
100 W USB power delivery adaptor reference design with VIPERGAN100W



Introduction

This document describes the [EVLVIPGAN100WP](#), a 100 W QR mode flyback adaptor reference design for USB Type-C™ PD adaptors with the following characteristics:

- Peak efficiency: > 92%.
- Compliant with IEC55022 Class B conducted electromagnetic interference, even with reduced EMI filter.
- RoHS compliant.

The evaluation board has been developed using VIPERGAN100W, a new advanced offline switcher by STMicroelectronics with the following features:

- 700 V power GaN with embedded senseFET (Si) and high voltage startup.
- QR operation with dynamic blanking time and adjustable valley synchronization delay functions to maximize efficiency at any input line and load condition.
- Valley-lock to ensure constant valley skipping.
- Input voltage feedforward compensation for mains-independent OPP intervention.
- Adaptive burst mode for advanced power management in light load conditions.
- Frequency jittering for EMI suppression.

1 Overview

The main features of the **EVLVIPGAN100WP** are:

- Input voltage: Universal AC from 90 V_{AC} to 264 V_{AC} with 47 Hz to 63 Hz frequency
- Output voltage: Single Type-C output 5 V_{DC} – 20 V_{DC}
- Output power: 20 V 5 A 100 W max.
- Size: 83.3 X 40.7 X 20 mm (L X W X H)
- Power density (unboxed): > 24 W/in³
- PCB copper thickness is 2.0 oz.
- Efficiency: Meets CoC Tier 2 and DoE Level 6 efficiency requirements, peak efficiency > 92% at 230 V_{AC} 100 W
- PFC stage based on the L6564 (current mode PFC controller operating in transition mode (TM))
- Flyback stage based on the VIPerGaN100W HV converter with optocoupler feedback for voltage regulation and the SRK1001 adaptive synchronous rectification controller to increase the system efficiency
- Quasi-resonant operations with dynamic blanking time and adjustable valley synchronization delay functions, to maximize efficiency at any input line and load condition
- Integrated GaN IC VIPERGAN100W results in a compact, simplified PCB layout and bill of material reduction
- Support for USB Power Delivery.

Figure 1. EVLVIPGAN100WP reference design – top

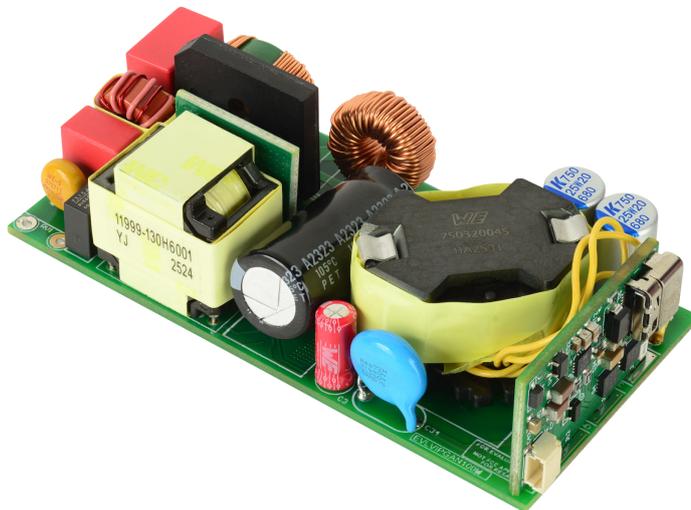
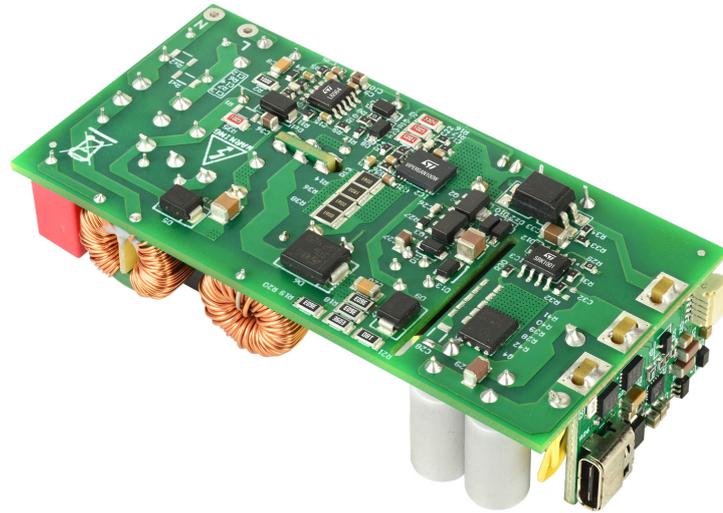


Figure 2. EVLVIPGAN100WP reference design – bottom



2 Test board: design and evaluation

The electrical specifications of the evaluation board are listed in [Table 1](#), according to USB Power Delivery specification rev. 3.0.

Table 1. Electrical specifications

Parameter	Min.	Typ.	Max.	Unit
AC main input voltage	90		264	V _{AC}
Main frequency (f _L)	47		63	Hz
Standby input power – 5 V _{OUT} @230 V _{AC}			90.6	mW
Ambient operating temperature			60	°C
Output parameters – 5 V setting				
Output voltage	4.75	5	5.25	V
Output current	2.85	3	3.15	A
Output parameters – 9 V setting				
Output voltage	8.55	9	9.45	V
Output current	2.85	3	3.15	A
Output parameters – 12 V setting				
Output voltage	11.4	12	12.6	V
Output current	2.85	3	3.15	A
Output parameters – 15 V setting				
Output voltage	14.25	15	15.75	V
Output current	2.85	3	3.15	A
Output parameters – 20 V setting				
Output voltage	19	20	21	V
Output current	4.987	5	5.25	A

3 Schematic and bill of materials

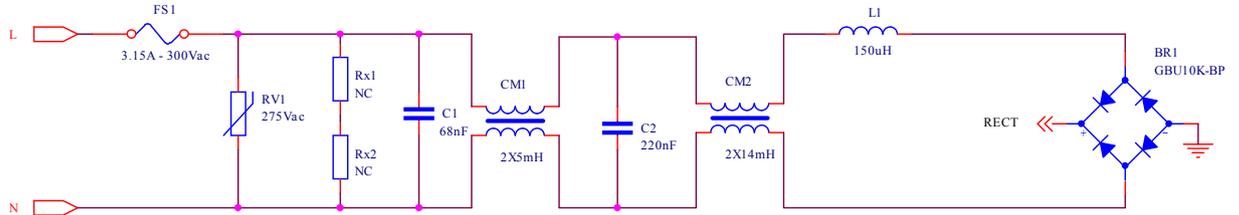
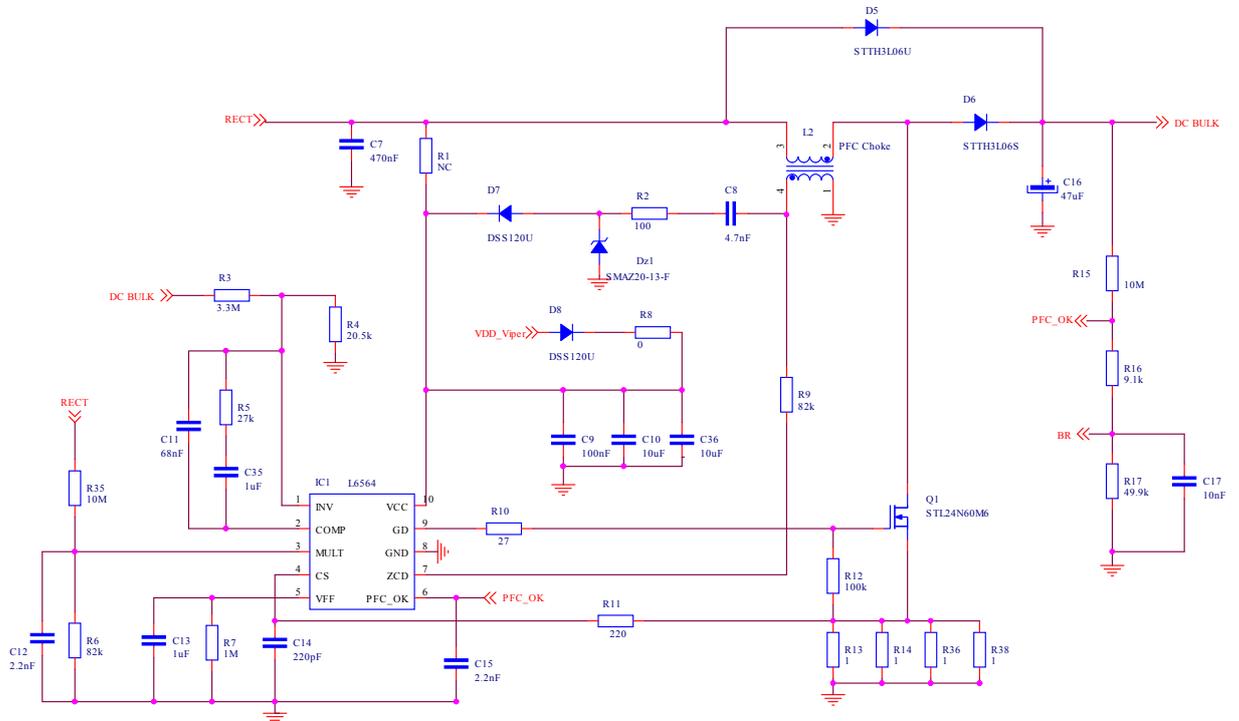
Figure 3. Input stage schematic

