013 | Keystone | |
| 146 | TP11 | Test point | Black | TH-5013 | Keystone | |
| 147 | TP12 | Test point | Black | TH-5013 | Keystone | |
| 148 | TP13 | Test point | Red | TH-5013 | Keystone | |
| 149 | TP14 | Test point | Red | TH-5013 | Keystone | |
| 150 | TP15 | Test point | Red | TH-5013 | Keystone | |
| 151 | TP16 | Test point | Red | TH-5013 | Keystone | |
| 152 | TP18 | Test point | Red | TH-5013 | Keystone | |
| 153 | TP19 | Test point | Black | TH-5013 | Keystone | |
| 154 | TP20 | Test point | Red | TH-5013 | Keystone | |
| 155 | TP21 | Test point | Red | TH-5013 | Keystone | |
| 156 | TP22 | Test point | Red | TH-5013 | Keystone | |
| 157 | TP23 | Test point | Black | TH-5013 | Keystone | |

Table 3. STEVAL-TSP009V2 evaluation board BOM (continued)

| Item | Ref. | Description | Value | PCB footprint | Supplier | Voltage |
|---|---|---|---|---|---|---|
| 158 | TP24 | Test point | Black | TH-5013 | Keystone | |
| 159 | T1 | Data transfo | ETH1-460 | ETH1-460 | Coilcraft | |
| 160 | T5 | Power transfo | COILCRAFT JA4173 - AL | PA2328NL | Coilcraft | |
| 161 | T8 | Power transfo | COILCRAFT DA2319-AL | DA2318-AL | Coilcraft | |
| 162 | U1 | Controller IC | PM8803 | HTSSOP20-LARGE | STM | |
| 163 | U2 | Optocoupler | Fairchild FOD817AS | FOD817 | Fairchild | |
| 164 | U3 | Optocoupler | Fairchild FOD817AS | FOD817 | Fairchild | |
| 165 | U4 | Voltage reference | TS431AILT | SOT23-5L | STM | |
| 166 | U7 | Optocoupler | Fairchild FOD817AS | FOD817 | Fairchild | |

# 3 Measurements results

## 3.1 Efficiency comparison with three rectification bridge options

STEVAL-TSP009V2 provides different rectification bridge options: single Schottky diode, half active bridge, full active bridge and diode bridge. They are alternatively usable thanks the options available on the STEVAL-TSP009V2 demo's PCB. Efficiency measurements have been executed to compare the different characteristics cost/efficiency through three different rectification bridge options. Here below the schematics:

