AN4172
Application note

IEEE802.3af class 3 PoE converter reference design high efficiency flyback converter based on the PM8800A

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Introduction

The PM8800A is a highly integrated device embedding an IEEE802.3af compliant powered device (PD) interface together with a PWM controller and support for auxiliary sources.

This document focuses on a reference design for a high efficiency, class 3 PD (up to 13 W input) power converter based on a flyback topology with pulse transformer driven synchronous rectification using the PM8800A as the main controller.

Schematics of the PoE converter are given in *Section 2*, while the related bill of material is detailed in *Section 3*. In *Section 4* efficiency measurements together with main waveforms of the PoE interface and power converter are shown.

Contents

1 Electrical specifications

Table 1. Specifications for 3.3 V output

Parameter	Description	Min.	Typ.	Max.	Unit
Input voltage range	Applied at RJ45 connector	0		57	V
Operative input voltage		42		57	V
UVLO	Vin rising edge			36	V
	Vin falling edge	30			V
Auxiliary input voltage range		42	48	56	V
Output voltage (Vout)	Vin = 42 V to 57 V, Iout 0 to Imax	3.25	3.35	3.45	V
Output current (Iout)	Vin = 42 V to 57 V	0		3.5	A
Peak-to-peak output ripple	48 Vin, Iout = Imax		30	50	mVpp
Efficiency DC-DC only	Vin = 48 V, Iout = Imax		90		%
Overall efficiency	Vin = 48 V, Iout = Imax		88		%
Switching frequency			150		kHz

2 Schematics

Figure 1. High efficiency PoE converter schematic: detail of the input section including data transformers and terminations