Figure 4. PFC stage schematic


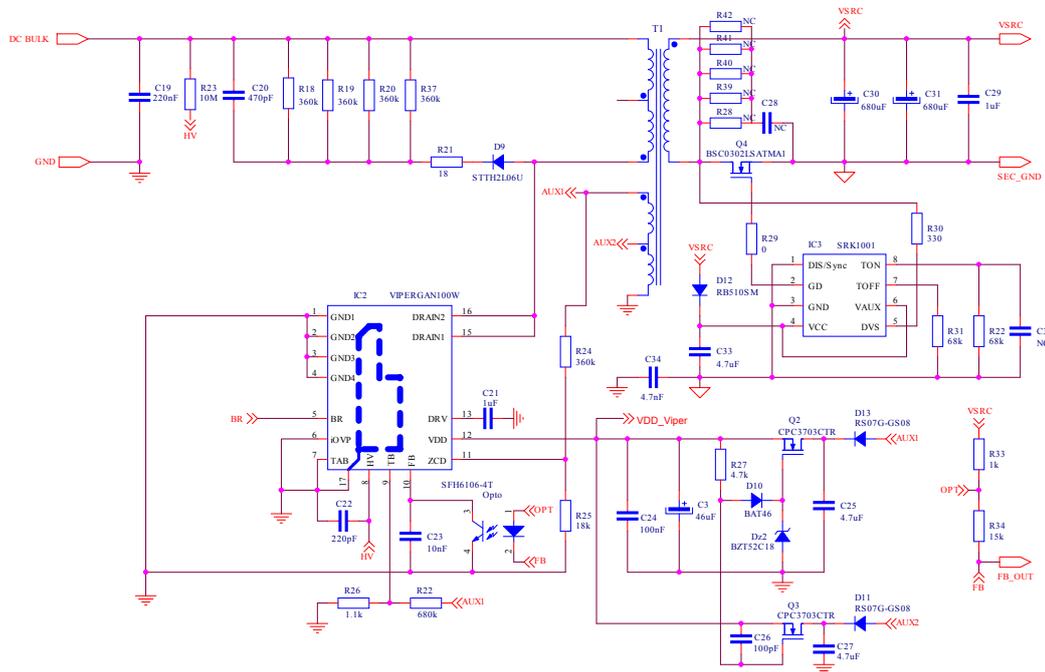
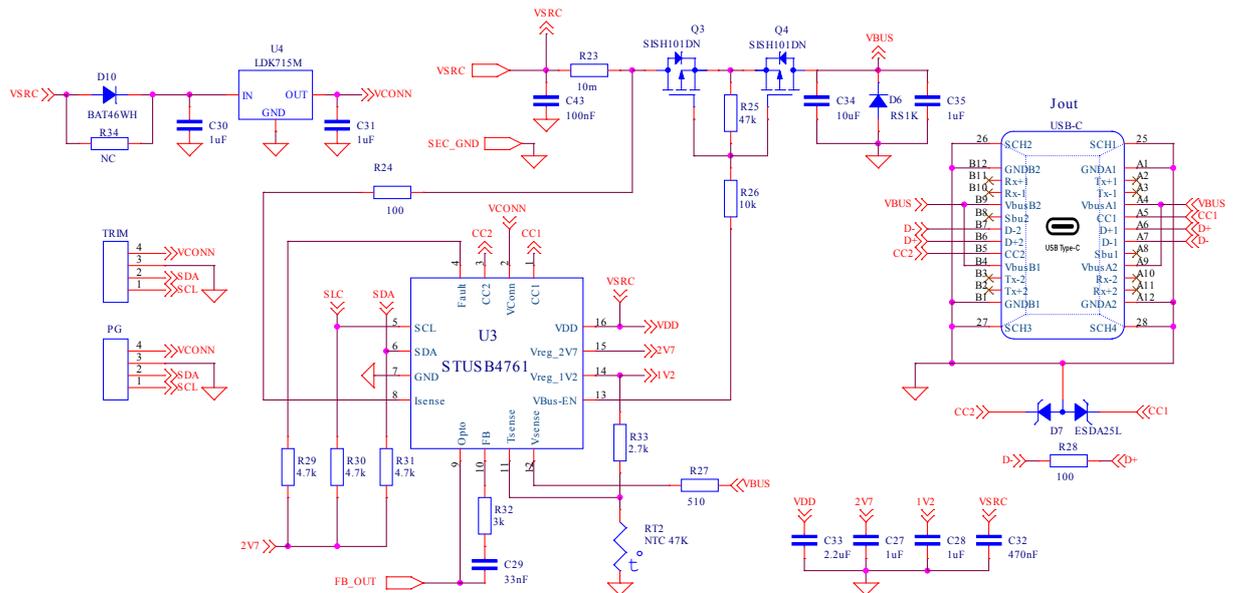
Figure 5. Flyback stage schematic

Figure 6. Daughterboard schematic


Table 2. Bill of materials of the reference design – input stage

Reference	Part/value	Description	Manufacturer	Order code
BR1	800 V – 10 A	Bridge rectifier	Micro commercial components (MCC)	GBU10K-BP
C1	68 nF – 275 Vac	Polypropylene X2 capacitor	Würth Elektronik	890324022017
C2	220 nF – 275 Vac	Polypropylene X2 capacitor	Würth Elektronik	890324023028
CM1	1.5 mH	Common-mode choke	Würth Elektronik	750320246
CM2	18 mH	Common-mode choke	Sumida	04291-T231
FS1	3.15 A – 250 Vac	FUSE	Eaton Bussmann	SS-5H-3-15A-BK
L1	150 uH – 2.5 A	Power choke	Würth Elektronik	7447018
RV1	275 Vac	Disk varistor	Würth Elektronik	820572711

Table 3. Bill of materials of the reference design – PFC stage

Reference	Part/value	Description	Manufacturer	Order code
C7	470 nF – 450 Vdc	Film capacitors	Kemet	R71XF347050H0M
C8	4.7 nF – 100 V	MLCC capacitor	Würth Elektronik	885012208110
C9	100 nF – 50 V	MLCC capacitor	Würth Elektronik	885012206095
C10	10 uF – 50 V	MLCC capacitor	Murata	GRM21BR61H106KE43K
C11	68 nF – 50 V	MLCC capacitor	Würth Elektronik	885012206094
C12	2.2 nF – 50 V	MLCC capacitor	Murata	GCJ188R71H222KA01D
C13	1 uF – 50 V	MLCC capacitor	TDK	C1608X5R1H105K080AB
C14	220 pF – 50 V	MLCC capacitor	Würth Elektronik	885012006059
C15	2.2 nF – 50 V	MLCC capacitor	Murata	GCJ188R71H222KA01D
C16	47 uF – 450 V	Electrolytic capacitors	Rubycon	450HXW47MEFR12.5X25
C17	10 nF – 100 V	MLCC capacitor	Würth Elektronik	885012206114
C36	10 uF – 50 V	MLCC capacitor	Murata	GRM21BR61H106KE43K
D5	3 A – 600 V	Ultrafast switching diode	STMicroelectronics	STTH3L06U
D6	3 A – 600 V	Ultrafast switching diode	STMicroelectronics	STTH3L06S
D7	1 A – 200 V	Schottky diode	SMC Diode solutions	DSS120U
D8	1 A – 200 V	Small signal switching diode	SMC Diode solutions	DSS120U
Dz1	20 V – 1 W	Zener diode	Diodes	SMAZ20-13-F
L2	420 uH – 4 A	PFC choke	Yu Jing technology	11999-130H600110
R1	NC	Thick film resistors	Panasonic	ERJ-P08F3603V
R2	100 Ω±1% – 0.66 W	Thick film resistors	Panasonic	ERJ-P08F1000V
R3	3.3 MΩ±1% – 0.25 W	Thick film resistors	Bourns	CHV1206-FX-3304ELF
R4	20.5 kΩ±1% – 0.25 W	Thick film resistors	Panasonic	ERJ-PA3F2052V
R5	27 kΩ±1% – 0.25 W	Thick film resistors	Panasonic	ERJ-UP3F2702V
R6	82 kΩ±1% – 0.25 W	Thick film resistors	Panasonic	ERJ-UP3F8202V
R7	1 MΩ±1% – 0.25 W	Thick film resistors	Panasonic	ERJ-UP3F1004V
R8	0 Ω	Thick film resistors	Yageo	RC0603FR-100RL
R9	82 kΩ±1% – 0.25 W	Thick film resistors	Panasonic	ERJ-UP3F8202V
R10	27 Ω±1% – 0.25 W	Thick film resistors	Panasonic	ERJ-UP3F27R0V

Reference	Part/value	Description	Manufacturer	Order code
R11	220 Ω±1% – 0.25 W	Thick film resistors	Panasonic	ERJ-UP3F2200V
R12	100 kΩ±0.5% – 0.1 W	Thick film resistors	Panasonic	ERJ-UP3D1003V
R13	1 Ω±1% – 0.5 W	Thick film resistors	ROHM Semiconductor	ESR25JZPF1R00
R14	1 Ω±1% – 0.5 W	Thick film resistors	ROHM Semiconductor	ESR25JZPF1R00
R15	10 MΩ±1% – 0.25 W	Thick film resistors	Bourns	CHV1206-FX-1005ELF
R16	9.1 kΩ±1% – 0.25 W	Thick film resistors	Panasonic	ERJ-UP3F9101V
R17	49.9 kΩ±1% – 0.25 W	Thick film resistors	Panasonic	ERJ-UP3F4992V
R35	10 MΩ±1% – 0.25 W	Thick film resistors	Bourns	CHV1206-FX-1005ELF
R36	1 Ω±1% – 0.5 W	Thick film resistors	ROHM Semiconductor	ESR25JZPF1R00
R38	1 Ω±1% – 0.5 W	Thick film resistors	ROHM Semiconductor	ESR25JZPF1R00
Q1	600 V, 0.175 Ohm, 15 A	N-channel, power MOSFET	STMicroelectronics	STL24N60M6

Table 4. Bill of materials of the reference design – flyback stage

Reference	Part/value	Description	Manufacturer	Order code
C3	46 µF – 35 V	Electrolytic capacitor	Würth Elektronik	860040572002
C19	220 nF – 450 V	MLCC capacitor	TDK	C3225X7T2W224M200AE
C20	470 pF – 1000 V	MLCC capacitor	Würth Elektronik	885342208017
C21	1 µF – 50 V	MLCC capacitor	TDK	C1608X5R1H105K080AB
C22	220 pF – 50 V	MLCC capacitor	Würth Elektronik	885012006059
C23	10 nF – 100 V	MLCC capacitor	Würth Elektronik	885012206114
C24	100 nF – 50 V	MLCC capacitor	Würth Elektronik	885012206095
C25	4.7 µF – 100 V	MLCC capacitor	AVX	12101C475K4T2A
C26	100 pF – 100 V	MLCC capacitor	Würth Elektronik	885012006079
C27	4.7 µF – 50 V	MLCC capacitor	Murata	GRM21BC71H475ME11L
C28	NC	MLCC capacitor	Würth Elektronik	885342208008
C29	1 µF – 100 V	MLCC capacitor	TDK	C3216X7R2A105K160AA
C30	680 µF – 25 V	Conductive polymer hybrid ECAP	Kemet	A750KW687M1EAAE016
C31	680 µF – 25 V	Conductive polymer hybrid ECAP	Kemet	A750KW687M1EAAE016
C32	NC	MLCC capacitor	Kemet	C0603C101F1GACTU
C33	4.7 µF – 50 V	MLCC capacitor	Würth Elektronik	885012208094
C34	4.7 nF – 250 Vac	Y1 safety ceramic disc capacitors	Murata	DE1E3RA472MA4BN1F
D9	2 A – 600 V	Fast switching rectifier	STMicroelectronics	STTH2L06U
D10	250 mA – 100 V	Small signal switching diode	NXP	BAT46WH,115
D11	1.4 A – 400 V	Standard switching rectifier	Vishay	RS07G-GS08
D12	100 mA – 40 V	Small signal schottky diode	Rohm	RB510SM-40FHT2R
D13	1.4 A – 400 V	Standard switching rectifier	Vishay	RS07G-GS08
Dz2	18 V – 500 mW	Zener diode	Diodes	BZT52C18
IC1		PFC controller	STMicroelectronics	L6564
IC2		HV converter	STMicroelectronics	ViperGAN100W®
IC3		Synchronous rectification controller	STMicroelectronics	SRK1001