**Figure 4. Schematic Schottky bridge**

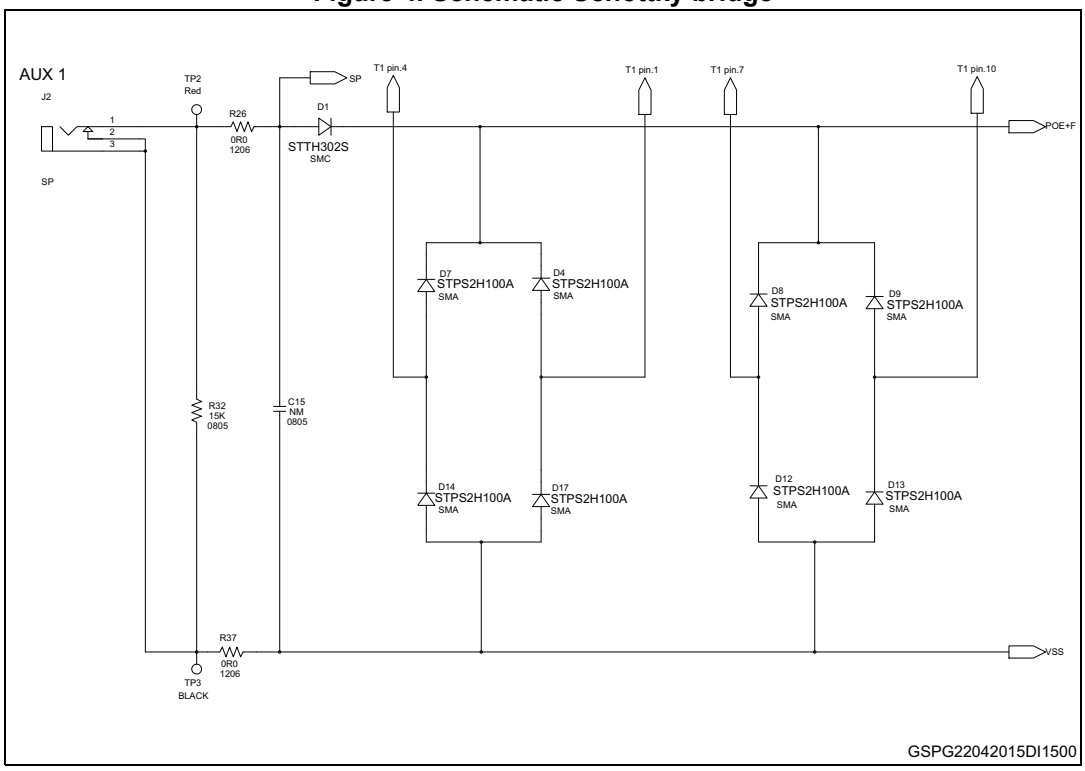


**Figure 5. Schematic full active bridge**

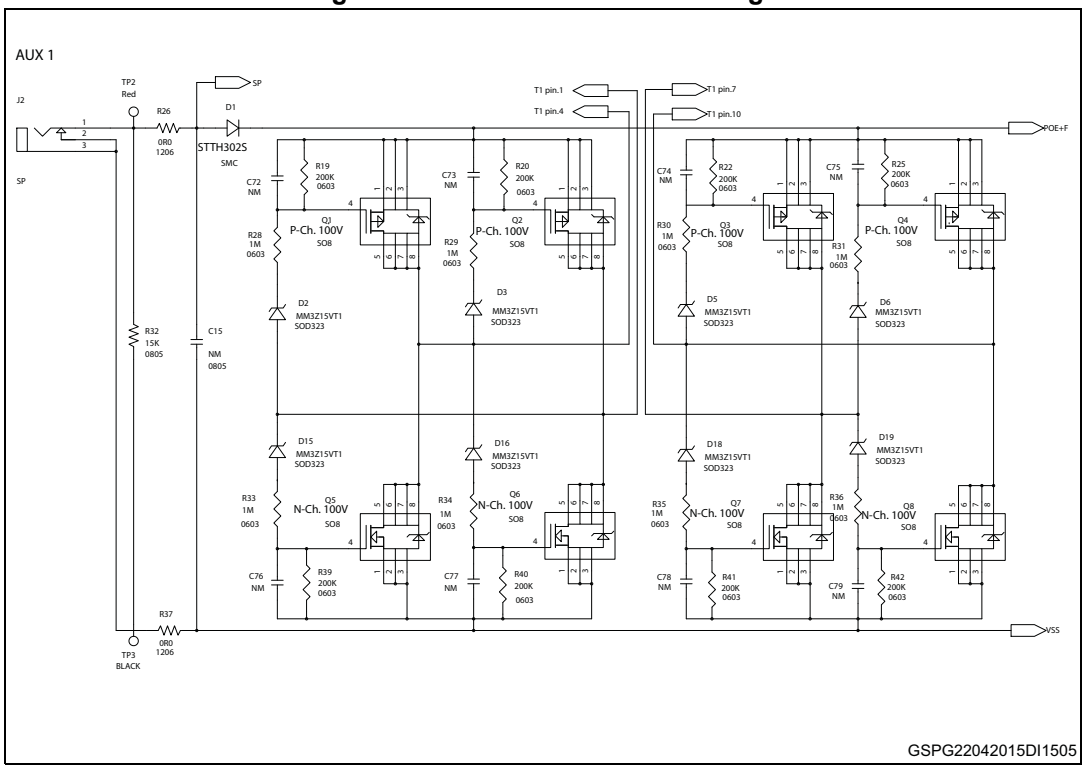



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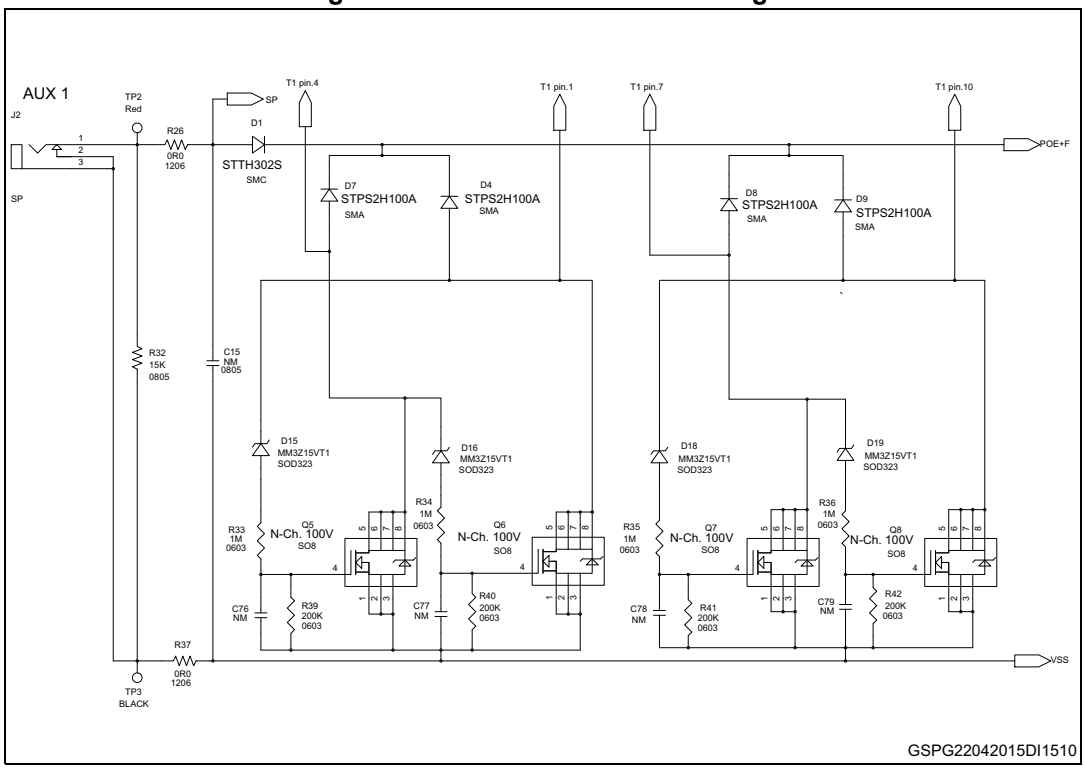
**Figure 6. Schematic half active bridge**

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The measurement has been executed providing a 48 V on the RJ45 connector and connecting the Poe+/Vss (TP22 vs TP23) with external electronic load with different current values to cover around 40 W of input power.

**Figure 7. Comparison efficiency bridge**

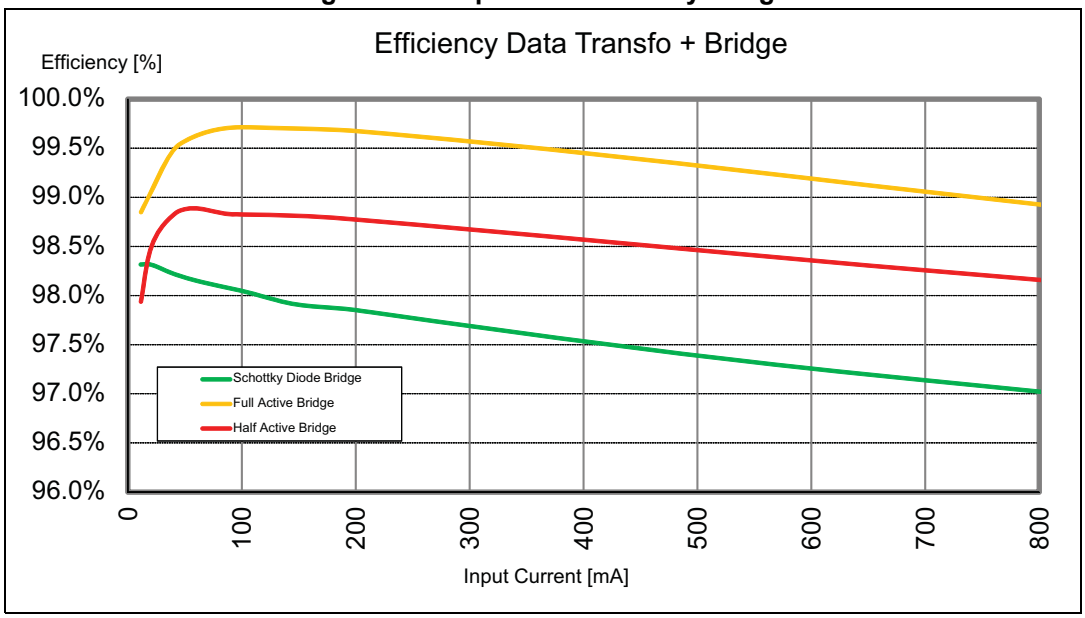



*Figure 7* shows the input stage efficiency comparison with three different bridge rectification type. The green line shows the efficiency of the Schottky diode bridge option, the cheaper of them, populated with four Schottky diodes STPS2H100A of each bridge. The yellow line shows the efficiency of the full active bridge, the most efficient, using two 100 V - 240 mΩ, P-channel MOSFET on high side and two 100 V - 65 mΩ N-channel MOSFET on low side of each bridge. The red line shows the half active bridge solution, which represent a right compromise in term of cost vs. efficiency.

Changing the input bridge it is possible to gain up to 2% about on the overall converter efficiency.

## 3.2 Converter efficiency

**Figure 8. Overall and DC/DC efficiency**

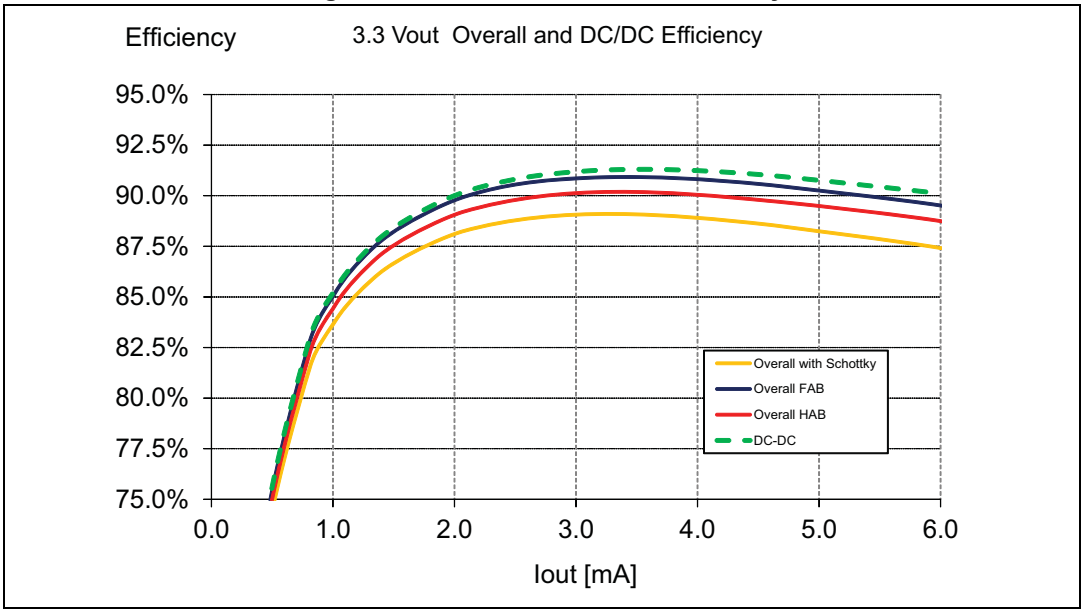



*Figure 8* shows overall and DC/DC efficiencies for the converter at 48 Vindc.

