| | |
|---|---|
| **Title** | *72 W Isolated Flyback Power Supply Using LinkSwitch™-HP LNK6779E* |
| **Specification** | 85 VAC – 265 VAC Input;<br>12 V / 6 A Output |
| **Application** | Appliance |
| **Author** | Applications Engineering Department |
| **Document Number** | DER-1036 |
| **Date** | July 11, 2025 |
| **Revision** | A |


**Summary and Features**

- Primary-side regulated isolated flyback converter with ±5% regulation (including estimated production and temperature variations)
- 132 kHz switching frequency for small transformer and output filter size
- 72 W output power
- Continuous Conduction Mode (CCM) at full load improves efficiency and reduces output capacitor ripple current
- <70 mW no-load input power at 230 VAC
- Multimode operation maximizes efficiency across load range
    - 86% full load efficiency @ 115 VAC and 87% full load efficiency @ 230 VAC
- Extensive protection features including over-temperature protection (OTP), brown-in/out, and lost-regulation (auto-restart)
- Class B Conducted EMI with > 6 db margin





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# Table of Contents

**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 report describes a flyback converter that provides an isolated nominal output voltage of 12 V at 6 A load from a wide input voltage range of 85 VAC to 265 VAC. This power supply utilizes the LNK6779E from the LinkSwitch-HP family of ICs.

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

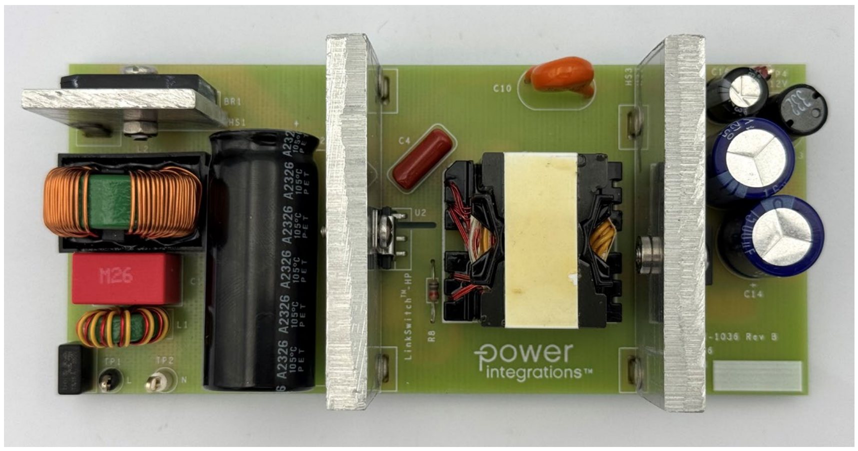



**Figure 1** – Populated Circuit Board, Top View.

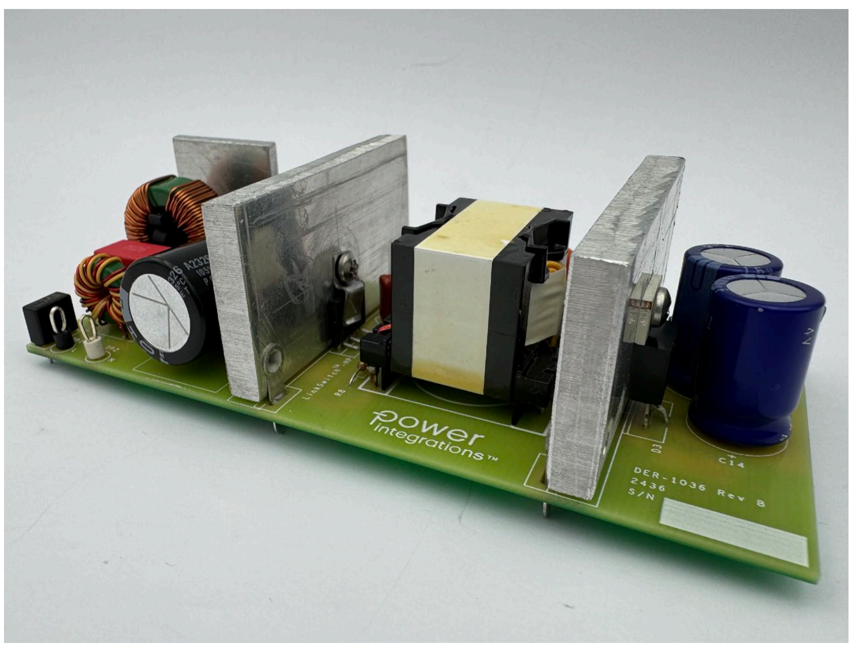



**Figure 2** – Populated Circuit Board, Side View.

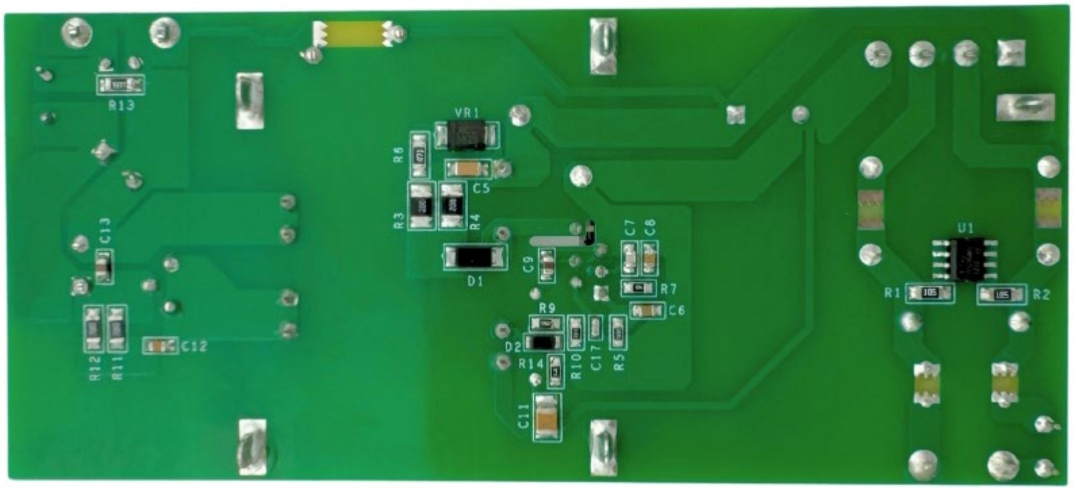



**Figure 3** – Populated Circuit Board, Bottom View.

# 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) | | | | 70 | mW | |
| **Output1** | | | | | | |
| Output Voltage | $V_{OUT1}$ | 11.4 | 12 | 12.6 | V | ± 5% |
| Output Ripple Voltage | $V_{RIPPLE1}$ | | | 150 | mV | 20 MHz Bandwidth. |
| Output Current | $I_{OUT1}$ | 0 | | 6 | A | |
| **Total Output Power** | | | | | | |
| Continuous Output Power | $P_{OUT}$ | 0 | | 72 | W | |
| **Efficiency** | | | | | | |
| Full Load 115Vac | $\eta_{115Vac}$ | 86 | | | % | Measured at $P_{OUT}$ 25 °C. |
| Full Load 230Vac | $\eta_{230Vac}$ | 87 | | | % | |
| Average efficiency at 25, 50, 75 and 100 % of $P_{OUT}$ | $\eta_{DOE}$ | 88 | | | % | Measured at Nominal Input 115 VAC and 230 VAC. |
| **Environmental** | | | | | | |
| Conducted EMI | | Meets CISPR22B / EN55022B | | | | |
| Surge (Differential) | | | | ±1 | kV | 1.2/50 μs Surge, IEC 61000-4-5 |
| Ring Wave (Common Mode) | | | | ±4 | kV | |
| Electrical Fast Transient | | | | ±4 | kV | |
| 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 Specifications.

# 3 Schematic

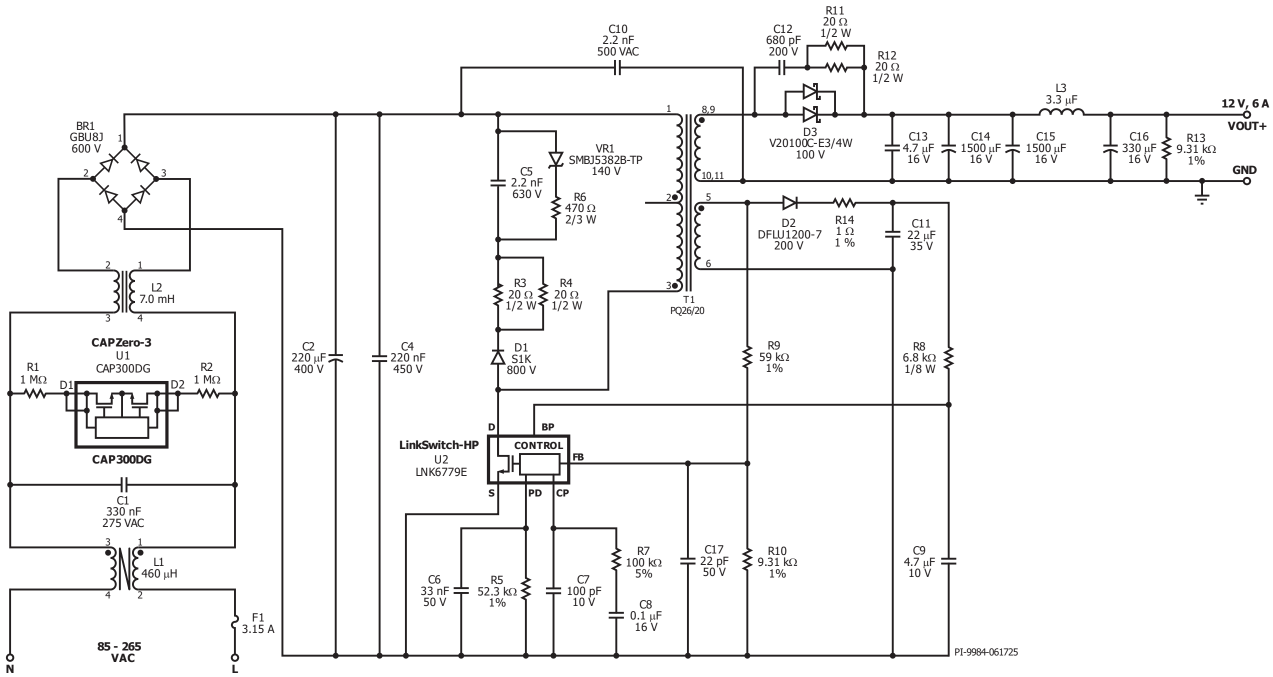



**Figure 4** – DER-1036 Schematic.

# 4 Circuit Description

The circuit shown in Figure 4 utilizes the LNK6779E device in a 12 V, 72 W isolated flyback power supply.

## 4.1 Input EMI Filtering and Rectification

Fuse F1 isolates the circuit and provides protection from component failure. X-capacitor C1 with common mode chokes L1 and L2 form an EMI filter that attenuates both common mode and differential mode conducted EMI. Resistors R1 and R2 together with the CAP300DG CAPZero™ IC (U1) discharge C1 when Alternating Current (AC) is removed. BR1 converts the AC line voltage into the DC voltage seen across bulk capacitor C2.

## 4.2 LinkSwitch-HP Primary

The LNK6779E device (U2) integrates an oscillator, error amplifier, multi-mode control circuit, start-up and protection circuitry, and a high-voltage power Metal-Oxide-Semiconductor Field-Effect Transistor (MOSFET) all in one monolithic integrated circuit (IC).

When AC is first applied, an internal current source connected to the DRAIN (D) pin charges C9 to power the controller inside the IC. During normal operation (steady-state), the device controller is powered via the bias winding through the current limiting resistor R8 to minimize losses.

At the start of a switching cycle, the internal power MOSFET turns on, allowing current through the primary winding to ramp to a threshold that is set by the output of the internal error amplifier pin voltage, which is presented on the compensation (CP) pin. Due to the phase orientation of the transformer windings, the freewheeling diode D3 is reverse biased at this point in the cycle. D3 only conducts when the internal power MOSFET is off, allowing the energy stored in the core of the transformer to be delivered to the output.

Capacitor C9 (4.7 μF) connected to the BYPASS (BP) pin sets over-temperature protection (OTP) to hysteretic mode, and overvoltage protection (OVP) and lost regulation protection to automatic-restart, AR, after a given off-period (typ. 1.5 s).

## 4.3 Primary RZCD Snubber

Diode D1, Zener Diode VR1, Capacitor C5 and Resistor R6 form a Resistor-Zener Capacitor Diode (RZCD) snubber circuit that is used to limit the voltage stress across the LinkSwitch-HP IC. Peak drain voltage is limited to less than 600 V providing significant margin to the 725 V drain voltage limit (Breakdown Voltage, Drain-Source at Zero Gate-Source Voltage, BVDSS). Zener diode VR1 prevents the capacitor C5 from fully discharging every switching cycle to reduce power consumption during standby operation. Resistors R3 and R4 damp drain oscillations for better output voltage regulation and reduced Electromagnetic Interference (EMI).

## 4.4 Output Rectification

Schottky diode D3 rectifies the 12 V secondary winding output of T1. The output voltage is filtered by C13, C14, C15, L3, and C16. Resistors R11 and R12 and capacitor C12 snub the voltage spike caused by the commutation of D3. Low Equivalent Series Resistance (ESR) capacitors C14 and C15 minimize output voltage ripple, while the post filter formed by L3 and C16 further attenuate noise and ripple. Resistor R13 acts as a preload to improve load regulation, especially at no load.

## 4.5 External Current Limit Setting

The maximum cycle-by-cycle current limit is set by the resistor R5 connected to the PROGRAM (PD) pin. A 52.3 kΩ resistor in the design sets the maximum current limit to 80% of the LNK6779E’s default current limit.

## 4.6 Output Feedback

The output voltage is indirectly sensed through the bias winding via a resistor divider (R9 and R10) and applied to the FEEDBACK (FB) pin voltage. This network is also used to indirectly monitor the bus voltage during start-up and enables output power delivery only when the input voltage reaches the brown-in threshold and stops when the input voltage is below brown-out level. If the bus voltage reaches excessive levels (e.g., caused by a line surge) the device stops switching. The cycle-by-cycle current limit is compensated over line to limit the power available in overload.

The voltage sensed at the FB pin produces a control voltage at the CP pin. Resistor R7 and capacitors C7 and C8 are used for control loop compensation. The peak primary current and the switching frequency are determined by the CP pin voltage.

# 5 PCB Layout

## 5.1 PCB Specification

- Layer: 1
- Board Thickness: 1.6 mm.
- Copper Thickness: 2 oz.
- Material: FR-4

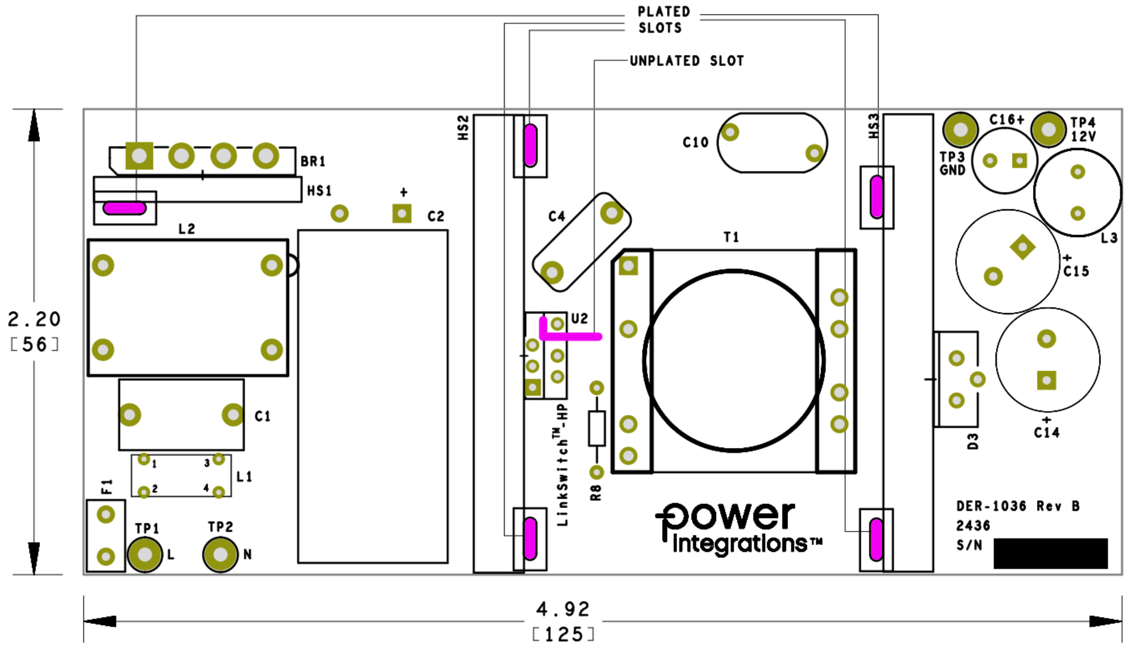



**Figure 5** – Printed Circuit Board, Top View.

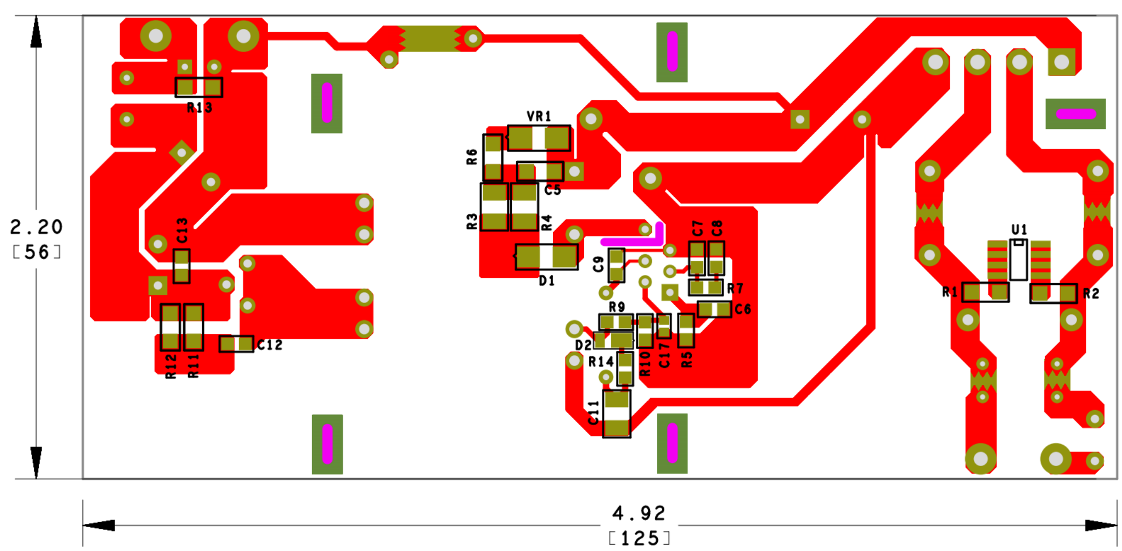



**Figure 6** – Printed Circuit Board, Bottom View.

# 6 Bill of Materials

## 6.1 Electrical BOM

| Item | Qty. | Reference Designator | Description | Mfr. Part Number | Manufacturer |
|---|---|---|---|---|---|
| 1 | 1 | BR1 | 600 V, 8 A, Bridge Rectifier, GBU Case | GBU8J-BP | Micro Commercial Co. |
| 2 | 1 | C1 | 330 nF, ±10%, 275 VAC, Polypropylene Film, X2, 15.00mm x 8.50mm | 890324024003CS | Wurth Electronics Inc. |
| 3 | 1 | C2 | 220 µF, 400 V, Electrolytic, General Purpose, (18 x 40) | 400HXW220MEFR18X40 | Rubycon |
| 4 | 1 | C4 | 220 nF, 450 V, Film | MEXXF32204JJ | Duratech |
| 5 | 1 | C5 | 2.2 nF, 630 V, Ceramic, X7R, 1206 | C3216X7R2J222K115AA | TDK Corp |
| 6 | 1 | C6 | 33 nF, 50 V, Ceramic, X7R, 0805 | CC0805KRX7R9BB333 | Yageo |
| 7 | 1 | C7 | 100 pF, ±10%, 10 V, Ceramic, X7R, 0805 (2012 Metric) | C0805C101K8RACAUTO | Kemet |
| 8 | 1 | C8 | 0.1 µF ±10% 16V Ceramic Capacitor X7R 0805 (2012 Metric) | C0805C104K4RECAUTO | KEMET |
| 9 | 1 | C9 | 4.7µF ±10% 10V Ceramic Capacitor X7R 0805 (2012 Metric) | LMK212B7475KGHT | Taiyo Yuden |
| 10 | 1 | C10 | 2200PF, ±20%, 500VAC (Y1),760VAC (X1), Ceramic, Y5U (E), RADIAL | 440LD22-R | Vishay |
| 11 | 1 | C11 | 22 µF, ±20%, 35V, Ceramic Capacitor X5R, 1210 (3225 Metric) | GMK325BJ226MM-P | Taiyo Yuden |
| 12 | 1 | C12 | 680 pF 200V X7R MULTI-LAYER CERAMIC +/- 10 % | C0805C681K2RACAUTO | Kemet |
| 13 | 1 | C13 | 4.7 µF, 16 V, Ceramic, X7R, 0805 (2012 Metric) | CL21B475KOFNNNE | Samsung Electro-Mechanics |
| 14 | 2 | C14 C15 | 1500 µF, 16 V, Electrolytic, Low ESR, 38 mOhm, (12.5 x 20) | ELXZ160ELL152MK20S | Nippon Chemi-Con |
| 15 | 1 | C16 | 330 µF, 16 V, Electrolytic, Very Low ESR, 72 mOhm, (8 x 11.5) | 16ZL330M8X11.5 | Rubycon |
| 16 | 1 | C17 | 22 pF, 50 V, Ceramic, NP0, 0603 | C1608C0G1H220J | TDK Corp |
| 17 | 1 | D1 | DIODE, GEN PURP, 800V, 1A, Standard Recovery >500ns, > 200mA (Io), SMA (DO-214AC) | S1K | ON Semiconductor |
| 18 | 1 | D2 | DIODE, UFAST, 200V, 1A, POWERDI123 | DFLU1200-7 | Diodes Inc |
| 19 | 1 | D3 | Diode Array, 1 Pair, Common Cathode, 100 V, 10A, Through Hole TO-220-3 | V20100C-E3/4W | Vishay Semiconductor Diodes Division |
| 20 | 1 | F1 | 3.15 A, 250V, Slow, RST | RST 3.15-BULK | Belfuse |
| 21 | 1 | L1 | 460 µH, Toroidal Common Mode Choke, 1.5 A, custom, DER-931, wound on 32-00315-00 core | 32-00416-00 | Power Integrations |
| 22 | 1 | L2 | 7.0 mH, 2.2 A, Common Mode Choke | 52705C | Murata |
| 23 | 1 | L3 | FIXED IND, 3.3uH, ±20%, 9.5A, 10 mOHM, TH, 10.5 mmD x 12 mmH | DR0810-332L | Coilcraft |
| 24 | 2 | R1 R2 | RES, 1.0 M, 5%, 2/3 W, Thick Film, 1206 | ERJ-P08J105V | Panasonic |
| 25 | 2 | R3 R4 | RES, 20 Ohm, ±5%, 0.5W, 1/2W, 1210 (3225 Metric), Thick Film | CRCW121020R0JNEA | Vishay Dale |
| 26 | 1 | R5 | RES, 52.3 k, 1%, 1/8 W, Thick Film, 0805 | ERJ-6ENF5232V | Panasonic |
| 27 | 1 | R6 | RES, 470 R, 5%, 2/3 W, Thick Film, 1206 | ERJ-P08J471V | Panasonic |
| 28 | 1 | R7 | RES, 100 k, 5%, 1/8 W, Thick Film, 0805 | ERJ-6GEYJ104V | Panasonic |
| 29 | 1 | R8 | RES, 6.8 k, 5%, 1/8 W, Carbon Film | CF18JT6K80 | Stackpole |
| 30 | 1 | R9 | RES, 59.0 k, 1%, 1/8 W, Thick Film, 0805 | ERJ-6ENF5902V | Panasonic |
| 31 | 1 | R10 | RES, 9.31 k, 1%, 1/8 W, Thick Film, 0805 | ERJ-6ENF9311V | Panasonic |
| 32 | 2 | R11 R12 | RES, 20 R, 1%, 1/2 W, Thin Film, 1206 | RNCP1206FTD20R0 | Stackpole Electronics |
| 33 | 1 | R13 | RES, 9.31 k, 1%, 1/4 W, Thick Film, 1206 | ERJ-8ENF9311V | Panasonic |
| 34 | 1 | R14 | RES, 1.00 R, 1%, 1/8W, 0805, Thick Film | RMCF0805FT1R00 | Stackpole Electronics Inc. |
| 35 | 1 | T1 | Bobbin, PQ26/20, Vertical, 12 pins | B65878E0012D001 | EPCOS (TDK) |

| | | | | | |
|---|---|---|---|---|---|
| 36 | 1 | U1 | CAPZero-3, CAP300DG, SO-8C | CAP300DG | Power Integrations |
| 37 | 1 | U2 | LinkSwitch-HP, LNK6779E, Esip-7C | LNK6779E | Power Integrations |
| 38 | 1 | VR1 | Zener Diode, 140 V, 5 W, ±5%, Surface Mount DO-214AA (SMB) | SMBJ5382B-TP | Micro Commercial Co |

**Table 2** – Electrical Bill of Materials.

## 6.2 Mechanical BOM

| Item | Qty. | Reference Designator | Description | Mfr. Part Number | Manufacturer |
|---|---|---|---|---|---|
| 1 | 1 | ESIP CLIP1 | Heatsink Hardware, Edge Clip, 12.40 mm x 6.50 mm | TRK-24 | Kang Tang Hardware Enterprise Co. Ltd. |
| 2 | 1 | HS1 | SHTM, Heat Sink, DER-1036_LinkSwitch_Heatsink | 61-00370-00 | Custom |
| 3 | 1 | HS2 | SHTM, Heat Sink, DER-1036_Bridge_Heatsink | 61-00371-00 | Custom |
| 4 | 1 | HS3 | SHTM, Heat Sink, DER-1036_SEC_Diode_Heatsink | 61-00372-00 | Custom |
| 5 | 3 | NUT1 NUT2 NUT3 | Nut, Hex, 4-40, 3/16W x 1/16 T, Stl Znc | 4CSHNZR | Olander Co. |
| 6 | 3 | RTV1 RTV2 RTV3 | Thermally conductive Silicone Grease | 120-SA | Wakefield |
| 7 | 3 | SCREW1 SCREW2 SCREW3 | SCREW MACHINE PHIL 4-40 X 3/8 SS | PMSSS 440 0038 PH | Building Fasteners |
| 8 | 5 | TE1 TE2 TE3 TE4 TE5 | Terminal, Eyelet, Tin Plated Brass, Zierick PN 190 | 190 | Zierick |
| 9 | 1 | WASHER1 | Washer, Lk, #4 SS | 4NSLWS | Olander Co. |
| 10 | 2 | TP1 TP3 | Test Point, BLK,THRU-HOLE MOUNT | 5011 | Keystone |
| 11 | 1 | TP2 | Test Point, WHT,THRU-HOLE MOUNT | 5012 | Keystone |
| 12 | 1 | TP4 | Test Point, RED,THRU-HOLE MOUNT | 5010 | Keystone |