Reference	Part/value	Description	Manufacturer	Order code
OPTO1	70 V – 100 mA	Optocoupler	Vishay	SFH6106-4T
Q2	250 V – 4 Ω	N-channel - dep mode	IXYS integrated circuits	CPC3703CTR
Q3	250 V – 4 Ω	N-channel - dep mode	IXYS integrated circuits	CPC3703CTR
Q4	120 V – 8 mΩ – Logic Level	N-channel power MOSFET	Infineon	BSC0302LSATMA1
R18	360 kΩ±1% – 0.66 W	Thick film chip resistors	Panasonic	ERJ-P08F3603V
R19	360 kΩ±1% – 0.66 W	Thick film chip resistors	Panasonic	ERJ-P08F3603V
R20	360 kΩ±1% – 0.66 W	Thick film chip resistors	Panasonic	ERJ-P08F3603V
R21	18 Ω±5% – 0.66 W	Anti-surge thick film chip resistor	Panasonic	ERJP08J180V
R22	680 kΩ±1% – 0.25 W	Thick film chip resistors	Panasonic	ERJ-UP3F6803V
R23	10 MΩ±1% – 0.25 W	Thick film chip resistors	Bourns	CHV1206-FX-1005ELF
R24	360 kΩ±1% – 0.25 W	Thick film chip resistors	Panasonic	ERJ-UP3F3603V
R25	18 kΩ±1% – 0.25 W	Thick film chip resistors	Panasonic	ERJ-UP3F1802V
R26	1.1 kΩ±1% – 0.25 W	Thick film chip resistors	Panasonic	ERJ-PA3F1101V
R27	4.7 kΩ±1% – 0.25 W	Thick film chip resistors	Panasonic	ERJPA3F4701V
R28	NC	Thick film chip resistor	Panasonic	ERJ-P06F30R0V
R29	0 Ω		Yageo	603-RC0603FR-100RL
R30	330 Ω±1% – 0.25 W	Thick film chip resistors	Panasonic	ERJ-UP3F3300V
R31	68 kΩ±1% – 0.25 W	Thick film chip resistors	Panasonic	ERJ-UP3F6802V
R32	68 kΩ±1% – 0.25 W	Thick film chip resistors	Panasonic	ERJ-UP3F6802V
R33	1 kΩ±1% – 0.25 W	Thick film chip resistors	Panasonic	ERJ-UP3F1001V
R34	15 kΩ±1% – 0.25 W	Thick film chip resistors	Panasonic	ERJ-UP3F1502V
R37	360 kΩ±5% – 0.5 W	Thick film chip resistors	Panasonic	ERJ-P08F3603V
R39	NC	Thick film chip resistor	Panasonic	ERJ-P06F30R0V
R40	NC	Thick film chip resistor	Panasonic	ERJ-P06F30R0V
R41	NC	Thick film chip resistor	Panasonic	ERJ-P06F30R0V
R42	NC	Thick film chip resistor	Panasonic	ERJ-P06F30R0V
TF1	500 uH	Flyback transformer	Würth Elektronik	750320045 rev.02

Table 5. Bill of materials of the reference design – daughterboard

Reference	Part/value	Description	Manufacturer	Order code
C27	1 uF – 50 V	MLCC capacitor	Würth Elektronik	885012207103
C28	1 uF – 50 V	MLCC capacitor	Würth Elektronik	885012207103
C29	33 nF – 50 V	MLCC capacitor	Würth Elektronik	885012206092
C30	1 uF – 100 V	MLCC capacitor	TDK	C3216X7R2A105K160AA
C31	1 uF – 100 V	MLCC capacitor	TDK	C3216X7R2A105K160AA
C32	470 nF – 100 V	MLCC capacitor	AVX	08051C474KAT2A
C33	2.2 uF – 50 V	MLCC capacitor	Murata	GRM188R61H225KE11D
C34	10 uF – 50 V	MLCC capacitor	Murata	GRT31CR61H106KE1L
C35	1 uF – 100 V	MLCC capacitor	Murata	GCM21BC72A105KE36L
C43	100 nF – 100 V	MLCC capacitor	Murata	GCM21BR72A104KA7K
D6	1 A – 800 V	Fast switching rectifier	VISHAY	RS1K
D7	1.2 V – 10 mA	Dual TRANSIL array for ESD protection	STMicroelectronics	ESDA25LY
D10	250 mA – 100 V	Small signal switching diode	NXP	BAT46WH,115
Jout		Connector USB 3.1, type C,90°	Molex	201267-0005
Q3	30 V – 10 m	P-channel power MOSFET	Vishay	SISH101DN-T1-GE3
Q4	30 V – 10 m	P-channel power MOSFET	Vishay	SISH101DN-T1-GE3
R23	10 mΩ±1% – 0.75 W	Metal foil low resistance chip resistors	Susumu	KRL1632E-C-R010-F-T1
R24	100 Ω±1% – 0.5 W	Thick film chip resistors	Panasonic	ERJP06F1000V
R25	47 kΩ±1% – 0.1 W	Thick film chip resistors	Vishay	CRCW060347K0FKEA
R26	10 kΩ±1% – 0.25 W	Thick film chip resistors	Panasonic	ERJ-UP3F1002V
R27	510 Ω±1% – 0.25 W	Thick film chip resistors	Panasonic	ERJ-PA3F5100V
R28	100 Ω±1% – 0.25 W	Thick film chip resistors	Panasonic	ERJ-UP3F1000V
R29	4.7 kΩ±1% – 0.1 W	Thick film chip resistors	Panasonic	ERJ-3EKF4701V
R30	4.7 kΩ±1% – 0.1 W	Thick film chip resistors	Panasonic	ERJ-3EKF4701V
R31	4.7 kΩ±1% – 0.1 W	Thick film chip resistors	Panasonic	ERJ-3EKF4701V
R32	3 kΩ±1% – 0.25 W	Thick film chip resistors	Panasonic	ERJ-UP3F3001V
R33	2.7 kΩ±1% – 0.1 W	Thick film chip resistors	Panasonic	ERJ-3EKF2701V
R34	NC			
RT2	47 kΩ±5% – 0.125 W	NTC thermistor	Vishay	NTCS0603E3473JHT
U3		Standalone USB PD controller	STMicroelectronics	STUSB4761QTR
U4	5 V –85 mA	LDO regulator	STMicroelectronics	LDK715M50R
TRIM		SMT vertical header	Würth Elektronik	6651041318

Table 6. Transformer characteristics

The transformer characteristics are listed in the table below

Parameter	Value
Manufacturer	Würth Elektronik
Part number	750320045 rev.02
Primary inductance	500 μ H \pm 10%
Leakage inductance	7.5 μ H max.
Primary (12 – 1) to aux1 (10 – 2) turns ratio	2.53
Primary (12 – 1) to aux2 (3 – 2) turns ratio	3.43
Primary (12 – 1) to secondary (FL1 – FL2) turns ratio	6

Figure 7. Dimensional drawing and pin placement diagram – distances, bottom view

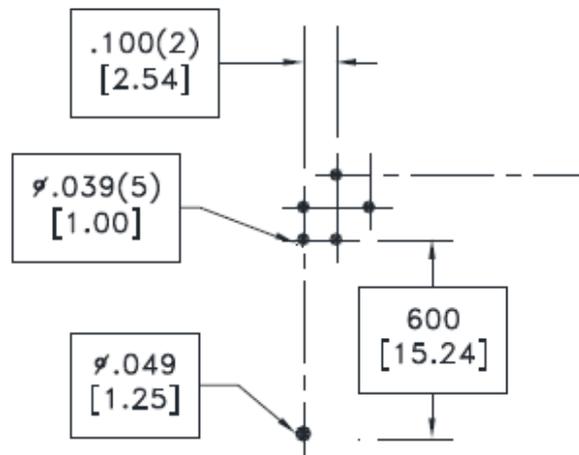


Figure 8. Dimensional drawing and pin placement diagram – electrical diagram

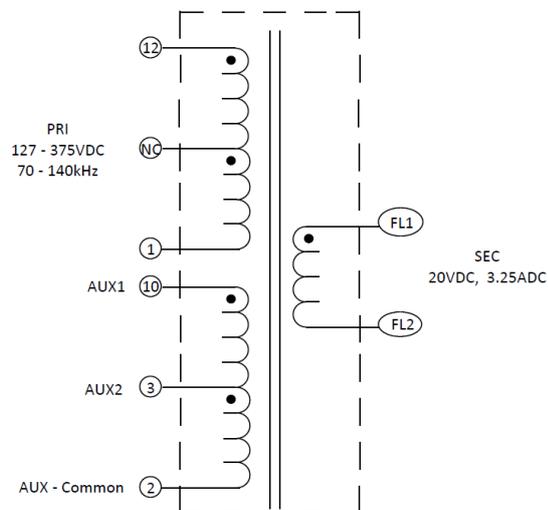
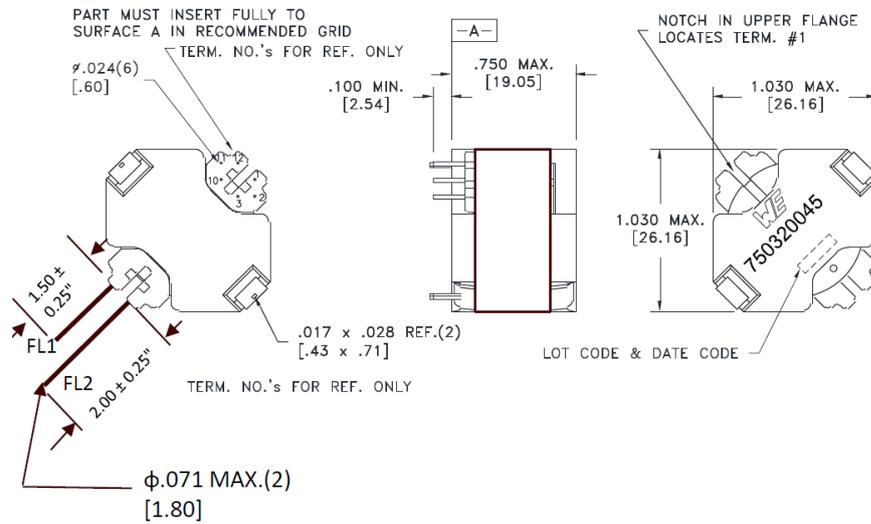
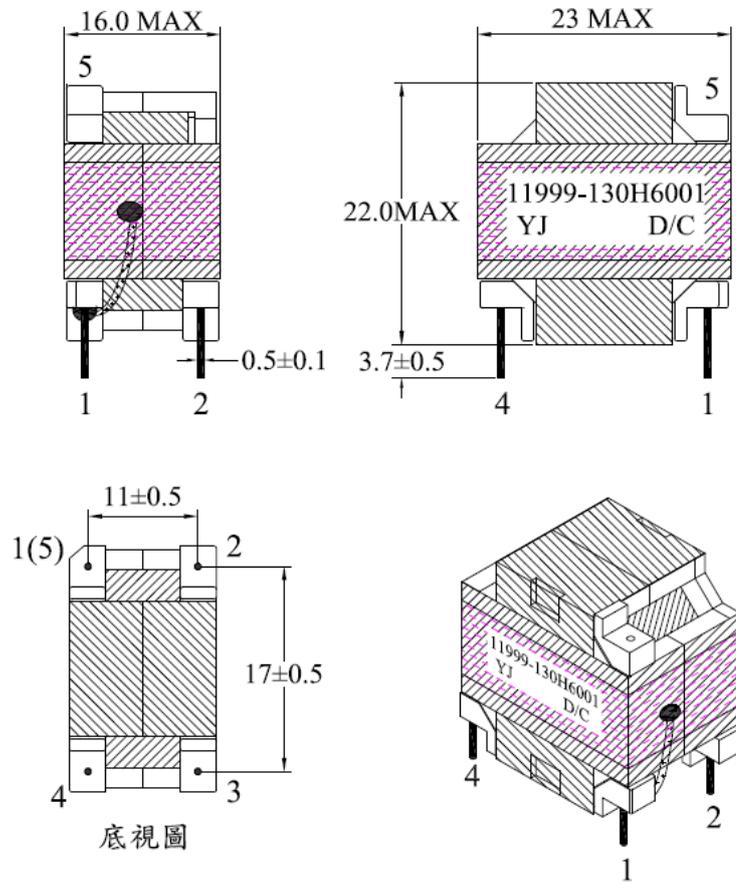
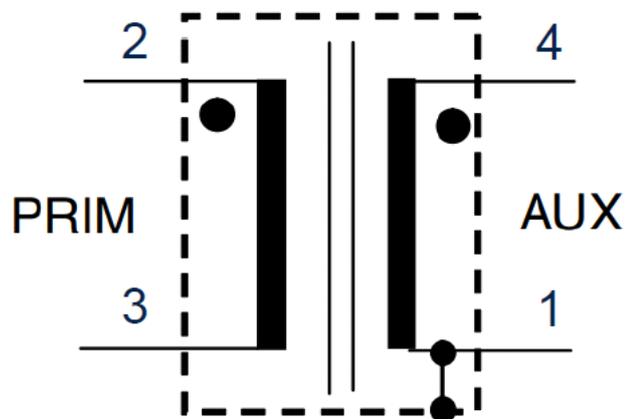