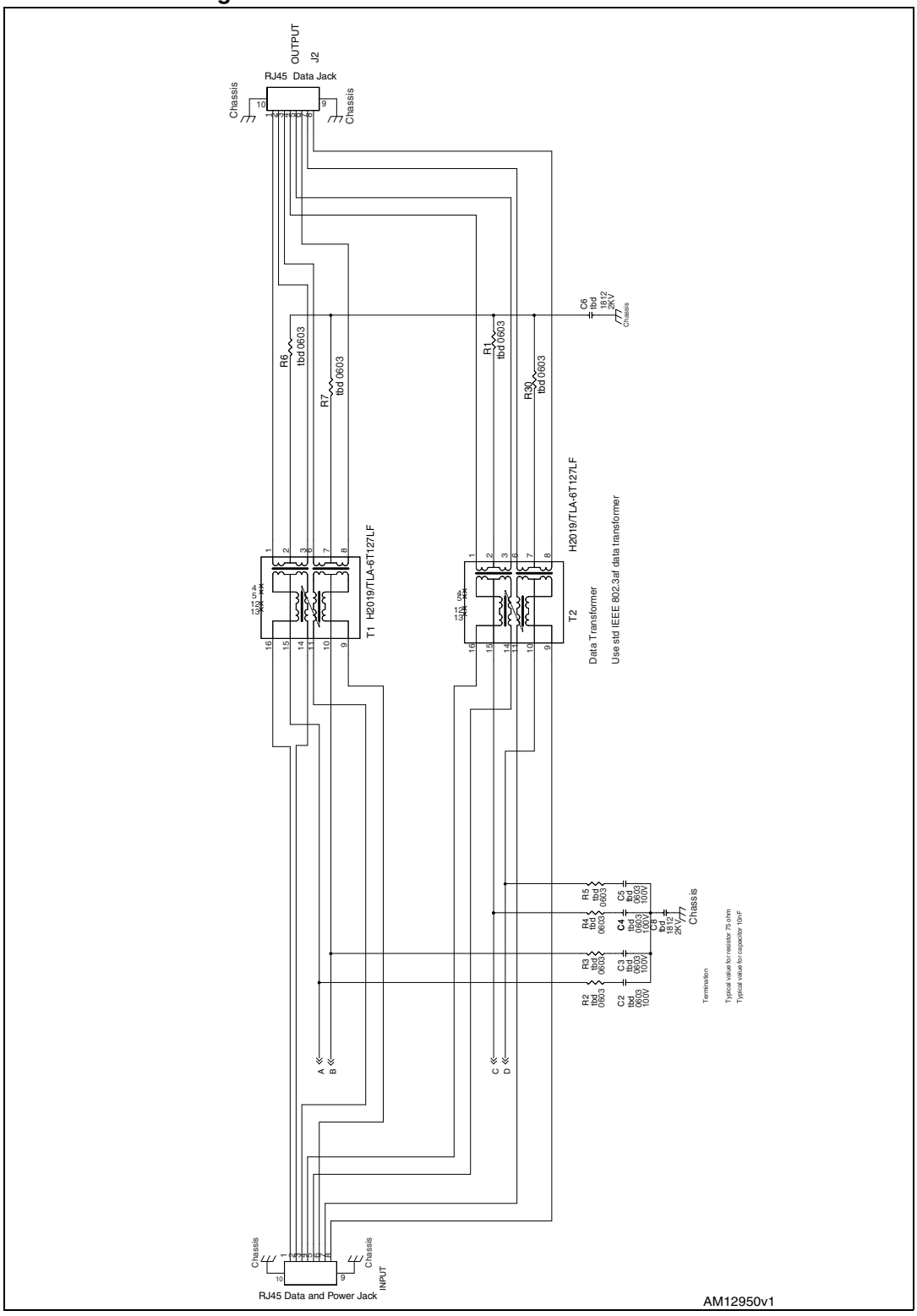
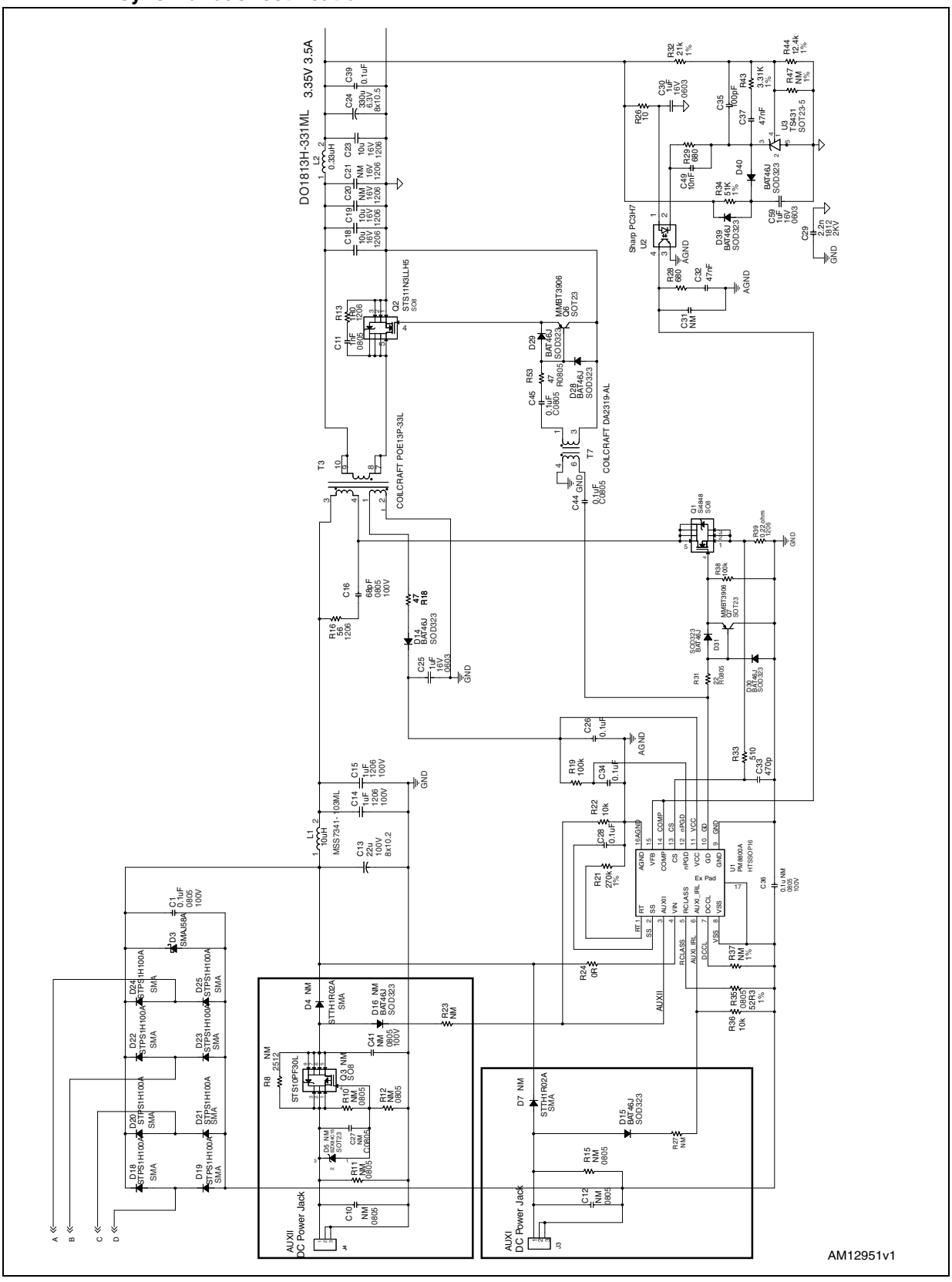


Figure 2. High efficiency PoE converter: flyback topology with pulse transformer driven synchronous rectification