**Table 3** – Mechanical Bill of Materials.

# 7 Transformer Specification

## 7.1 Electrical Diagram

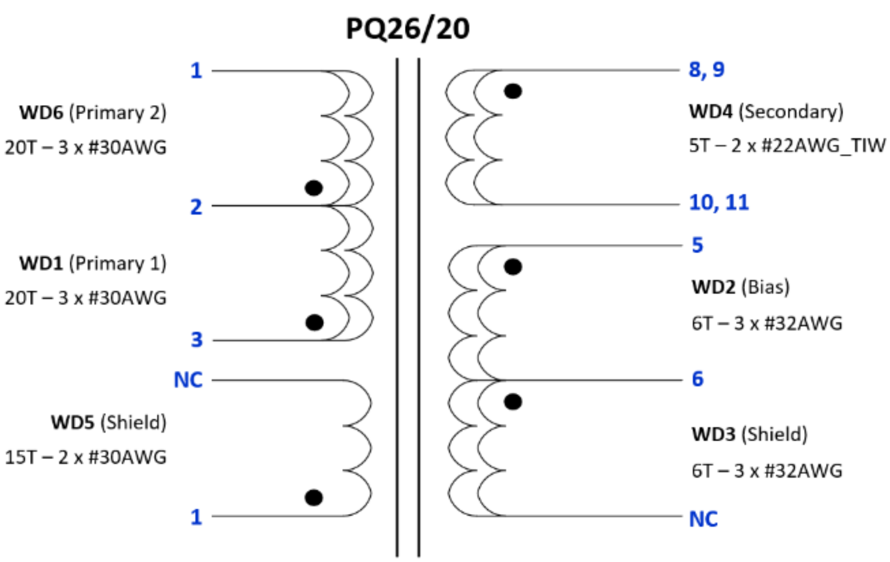



**Figure 7** – Transformer Electrical Diagram.

## 7.2 Electrical Specifications

| Parameter | Condition | Spec. |
|---|---|---|
| **Nominal Primary Inductance** | **Measured at 1 $V_{PK-PK}$, 100 kHz switching frequency, between pin 1 and pin 3 with all other windings open.** | **519 μH** |
| **Tolerance** | **Tolerance of Primary Inductance.** | **±5%** |
| **Leakage Inductance** | **Measured across primary winding with all other windings shorted.** | **< 10.39 μH** |

**Table 4** – Electrical Specifications.

## 7.3 Material List

| Item | Description |
|---|---|
| **[1]** | Core: PQ26/20, TDK-PC95, gapped for ALG of 325 nH/T^2. |
| **[2]** | Bobbin: PQ26/20, Vertical, 12 pins (6/6), TDK; or Equivalent. |
| **[3]** | Magnet Wire: #30 AWG. |
| **[4]** | Magnet Wire: #32 AWG. |
| **[5]** | TIW Wire: #22 AWG. |
| **[6]** | Polyester Tape: 10 mm. |
| **[7]** | Polyester Tape: 11.5 mm. |
| **[8]** | Varnish: Dolph BC 359; or Equivalent. |

**Table 5** – Material List.

## 7.4 Transformer Build Diagram

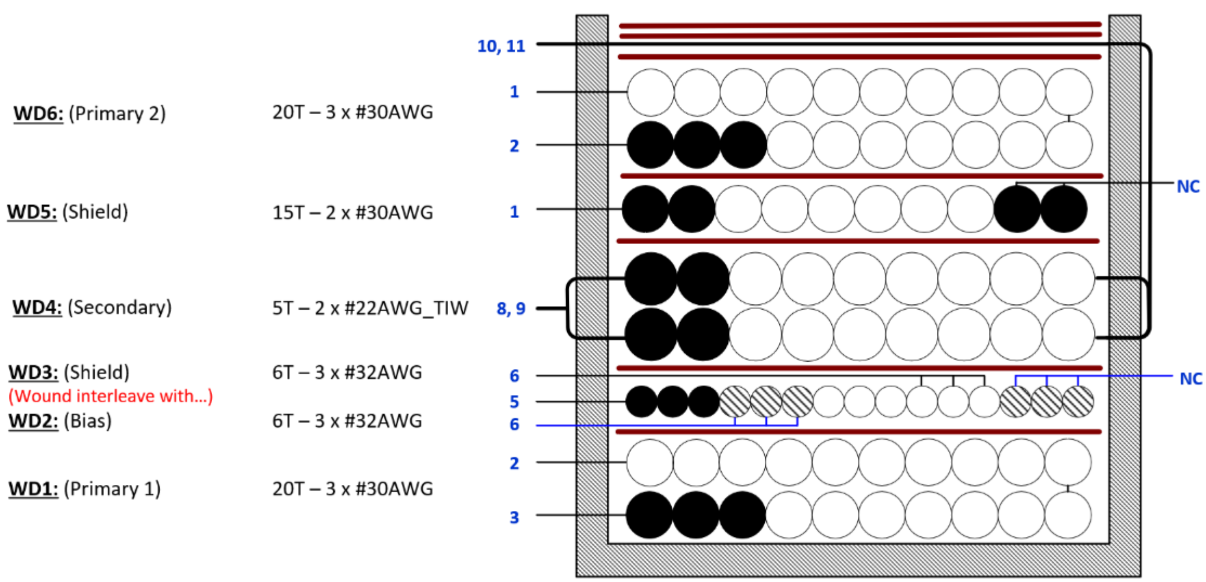


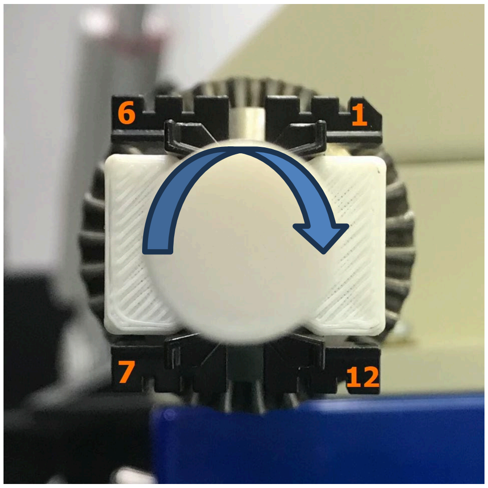
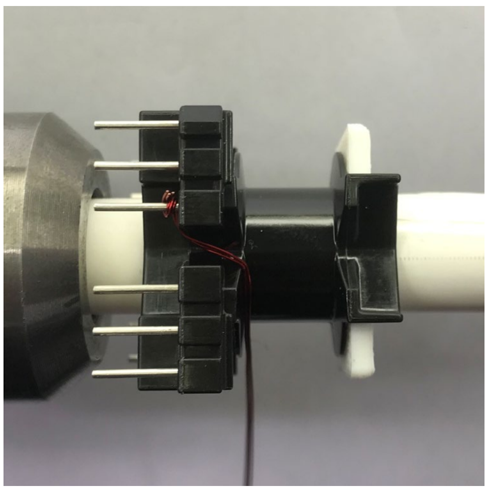
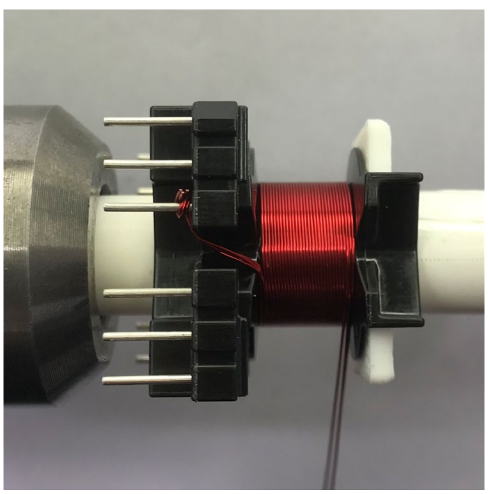

**Figure 8** – Transformer Build Diagram.

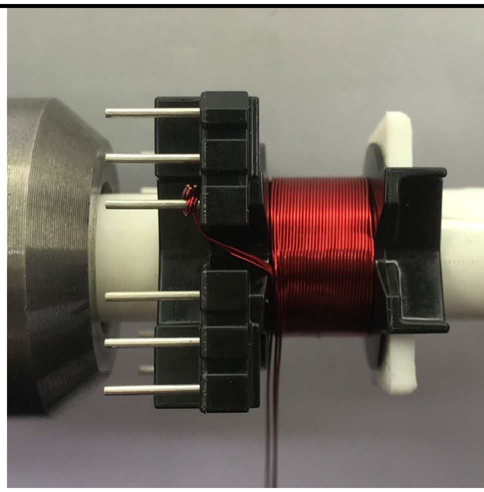
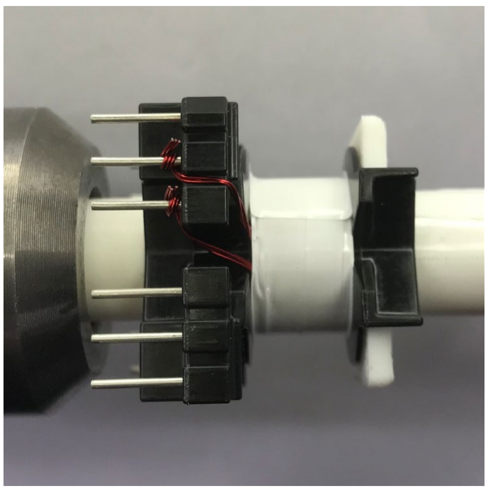
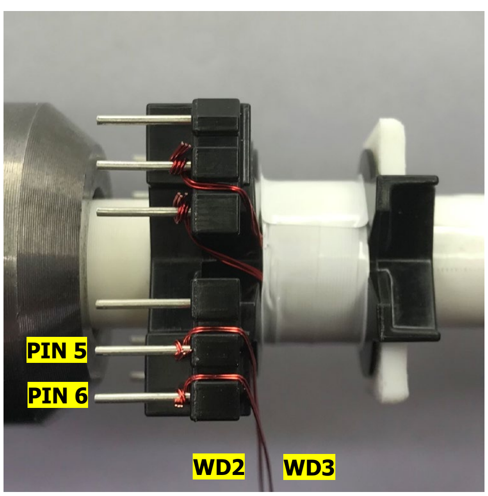
## 7.5 Transformer Instructions

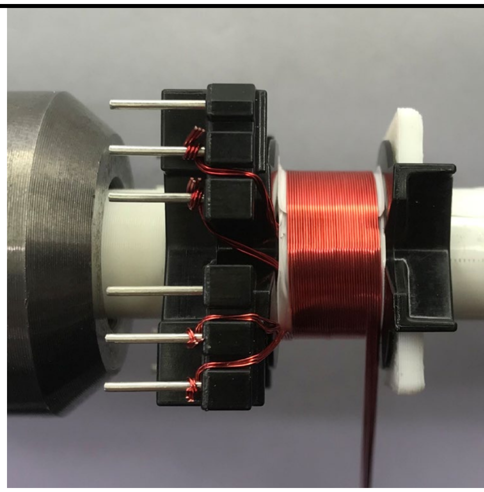
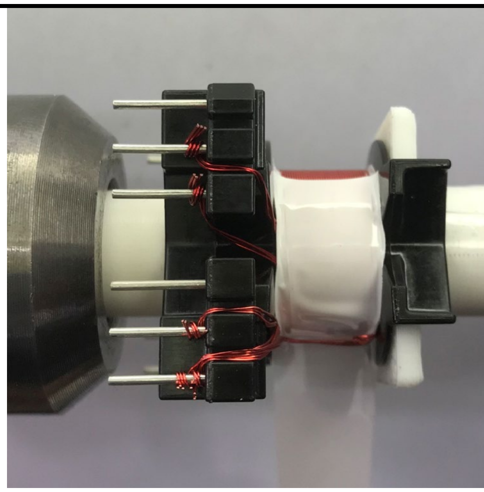
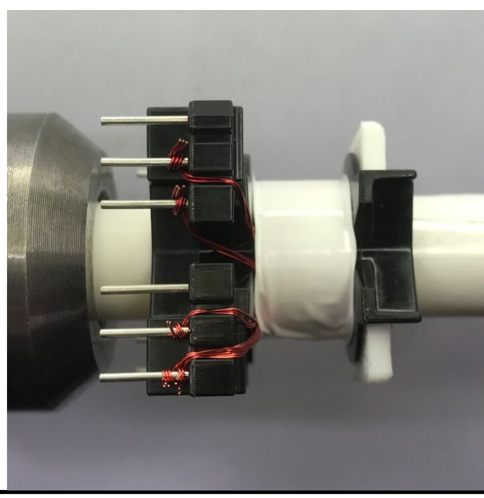
| | |
|---|---|
| **WD1 1st Primary** | Place the bobbin Item [2] such that pins 1-6 are on upper side while 7-12 are on lower side. The notch on the bobbin signifies Pin 1. Winding direction is clockwise as shown. Prepare 3 strands of wire Item [3]. Start at pin 3, wind 10 turns of wire Item [3] for the first layer from left to right. Wind the other 10 turns for the second layer from right to left. Finish WD1 at pin 2. |
| **Insulation** | Apply 1 layer of tape Item [6] for insulation. Wrap the tape to cover WD1. |
| **WD2 & WD3 Bias and Shield** | Prepare 6 strands of wire Item [4] for WD2 and WD3. Start WD2 at pin 5 with 3 strands and WD3 at pin 6 with another 3 strands. Mark the end of WD2 to avoid confusion. Position WD2 first and followed by WD3. Wind all the wires together for 6 turns from left to right. |
| **Insulation** | Apply 1 layer of tape Item [6] for insulation and to hold wires in place. Finish WD2 at Pin 6. Bend the end of WD3 90 degrees, cut as shown and leave it floating. Finish wrapping the tape to cover both WD2 and WD3. |
| **WD4 Secondary** | Prepare 4 strands of wire Item [5]. Start by fixing the first 2 strands of wire Item [5] on the left side and fixing it with tape. Wind the first 2 strands of wire 5 turns from left to right. Set aside the remaining wire on the right side and fix it with tape. Place the second 2 strands of wire above the first layer. Wind the second 2 strands of wire above the first layer 5 turns from left to right. Set aside the remaining wire on the right side and fix it with tape. |
| **Insulation** | Use 1 layer of tape Item [6] for insulation. |
| **WD5 Shield** | Prepare 3 strands of wire Item [3]. Start at pin 1, wind 15 turns of wire Item [3] in 1 layer from left to right. |
| **Insulation** | Apply 1 layer of tape Item [6] for insulation and to hold wires in place. Bend the end of WD5 90 degrees, cut as shown and leave it floating. Finish wrapping the tape to cover WD5. |
| **WD6 2nd Primary** | Prepare 3 strands of wire Item [3]. Start at pin 2, wind 10 turns of wire Item [3] for the first layer from left to right. Wind the other 10 turns for the second layer from right to left. Finish WD6 at pin 1. |
| **Insulation** | Apply 1 layer of tape Item [6] for insulation. Wrap the tape to cover WD6. |
| **WD4 Continuation** | Bend the wires from WD4 that are floating at the right side for 180 degrees, placing it beside pins 7-12. Apply 2 layers of tape Item [6] for insulation. Wrap the tape to cover WD4. To finish WD4, bend the wires from the lower side and terminate at pins 8-9 and bend wires from the upper side and terminate at pins 10-11. |
| **Insulation** | Apply 2 layers of tape Item [6] for insulation. Wrap the tape to cover WD4. To finish WD4, bend the wires from the lower side to finish winding at pins 8-9 and wires from the upper side to finish winding at pins 10-11. |
| **Assembly** | Grind the center leg of the upper half of Item [1] to get 519 µH measured between Pin 1 and Pin 3 with all other pins open. Wrap the body of transformer with 2 layers of tape Item [7]. Measure Primary Inductance between Pin 1 and Pin 3 with all other pins open, then Leakage Inductance between Pin 1 and Pin 3 with all other pins shorted together. |
| **Finish** | Varnish using Item [8]. Check Primary Inductance and Leakage Inductance to confirm that the varnished transformer is within specification. |

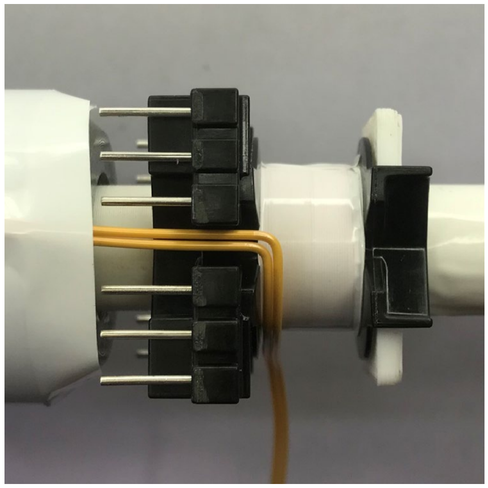
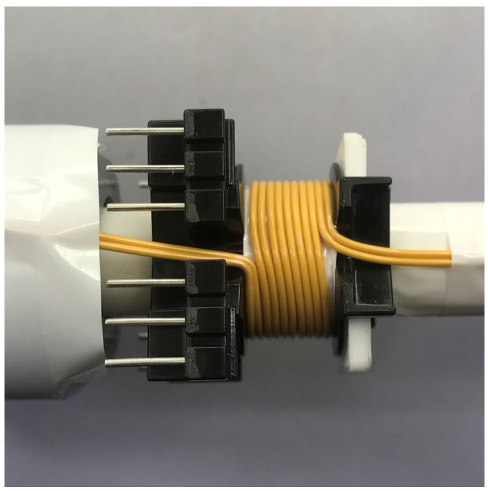
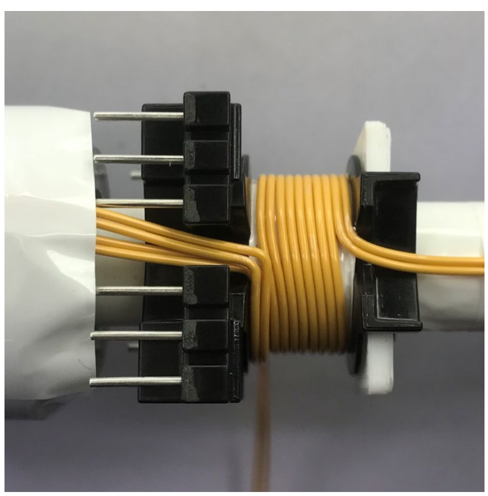
**Table 6** – Transformer Instructions.

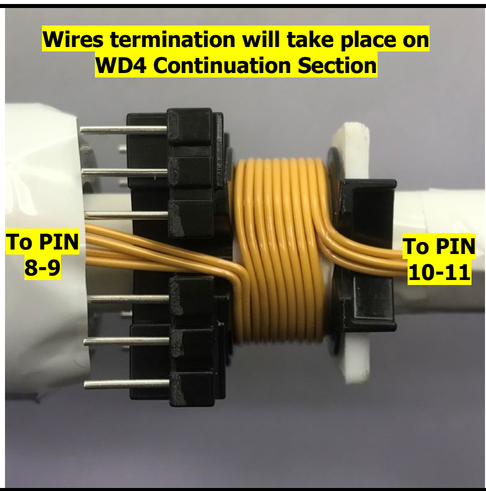
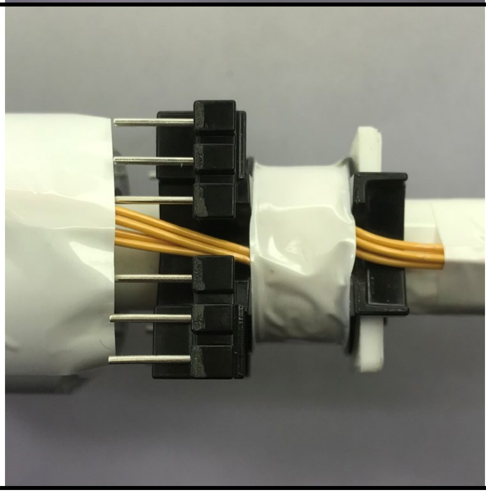
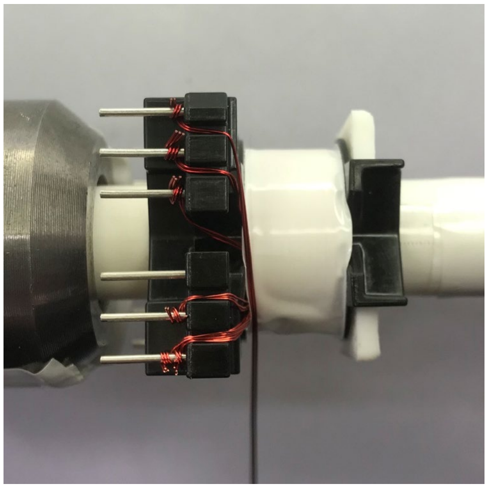
### 7.6 Transformer Winding Illustrations

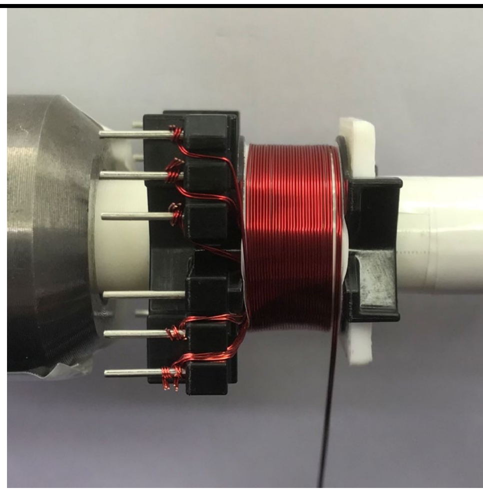
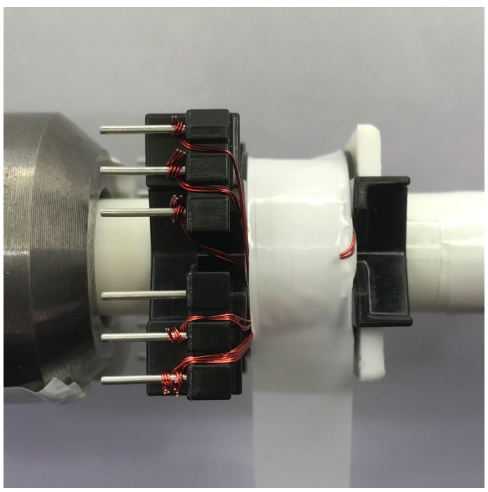
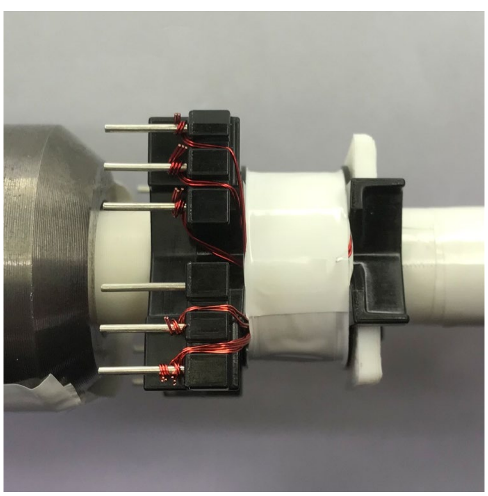
| | | |
|---|---|---|
| **WD1**<br>**1st Primary** |  | Place the bobbin Item [2] such that pins 1-6 are on upper side while 7-12 are on lower side. The notch on the bobbin signifies Pin 1. Winding direction is clockwise as shown. |
| |  | Prepare 3 strands of wire Item [3]. |
| |  | Start at pin 3, wind 10 turns of wire Item [3] for the first layer from left to right. |

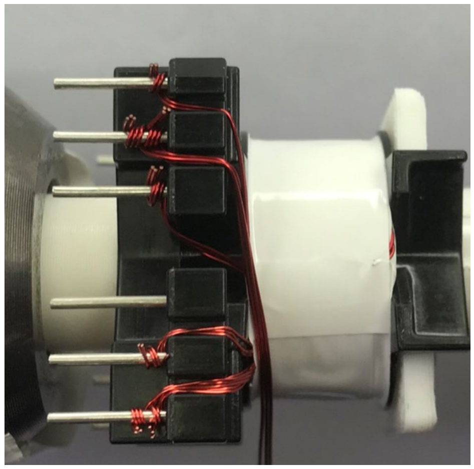
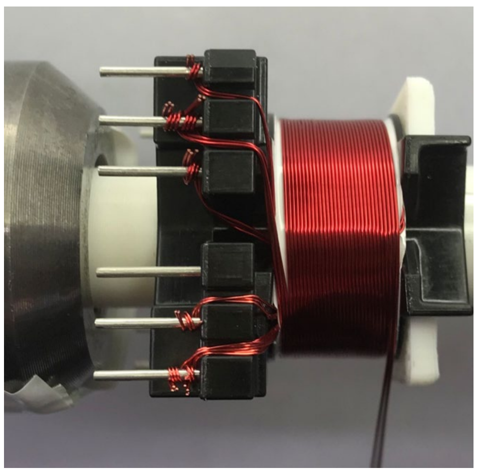
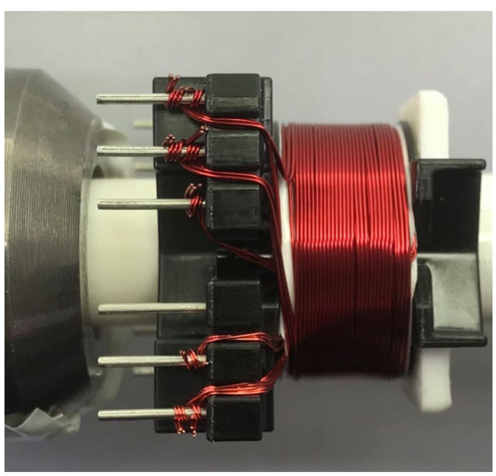
| | | |
|---|---|---|
| |  | Wind the other 10 turns for the second layer from right to left.<br><br>Finish WD1 at pin 2. |
| **Insulation** |  | Apply 1 layer of tape Item [6] for insulation.<br><br>Wrap the tape to cover WD1. |
| **WD2 & WD3 Bias and Shield** |  | Prepare 6 strands of wire Item [4] for WD2 and WD3.<br><br>Start WD2 at pin 5 with 3 strands and WD3 at pin 6 with another 3 strands. Mark the end of WD2 to avoid confusion.<br><br>Position WD2 first and followed by WD3. |

