Design Example Report

Title	**120 W Isolated Flyback Power Supply Using TOPSwitchGaN (TOP7078K)**
Specification	85 – 265 VAC Input; 24 V / 5 A Output
Application	Appliance
Author	Applications Engineering Department
Document Number	DER-1107
Date	June 26, 2026
Revision	A

Summary and Features

- >90% full load efficiency at 115 VAC and 91% full load efficiency at 230 VAC
- ≥89% efficient at 10% load at 115 VAC and 230 VAC Input
- >90% average efficiency at 115 VAC and 230 VAC
- Extensive protection features including:
    - Line overvoltage and undervoltage protection
    - Overtemperature Protection (OTP)
    - Short circuit protection
- Class B conducted EMI with > 6 dB margin

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Important Note:
Although this board is designed to satisfy safety isolation requirements, the engineering prototype has not been agency approved. Therefore, all testing should be performed using an isolation transformer to provide the AC input to the prototype board.

1 Introduction

This engineering report describes a flyback converter that provides an isolated output voltage of 24 V at 5 A from a wide input voltage range of 85 VAC to 265 VAC. This power supply utilizes the TOP7078K from the TOPSwitchGaN™ family of ICs.

This report contains the complete power supply specification, bill of materials, transformer construction information, circuit schematic and printed circuit board (PCB) layout, along with performance data and electrical waveforms.

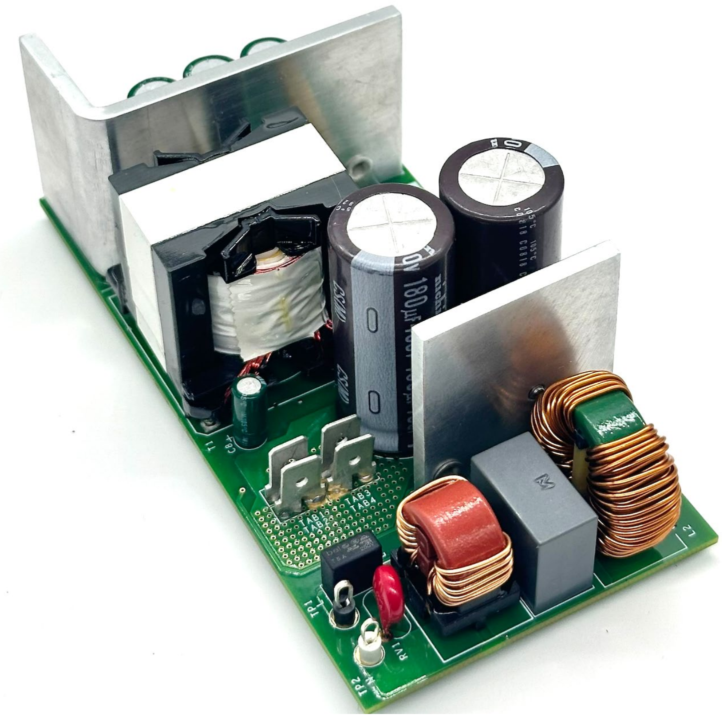


Figure 1 – Oblique View.

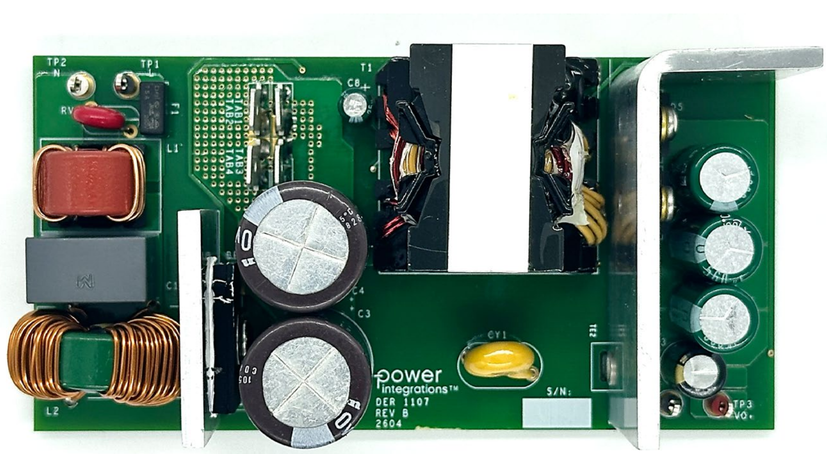


Figure 2 – Top View.

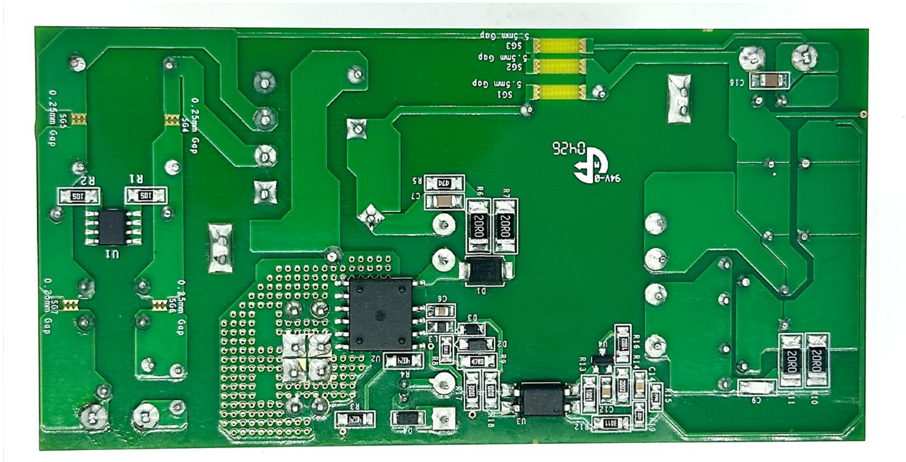


Figure 3 – Bottom View.

2 Power Supply Specification

The table below represents the minimum acceptable performance of the design. Actual performance is listed in the results section.

Description	Symbol	Min	Typ	Max	Units	Comment
Input						
Voltage	V_{IN}	85	115/230	265	VAC	2 Wire – no P.E.
Frequency	f_{LINE}	47	50 / 60	64	Hz	
No-load Input Power (230 VAC)				142	mW	Measured at 230 VAC.
Output1						
Output Voltage	V_{OUT1}	22.8	24	25.2	V	± 5%
Output Ripple Voltage	$V_{RIPPLE1}$			240	mV	20 MHz bandwidth.
Output Current	I_{OUT1}	0		5	A	
Total Output Power						
Continuous Output Power	P_{OUT}		120		W	
Efficiency						
Full Load 115 VAC	$\eta_{115\ VAC}$		90.6		%	Measured at P_{OUT} 25°C.
Full Load 230 VAC	$\eta_{230\ VAC}$		91.8		%	
Average efficiency at 25, 50, 75 and 100% of P_{OUT}	η_{DOE}		90.8		%	Measured at Nominal Input 115 VAC and 230 VAC.
Environmental						
Conducted EMI		Meets CISPR22B / EN55022B				
Surge (Differential)				±2	kV	1.2/50 µs Surge, IEC 61000-4-5 Differential Mode: Series Impedance = 2 Ω
Ring Wave (Common Mode)				±6	kV	100 kHz Ring Wave Common Mode: Series Impedance = 12 Ω
Electrical Fast Transient (EFT)				±4	kV	15 ms @ 5 kHz 0.75 ms @ 100 kHz
ESD – Air Discharge				±16.5	kV	
ESD – Contact Discharge				±8.8	kV	
Ambient Temperature	T_{AMB}	0		40	°C	Free Convection, Sea Level.

Table 1 – Power Supply Specification.

3 Schematic

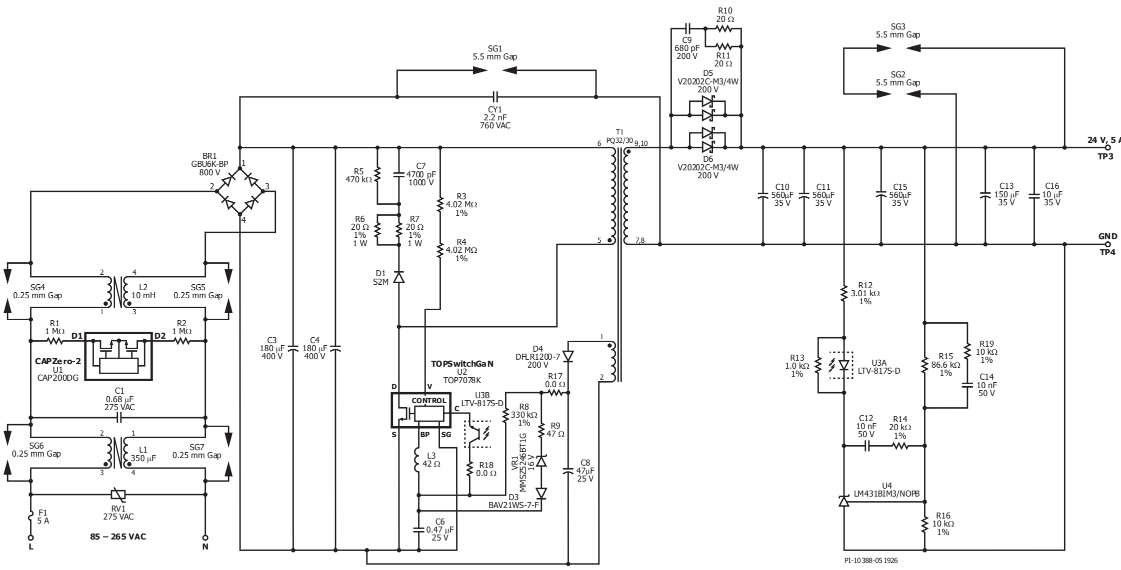


Figure 4 – Schematic.

4 Circuit Description

This power supply employs a TOP7078K off-line switcher operating (U2) in a flyback configuration. U2 has an integrated high voltage PowiGaN™ switch. It regulates the output by adjusting the PowiGaN switch off-time duration, which is proportional to the current fed into its CONTROL pin. ILIM is adjusted according to switching frequency.

4.1 Input EMI Filtering and Rectification

Fuse F1 isolates the circuit and provides protection from component failure. X-Capacitor C1 together with common mode choke (CMC) L1 and L2 forms an EMI filter that attenuates both common mode and differential mode conducted EMI. BR1 converts the AC line voltage into the DC voltage seen across bulk capacitors C3 and C4. The CAPZero™-2 IC (U1) along with bleed resistors, R1 and R2, discharges the stored energy in X capacitor C1 when AC is disconnected, meeting safety requirements. When AC is connected the resistors are disconnected, reducing no-load power consumption.

4.2 TOPSwitchGaN Primary

The TOP7078K device (U2) integrates an oscillator, a switch controller, start-up and protection circuitry, and PowiGaN switch, all on one monolithic IC. One side of the power transformer (T1) primary winding is connected to the positive side of the bulk capacitors C3 and C4, and the other side is connected to the DRAIN pin (D pin) of U2. When the PowiGaN switch turns off, the leakage inductance of the transformer induces a voltage spike on the drain node. The spike amplitude is limited by an RCD clamp network that consists of D1, R6, R7, C7 and R5. Resistors R6 and R7 are used together with capacitor C3 and resistor R5 to damp high frequency ringing and improve EMI. This arrangement was selected to reduce clamp losses under light and no-load conditions. Y capacitor CY1, connected between the primary and secondary side helps improve EMI.

The TOP7078K regulates the output by adjusting the power PowiGaN switch off-time duration in proportion to the current into its CONTROL pin. The power supply output voltage is sensed on the secondary side by shunt regulator U4 and provides a feedback signal to the primary side through optocoupler U3.

Line undervoltage and overvoltage thresholds are determined by the current supplied from resistors R3 and R4 to the V pin. R9, D3, and VR1 provide output overvoltage protection (OVP). An increase in output voltage causes an increase in the bias winding voltage, sensed by VR1. Once VR1 is activated, it will inject current to the BP pin causing the IC U2 to shut down and enter auto-restart (AR).

At start-up, bypass capacitor C6 is charged through the DRAIN (D) pin, which is placed as close as possible to U2. Once it is charged, U2 begins to switch. Capacitor C6 stores enough energy to ensure the TOPSwitchGaN IC is powered until the output reaches regulation. The value of C6 also sets the maximum ILIM for the primary switch (in this case ILIM is set to standard). After start-up, the bias winding delivers current via diode D4 and R8 to charge capacitor C8 which in turn powers the controller. Resistor R8 is used to set the typical bias current of the IC U4. Ferrite bead L3 minimizes the noise on the BP pin.

4.3 Output Rectification

Schottky diodes D5 and D6 rectify the secondary winding output of T1. The output voltage is filtered by C10, C11, C13, C15 and C16. Resistors R10 and R11 with capacitor C9 snubs the voltage spike caused by the commutation of D5 and D6. Low ESR capacitors C10, C11, C13, C15 and C16 help in minimizing output voltage ripple.

4.4 Output Feedback

The reference IC, U4 or LM431BIM3/NOPB, is used to set the output voltage programmed via the feedback resistor divider gcomposed of R15 and R16. The LM431BIM3/NOPB varies its cathode voltage to keep its input voltage constant (2.495 V, ±1%). As the cathode voltage changes, the current through the optocoupler LED and corresponding phototransistor within U2 changes. R12, C12, R14, R19 and C14 ensure stable operation, while resistor R13 maintains minimum bias to U3.

5 PCB Layout

5.1 PCB Specification

- Layer: 2
- Board Thickness: 1.6 mm
- Copper Thickness: 2 oz
- Finishing: LF HASL
- Material: FR4
- Solder mask: Green
- Silkscreen: White

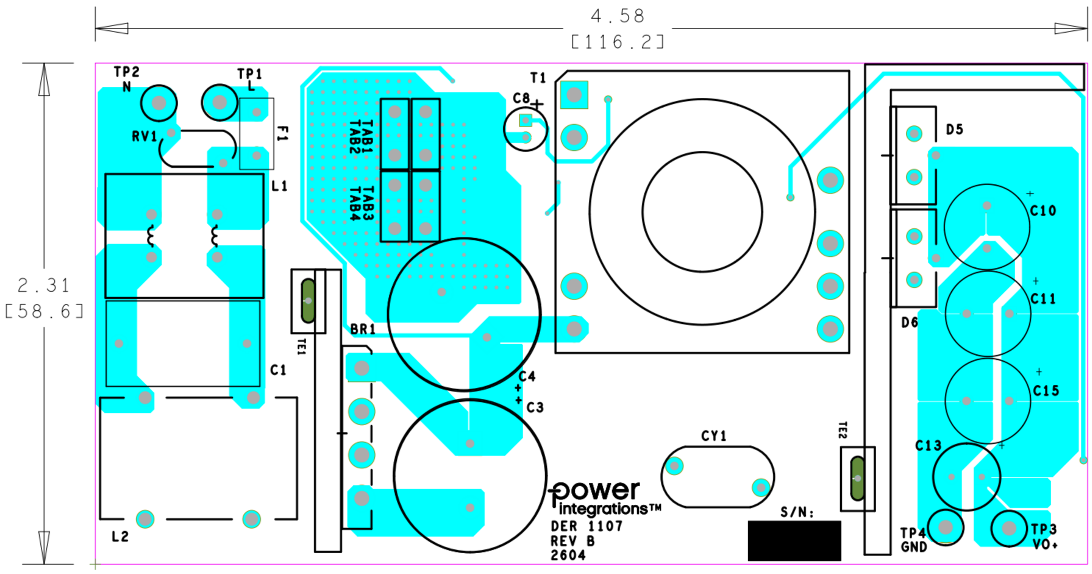


Figure 5 – Printed Circuit Layout, Top View.

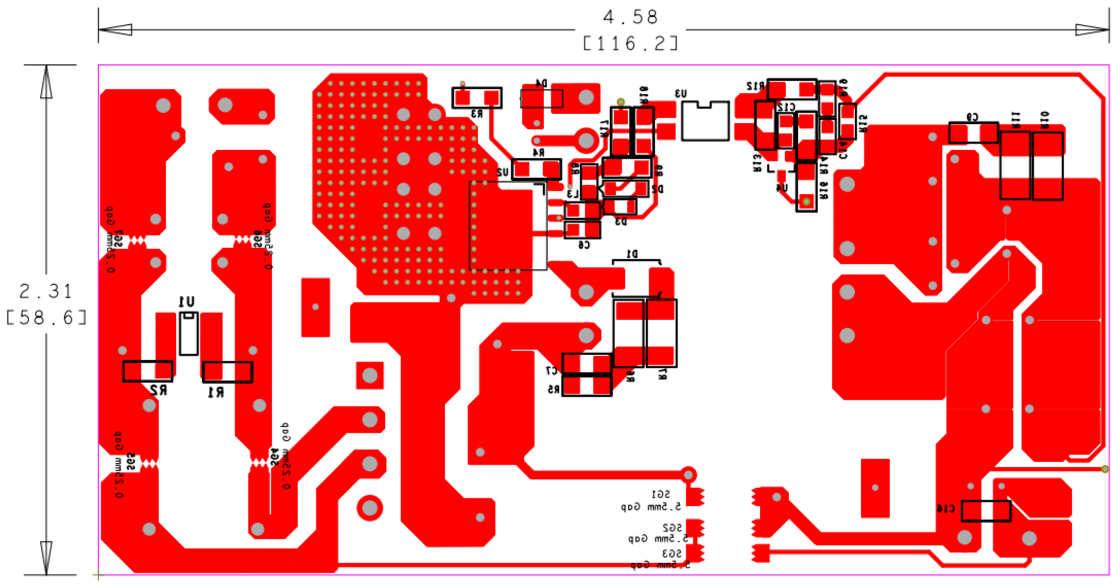


Figure 6 – Printed Circuit Layout, Bottom View.

6 Bill of Materials

6.1 Electrical BOM

Item	Qty.	Ref Des	Description	Mfr. Part Number	Manufacturer
1	1	BR1	800 V, 8 A, Bridge Rectifier, GBU Case	GBU8K-BP	Micro Commercial Co.
2	1	C1	0.68 µF, ±20%, 275 VAC, 560 VDC, Film Capacitor, X2, 18 mm x 10 mm x 16.1 mm	R46KI368045P1M	Kemet
3	2	C3 C4	180 µF, 400 V, Aluminum Electrolytic Capacitor, 18 mm x 42 mm	UPZ2G181MHD	Nichicon
4	1	C6	0.47 µF, ±10%, 25 V, Ceramic Capacitor, X7R, 0805 (2012 Metric)	CGA4J2X7R1E474K125AA	TDK Corporation
5	1	C7	4700 pF ±5% 500 V, Ceramic Capacitor, C0G, NP0,1206 (3216 Metric)	C1206C472JCGACAUTO	Kemet
6	1	C8	47 µF, ±20%, 25 V, Electrolytic Capacitor, Very Low ESR, 300 mΩ, 5 mm x 11 mm	EKZE250ELL470ME11D	Nippon Chemi-Con
7	1	C9	680 pF, ±5%, 200 V, Ceramic Capacitor, C0G, NP0, 1206 (3216 Metric)	KGM31VCG2D681JU	KYOCERA AVX
8	3	C10 C11 C15	560 µF, ±20%, 35 V, Electrolytic Capacitor, Very Low ESR, 22 mΩ, 10 mm x 25 mm	EKZE350ELL561MJ25S	Nippon Chemi-Con
9	2	C12 C14	10 nF, ±10%, 50 V, Ceramic Capacitor, X7R, 0805 (2012 Metric)	C0805X103K5RAC7210	Kemet
10	1	C13	150 µF, ±20%, 35 V, Electrolytic Capacitor, General Purpose, 8 mm x 11.5 mm	EEU-FM1V151	Panasonic
11	1	C16	10 µF, ±20%, 35 V, Ceramic Capacitor, X7R, 1206 (3216 Metric)	CGA5L1X7R1V106M160AE	TDK Corporation
12	1	CY1	2200 pF, ±20% ,760 VAC, Ceramic Capacitor Y5U, Radial, Disc	AY1222M47Y5UC63L0	Vishay/ BC Components
13	1	D1	1000 V, 2A, Standard Recovery Diode, Surface Mount, DO-214AA (SMB)	S2M	SMC Diode Solutions
14	1	D3	200 V, 0.2 A, Standard Recovery Diode, Surface Mount, SOD-323	BAV21WS-7-F	Diodes Inc.
15	1	D4	200 V, 1 A, Standard Recovery Diode, Surface Mount, POWERDI123	DFLR1200-7	Diodes Inc
16	2	D5 D6	200 V, 10A, Diode Array, Through Hole, TO-220-3	V20202C-M3/4W	Vishay Semiconductor Diodes Division
17	1	F1	5 A, 250 V, Slow Blow Fuse, Long Time Lag, RST	RST 5	Belfuse
18	1	L1	350 µH @ 100 kHz, 8.5 A, 7 mΩ DCR, 2 Line Common Mode Choke, Through Hole	7448226404	Würth Elect Inc
19	1	L2	10 mH, 60 mΩ DCR, Common Mode Choke, Toroidal	XF0093PI-VOCMC	XFMRS
20	1	L3	42 Ω @ 100 MHz, 4 A, 8 mΩ, 1 Power Line Ferrite Bead, 0805 (2012 Metric)	LSMCC201208T420RG	Taiyo Yuden
21	2	R1 R2	1.0 MΩ, ±5%, 2/3 W, Thick Film Resistor, 1206 (3216 Metric)	ERJ-P08J105V	Panasonic
22	2	R3 R4	4.02 MΩ, ±1%, 0.25 W, Thick Film Resistor, 1206 (3216 Metric)	RC1206FR-074M02L	Yageo
23	1	R5	470 kΩ, ±5%, 2/3 W, Thick Film Resistor, 1206 (3216 Metric)	ERJ-P08J474V	Panasonic
24	4	R6 R7 R10 R11	20 Ω, ±1%, 1 W, Thick Film Resistor, 2010 (5025 Metric)	CRCW201020R0FKEFHP	Vishay/Dale
25	1	R8	3.30 kΩ, ±1%, 1/8 W, Thick Film Resistor, 0805 (2012 Metric)	ERJ-6ENF3301V	Panasonic ECG
26	1	R9	47.0 Ω, ±1%, 1/4 W, Thick Film Resistor, 1206 (3216 Metric)	ERJ-8ENF47R0V	Panasonic
27	1	R12	3.01 kΩ, ±1%, 1/4 W, Thick Film Resistor, 1206 (3216 Metric)	ERJ-8ENF3011V	Panasonic
28	1	R13	1.0 kΩ, ±1%, 1/4 W, Thick Film Resistor, 1206 (3216 Metric)	ERJ-8ENF1001V	Panasonic
29	1	R14	20.0 kΩ, ±1%, 1/4 W, Thick Film Resistor, 1206 (3216 Metric)	ERJ-8ENF2002V	Panasonic
30	1	R15	86.6 kΩ, ±1%, 1/8 W, Thick Film Resistor, 0805 (2012 Metric)	ERJ-6ENF8662V	Panasonic
31	1	R16	10 kΩ, ±1%, 1/2W, Thick Film Resistor, 1206 (3216 Metric)	RC1206FR-7W10KL	Yageo
32	2	R17 R18	0 Ω, 5%, 1/4 W, Thick Film Resistor, 1206 (3216 Metric)	ERJ-8GEY0R00V	Panasonic
33	1	R19	10.0 kΩ, 1%, 1/8 W, Thick Film, 0805 (2012 Metric)	ERJ-6ENF1002V	Panasonic
34	1	RV1	23J, 275 VAC, 7 mm, RADIAL	V275LA4P	Littelfuse
35	1	T1	PQ32/30, Bobbin, Vertical, 12 pins	B65880E2012D001	TDK
36	1	U1	CAPZero-2, CAP200DG, SO-8C	CAP200DG	Power Integrations
37	1	U2	TOPSwitchGaN, TOP7078K, eSOP-12B	TOP7078K	Power Integrations
38	1	U3	Optoisolator, Transistor Output, 5300 Vrms, 70 V, CTR 100-6200%, 1 Channel 4-SMD	LTV-817S-D	Lite-On Inc.

39	1	U4	2.495V ±1%, Shunt Regulator IC, -40 to 85 °C, SOT-23	LM431BIM3/NOPB	National Semiconductor
40	1	VR1	16 V, 500 mW, ±5%, Zener Diode, Surface Mount SOD-123	MMSZ5246BT1G	onsemi

6.2 Mechanical BOM

Item	Qty.	Ref Des	Description	Mfr. Part Number	Manufacturer
1	1	HS1	Bridge Rectifier Heatsink	61-00422-00	Power Integrations
2	1	HS2	Output Rectifier Heatsink	61-00421-00	Power Integrations
3	1	NUT2	Nut, Hex 6-32, SS	H725-ND	BFirst Industrial
4	2	NUT3 NUT4	Nut, Hex, Metric, M3 SS	68024082	MSC
5	1	SCREW2	SCREW MACHINE PHIL 6-32 X 3/8 SS	PMSSS 632 0038 PH	PMSSS 632 0038 PH
6	2	SCREW3 SCREW4	SCR, Phillips, M3 X8 mm, Panhead Mach, Metric SS with rubber O-ring.	RM3X8MM 2701	APM HEXSEAL
7	4	TAB1 TAB2 TAB3 TAB4	0.250" (6.35mm) Quick Connect Male - Solder Connector Non-Insulated	1287-ST	Keystone Electronics
8	2	TE1 TE2	Terminal, Eyelet, Tin Plated Brass, Zierick PN 190	190	
9	2	TP1 TP4	Test Point, BLK, Thru-hole Mount	5011	Keystone
10	1	TP2	Test Point, WHT, Thru-hole Mount	5012	Keystone
11	1	TP3	Test Point, RED, Thru-hole Mount	5010	Keystone
12	1	WASHER2	Washer Flat #6, SS	FWSS 006	BFirst Industrial
13	2	WASHER3 WASHER4	Washer, Lk, M 3 Zinc, Metric	MLWZ 003	BFirst Industrial
14	2	WASHER5 WASHER6	Washer, Shoulder, #4, 0.125 Shoulder x 0.140 Dia, Polyphenylene Sulfide PPS	7721-3PPSG	Aavid Thermalloy

7 Transformer Specification

7.1 Electrical Diagram

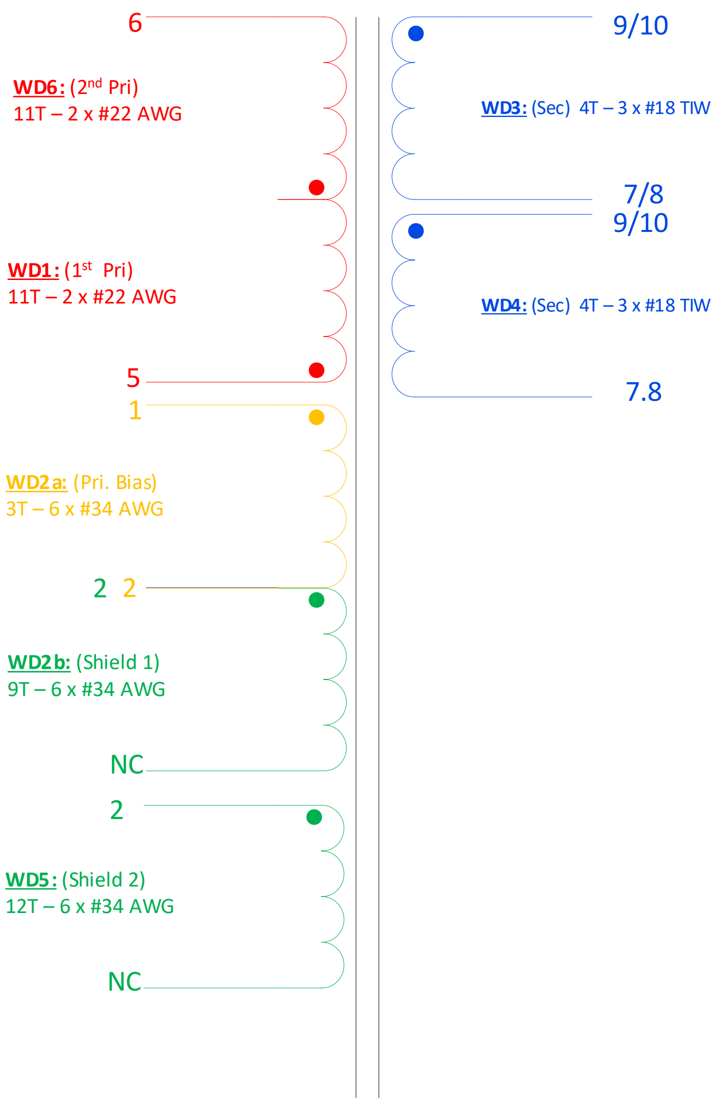


Figure 7 – Transformer Electrical Diagram.