3 Bill of material

Table 2. Bill of material

Qty.	Reference	Description	Value	Tol.	Voltage	Body	Vendor
1	C1	Ceramic capacitor	100 nF		100 V	603	TDK
4	C2, C3, C4, C5	Ceramic capacitor	TBD	10%	100 V	603	TDK
2	C6, C8	Ceramic capacitor	TBD		2 KV	1812	TDK
1	C11	Ceramic capacitor	1 nF	10%	100 V	805	TDK
1	C13	Aluminium capacitor	22 µF	20%	100 V	810x10.2	Std low ESR
2	C14, C15	Ceramic capacitor	1 µF	20%	100 V	1206	TDK
1	C16	Ceramic capacitor	68 pF		100 V	805	TDK
3	C18, C19, C23	Ceramic capacitor	10 µF		6.3 V	805	TDK
1	C24	Aluminium capacitor	330 µF		6.3 V	8x10.2	Std low ESR
3	C25,C30, C59	Ceramic capacitor	1 µF	20%	16 V	603	Std
6	C26, C28, C34, C39, C44, C45	Ceramic capacitor	100 nF	20%	50 V	603	Std
1	C29	Ceramic capacitor	2.2 nF		2 KV	1812	TDK
2	C32, C37	Ceramic capacitor	47 nF		50 V	603	Std
1	C33	Ceramic capacitor	470 pF		50 V	603	Std
1	C49	Ceramic capacitor	10 nF	20%	50 V	603	Std
1	D3	TVS diode	SMAJ58A			SMA	ST
9	D14, D15, D28, D29, D30, D31, D39, D40	Schottky diode	BAT46J		100 V	SOD323	ST
8	D4, D7, D8, D9, D12, D13, D14, D17	Schottky diode	STPS1H100A		100 V	SMA	ST
1	L1	SMT inductor	10 µH			MSS7341-103ML	Coilcraft
1	L2	SMT inductor	0.33 µH			DO1813H-331ML	Coilcraft
1	Q1	MOSFET, N ch.	Si 4848		150 V	SO8	Vishay
1	Q2	MOSFET, N ch.	STS11N3LLH5		30 V	SO8	ST
2	Q6, Q7	Transistor, PNP	MMBT3906LT1		40 V	SOT23	Std
8	R1, R2, R3, R4, R5, R6, R7, R30	Chip resistor	TBD			603	Std

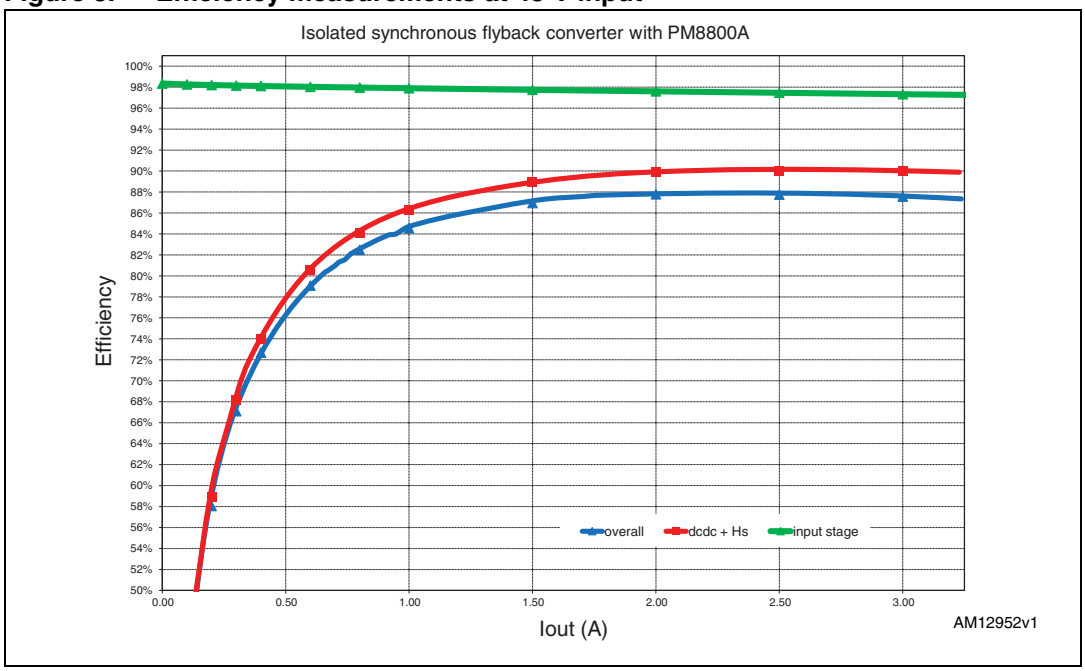
Table 2. Bill of material (continued)