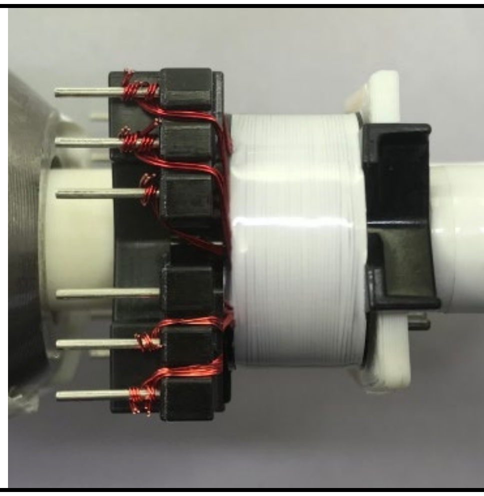
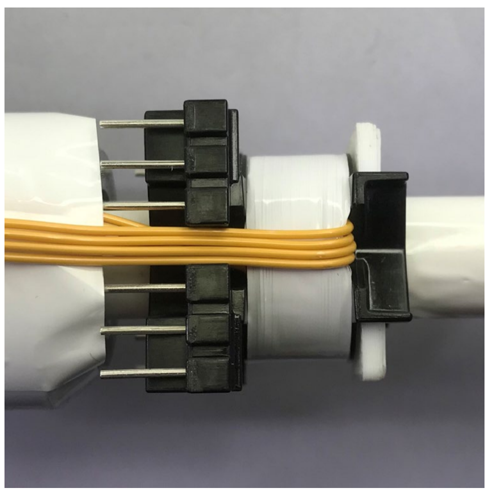
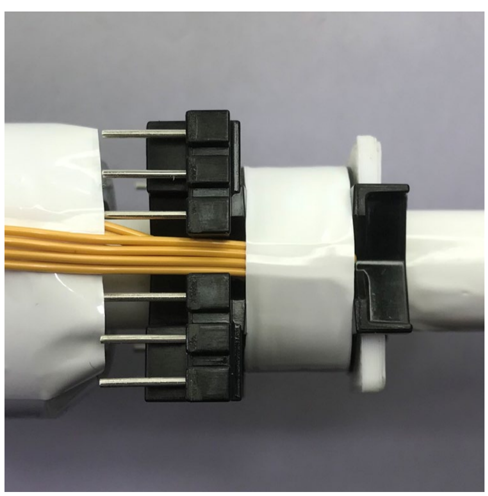
| | | |
|---|---|---|
| |  | Wind all the wires together for 6 turns from left to right. |
| **Insulation** |  | Apply 1 layer of tape Item [6] for insulation and to hold wires in place.<br><br>Finish WD2 at Pin 6.<br><br>Bend the end of WD3 90 degrees, cut as shown and leave it floating. |
| |  | Finish wrapping the tape to cover both WD2 and WD3. |

| | | |
|---|---|---|
| **WD4 Secondary** |  | Prepare 4 strands of wire Item [5].<br><br>Start by fixing the first 2 strands of wire Item [5] on the left side and fixing it with tape. |
| |  | Wind the first 2 strands of wire 5 turns from left to right.<br><br>Set aside the remaining wire on the right side and fix it with tape. |
| |  | Place the second 2 strands of wire above the first layer. |

| | | |
|---|---|---|
| |  | Wind the second 2 strands of wire above the first layer 5 turns from left to right.<br><br>Set aside the remaining wire on the right side and fix it with tape. |
| **Insulation** |  | Use 1 layer of tape Item [6] for insulation. |
| **WD5 Shield** |  | Prepare 3 strands of wire Item [3]. |

| | | |
|---|---|---|
| |  | Start at pin 1, wind 15 turns of wire Item [3] in 1 layer from left to right. |
| **Insulation** | <br> | Apply 1 layer of tape Item [6] for insulation and to hold wires in place.<br><br>Bend the end of WD5 90 degrees, cut as shown and leave it floating (NC).<br><br>Finish wrapping the tape to cover WD5. |

| | | |
|---|---|---|
| **WD6**<br>**2nd Primary** |  | Prepare 3 strands of wire Item [3].<br><br>Start at pin 2, wind 10 turns of wire Item [3] for the first layer from left to right. |
| |  | Wind the other 10 turns for the second layer from right to left. |
| |  | Finish WD6 at pin 1. |

| | | |
|---|---|---|
| **Insulation** |  | Apply 1 layer of tape Item [6] for insulation.<br><br>Wrap the tape to cover WD6. |
| **WD4 Continuation** |  | Bend the wires from WD4 that are floating at the right side for 180 degrees, placing it beside pins 7-12. |
| **Insulation** |  | Apply 2 layers of tape Item [6] for insulation.<br><br>Wrap the tape to cover WD4. |

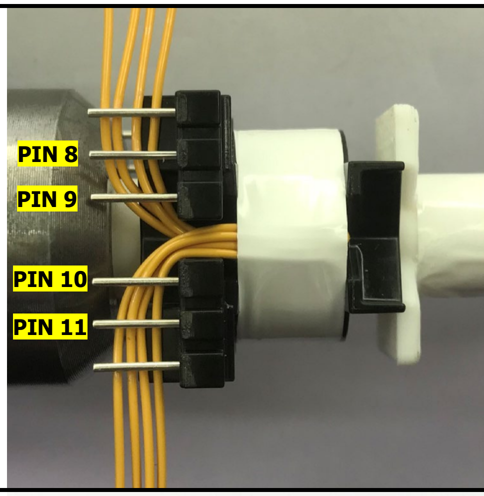
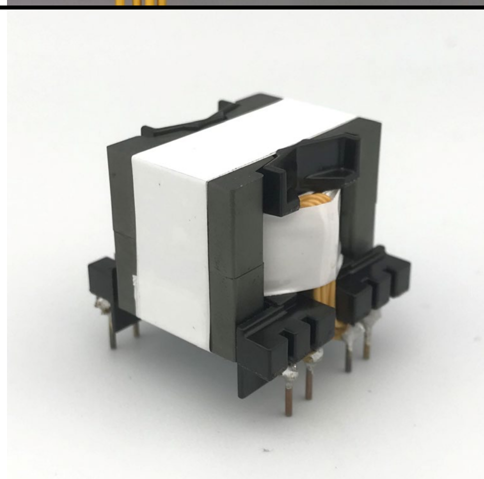
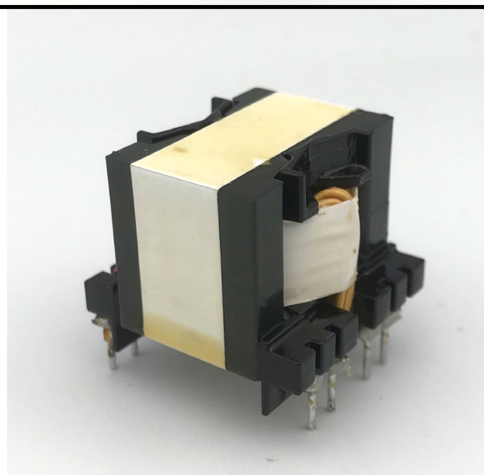
| | | |
|---|---|---|
| |  | To finish WD4, bend the wires from the lower side and terminate at pins 8-9 and bend wires from the upper side and terminate at pins 10-11. |
| **Assembly** |  | Grind the center leg of the upper half of Item [1] to get 519 µH measured between Pin 1 and Pin 3 with all other pins open.<br><br>Wrap the body of transformer with 2 layers of tape Item [7].<br><br>Measure Primary Inductance between Pin 1 and Pin 3 with all other pins open, then Leakage Inductance between Pin 1 and Pin 3 with all other pins shorted together. |
| **Finish** |  | Varnish using Item [8].<br><br>Check Primary Inductance and Leakage Inductance to confirm that the varnished transformer is within specification. |

**Table 7** – Transformer Winding Illustrations.

# 8 Common Mode Choke L1 Specification

## 8.1 Electrical Diagram

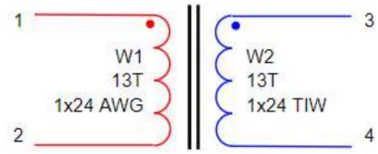



**Figure 9** – Choke Electrical Diagram.

## 8.2 Electrical Specifications

| Parameter | Condition | Spec. |
| --- | --- | --- |
| **Winding Inductance** | Pin 1 – Pin 2 (or Pin 3 – Pin 4), all other windings open, measured at 100 kHz, 0.4 $V_{RMS}$. | **460 µH ± 20%** |

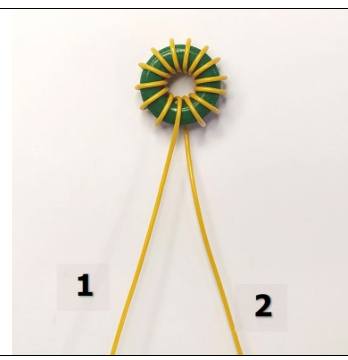
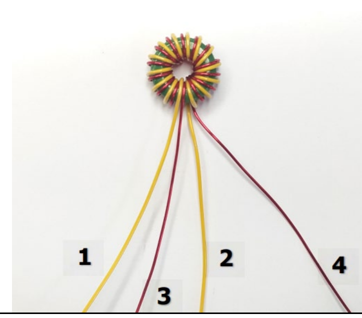
**Table 8** – Electrical Specifications.

## 8.3 Material List

| Item | Description |
| --- | --- |
| **[1]** | Toroid: FERRITE INDUCTOR TOROID 12 mm O.D.; Mfr. Part number: GL50 T 12X6X4-C Dim: 12mm O.D. x 4 mm I.D. x 6 mm Th. |
| **[2]** | Triple Insulated Wire: #24 AWG, Triple Coated. |
| **[3]** | Magnet Wire: #24 AWG, Double Coated. |

**Table 9** – Material List.

## 8.4 Common Mode Choke Construction

| | |
| --- | --- |
| Mark the start of the winding as 1 and wind 13 turns of Item [2] on Item [1]. Mark the end of this winding as 2 |  |
| Repeat the same procedure as above for the other winding using Item [3], making sure that the start/end and the direction of winding is the same as the first winding. Mark the start of this winding as 3 and the end as 4. |  |

# 9 Design Spreadsheet

| *1* | *ACDC_LinkSwitch-HP_060623; Rev.2.2; Copyright Power Integrations 2023* | *INPUT* | *INFO* | *OUTPUT* | *UNIT* | *ACDC_LinkSwitchHP_060623 Rev 2-2.xls: LinkSwitch-HP Flyback Continuous/Discontinuous Transformer Design Spreadsheet* |
|---|---|---|---|---|---|---|
| 2 | ENTER APPLICATION VARIABLES | | | | | Customer |
| 3 | VACMIN | 85 | | 85 | V | Minimum AC Input Voltage |
| 4 | VACMAX | 265 | | 265 | V | Maximum AC Input Voltage |
| 5 | fL | | | 50 | Hz | AC Mains Frequency |
| 6 | VO | 12.00 | | 12.00 | V | Output Voltage (main) |
| 7 | PO | 72.00 | | 72.00 | W | Load Power |
| 8 | n | 0.90 | | 0.90 | | Efficiency Estimate |
| 9 | Z | | | 0.50 | | Loss Allocation Factor |
| 10 | VB | 12.00 | | 12.00 | V | Bias Voltage |
| 11 | tC | | | 3.00 | ms | Bridge Rectifier Conduction Time Estimate |
| 12 | CIN | 220 | | 220 | µF | Input Filter Capacitor |
| 13 | Package | E/V | | E/V | | E and V Package Selected |
| 14 | Enclosure | Open Frame | | Open Frame | | Open Frame type enclosure |
| 15 | Heatsink | Metal | | Metal | | Metallic heatsink thermally connected to the exposed metal on the E-package |
| 16 | | | | | | |
| 17 | | | | | | |
| 18 | ENTER LinkSwitch-HP VARIABLES | | | | | |
| 19 | LinkSwitch-HP | LNK6779E | | LNK6779E | | Manual Device Selection |
| 20 | ILIMITMIN | | | 3.162 | A | Minimum Current limit |
| 21 | ILIMITMAX | | | 3.638 | A | Maximum current limit |
| 22 | ILIMITMIN_EXT | | | 2.53 | A | External Minimum Current limit |
| 23 | ILIMITMAX_EXT | | | 2.91 | A | External Maximum current limit |
| 24 | KI | 0.8 | | 0.8 | | Current limit reduction factor |
| 25 | Rpd | | | 52.30 | k-ohm | Program delay Resistor |
| 26 | Cpd | | | 33.0 | nF | Program delay Capacitor |
| 27 | Total programmed delay | | | 0.38 | sec | Total program delay |
| 28 | fS | | | 132 | kHz | LinkSwitch-HP Switching Frequency |
| 29 | fSmin | | | 120 | kHz | LinkSwitch-HP Minimum Switching Frequency |
| 30 | fSmax | | | 136 | kHz | LinkSwitch-HP Maximum Switching Frequency |
| 31 | KP | 0.40 | | 0.40 | | Ripple to Peak Current Ratio (0.4 < KP < 6.0) |
| 32 | VOR | 100.00 | | 100.00 | V | Reflected Output Voltage |
| 33 | Voltage Sense | | | | | |
| 34 | VUVON | 100.00 | | 100.00 | V | Undervoltage turn on |
| 35 | VUVOFF | | | 41.43 | V | Undervoltage turn off |
| 36 | VOV | | | 454.43 | V | Overvoltage threshold |
| 37 | FMAX_FULL_LOAD | | | 134.75 | kHz | Maximum switching frequency at full load |
| 38 | FMIN_FULL_LOAD | | | 118.90 | kHz | Minimum switching frequency at full load |
| 39 | TSAMPLE_FULL_LOAD | | | 3.58 | µs | Minimum available Diode conduction time at full load. This should be greater than 2.5 us |
| 40 | TSAMPLE_LIGHT_LOAD | | | 3.12 | µs | Minimum available Diode conduction time at light load. This should be greater than 1.4 us |
| 41 | VDS | | | 2.09 | V | LinkSwitch-HP on-state Drain to Source Voltage. |
| 42 | VD | | | 0.50 | V | Output Winding Diode Forward Voltage Drop |
| 43 | VDB | | | 0.70 | V | Bias Winding Diode Forward Voltage Drop |
| 44 | | | | | | |
| 45 | | | | | | |
| 46 | | | | | | |
| 47 | FEEDBACK SENSING SECTION | | | | | |
| 48 | RFB1 | | | 59.00 | k-ohms | Feedback divider upper resistor |
| 49 | RFB2 | | | 9.09 | k-ohms | Feedback divider lower resistor |
| 50 | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 51 | | | | | | |
| 52 | ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES | | | | | |
| 53 | Select Core Size | Custom | Info | Custom | | Manual Core Selected |
| 54 | Core | | | Custom | | Selected Core |
| 55 | Custom Core | PQ26/20 | | | | Enter name of custom core is applicable |
| 56 | AE | 1.21 | | 1.21 | cm^2 | Core Effective Cross-Sectional Area |
| 57 | LE | 4.50 | | 4.50 | cm | Core Effective Path Length |
| 58 | AL | 5530 | | 5530 | nH/T^2 | Ungapped Core Effective Inductance |
| 59 | BW | 9.00 | | 9.00 | mm | Bobbin Physical Winding Width |
| 60 | M | | | 0.00 | mm | Safety Margin Width (Half the Primary to Secondary Creepage Distance) |
| 61 | L | | | 2 | | Number of Primary Layers |
| 62 | NS | 5 | | 5 | | Number of Secondary Turns |
| 63 | | | | | | |
| 64 | | | | | | |
| 65 | DC INPUT VOLTAGE PARAMETERS | | | | | |
| 66 | VMIN | | | 97 | V | Minimum DC Input Voltage |
| 67 | VMAX | | | 375 | V | Maximum DC Input Voltage |
| 68 | | | | | | |
| 69 | | | | | | |
| 70 | CURRENT WAVEFORM SHAPE PARAMETERS | | | | | |
| 71 | DMAX | | | 0.51 | | Maximum Duty Cycle |
| 72 | IAVG | | | 0.83 | A | Average Primary Current |
| 73 | IP | | | 2.01 | A | Peak Primary Current |
| 74 | IR | | | 0.80 | A | Primary Ripple Current |
| 75 | IRMS | | | 1.17 | A | Primary RMS Current |
| 76 | | | | | | |
| 77 | | | | | | |
| 78 | TRANSFORMER PRIMARY DESIGN PARAMETERS | | | | | |
| 79 | LP_TYP | | | 519 | µH | Typical Primary Inductance |
| 80 | LP_TOL | 5 | | 5 | % | Primary inductance Tolerance |
| 81 | NP | | | 40 | | Primary Winding Number of Turns |
| 82 | NB | | | 6 | | Bias Winding Number of Turns |
| 83 | ALG | | | 325 | nH/T^2 | Gapped Core Effective Inductance |
| 84 | BM | | | 2159 | Gauss | Maximum Flux Density at PO, VMIN (BM<3100) |
| 85 | BP | | | 3279 | Gauss | Peak Flux Density (BP<3700) |
| 86 | BAC | | | 432 | Gauss | AC Flux Density for Core Loss Curves (0.5 X Peak to Peak) |
| 87 | ur | | | 1637 | | Relative Permeability of Ungapped Core |
| 88 | LG | | | 0.44 | mm | Gap Length (Lg > 0.1 mm) |
| 89 | BWE | | | 18 | mm | Effective Bobbin Width |
| 90 | OD | | | 0.45 | mm | Maximum Primary Wire Diameter including insulation |
| 91 | INS | | | 0.06 | mm | Estimated Total Insulation Thickness (= 2 * film thickness) |
| 92 | DIA | | | 0.39 | mm | Bare conductor diameter |
| 93 | AWG | | | 27 | AWG | Primary Wire Gauge (Rounded to next smaller standard AWG value) |
| 94 | CM | | | 203 | Cmils | Bare conductor effective area in circular mils |
| 95 | CMA | | Warning | 174 | Cmils/Amp | !!! INCREASE (200 < CMA < 500) Increase L(primary layers),decrease NS,larger Core |
| 96 | | | | | | |
| 97 | | | | | | |
| 98 | | | | | | |
| 99 | TRANSFORMER SECONDARY DESIGN PARAMETERS (SINGLE OUTPUT EQUIVALENT) | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 100 | Lumped parameters | | | | | |
| 101 | ISP | | | 16.10 | A | Peak Secondary Current |
| 102 | ISRMS | | | 9.07 | A | Secondary RMS Current |
| 103 | IO | | | 6.00 | A | Power Supply Output Current |
| 104 | IRIPPLE | | | 6.81 | A | Output Capacitor RMS Ripple Current |
| 105 | CMS | | | 1815 | Cmils | Secondary Bare Conductor minimum circular mils |
| 106 | AWGS | | | 17 | AWG | Secondary Wire Gauge (Rounded up to next larger standard AWG value) |
| 107 | DIAS | | | 1.15 | mm | Secondary Minimum Bare Conductor Diameter |
| 108 | ODS | | | 1.80 | mm | Secondary Maximum Outside Diameter for Triple Insulated Wire |
| 109 | INSS | | | 0.32 | mm | Maximum Secondary Insulation Wall Thickness |
| 110 | | | | | | |
| 111 | | | | | | |
| 112 | VOLTAGE STRESS PARAMETERS | | | | | |
| 113 | VDRAIN | | | 605 | V | Peak voltage across drain to source of Linkswitch-HP |
| 114 | PIVS | | | 59 | V | Output Rectifier Maximum Peak Inverse Voltage |
| 115 | PIVB | | | 68 | V | Bias Rectifier Maximum Peak Inverse Voltage |
| 116 | | | | | | |
| 117 | | | | | | |
| 118 | TRANSFORMER SECONDARY DESIGN PARAMETERS (MULTIPLE OUTPUTS) | | | | | |
| 119 | 1st output | | | | | |
| 120 | VO1 | | | 12.00 | V | Output Voltage |
| 121 | IO1 | | | 6.00 | A | Output DC Current |
| 122 | PO1 | | | 72 | W | Output Power |
| 123 | VD1 | | | 0.50 | V | Output Diode Forward Voltage Drop |
| 124 | NS1 | | | 5.00 | | Output Winding Number of Turns |
| 125 | ISRMS1 | | | 9.073 | A | Output Winding RMS Current |
| 126 | IRIPPLE1 | | | 6.81 | A | Output Capacitor RMS Ripple Current |
| 127 | PIVS1 | | | 59 | V | Output Rectifier Maximum Peak Inverse Voltage |
| 128 | CMS1 | | | 1815 | Cmils | Output Winding Bare Conductor minimum circular mils |
| 129 | AWGS1 | | | 17 | AWG | Wire Gauge (Rounded up to next larger standard AWG value) |
| 130 | DIAS1 | | | 1.15 | mm | Minimum Bare Conductor Diameter |
| 131 | ODS1 | | | 1.80 | mm | Maximum Outside Diameter for Triple Insulated Wire |
| 132 | | | | | | |
| 133 | | | | | | |
| 134 | 2nd output | | | | | |
| 135 | VO2 | | | 0.00 | V | Output Voltage |
| 136 | IO2 | | | 0.00 | A | Output DC Current |
| 137 | PO2 | | | 0 | W | Output Power |
| 138 | VD2 | | | 0.70 | V | Output Diode Forward Voltage Drop |
| 139 | NS2 | | | 1.00 | | Output Winding Number of Turns |
| 140 | ISRMS2 | | | 0 | A | Output Winding RMS Current |
| 141 | IRIPPLE2 | | | 0.00 | A | Output Capacitor RMS Ripple Current |
| 142 | PIVS2 | | | 9 | V | Output Rectifier Maximum Peak Inverse Voltage |
| 143 | CMS2 | | | 0 | Cmils | Output Winding Bare Conductor minimum circular mils |
| 144 | AWGS2 | | | N/A | AWG | Wire Gauge (Rounded up to next larger standard AWG value) |
| 145 | DIAS2 | | | N/A | mm | Minimum Bare Conductor Diameter |

| | | | | | | |
|---|---|---|---|---|---|---|
| 146 | ODS2 | | | N/A | mm | Maximum Outside Diameter for Triple Insulated Wire |
| 147 | | | | | | |
| 148 | | | | | | |
| 149 | 3rd output | | | | | |
| 150 | VO3 | | | 0.00 | V | Output Voltage |
| 151 | IO3 | | | 0.00 | A | Output DC Current |
| 152 | PO3 | | | 0 | W | Output Power |
| 153 | VD3 | | | 0.70 | V | Output Diode Forward Voltage Drop |
| 154 | NS3 | | | 1.00 | | Output Winding Number of Turns |
| 155 | ISRMS3 | | | 0 | A | Output Winding RMS Current |
| 156 | IRIPPLE3 | | | 0.00 | A | Output Capacitor RMS Ripple Current |
| 157 | PIVS3 | | | 9 | V | Output Rectifier Maximum Peak Inverse Voltage |
| 158 | CMS3 | | | 0 | Cmils | Output Winding Bare Conductor minimum circular mils |
| 159 | AWGS3 | | | N/A | AWG | Wire Gauge (Rounded up to next larger standard AWG value) |
| 160 | DIAS3 | | | N/A | mm | Minimum Bare Conductor Diameter |
| 161 | ODS3 | | | N/A | mm | Maximum Outside Diameter for Triple Insulated Wire |
| 162 | | | | | | |
| 163 | Total power | | | 72 | W | Total Power for Multi-output section |
| 164 | | | | | | |
| 165 | Negative Output | N/A | | N/A | | If negative output exists enter Output number; e.g. If VO2 is negative output, select 2 |
| 166 | | | | | | |
| 112 | VOLTAGE STRESS PARAMETERS | | | | | |

**Table 10** – Design Spreadsheet.

Note:

- RFB2 used is 9.31 kΩ.
- PIExpert primary winding CMA 174 Cmils/A due to single AWG 27 wire. Actual transformer winding design is 3 x AWG 30 wire with CMA of 257.36 which is within CMA specification (200 < CMA < 500).