Figure 9. Dimensional drawing and pin placement diagram – bottom, side and top view

Table 7. PFC Inductor characteristics

The PFC Inductor characteristics are listed in the table below

Parameter	Value
Manufacturer	Yu Jing Technology
Part number	11999-130H600110
Primary inductance	420 $\mu\text{H} \pm 10\%$
Peak primary current	4.1 A
Primary (2 – 3) to Aux (4 – 1) turns ratio	10.5

Figure 10. Dimensional drawing and pin placement diagram – bottom, side, and top view

Figure 11. Dimensional drawing and pin placement diagram – electrical diagram


4 Efficiency measurements

The active mode efficiency is defined as the average of the efficiencies measured at 25%, 50%, 75%, and 100% of the rated output power, at nominal input voltages ($V_{IN} = 115 V_{AC}$ and $V_{IN} = 230 V_{AC}$).

External power supplies (the power supplies that are contained in a separate housing from the end-use devices they are powering) need to comply with the Code of Conduct, version 5 “Active mode efficiency” criterion, which states that an SMPS with power throughput of 100 W should have an active mode efficiency higher than 89%.

Another standard to be applied is the DOE (Department of energy) recommendation, whose active mode efficiency requirement for the same power throughput is 88%.

Table 8 to Table 9 show the efficiency measurement results.

Table 8. Average efficiency at 115 V_{AC}

Output load (%)	I _{OUT} (A)	V _{OUT} (V)	P _{IN} (W)	P _{OUT} (W)	Efficiency (%)
5 V output					
25%	0.75	5.01	5.36	3.754	70.04
50%	1.5	5.01	9.59	7.517	78.38
75%	2.24	5.01	13.87	11.25	81.11
100%	3	5.01	17.96	15	83.55
Average efficiency					78.27
9 V output					
25%	0.75	9.015	8.66	6.76	78.05
50%	1.5	9.015	16.16	13.51	83.6
75%	2.24	9.015	23.47	20.25	86.28
100%	3	9.015	30.59	27	88.26
Average efficiency					84.05
12 V output					
25%	0.75	12.02	11.21	9.015	80.42
50%	1.49	12.02	21.02	18.02	85.71
75%	2.25	12.02	30.6	27.01	88.27
100%	3	12.02	40.1	36.01	89.8
Average efficiency					86.05
15 V output					
25%	0.75	15.03	13.85	11.267	81.35
50%	1.5	15.03	25.09	22.519	86.95
75%	2.25	15.03	37.96	33.761	89.94
100%	2.99	15.03	50	45.007	90.01
Average efficiency					86.81
20 V output					
25%	1.25	20.027	28.54	25.027	87.69
50%	2.5	20.027	55.48	50.077	90.26
75%	3.75	20.027	82.29	75.094	90.16
100%	4.99	20.027	111.013	100	90.08
Average efficiency					89.55

Table 9. Average efficiency at 230 V_{AC}

Output load (%)	I _{OUT} (A)	V _{OUT} (V)	P _{IN} (W)	P _{OUT} (W)	Efficiency (%)
5 V output					
25%	0.75	5.01	4.64	3.754	80.91
50%	1.5	5.01	9.06	7.516	82.96
75%	2.24	5.01	13.45	11.26	83.72
100%	3	5.01	17.77	15.004	84.43
Average efficiency					83
9 V output					
25%	0.75	9.015	8.09	6.76	83.55
50%	1.5	9.015	15.87	13.51	85.13
75%	2.25	9.015	23.44	20.25	86.39
100%	3	9.015	30.8	27	87.66
Average efficiency					85.68
12 V output					
25%	0.75	12.02	10.59	9.02	85.13
50%	1.49	12.02	20.94	18.02	86.05
75%	2.25	12.02	30.85	27.01	87.56
100%	3	12.02	39.79	36.01	90.5
Average efficiency					87.31
15 V output					
25%	0.75	15.03	13.4	11.266	84.07
50%	1.5	15.03	25.86	22.518	87.08
75%	2.25	15.03	38.3	33.759	88.14
100%	2.99	15.03	49.94	45.004	90.12
Average efficiency					87.35
20 V output					
25%	1.24	20.04	28.8	25.03	86.91
50%	2.5	20.04	55.2	50.071	90.71
75%	3.7	20.04	81.6	75.05	91.97
100%	4.99	20.04	108.3	100.02	92.34
Average efficiency					90.48

Table 10. Average efficiency at 10% of the max. output load

Table 10 shows the efficiency measured at 10% of the rated output power

V_{IN} [V _{AC}]	I_{OUT} (A)	V_{OUT} (V)	P_{IN} (W)	P_{OUT} (W)	Efficiency (%)
5 V output					
115	0.3	5.01	2.25	1.5	66.67
230	0.3	5.01	1.96	1.5	76.53
9 V output					
115	0.3	9.015	3.92	2.7	68.88
230	0.3	9.015	3.41	2.7	79.21
12 V output					
115	0.3	12.02	5.25	3.63	69.14
230	0.3	12.02	4.53	3.63	80.2
15 V output					
115	0.3	15.03	6.27	4.5	71.77
230	0.3	15.03	5.57	4.5	80.79
20 V output					
115	0.5	20.04	12.68	10.026	79.07
230	0.5	20.04	12.1	10.033	82.83

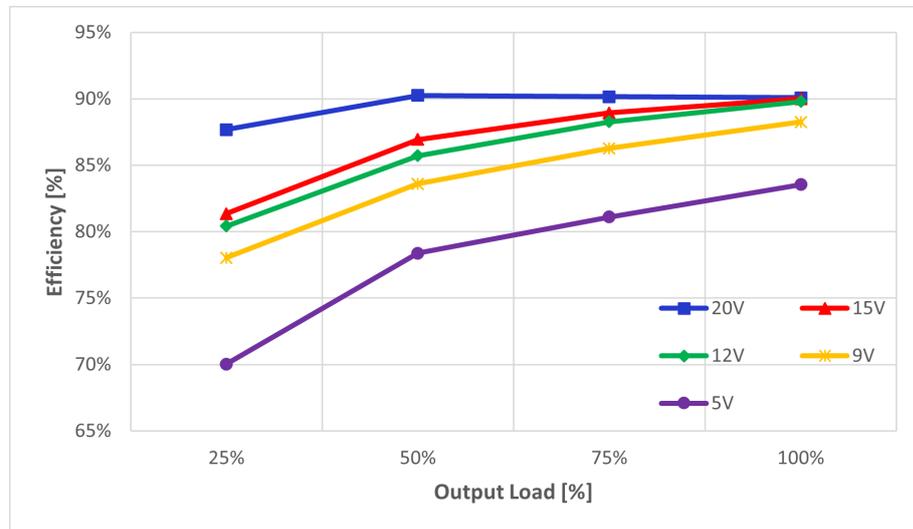
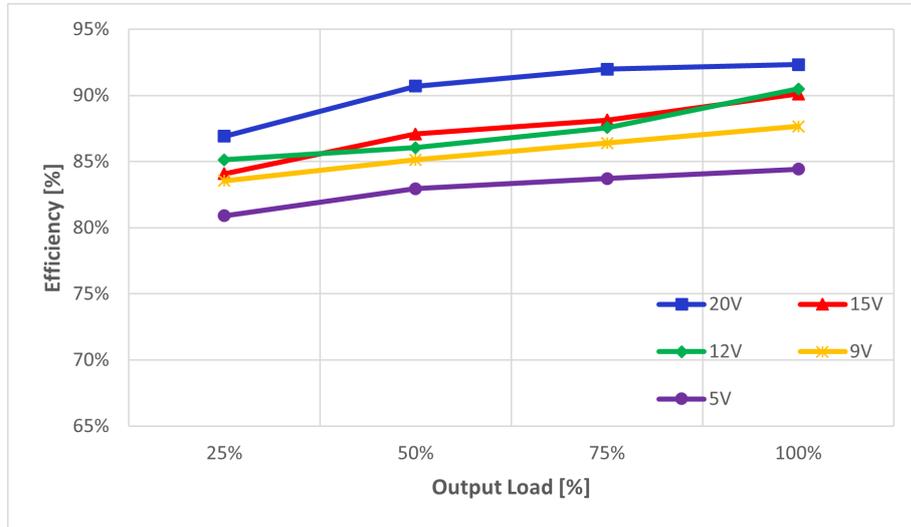
Figure 12. Efficiency at 115 V_{AC}


Figure 13. Efficiency at 230 V_{AC}


4.1 No load consumptions

The input power of the converter has been measured in no load; in this condition, the converter works in burst mode so that the average switching frequency is reduced, thus minimizing the frequency related losses. The no load condition is realized with nothing connected to the USB Type-C[®] port, which opens the by-pass MOSFETs Q3 and Q4 in the daughterboard and sets the output voltage of the converter to 5 V.

Table 11. No load consumptions

V _{IN} [V _{AC}]	P _{IN} (mW)
5 V output	
115	40
230	96

5 Typical waveforms

The following figures show the GaN (primary side) and SR MOSFET (secondary side) drain to source voltage for minimum and maximum AC input voltage at maximum output power.