Qty.	Reference	Description	Value	Tol.	Voltage	Body	Vendor
1	R13	Chip resistor	1R0			1206	Std
1	R16	Chip resistor	56			1206	Std
2	R18, R53	Chip resistor	47			603	Std
1	R19	Chip resistor	100 K			805	Std
1	R21	Chip resistor	270 K	1%		603	Std
2	R22, R36	Chip resistor	10 K			603	Std
1	R24	Chip resistor	0 R			603	Std
1	R26	Chip resistor	10 R			603	Std
2	R28, R29	Chip resistor	680			603	Std
1	R31	Chip resistor	22			603	Std
1	R32	Chip resistor	21 K	1%		603	Std
1	R33	Chip resistor	510			603	Std
1	R34	Chip resistor	51 K	1%		603	Std
1	R35	Chip resistor	52R3	1%		603	Std
1	R38	Chip resistor	100 K			603	Std
1	R39	Chip resistor	0.22 R			603	Std
1	R43	Chip resistor	3.31 K	1%		603	Std
1	R44	Chip resistor	12.4 K	1%		603	Std
2	T1, T2	POE+ magnetics	H2019				Pulse
1	T3	Power transformer	POE13P-33L				Coilcraft
1	T7	Gate driver transformer	DA2319-AL				Coilcraft
1	U1	POE controller	PM8800A			HTSSOP16	ST
1	U2	SMT optocoupler	PC3H7			4PDIP	Sharp
1	U3	Shunt regulator	TS431AILT			SOT23-5	ST

4 Test results

4.1 Efficiency measurements

Figure 3. Efficiency measurements at 48 V input



The difference between DC-DC and overall measurements is about 2% from 1 A to full load.

In *Figure 3* it is possible to see the contribution to the total losses of the PD interface section of the converter; the major contribution comes from the rectification bridge.