# 10 Heat Sinks

## 10.1 LinkSwitch-HP Heat Sink

### 10.1.1 LinkSwitch-HP Heat Sink Metal Drawing

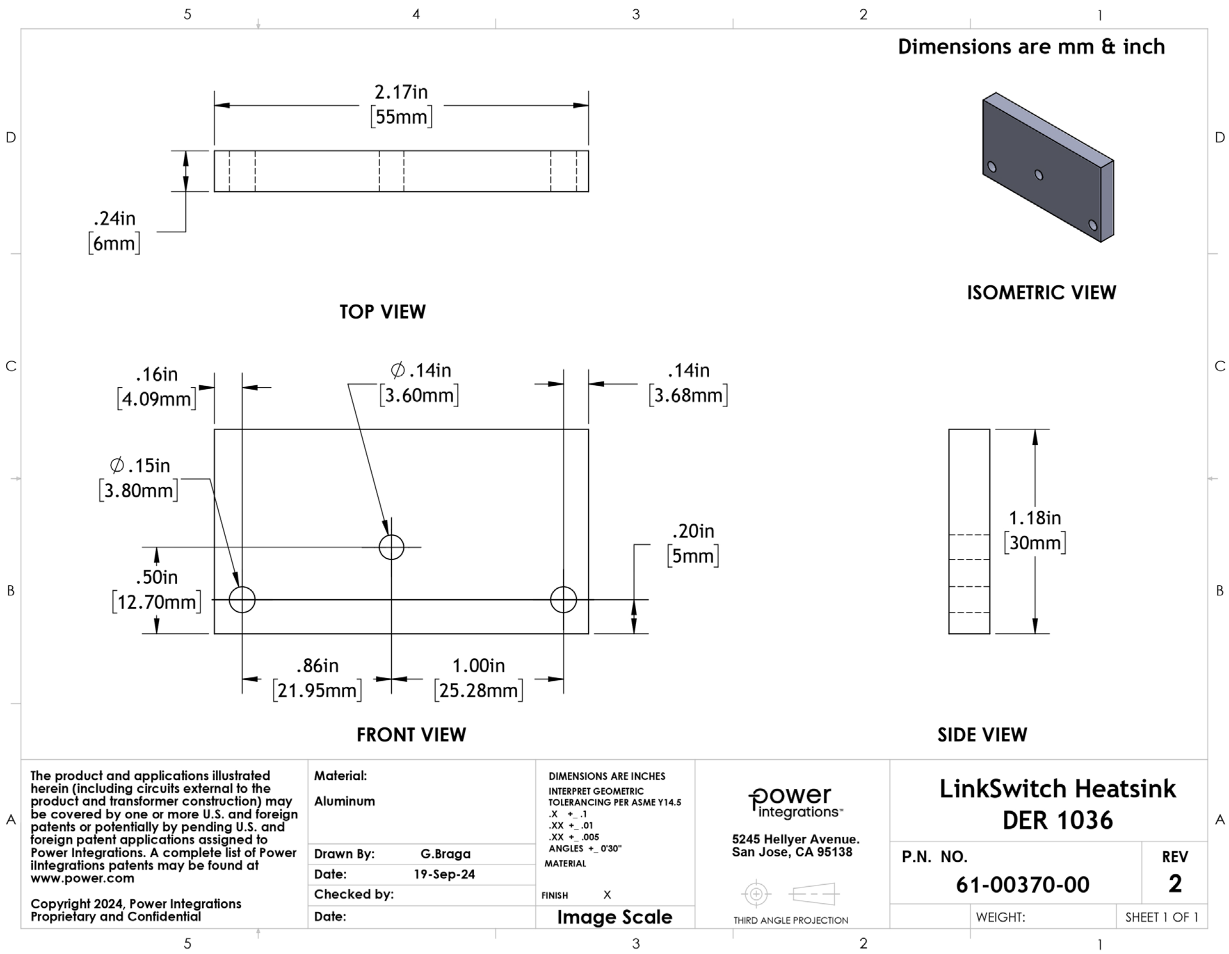
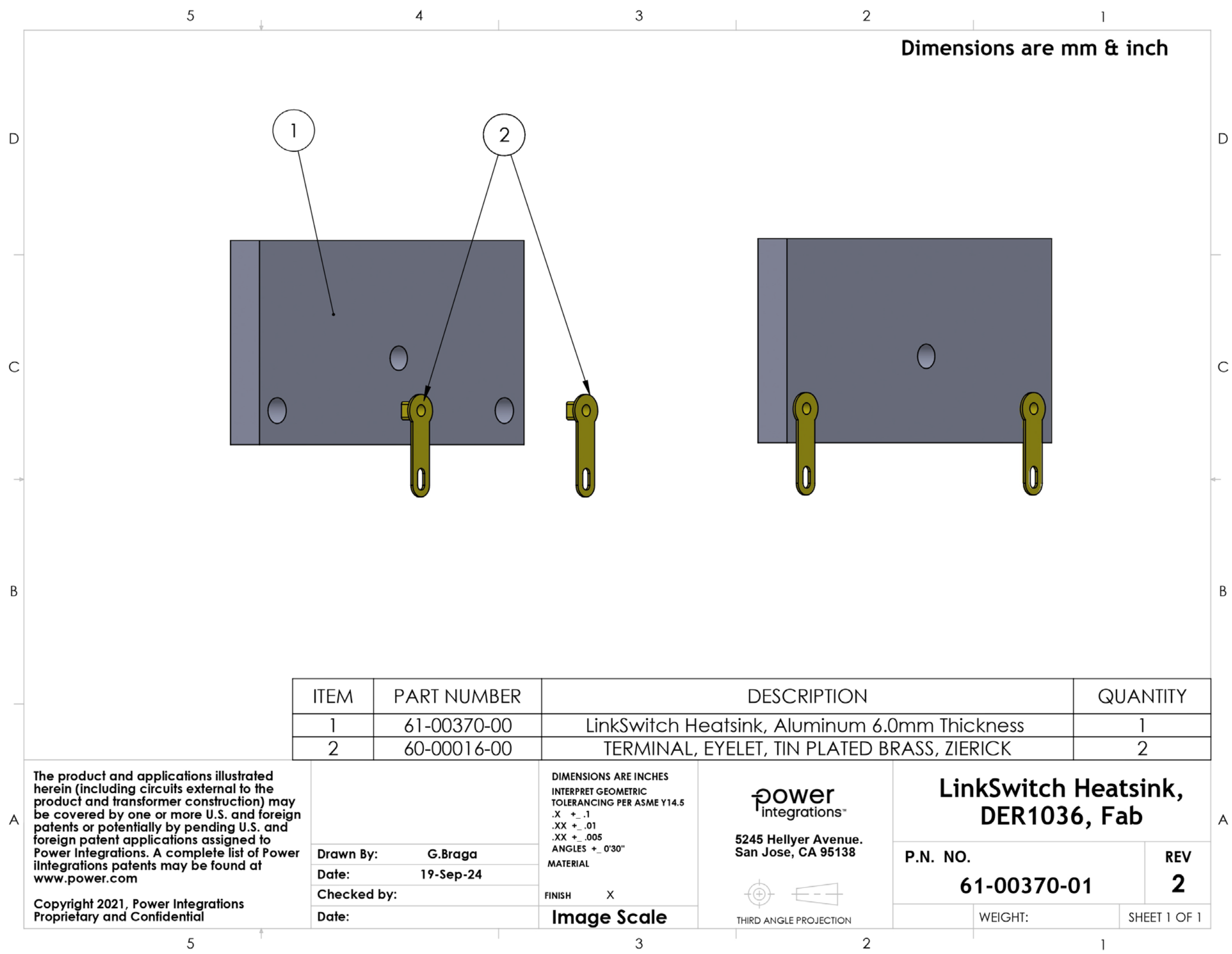



**Figure 10** – DER-1036 LinkSwitch-HP Heat Sink Metal Drawing.

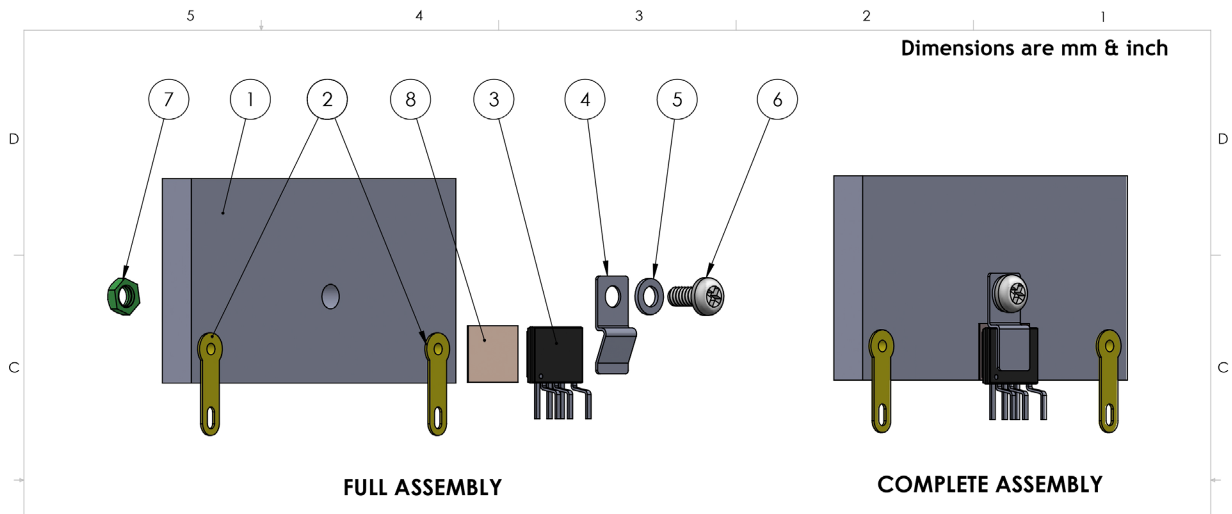
### 10.1.2 Finished LinkSwitch-HP Heat Sink with Hardware




| ITEM | PART NUMBER | DESCRIPTION | QUANTITY |
|---|---|---|---|
| 1 | 61-00370-00 | LinkSwitch Heatsink, Aluminum 6.0mm Thickness | 1 |
| 2 | 60-00016-00 | TERMINAL, EYELET, TIN PLATED BRASS, ZIERICK | 2 |

**Figure 11** – DER-1036 LinkSwitch-HP Heat Sink with Hardware.

### 10.1.3 LinkSwitch-HP Heat Sink Assembly




| ITEM | PART NUMBER | DESCRIPTION | QUANTITY |
|---|---|---|---|
| 1 | 61-00370-00 | LinkSwitch Heatsink, Aluminum 6.0mm Thickness | 1 |
| 2 | 60-00016-00 | TERMINAL, EYELET, TIN PLATED BRASS, ZIERICK | 2 |
| 3 | 10-00826-00 | LinkSwitch-HP, LNK6779E, Esip-7C | 1 |
| 4 | 60-00037-00 | HEATSINK HARDWARE, EDGE CLIP, 12.40mm x 6.50mm | 1 |
| 5 | 75-00153-00 | WASHER, SPLIT LOCK #4 | 1 |
| 6 | 75-00003-00 | SCREW MACHINE PHIL 4-40 X 3/8 SS | 1 |
| 7 | 75-00183-00 | NUT, HEX, 4-40, 3/16W x 1/16T, STL ZNC | 1 |
| 8 | 66-00084-00 | THERMALLY CONDUCTIVE SILICONE GREASE | 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



Drawn By: G.Braga
Date: 12-Oct-24
Checked by:
Date:

DIMENSIONS ARE INCHES
INTERPRET GEOMETRIC TOLERANCING PER ASME Y14.5
.X +_ .1
.XX +_ .01
.XX +_ .005
ANGLES +_ 0'30"
MATERIAL
FINISH X
Image Scale

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5245 Hellyer Avenue.
San Jose, CA 95138
THIRD ANGLE PROJECTION

LinkSwitch Heatsink, DER1036, Assembly
P.N. NO. 61-00370-02
REV 2
WEIGHT:
SHEET 1 OF 1

**Figure 12** – DER-1036 LinkSwitch-HP Heat Sink Assembly.

## 10.2 Bridge Rectifier Heat Sink

### 10.2.1 Bridge Rectifier Heat Sink Metal Drawing

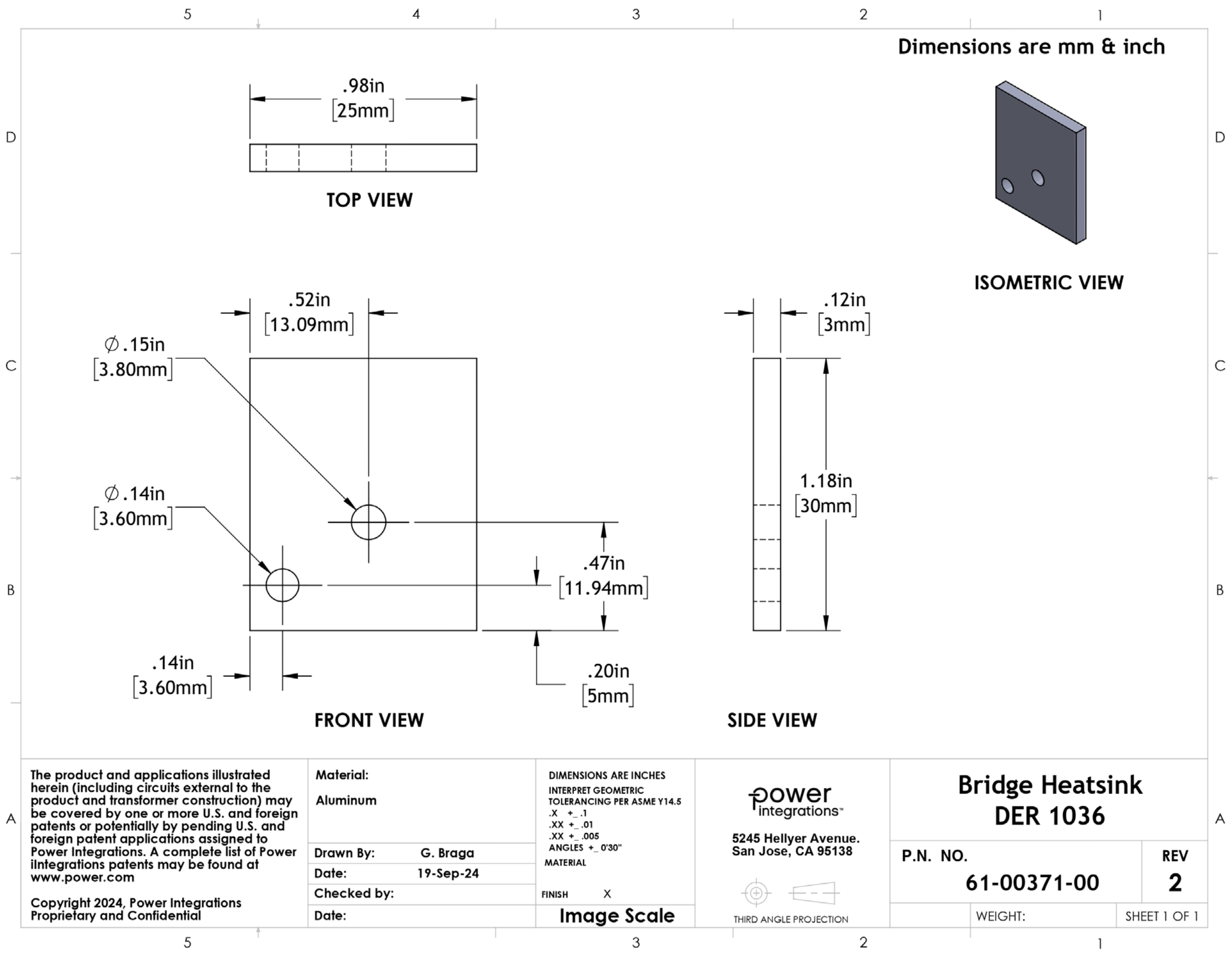
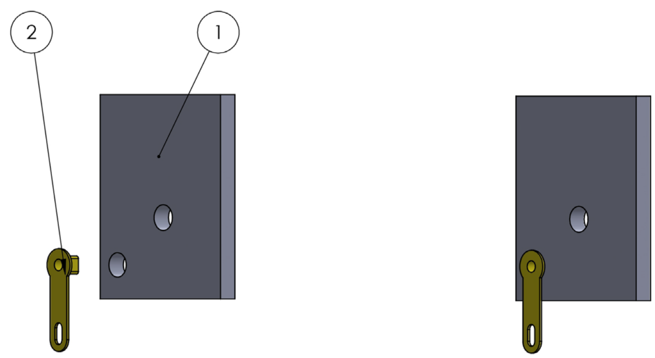



**Figure 13** – DER-1036 Bridge Rectifier Heat Sink Metal Drawing.

### 10.2.2 Finished Bridge Rectifier Heat Sink with Hardware

**Dimensions are mm & inch**




| ITEM | PART NUMBER | DESCRIPTION | QUANTITY |
|---|---|---|---|
| 1 | 61-00371-00 | Bridge Heatsink, Aluminum 3.0mm Thickness | 1 |
| 2 | 60-00016-00 | TERMINAL, EYELET, TIN PLATED BRASS, ZIERICK | 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



Drawn By: G.BRAGA
Date: 19-Sep-24
Checked by:
Date:

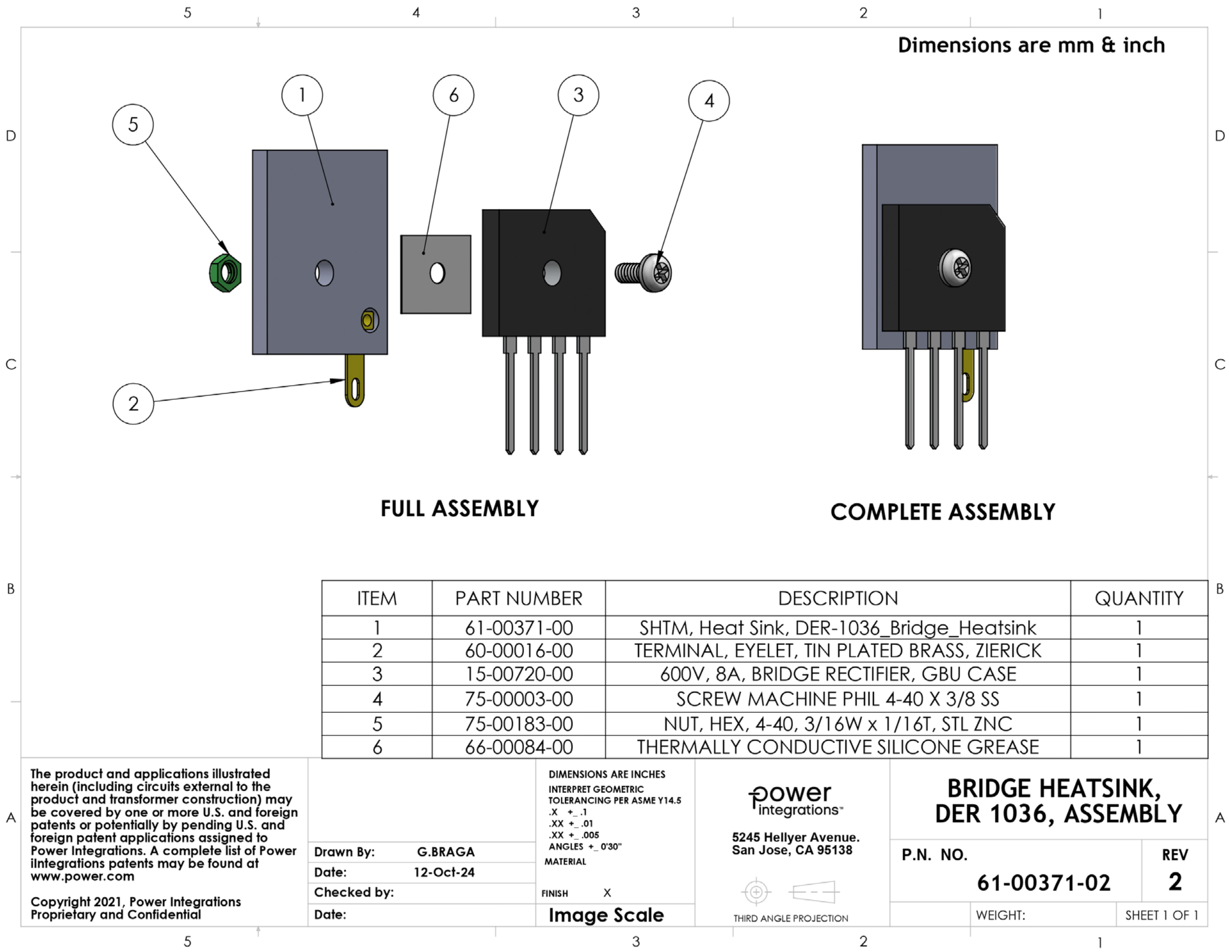
DIMENSIONS ARE INCHES
INTERPRET GEOMETRIC TOLERANCING PER ASME Y14.5
.X +_ .1
.XX +_ .01
.XX +_ .005
ANGLES +_ 0'30"
MATERIAL
FINISH X
Image Scale

power integrations
5245 Hellyer Avenue.
San Jose, CA 95138
THIRD ANGLE PROJECTION

BRIDGE HEATSINK, DER 1036, FAB
P.N. NO. 61-00371-01
REV 2
WEIGHT:
SHEET 1 OF 1

**Figure 14** – DER-1036 Bridge Rectifier Heat Sink with Hardware.

### 10.2.3 Bridge Rectifier Heat Sink Assembly




| ITEM | PART NUMBER | DESCRIPTION | QUANTITY |
|---|---|---|---|
| 1 | 61-00371-00 | SHTM, Heat Sink, DER-1036_Bridge_Heatsink | 1 |
| 2 | 60-00016-00 | TERMINAL, EYELET, TIN PLATED BRASS, ZIERICK | 1 |
| 3 | 15-00720-00 | 600V, 8A, BRIDGE RECTIFIER, GBU CASE | 1 |
| 4 | 75-00003-00 | SCREW MACHINE PHIL 4-40 X 3/8 SS | 1 |
| 5 | 75-00183-00 | NUT, HEX, 4-40, 3/16W x 1/16T, STL ZNC | 1 |
| 6 | 66-00084-00 | THERMALLY CONDUCTIVE SILICONE GREASE | 1 |

**Figure 15** – DER-1036 Bridge Rectifier Heat Sink Assembly.

## 10.3 Secondary Diode Heat Sink

### 10.3.1 Secondary Diode Heat Sink Metal Drawing

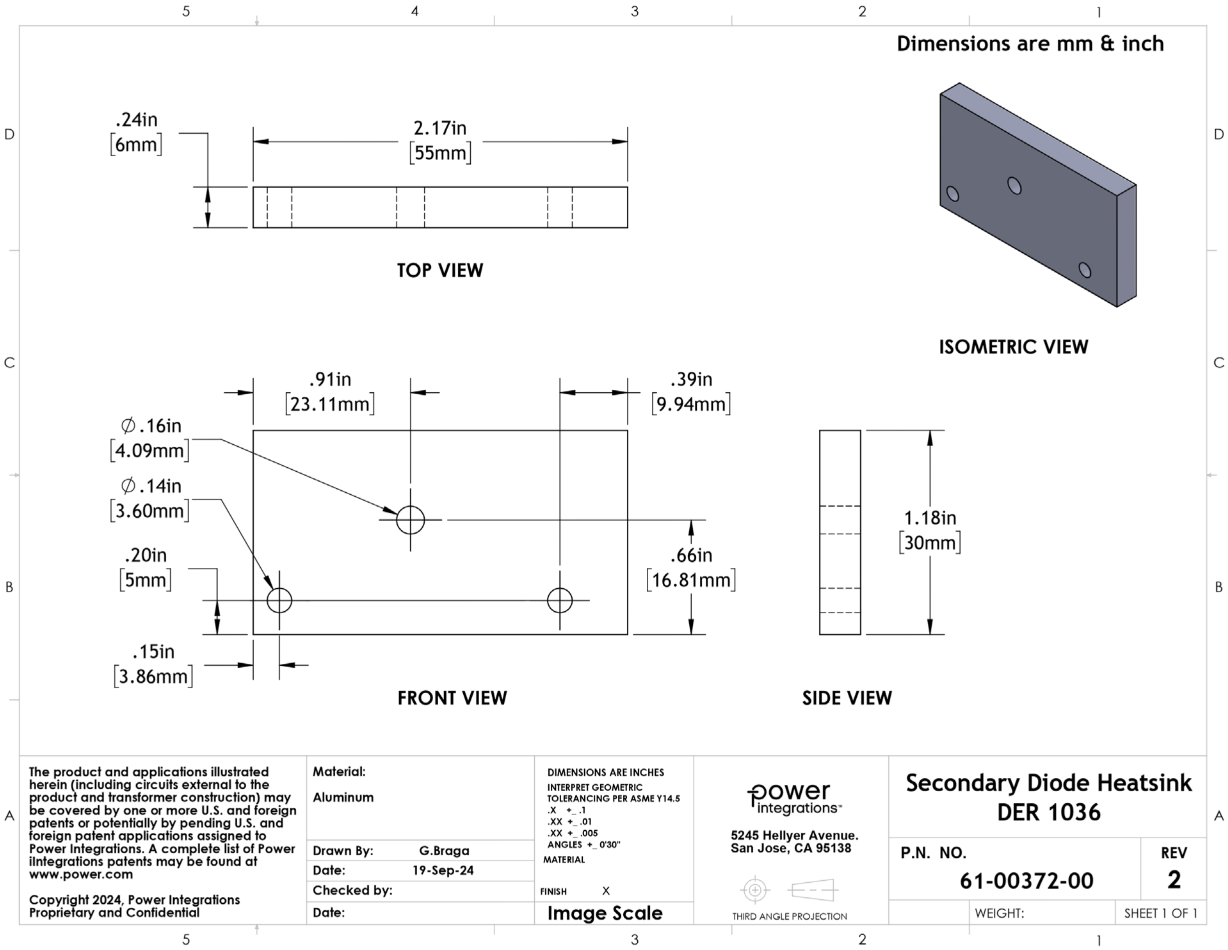
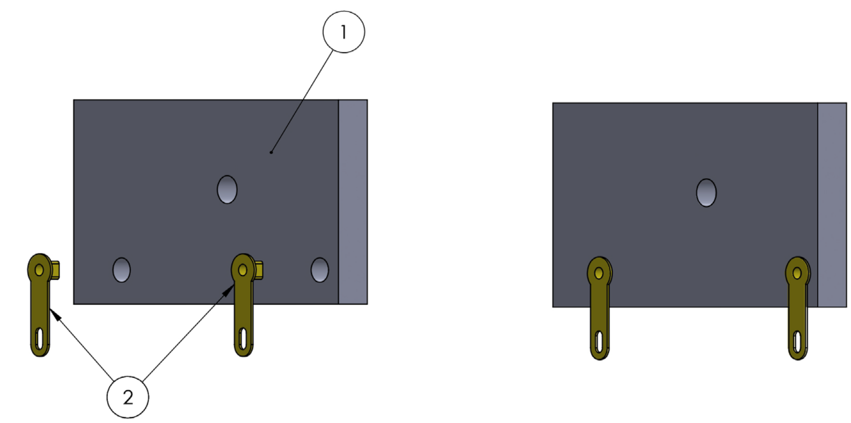



**Figure 16** – DER-1036 Secondary Diode Heat Sink Metal Drawing.

### 10.3.2 Finished Secondary Diode Heat Sink with Hardware

**Dimensions are mm & inch**




| ITEM | PART NUMBER | DESCRIPTION | QUANTITY |
|---|---|---|---|
| 1 | 61-00372-00 | Secondary Diode Heatsink, Aluminum 6.0mm Thickness | 1 |
| 2 | 60-00016-00 | TERMINAL, EYELET, TIN PLATED BRASS, ZIERICK | 2 |



Drawn By: G.Braga
Date: 19-Sep-24
Checked by:
Date:

DIMENSIONS ARE INCHES
INTERPRET GEOMETRIC TOLERANCING PER ASME Y14.5
.X +_ .1
.XX +_ .01
.XX +_ .005
ANGLES +_ 0'30"
MATERIAL
FINISH X
Image Scale

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THIRD ANGLE PROJECTION

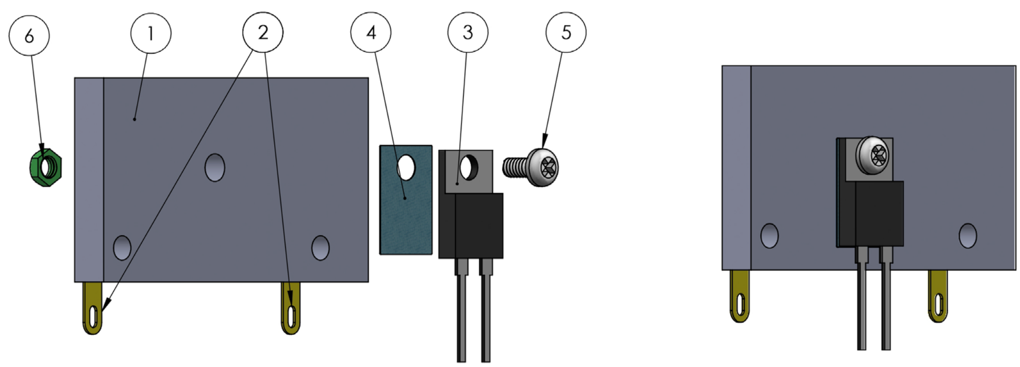
**Secondary Diode Heatsink DER 1036, Fab**

P.N. NO. 61-00372-01
REV 2
WEIGHT:
SHEET 1 OF 1

**Figure 17** – DER-1036 Secondary Diode Heat Sink with Hardware.

### 10.3.3 Secondary Diode Heat Sink Assembly

Dimensions are mm & inch




| ITEM | PART NUMBER | DESCRIPTION | QUANTITY |
|---|---|---|---|
| 1 | 61-00372-00 | SHTM, Heat Sink, DER-1036_SEC_Diode_Heatsink | 1 |
| 2 | 60-00016-00 | TERMINAL, EYELET, TIN PLATED BRASS, ZIERICK | 2 |
| 3 | 15-02092-00 | Diode Array, 1 Pair, Common Cathode, 100 V, 10A, TO-220-3 | 1 |
| 4 | 66-00084-00 | THERMALLY CONDUCTIVE SILICONE GREASE | 1 |
| 5 | 75-00003-00 | SCREW MACHINE PHIL 4-40 X 3/8 SS | 1 |
| 6 | 75-00183-00 | NUT, HEX, 4-40, 3/16W x 1/16T, STL ZNC | 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



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Date: 12-Oct-24
Checked by:
Date:

DIMENSIONS ARE INCHES
INTERPRET GEOMETRIC TOLERANCING PER ASME Y14.5
.X +_ .1
.XX +_ .01
.XX +_ .005
ANGLES +_ 0'30"
MATERIAL
FINISH X
Image Scale

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Secondary Diode Heatsink
DER 1036, Assembly

P.N. NO. 61-00372-02
REV 2
WEIGHT:
SHEET 1 OF 1

**Figure 18** – DER-1036 Secondary Diode Heat Sink Assembly.

# 11 Performance Data

## 11.1 Full Load Efficiency vs. Line

Test Condition: Soak for 15 minutes for each line.