The dotted green line is the STEVAL-TSP009V2 DC-DC efficiency. The measurement has been executed supplying 48 V to the input RJ45 connector J1 and measuring the input voltage by TP22/TP23, input voltage of DC/DC converter stage. *Figure 8* shows also the overall efficiency comparison measured with the same DC-DC converter stage connected to the three different rectification bridge stages previously mentioned.

Please note that:

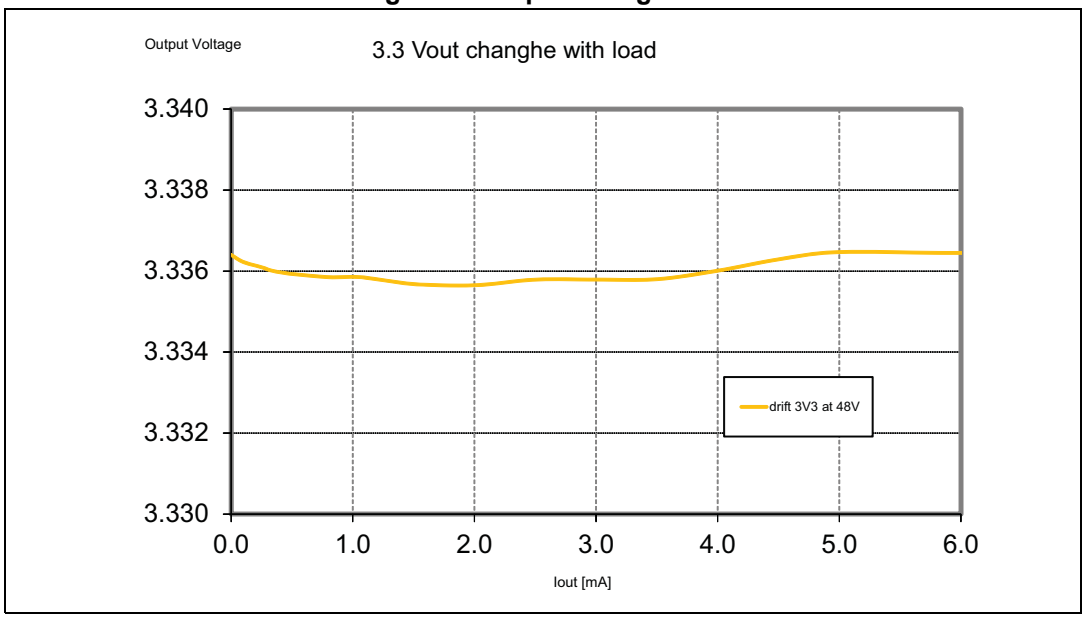
Overall efficiency includes all loss from RJ45 to the output voltage rail.

DC/DC efficiency is a figure of merit of the converter standalone and typically does not include the losses associated to the PoE interface section that are: the RJ45 connector, data transformer, bridges, power consumption of the I/F of the PM8803 device.

On the STEVAL-TSP009V2 eval board is mounted the simple Schottky diodes bridge solution (green line).

Thanks to the bridge rectification options foreseen on the pcb it is then possible to select the best compromise cost/efficiency depending on the target request.

Figure 9. Output voltage drift




## 3.3 Voltage ripple

Figure 10. Ripple on 3.3 V at 0.6 A

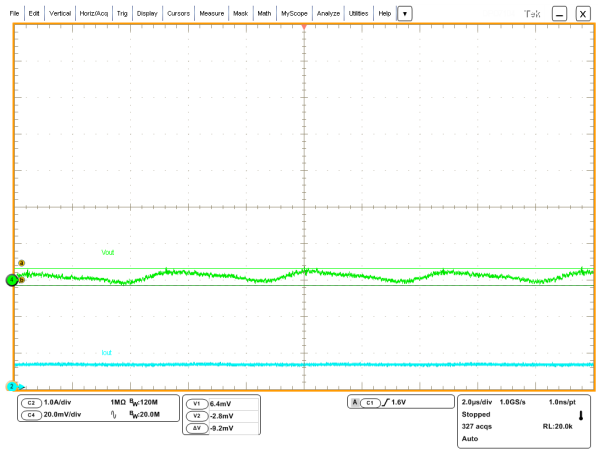
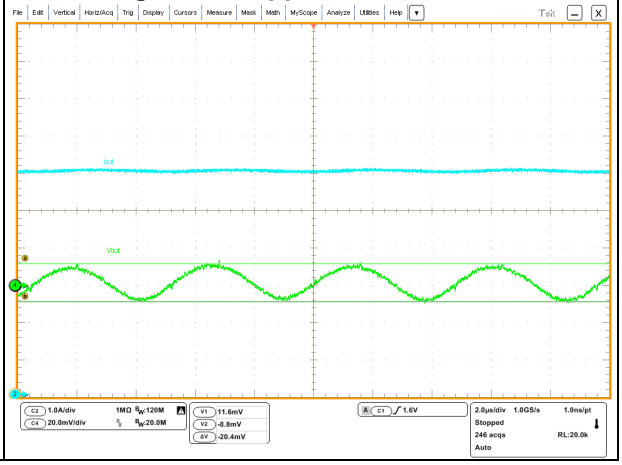


Figure 11. Ripple on 3.3 V at 6 A



Above measurements are referred at the output voltage ripple.

**Figure 12. Ripple before and after input filter with 3.3 V at 0.6 A (measured on C26 and C28)**

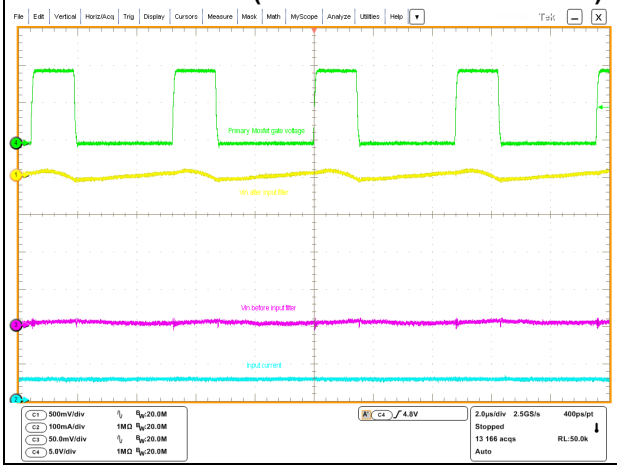
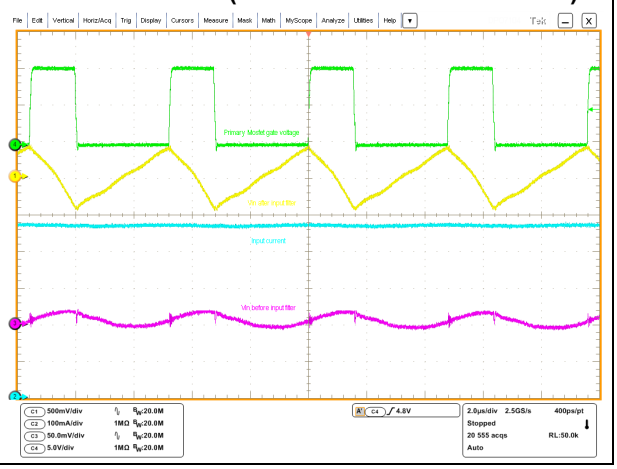



**Figure 13. Ripple before and after input filter with 3.3V at 6A (measured on C26 and C28)**




In *Figure 12* and *Figure 13* a measurement of the ripple on the input voltage has been done, to give an indication of the noise at the input of the converter.