Figure 14. VIPerGaN and SR MOSFET V_{DS} at 90 V_{AC} (20 V – 5 A)

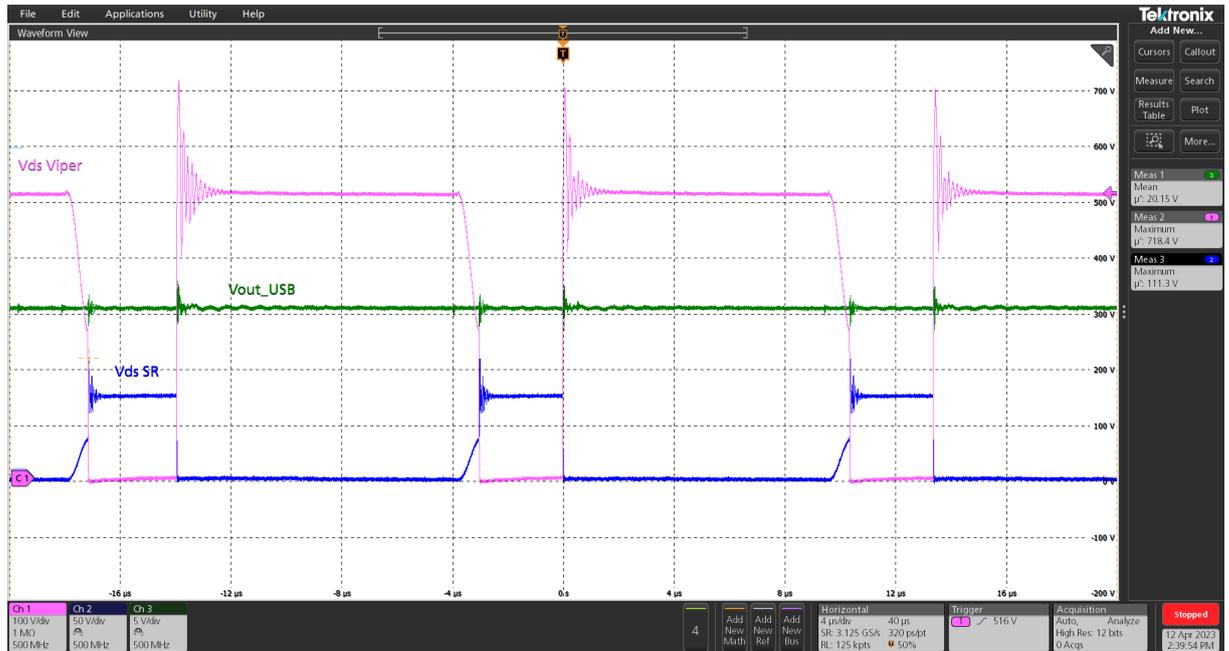
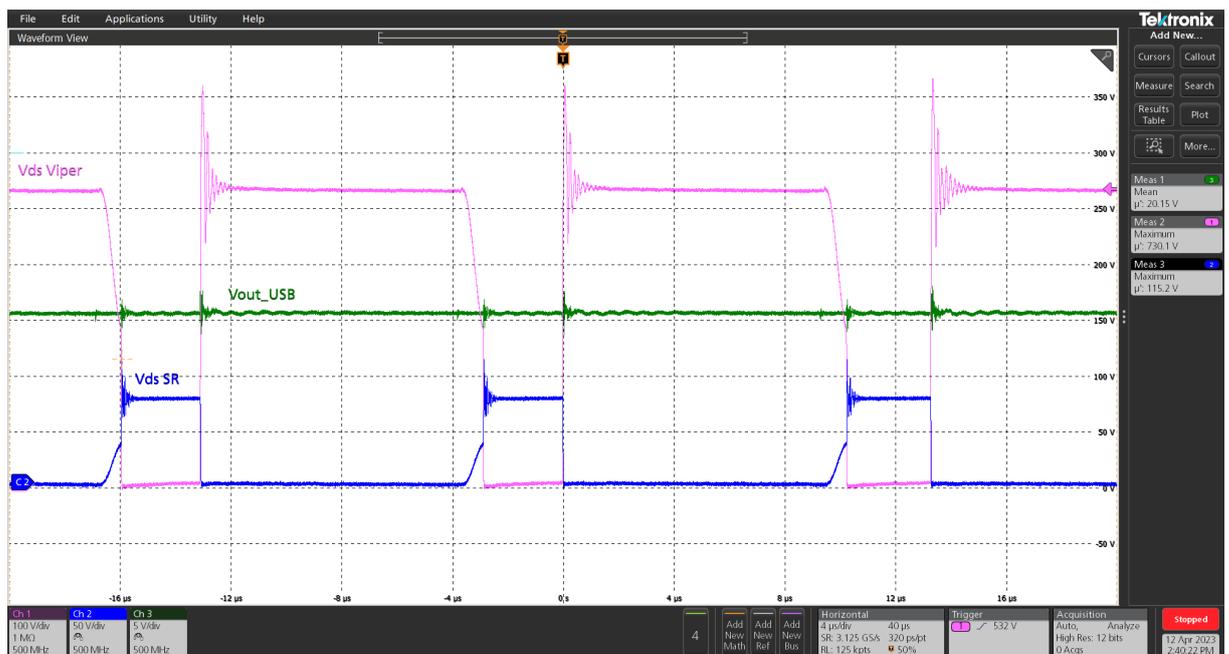


Figure 15. VIPerGaN and SR MOSFET V_{DS} at 265 V_{AC} (20 V – 5 A)



The output voltage ripple has been measured at different output voltages with two different loads (0 A and maximum available current). Tests have been performed at the nominal input voltages (115 V_{AC} and 230 V_{AC}).