7.2 Electrical Specifications

Parameter	Condition	Spec.
Nominal Primary Inductance	Measured at 1 V_{PK-PK} and 100 kHz frequency, between pin 1 to pin 4, with all other Windings open.	240 μH
Tolerance	Tolerance of Primary Inductance.	±5%
Leakage Inductance	Measured across primary winding with all other windings shorted.	< 2.5 μH

7.3 Material List

Item	Description
[1]	Core: PQ32/30, PC95, gapped for ALG of 629 nH / T^2
[2]	Bobbin: PQ32/30, 12pins (6/6), PI#: 25-01198-00; or equivalent.
[3]	Magnet wire: #22 AWG, double coated.
[4]	Magnet wire: #34 AWG, double coated.
[5]	Magnet wire: #18 AWG, Triple Insulated Wire.
[6]	Tape: 3M 13450-F, Polyester Film, 1 mil thickness, 18.6mm width.
[7]	Bus wire: #28, Alpha wire, tinned copper.
[8]	Varnish: Dolph BC-359.

7.4 Transformer Build Diagram

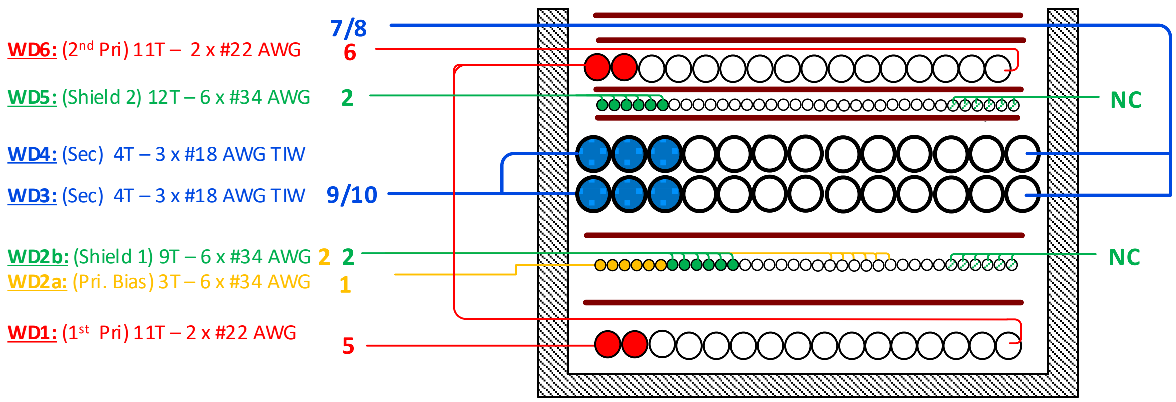


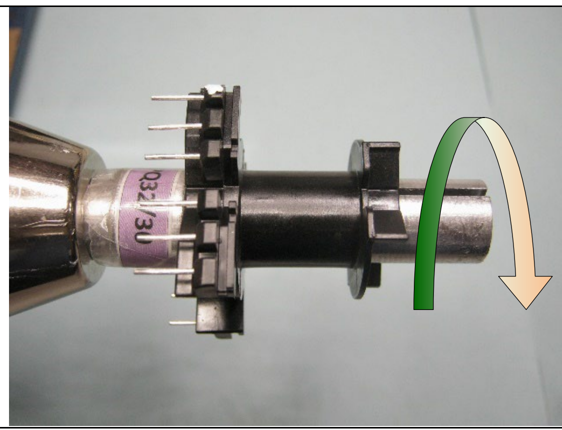
Figure 8 – Transformer Build Diagram.

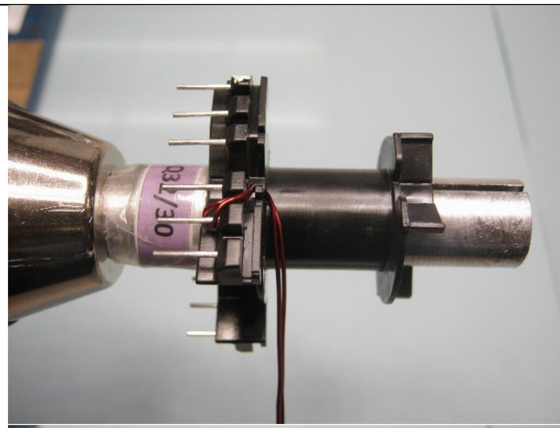
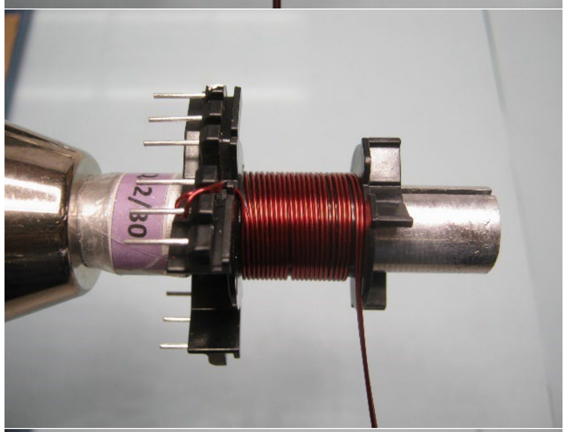
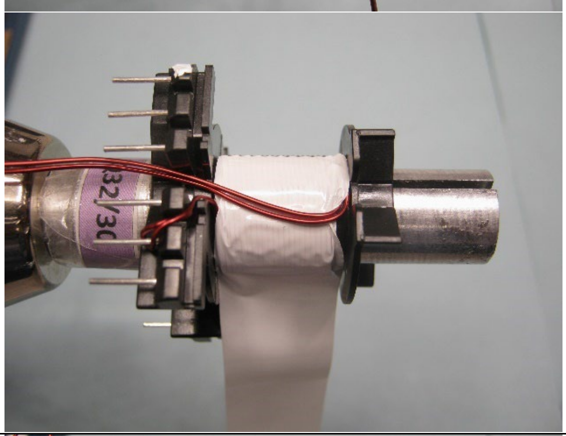
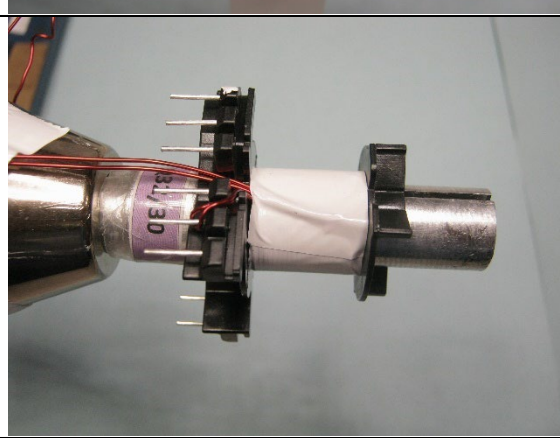
7.5 Transformer Instructions

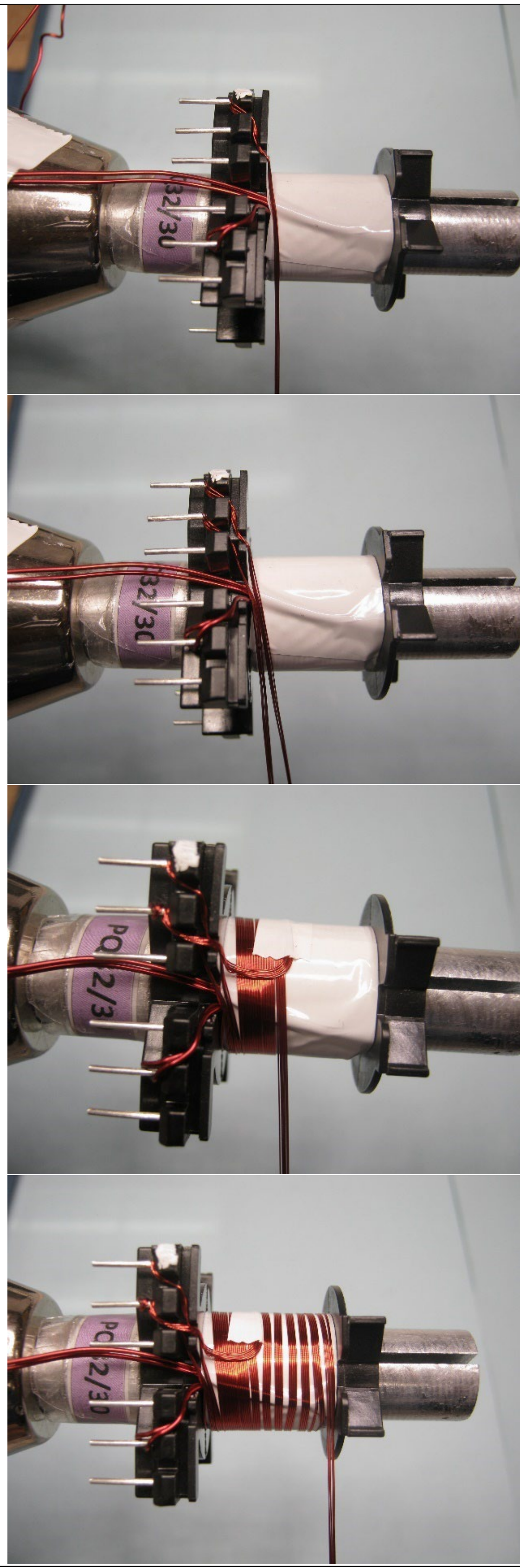
Winding preparation	Position the bobbin item [2] on the mandrel such that the primary side of the bobbin is on the left side. Winding direction is clockwise direction for forward direction.
WD1 1st Primary	Start at pin 5, wind 11 bifilar turns of wire item [3] in 1 layer, with tight tension, from left to right. At the last turn, bring the wire back to left, and leave the wire floating, enough length for Primary winding 2.
Insulation	1 layer of tape item [6].
WD2a: Pri-Bias & WD2b: Shield 1	Use 6 wires item [4] start at pin 1 for Bias winding, also use 6 wires same item [4] start at pin 2 for Shield1 winding. Wind all 12 wires in parallel, at the 3rd turn, place 1 small piece of tape to hold the windings, bring 6 wires of Bias winding to the left and terminate at pin 2. Continue winding 6 more turns then cut short 4 wires for Shield Winding as No-Connect.
Insulation	1 layer of tape item [6].
WD3 & WD4 Secondary	Start at pin 9, use 3 wires of item [5], wind 6 turns from left to right. At the last turn exit the wires and leave ~ 2” floating for later termination for WD3-Secondary Repeat the same with start pin 10 and exit the wires as above for WD4-Secondary
Insulation	1 layer of tape item [6].

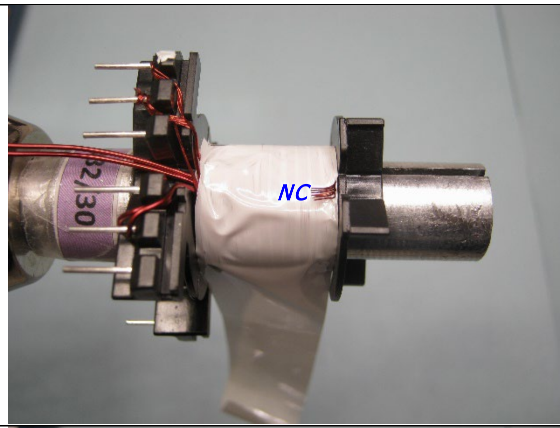
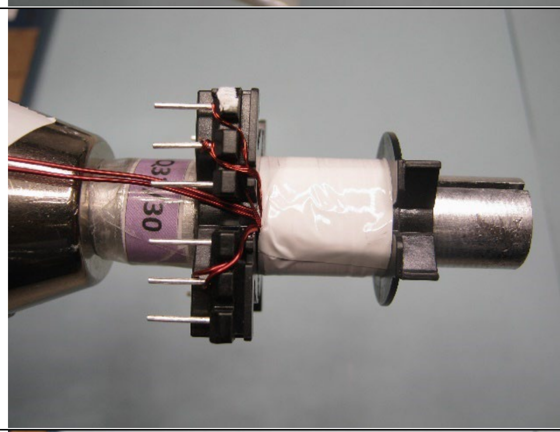
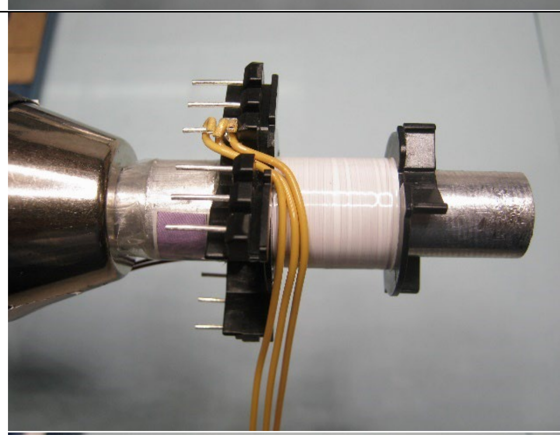
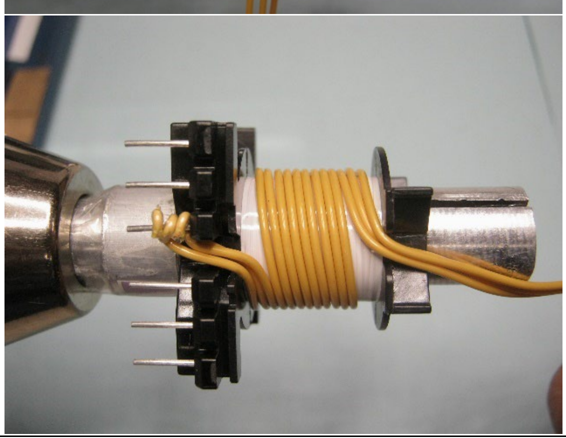
WD5 Shield 2	Start at pin 2, use 6 wires of item [4], wind 12 turns from left to right, spread the wires evenly. At the last turn, cut short the wire as No-Connect, NC.
Insulation	1 layer of tape item [6].
WD6 2nd Primary	Use floating wires from WD1-1st Primary winding, continue to wind 11 turns from left to right with tight tension in 1 layer. At the last turn, bring the wire back to left, and terminate at pin 6.
Finish	Bring 6 wires floating from secondary windings to the left to terminate at pins 7,8, and secure with 2 layers of tape item [6]. Gap core halves to get 240 uH, solder wire item [7], lean along the cores and secure with tape. Remove pins 3, 4, 11 & 12. Varnish with item [8].

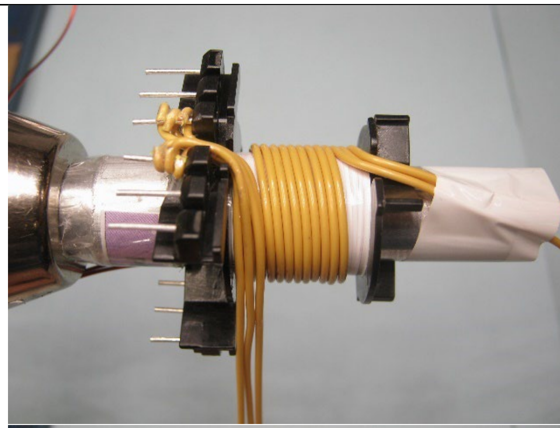
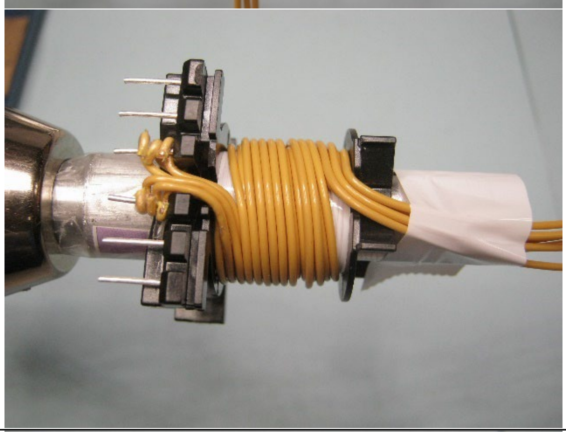
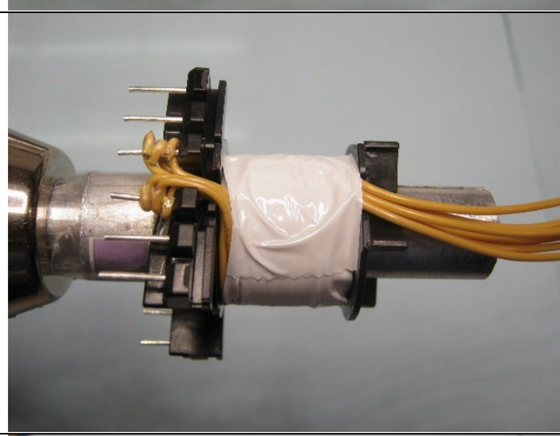
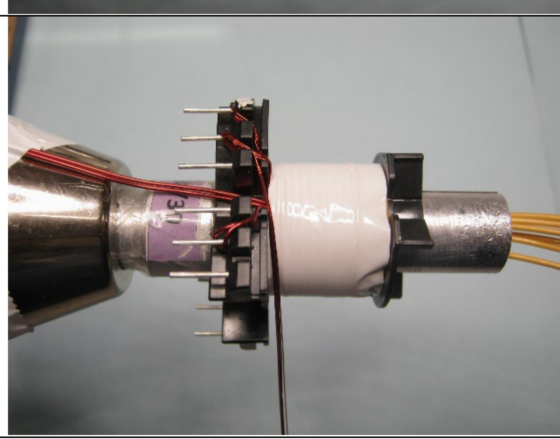
7.6 Transformer Winding Illustrations

Winding preparation		Position the bobbin item [2] on the mandrel such that the primary side of the bobbin is on the left side. Winding direction is clockwise direction for forward direction.

WD1 **1st Primary**	  	Start at pin 5, wind 11 bifilar turns of wire item [3] in 1 layer, with tight tension, from left to right. At the last turn, bring the wire back to left, and leave the wire floating, enough length for Primary winding 2.
Insulation		1 layer of tape item [6].

WD2a: Pri-Bias & WD2b: Shield 1		Use 6 wires item [4] start at pin 1 for Bias winding, also use 6 wires same item [4] start at pin 2 for Shield1 winding. Wind all 12 wires in parallel, at the 3rd turn, place 1 small piece of tape to hold the windings, bring 6 wires of Bias winding to the left and terminate at pin 2. Continue winding 6 more turns then cut short 4 wires for Shield Winding as NC.

		
Insulation		1 layer of tape item [6].
WD3 & WD4 Secondary	 	Start at pin 9, use 3 wires of item [5], wind 6 turns from left to right. At the last turn exit the wires and leave ~ 2” floating for later termination for WD3-Secondary Repeat the same with start pin 10 and exit the wires as above for WD4-Secondary

		
Insulation		1 layer of tape item [6].
WD5 **Shield 2**		Start at pin 2, use 6 wires of item [4], wind 12 turns from left to right, spread the wires evenly. At the last turn, cut short the wire as No-Connect, NC.

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<tr>
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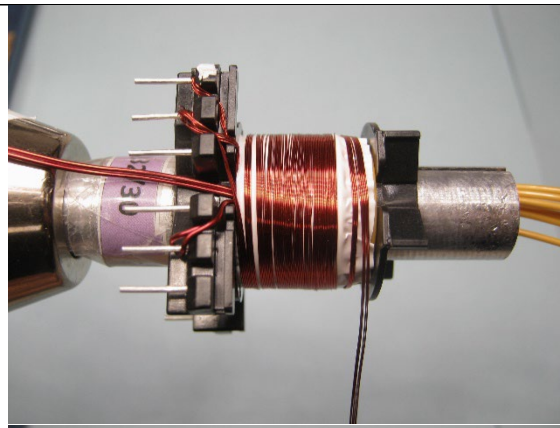
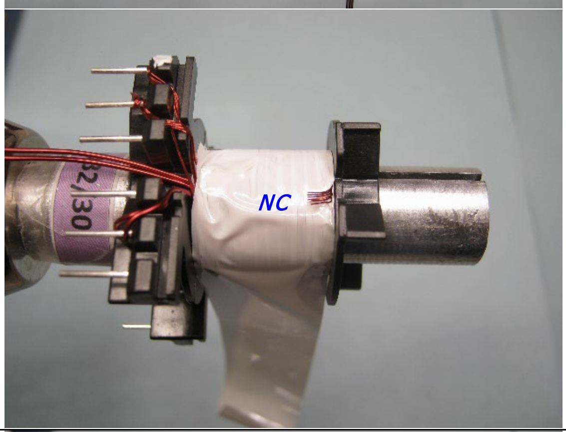
<td>

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<td></td>
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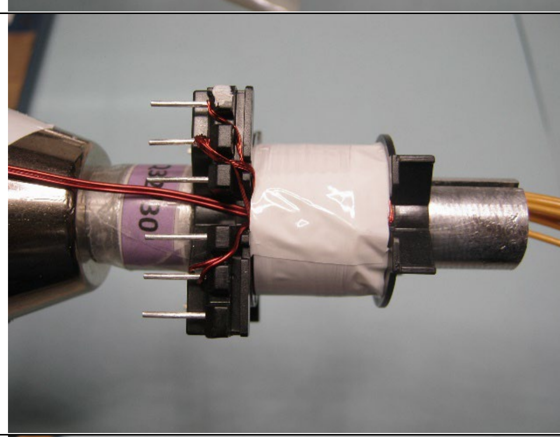
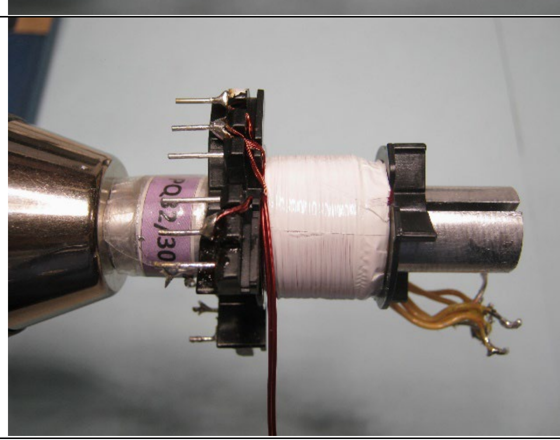
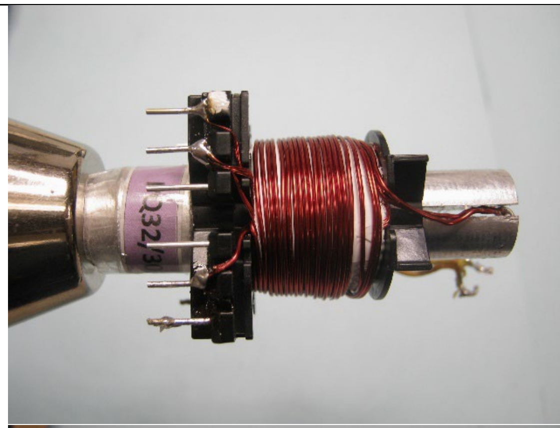
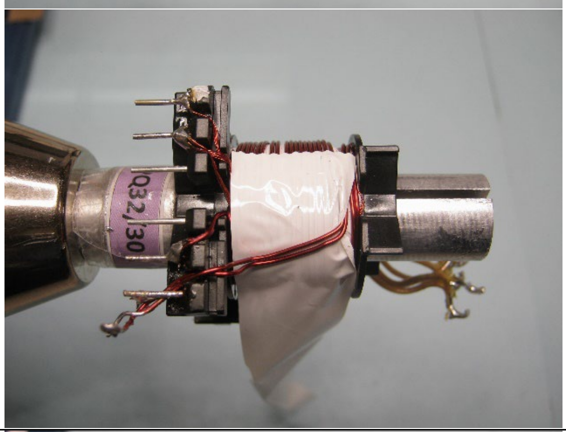
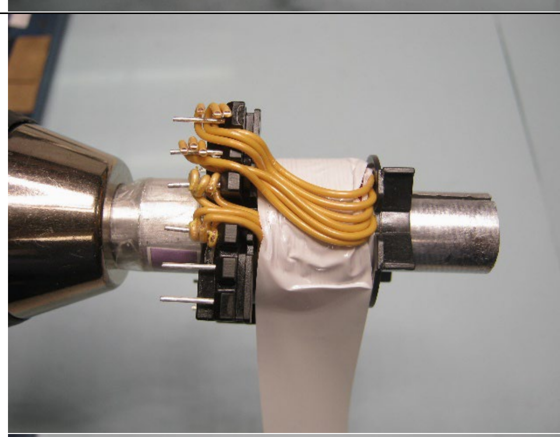
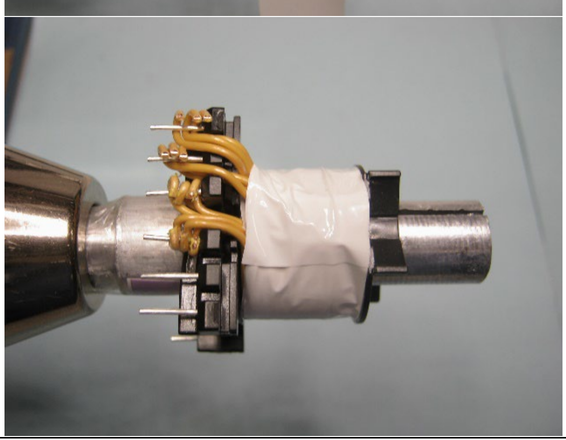
<tr>
<td>Insulation</td>
<td></td>
<td>1 layer of tape item [6].</td>
</tr>
<tr>
<td>WD6
2nd Primary</td>
<td></td>
<td>Use floating wires from WD1-1st Primary winding, continue to wind 11 turns from left to right with tight tension in 1 layer. At the last turn, bring the wire back to left, and terminate at pin 6.</td>
</tr>
</table>

	 	
Finish	 	Bring 6 wires floating from secondary windings to the left to terminate at pins 7,8, and secure with 2 layers of tape item [6]. Gap core halves to get 240 uH, solder wire item [7], lean along the cores and secure with tape. Remove pins 3, 4, 11 & 12. Varnish with item [8].