## 3.4 Startup

**Figure 14. Startup from Microsemi 9001G injector - 3.3 V at 0.6 A**

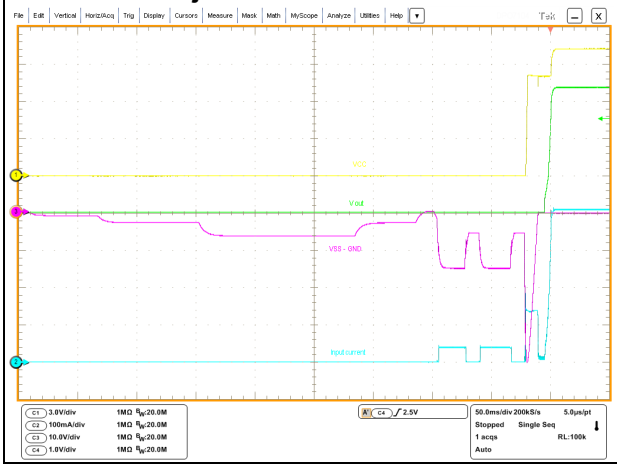



**Figure 15. Startup from Microsemi 9001G injector - 3.3 V at 6 A**

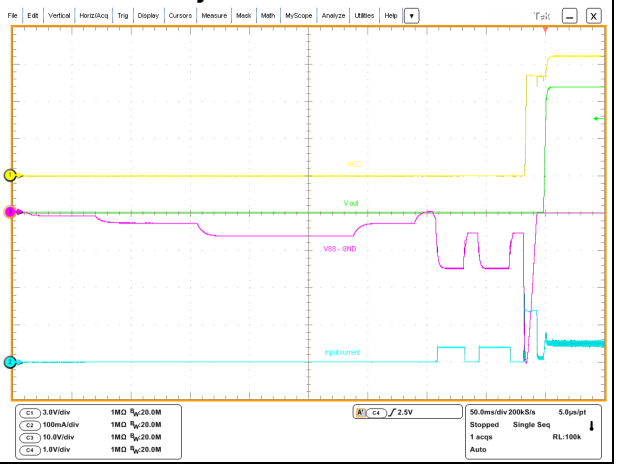


**Figure 16. Startup from Microsemi 9501G injector - 3.3 V at 0.6 A**

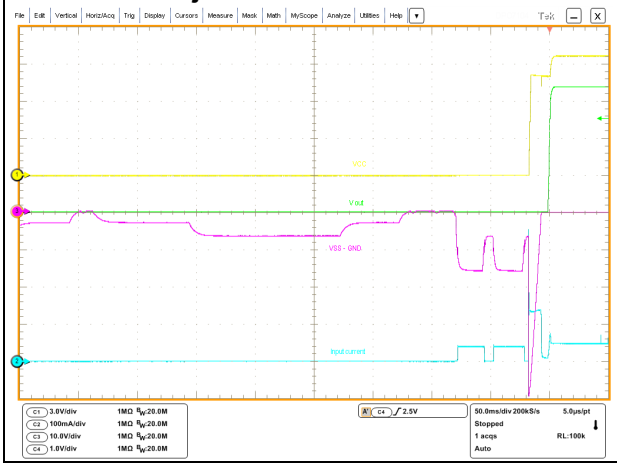



**Figure 17. Startup from Microsemi 9501G injector - 3.3 V at 6 A**

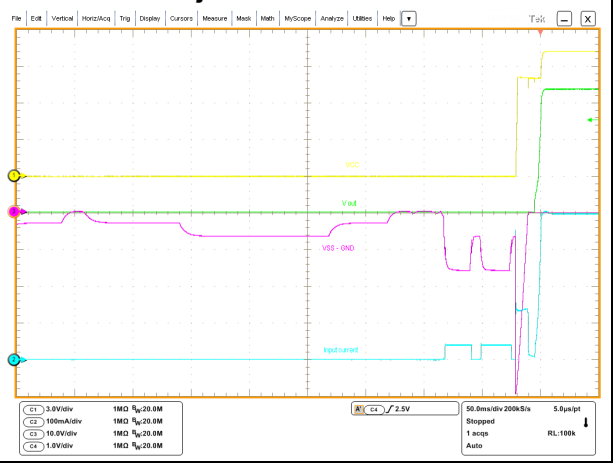



**Figure 18. Detail of the output voltage at startup with no load**

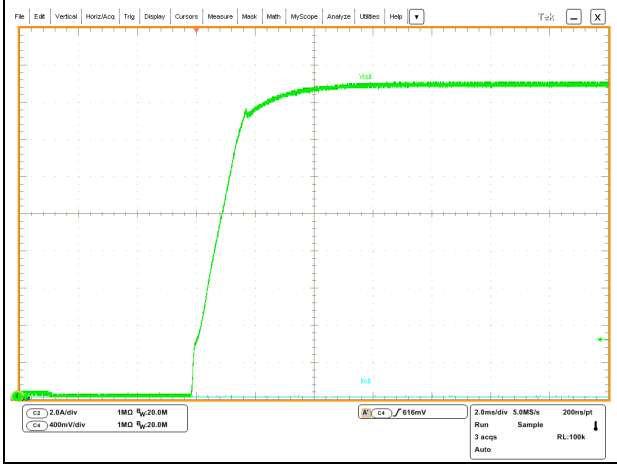
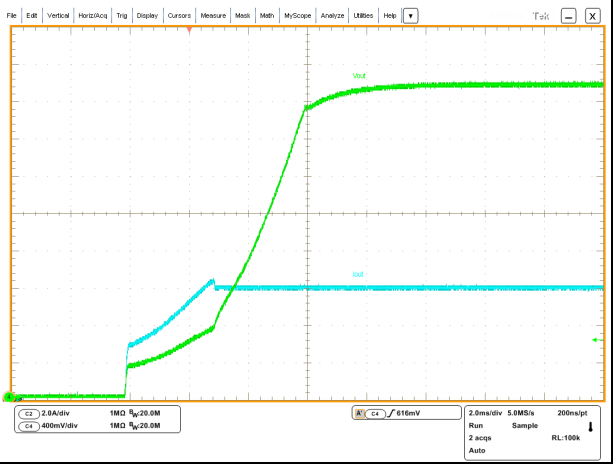