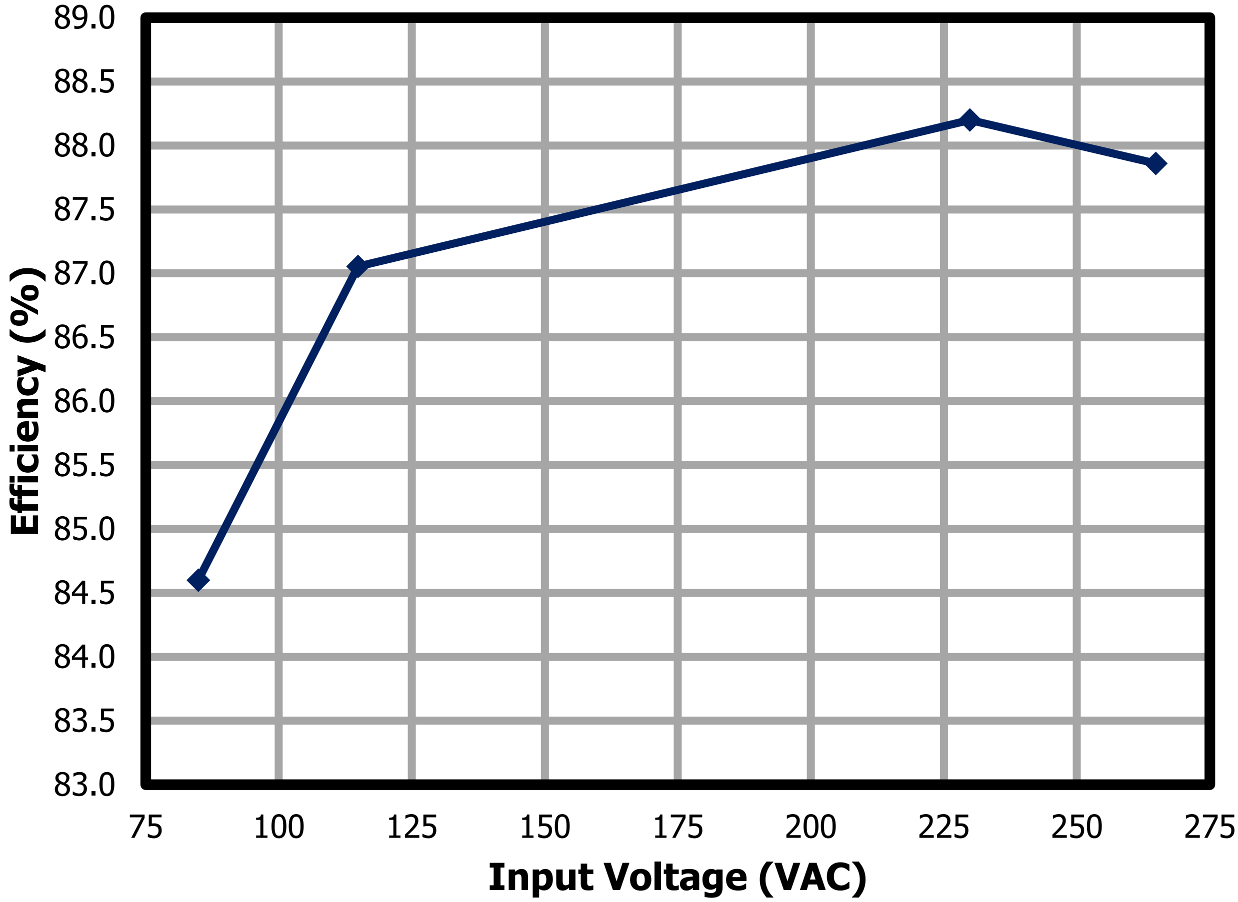



**Figure 19** – Efficiency vs. Input Voltage.

## 11.2 Efficiency vs. Load

Test Condition: Soak for 15 minutes each line at full load, and 10 seconds for each load.

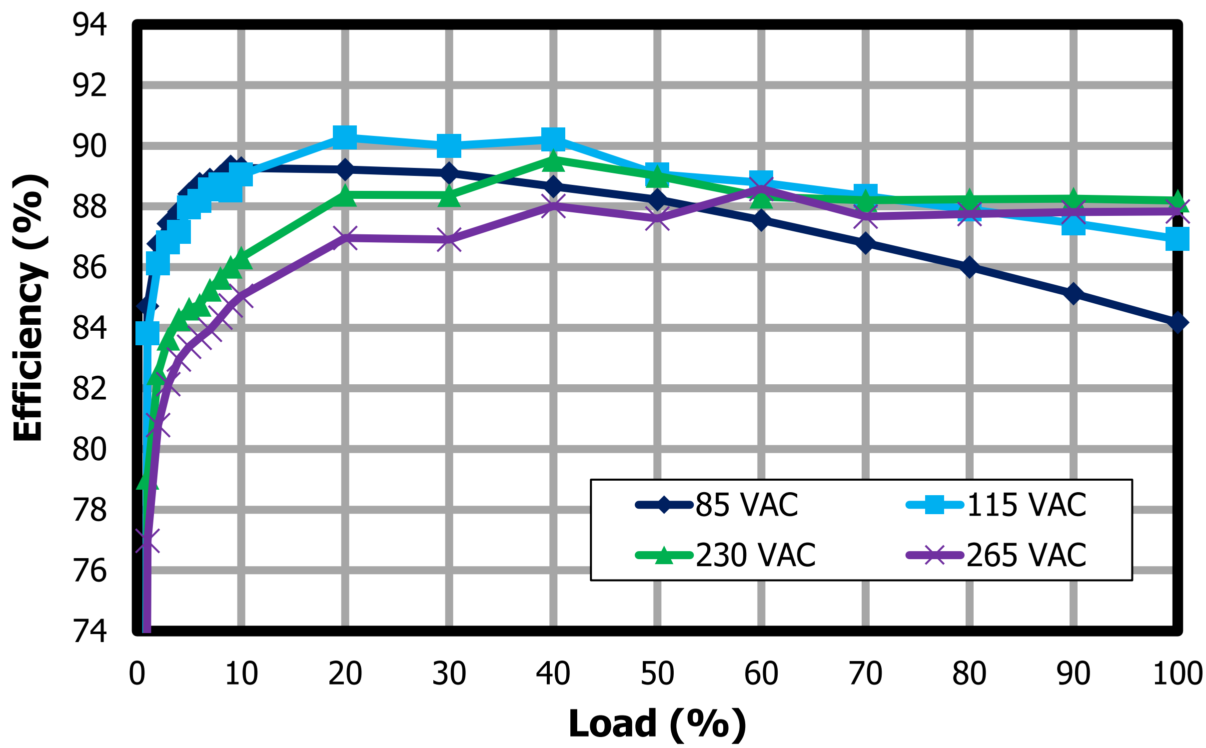



**Figure 20** – Efficiency vs. Percentage Load.

## 11.3 Average and 10% Efficiency

### 11.3.1 Average and 10% Efficiency at 115 VAC

| Load | $P_{IN}$ | $V_{OUT}$ at PCB | $I_{OUT}$ | $P_{OUT}$ | Efficiency at PCB | Average Efficiency | DOE6 Limit |
|---|---|---|---|---|---|---|---|
| **(A)** | **(W)** | **(VDC)** | **($mA_{DC}$)** | **(W)** | **(%)** | **(%)** | **(%)** |
| 100% | 81.3 | 11.8 | 6000 | 70.8 | 87.1 | **88.7** | 88 |
| 75% | 60.5 | 11.9 | 4500 | 53.4 | 88.2 | | |
| 50% | 40.4 | 12 | 3000 | 35.9 | 89.0 | | |
| 25% | 20.0 | 12.1 | 1500 | 18.1 | 90.3 | | |
| 10% | 8.20 | 12.2 | 600 | 7.31 | 89.1 | --- | --- |

**Table 11 –** Average and 10% Efficiency at 115 VAC.

### 11.3.2 Average and 10% Efficiency at 230 VAC

| Load | $P_{IN}$ | $V_{OUT}$ at PCB | $I_{OUT}$ | $P_{OUT}$ | Efficiency at PCB | Average Efficiency | DOE6 Limit |
|---|---|---|---|---|---|---|---|
| **(A)** | **(W)** | **(VDC)** | **($mA_{DC}$)** | **(W)** | **(%)** | **(%)** | **(%)** |
| 100% | 80.2 | 11.8 | 6000 | 70.8 | 88.3 | **88.6** | 88 |
| 75% | 60.5 | 11.9 | 4500 | 53.4 | 88.2 | | |
| 50% | 40.2 | 11.9 | 3000 | 35.8 | 89 | | |
| 25% | 20.2 | 12.0 | 1500 | 18.0 | 89.1 | | |
| 10% | 8.43 | 12.1 | 600 | 7.28 | 86.4 | --- | --- |

**Table 12** – Average and 10% Efficiency at 230 VAC.

### 11.4 No-Load Input Power

Test Condition: Soak for 15 minutes each line and 1 minute integration time.

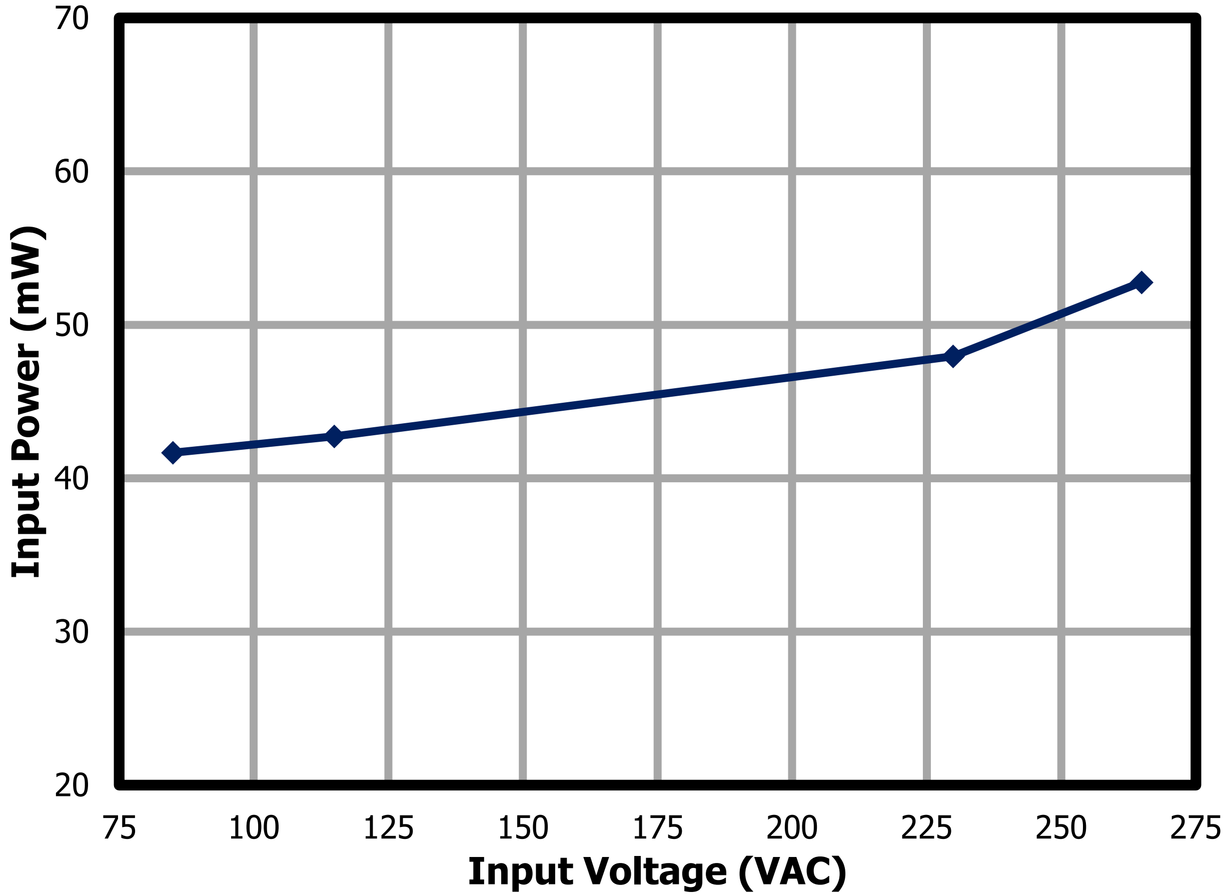



**Figure 21** – No-Load Input Power vs. Line at Room Temperature.

## 11.5 Line Regulation

Test Condition: Soak for 15 minutes for each line.

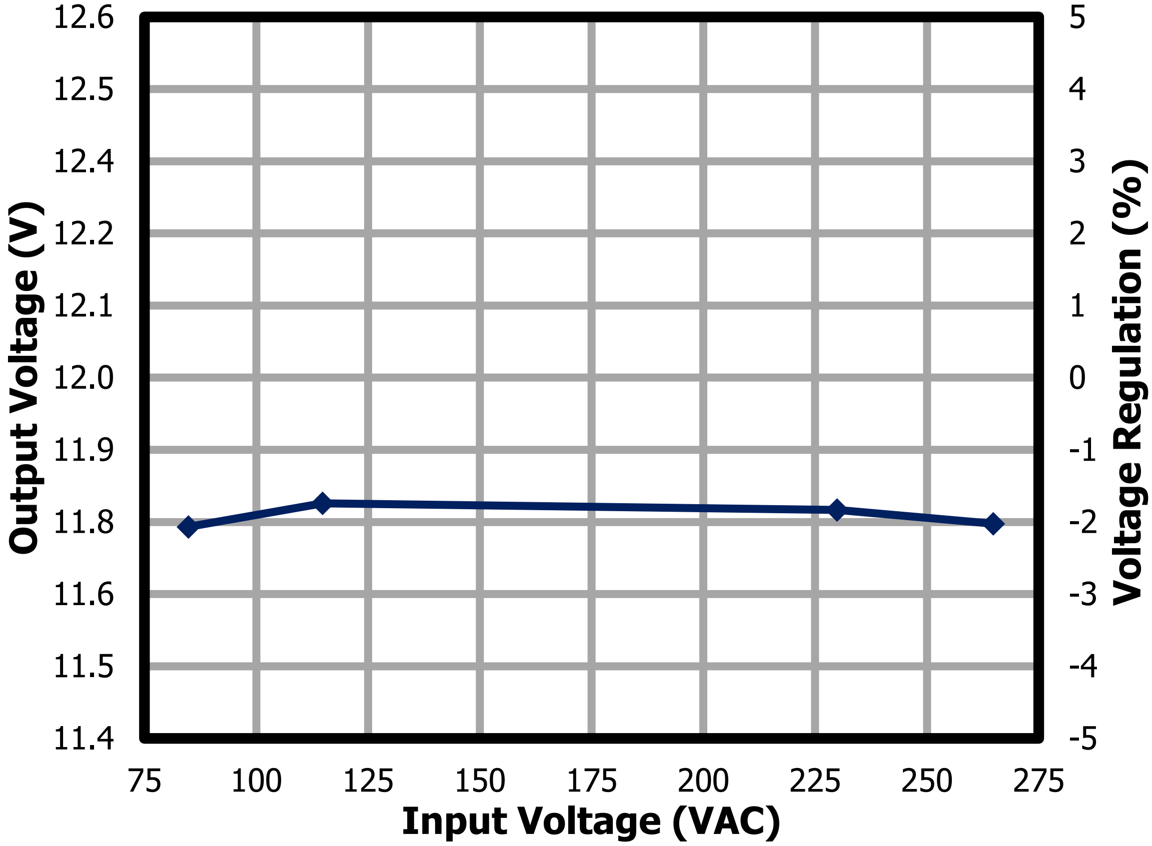



**Figure 22** – Output Voltage vs. Line Voltage.

## 11.6 Load Regulation

Test Condition: Soak for 15 minutes each line at full load, and 10 seconds for each load.

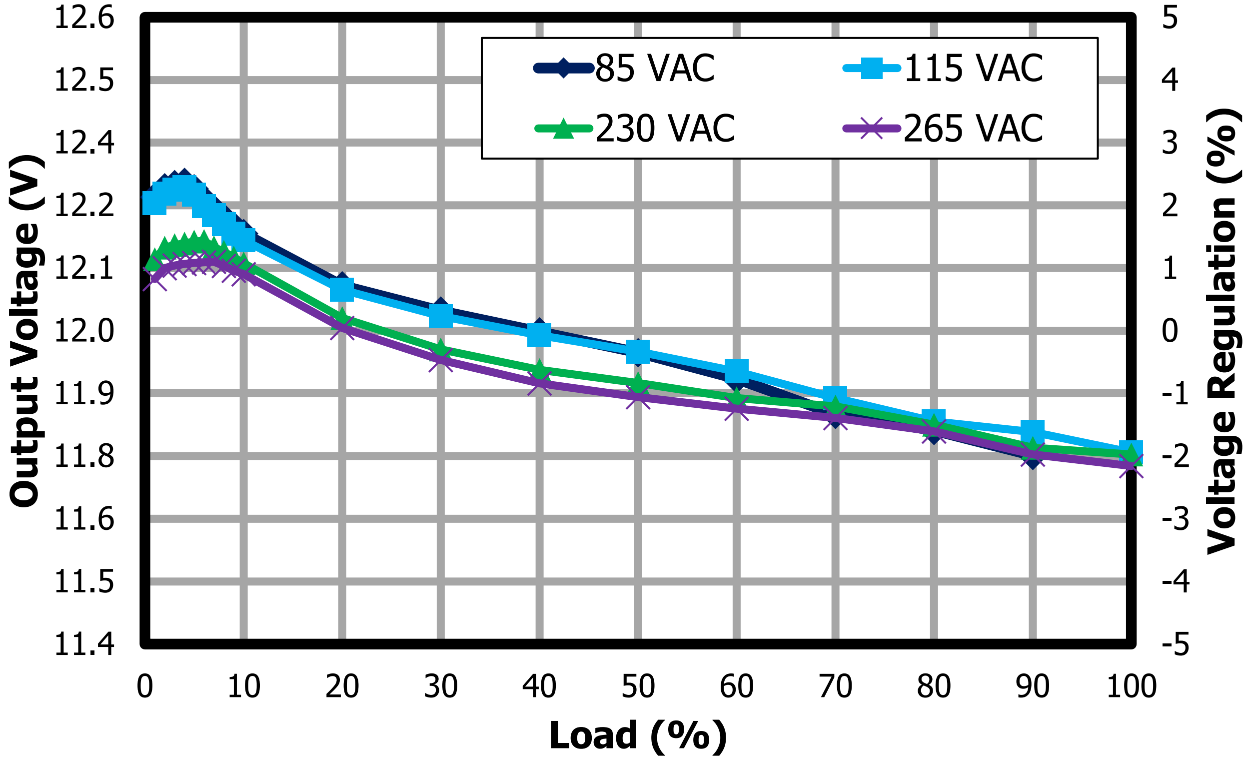



**Figure 23** – Output Voltage vs. Percent Load.

# 12 Waveforms

## 12.1 Load Transient Response

Test Condition: Dynamic load frequency = 33.3 Hz, Duty cycle = 50 %
Slew Rate = 0.8 A / μs

### 12.1.1 Transient 10% - 100% Load Change

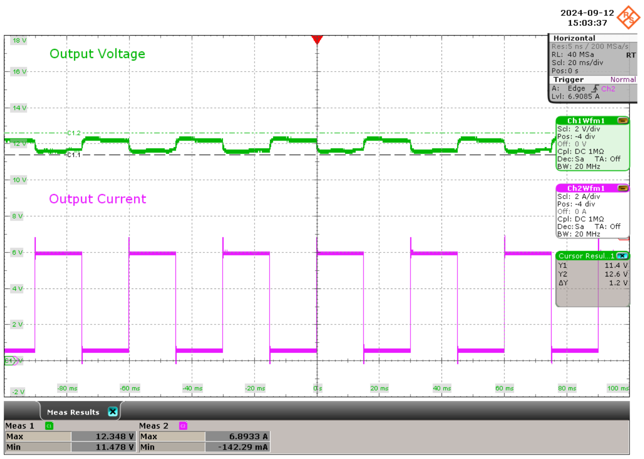



**Figure 24** – 85 VAC 60 Hz.
CH1: Output Voltage, 2 V / div., 20 ms / div.
CH2: Output Current, 2 A / div., 20 ms / div.
$V_{OUT}$: $V_{MAX}$: 12.3 V
$V_{MIN}$: 11.5 V

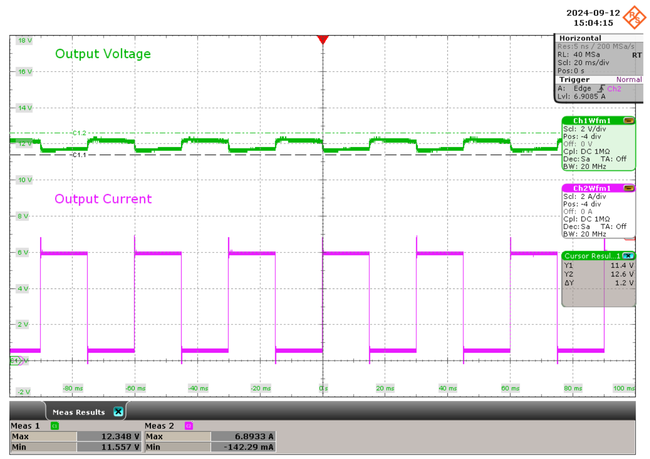



**Figure 25** – 115 VAC 60 Hz.
CH1: Output Voltage, 2 V / div., 20 ms / div.
CH2: Output Current, 2 A / div., 20 ms / div.
$V_{OUT}$: $V_{MAX}$: 12.3 V
$V_{MIN}$: 11.6 V

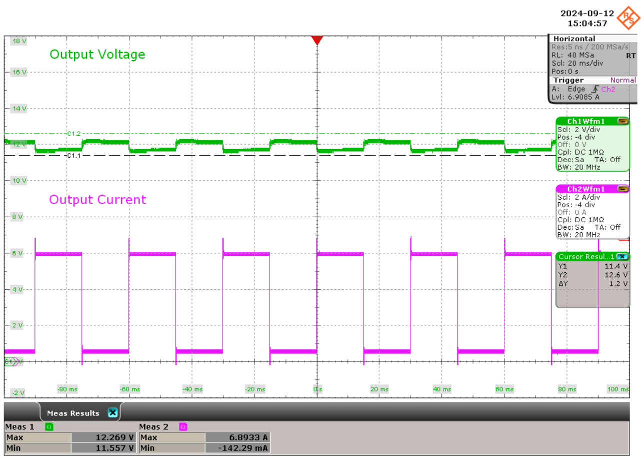



**Figure 26** – 230 VAC 50 Hz.
CH1: Output Voltage, 2 V / div., 20 ms / div.
CH2: Output Current, 2 A / div., 20 ms / div.
$V_{OUT}$: $V_{MAX}$: 12.3 V
$V_{MIN}$: 11.6 V

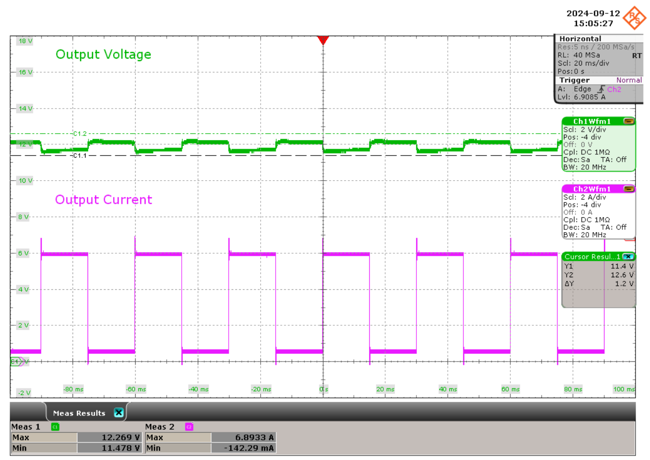



**Figure 27** – 265 VAC 50 Hz.
CH1: Output Voltage, 2 V / div., 20 ms / div.
CH2: Output Current, 2 A / div., 20 ms / div.
$V_{OUT}$: $V_{MAX}$: 12.3 V
$V_{MIN}$: 11.5 V