8 Design Spreadsheet

1	**ACDC_TOPSwitch-GaN_Flyback_102425; Rev.0.4; Copyright Power Integrations 2025**	**INPUT**	**INFO**	**OUTPUT**	**UNITS**	**TOPSwitch-GaN Single/Multi Output Flyback Design Spreadsheet**
2	APPLICATION VARIABLES					Design Title
3	INPUT_TYPE	AC		AC		Input Type
4	VIN_MIN	85		85	V	Minimum AC input voltage
5	VIN_MAX			265	V	Maximum AC input voltage
6	VIN_RANGE			85-265VAC		Range of AC input voltage
7	LINEFREQ			60	Hz	AC Input voltage frequency
8	CAP_INPUT	360.0		360.0	µF	Input capacitor
9	VOUT	24.00		24.00	V	Output voltage at the board
10	IOUT	5.000		5.000	A	Output current
11	POUT			120.00	W	Output power
12	EFFICIENCY	0.89		0.89		AC-DC efficiency estimate at full load given that the converter is switching at the valley of the rectified minimum input AC voltage
13	FACTOR_Z			0.60		Z-factor estimate
14	ENCLOSURE	OPEN FRAME		OPEN FRAME		Power supply enclosure
15						
16						
17						
18	PRIMARY CONTROLLER SELECTION					
19	PACKAGE_DEVICE	eSOP		eSOP		Device Package
20	ILIMIT_MODE	STANDARD		STANDARD		Device current limit mode
21	DEVICE_GENERIC	TOP7078		TOP7078		Generic device code
22	DEVICE_CODE			TOP7078K		Actual device code
23	POUT_MAX			135	W	Power capability of the device based on thermal performance
24	RDSON_100DEG			0.23	Ω	Primary switch on time drain resistance at 100 degC
25	ILIMIT_MIN			3.543	A	Minimum current limit of the primary switch
26	ILIMIT_TYP			3.810	A	Typical current limit of the primary switch
27	ILIMIT_MAX			4.077	A	Maximum current limit of the primary switch
28	VDRAIN_BREAKDOWN			800	V	Device breakdown voltage
29	VDRAIN_ON_PRSW			0.31	V	Primary switch on time drain voltage
30	VDRAIN_OFF_PRSW			624.2	V	Peak drain voltage on the primary switch during turn-off. A 121V leakage spike voltage is assumed
31						
32						
33						
34	WORST CASE ELECTRICAL PARAMETERS					
35	FSWITCHING_MAX	100000		100000	Hz	Maximum switching frequency at full load and

						valley of the rectified minimum AC input voltage.
36	VOR	130.0		130.0	V	Secondary voltage reflected to the primary when the primary switch turns off
37	VMIN			97.27	V	Valley of the minimum input AC voltage at full load
38	KP			0.68		Measure of continuous/discontinuous mode of operation
39	MODE_OPERATION			CCM		Mode of operation
40	DUTYCYCLE			0.573		Primary switch duty cycle
41	TIME_ON_MAX			12.50	us	Primary switch on-time
42	TIME_ON_AT_FSWITCHING_MAX			5.73	us	Primary switch on-time at FSWITCHING_MAX
43	TIME_OFF			4.27	us	Primary switch off-time at 85VAC, 120W, and 100000Hz.
44	LPRIMARY_MIN			226.9	uH	Minimum primary inductance
45	LPRIMARY_TYP			238.9	uH	Typical primary inductance
46	LPRIMARY_TOL			5.0	%	Primary inductance tolerance
47	LPRIMARY_MAX			250.8	uH	Maximum primary inductance
48						
49	PRIMARY CURRENT					
50	IPEAK_PRIMARY			3.949	A	Primary switch peak current
51	IPEDESTAL_PRIMARY			1.124	A	Primary switch current pedestal
52	IAVG_PRIMARY			1.329	A	Primary switch average current
53	IRIPPLE_PRIMARY			3.257	A	Primary switch ripple current
54	IRMS_PRIMARY			1.895	A	Primary switch RMS current
55						
56	SECONDARY CURRENT					
57	IPEAK_SECONDARY			21.720	A	Secondary winding peak current
58	IPEDESTAL_SECONDARY			6.185	A	Secondary winding current pedestal
59	IRMS_SECONDARY			9.002	A	Secondary winding RMS current
60						
61						
62						
63	TRANSFORMER CONSTRUCTION PARAMETERS					
64	CORE SELECTION					
65	CORE	PQ32		PQ32		Core selection. Refer to the 'Transformer Construction' tab to see the detailed report
66	CORE CODE			PQ32/30-3C95		Core code
67	AE			167.00	mm^2	Core cross sectional area
68	LE			74.70	mm	Core magnetic path length
69	AL			6570	nH/turns^2	Ungapped core effective inductance
70	VE			12500.0	mm^3	Core volume
71	BOBBIN			CPV-PQ32/30-1S-12P-Z		Bobbin

72	AW			98.18	mm^2	Window area of the bobbin
73	BW			18.70	mm	Bobbin width
74	MARGIN			0.0	mm	Safety margin width (Half the primary to secondary creepage distance)
75						
76	PRIMARY WINDING					
77	NPRIMARY			22		Primary turns
78	BPEAK			2873	Gauss	Peak flux density
79	BMAX			2669	Gauss	Maximum flux density
80	BAC			1084	Gauss	AC flux density (0.5 x Peak to Peak)
81	ALG			494	nH/turns^2	Typical gapped core effective inductance
82	LG			0.393	mm	Core gap length
83						
84	PRIMARY BIAS WINDING					
85	NBIAS_PRIMARY			3	turns	Primary bias winding number of turns
86						
87	SECONDARY WINDING					
88	NSECONDARY	4		4	turns	Secondary winding number of turns
89						
90	SECONDARY BIAS WINDING					
91	NBIAS_SECONDARY			NA	turns	Secondary bias winding number of turns
92						
93						
94						
95	PRIMARY COMPONENTS SELECTION					
96	LINE UNDERVOLTAGE					
97	BROWN-IN REQURED			66.30	V	Required AC RMS/DC line voltage brown-in threshold
98	RLS			6.80	MΩ	Connect two 3.4 MOhm resistors to the V-pin for the required UV/OV threshold
99	BROWN-IN ACTUAL			55V - 67.7V	V	Actual AC RMS/DC brown-in range
100	BROWN-OUT ACTUAL			46.9V - 58.5V	V	Actual AC RMS/DC brown-out range
101						
102	LINE OVERVOLTAGE					
103	OVERVOLTAGE_LINE		Info	256.4V - 287.7V	V	The line over-voltage threshold is lower than the maximum input AC RMS/DC voltage
104						
105	PRIMARY BIAS DIODE					
106	VBIAS_PRIMARY			12.0	V	Rectified primary bias voltage
107	VF_BIAS_PRIMARY			0.70	V	Bias winding diode forward drop
108	VREVERSE_BIASDIODE_PRIMARY			68.91	V	Bias diode reverse voltage (not accounting parasitic voltage ring)
109	CBIAS_PRIMARY			22	µF	Bias winding rectification capacitor
110	CBP			0.47	µF	BP pin capacitor

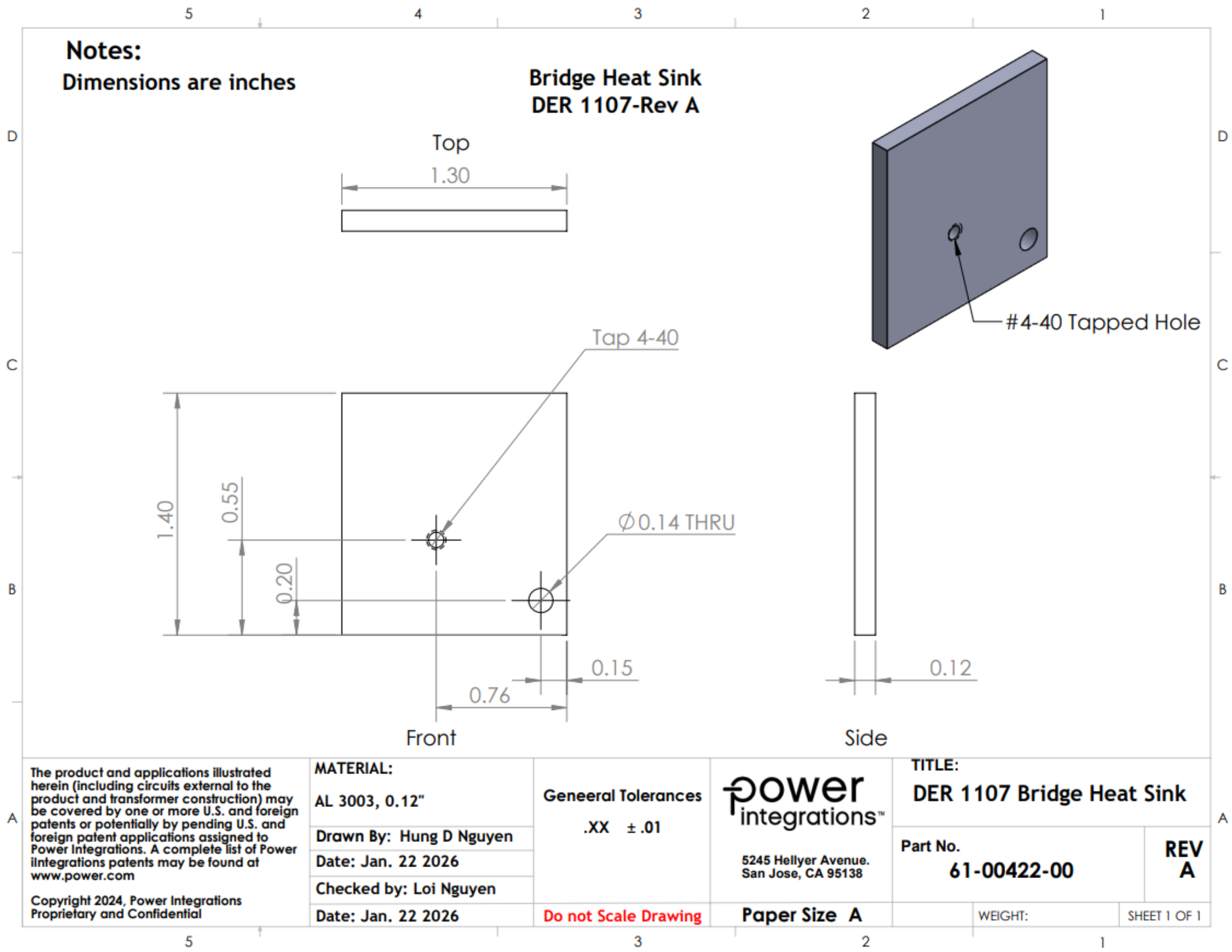
111						
112						
113						
114	SECONDARY COMPONENTS					
115	VREF_REG			1.25	V	Reference voltage of the feedback
116	RFB_UPPER			100.00	kΩ	Upper feedback resistor (connected to the first output voltage)
117	RFB_LOWER			5.49	kΩ	Lower feedback resistor
118						
119	SECONDARY BIAS DIODE					
120	USE_SECONDARY_BIAS	NO		NO		Use secondary bias winding for the design
121	VBIAS_SECONDARY			NA	V	Rectified secondary bias voltage
122	VF_BIAS_SECONDARY			NA	V	Bias winding diode forward drop
123	VREVERSE_BIASDIODE_SECONDARY			NA	V	Bias diode reverse voltage (not accounting parasitic voltage ring)
124	CBIAS_SECONDARY			NA	µF	Bias winding rectification capacitor
125						
126						
127	MULTIPLE OUTPUT PARAMETERS					
128	OUTPUT 1					
129	VOUT1			24.00	V	Output 1 voltage
130	IOUT1			5.00	A	Output 1 current
131	POUT1			120.00	W	Output 1 power
132	VD1			0.70	V	Forward voltage drop of diode for output 1
133	NS1			4.00	turns	Number of turns for output 1
134	ISPEAK1			21.72	A	Instantaneous peak value of the secondary current for output 1
135	ISRMS1			9.002	A	Root-mean-squared value of the secondary current for output 1
136	ISRIPPLE1			7.485	A	Current ripple on the secondary waveform for output 1
137	PIV1_CALCULATED			110.20	V	Computed peak inverse voltage stress on the diode for output 1
138	OUTPUT_RECTIFIER1	AUTO		BYV32-200		Recommended diode for output 1.
139	PIV1_RATING			200.00	V	Peak inverse voltage rating on the diode for output 1
140	TRR1			25.00	ns	Reverse recovery time of the diode for output 1
141	IFM1			18.00	A	Maximum forward continuous current of the diode for output 1
142	PLOSS_DIODE1			6.88	W	Maximum diode power loss for output 1
143						
144	OUTPUT 2					
145	VOUT2			0.00	V	Output 2 voltage
146	IOUT2			0.000	A	Output 2 current
147	POUT2			0.00	W	Output 2 power

148	VD2			N/A	V	Forward voltage drop of diode for output 2
149	NS2			N/A	turns	Number of turns for output 2
150	ISPEAK2			N/A	A	Instantaneous peak value of the secondary current for output 1
151	ISRMS2			N/A	A	Root mean squared value of the secondary current for output 2
152	ISRIPPLE2			N/A	A	Current ripple on the secondary waveform for output 2
153	PIV2			N/A	V	Computed peak inverse voltage stress on the diode for output 2
154	OUTPUT_RECTIFIER2	AUTO		N/A		Recommended diode for output 2.
155	PIV2_RATING			N/A	V	Peak inverse voltage rating on the diode for output 2
156	TRR2			N/A	ns	Reverse recovery time of the diode for output 2
157	IFM2			N/A	A	Maximum forward continuous current of the diode for output 2
158	PLOSS_DIODE2			N/A	W	Maximum diode power loss for output 2
159						
160	OUTPUT 3					
161	VOUT3			0.00	V	Output 3 voltage
162	IOUT3			0.000	A	Output 3 current
163	POUT3			0.00	W	Output 3 power
164	VD3			N/A	V	Forward voltage drop of diode for output 3
165	NS3			N/A	turns	Number of turns for output 3
166	ISPEAK3			N/A	A	Instantaneous peak value of the secondary current for output 1
167	ISRMS3			N/A	A	Root mean squared value of the secondary current for output 3
168	ISRIPPLE3			N/A	A	Current ripple on the secondary waveform for output 3
169	PIV3			N/A	V	Computed peak inverse voltage stress on the diode for output 3
170	OUTPUT_RECTIFIER3	AUTO		N/A		Recommended diode for output 3.
171	PIV3_RATING			N/A	V	Peak inverse voltage rating on the diode for output 3
172	TRR3			N/A	ns	Reverse recovery time of the diode for output 3
173	IFM3			N/A	A	Maximum forward continuous current of the diode for output 3
174	PLOSS_DIODE3			N/A	W	Maximum diode power loss for output 2
175						
176	PO_TOTAL			120.00	W	Total power of all outputs
177	NEGATIVE OUTPUT	N/A		N/A		If negative output exists, enter the output number; e.g. If VO2 is negative output, select 2
178						
179						

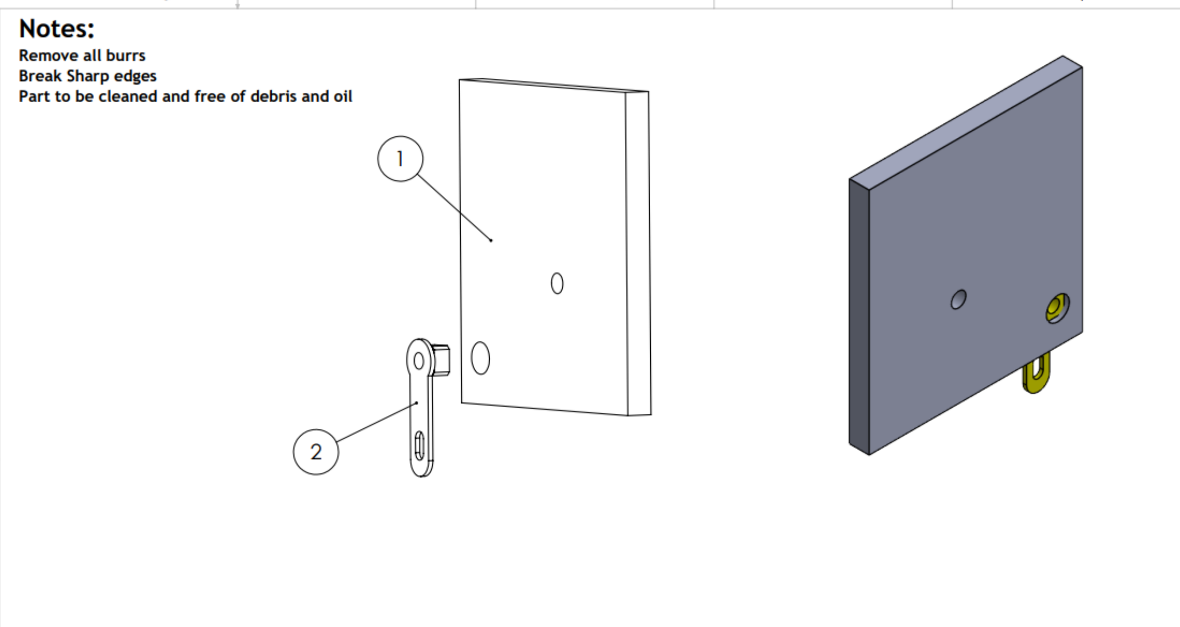
9 Heatsink Assembly

9.1 Bridge Rectifier Heatsink

9.1.1 Drawing



9.1.2 Fabrication



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	61-00422-00	Heat sink for Bridge	1
2	60-00016-00	TERMINAL, EYELET, ZIERICK 190	1

The product and applications illustrated herein (including circuits external to the product and transformer construction) may be covered by one or more U.S. and foreign patents or potentially by pending U.S. and foreign patent applications assigned to Power Integrations. A complete list of Power Iintegrations patents may be found at www.power.com

MATERIAL: AL 3003, 0.120"

Drawn By: Hung Nguyen
Drawing Date: Jan. 22 2026
Checked by: Loi
Date: Jan. 22 2026

General Tolerances
.XX ± .01

DO NOT SCALE DRAWING

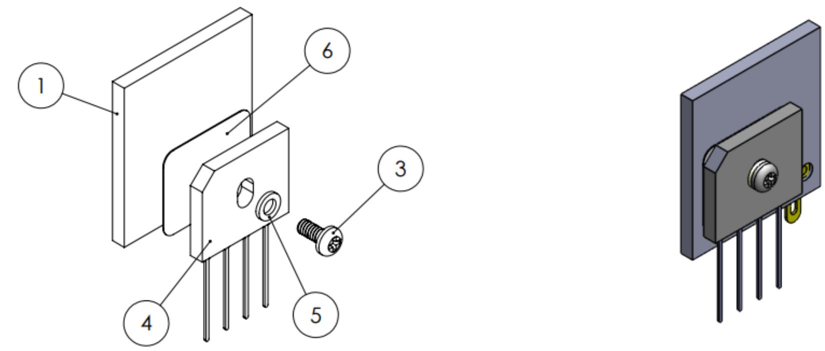
power integrations™
5245 Hellyer Avenue.
San Jose, CA 95138

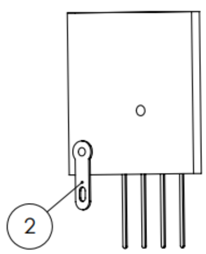
Paper Size A

TITLE: FAB_DER-1107_Bridge

Part No. 61-00422-01
REV A
SHEET 1 OF 1

9.1.3 Assembly





ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	61-00422-00	Heat sink for Bridge	1
2	60-00016-00	TERMINAL, EYELET, ZIERICK 190	1
3	75-00001-00	Machine screw #4-40 x .250	1
4	15-00347-00	800V, 8A, Bridge Rectifier, BGU case	1
5	75-00164-00	Flat Washer, #4	1
6	66-00120-00	Wakefield_Thermal_Joint_Compound	1

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MATERIAL:
Al 3003, 0.120"
Drawn By: Hung D Nguyen
Date: Jan. 22 2026
Checked by: Loi

General Tolerances
.XX ± .01

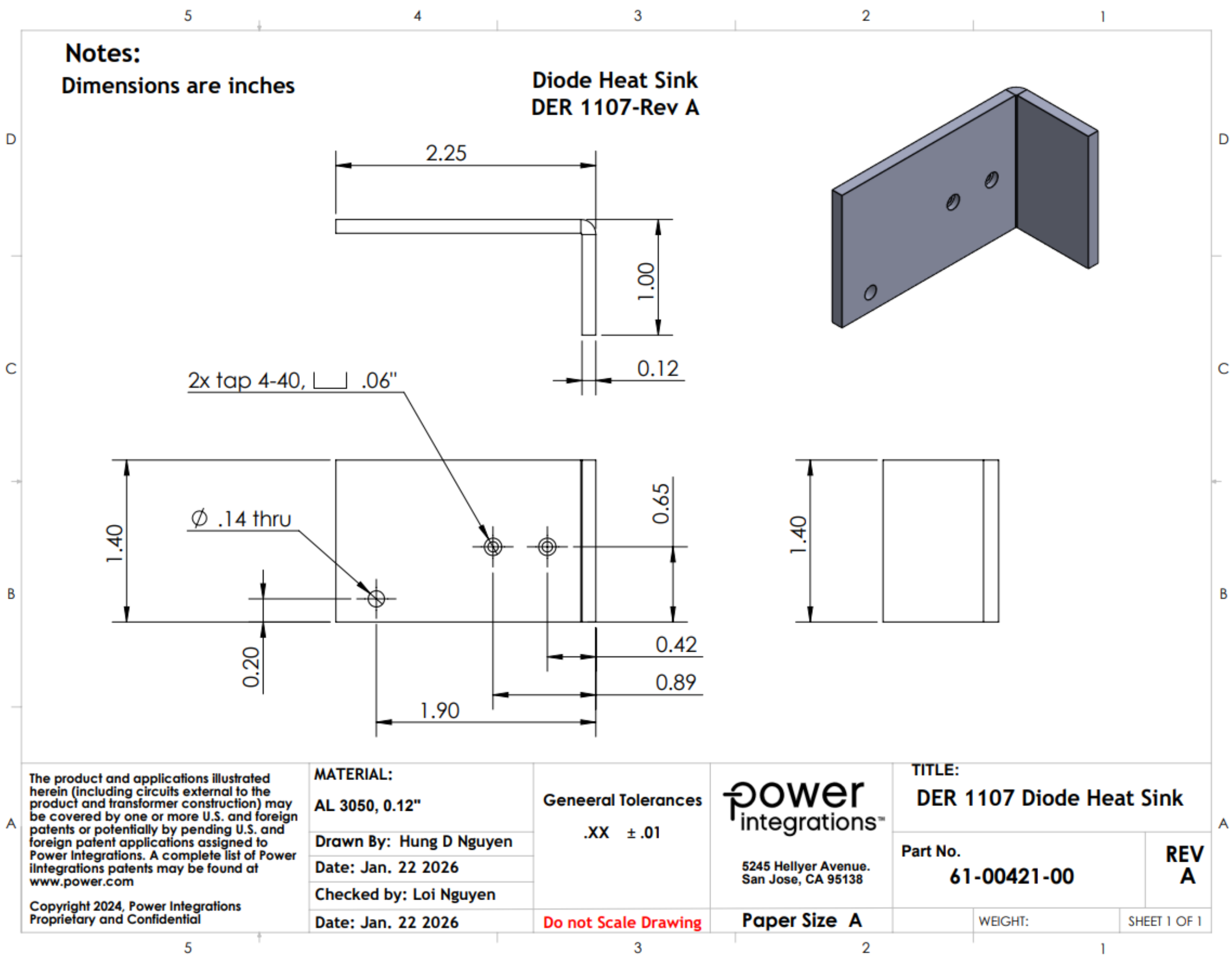
Do not Scale Drawing

power integrations
5245 Hellyer Avenue.
San Jose, CA 95138

DER 1107 Bridge Heat Sink Assembly
PI Part NO. 61-00422-02
REV A
WEIGHT:
SHEET 1 OF 1

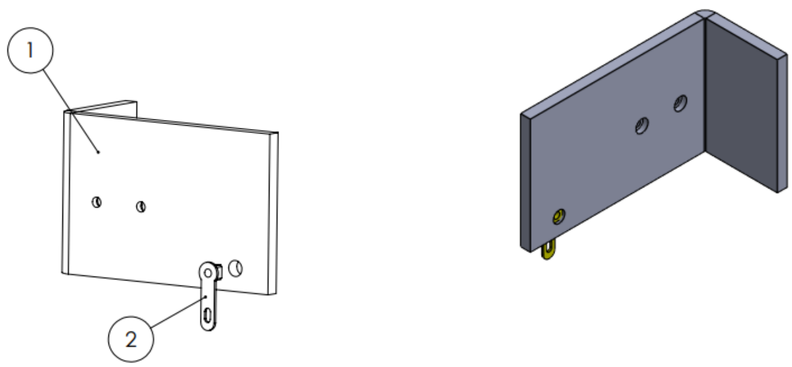
9.2 Output Rectifier Heatsink

9.2.1 Drawing



9.2.2 Fabrication

Notes:
Remove all burrs
Break Sharp edges
Part to be cleaned and free of debris and oil



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	61-00421-00	Heat sink for Diodes	1
2	60-00016-00	TERMINAL, EYELET, ZIERICK 190	1

The product and applications illustrated herein (including circuits external to the product and transformer construction) may be covered by one or more U.S. and foreign patents or potentially by pending U.S. and foreign patent applications assigned to Power Integrations. A complete list of Power iIntegrations patents may be found at www.power.com

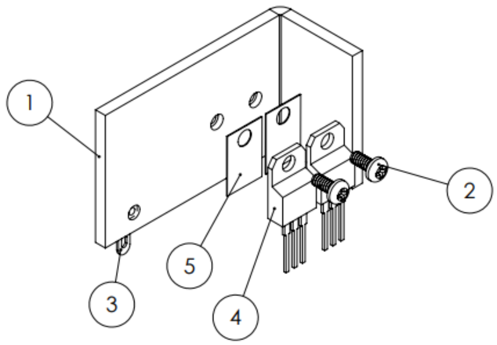
MATERIAL: **AL 3003, 0.12"**
Drawn By: Hung Nguyen
Drawing Date: Jan 22 2026
Checked by: Loi
Date: Jan 22 2026

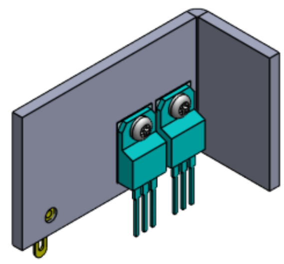
General Tolerances
.XX ± .01
DO NOT SCALE DRAWING

power integrations™
5245 Hellyer Avenue. San Jose, CA 95138
Paper Size A

TITLE: FAB_DER-1107_Diode
Part No. 61-00421-01
REV A
SHEET 1 OF 1

9.2.3 Assembly





ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	61-00421-00	Heat sink for Diodes	1
2	75-00001-00	Machine screw #4-40 x .250	2
3	60-00016-00	TERMINAL, EYELET, ZIERICK 190	1
4	15-02210-00	Diode Array,1 Pair,Common Cathode, 200 V, 10A, Through Hole TO-220-3	2
5	66-00096-00	THERMAL PAD-BER103, 0.009-THK-TO-220	2

The product and applications illustrated herein (including circuits external to the product and transformer construction) may be covered by one or more U.S. and foreign patents or potentially by pending U.S. and foreign patent applications assigned to Power Integrations. A complete list of Power Iintegrations patents may be found at www.power.com

MATERIAL:
AL 3003, 0.12"
Drawn By: Hung D Nguyen
Date: Jan. 22 2026
Checked by: Loi

General Tolerances
.XX ± .01
Do not Scale Drawing

power integrations
5245 Hellyer Avenue.
San Jose, CA 95138

DER 1107 Diode Heat Sink Assembly
PI Part NO. 61-00421-02
REV A
WEIGHT:
SHEET 1 OF 1

10 Performance Data

10.1 Full Load Efficiency vs. Line

Test Condition: The board was soaked for 15 minutes at each line voltage prior to taking measurements.

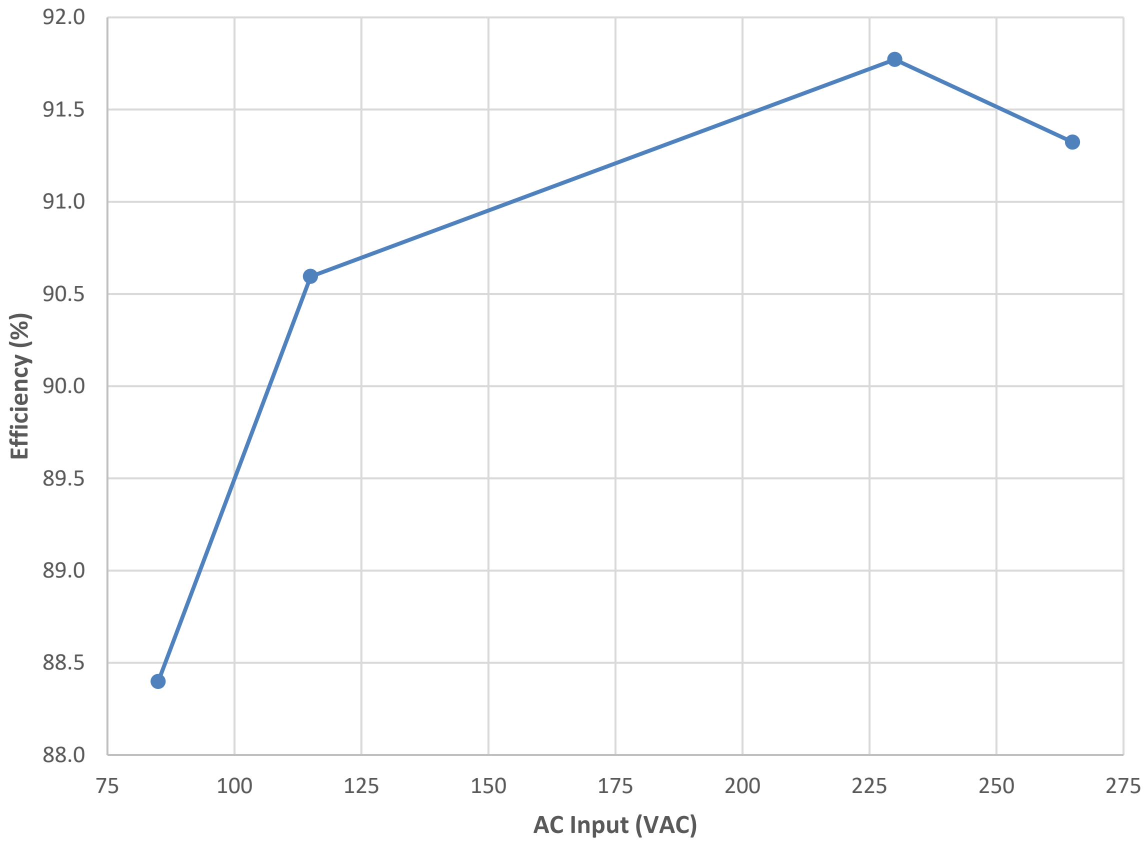


Figure 9 – Efficiency vs. Input Voltage.