**Figure 19. Detail of the output voltage at startup with 6 A load**



## 3.5 Primary side waveforms

Figure 20. Primary steady state 0.6 A

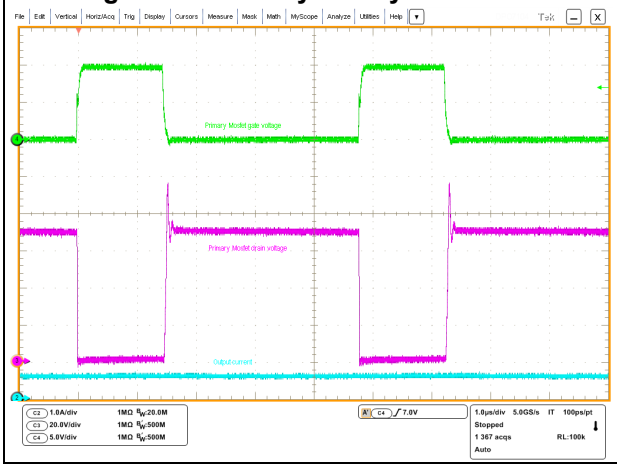



Figure 21. Primary steady state 6 A

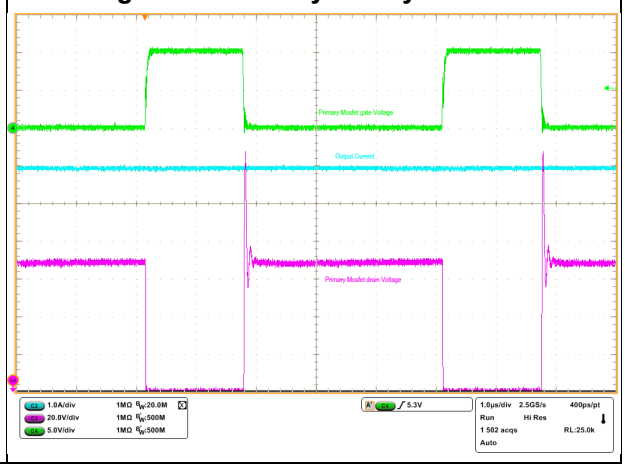
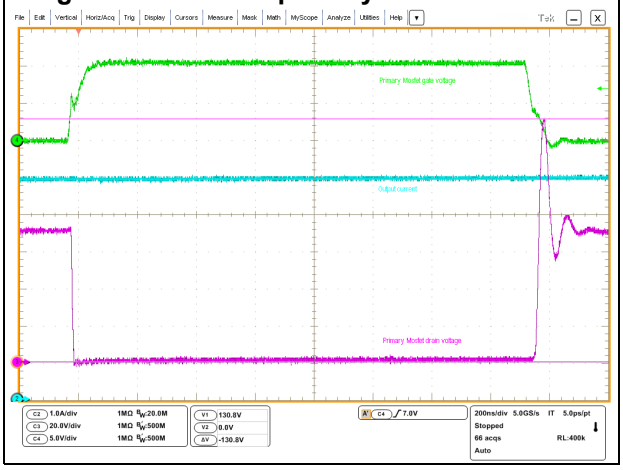



Figure 22. Detail of primary drain at 6 A load



## 3.6 Secondary side waveforms

Figure 23. Secondary steady state 0.6 A

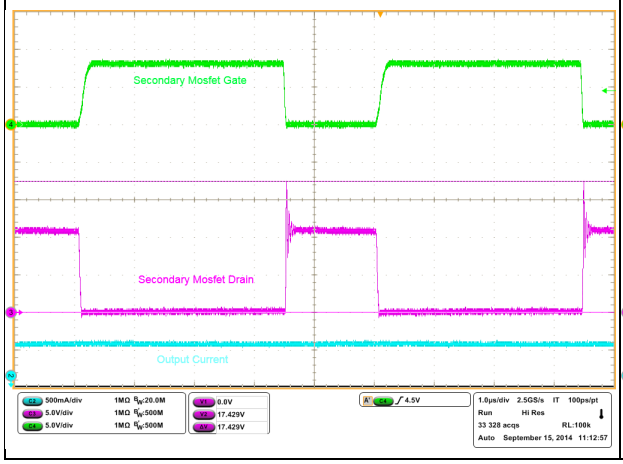



Figure 24. Secondary steady state 6 A

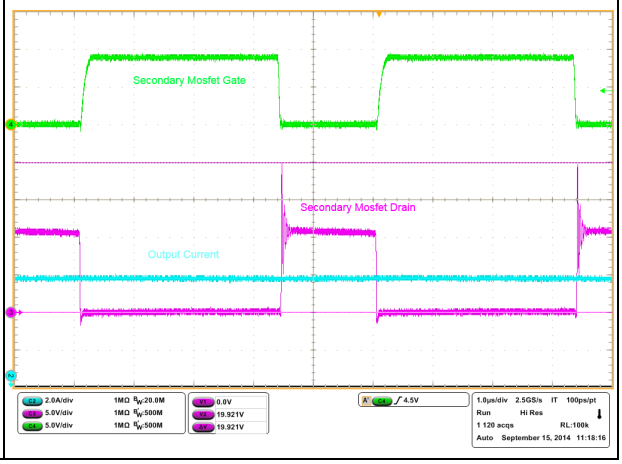
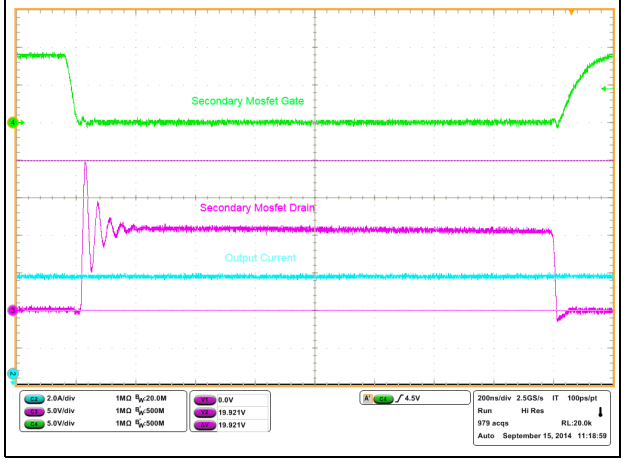



Figure 25. Detail of secondary drain at 6 A load




## 3.7 Load transients

Figure 26. Secondary steady state 0.6 A

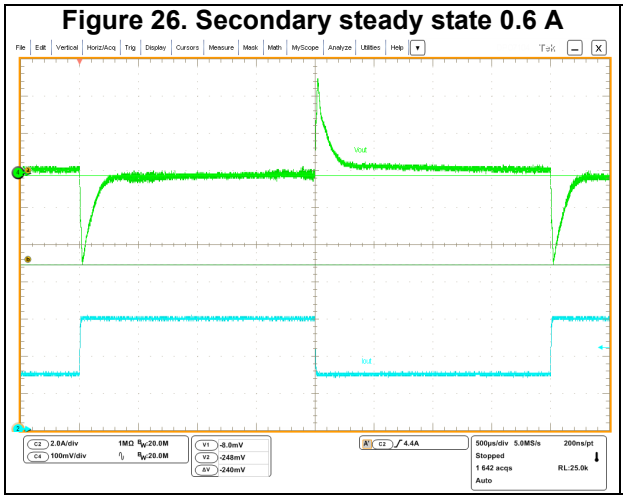
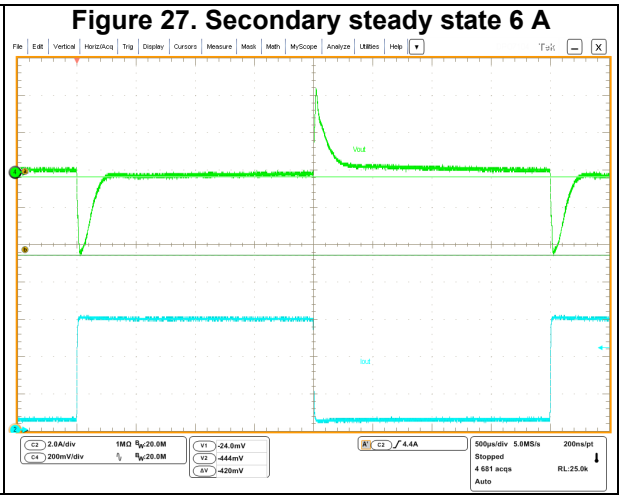
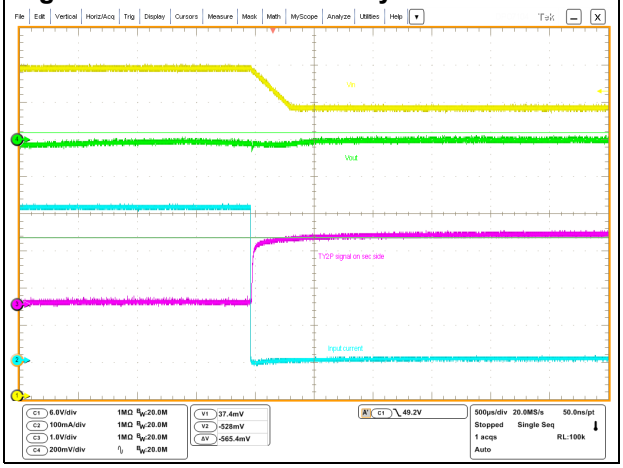



Figure 27. Secondary steady state 6 A



## 3.8 PoE to auxiliary switchover

**Figure 28. Detail of secondary drain at 6 A load**




In *Figure 28* is shown a smooth transition from a PoE line set to 54 V toward an auxiliary adapter at 44 V; the output voltage is maintained stable during the transition.