### 12.1.2 Transient 50% - 100% Load Change

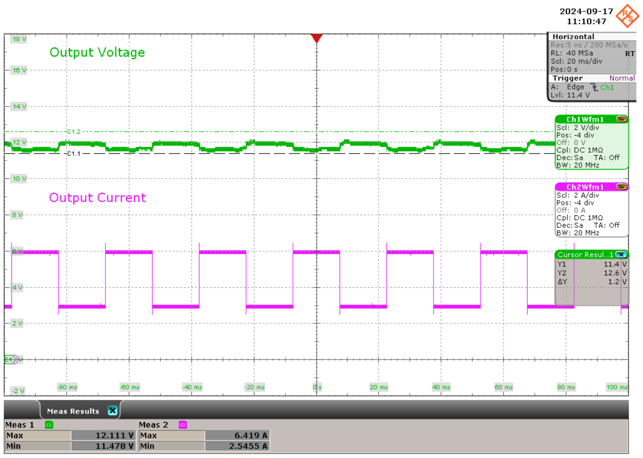



**Figure 28** – 85 VAC 60 Hz.
CH1: Output Voltage, 2 V / div., 20 ms / div.
CH2: Output Current, 2 A / div., 20 ms / div.
$V_{OUT}$: $V_{MAX}$: 12.1 V
$V_{MIN}$: 11.5 V

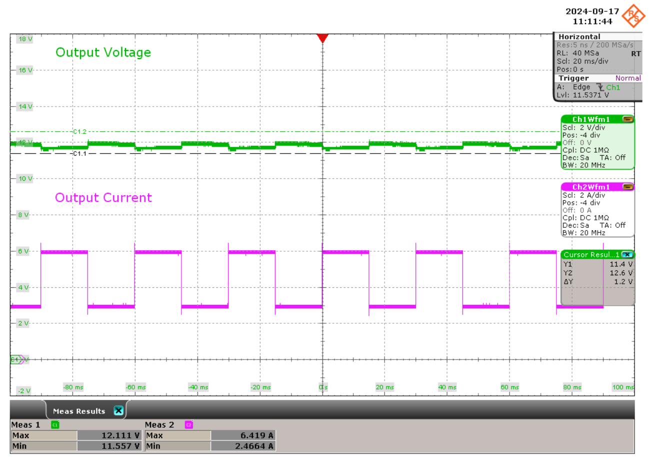



**Figure 29** – 115 VAC 60 Hz.
CH1: Output Voltage, 2 V / div., 20 ms / div.
CH2: Output Current, 2 A / div., 20 ms / div.
$V_{OUT}$: $V_{MAX}$: 12.1 V
$V_{MIN}$: 11.6 V

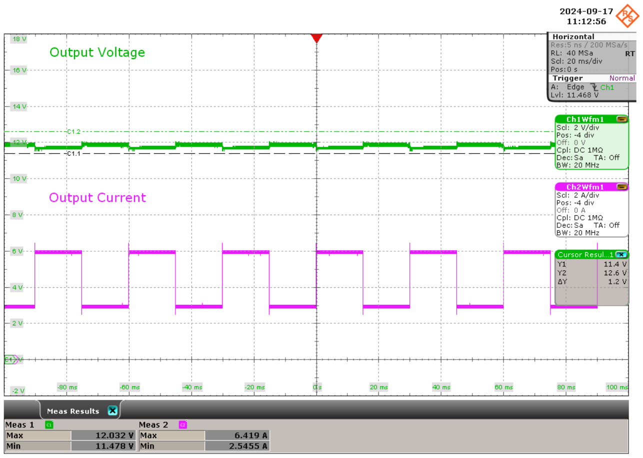



**Figure 30** – 230 VAC 50 Hz.
CH1: Output Voltage, 2 V / div., 20 ms / div.
CH2: Output Current, 2 A / div., 20 ms / div.
$V_{OUT}$: $V_{MAX}$: 12.0 V
$V_{MIN}$: 11.5 V

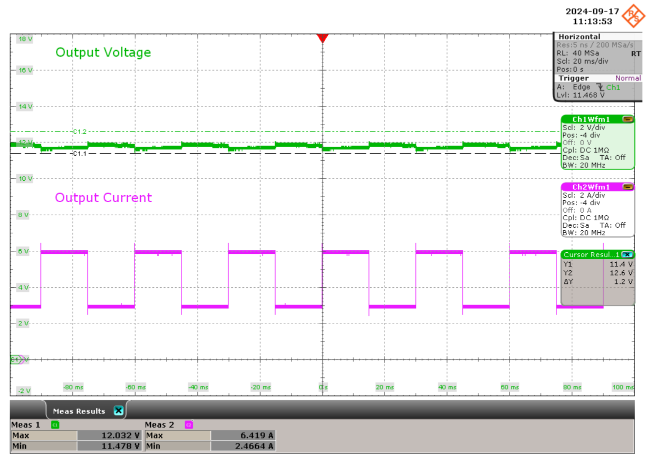



**Figure 31** – 265 VAC 50 Hz.
CH1: Output Voltage, 2 V / div., 20 ms / div.
CH2: Output Current, 2 A / div., 20 ms / div.
$V_{OUT}$: $V_{MAX}$: 12.0 V
$V_{MIN}$: 11.5 V

## 12.2 Output Start-up

### 12.2.1 Full Load CC Mode

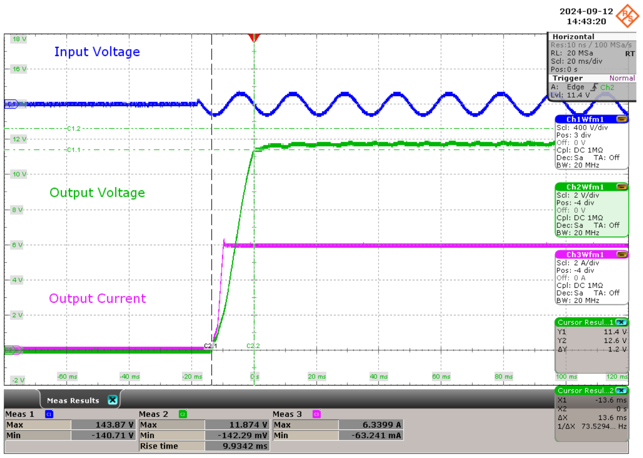



**Figure 32** – 85 VAC 60 Hz.
CH1: Input Voltage, 400 V / div., 20 ms / div.
CH2: Output Voltage, 2 V / div., 20 ms / div.
CH3: Output Current, 2 A / div., 20 ms / div.
Rise Time = 13.6 ms.
$V_{MAX}$ = 11.9 V

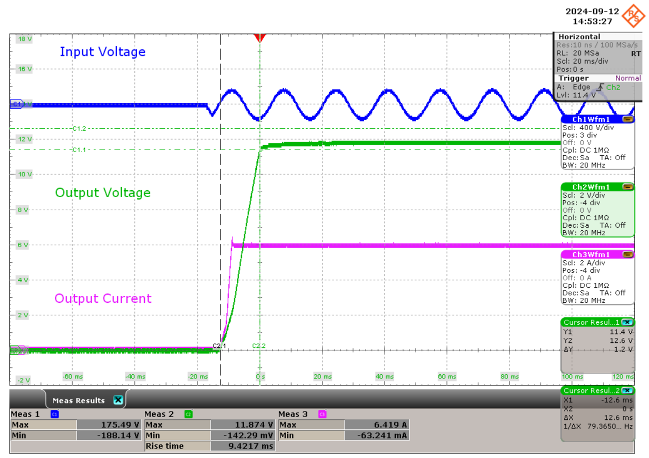



**Figure 33** – 115 VAC 60 Hz.
CH1: Input Voltage, 400 V / div., 20 ms / div.
CH2: Output Voltage, 2 V / div., 20 ms / div.
CH3: Output Current, 2 A / div., 20 ms / div.
Rise Time = 12.6 ms.
$V_{MAX}$ = 11.9 V

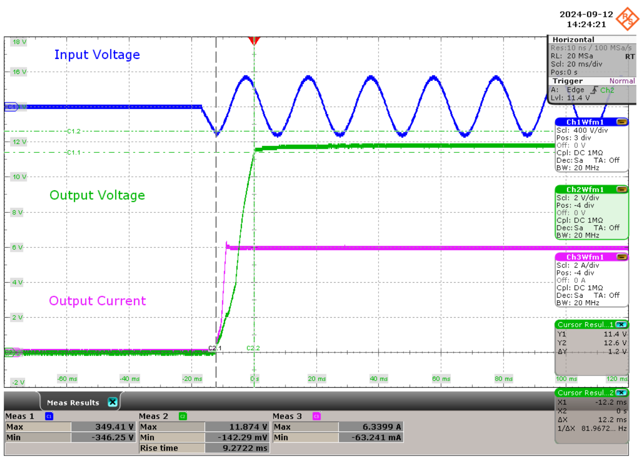



**Figure 34** – 230 VAC 50 Hz.
CH1: Input Voltage, 400 V / div., 20 ms / div.
CH2: Output Voltage, 2 V / div., 20 ms / div.
CH3: Output Current, 2 A / div., 20 ms / div.
Rise Time = 12.2 ms.
$V_{MAX}$ = 11.9 V

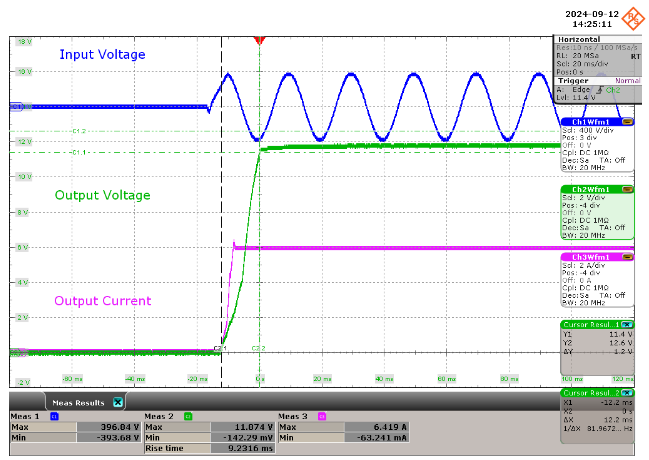



**Figure 35** – 265 VAC 50 Hz.
CH1: Input Voltage, 400 V / div., 20 ms / div.
CH2: Output Voltage, 2 V / div., 20 ms / div.
CH3: Output Current, 2 A / div., 20 ms / div.
Rise Time = 12.2 ms.
$V_{MAX}$ = 11.9 V

### 12.2.2 Full Load CR Mode

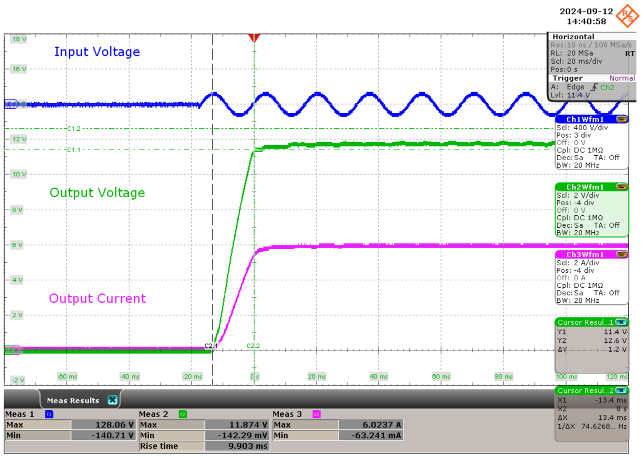



**Figure 36** – 85 VAC 60 Hz.
CH1: Input Voltage, 400 V / div., 20 ms / div.
CH2: Output Voltage, 2 V / div., 20 ms / div.
CH3: Output Current, 2 A / div., 20 ms / div.
Rise Time = 13.4 ms.
$V_{MAX}$ = 11.9 V

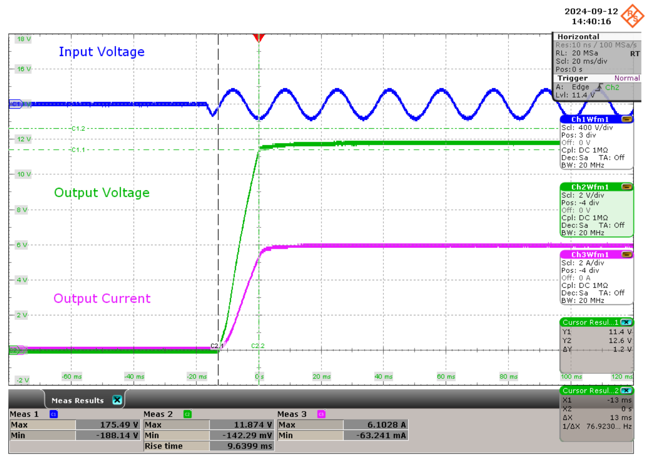



**Figure 37** – 115 VAC 60 Hz.
CH1: Input Voltage, 400 V / div., 20 ms / div.
CH2: Output Voltage, 2 V / div., 20 ms / div.
CH3: Output Current, 2 A / div., 20 ms / div.
Rise Time = 13 ms.
$V_{MAX}$ = 11.9 V

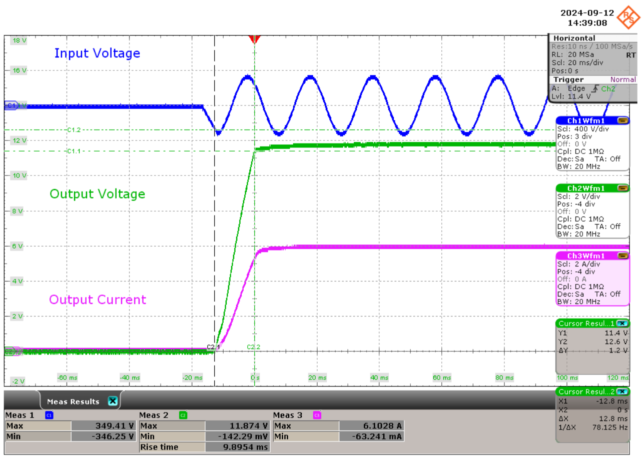



**Figure 38** – 230 VAC 50 Hz.
CH1: Input Voltage, 400 V / div., 20 ms / div.
CH2: Output Voltage, 2 V / div., 20 ms / div.
CH3: Output Current, 2 A / div., 20 ms / div.
Rise Time = 12.8 ms.
$V_{MAX}$ = 11.9 V

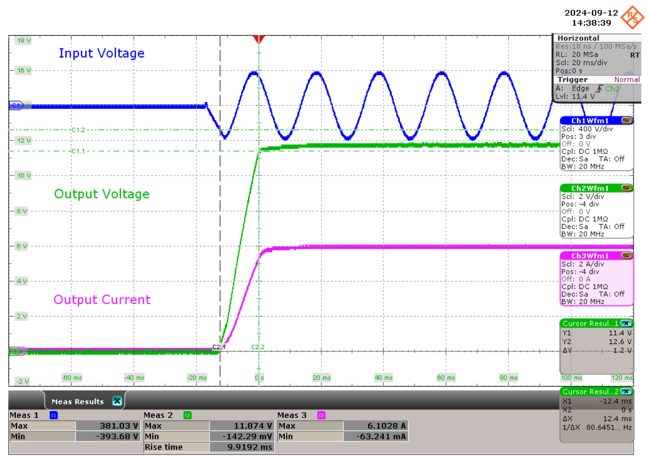



**Figure 39** – 265 VAC 50 Hz.
CH1: Input Voltage, 400 V / div., 20 ms / div.
CH2: Output Voltage, 2 V / div., 20 ms / div.
CH3: Output Current, 2 A / div., 20 ms / div.
Rise Time = 12.4 ms.
$V_{MAX}$ = 11.9 V

### 12.2.3 No Load

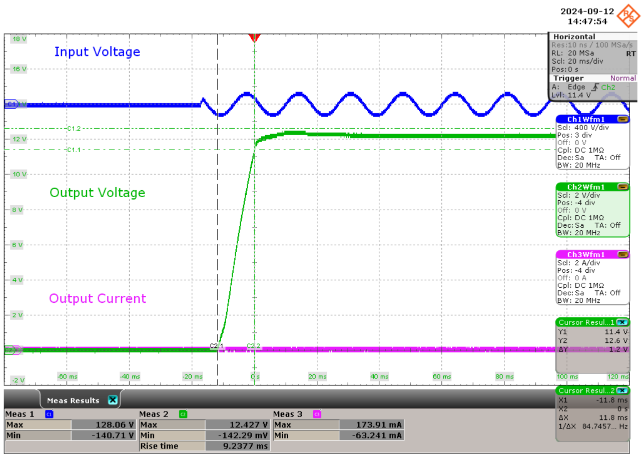



**Figure 40** – 85 VAC 60 Hz.
CH1: Input Voltage, 400 V / div., 20 ms / div.
CH2: Output Voltage, 2 V / div., 20 ms / div.
CH3: Output Current, 2 A / div., 20 ms / div.
Rise Time = 11.8 ms.
$V_{MAX}$ = 12.4 V

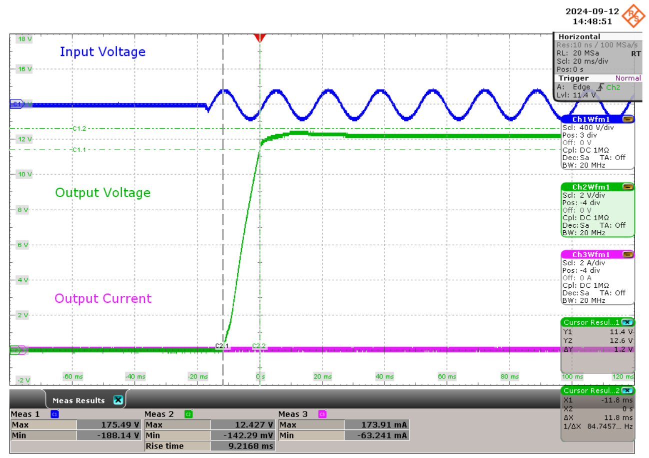



**Figure 41** – 115 VAC 60 Hz.
CH1: Input Voltage, 400 V / div., 20 ms / div.
CH2: Output Voltage, 2 V / div., 20 ms / div.
CH3: Output Current, 2 A / div., 20 ms / div.
Rise Time = 11.8 ms.
$V_{MAX}$ = 12.4 V

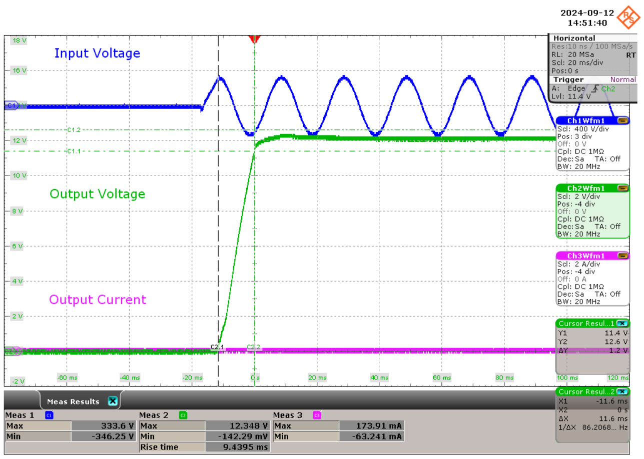



**Figure 42** – 230 VAC 50 Hz.
CH1: Input Voltage, 400 V / div., 20 ms / div.
CH2: Output Voltage, 2 V / div., 20 ms / div.
CH3: Output Current, 2 A / div., 20 ms / div.
Rise Time = 11.6 ms.
$V_{MAX}$ = 12.3 V

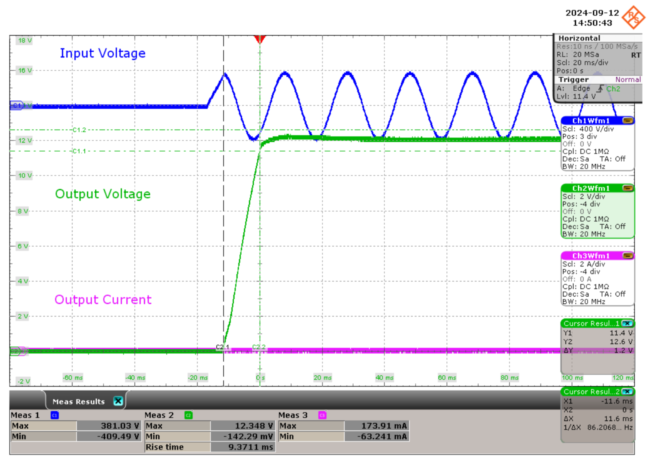



**Figure 43** – 265 VAC 50 Hz.
CH1: Input Voltage, 400 V / div., 20 ms / div.
CH2: Output Voltage, 2 V / div., 20 ms / div.
CH3: Output Current, 2 A / div., 20 ms / div.
Rise Time = 11.6 ms.
$V_{MAX}$ = 12.3 V

## 12.3 Switching Waveforms

### 12.3.1 Primary MOSFET Drain-Source Voltage and Current at Normal Operation

#### 12.3.1.1 Full Load

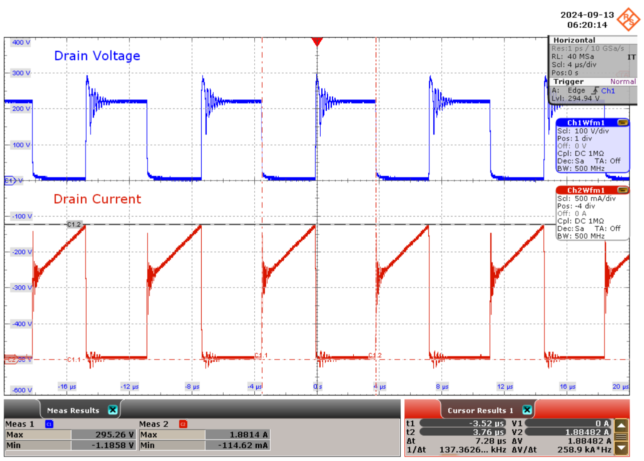



**Figure 44** – 85 VAC 60 Hz.
CH1: Drain Voltage, 100 V / div., 4 µs / div.
CH2: Drain Current, 500 mA / div., 4 µs / div.
Drain Voltage$_{(MAX)}$ = 295 V
Drain Current$_{(MAX)}$ = 1.88 A

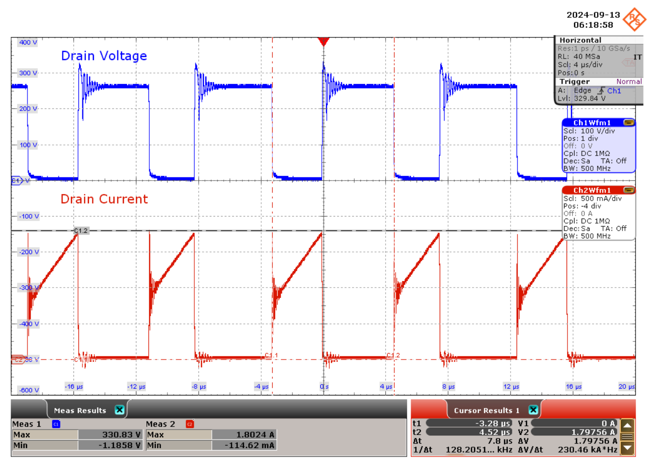



**Figure 45** – 115 VAC 60 Hz.
CH1: Drain Voltage, 100 V / div., 4 µs / div.
CH2: Drain Current, 500 mA / div., 4 µs / div.
Drain Voltage$_{(MAX)}$ = 331 V
Drain Current$_{(MAX)}$ = 1.8 A

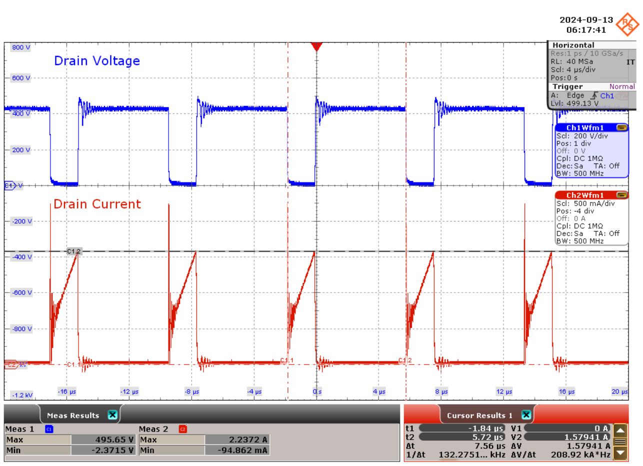



**Figure 46** – 230 VAC 50 Hz.
CH1: Drain Voltage, 200 V / div., 4 µs / div.
CH2: Drain Current, 500 mA / div., 4 µs / div.
Drain Voltage$_{(MAX)}$ = 496 V
Drain Current$_{(MAX)}$ = 2.24 A

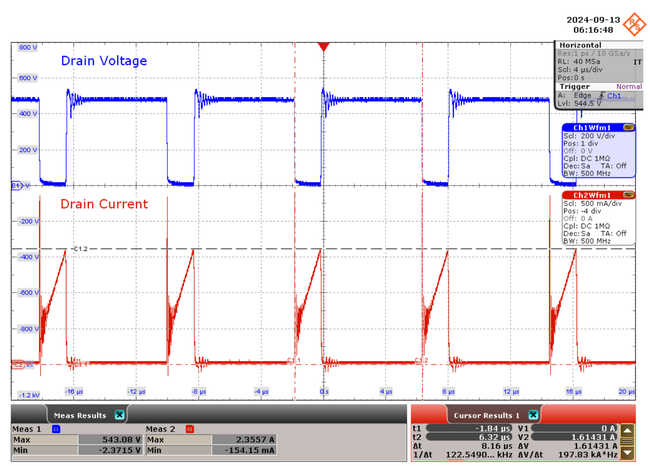



**Figure 47** – 265 VAC 50 Hz.
CH1: Drain Voltage, 200 V / div., 4 µs / div.
CH2: Drain Current, 500 mA / div., 4 µs / div.
Drain Voltage$_{(MAX)}$ = 543 V
Drain Current$_{(MAX)}$ = 2.36 A

#### 12.3.1.2 No Load

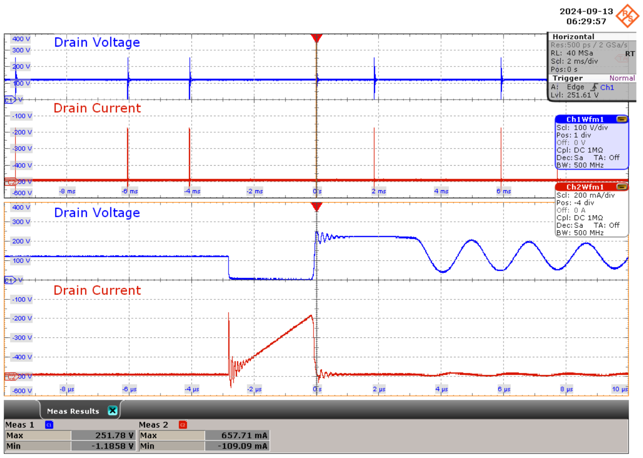



**Figure 48** – 85 VAC 60 Hz.
CH1: Drain Voltage, 100 V / div., 2 ms / div.
CH2: Drain Current, 200 mA / div., 2 ms / div.
Zoom: 2 µs / div.
Drain Voltage$_{(MAX)}$ = 252 V
Drain Current$_{(MAX)}$ = 658 mA