VAC	Freq	P_{IN}	V_{OUT}	I_{OUT}	P_{OUT}	Efficiency
(RMS)	**(Hz)**	**(W)**	**(V)**	**(A)**	**(W)**	**(%)**
85	60	135	24	4.99	119	88.4
115	60	132	24	4.99	119	90.6
230	50	130	23.9	4.99	119	91.8
265	50	130	23.9	4.99	119	91.3

10.2 Efficiency vs. Load

Test Condition: The board was soaked for 15 minutes at each line voltage, and the signal was integrated for 10 seconds to derive each measurement.

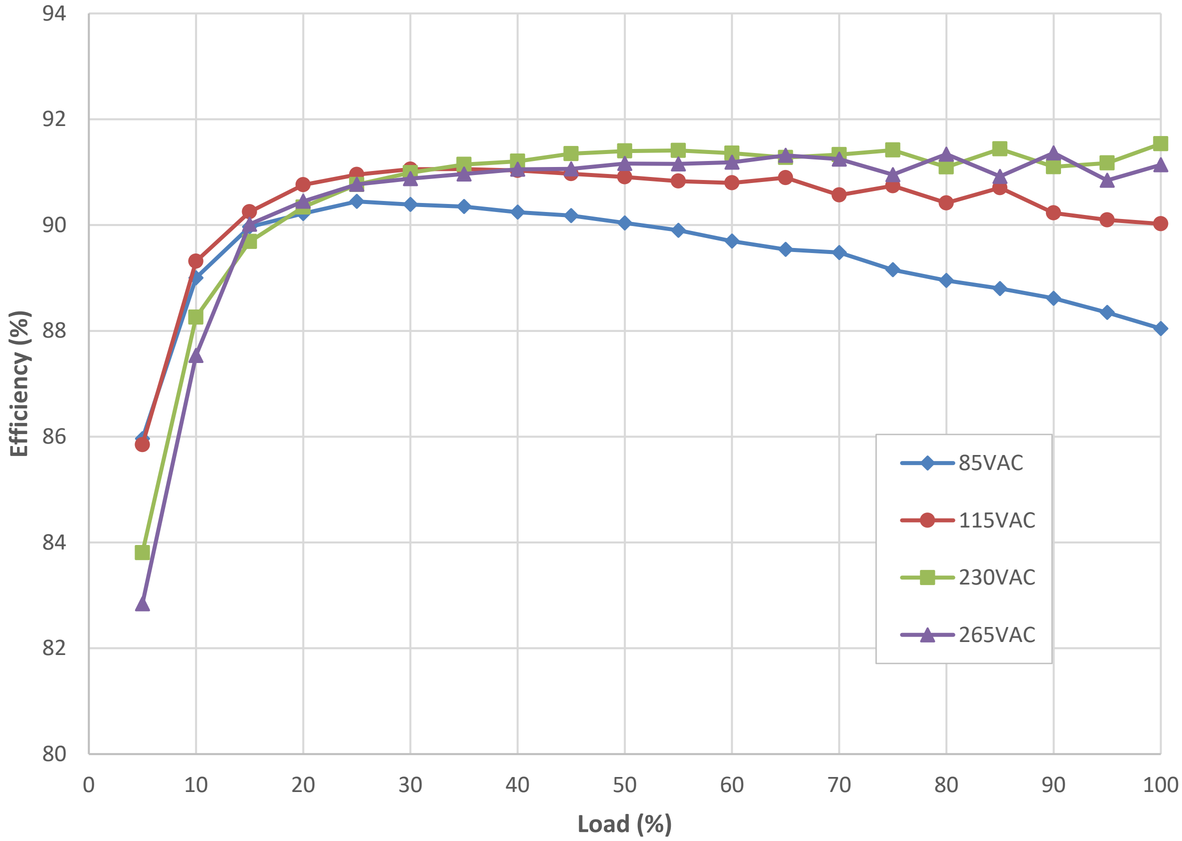


Figure 10 – Efficiency vs. Percentage Load.

10.3 Average and 10% Efficiency

10.3.1 Average Efficiency Standard

	Test	Average	Average	10% Load
Output Voltage (V)	**Power (W)**	**DOE6 Limit (%)**	**CoC v5 Tier 2 (%)**	**CoC v5 Tier 2 (%)**
24	120	88.0	89.0	79.0

10.3.2 Average and 10% Efficiency at 115 VAC

Load	P_{IN}	V_{OUT} at PCB	I_{OUT}	P_{OUT}	Efficiency at PCB	Average Efficiency	COC5T2 Limit
(A)	**(W)**	**(V_{DC})**	**(A_{DC})**	**(W)**	**(%)**	**(%)**	**(%)**
100%	133	24.0	4.99	120	90.2	**90.8**	89.0
75%	99.0	24.0	3.74	89.8	90.7		
50%	65.7	24.0	2.50	59.8	91.0		
25%	32.8	24.0	1.24	29.9	91.2		
10%	13.4	24.0	0.49	12.0	89.6	---	79.0

10.3.3 Average and 10% Efficiency at 230 VAC

Load	P_{IN}	V_{OUT} at PCB	I_{OUT}	P_{OUT}	Efficiency at PCB	Average Efficiency	COC5T2 Limit
(A)	**(W)**	**(V_{DC})**	**(A_{DC})**	**(W)**	**(%)**	**(%)**	**(%)**
100%	130	23.9	4.99	119	91.3	**91.2**	89.0
75%	97.8	23.9	3.74	89.4	91.4		
50%	65.3	23.9	2.50	59.7	91.4		
25%	32.9	24.0	1.24	29.8	90.6		
10%	13.5	24.0	0.49	12.0	88.9	---	79.0

10.3.4 No-Load Input Power

Test Condition: The board was soaked for 15 minutes at each line voltage, and the signal was integrated for 5 minutes to derive each measurement.

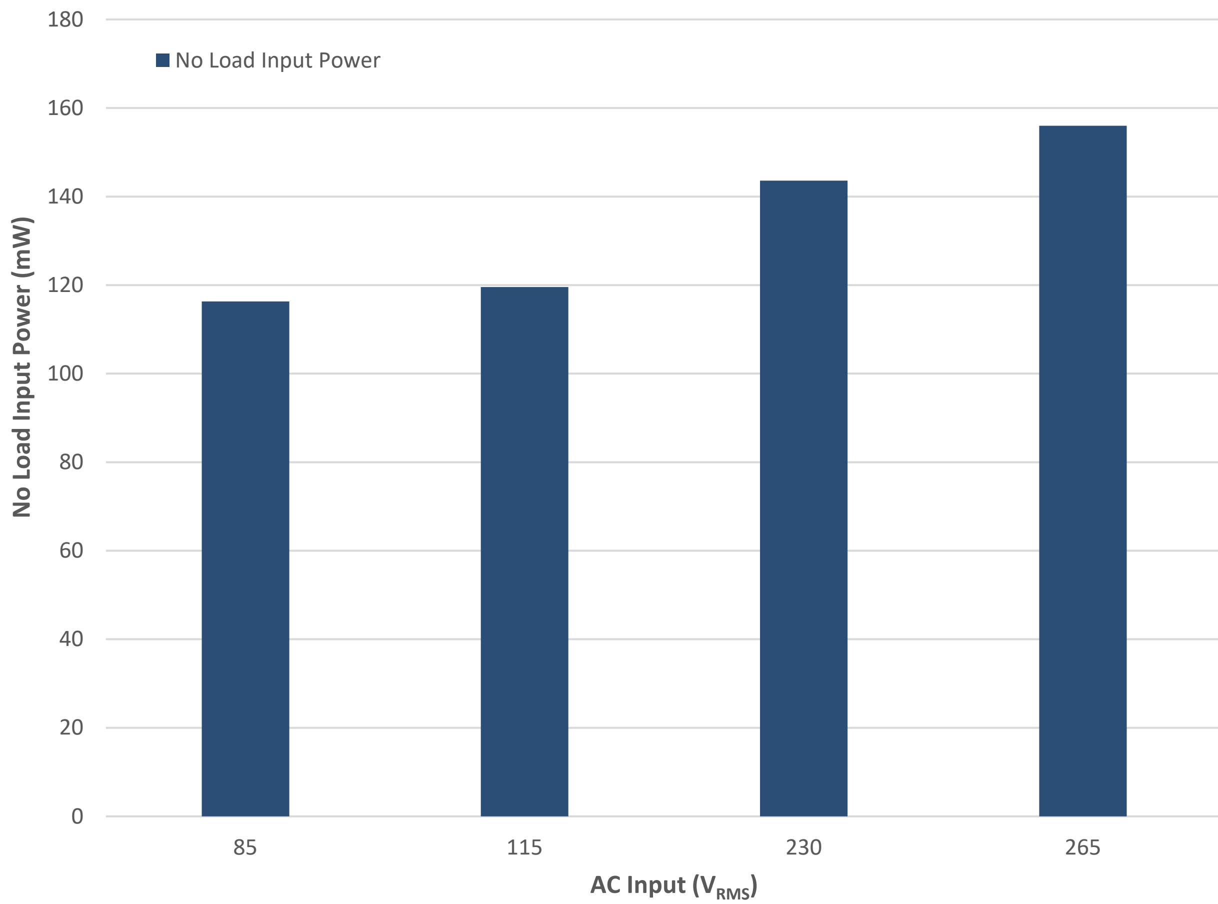


Figure 11 – No-Load Input Power vs. Line at Room Temperature.

10.3.5 Line Regulation

Test Condition: The board was soaked for 15 minutes at each line voltage before taking measurements.

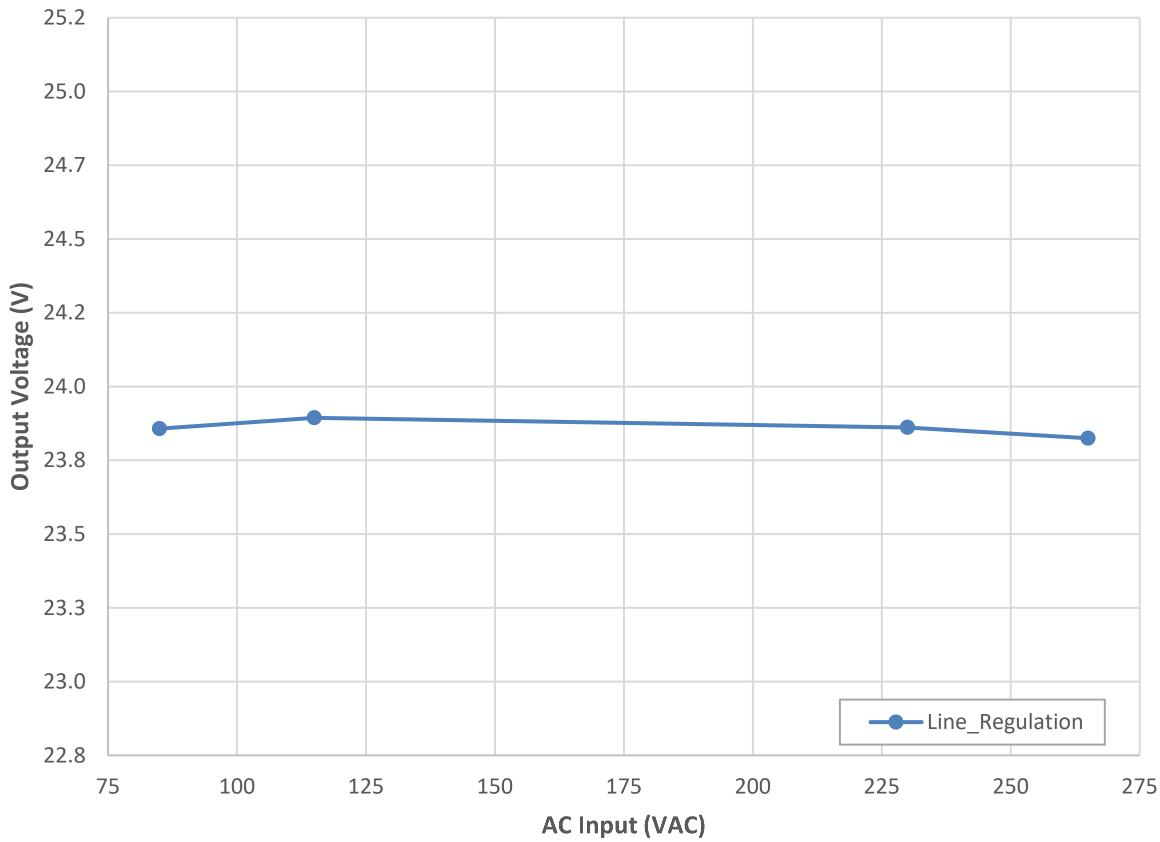


Figure 12 – Output Voltage vs. Line Voltage.

10.3.6 Load Regulation

Test Condition: The board was soaked for 15 minutes at each line voltage, and the signal was integrated for 10 seconds to derive each measurement.

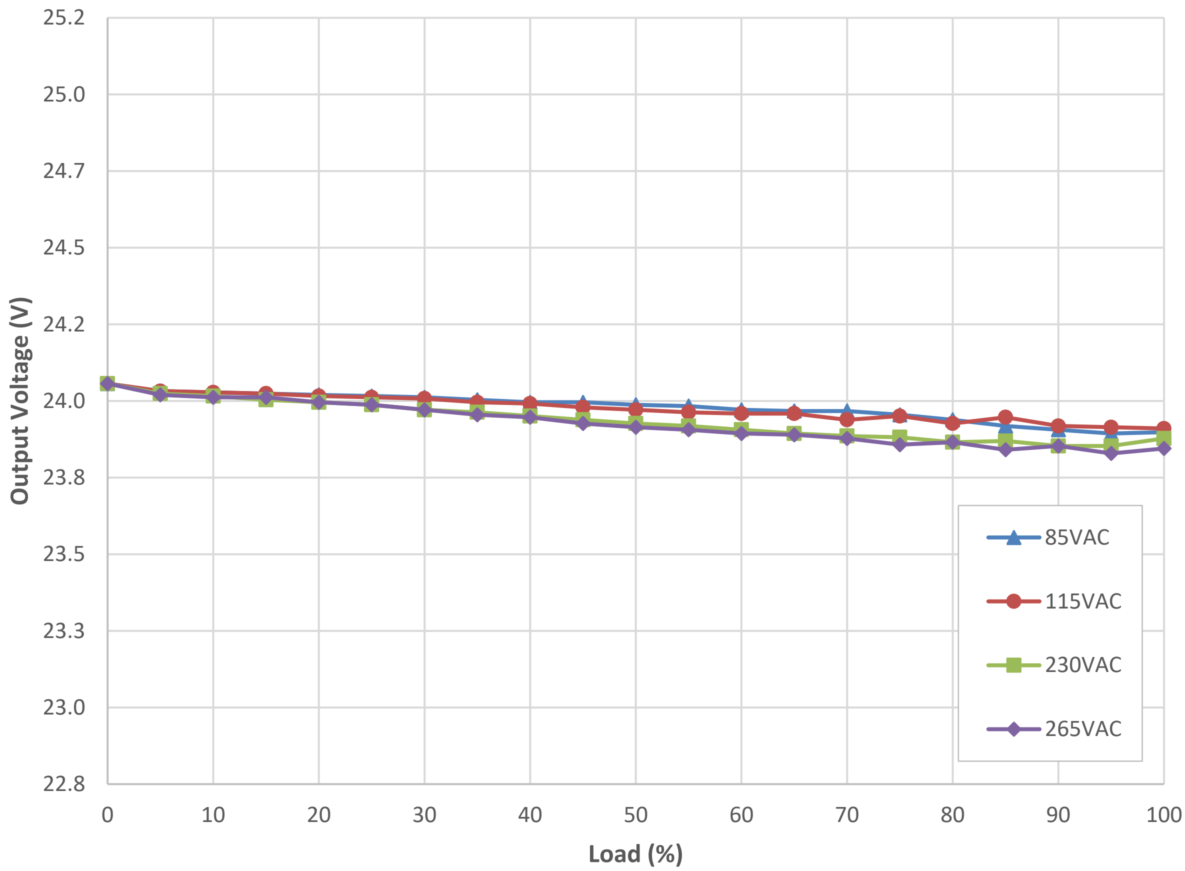


Figure 13 – Output Voltage vs. Percent Load.

10.3.7 Standby Efficiency

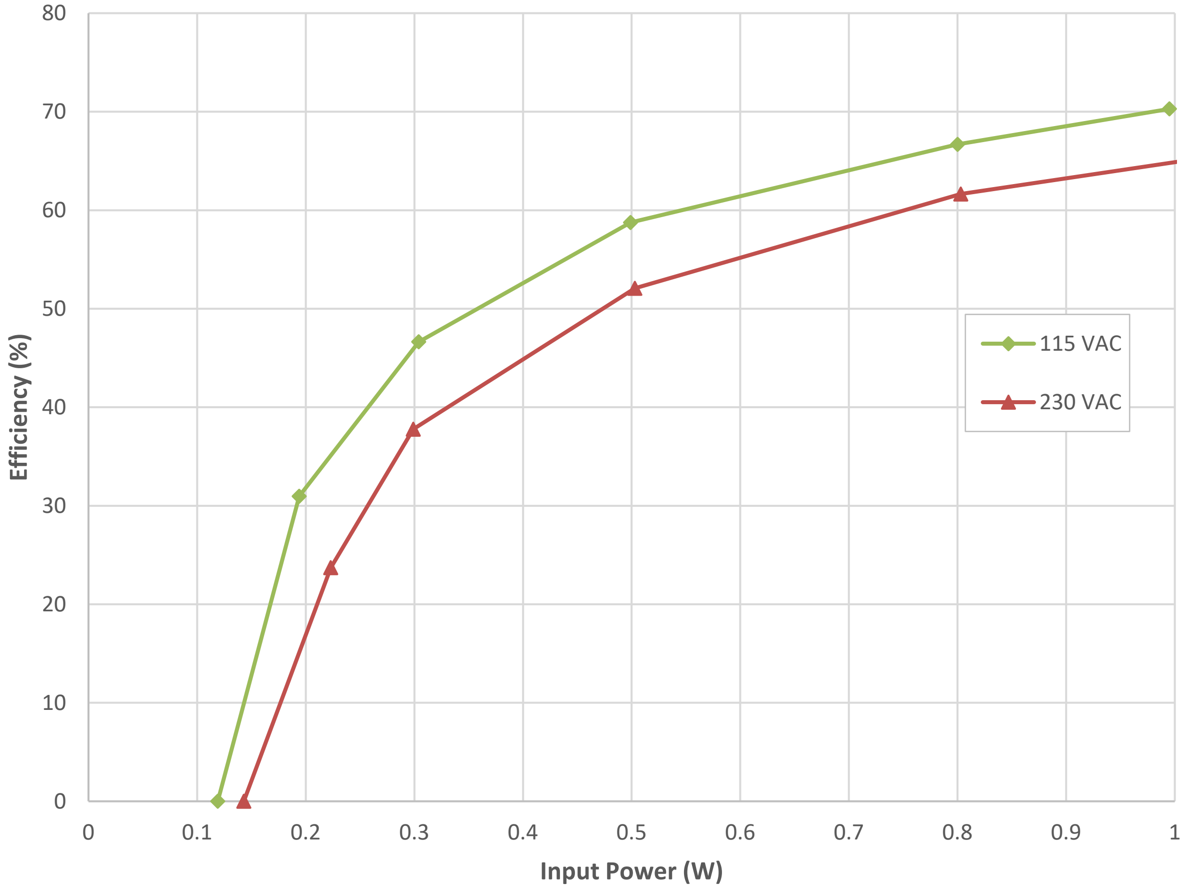


Figure 14 – Efficiency vs Input Power.

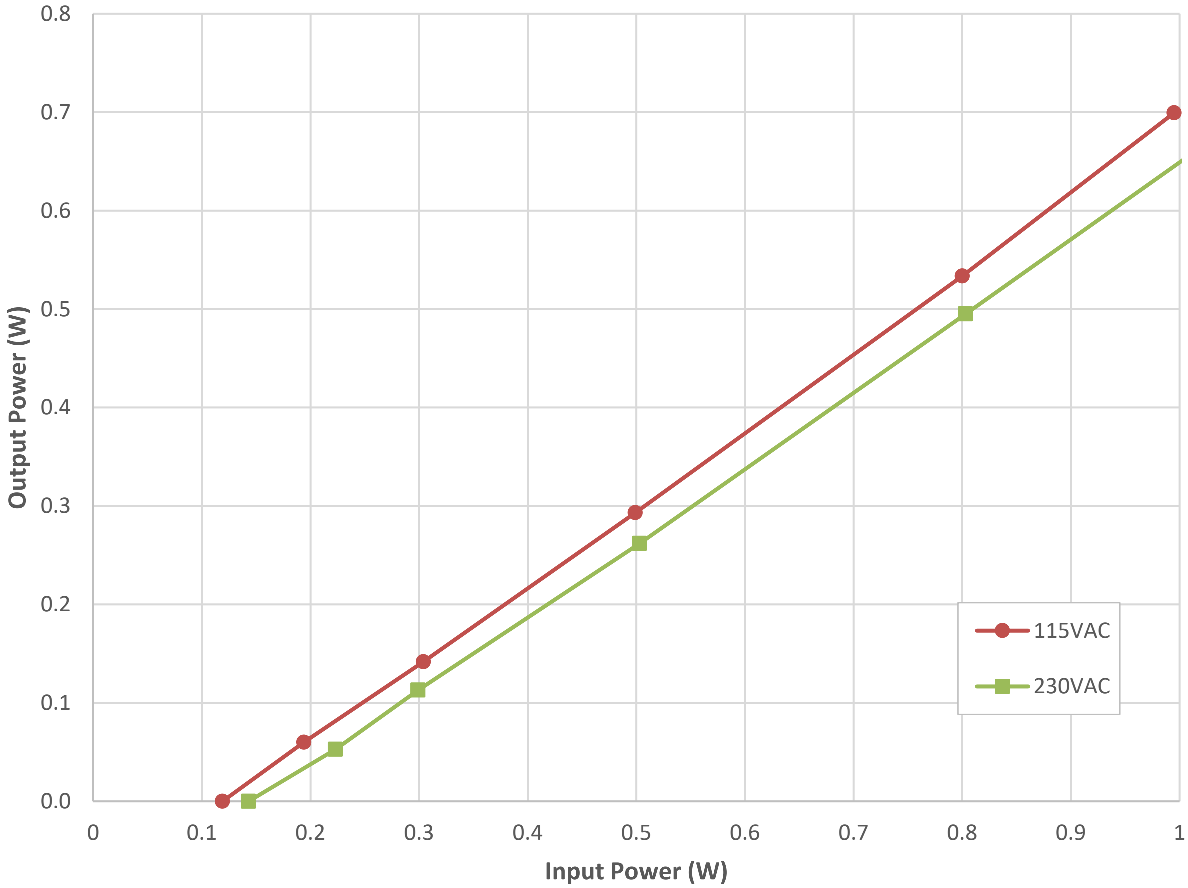


Figure 15 – Output Power vs Input Power.

11 Waveforms

11.1 Load Transient Response

Test Condition: Dynamic load frequency = 10 Hz, Duty cycle = 50%
Slew Rate = 0.4 A / µs

11.1.1 0% to 100% Output Load Transient Condition

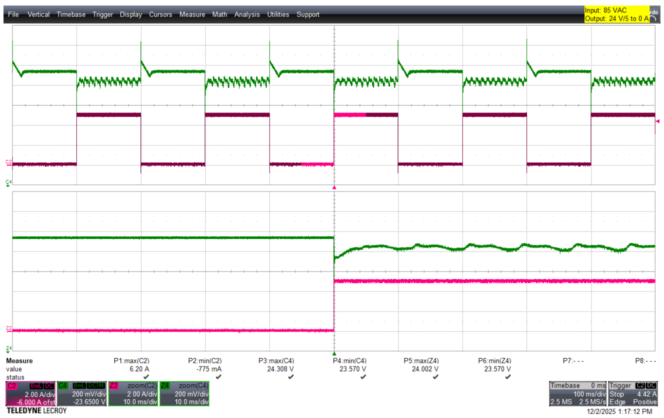


Figure 16 – 85 VAC, 60 Hz. Io = 0 – 5 A (0-100%) load step.
CH1: V_{OUT}, 200 mV / div., 100 ms / div.
CH2: I_{OUT}, 2 A / div., 100 ms / div.
Zoom: 10 ms/div.
Output Voltage, max = 24.3 V
Output Voltage, min = 23.6 V

Figure 17 – 115 VAC, 60 Hz. Io = 0 – 5 A (0-100%) load step.
CH1: V_{OUT}, 200 mV / div., 100 ms / div.
CH2: I_{OUT}, 2 A / div., 100 ms / div.
Zoom: 10 ms/div.
Output Voltage, max = 24.3 V
Output Voltage, min = 23.6 V

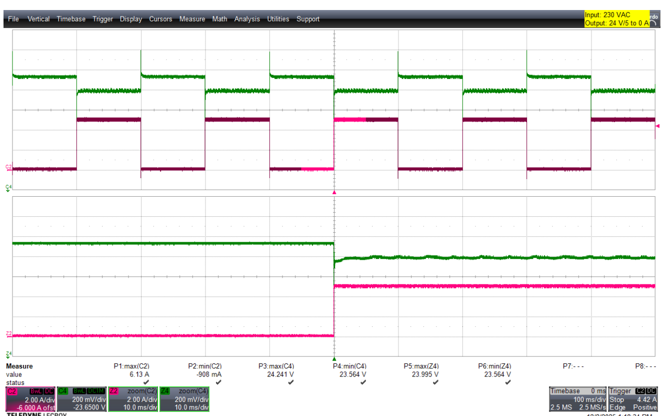


Figure 18 – 230 VAC, 50 Hz. Io = 0 – 5 A (0-100%) load step.
CH1: V_{OUT}, 200 mV / div., 100 ms / div.
CH2: I_{OUT}, 2 A / div., 100 ms / div.
Zoom: 10 ms/div.
Output Voltage, max = 24.2 V
Output Voltage, min = 23.6 V

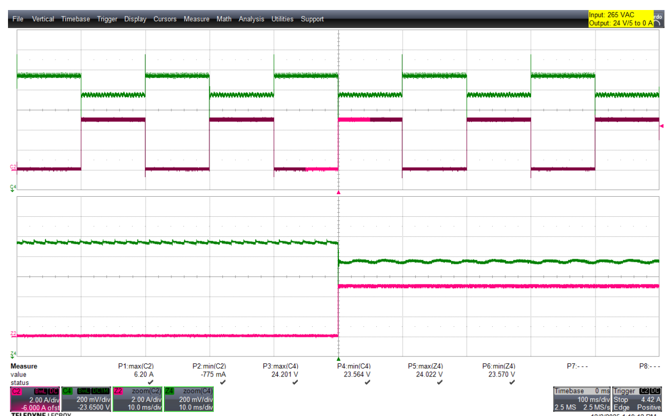


Figure 19 – 265 VAC, 50 Hz. Io = 0 – 5 A (0-100%) load step.
CH1: V_{OUT}, 200 mV / div., 100 ms / div.
CH2: I_{OUT}, 2 A / div., 100 ms / div.
Zoom: 10 ms/div.
Output Voltage, max = 24.2 V
Output Voltage, min = 23.6 V

11.1.2 100% to 0% Output Load Transient Condition

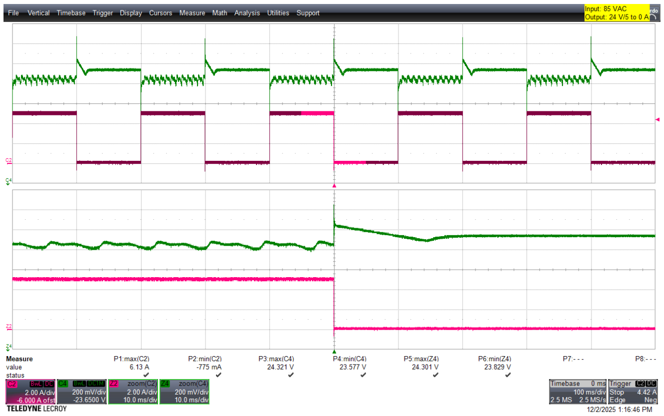


Figure 20 – 85 VAC, 60 Hz. Io = 5 – 0 A (100-0%) load step.
CH1: V_{OUT}, 200 mV / div., 100 ms / div.
CH2: I_{OUT}, 2 A / div., 100 ms / div.
Zoom: 10 ms/div.
Output Voltage, max = 24.3 V
Output Voltage, min = 23.6 V