## 3.9 Gloop

**Figure 29. Gloop 48 V at 6 A**

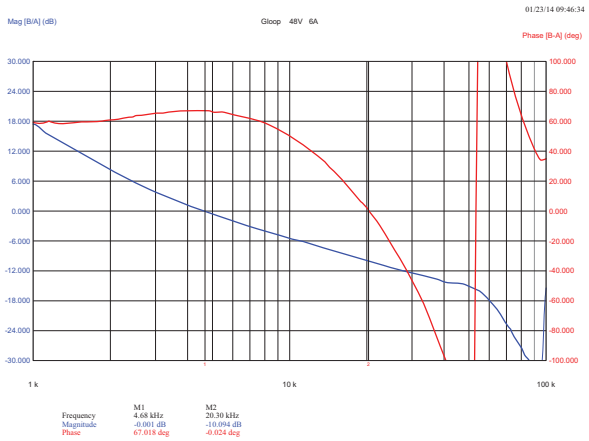



**Figure 30. Gloop 48 V at no load**

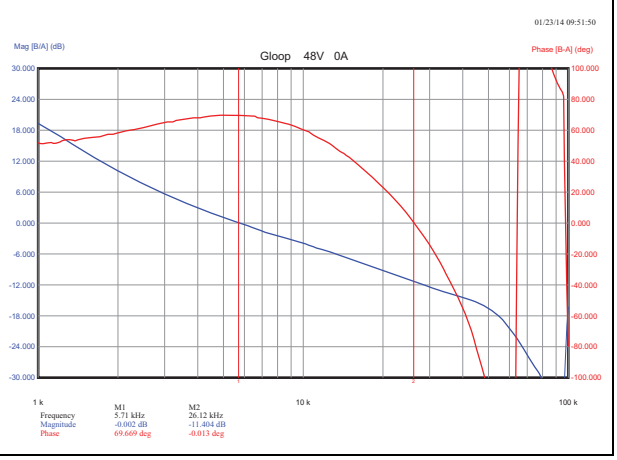


**Figure 31. Gloop 40 V at 6 A**

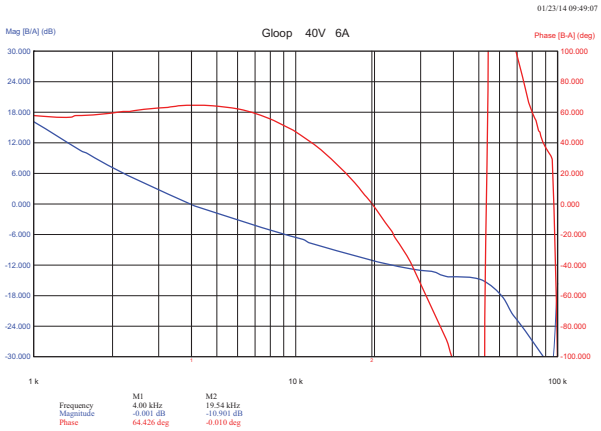
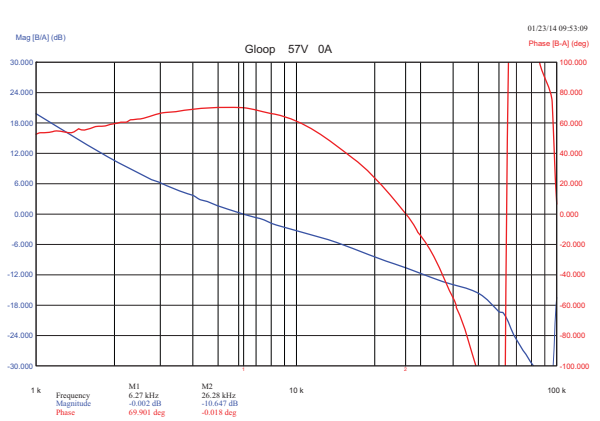