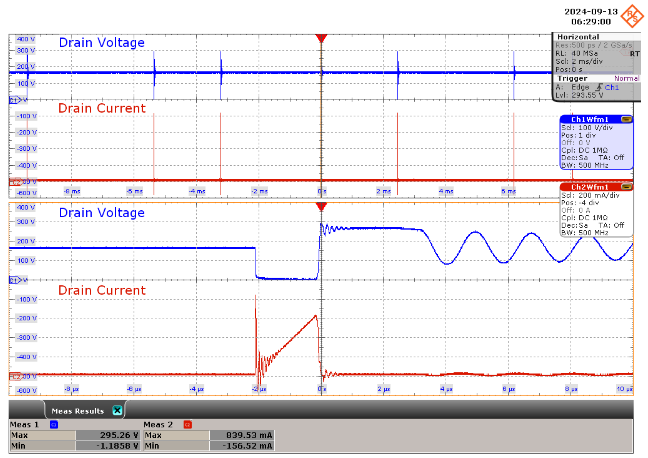



**Figure 49** – 115 VAC 60 Hz.
CH1: Drain Voltage, 100 V / div., 2 ms / div.
CH2: Drain Current, 200 mA / div., 2 ms / div.
Zoom: 2 µs / div.
Drain Voltage$_{(MAX)}$ = 295 V
Drain Current$_{(MAX)}$ = 840 mA

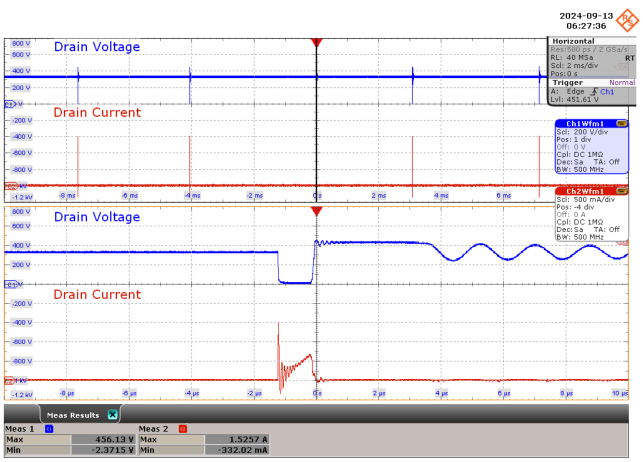



**Figure 50** – 230 VAC 50 Hz.
CH1: Drain Voltage, 200 V / div., 2 ms / div.
CH2: Drain Current, 500 mA / div., 2 ms / div.
Zoom: 2 µs / div.
Drain Voltage$_{(MAX)}$ = 456 V
Drain Current$_{(MAX)}$ = 1.53 A

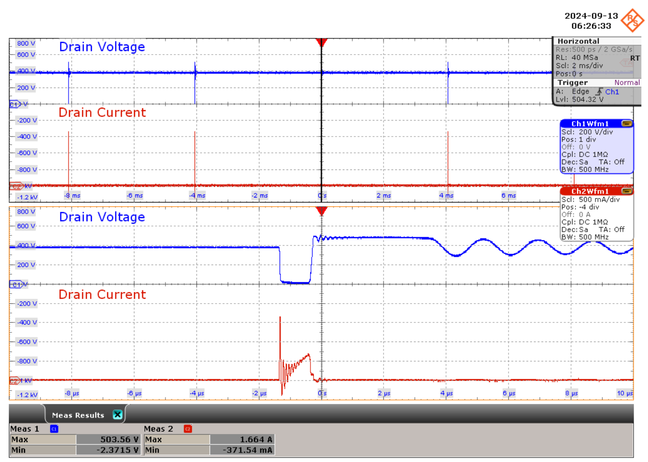



**Figure 51** – 265 VAC 50 Hz.
CH1: Drain Voltage, 200 V / div., 2 ms / div.
CH2: Drain Current, 500 mA / div., 2 ms / div.
Zoom: 2 µs / div.
Drain Voltage$_{(MAX)}$ = 504 V
Drain Current$_{(MAX)}$ = 1.66 A

### 12.3.2 Primary MOSFET Drain-Source Voltage and Current at Start-up Operation

#### 12.3.2.1 Full Load

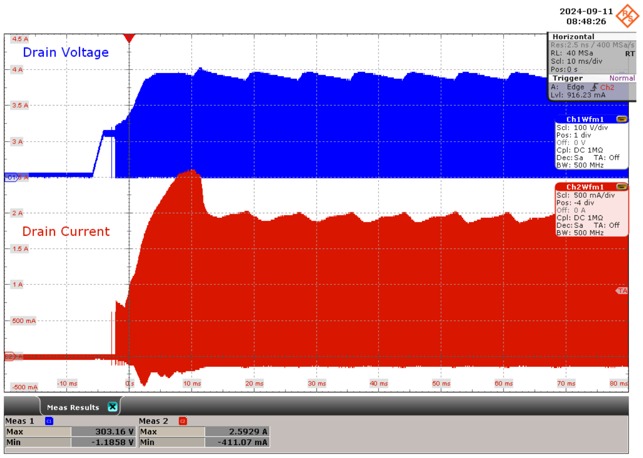



**Figure 52** – 85 VAC 60 Hz.
CH1: Drain Voltage, 100 V / div., 10 ms / div.
CH2: Drain Current, 500 mA / div., 10 ms / div.
Drain Voltage$_{(MAX)}$ = 303 V
Drain Current$_{(MAX)}$ = 2.59 A

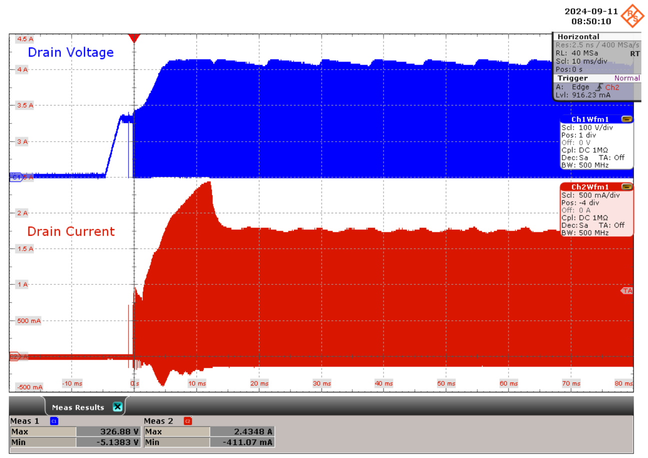



**Figure 53** – 115 VAC 60 Hz.
CH1: Drain Voltage, 100 V / div., 10 ms / div.
CH2: Drain Current, 500 mA / div., 10 ms / div.
Drain Voltage$_{(MAX)}$ = 327 V
Drain Current$_{(MAX)}$ = 2.43 A

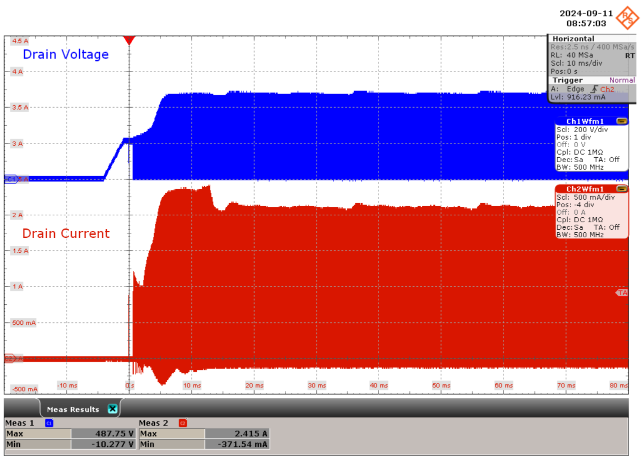



**Figure 54** – 230 VAC 50 Hz.
CH1: Drain Voltage, 200 V / div., 10 ms / div.
CH2: Drain Current, 500 mA / div., 10 ms / div.
Drain Voltage$_{(MAX)}$ = 488 V
Drain Current$_{(MAX)}$ = 2.41 A

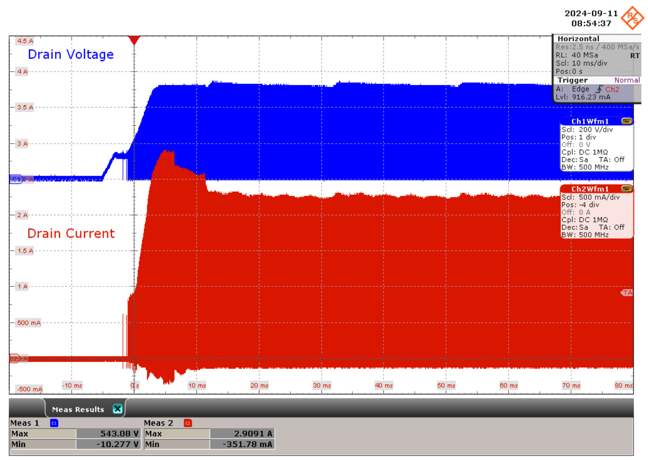



**Figure 55** – 265 VAC 50 Hz.
CH1: Drain Voltage, 200 V / div., 10 ms / div.
CH2: Drain Current, 500 mA / div., 10 ms / div.
Drain Voltage$_{(MAX)}$ = 543 V
Drain Current$_{(MAX)}$ = 2.91 A

### 12.3.2.2 No Load

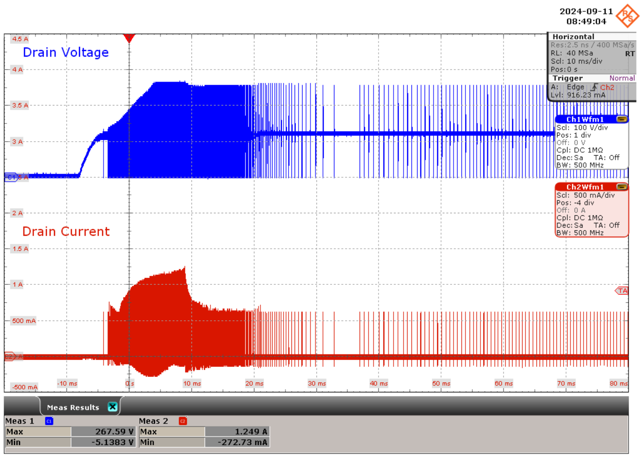



**Figure 56** – 85 VAC 60 Hz.
CH1: Drain Voltage, 100 V / div., 10 ms / div.
CH2: Drain Current, 500 mA / div., 10 ms / div.
Drain Voltage$_{(MAX)}$ = 268 V
Drain Current$_{(MAX)}$ = 1.25 A

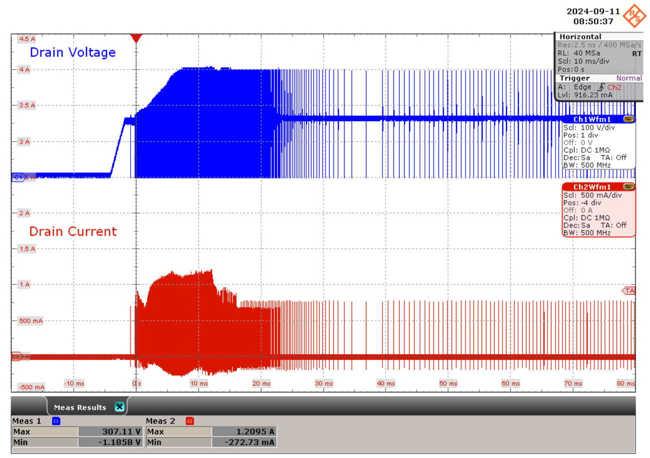



**Figure 57** – 115 VAC 60 Hz.
CH1: Drain Voltage, 100 V / div., 10 ms / div.
CH2: Drain Current, 500 mA / div., 10 ms / div.
Drain Voltage$_{(MAX)}$ = 307 V
Drain Current$_{(MAX)}$ = 1.21 A

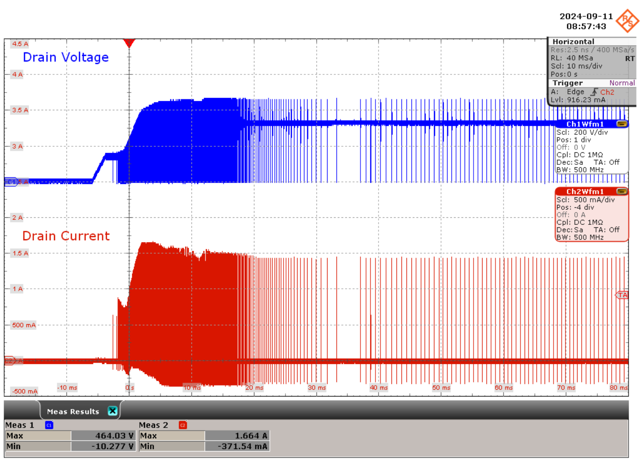



**Figure 58** – 230 VAC 50 Hz.
CH1: Drain Voltage, 200 V / div., 10 ms / div.
CH2: Drain Current, 500 mA / div., 10 ms / div.
Drain Voltage$_{(MAX)}$ = 464 V
Drain Current$_{(MAX)}$ = 1.66 A

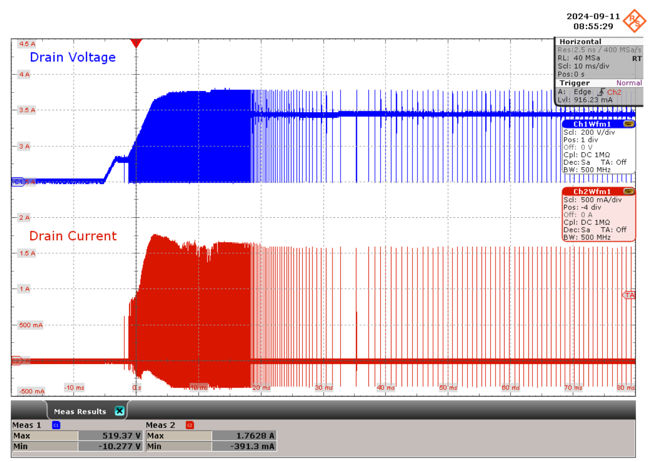



**Figure 59** – 265 VAC 50 Hz.
CH1: Drain Voltage, 200 V / div., 10 ms / div.
CH2: Drain Current, 500 mA / div., 10 ms / div.
Drain Voltage$_{(MAX)}$ = 519 V
Drain Current$_{(MAX)}$ = 1.76 A

### 12.3.3 Freewheeling Diode Voltage and Current at Normal Operation

#### 12.3.3.1 Full Load

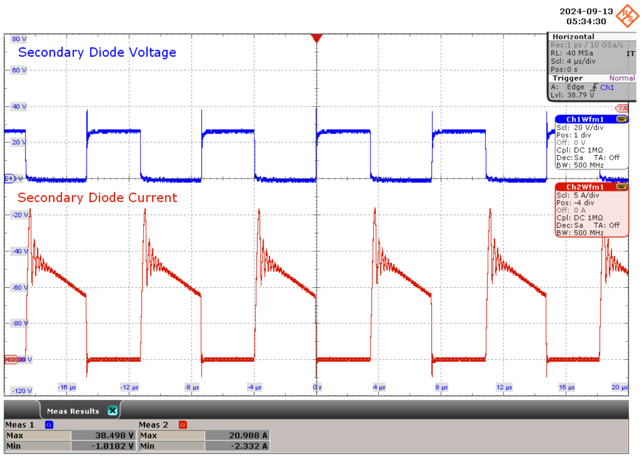



**Figure 60** – 85 VAC 60 Hz.
CH1: Secondary Diode Voltage, 20 V / div., 4 µs / div.
CH2: Secondary Diode Current, 5 A / div., 4 µs / div.
Secondary Diode Voltage$_{(MAX)}$ = 38.5 V
Secondary Diode Current$_{(MAX)}$ = 21 A

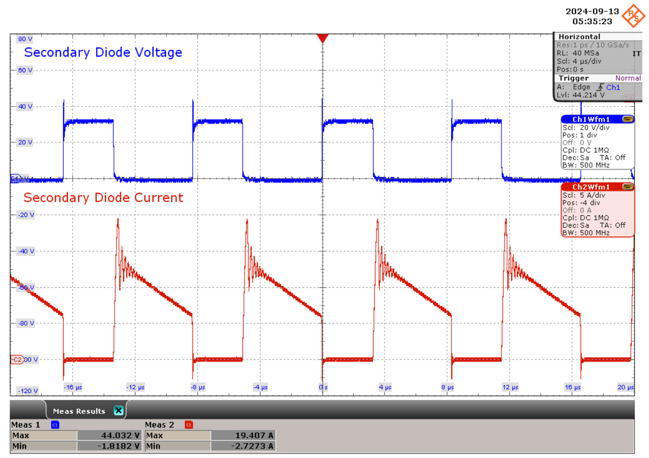



**Figure 61** – 115 VAC 60 Hz.
CH1: Secondary Diode Voltage, 20 V / div., 4 µs / div.
CH2: Secondary Diode Current, 5 A / div., 4 µs / div.
Secondary Diode Voltage$_{(MAX)}$ = 44.0 V
Secondary Diode Current$_{(MAX)}$ = 19.4 A

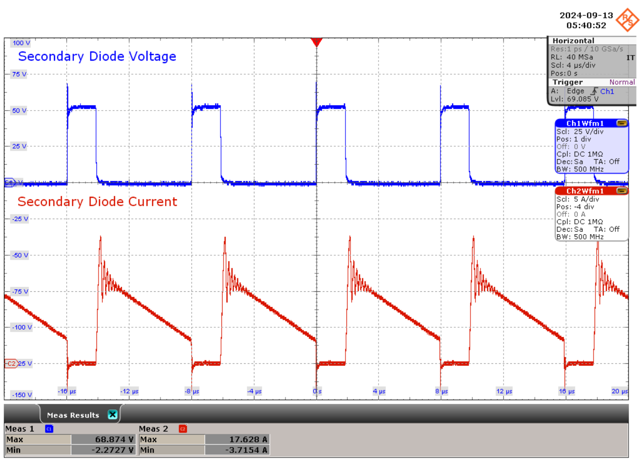



**Figure 62** – 230 VAC 50 Hz.
CH1: Secondary Diode Voltage, 25 V / div., 4 µs / div.
CH2: Secondary Diode Current, 5 A / div., 4 µs / div.
Secondary Diode Voltage$_{(MAX)}$ = 68.9 V
Secondary Diode Current$_{(MAX)}$ = 17.6 A

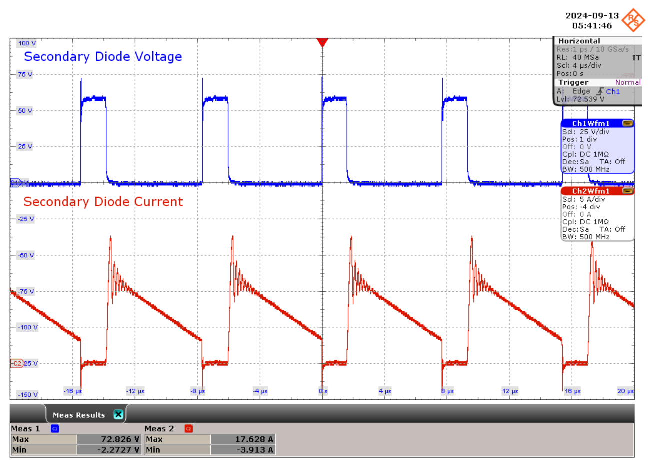



**Figure 63** – 265 VAC 50 Hz.
CH1: Secondary Diode Voltage, 25 V / div., 4 µs / div.
CH2: Secondary Diode Current, 5 A / div., 4 µs / div.
Secondary Diode Voltage$_{(MAX)}$ = 72.8 V
Secondary Diode Current$_{(MAX)}$ = 17.6 A

#### 12.3.3.2 No Load

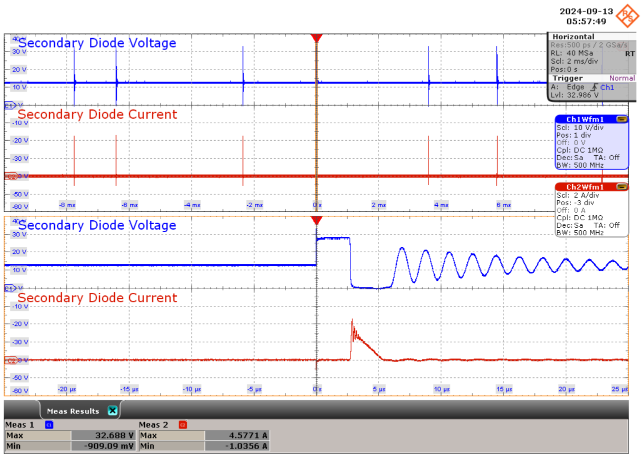



**Figure 64** – 85 VAC 60 Hz.
CH1: Secondary Diode Voltage, 10 V / div., 2 ms / div.
CH2: Secondary Diode Current, 2 A / div., 2 ms / div.
Zoom: 5 µs / div.
Secondary Diode Voltage$_{(MAX)}$ = 32.7 V
Secondary Diode Current$_{(MAX)}$ = 4.58 A

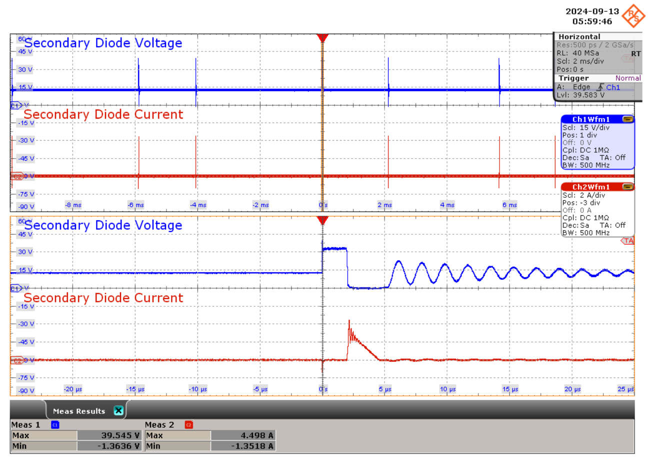



**Figure 65** – 115 VAC 60 Hz.
CH1: Secondary Diode Voltage, 15 V / div., 2 ms / div.
CH2: Secondary Diode Current, 2 A / div., 2 ms / div.
Zoom: 5 µs / div.
Secondary Diode Voltage$_{(MAX)}$ = 39.5 V
Secondary Diode Current$_{(MAX)}$ = 4.5 A

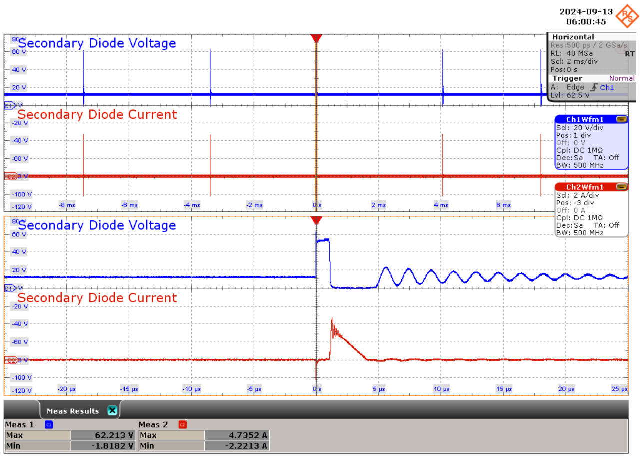



**Figure 66** – 230 VAC 50 Hz.
CH1: Secondary Diode Voltage, 20 V / div., 2 ms / div.
CH2: Secondary Diode Current, 2 A / div., 2 ms / div.
Zoom: 5 µs / div.
Secondary Diode Voltage$_{(MAX)}$ = 62.2 V
Secondary Diode Current$_{(MAX)}$ = 4.74 A

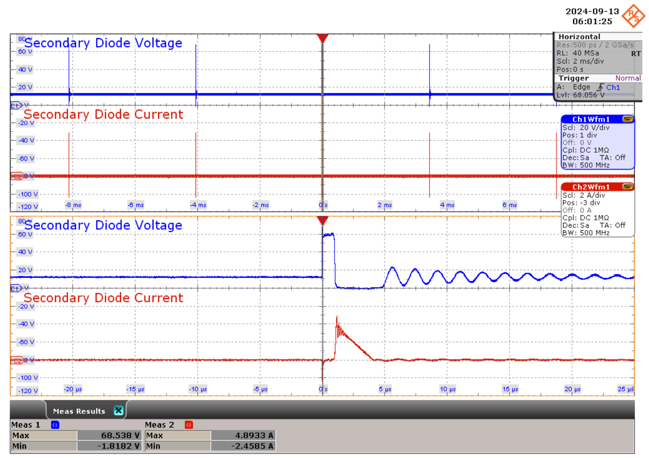



**Figure 67** – 265 VAC 50 Hz.
CH1: Secondary Diode Voltage, 20 V / div., 2 ms / div.
CH2: Secondary Diode Current, 2 A / div., 2 ms / div.
Zoom: 5 µs / div.
Secondary Diode Voltage$_{(MAX)}$ = 68.5 V
Secondary Diode Current$_{(MAX)}$ = 4.89 A

### 12.3.4 Freewheeling Diode Voltage and Current at Start-Up

#### 12.3.4.1 Full Load

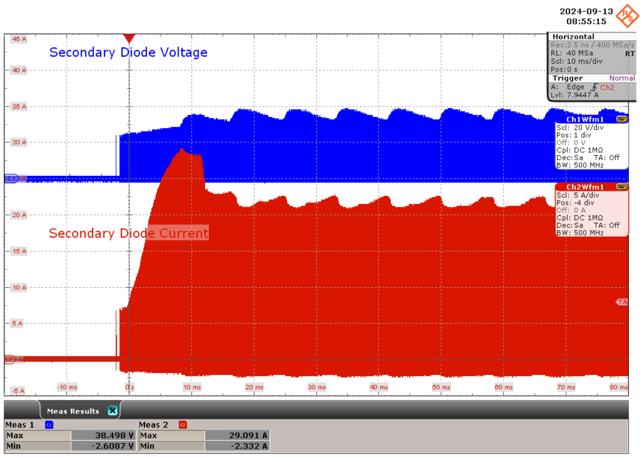



**Figure 68** – 85 VAC 60 Hz.
CH1: Secondary Diode Voltage, 20 V / div., 10 ms / div.
CH2: Secondary Diode Current, 5 A / div., 10 ms / div.
Secondary Diode Voltage$_{(MAX)}$ = 38.5 V
Secondary Diode Current$_{(MAX)}$ = 29.1 A