4.2 Waveforms

4.2.1 Startup sequence

Figure 4. Startup from the Cisco Catalyst 3750E switch with 3 A load

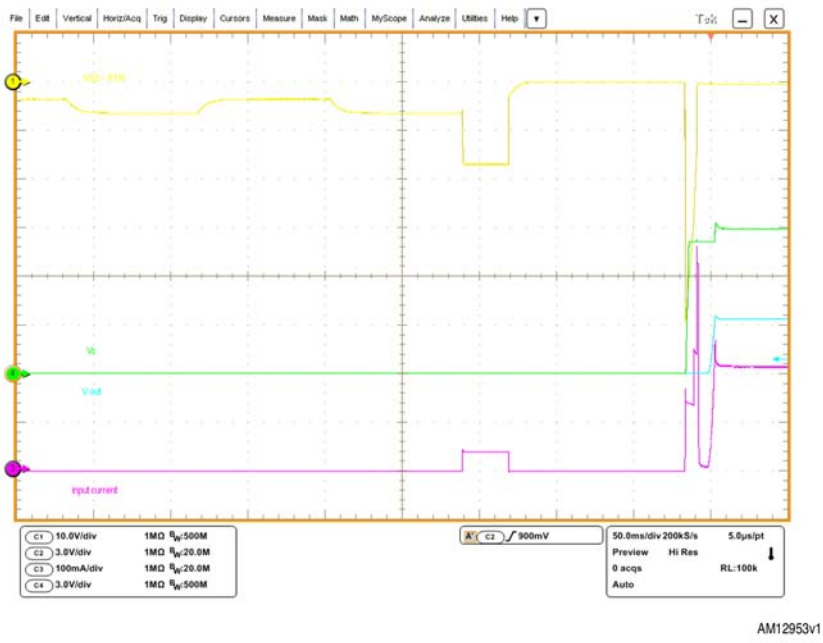


Figure 5. Startup from the PowerDsine 9001GR.at injector with 3 A load

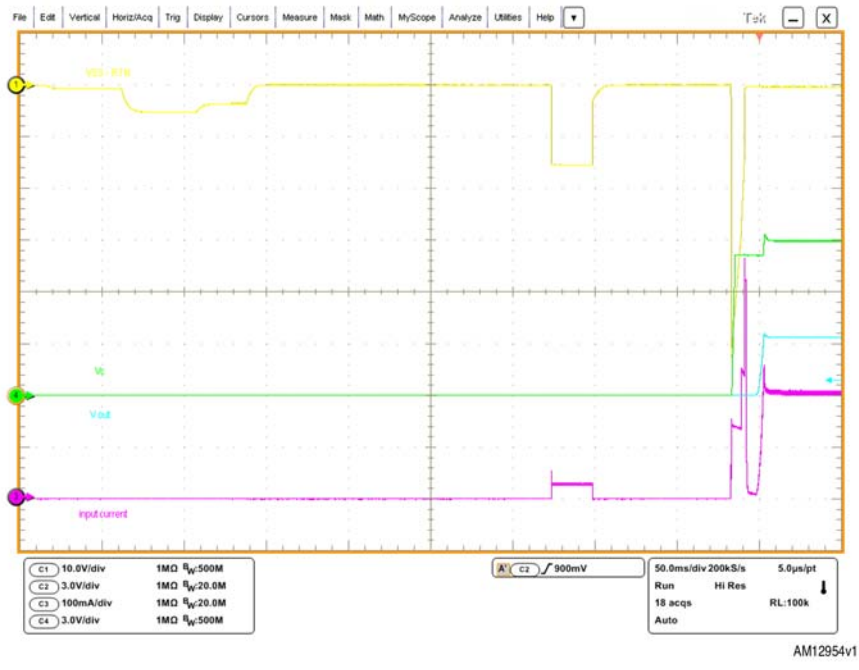