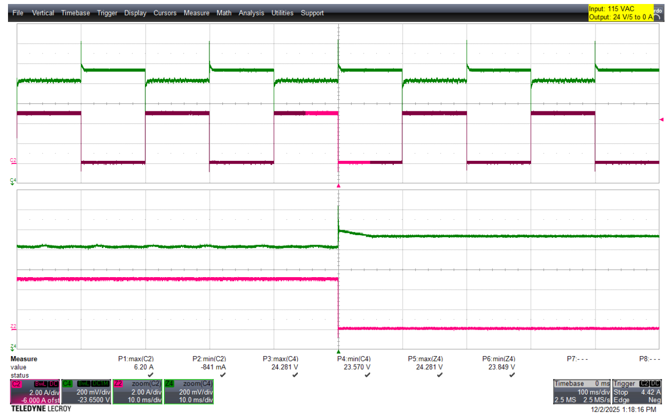


Figure 21 – 115 VAC, 60 Hz. Io = 5 – 0 A (100-0%) load step.
CH1: V_{OUT}, 200 mV / div., 100 ms / div.
CH2: I_{OUT}, 2 A / div., 100 ms / div.
Zoom: 10 ms/div.
Output Voltage, max = 24.3 V
Output Voltage, min = 23.6 V

Figure 22 – 230 VAC, 50 Hz. Io = 5 – 0 A (100-0%) load step.
CH1: V_{OUT}, 200 mV / div., 100 ms / div.
CH2: I_{OUT}, 2 A / div., 100 ms / div.
Zoom: 10 ms/div.
Output Voltage, max = 24.2 V
Output Voltage, min = 23.6 V

Figure 23 – 265 VAC, 50 Hz. Io = 5 – 0 A (100-0%) load step.
CH1: V_{OUT}, 200 mV / div., 100 ms / div.
CH2: I_{OUT}, 2 A / div., 100 ms / div.
Zoom: 10 ms/div.
Output Voltage, max = 24.2 V
Output Voltage, min = 23.6 V

11.2 Output Start-up

11.2.1 Full Load CC Mode

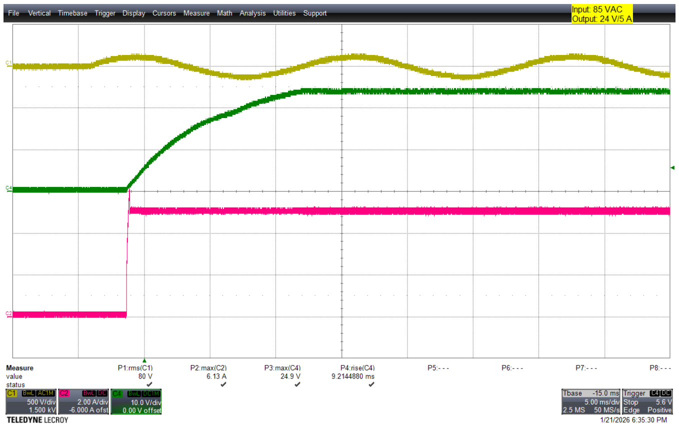


Figure 24 – 85 VAC, 60 Hz. 24 V / 5 A.
CH1: AC INPUT, 500 V / div., 5 ms / div.
CH2: I_{OUT}, 2 A / div., 5 ms / div.
CH4: V_{OUT}, 500 V / div., 10 ms / div.
Output Voltage Rise time = 9.21 ms

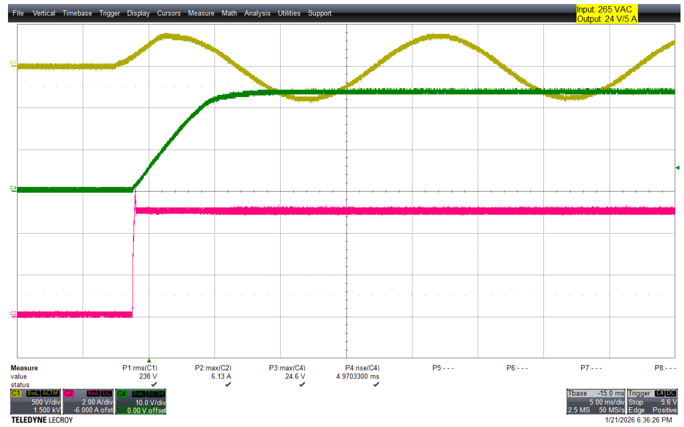


Figure 25 – 265 VAC, 50 Hz. 24 V / 5 A.
CH1: AC INPUT, 500 V / div., 5 ms / div.
CH2: I_{OUT}, 2 A / div., 5 ms / div.
CH4: V_{OUT}, 500 V / div., 10 ms / div.
Output Voltage Rise time = 4.97 ms

11.2.2 Full Load CR Mode

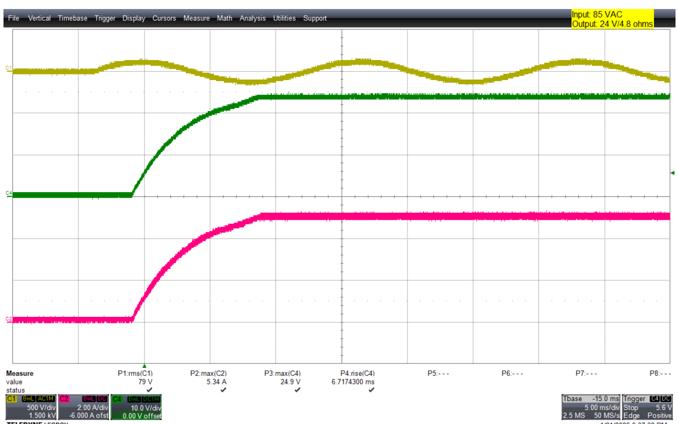


Figure 26 – 85 VAC, 60 Hz. 24 V / 4.8 Ω.
CH1: AC INPUT, 500 V / div., 5 ms / div.
CH2: I_{OUT}, 2 A / div., 5 ms / div.
CH4: V_{OUT}, 500 V / div., 10 ms / div.
Output Voltage Rise time = 6.72 ms

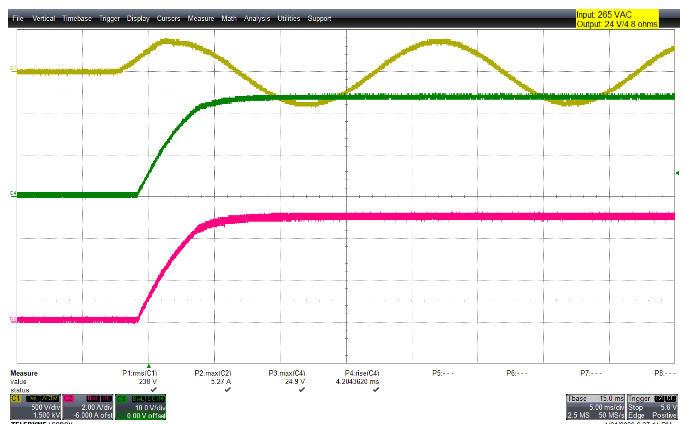


Figure 27 – 265 VAC, 50 Hz. 24 V / 4.8 Ω.
CH1: AC INPUT, 500 V / div., 5 ms / div.
CH2: I_{OUT}, 2 A / div., 5 ms / div.
CH4: V_{OUT}, 500 V / div., 10 ms / div.
Output Voltage Rise time = 4.20 ms

11.2.3 No Load

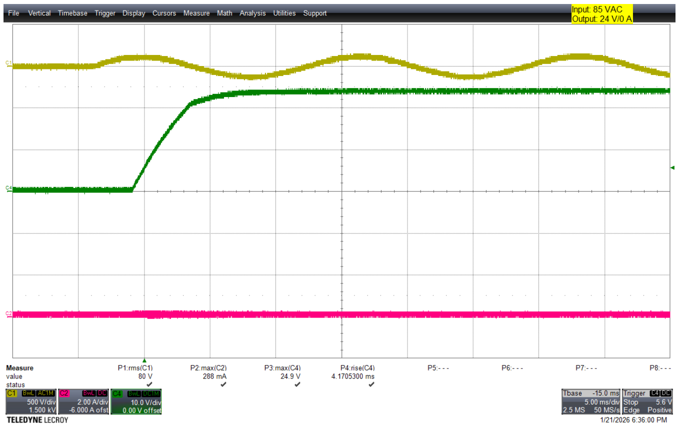


Figure 28 – 85 VAC, 60 Hz. 24 V / 0 A.
CH1: AC INPUT, 500 V / div., 5 ms / div.
CH2: I_{OUT}, 2 A / div., 5 ms / div.
CH4: V_{OUT}, 500 V / div., 10 ms / div.
Output Voltage Rise time = 4.17 ms

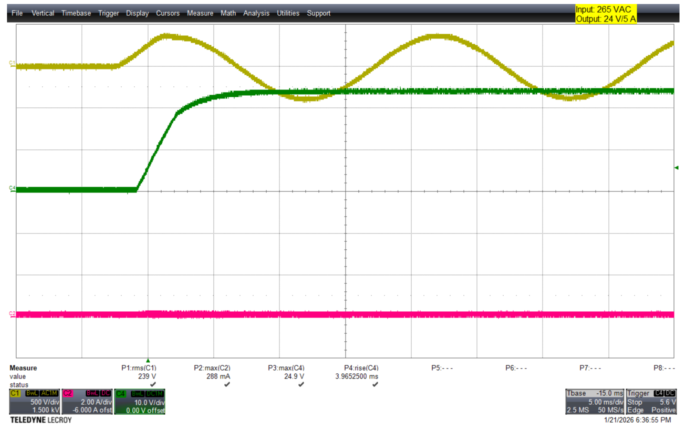


Figure 29 – 265 VAC, 50 Hz. 24 V / 0 A.
CH1: AC INPUT, 500 V / div., 5 ms / div.
CH2: I_{OUT}, 2 A / div., 5 ms / div.
CH4: V_{OUT}, 500 V / div., 10 ms / div.
Output Voltage Rise time = 3.96 ms

11.3 Switching Waveforms

11.3.1 Primary Drain Voltage and Current at Normal Operation

11.3.1.1 Full Load

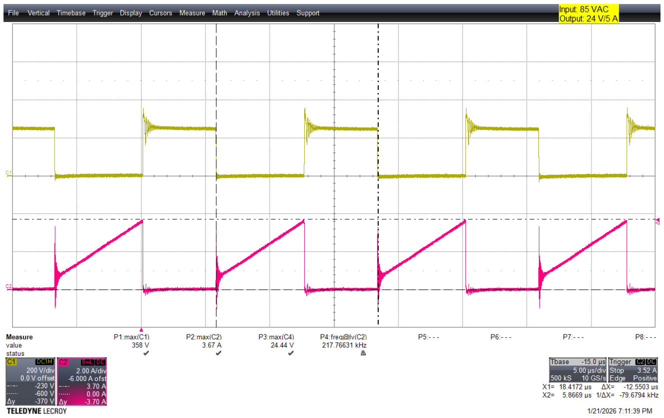


Figure 30 – 85 VAC, Io = 24 V/ 5 A (Full-Load).
CH1: TOP7078K_V_{DS}, 200 V / div., 5 µs / div.
CH2: TOP7078K_I_{DS}, 2 A / div., 5 µs / div.
TOP7078K Drain voltage, max = 358 V
TOP7078K Drain current, max = 3.67 A
ILIM = 3.7 A

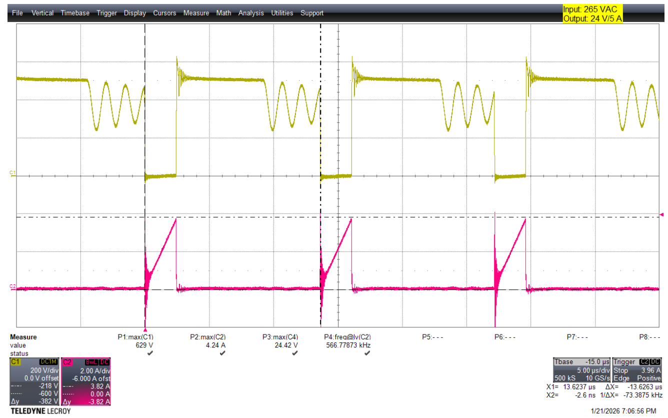


Figure 31 – 265 VAC, Io = 24 V/ 5 A (Full-Load).
CH1: TOP7078K_V_{DS}, 200 V / div., 5 µs / div.
CH2: TOP7078K_I_{DS}, 2 A / div., 5 µs / div.
TOP7078K Drain voltage, max = 629 V
TOP7078K Drain current, max = 4.24 A
ILIM = 3.82 A

11.3.1.2 No Load

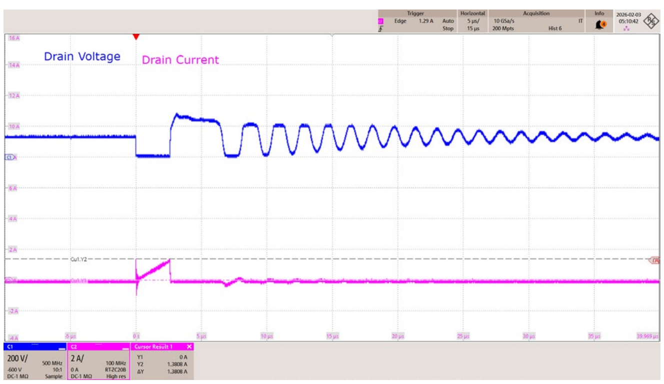


Figure 32 – 85 VAC, Io = 24 V/ 0 A (Full-Load).
CH1: TOP7078K_V_{DS}, 200 V / div., 5 µs / div.
CH2: TOP7078K_I_{DS}, 2 A / div., 5 µs / div.
TOP7078K Drain voltage, max = 292 V
TOP7078K Drain current, max = 1.47 A
ILIM = 1.38 A

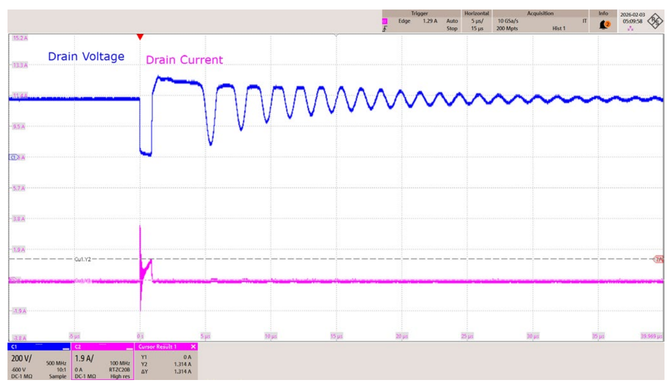


Figure 33 – 265 VAC, Io = 24 V/ 0 A (Full-Load).
CH1: TOP7078K_V_{DS}, 200 V / div., 5 µs / div.
CH2: TOP7078K_I_{DS}, 2 A / div., 5 µs / div.
TOP7078K Drain voltage, max = 566 V
TOP7078K Drain current, max = 3.8 A
ILIM = 1.314

11.3.2 Primary Drain Voltage and Current at Start-up Operation

11.3.2.1 Full Load

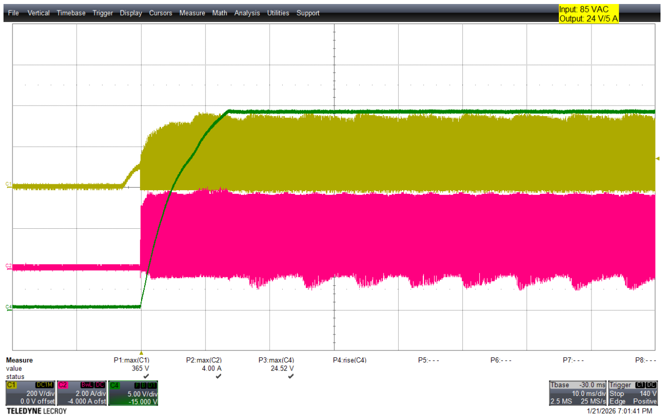


Figure 34 – 85 VAC, Io = 24 V/5 A (Full-Load).
CH1: TOP7078K_V_{DS}, 200 V / div., 10 ms / div.
CH2: TOP7078K_I_{DS}, 2 A / div., 10 ms / div.
CH4: V_{OUT}, 5 V / div., 10 ms / div.
TOP7078K Drain voltage, max = 365 V
TOP7078K Drain current, max = 4.0 A

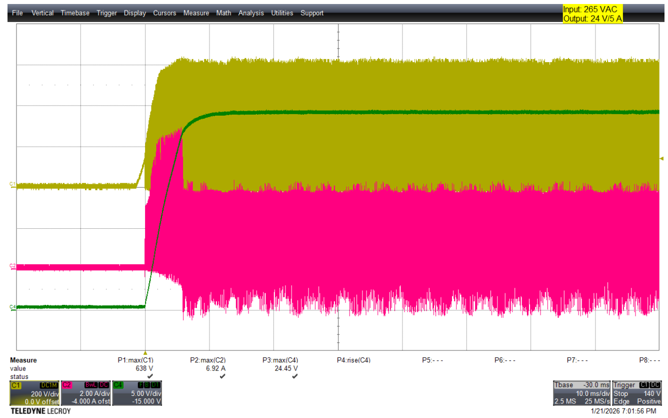


Figure 35 – 265 VAC, Io = 24 V/5 A (Full-Load).
CH1: TOP7078K_V_{DS}, 200 V / div., 10 ms / div.
CH2: TOP7078K_I_{DS}, 2 A / div., 10 ms / div.
CH4: V_{OUT}, 5 V / div., 10 ms / div.
TOP7078K Drain voltage, max = 638 V
TOP7078K Drain current, max = 6.92 A

11.3.2.2 No Load

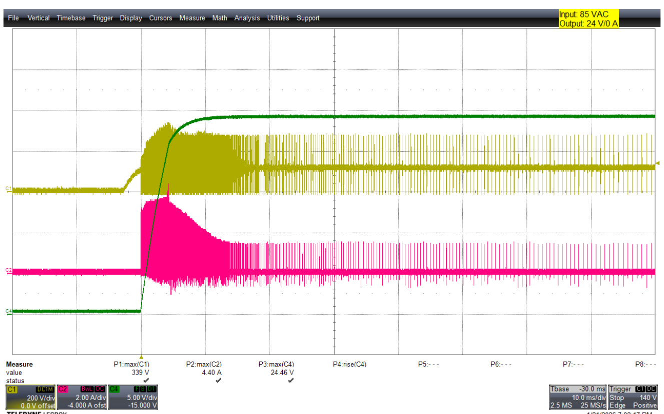


Figure 36 – 85 VAC, Io = 24 V/0 A (No-Load).
CH1: TOP7078K_V_{DS}, 200 V / div., 10 ms / div.
CH2: TOP7078K_I_{DS}, 2 A / div., 10 ms / div.
CH4: V_{OUT}, 5 V / div., 10 ms / div.
TOP7078K Drain voltage, max = 339 V
TOP7078K Drain current, max = 4.4 A

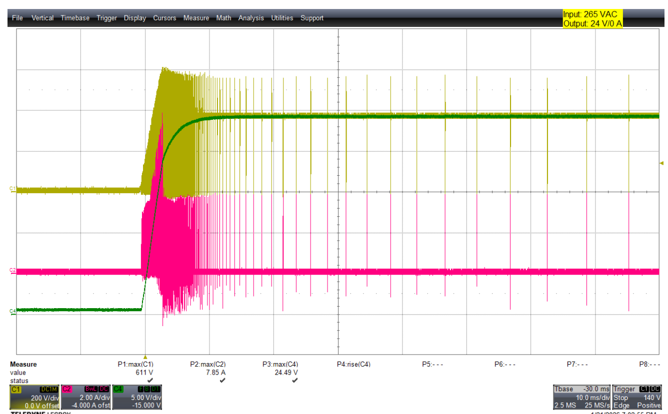


Figure 37 – 265 VAC, Io = 24 V/0 A (No-Load).
CH1: TOP7078K_V_{DS}, 200 V / div., 10 ms / div.
CH2: TOP7078K_I_{DS}, 2 A / div., 10 ms / div.
CH4: V_{OUT}, 5 V / div., 10 ms / div.
TOP7078K Drain voltage, max = 611 V
TOP7078K Drain current, max = 7.85 A

11.3.3 Freewheeling Diode Voltage at Normal Operation

11.3.3.1 Full Load

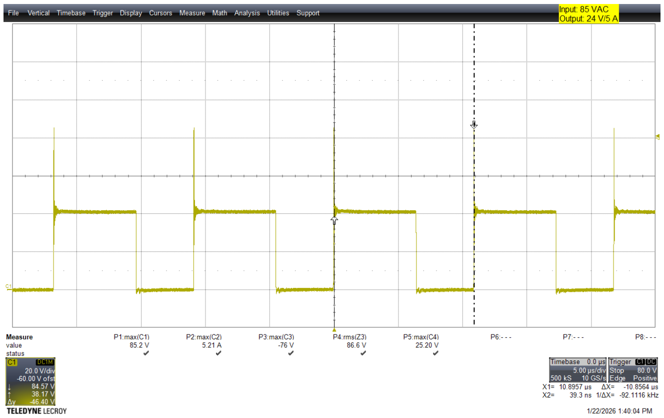


Figure 38 – 85 VAC, Io = 24 V/5 A (Full-Load).
CH1: OUTPUT RECTIFIER VOLTAGE: 200 V / div., 5 μs / div.
OUTPUT RECTIFIER VOLTAGE, max = 85.2 V

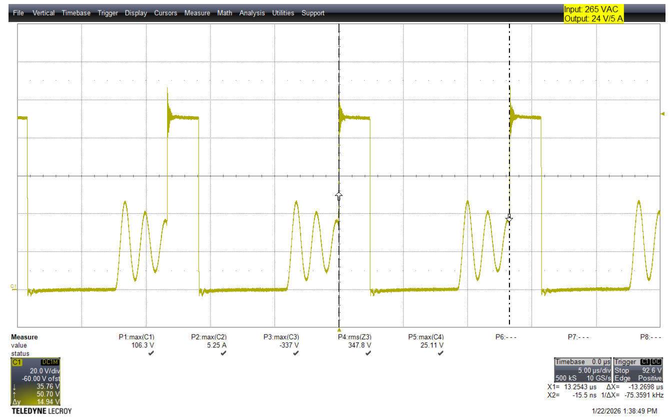


Figure 39 – 265 VAC, Io = 24 V/5 A (Full-Load).
CH1: OUTPUT RECTIFIER VOLTAGE: 200 V / div., 5 μs / div.
OUTPUT RECTIFIER VOLTAGE, max = 106.3 V

11.3.3.2 No Load

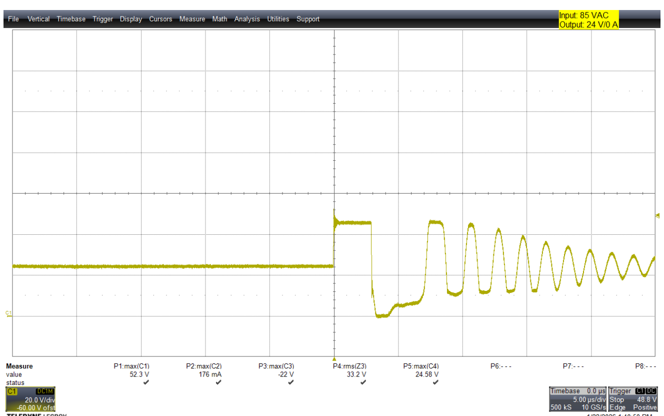


Figure 40 – 85 VAC, Io = 24 V/0 A (No-Load).
CH1: OUTPUT RECTIFIER VOLTAGE: 200 V / div., 5 μs / div.
OUTPUT RECTIFIER VOLTAGE, max = 52.3 V

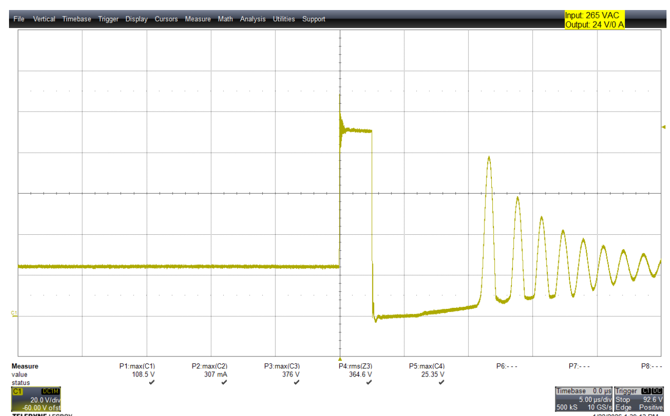


Figure 41 – 265 VAC, Io = 24 V/0 A (No-Load).
CH1: OUTPUT RECTIFIER VOLTAGE: 200 V / div., 10 ms / div.
OUTPUT RECTIFIER VOLTAGE, max = 108.5 V

11.3.4 Freewheeling Diode Voltage at Start-Up

11.3.4.1 Full Load

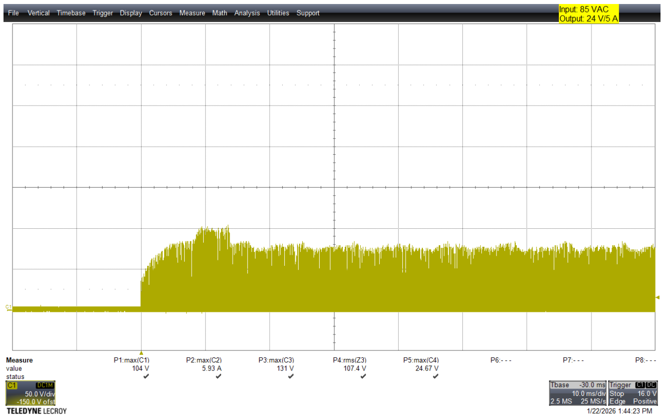


Figure 42 – 85 VAC, Io = 24 V/5 A (Full-Load).
CH1: OUTPUT RECTIFIER VOLTAGE: 200 V / div., 10 ms / div.
OUTPUT RECTIFIER VOLTAGE, max = 104 V

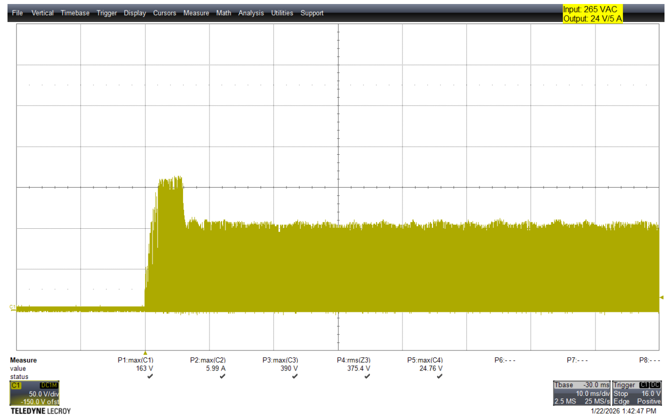


Figure 43 – 265 VAC, Io = 24 V/5 A (Full-Load).
CH1: OUTPUT RECTIFIER VOLTAGE: 200 V / div., 10 ms / div.
OUTPUT RECTIFIER VOLTAGE, max = 163 V

11.3.4.2 No Load

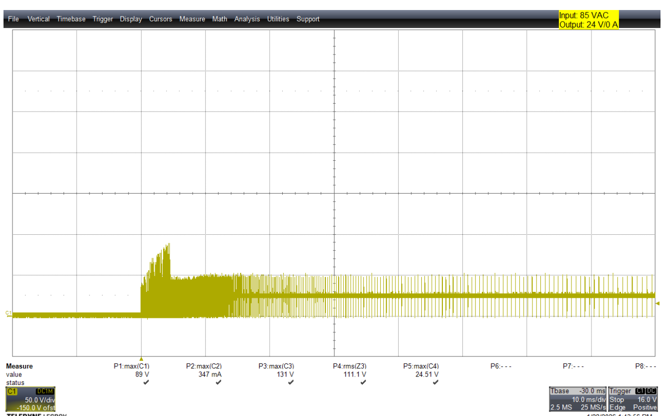


Figure 44 – 85 VAC, Io = 24 V/0 A (No-Load).
CH1: OUTPUT RECTIFIER VOLTAGE: 200 V / div., 10 ms / div.
OUTPUT RECTIFIER VOLTAGE, max = 89 V

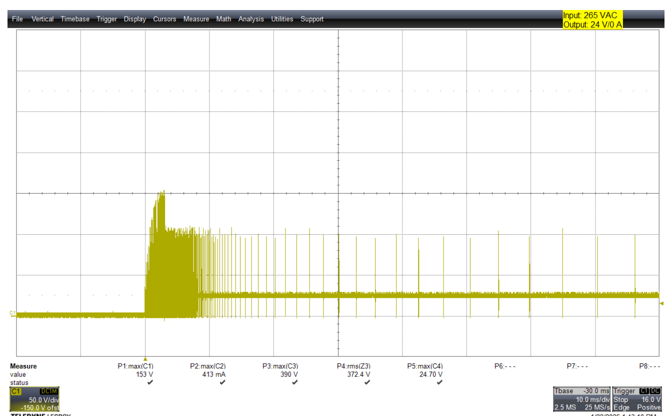


Figure 45 – 265 VAC, Io = 24 V/0 A (No-Load).
CH1: OUTPUT RECTIFIER VOLTAGE: 200 V / div., 10 ms / div.
OUTPUT RECTIFIER VOLTAGE, max = 153 V

11.4 Output Voltage Ripple

11.4.1 Ripple Measurement Technique

For DC output ripple measurements, a modified oscilloscope test probe must be utilized to reduce spurious signals due to pick-up. Details of the probe modification are provided in figures 46 and 47.