**Figure 32. Gloop 57 V at no load**



# 4 Support material

## 4.1 PCB layers

**Figure 33. PCB top assembly**

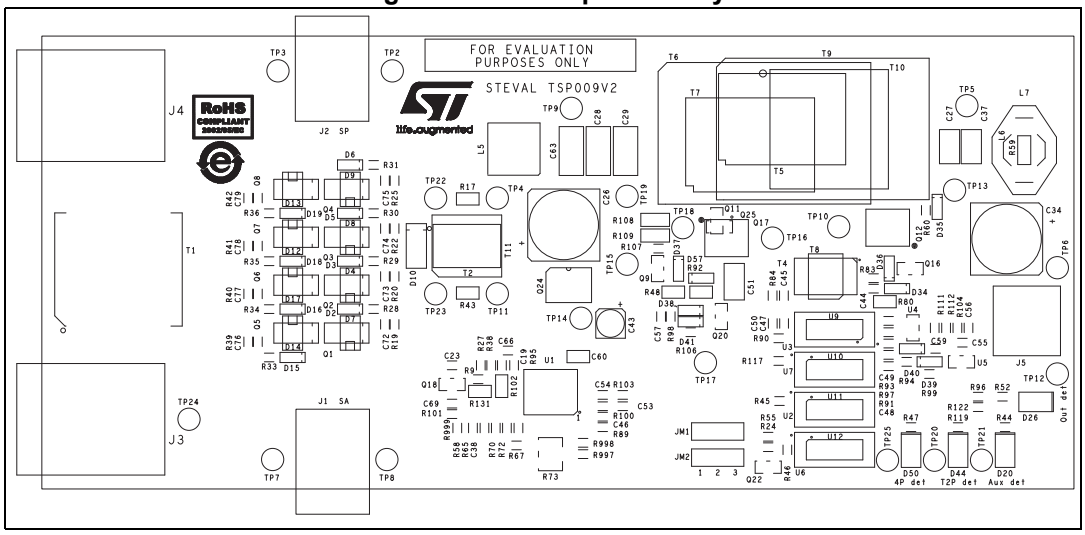



**Figure 34. PCB bottom assembly**

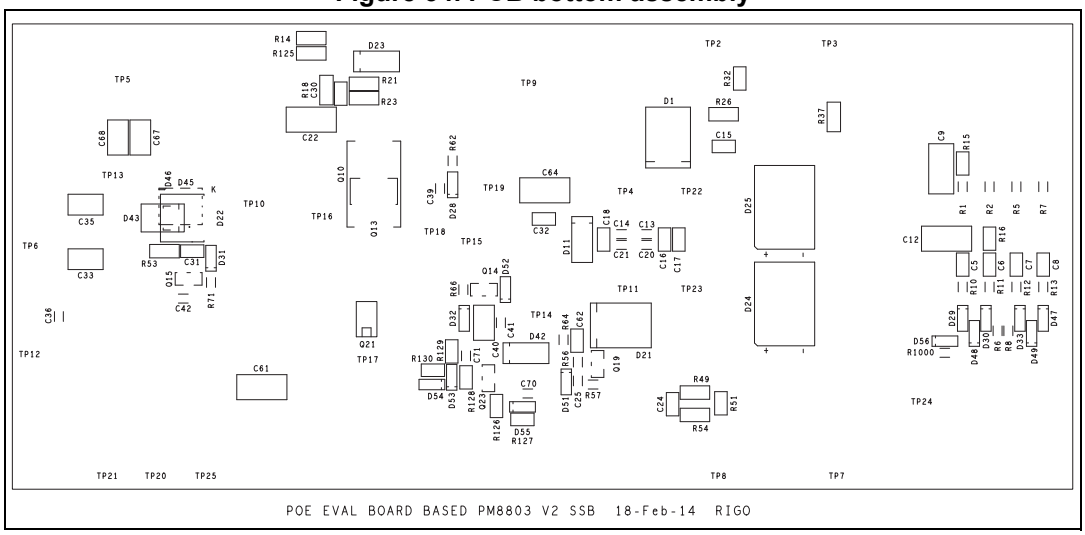


Figure 35. PCB layer 1 top

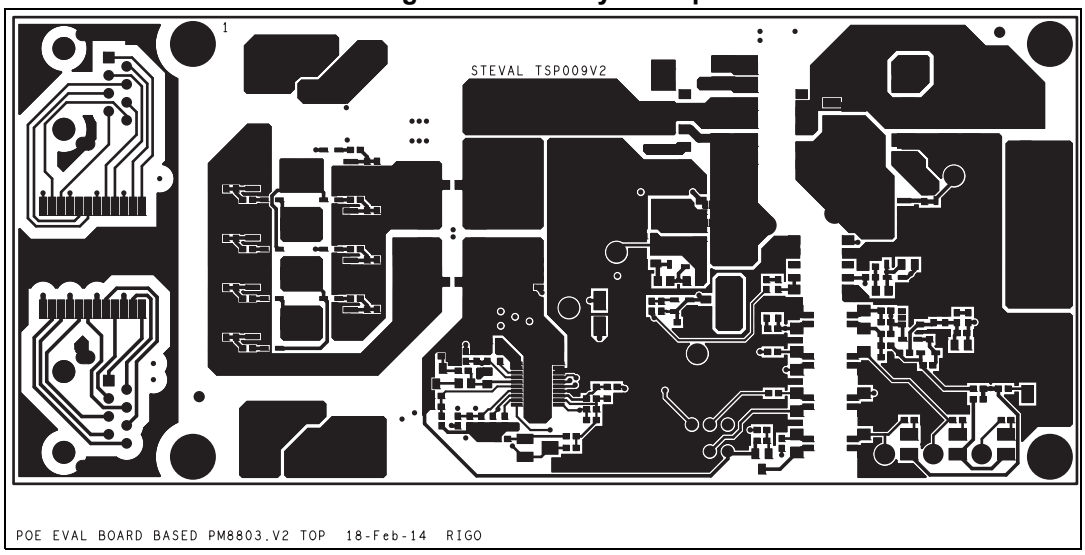



Figure 36. PCB layer 2

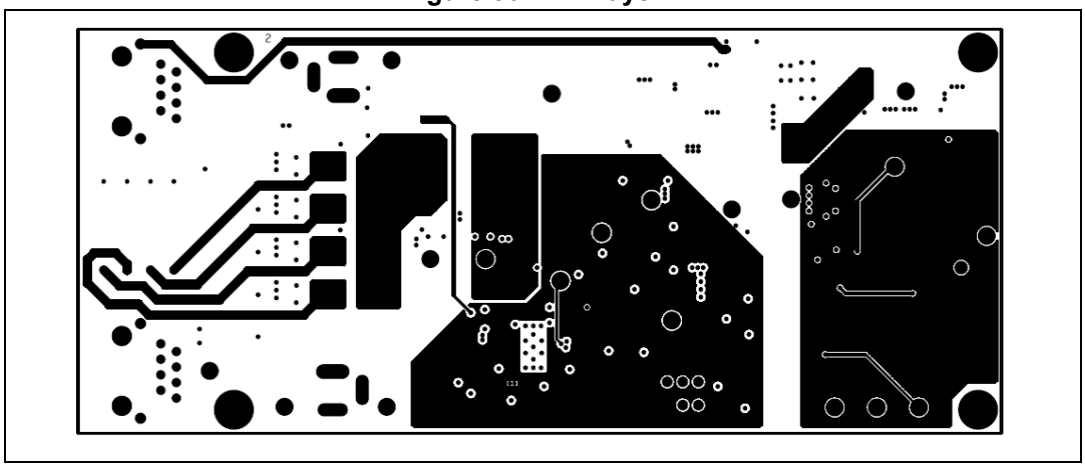



Figure 37. PCB layer 3

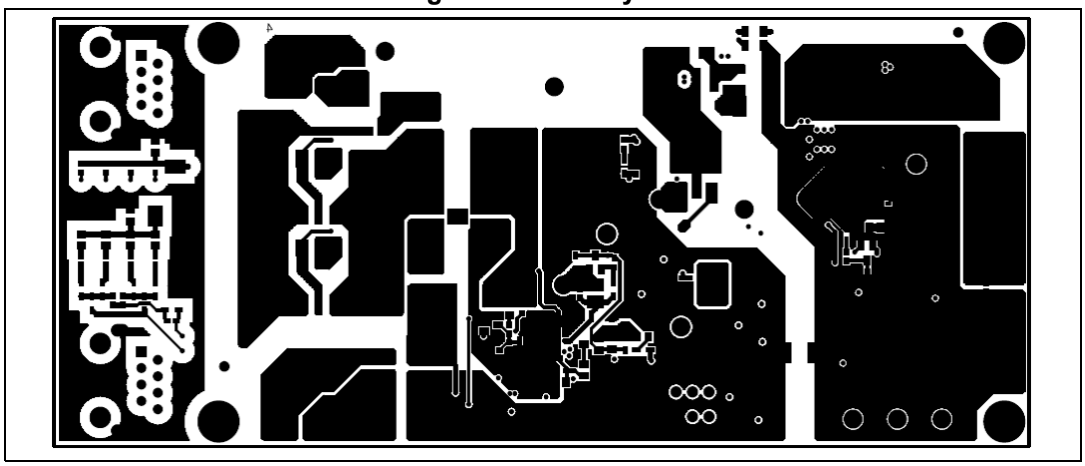
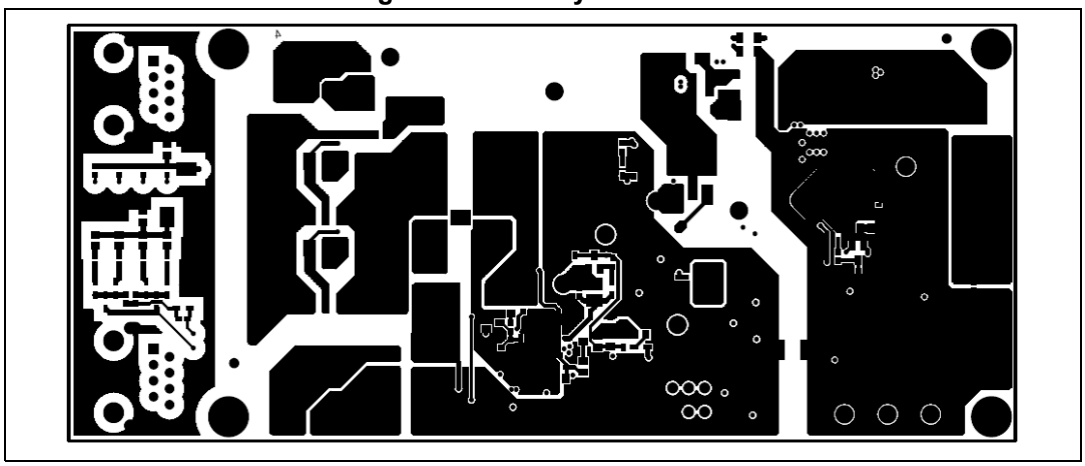