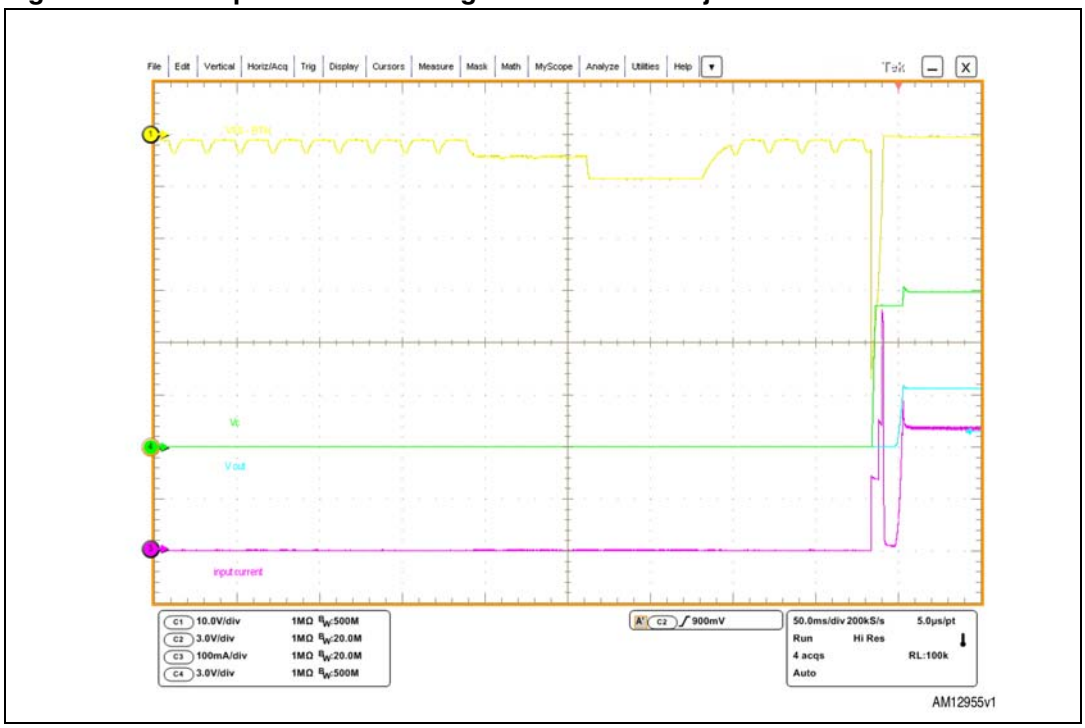


Figure 6. Startup from the Phihong PSA16U-480.af injector with 3 A load



4.2.2 Primary side MOSFET

Figure 7. Primary side Power MOSFET waveforms at 0 A load

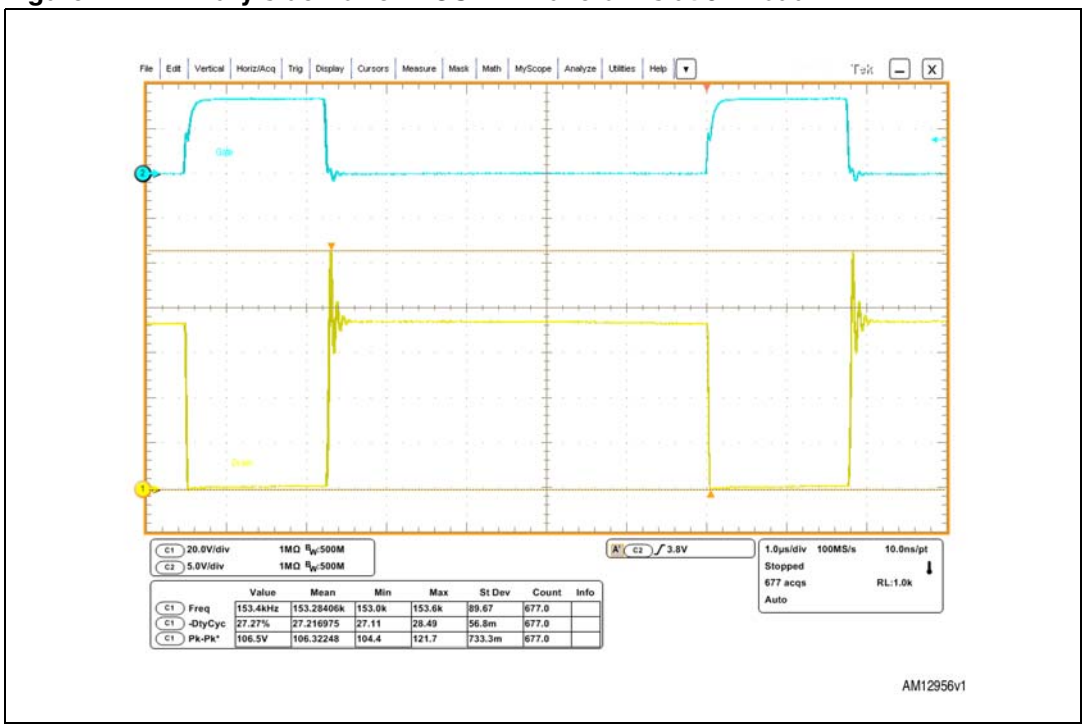
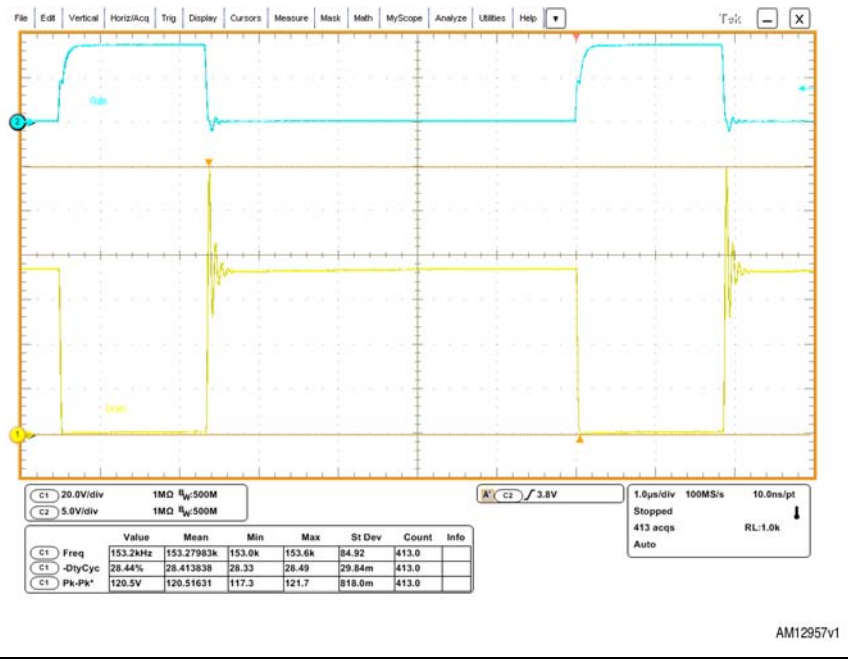