Figure 16. Ripple at 115 V_{AC}, 5 V – 0 A

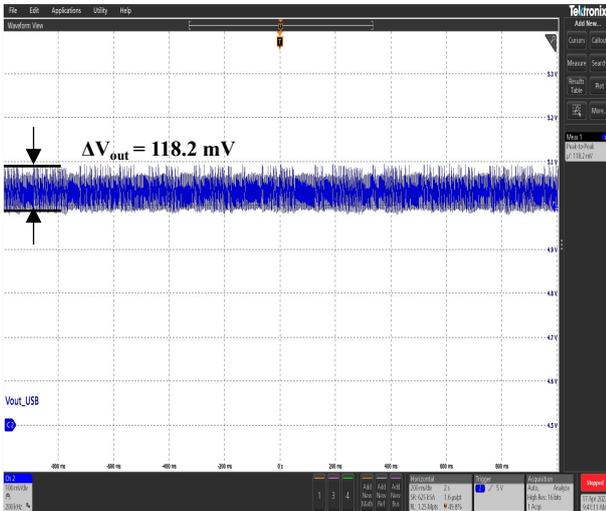


Figure 17. Ripple at 230 V_{AC}, 5 V – 0 A

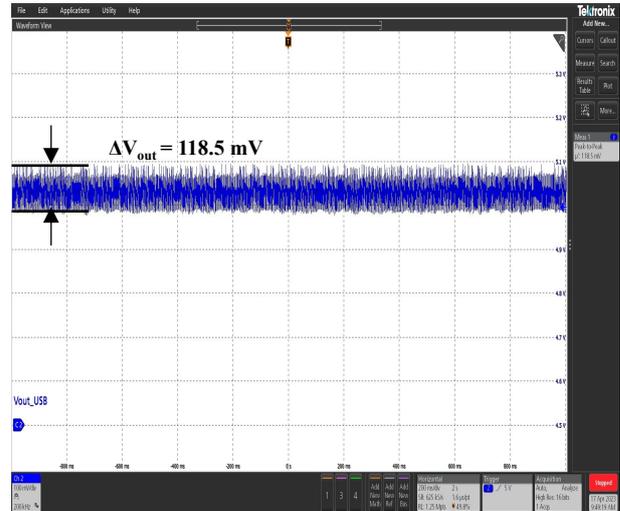


Figure 18. Ripple at 115 V_{AC}, 5 V – 3 A

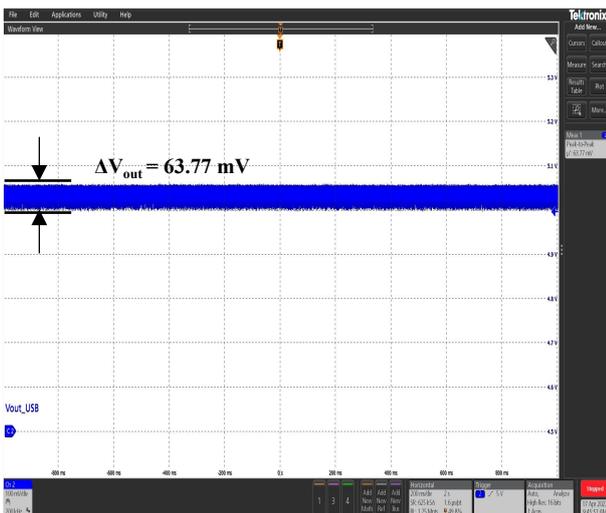


Figure 19. Ripple at 230 V_{AC}, 5 V – 3 A

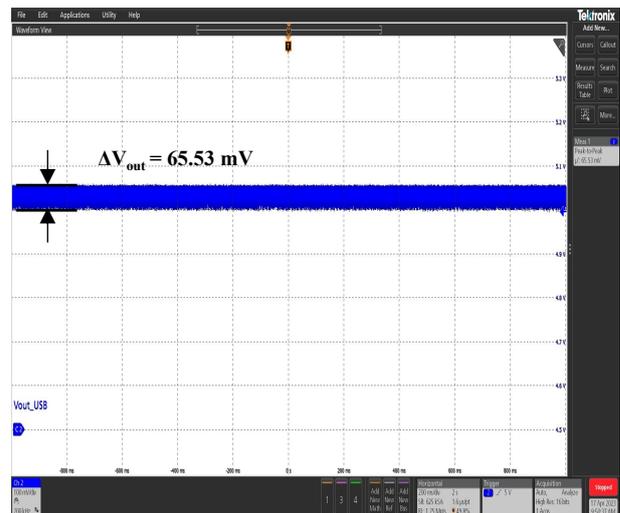


Figure 20. Ripple at 115 V_{AC}, 9 V – 0 A

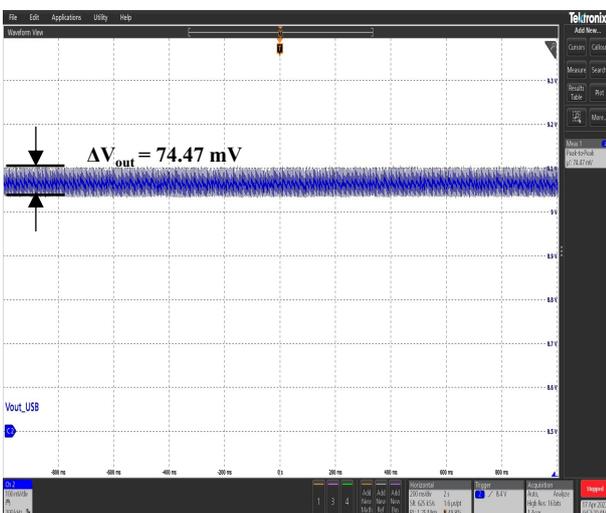


Figure 21. Ripple at 230 V_{AC}, 9 V – 0 A

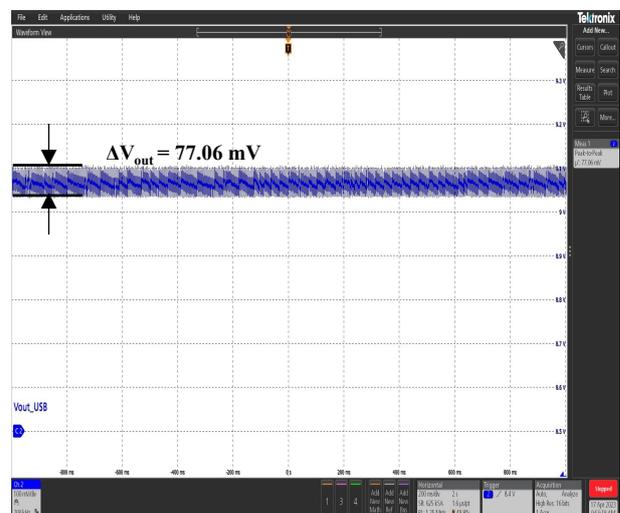


Figure 22. Ripple at 115 V_{AC}, 9 V – 3 A

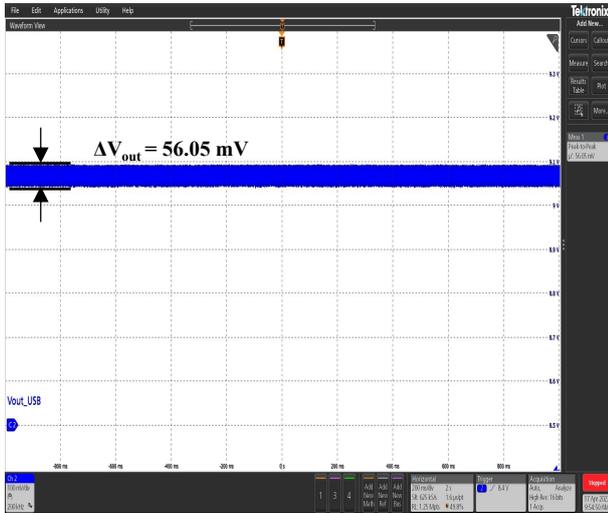


Figure 23. Ripple at 230 V_{AC}, 9 V – 3 A

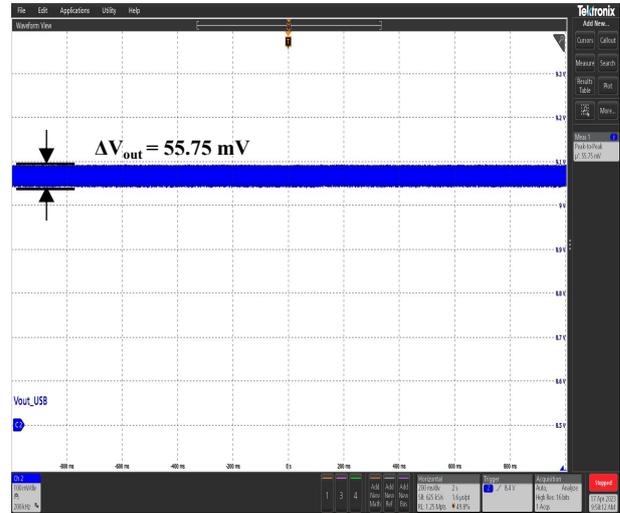


Figure 24. Ripple at 115 V_{AC}, 12 V – 0 A

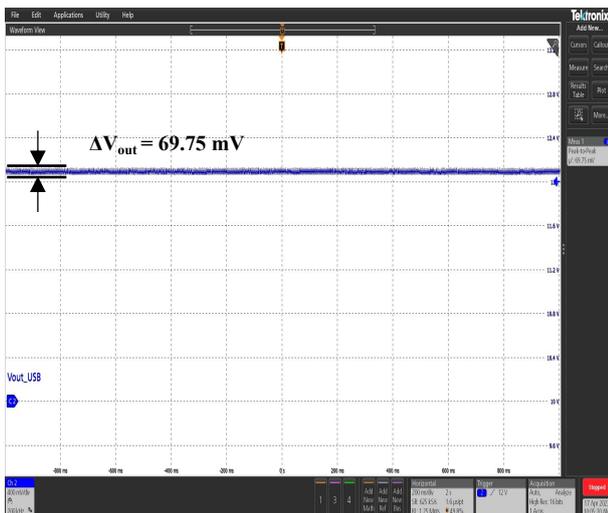


Figure 25. Ripple at 230 V_{AC}, 12 V – 0 A

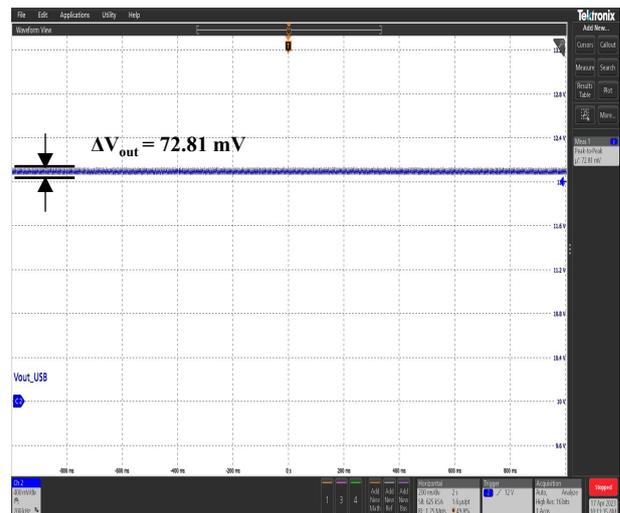


Figure 26. Ripple at 115 V_{AC}, 12 V – 3 A

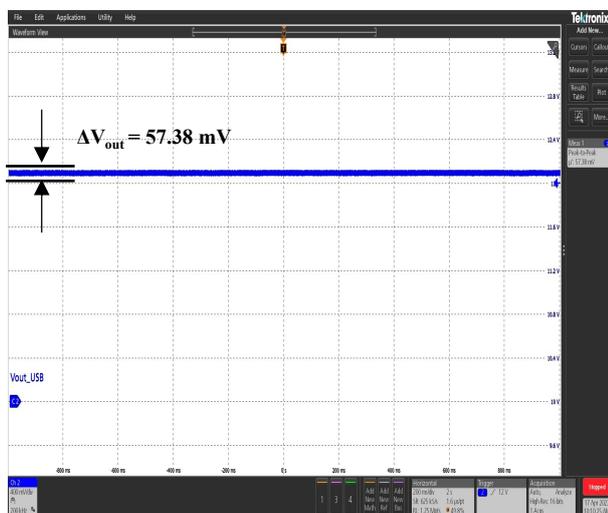


Figure 27. Ripple at 230 V_{AC}, 12 V – 3 A

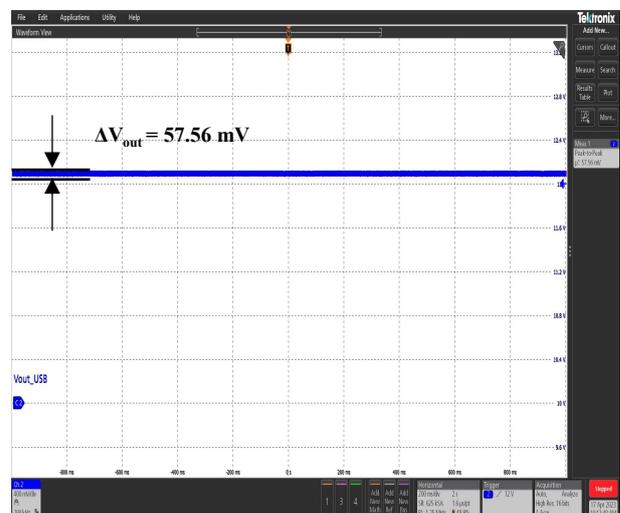


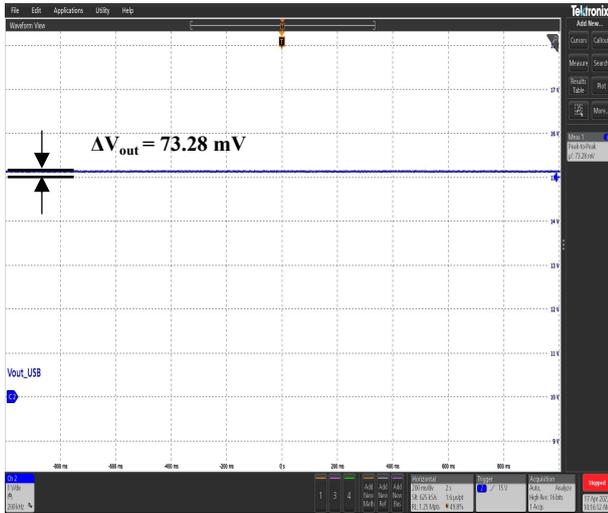
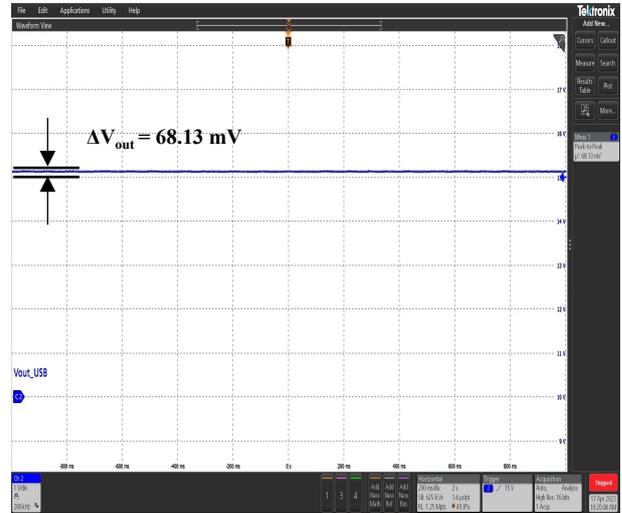
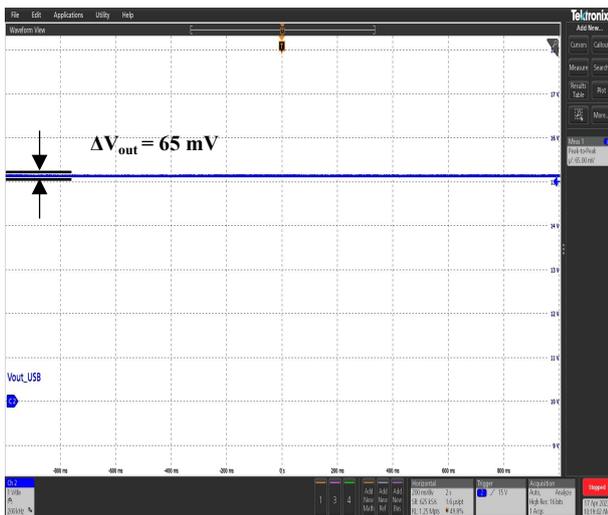
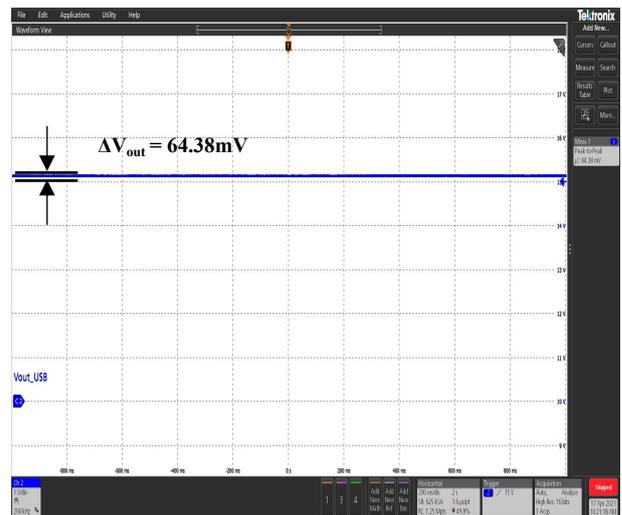
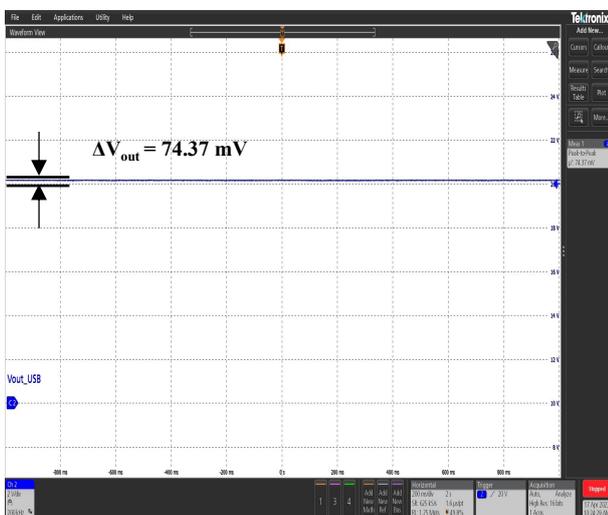
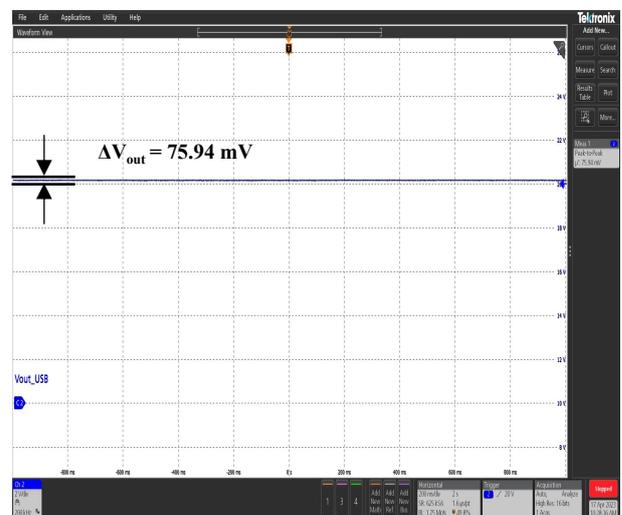
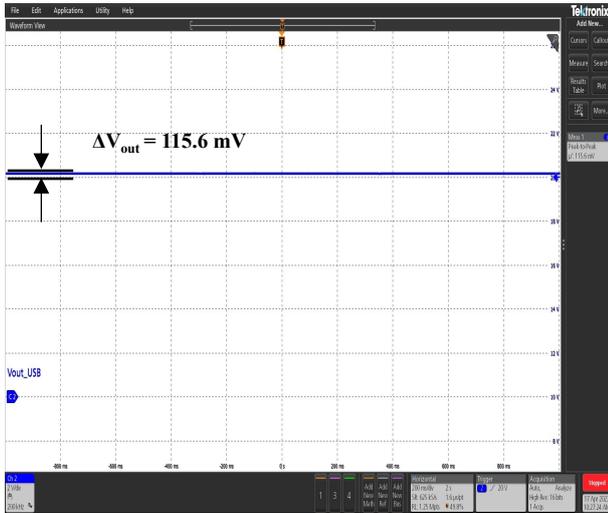
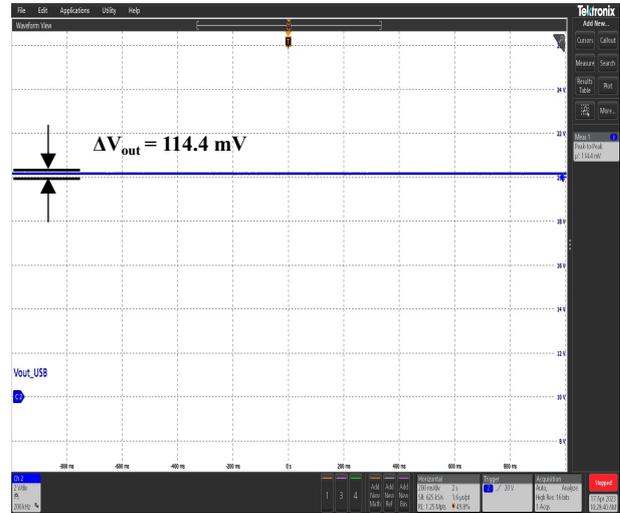
Figure 28. Ripple at 115 V_{AC}, 15 V – 0 A

Figure 29. Ripple at 230 V_{AC}, 15 V – 0 A

Figure 30. Ripple at 115 V_{AC}, 15 V – 3 A

Figure 31. Ripple at 230 V_{AC}, 15 V – 3 A

Figure 32. Ripple at 115 V_{AC}, 20 V – 0 A

Figure 33. Ripple at 230 V_{AC}, 20 V – 0 A