Figure 38. PCB layer 4 bottom



# 5 Electrical diagram general

**Figure 39. Schematic 1 of 2 (general)**

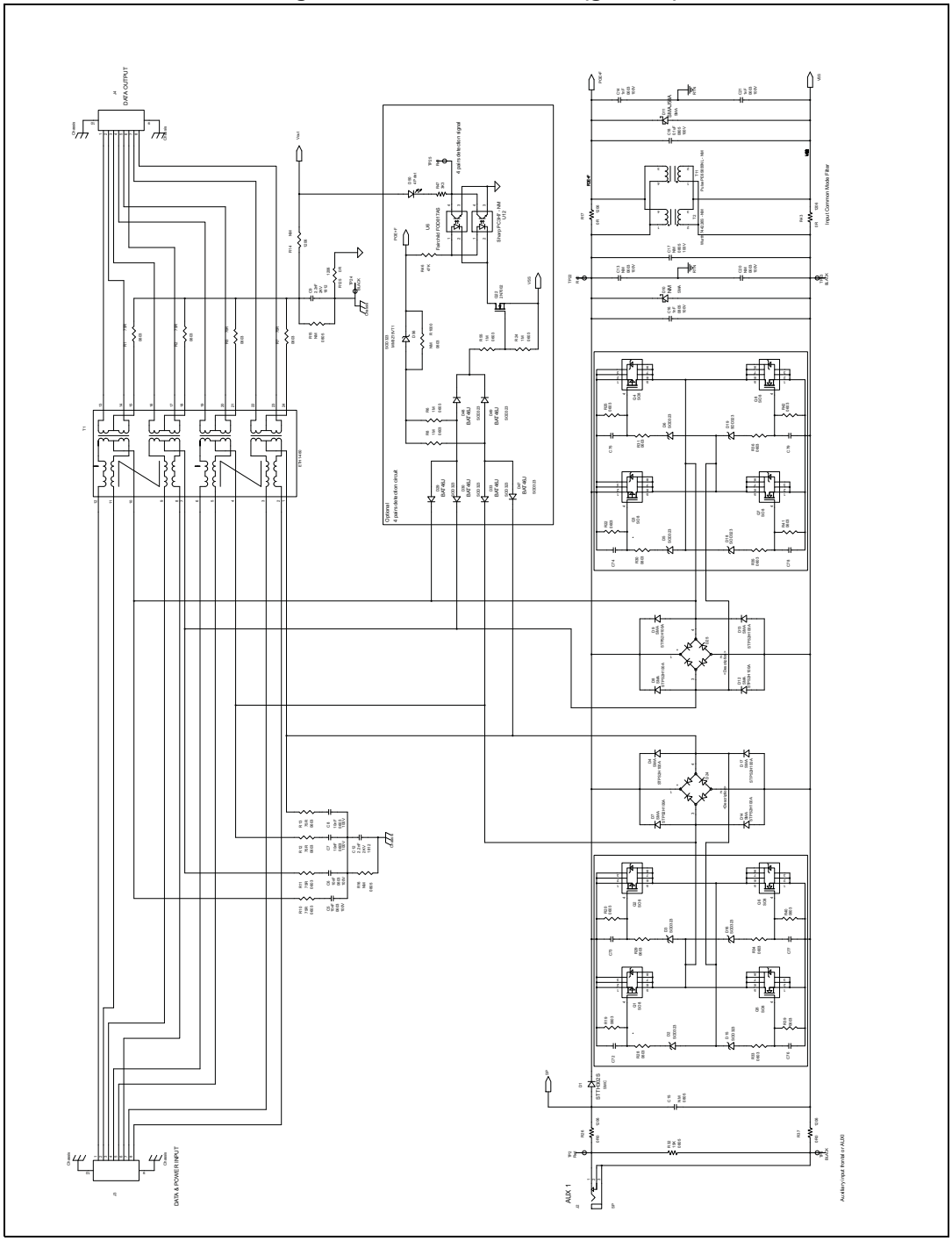
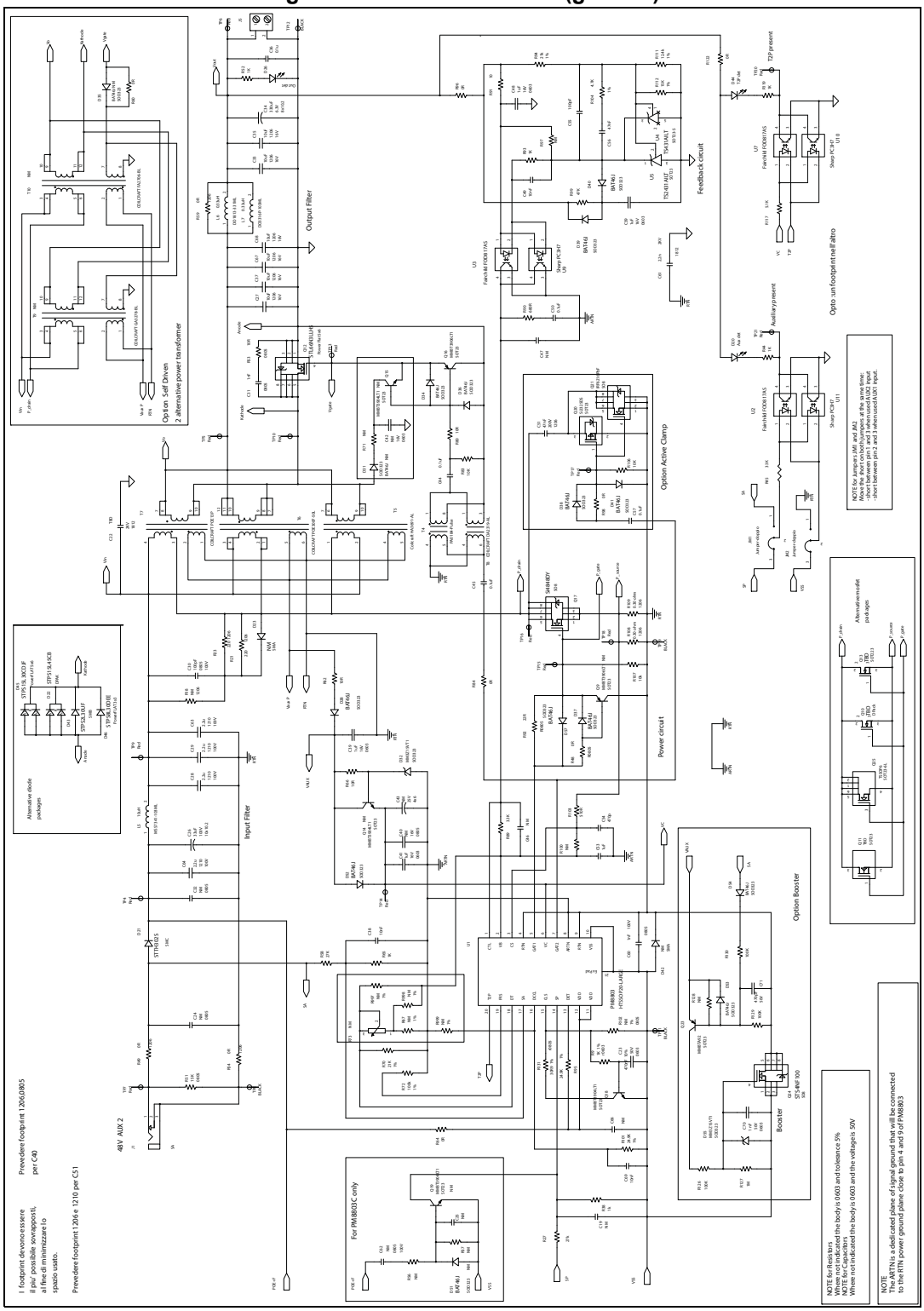


**Figure 40. Schematic 2 of 2 (general)**



# 6 Revision history

Table 4. Document revision history

| Date | Revision | Changes |
|---|---|---|
| 25-May-2015 | 1 | Initial release. |