Figure 8. Primary side Power MOSFET waveforms at 3 A load



4.2.3 Secondary side MOSFET

Figure 9. Secondary side Power MOSFET waveforms at 0 A load

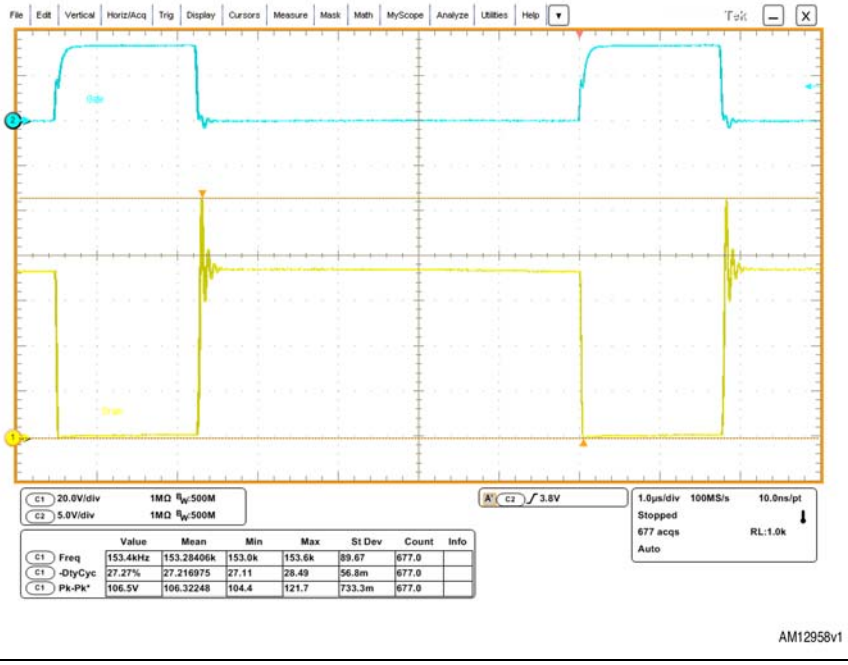
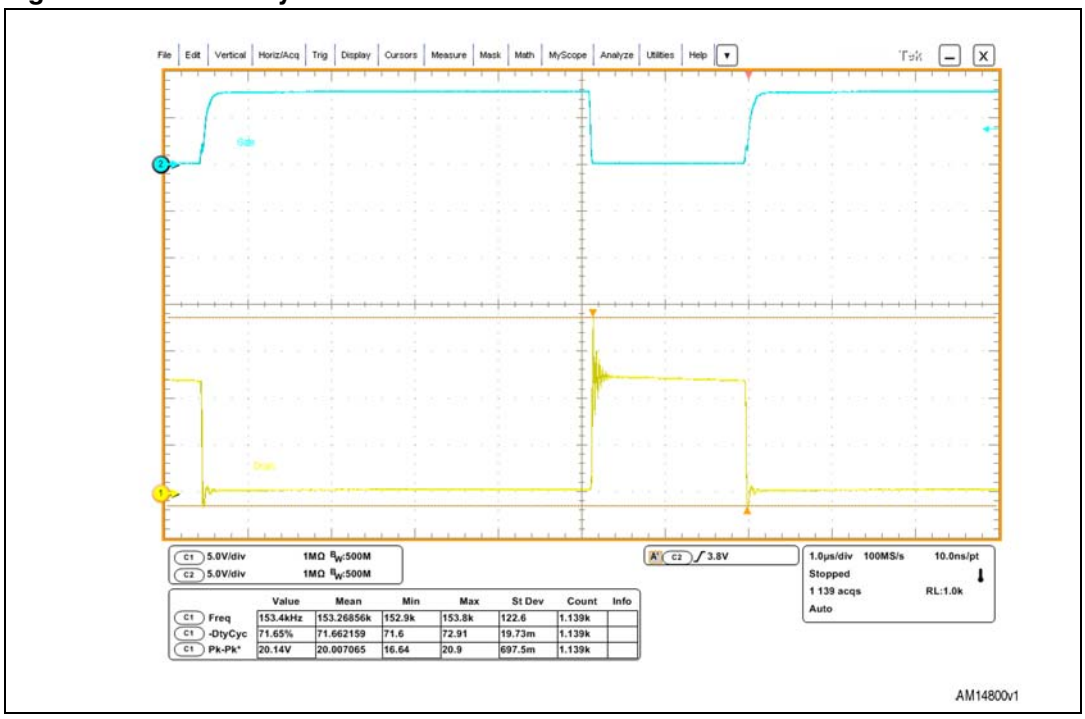
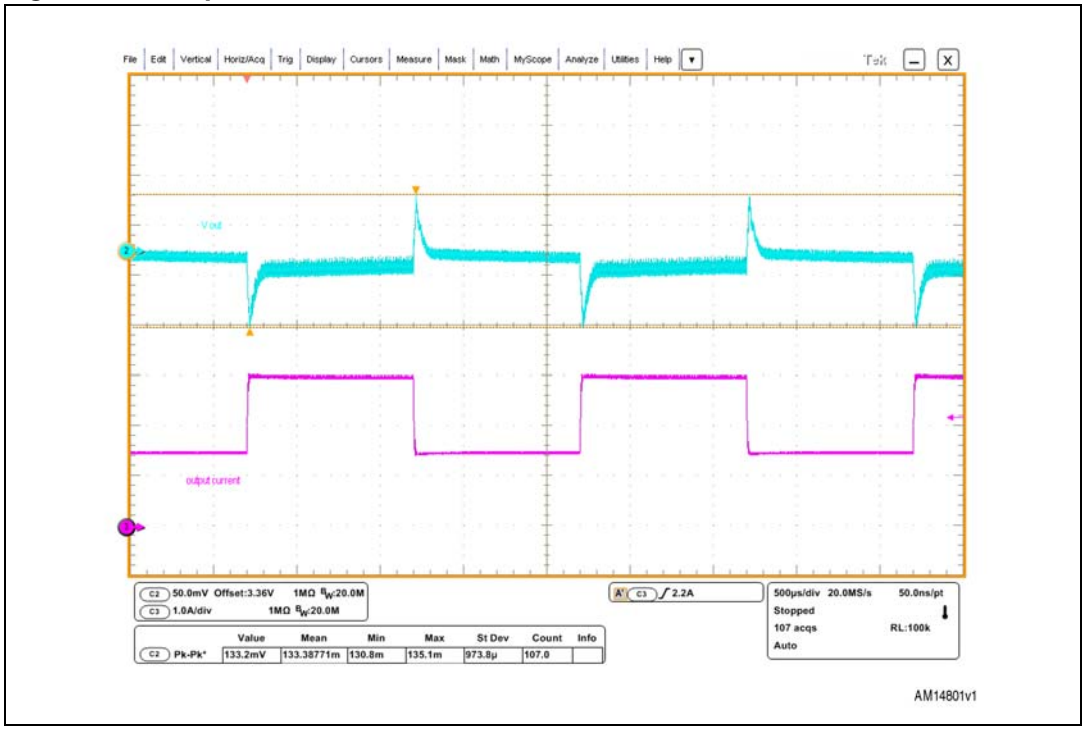