Figure 34. Ripple at 115 V_{AC}, 20 V – 5 A

Figure 35. Ripple at 230 V_{AC}, 20 V – 5 A

Table 12. Output voltage ripple test results

V _{IN} [V _{AC}]	V _{OUT} (V)	I _{OUT} (A)	Ripple (mV)	Max. ripple (mV) allowed by USB PD specification
115 V _{AC}	5	0	± 118.2	± 250
	5	3	± 63.77	± 250
	9	0	± 74.47	± 450
	9	3	± 56.05	± 450
	12	0	± 69.75	± 600
	12	3	± 57.38	± 600
	15	0	± 73.28	± 750
	15	3	± 65	± 750
	20	0	± 74.37	± 1000
	20	5	± 115.6	± 1000
230 V _{AC}	5	0	± 118.5	± 250
	5	3	± 65.53	± 250
	9	0	± 77.06	± 450
	9	3	± 55.75	± 450
	12	0	± 72.81	± 600
	12	3	± 57.56	± 600
	15	0	± 68.13	± 750
	15	3	± 64.38	± 750
	20	0	± 75.94	± 1000
	20	5	± 114.4	± 1000

6 Dynamic step load regulation

The following figures show the load transient response when the converter is subjected to repetitive dynamic load transitions from zero to full load at 115 V_{AC} and 230 V_{AC}.

The transition period is 200 ms with a 50% duty cycle and slew rate of 150 mA/μs.

There are no abnormal oscillations in the output voltage and the overshoot and undershoot are acceptable.

Figure 36. Dynamic step load ($V_{OUT} = 5\text{ V}$, I_{OUT} from 0 to 3 A) at 115 V_{AC}

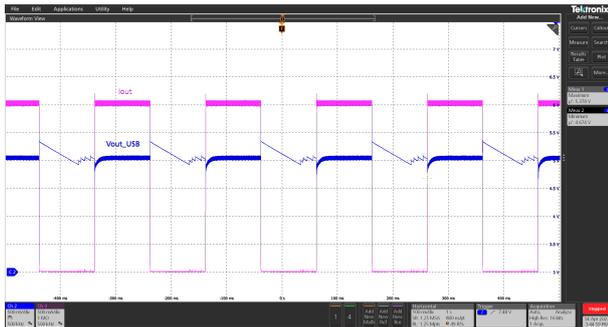


Figure 37. Dynamic step load ($V_{OUT} = 5\text{ V}$, I_{OUT} from 0 to 3 A) at 230 V_{AC}

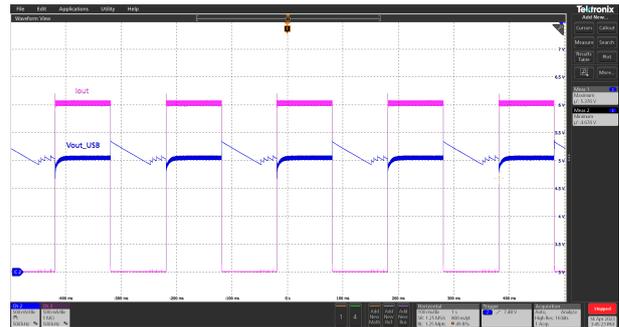


Figure 38. Dynamic step load ($V_{OUT} = 9\text{ V}$, I_{OUT} from 0 to 3 A) at 115 V_{AC}

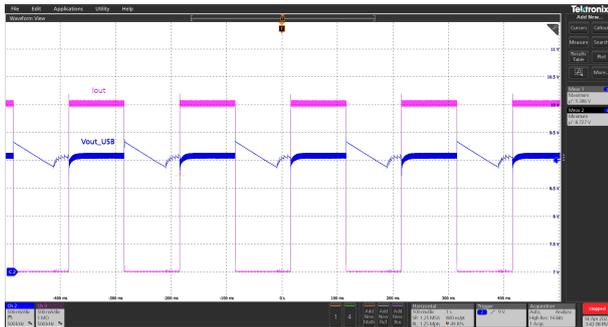


Figure 39. Dynamic step load ($V_{OUT} = 9\text{ V}$, I_{OUT} from 0 to 3 A) at 230 V_{AC}

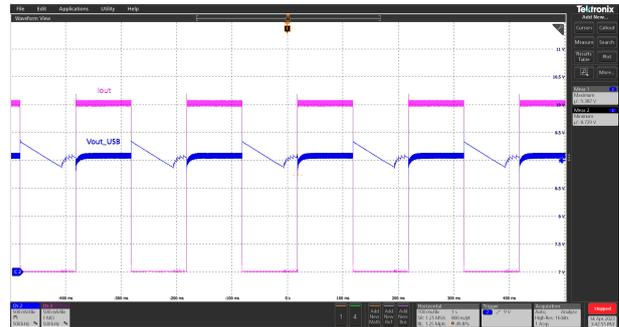


Figure 40. Dynamic step load ($V_{OUT} = 12\text{ V}$, I_{OUT} from 0 to 3 A) at 115 V_{AC}