The 4987BA probe adapter is affixed with two capacitors connected in parallel across the probe tip. The capacitors include one 0.1 μF / 100 V ceramic type and one 47 μF / 50 V aluminum electrolytic. The aluminum electrolytic capacitor is polarized, so proper polarity across DC outputs must be maintained during measurements (see below).

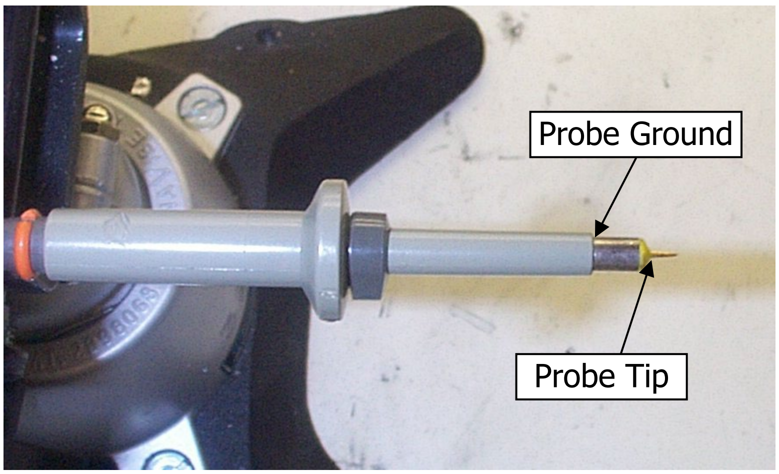


Figure 46 – Oscilloscope Probe Prepared for Ripple Measurement. (End Cap and Ground Lead Removed.)

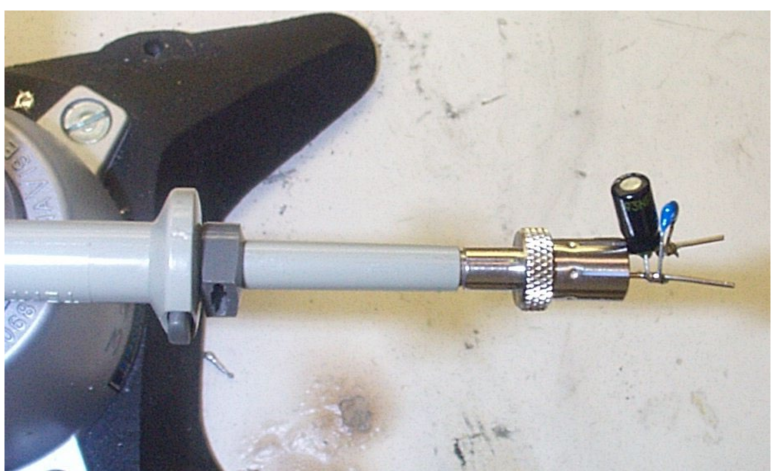


Figure 47 – Oscilloscope Probe with Probe Master (**www.probemaster.com**) 4987A BNC Adapter. (Modified with wires for ripple measurement, and two parallel decoupling capacitors added.)

11.4.2 Measurement Results

Note: All ripple measurements were taken at PCB end.

11.4.2.1 100% Load Condition

85 VAC – 24 V/5 A

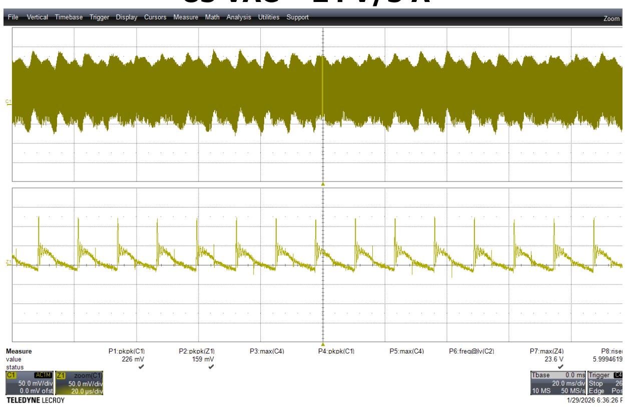


Figure 48 – 85 VAC, 60 Hz. 24 V / 5 A.
CH1: $V_{OUT(pk-pk)}$, 50 mV / div, 20 ms / div.
Zoom: 20 µs / div.
V_{OUT} Ripple = 226 mV_{PK-PK}

115 VAC – 24 V/5 A

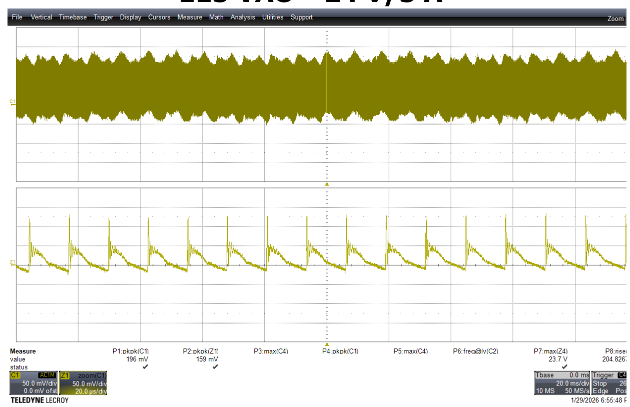


Figure 49 – 115 VAC, 60 Hz. 24 V / 5 A.
CH1: $V_{OUT(pk-pk)}$, 50 mV / div, 20 ms / div.
Zoom: 20 µs / div.
V_{OUT} Ripple = 196 mV_{PK-PK}

230 VAC – 24 V/5 A

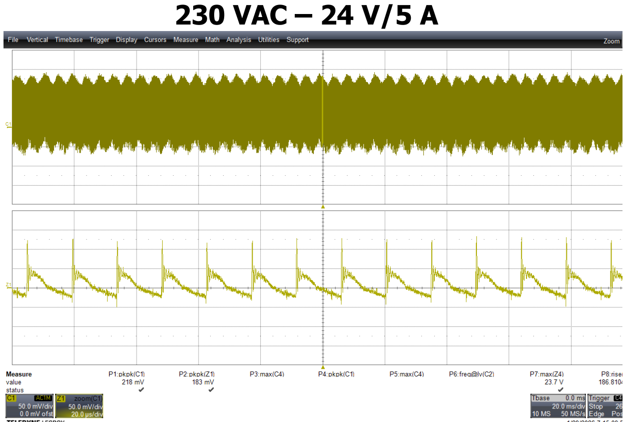


Figure 50 – 230 VAC, 50 Hz. 24 V / 5 A.
CH1: $V_{OUT(pk-pk)}$, 50 mV / div, 20 ms / div.
Zoom: 20 µs / div.
V_{OUT} Ripple = 218 mV_{PK-PK}

265 VAC – 24 V/5 A

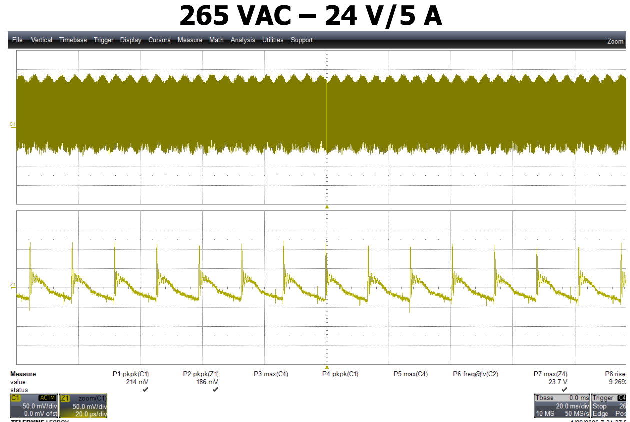


Figure 51 – 265 VAC, 50 Hz. 24 V / 5 A.
CH1: $V_{OUT(pk-pk)}$, 50 mV / div, 20 ms / div.
Zoom: 20 µs / div.
V_{OUT} Ripple = 214 mV_{PK-PK}

11.4.2.2 75% Load Condition

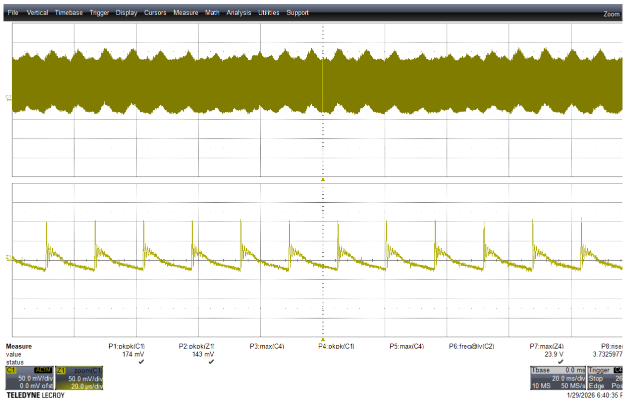


Figure 52 – 85 VAC, 60 Hz. 24 V / 3.75 A.
CH1: $V_{OUT(pk-pk)}$, 50 mV / div, 20 ms / div.
Zoom: 20 µs / div.
V_{OUT} Ripple = 174 mV_{PK-PK}

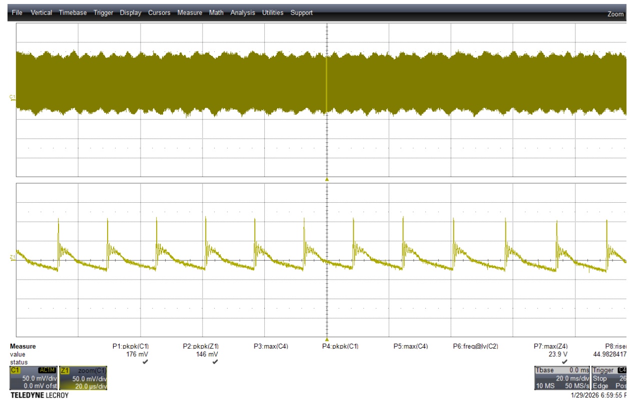


Figure 53 – 115 VAC, 60 Hz. 24 V / 3.75 A.
C CH1: $V_{OUT(pk-pk)}$, 50 mV / div, 20 ms / div.
Zoom: 20 µs / div.
V_{OUT} Ripple = 176 mV_{PK-PK}

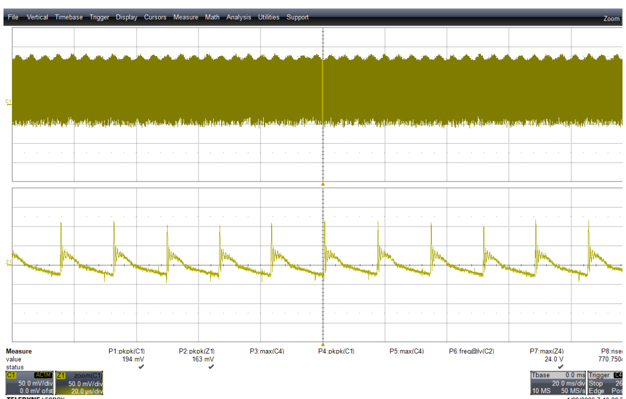


Figure 54 – 230 VAC, 50 Hz. 24 V / 3.75 A.
CH1: $V_{OUT(pk-pk)}$, 50 mV / div, 20 ms / div.
Zoom: 20 µs / div.
V_{OUT} Ripple = 194 mV_{PK-PK}

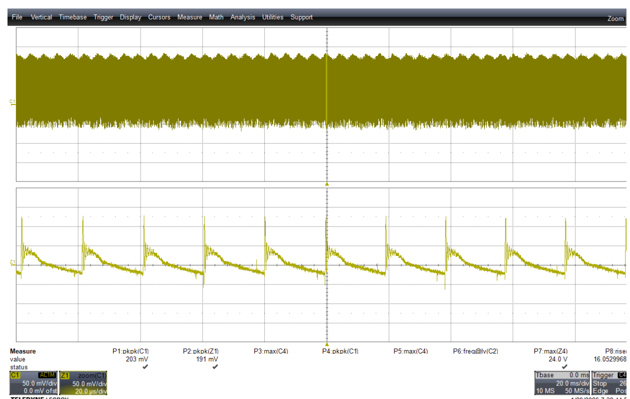


Figure 55 – 265 VAC, 50 Hz. 24 V / 3.75 A.
CH CH1: $V_{OUT(pk-pk)}$, 50 mV / div, 20 ms / div.
Zoom: 20 µs / div.
V_{OUT} Ripple = 203 mV_{PK-PK}

11.4.2.3 50% Load Condition

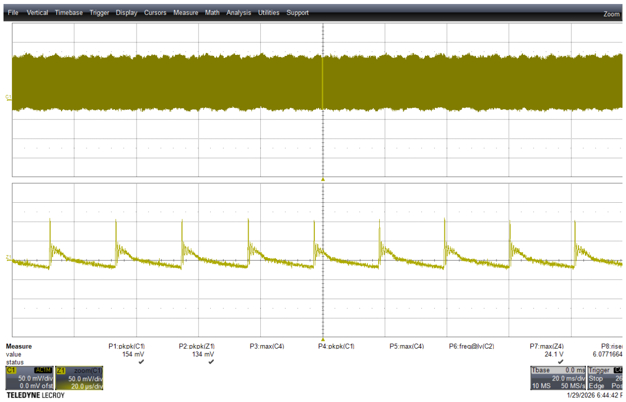


Figure 56 – 85 VAC, 60 Hz. 24 V / 2.5 A.
CH1: $V_{OUT(pk-pk)}$, 50 mV / div, 20 ms / div.
Zoom: 20 μs / div.
V_{OUT} Ripple = 154 mV_{PK-PK}

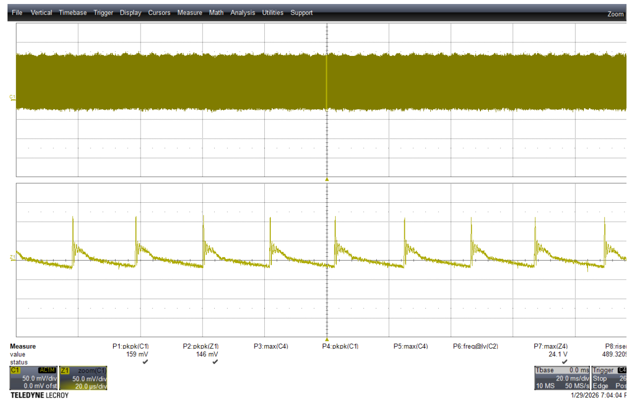


Figure 57 – 115 VAC, 60 Hz. 24 V / 2.5 A.
CH1: $V_{OUT(pk-pk)}$, 50 mV / div, 20 ms / div.
Zoom: 20 μs / div.
V_{OUT} Ripple = 159 mV_{PK-PK}

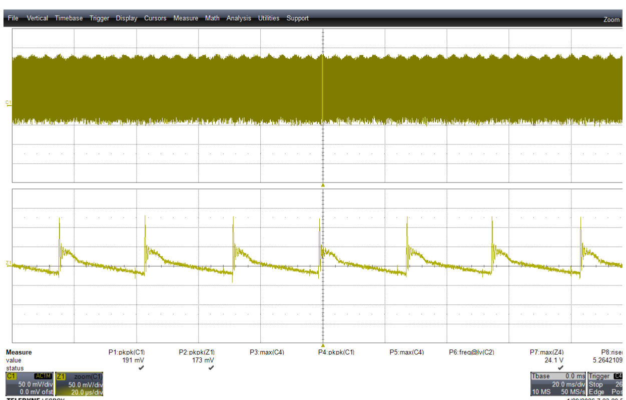


Figure 58 – 230 VAC, 50 Hz. 24 V / 2.5 A.
CH1: $V_{OUT(pk-pk)}$, 50 mV / div, 20 ms / div.
Zoom: 20 μs / div.
V_{OUT} Ripple = 191 mV_{PK-PK}

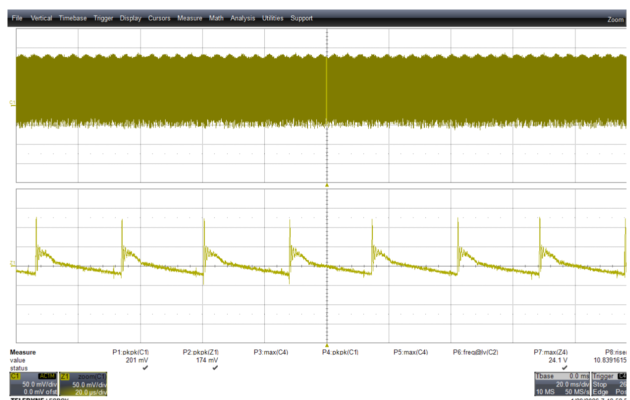


Figure 59 – 265 VAC, 50 Hz. 24 V / 2.5 A.
CH1: $V_{OUT(pk-pk)}$, 50 mV / div, 20 ms / div.
Zoom: 20 μs / div.
V_{OUT} Ripple = 201 mV_{PK-PK}

11.4.2.4 25% Load Condition

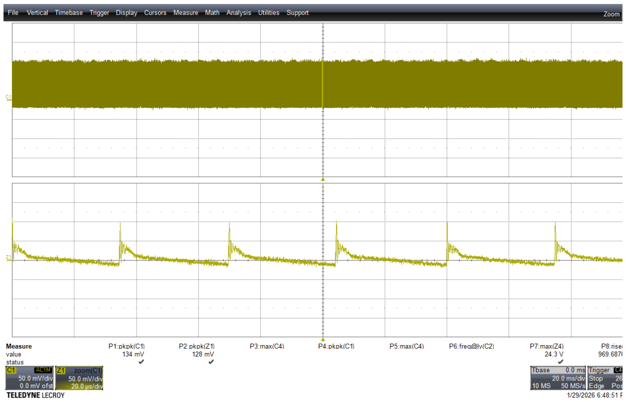


Figure 60 – 85 VAC, 60 Hz. 24 V / 1.25 A.
CH1: $V_{OUT(pk-pk)}$, 50 mV / div, 20 ms / div.
Zoom: 20 µs / div.
V_{OUT} Ripple = 134 mV_{PK-PK}

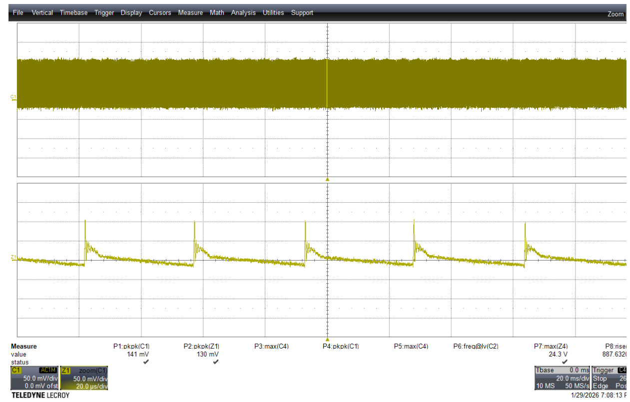


Figure 61 – 115 VAC, 60 Hz. 24 V / 1.25 A.
CH1: $V_{OUT(pk-pk)}$, 50 mV / div, 20 ms / div.
Zoom: 20 µs / div.
V_{OUT} Ripple = 141 mV_{PK-PK}

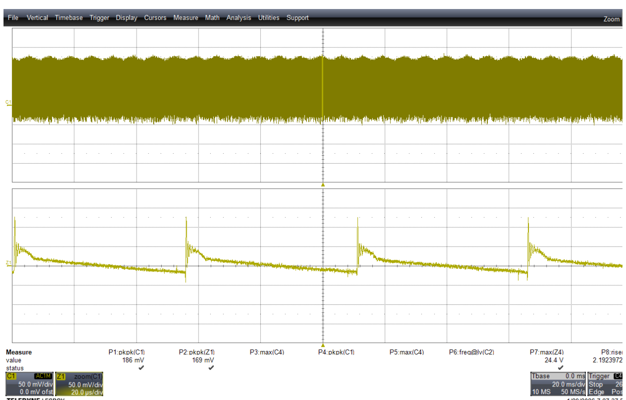


Figure 62 – 230 VAC, 50 Hz. 24 V / 1.25 A.
CH1: $V_{OUT(pk-pk)}$, 50 mV / div, 20 ms / div.
Zoom: 20 µs / div.
V_{OUT} Ripple = 186 mV_{PK-PK}

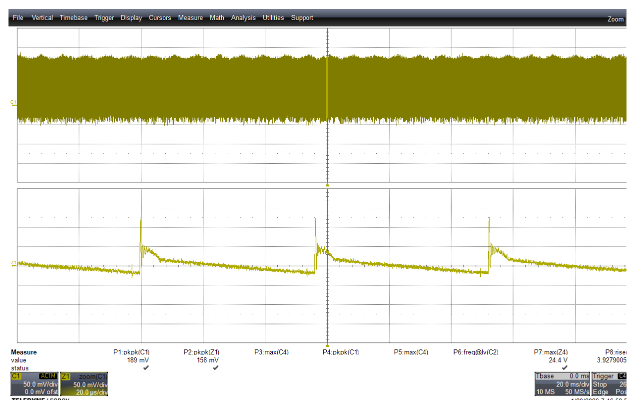


Figure 63 – 265 VAC, 50 Hz. 24 V / 1.25 A.
CH1 CH1: $V_{OUT(pk-pk)}$, 50 mV / div, 20 ms / div.
Zoom: 20 µs / div.
V_{OUT} Ripple = 189 mV_{PK-PK}

11.4.2.5 0% Load Condition

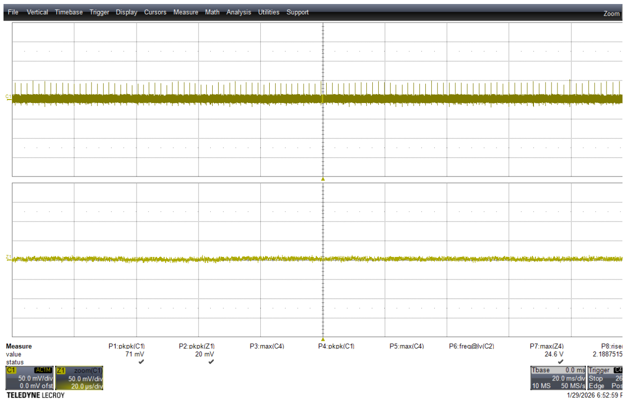


Figure 64 – 85 VAC, 60 Hz. 24 V / 0 A.
CH1: $V_{OUT(pk-pk)}$, 100 mV / div, 20 ms / div.
Zoom: 20 μs / div.
V_{OUT} Ripple = 71 mV_{PK-PK}

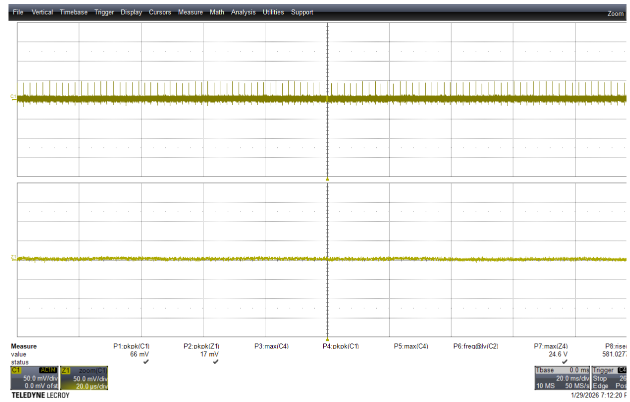


Figure 65 – 115 VAC, 60 Hz. 24 V / 0 A.
CH1: $V_{OUT(pk-pk)}$, 100 mV / div, 20 ms / div.
Zoom: 20 μs / div.
V_{OUT} Ripple = 66 mV_{PK-PK}

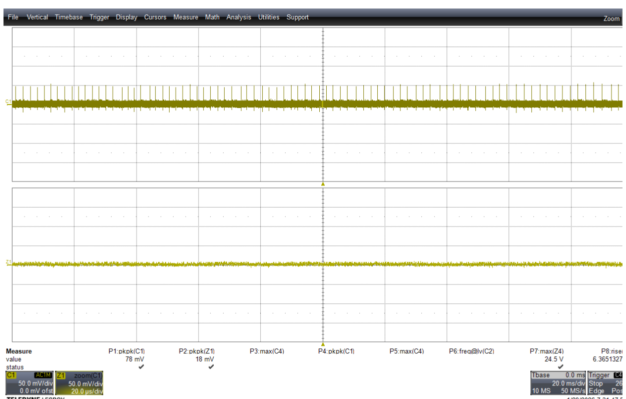


Figure 66 – 230 VAC, 50 Hz. 24 V / 0 A.
CH1: $V_{OUT(pk-pk)}$, 100 mV / div, 20 ms / div.
Zoom: 20 μs / div.
V_{OUT} Ripple = 78 mV_{PK-PK}

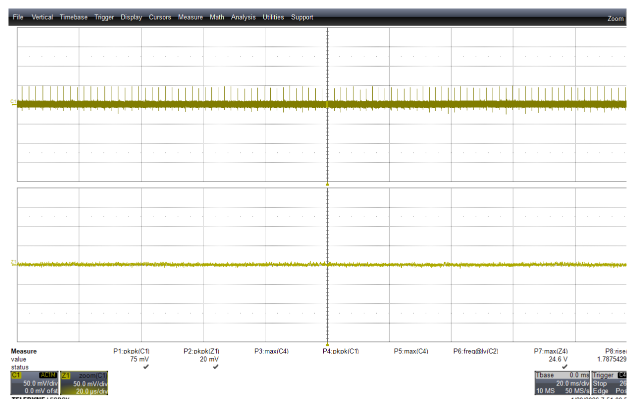


Figure 67 – 265 VAC, 50 Hz. 24 V / 0 A.
CH1: $V_{OUT(pk-pk)}$, 100 mV / div, 20 ms / div.
Zoom: 20 μs / div.
V_{OUT} Ripple = 75 mV_{PK-PK}

11.4.3 Output Ripple Voltage Graph

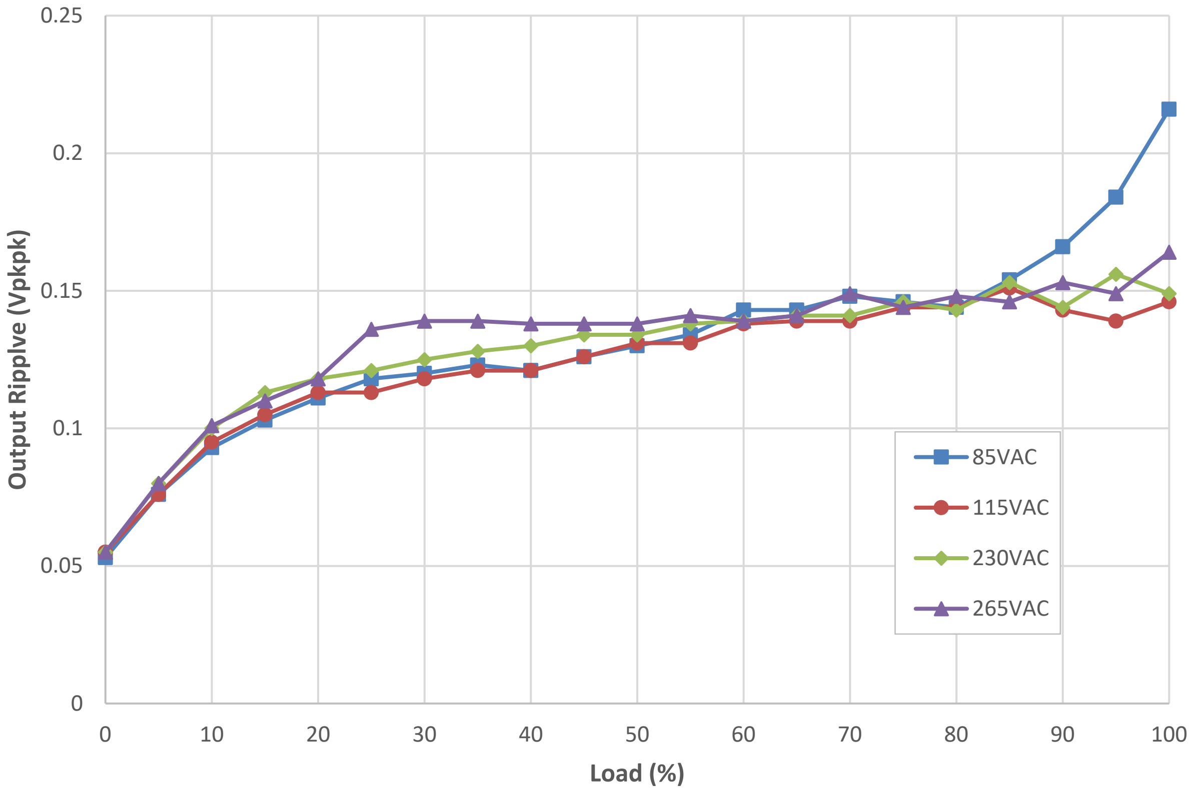


Figure 68 – Voltage Ripple (Measured at PCB End and at Room Temperature).