Figure 10. Secondary side Power MOSFET waveforms at 3 A load



4.2.4 Load transient

Figure 11. Response of the converter to a 1.5 A - 3 A load transient



4.2.5 Output ripple

Figure 12. Output ripple measurement at 3 A

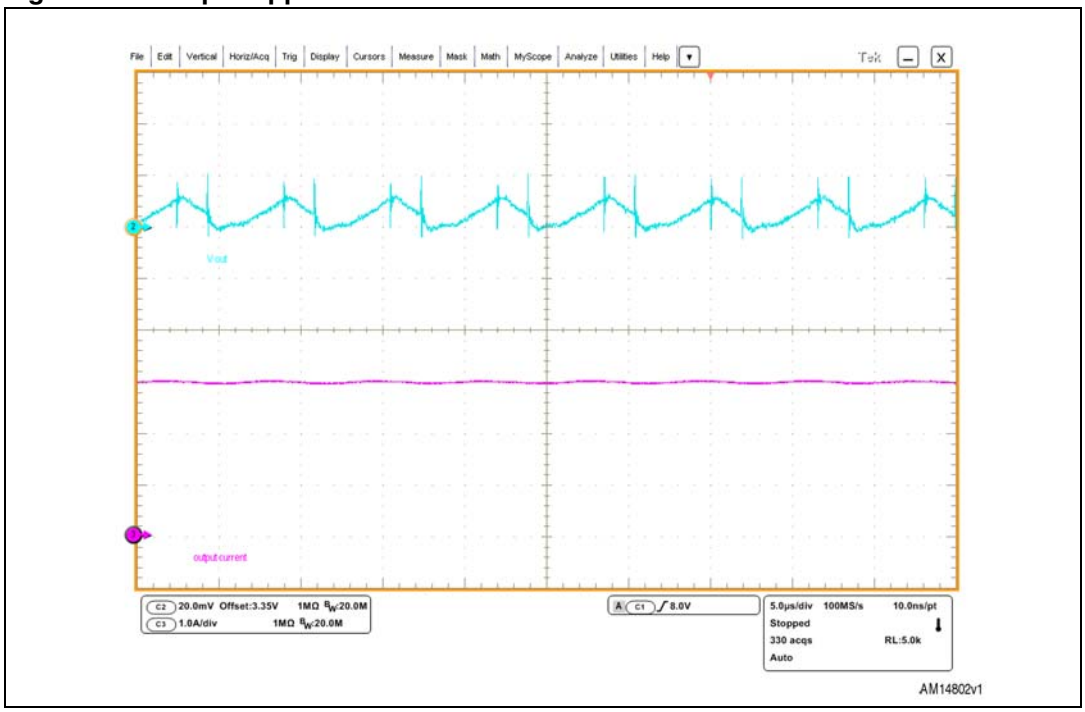


Figure 13. Output ripple measurement at 3 A with infinite persistence

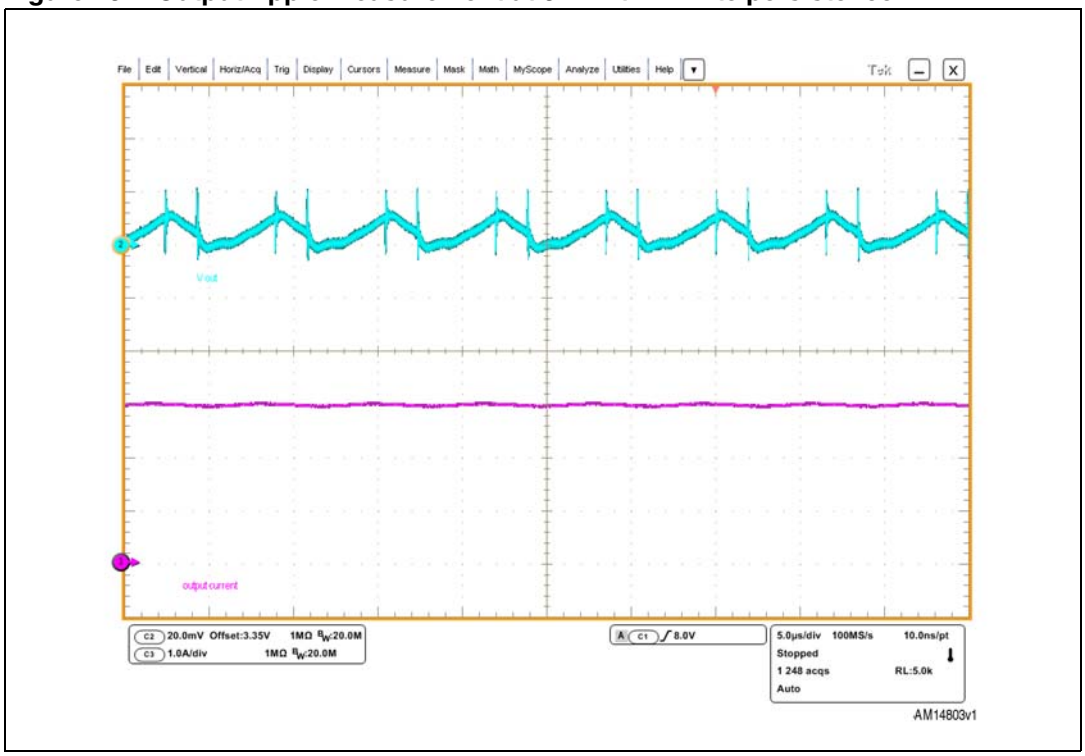


Figure 14. Output ripple measurement at 0 A

5 Revision history

Table 3. Document revision history

Date	Revision	Changes
02-Oct-2012	1	Initial release.

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