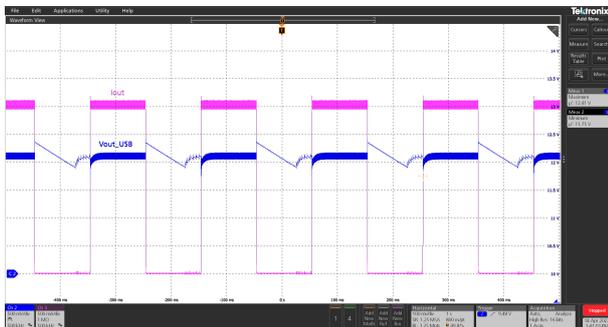


Figure 41. Dynamic step load ($V_{OUT} = 12\text{ V}$, I_{OUT} from 0 to 3 A) at 230 V_{AC}

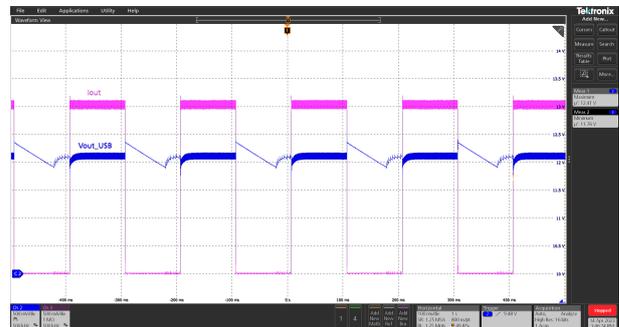


Figure 42. Dynamic step load ($V_{OUT} = 15\text{ V}$, I_{OUT} from 0 to 3 A) at 115 V_{AC}

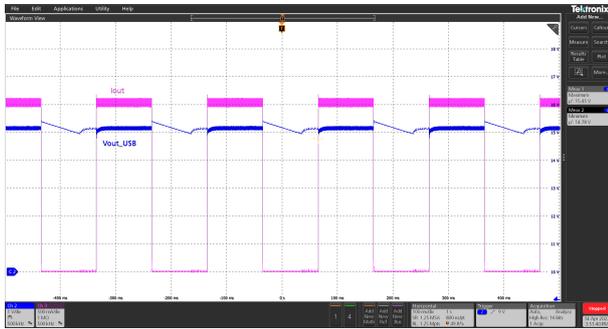


Figure 43. Dynamic step load ($V_{OUT} = 15\text{ V}$, I_{OUT} from 0 to 3 A) at 230 V_{AC}

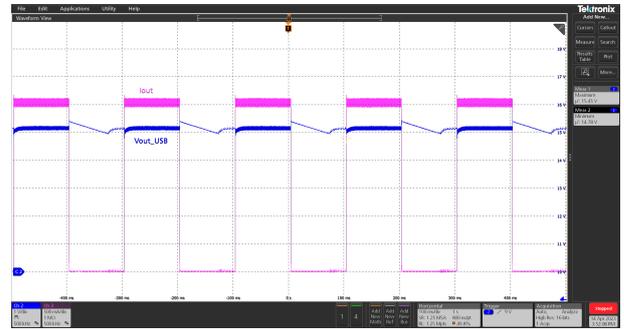


Figure 44. Dynamic step load ($V_{OUT} = 20\text{ V}$, I_{OUT} from 0 to 5 A) at 115 V_{AC}

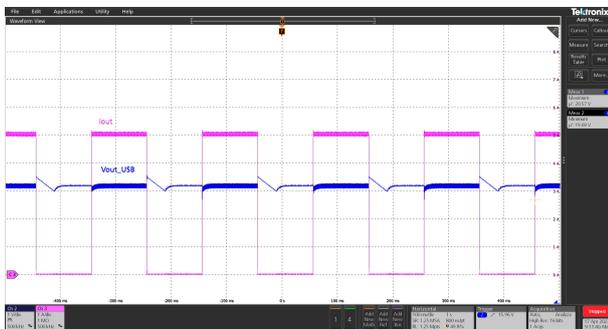
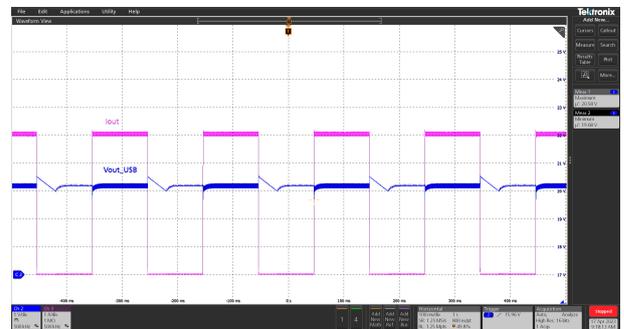


Figure 45. Dynamic step load ($V_{OUT} = 20\text{ V}$, I_{OUT} from 0 to 5 A) at 230 V_{AC}

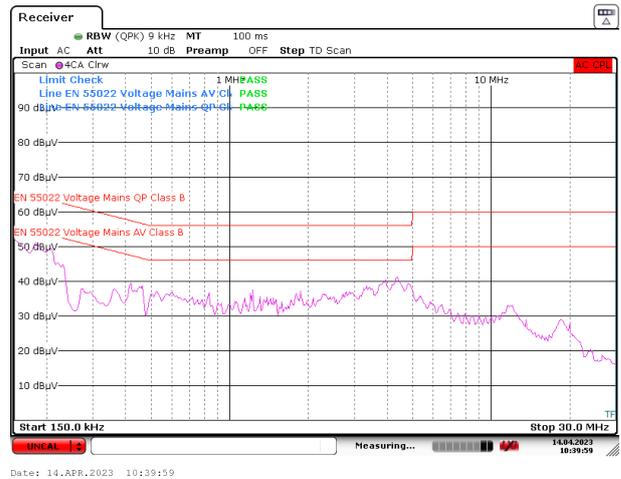
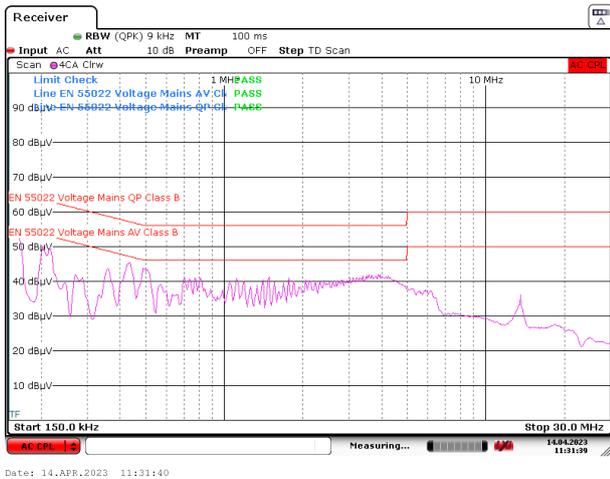


7 Conducted noise measurements

The VIPERGAN100W[®] frequency jittering feature allows the spectrum to be spread over frequency bands rather than being concentrated on a single frequency value. Especially when measuring conducted emission with the average detection method, the level reduction can be several dB μ V.

A pre-compliance test for the EN55022 (Class B) European normative was performed and the average measurements of the conducted noise emissions at nominal mains voltages, with output set to 20 V and maximum load (5 A), are shown in the following figures.

Figure 46. CE average measurement at 115 V_{AC} (V_{OUT} = 20 V, I_{OUT} = 5 A) **Figure 47. CE average measurement at 230 V_{AC} (V_{OUT} = 20 V, I_{OUT} = 5 A)**



8 Thermal measurements

A thermal analysis of the board has been performed using an IR camera module. The test was performed with the output voltage set to 20 V under full load condition for the two nominal input voltages (115 V_{AC} and 230 V_{AC}). The results are shown below.

Figure 48. Thermal map at 115 V_{AC} (20 V – 5 A), bottom layer

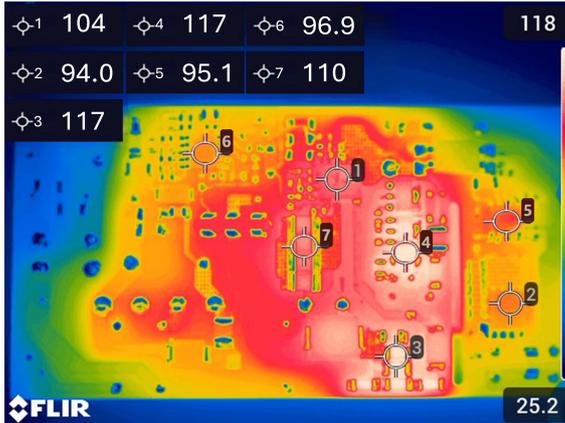


Figure 50. Thermal map at 230 V_{AC} (20 V – 5 A), bottom layer

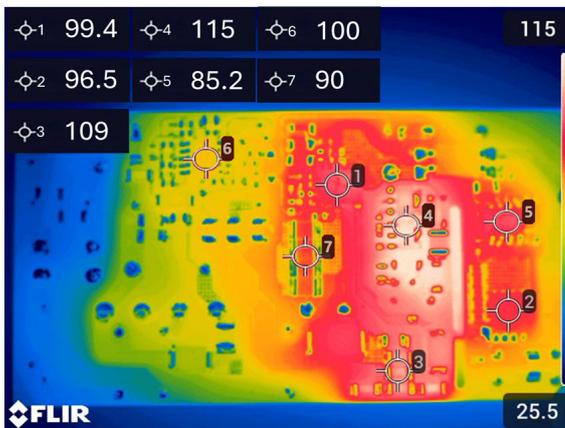


Figure 49. Thermal map at 115 V_{AC} (20 V – 5 A), top layer



Figure 51. Thermal map at 230 V_{AC} (20 V – 5 A), top layer



Table 13. Temperature of key components (T_{AMB} = 25 °C, emissivity = 0.95 for all points) bottom side

Point	Temp (°C)		Reference
	115 V _{AC}	230 V _{AC}	
1	104	99.4	VIPerGaN
2	94	96.5	SR MOSFET
3	117	109	Snubber resistors
4	117	115	Q2-Q3 channel depletion mode
5	95.1	85.2	SRK1001
6	96.9	100	L6564
7	110	90	PFC sense resistors

Table 14. Temperature of key components ($T_{AMB} = 25\text{ °C}$, emissivity = 0.95 for all points) top side

Point	Temp (°C)		Reference
	115 V _{AC}	230 V _{AC}	
1	98	77	Mos PFC
2	121	114	Transformer
3	94	72	Bridge diode
4	102	77	PFC inductor

9 Conclusions

The test results shown demonstrate the good performances achieved by EVLVIPGAN100WP.

The reference design shows peak efficiency > 92%. It also meets CoC Tier 2 and DoE Level 6 efficiency requirements for average efficiency. The quasi-resonant topology helps to minimize the switching losses. The low quiescent current consumption makes it best-in-class no-load consumption.

The VIPerGaN100W[®] is an offline quasi-resonant (valley switching at switch turn-on) flyback converter. Depending on the converter's load condition, the device is able to work in different modes. Based on the quasi-resonant, the primary switching losses are minimized. The secondary losses are minimized by using the highly efficient and optimized synchronous rectification controller.

Users no longer need to take care of GaN driving complexity to enjoy the benefits of GaN technology thanks to the highly integrated VIPerGaN100W[®] IC, enhancing the robustness of the application.

Revision history

Table 15. Document revision history

Date	Version	Changes
13-Feb-2026	1	Initial release.

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