11.5 Brown In & Brown Out

Brown in and brown out slew rate set at 0.1 V/s.

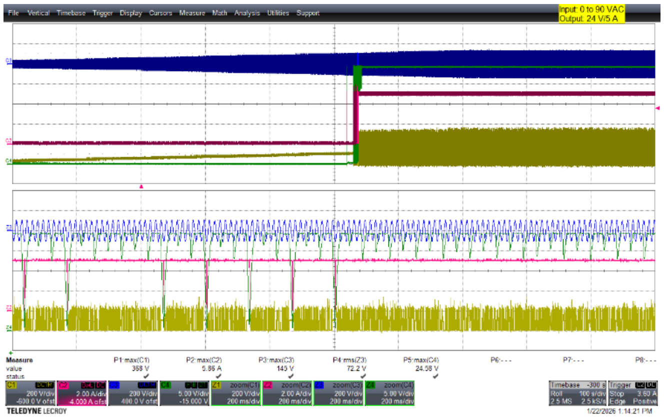


Figure 69 – Brown In, Full Load Condition – 0 to 90 VAC.
CH1: TOP7078K_V_{DS}, 200 V / div., 100 s / div.
CH2: I_{OUT}, 2 A / div., 100 s / div.
CH3: AC INPUT, 200 V / div., 100 s / div.
CH3: V_{OUT}, 5 V / div., 100 s / div.
Zoom: 200 ms/div.
Brown In Voltage = 72.2 VAC

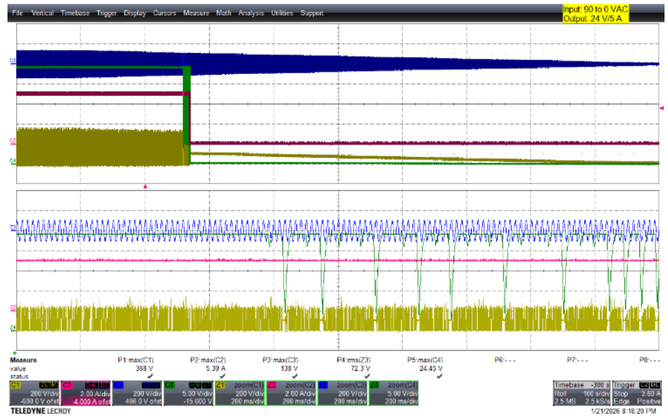


Figure 70 – Brown Out, Full Load Condition – 90 to 0 VAC.
CH1: TOP7078K_V_{DS}, 200 V / div., 100 s / div.
CH2: I_{OUT}, 2 A / div., 100 s / div.
CH3: AC INPUT, 200 V / div., 100 s / div.
CH3: V_{OUT}, 5 V / div., 100 s / div.
Zoom: 200 ms/div.
Brown Out Voltage = 72.3 VAC

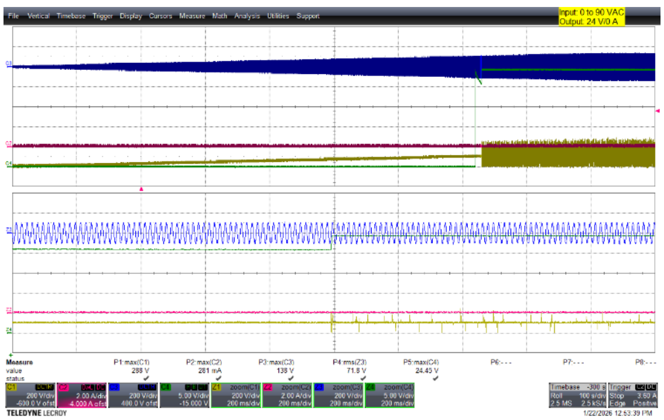


Figure 71 – Brown In, No Load Condition – 0 to 90 VAC.
CH1: TOP7078K_V_{DS}, 200 V / div., 100 s / div.
CH2: I_{OUT}, 2 A / div., 100 s / div.
CH3: AC INPUT, 200 V / div., 100 s / div.
CH3: V_{OUT}, 5 V / div., 100 s / div.
Zoom: 200 ms/div.
Brown In Voltage = 71.8 VAC

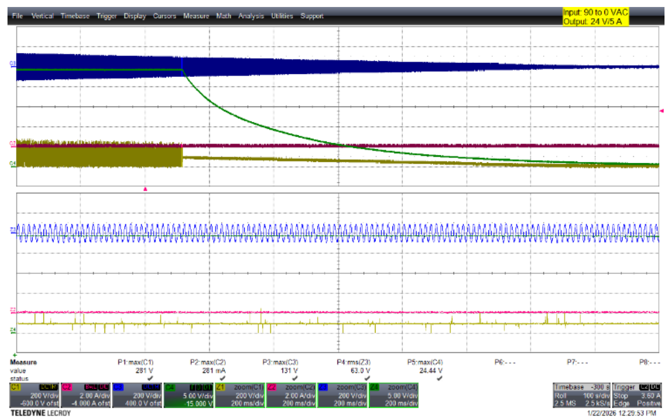


Figure 72 – Brown Out, No Load Condition – 90 to 0 VAC.
CH1: TOP7078K_V_{DS}, 200 V / div., 100 s / div.
CH2: I_{OUT}, 2 A / div., 100 s / div.
CH3: AC INPUT, 200 V / div., 100 s / div.
CH3: V_{OUT}, 20V / div., 100 s / div.
Zoom: 200 ms/div.
Brown In Voltage = 63.0 VAC

12 Thermal Performance

12.1 Thermal Performance at Room Temperature

12.1.1 85 VAC Full Load at Room Ambient

Test result after 2 hours running continuously inside an enclosure at 85 VAC full load using FLIR thermal camera to measure component temperatures.

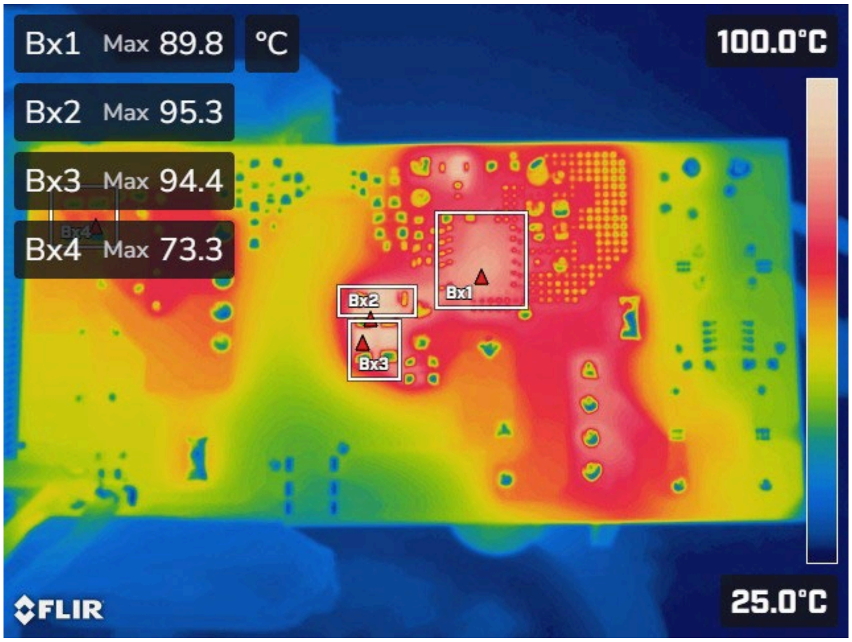


Figure 73 – 85 VAC 60 Hz. Thermals – Bottom Side.

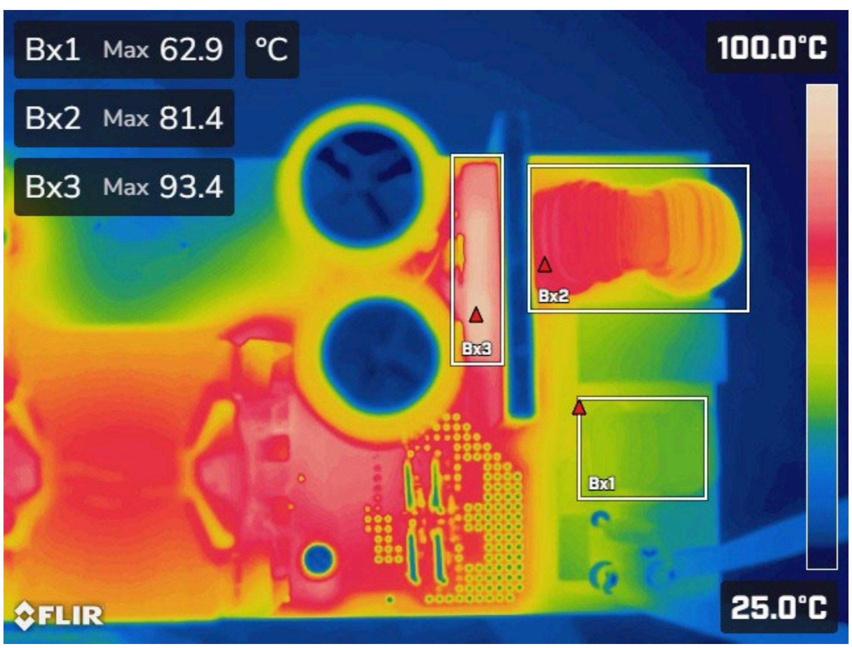


Figure 74 – 85 VAC 60 Hz. Thermals – Top Side - Input Filter.

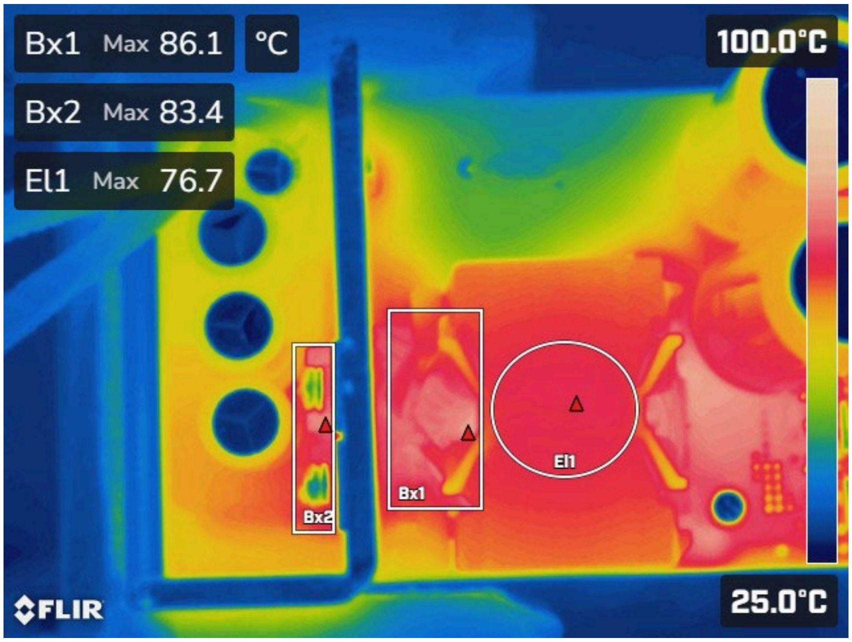


Figure 75 – 85 VAC 60 Hz. Thermals – Top Side – Transformer and Output Rectifier.

Component		Actual Temperature	Projected temperature at maximum 40 °C Ambient (°C)
	Ambient	35.2	40
U2	TOP7078K	89.8	94.6
D1	Primary Snubber Diode	95.3	100.1
R6 & R7	Primary Snubber Resistor	94.4	99.2
BR1	Bridge Rectifier	93.4	98.2
L1	CMC 1	62.9	67.7
L2	CMC 2	81.4	86.2
T1	Transformer Core	76.7	81.5
T1	Transformer Winding	86.1	90.9
D5 & D6	Output Rectifier	83.4	88.2
R10 & R11	Secondary Snubber Resistor	73.3	78.1

12.1.2 265 VAC Full Load at Room Ambient

Test result after 2 hours running continuously inside an enclosure at 265 VAC full load using FLIR thermal camera to measure component temperatures.

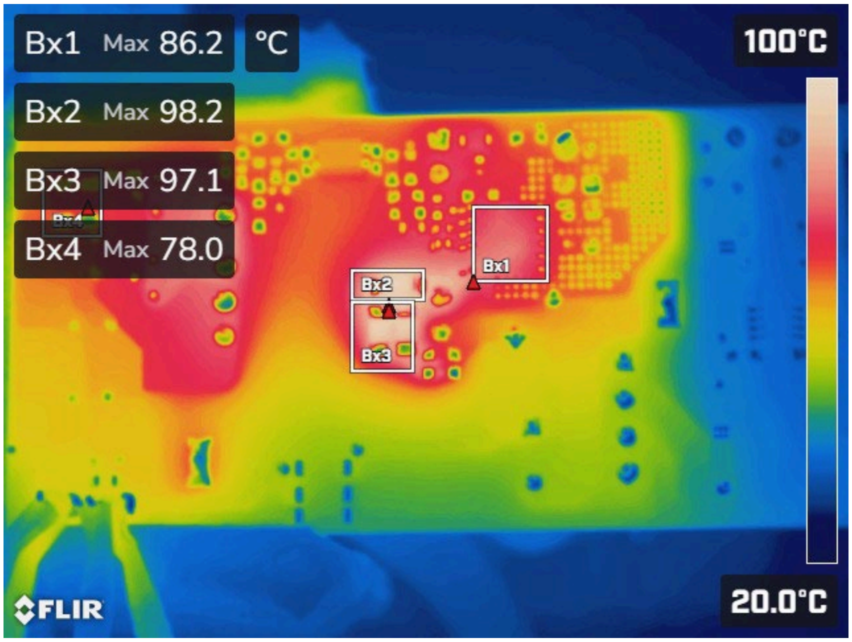


Figure 76 – 265 VAC 50 Hz. Thermals – Bottom Side.

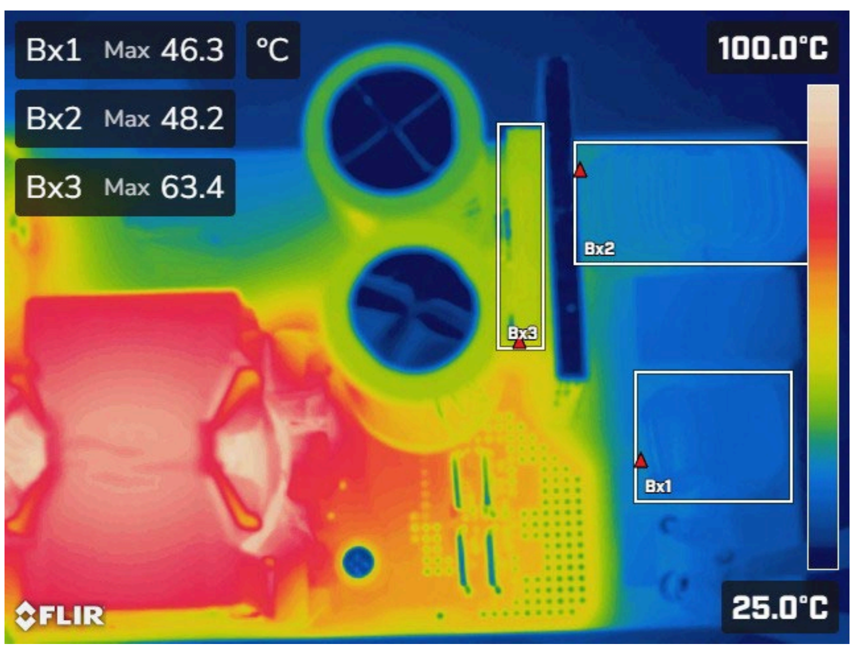


Figure 77 – 265 VAC 50 Hz. Thermals – Top Side - Input Filter.

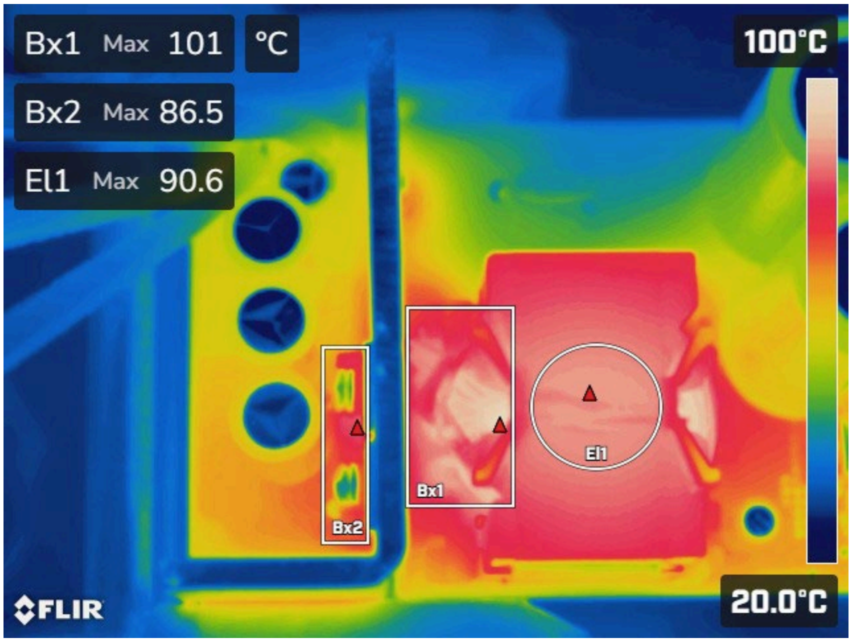


Figure 78 – 265 VAC 50 Hz. Thermals – Top Side – Transformer and Output Rectifier.

Component		Actual Temperature	Projected temperature at maximum 40 °C Ambient (°C)
	Ambient	33.5	40
U2	TOP7078K	86.2	92.7
D1	Primary Snubber Diode	98.2	104.7
R6 & R7	Primary Snubber Resistor	97.1	103.6
BR1	Bridge Rectifier	63.4	69.9
L1	CMC 1	46.3	52.8
L2	CMC 2	48.2	54.7
T1	Transformer Core	90.6	97.1
T1	Transformer Winding	101	107.5
D5 & D6	Output Rectifier	86.5	93
R10 & R11	Secondary Snubber Resistor	78.0	84.5

12.2 Thermal Performance at 40 °C Ambient

12.2.1 85 VAC Full Load at 40 °C Ambient

Test result after 60 mins running continuously inside thermal chamber at 85 VAC full load using thermocouple to measure component temperatures.

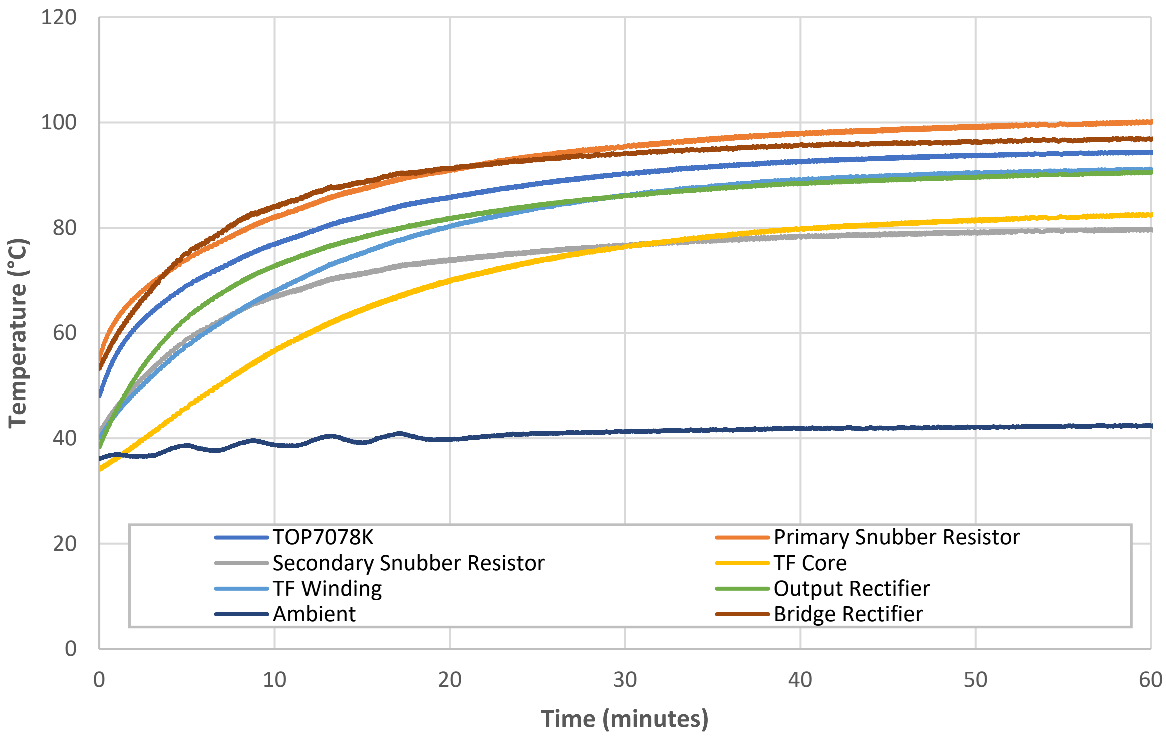


Figure 79 – 85 VAC 60 Hz Component Thermals.

Component	Temperature (°C)
TOP7078K	94.8
Primary Snubber Resistor	101
Secondary Snubber Resistor	80.1
TF Core	83.3
TF Winding	91.5
Output Rectifier	91.2
Bridge Rectifier	97.4
Ambient	42.7

12.2.2 265 VAC Full Load at 40 °C Ambient

Test result after 60 mins running continuously inside thermal chamber at 265 VAC full load using thermocouple to measure component temperatures.

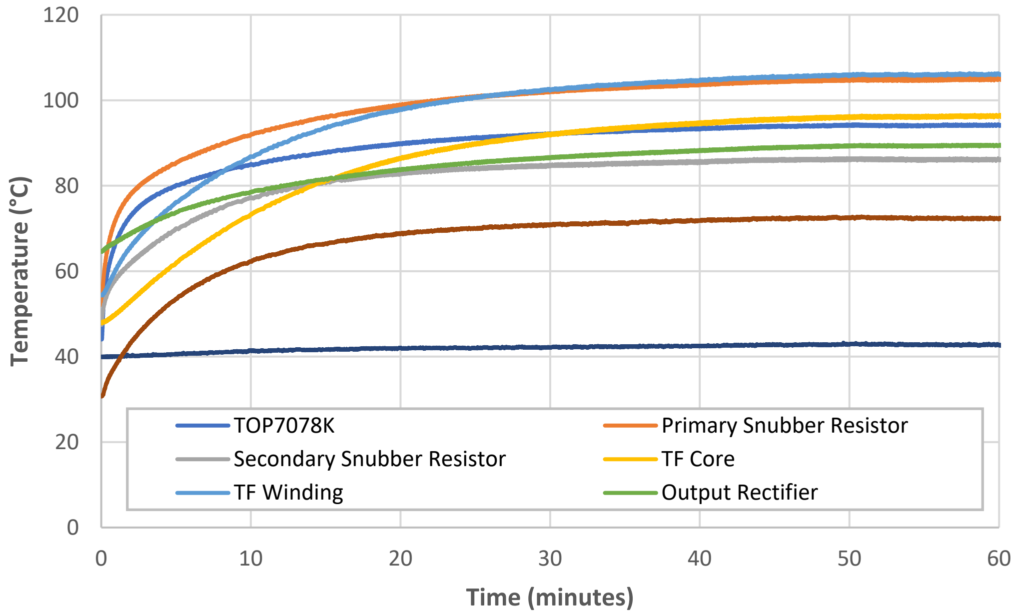


Figure 80 – 265 VAC 50 Hz Component Thermals.

Component	Temperature (°C)
TOP7078K	91.2
Primary Snubber Resistor	105
Secondary Snubber Resistor	85.9
TF Core	96.5
TF Winding	106
Output Rectifier	94.5
Bridge Rectifier	72.4
Ambient	42.8

13 Fault Protection

13.1 Output Overvoltage Protection

To trigger Output OVP, lower feedback resistor (R16) is shorted.

13.1.1 OVP during Start-Up Condition

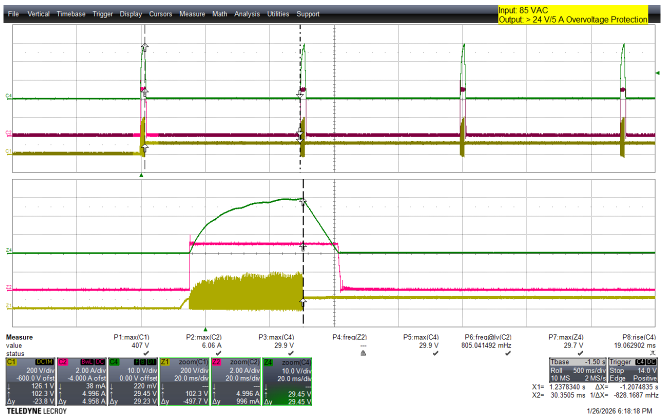


Figure 81 – 85 VAC, Full Load – OVP during startup condition.
CH1: TOP7078K_V_{DS}, 200 V / div., 500 ms / div.
CH2: I_{OUT}, 2 A / div., 500 ms / div.
CH3: V_{OUT}, 10 V / div., 500 ms / div.
Zoom: 20 ms/div.
Maximum Output Voltage = 29.9 V.

Figure 82 – 265 VAC, Full Load – OVP during startup condition.
CH1: TOP7078K_V_{DS}, 200 V / div., 500 ms / div.
CH2: I_{OUT}, 2 A / div., 500 ms / div.
CH3: V_{OUT}, 10 V / div., 500 ms / div.
Zoom: 20 ms/div.
Maximum Output Voltage = 29.8 V.

Figure 83 – 85 VAC, No Load – OVP during startup condition.
CH1: TOP7078K_V_{DS}, 200 V / div., 500 ms / div.
CH2: I_{OUT}, 2 A / div., 500 ms / div.
CH3: V_{OUT}, 10 V / div., 500 ms / div.
Zoom: 20 ms/div.
Maximum Output Voltage = 31.0 V.

Figure 84 – 265 VAC, No Load – OVP during startup condition.
CH1: TOP7078K_V_{DS}, 200 V / div., 500 ms / div.
CH2: I_{OUT}, 2 A / div., 500 ms / div.
CH3: V_{OUT}, 10 V / div., 500 ms / div.
Zoom: 20 ms/div.
Maximum Output Voltage = 30.9 V.

13.1.2 OVP during Normal Condition

Figure 85 – 85 VAC, Full Load – OVP during normal condition.
CH1: TOP7078K_V_{DS}, 200 V / div., 500 ms / div.
CH2: I_{OUT}, 2 A / div., 500 ms / div.
CH3: V_{OUT}, 10 V / div., 500 ms / div.
Zoom: 20 ms/div.
Maximum Output Voltage = 29.8 V.

Figure 86 – 265 VAC, Full Load – OVP during normal condition.
CH1: TOP7078K_V_{DS}, 200 V / div., 500 ms / div.
CH2: I_{OUT}, 2 A / div., 500 ms / div.
CH3: V_{OUT}, 10 V / div., 500 ms / div.
Zoom: 20 ms/div.
Maximum Output Voltage = 29.6 V.

Figure 87 – 85 VAC, No Load – OVP during normal condition.
CH1: TOP7078K_V_{DS}, 200 V / div., 500 ms / div.
CH2: I_{OUT}, 2 A / div., 500 ms / div.
CH3: V_{OUT}, 10 V / div., 500 ms / div.
Zoom: 20 ms/div.
Maximum Output Voltage = 31.0 V.

Figure 88 – 265 VAC, No Load – OVP during normal condition.
CH1: TOP7078K_V_{DS}, 200 V / div., 500 ms / div.
CH2: I_{OUT}, 2 A / div., 500 ms / div.
CH3: V_{OUT}, 10 V / div., 500 ms / div.
Zoom: 20 ms/div.
Maximum Output Voltage = 30.9 V.

13.2 Output Short-Circuit Protection

To trigger Output OVP, Output Capacitor (C16) is shorted.

13.2.1 Output Short Circuit during Start-Up Condition

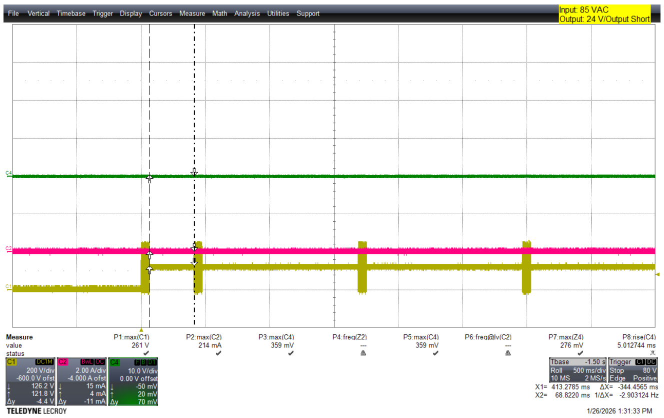


Figure 89 – 85 VAC, Full Load – Output short circuit during startup condition.
CH1: TOP7078K_V_{DS}, 200 V / div., 500 ms / div.
CH2: I_{OUT}, 2 A / div., 500 ms / div.
CH3: V_{OUT}, 10V / div., 500 ms / div.
Maximum TOP7078K_V_{DS} = 261 V.

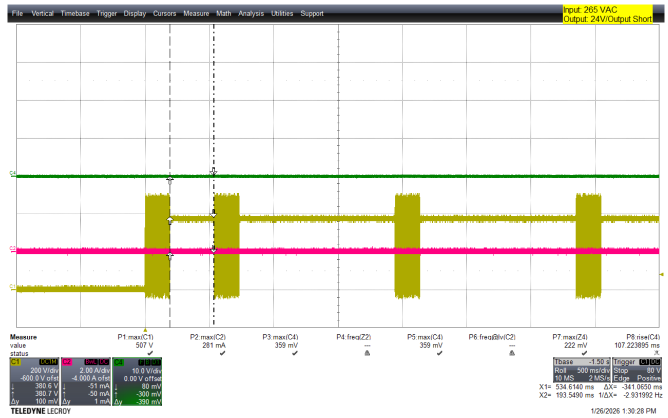


Figure 90 – 265 VAC, Full Load – Output short circuit during startup condition.
CH1: TOP7078K_V_{DS}, 200 V / div., 500 ms / div.
CH2: I_{OUT}, 2 A / div., 500 ms / div.
CH3: V_{OUT}, 10V / div., 500 ms / div.
Maximum TOP7078K_V_{DS} = 507 V. (89% derating).

13.2.2 Output Short Circuit during Normal Condition

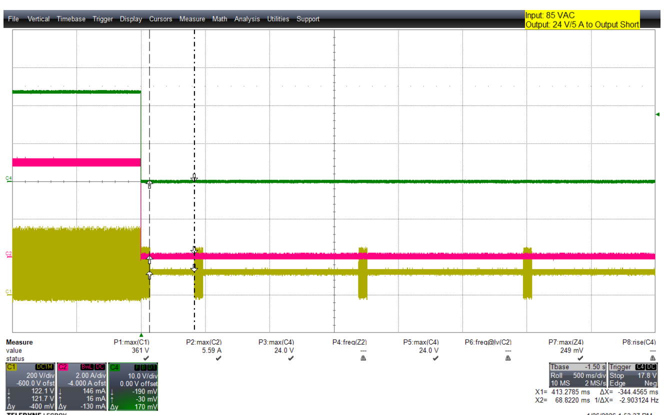


Figure 91 – 85 VAC, Full Load – Output Short circuit during normal condition.
CH1: TOP7078k_V_{DS}, 200 V / div., 500 ms / div.
CH2: I_{OUT}, 2 A / div., 500 ms / div.
CH3: V_{OUT}, 20V / div., 500 ms / div.
Maximum TOP7078K_V_{DS} = 361 V.

Figure 92 – 265 VAC, Full Load – Output Short circuit during normal condition.
CH1: TOP7078k_V_{DS}, 200 V / div., 500 ms / div.
CH2: I_{OUT}, 2 A / div., 500 ms / div.
CH3: V_{OUT}, 20V / div., 500 ms / div.
Maximum TOP7078K_V_{DS} = 640 V. (80% derating)

Figure 93 – 85 VAC, No Load – Output short circuit during normal condition.

CH1: TOP7078k_V_{DS}, 200 V / div., 500 ms / div.
CH2: I_{OUT}, 2 A / div., 500 ms / div.
CH3: V_{OUT}, 20V / div., 500 ms / div.
Maximum TOP7078K_V_{DS} = 321 V.

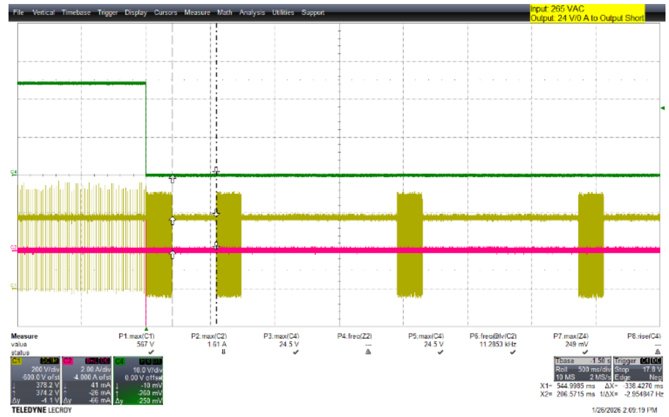


Figure 94 – 265 VAC, No Load – Output short circuit during normal condition.

CH1: TOP7078k_V_{DS}, 200 V / div., 500 ms / div.
CH2: I_{OUT}, 2 A / div., 500 ms / div.
CH3: V_{OUT}, 20V / div., 500 ms / div.
Maximum TOP7078K_V_{DS} = 567 V. (70.9% derating)

13.3 Overtemperature Protection

The unit was placed inside the thermal chamber and ambient temperature was increased to trigger over-temperature conditions and then decreased for thermal recovery. IC case temperature was measured using thermocouple.

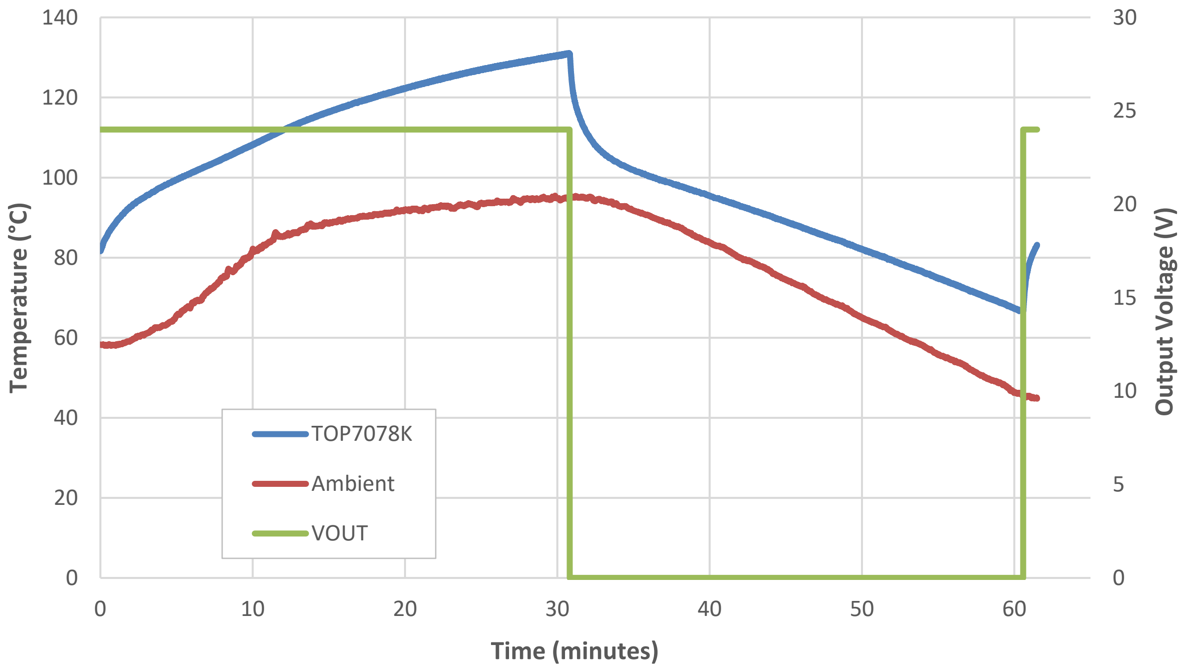


Figure 95 – 85 VAC Full Load OTP.

OTP Temperature	131 °C
Recovery Temperature	66.5 °C
Hysteresis	64.5 °C

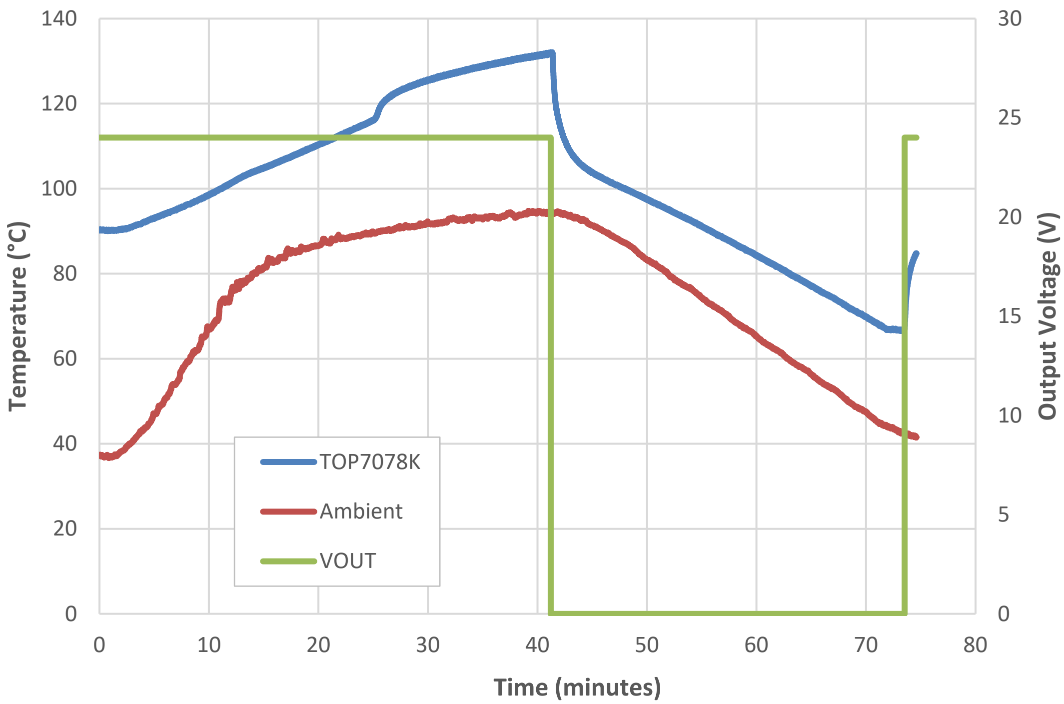


Figure 96 – 265 VAC Full Load OTP.

OTP Temperature	132 °C
Recovery Temperature	66.9 °C
Hysteresis	65.1 °C

14 Conducted EMI

Conducted emissions tests were performed at 115 VAC and 230 VAC at full load (24 V, 5 A). Measurements were taken with floating ground.

14.1 Test Set-up Equipment

14.1.1 Equipment and Load Used

1. Rohde and Schwarz ENV216 two-line V-network.
2. Rohde and Schwarz ESRP EMI test receiver.
3. Input voltage set at 115 VAC and 230 VAC.
4. 24 V R_{LOAD} resistance is 4.8 Ohms.

14.2 Output Float

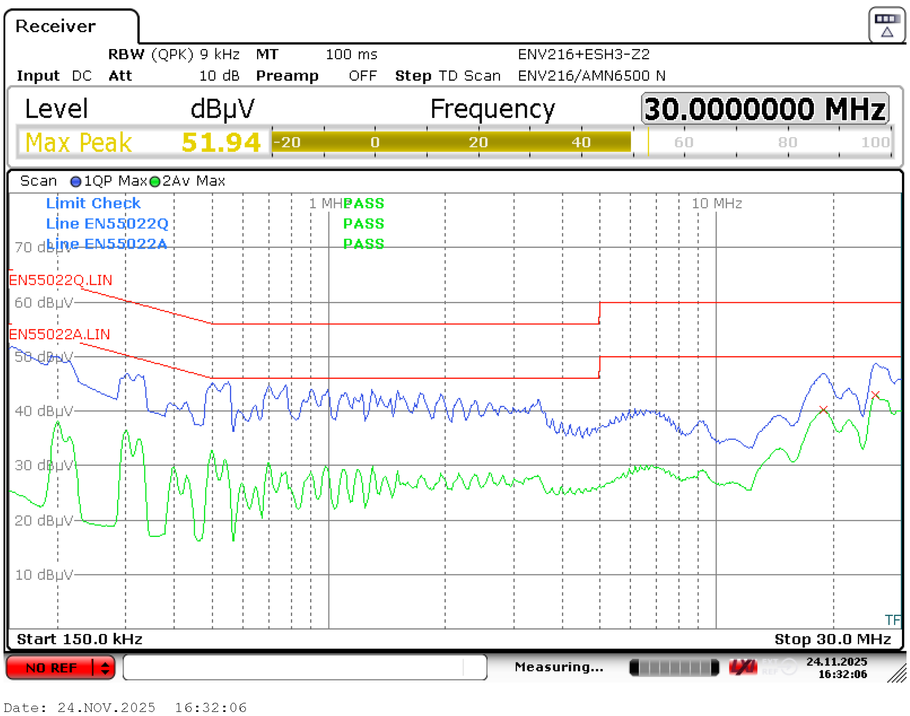


Figure 97 – 115 VAC 60 Hz.
Line / Neutral - Floating

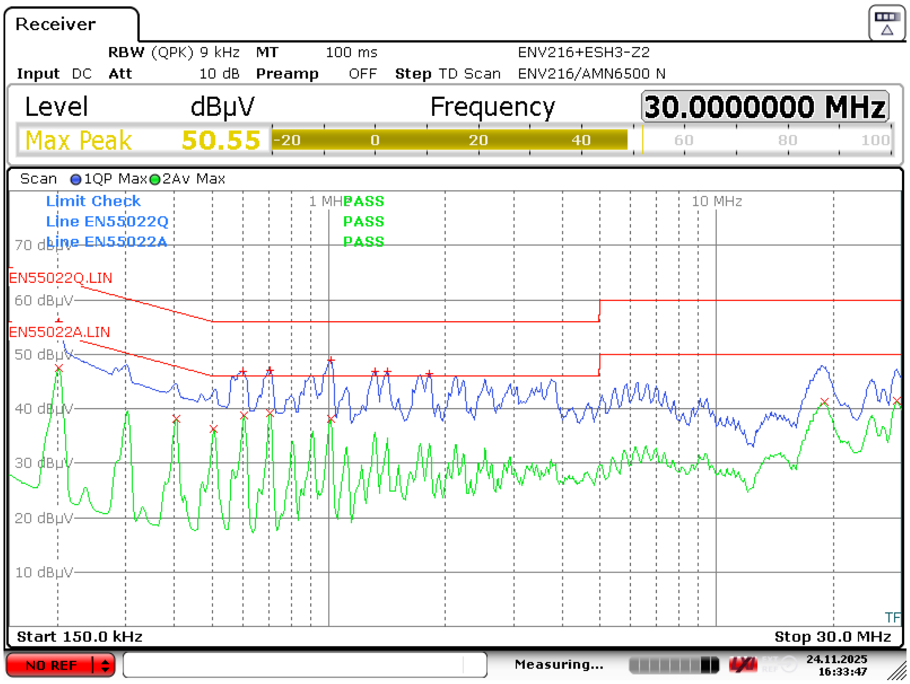


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Figure 98 – 230 VAC 50 Hz.
Line / Neutral - Floating

15 ESD

All ESD strikes were applied at PCB end with 115 and 230 VAC input voltage and full load.

Input: 115 VAC, Output: 24 V/4.8 Ω Full Load

Passed ±8.8 kV contact discharge

Contact Discharge Voltage (kV)	Applied to	Number of Strikes	Test Result
+8.8	24 V	10	PASS
-8.8	24 V	10	PASS
+8.8	GND	10	PASS
-8.8	GND	10	PASS

Note: In all PASS results, power supply was still functional after the test.

Passed ±16.5 kV air discharge

Air Discharge Voltage (kV)	Applied to	Number of Strikes	Test Result
+16.5	24 V	10	PASS
-16.5	24 V	10	PASS
+16.5	GND	10	PASS
-16.5	GND	10	PASS

Note: In all PASS results, power supply was still functional after the test.

Input: 230 VAC, Output: 24 V/4.8 Ω Full Load

Passed ±8.8 kV contact discharge.

Contact Discharge Voltage (kV)	Applied to	Number of Strikes	Test Result
+8.8	24 V	10	PASS
-8.8	24 V	10	PASS
+8.8	GND	10	PASS
-8.8	GND	10	PASS

Note: In all PASS results, power supply was still functional after the test.

Passed ±16.5 kV air discharge.

Air Discharge Voltage (kV)	Applied to	Number of Strikes	Test Result
+16.5	24 V	10	PASS
-16.5	24 V	10	PASS
+16.5	GND	10	PASS
-16.5	GND	10	PASS

Note: In all PASS results, power supply was still functional after the test.

16 Combination Wave (Differential Mode)

Tested at 115 and 230 VAC input voltage and full load

Input: 115 VAC, Output: 24 V/4.8 Ω Full Load

Passed 2 kV Differential Mode Combination Surge Event

Surge Voltage	Phase Angle	IEC Coupling	Generator Impedance	Number of Strikes	Results
+2000 V	0°	L, N	2 Ω	10	PASS
–2000 V	0°	L, N	2 Ω	10	PASS
+2000 V	90°	L, N	2 Ω	10	PASS
–2000 V	90°	L, N	2 Ω	10	PASS
+2000 V	180°	L, N	2 Ω	10	PASS
–2000 V	180°	L, N	2 Ω	10	PASS
+2000 V	270°	L, N	2 Ω	10	PASS
–2000 V	270°	L, N	2 Ω	10	PASS

Input: 230 VAC, Output: 24 V/4.8 Ω Full Load

Passed 2 kV Differential Mode Combination Surge Event

Surge Voltage	Phase Angle	IEC Coupling	Generator Impedance	Number of Strikes	Results
+2000 V	0°	L, N	2 Ω	10	PASS
–2000 V	0°	L, N	2 Ω	10	PASS
+2000 V	90°	L, N	2 Ω	10	PASS
–2000 V	90°	L, N	2 Ω	10	PASS
+2000 V	180°	L, N	2 Ω	10	PASS
–2000 V	180°	L, N	2 Ω	10	PASS
+2000 V	270°	L, N	2 Ω	10	PASS
–2000 V	270°	L, N	2 Ω	10	PASS

17 Ring Wave (Common Mode)

Tested at 115 VAC and 230 VAC input voltage and full load

Input: 115 VAC, Output: 24 V/4.8 Ω Full Load

Passed 6 kV Common Mode Ring Wave Surge Event

Surge Voltage	Phase Angle	IEC Coupling	Generator Impedance	Number of Strikes	Results
+6000 V	0°	L/N - PE	12	10	PASS
–6000 V	0°	L/N - PE	12	10	PASS
+6000 V	90°	L/N - PE	12	10	PASS
–6000 V	90°	L/N - PE	12	10	PASS
+6000 V	180°	L/N - PE	12	10	PASS
–6000 V	180°	L/N - PE	12	10	PASS
+6000 V	270°	L/N - PE	12	10	PASS
–6000 V	270°	L/N - PE	12	10	PASS

Input: 230 VAC, Output: 24 V/4.8 Ω Full Load

Passed 6 kV Common Mode Ring Wave Surge Event

Surge Voltage	Phase Angle	IEC Coupling	Generator Impedance	Number of Strikes	Results
+6000 V	0°	L/N - PE	12	10	PASS
–6000 V	0°	L/N - PE	12	10	PASS
+6000 V	90°	L/N - PE	12	10	PASS
–6000 V	90°	L/N - PE	12	10	PASS
+6000 V	180°	L/N - PE	12	10	PASS
–6000 V	180°	L/N - PE	12	10	PASS
+6000 V	270°	L/N - PE	12	10	PASS
–6000 V	270°	L/N - PE	12	10	PASS

18 EFT

Tested at 115 VAC & VAC Input Voltage and Full Load

Input: 115 VAC, Output: 24 V/4.8 Ω Full Load

Passed 4 kV EFT Event

Surge Voltage	Injection Phase	Frequency	T-Burst	T-Rep	Test Duration	Injection Location	Remarks
+4000 V	0°	5 kHz	15 ms	300 ms	120 s	L1/L2	Pass
–4000 V	0°	5 kHz	15 ms	300 ms	120 s	L1/L2	Pass
+4000 V	0°	100 kHz	750 μs	300 ms	120 s	L1/L2	Pass
–4000 V	0°	100 kHz	750 μs	300 ms	120 s	L1/L2	Pass
+4000 V	90°	5 kHz	15 ms	300 ms	120 s	L1/L2	Pass
–4000 V	90°	5 kHz	15 ms	300 ms	120 s	L1/L2	Pass
+4000 V	90°	100 kHz	750 μs	300 ms	120 s	L1/L2	Pass
–4000 V	90°	100 kHz	750 μs	300 ms	120 s	L1/L2	Pass
+4000 V	180°	5 kHz	15 ms	300 ms	120 s	L1/L2	Pass
–4000 V	180°	5 kHz	15 ms	300 ms	120 s	L1/L2	Pass
+4000 V	180°	100 kHz	750 μs	300 ms	120 s	L1/L2	Pass
–4000 V	180°	100 kHz	750 μs	300 ms	120 s	L1/L2	Pass
+4000 V	270°	5 kHz	15 ms	300 ms	120 s	L1/L2	Pass
–4000 V	270°	5 kHz	15 ms	300 ms	120 s	L1/L2	Pass
+4000 V	270°	100 kHz	750 μs	300 ms	120 s	L1/L2	Pass
–4000 V	270°	100 kHz	750 μs	300 ms	120 s	L1/L2	Pass

Surge Voltage	Injection Phase	Frequency	T-Burst	T-Rep	Test Duration	Injection Location	Remarks
+4000 V	0°	5 kHz	15 ms	300 ms	120 s	L1/L2 - PE	Pass
–4000 V	0°	5 kHz	15 ms	300 ms	120 s	L1/L2 - PE	Pass
+4000 V	0°	100 kHz	750 µs	300 ms	120 s	L1/L2 - PE	Pass
–4000 V	0°	100 kHz	750 µs	300 ms	120 s	L1/L2 - PE	Pass
+4000 V	90°	5 kHz	15 ms	300 ms	120 s	L1/L2 - PE	Pass
–4000 V	90°	5 kHz	15 ms	300 ms	120 s	L1/L2 - PE	Pass
+4000 V	90°	100 kHz	750 µs	300 ms	120 s	L1/L2 - PE	Pass
–4000 V	90°	100 kHz	750 µs	300 ms	120 s	L1/L2 - PE	Pass
+4000 V	180°	5 kHz	15 ms	300 ms	120 s	L1/L2 - PE	Pass
–4000 V	180°	5 kHz	15 ms	300 ms	120 s	L1/L2 - PE	Pass
+4000 V	180°	100 kHz	750 µs	300 ms	120 s	L1/L2 - PE	Pass
–4000 V	180°	100 kHz	750 µs	300 ms	120 s	L1/L2 - PE	Pass
+4000 V	270°	5 kHz	15 ms	300 ms	120 s	L1/L2 - PE	Pass
–4000 V	270°	5 kHz	15 ms	300 ms	120 s	L1/L2 - PE	Pass
+4000 V	270°	100 kHz	750 µs	300 ms	120 s	L1/L2 - PE	Pass
–4000 V	270°	100 kHz	750 µs	300 ms	120 s	L1/L2 - PE	Pass

Input: 230 VAC, Output: 24 V/4.8 Ω Full Load

Passed 4 kV EFT Event

Surge Voltage	Injection Phase	Frequency	T-Burst	T-Rep	Test Duration	Injection Location	Remarks
+4000 V	0°	5 kHz	15 ms	300 ms	120 s	L1/L2	Pass
–4000 V	0°	5 kHz	15 ms	300 ms	120 s	L1/L2	Pass
+4000 V	0°	100 kHz	750 μs	300 ms	120 s	L1/L2	Pass
–4000 V	0°	100 kHz	750 μs	300 ms	120 s	L1/L2	Pass
+4000 V	90°	5 kHz	15 ms	300 ms	120 s	L1/L2	Pass
–4000 V	90°	5 kHz	15 ms	300 ms	120 s	L1/L2	Pass
+4000 V	90°	100 kHz	750 μs	300 ms	120 s	L1/L2	Pass
–4000 V	90°	100 kHz	750 μs	300 ms	120 s	L1/L2	Pass
+4000 V	180°	5 kHz	15 ms	300 ms	120 s	L1/L2	Pass
–4000 V	180°	5 kHz	15 ms	300 ms	120 s	L1/L2	Pass
+4000 V	180°	100 kHz	750 μs	300 ms	120 s	L1/L2	Pass
–4000 V	180°	100 kHz	750 μs	300 ms	120 s	L1/L2	Pass
+4000 V	270°	5 kHz	15 ms	300 ms	120 s	L1/L2	Pass
–4000 V	270°	5 kHz	15 ms	300 ms	120 s	L1/L2	Pass
+4000 V	270°	100 kHz	750 μs	300 ms	120 s	L1/L2	Pass
–4000 V	270°	100 kHz	750 μs	300 ms	120 s	L1/L2	Pass

Surge Voltage	Injection Phase	Frequency	T-Burst	T-Rep	Test Duration	Injection Location	Remarks
+4000 V	0°	5 kHz	15 ms	300 ms	120 s	L1/L2 - PE	Pass
–4000 V	0°	5 kHz	15 ms	300 ms	120 s	L1/L2 - PE	Pass
+4000 V	0°	100 kHz	750 μs	300 ms	120 s	L1/L2 - PE	Pass
–4000 V	0°	100 kHz	750 μs	300 ms	120 s	L1/L2 - PE	Pass
+4000 V	90°	5 kHz	15 ms	300 ms	120 s	L1/L2 - PE	Pass
–4000 V	90°	5 kHz	15 ms	300 ms	120 s	L1/L2 - PE	Pass
+4000 V	90°	100 kHz	750 μs	300 ms	120 s	L1/L2 - PE	Pass
–4000 V	90°	100 kHz	750 μs	300 ms	120 s	L1/L2 - PE	Pass
+4000 V	180°	5 kHz	15 ms	300 ms	120 s	L1/L2 - PE	Pass
–4000 V	180°	5 kHz	15 ms	300 ms	120 s	L1/L2 - PE	Pass
+4000 V	180°	100 kHz	750 μs	300 ms	120 s	L1/L2 - PE	Pass
–4000 V	180°	100 kHz	750 μs	300 ms	120 s	L1/L2 - PE	Pass
+4000 V	270°	5 kHz	15 ms	300 ms	120 s	L1/L2 - PE	Pass
–4000 V	270°	5 kHz	15 ms	300 ms	120 s	L1/L2 - PE	Pass
+4000 V	270°	100 kHz	750 μs	300 ms	120 s	L1/L2 - PE	Pass
–4000 V	270°	100 kHz	750 μs	300 ms	120 s	L1/L2 - PE	Pass

19 Revision History

Date	Author	Revision	Description and Changes	Reviewed
26-June-26	MA	A	Initial Release	Apps & Mktg.

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