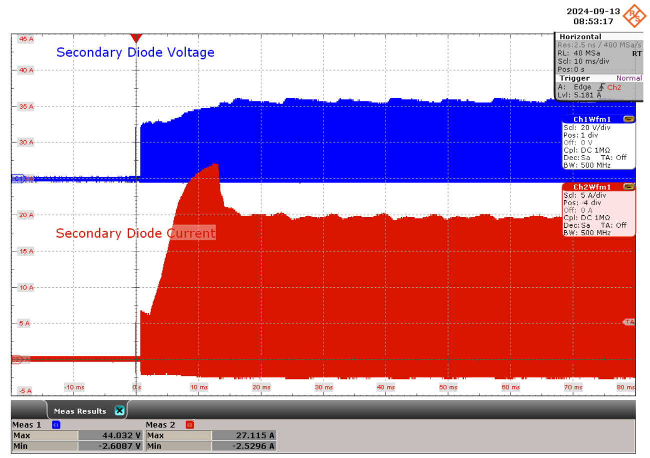



**Figure 69** – 115 VAC 60 Hz.
CH1: Secondary Diode Voltage, 20 V / div., 10 ms / div.
CH2: Secondary Diode Current, 5 A / div., 10 ms / div.
Secondary Diode Voltage$_{(MAX)}$ = 44.0 V
Secondary Diode Current$_{(MAX)}$ = 27.1 A

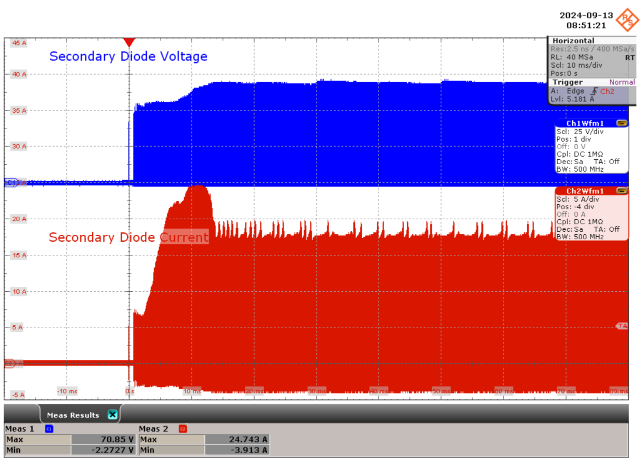



**Figure 70** – 230 VAC 50 Hz.
CH1: Secondary Diode Voltage, 25 V / div., 10 ms / div.
CH2: Secondary Diode Current, 5 A / div., 10 ms / div.
Secondary Diode Voltage$_{(MAX)}$ = 70.9 V
Secondary Diode Current$_{(MAX)}$ = 24.7 A

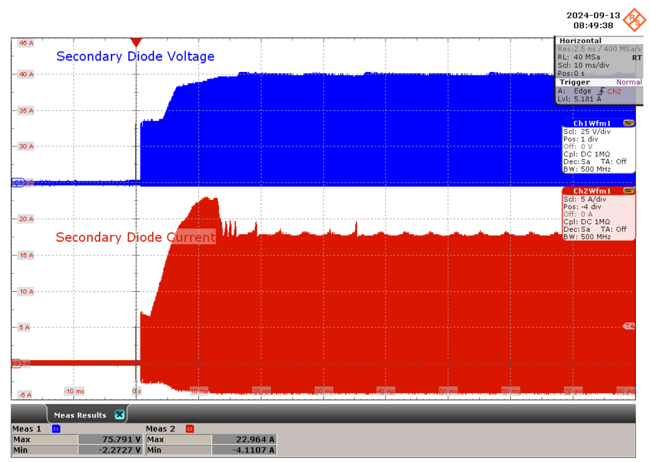



**Figure 71** – 265 VAC 50 Hz.
CH1: Secondary Diode Voltage, 25 V / div., 10 ms / div.
CH2: Secondary Diode Current, 5 A / div., 10 ms / div.
Secondary Diode Voltage$_{(MAX)}$ = 75.8 V
Secondary Diode Current$_{(MAX)}$ = 23 A

#### 12.3.4.2 No Load

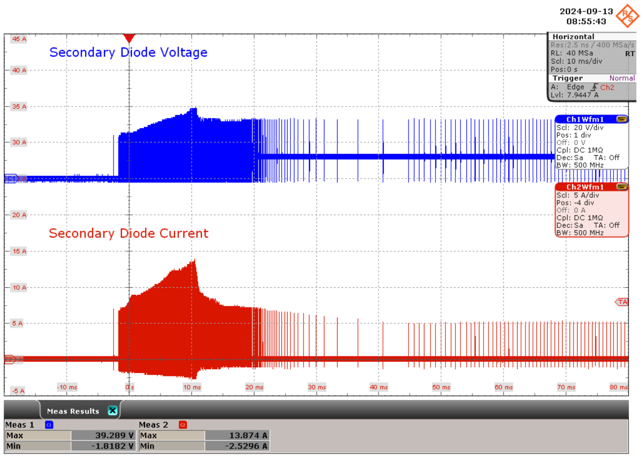



**Figure 72** – 85 VAC 60 Hz.
CH1: Secondary Diode Voltage, 20 V / div., 10 ms / div.
CH2: Secondary Diode Current, 5 A / div., 10 ms / div.
Secondary Diode Voltage$_{(MAX)}$ = 39.3 V
Secondary Diode Current$_{(MAX)}$ = 13.9 A

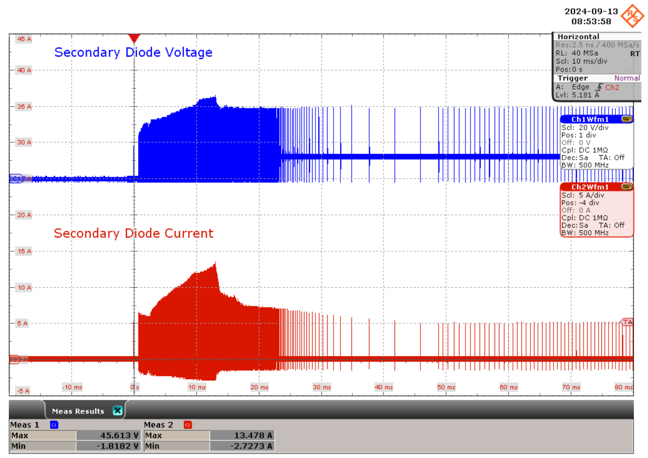



**Figure 73** – 115 VAC 60 Hz.
CH1: Secondary Diode Voltage, 20 V / div., 10 ms / div.
CH2: Secondary Diode Current, 5 A / div., 10 ms / div.
Secondary Diode Voltage$_{(MAX)}$ = 45.6 V
Secondary Diode Current$_{(MAX)}$ = 13.5 A

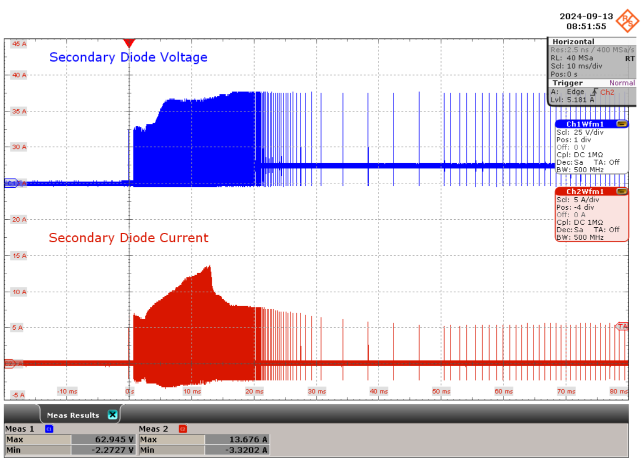



**Figure 74** – 230 VAC 50 Hz.
CH1: Secondary Diode Voltage, 25 V / div., 10 ms / div.
CH2: Secondary Diode Current, 5 A / div., 10 ms / div.
Secondary Diode Voltage$_{(MAX)}$ = 63 V
Secondary Diode Current$_{(MAX)}$ = 13.7 A

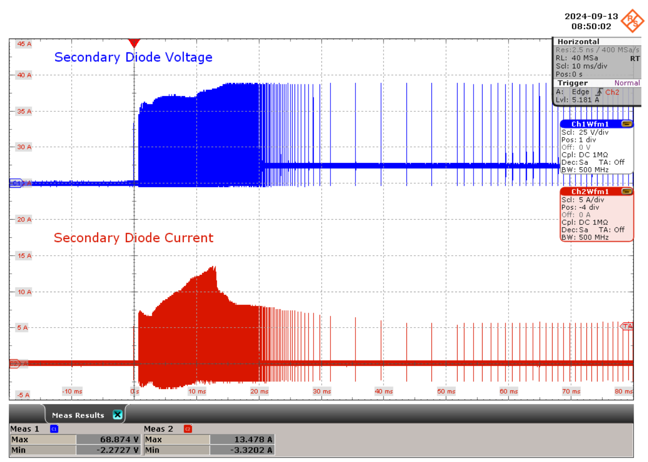



**Figure 75** – 265 VAC 50 Hz.
CH1: Secondary Diode Voltage, 25 V / div., 10 ms / div.
CH2: Secondary Diode Current, 5 A / div., 10 ms / div.
Secondary Diode Voltage$_{(MAX)}$ = 68.9 V
Secondary Diode Current$_{(MAX)}$ = 13.5 A

## 12.4 Brown-In and Brown-Out

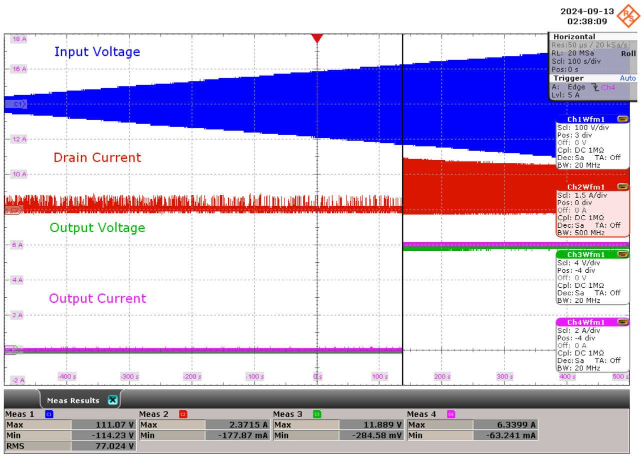



**Figure 76** – Brown-In Full Load.
CH1: Input Voltage, 100 V / div., 100 s / div.
CH2: Drain Current, 1.5 A / div., 100 s / div.
CH3: Output Voltage, 4 V / div., 100 s / div.
CH4: Output Current, 2 A / div., 100 s / div.
$V_{BROWN-IN}$ = 77.0 $V_{RMS}$

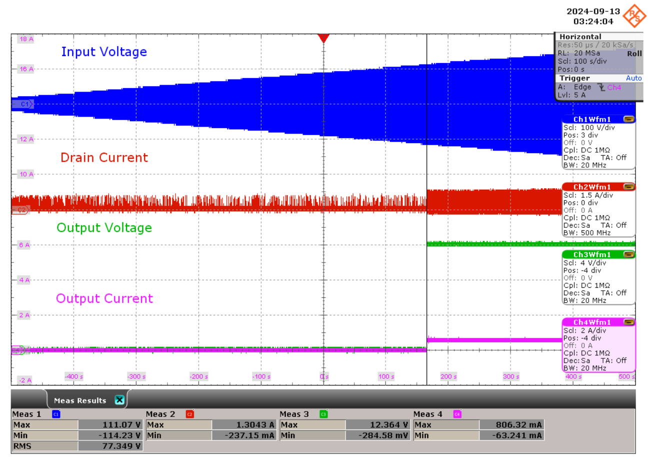



**Figure 77** – Brown-In 10% Load.
CH1: Input Voltage, 100 V / div., 100 s / div.
CH2: Drain Current, 1.5 A / div., 100 s / div.
CH3: Output Voltage, 4 V / div., 100 s / div.
CH4: Output Current, 2 A / div., 100 s / div.
$V_{BROWN-IN}$ = 77.3 $V_{RMS}$

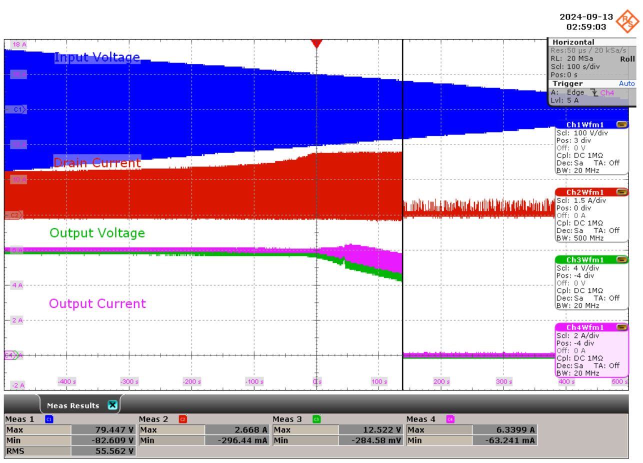



**Figure 78** – Brown-Out Full Load.
CH1: Input Voltage, 100 V / div., 100 s / div.
CH2: Drain Current, 1.5 A / div., 100 s / div.
CH3: Output Voltage, 4 V / div., 100 s / div.
CH4: Output Current, 2 A / div., 100 s / div.
$V_{BROWN-IN}$ = 55.6 $V_{RMS}$

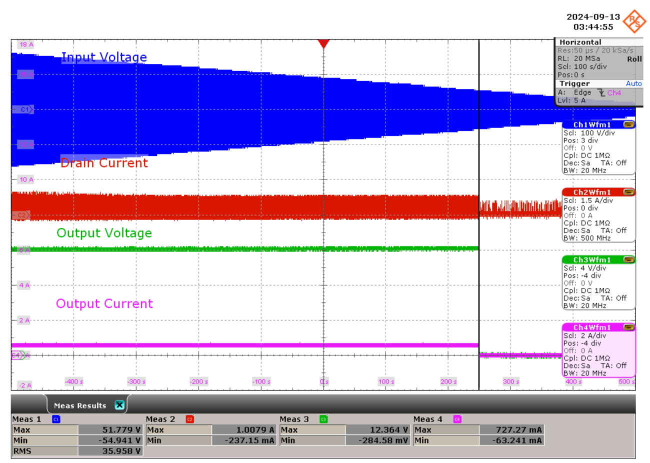



**Figure 79** – Brown-Out 10% Load.
CH1: Input Voltage, 100 V / div., 100 s / div.
CH2: Drain Current, 1.5 A / div., 100 s / div.
CH3: Output Voltage, 4 V / div., 100 s / div.
CH4: Output Current, 2 A / div., 100 s / div.
$V_{BROWN-IN}$ = 36 $V_{RMS}$

## 12.5 Output Voltage Ripple

### 12.5.1 Ripple Measurement Technique

For DC output ripple measurements, a modified oscilloscope test probe was utilized to minimize spurious signals due to pick-up. Details of the probe modification are provided in the Figures below.

The 4987BA probe adapter is affixed with two capacitors tied in parallel across the probe tip. The capacitors are one (1) 0.1 μF / 50 V ceramic type and one (1) 47 μF / 50 V aluminum electrolytic. The aluminum electrolytic type capacitor is polarized, so proper polarity across DC outputs must be maintained (see below).

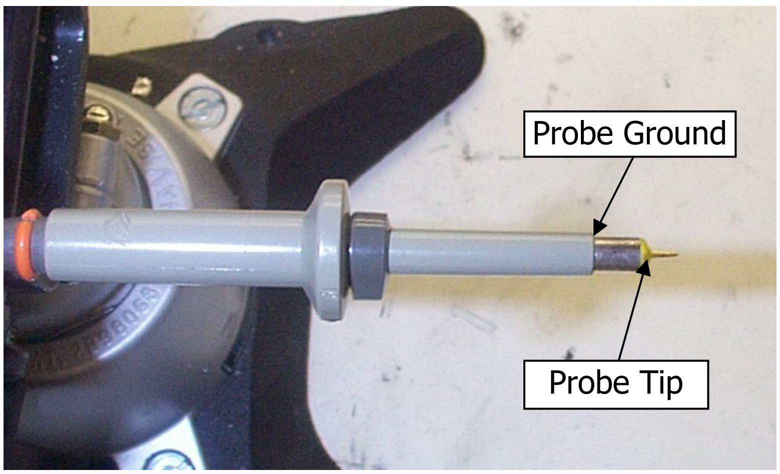



**Figure 80** – Oscilloscope Probe Prepared for Ripple Measurement. (End Cap and Ground Lead Removed.)

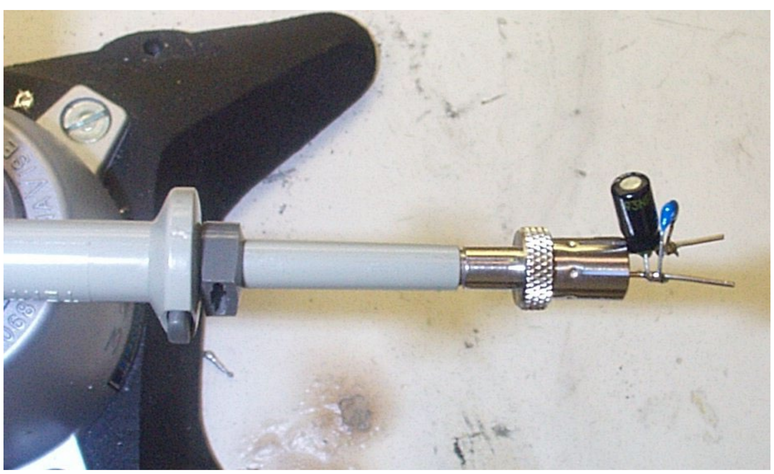


**Figure 81** – Oscilloscope Probe with Probe Master (**www.probemaster.com**) 4987A BNC Adapter. (Modified with wires for ripple measurement, and two parallel decoupling capacitors added.)

### 12.5.2 Measurement Results

Note: All ripple measurements were taken at PCB end.

#### 12.5.2.1 100% Load Condition

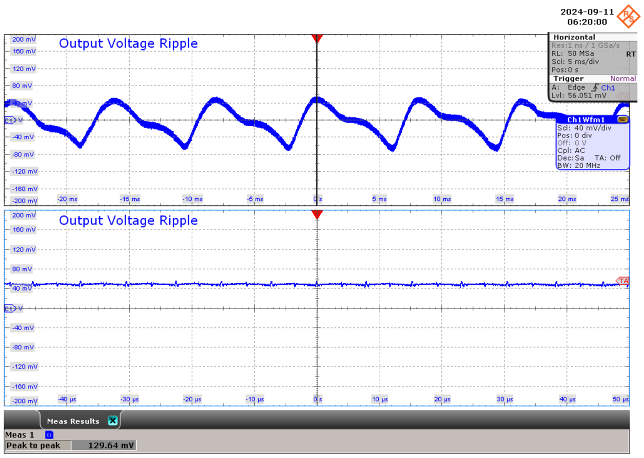



**Figure 82** – 85 VAC 60 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 µs / div.
Output Ripple = 130 mV

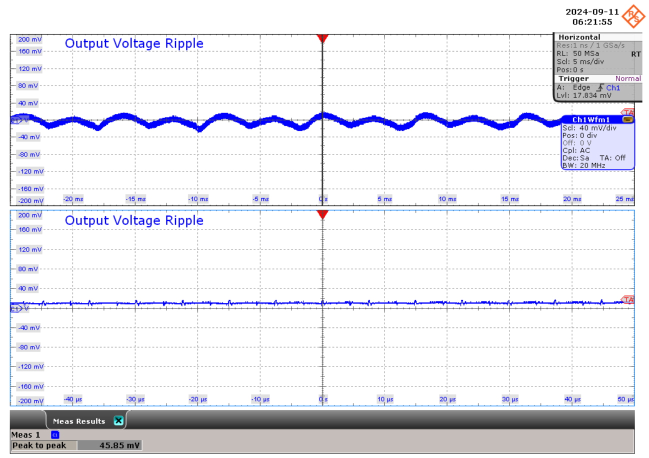



**Figure 83** – 115 VAC 60 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 µs / div.
Output Ripple = 45.9 mV

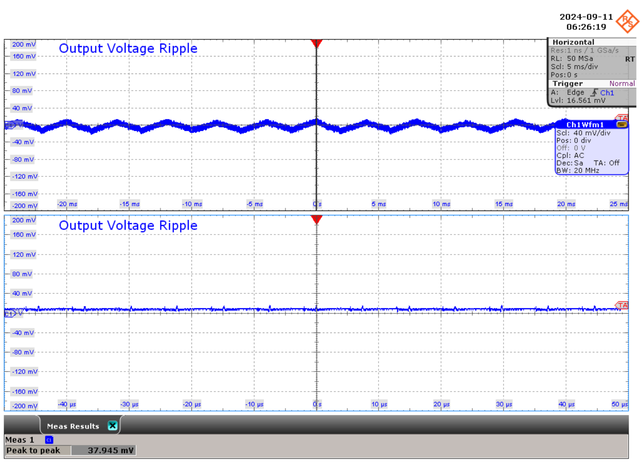



**Figure 84** – 230 VAC 50 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 µs / div.
Output Ripple = 38 mV

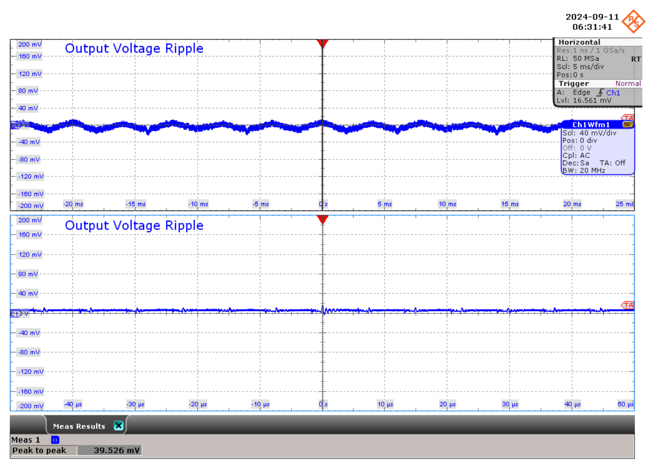



**Figure 85** – 265 VAC 50 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 µs / div.
Output Ripple = 40 mV

## 12.5.2.2 75% Load Condition

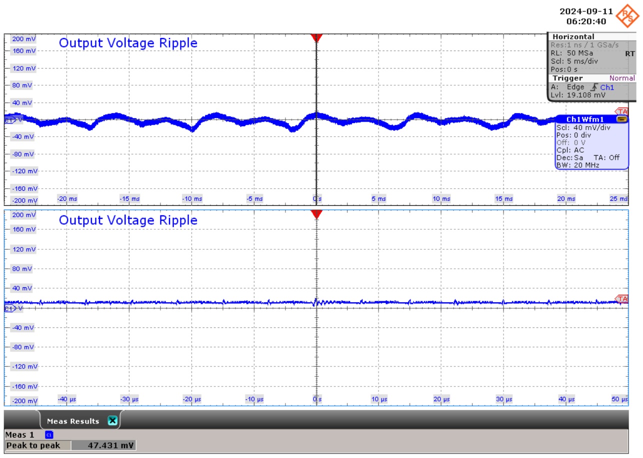



**Figure 86** – 85 VAC 60 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 μs / div.
Output Ripple = 47.4 mV

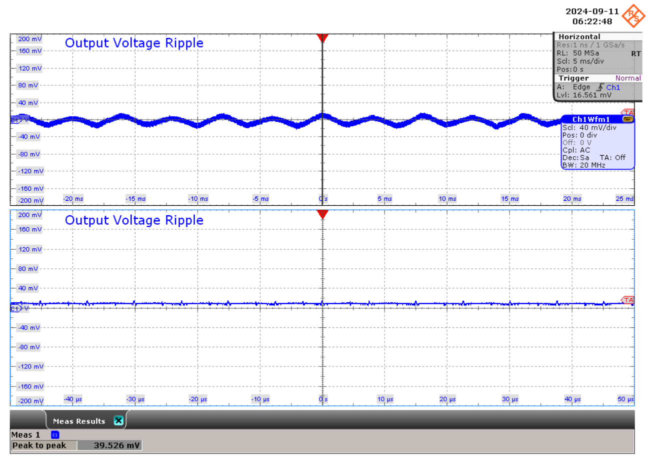



**Figure 87** – 115 VAC 60 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 μs / div.
Output Ripple = 40 mV

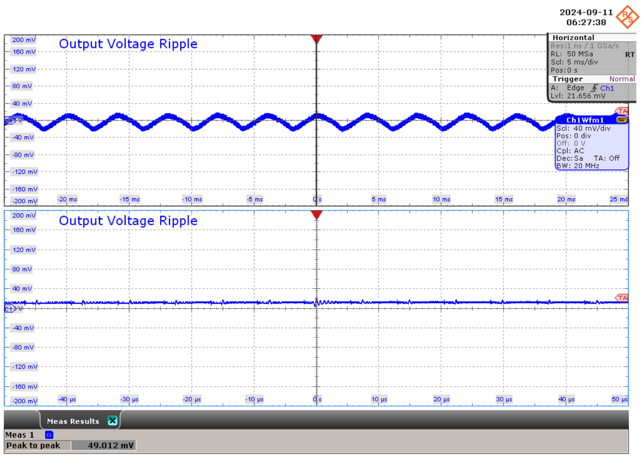



**Figure 88** – 230 VAC 50 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 μs / div.
Output Ripple = 49.0 mV

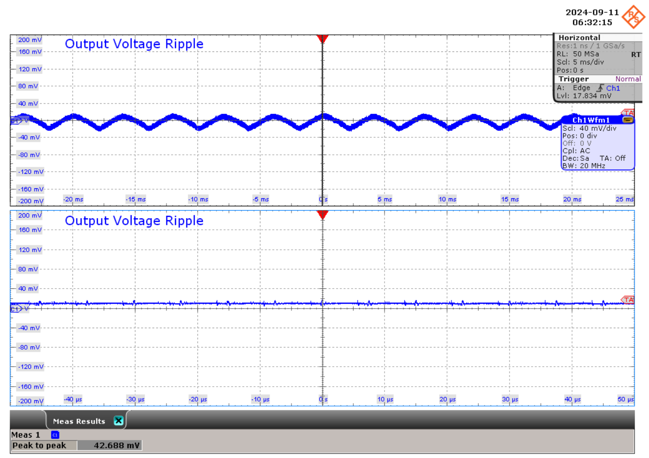



**Figure 89** – 265 VAC 50 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 μs / div.
Output Ripple = 42.7 mV

### 12.5.2.3 50% Load Condition

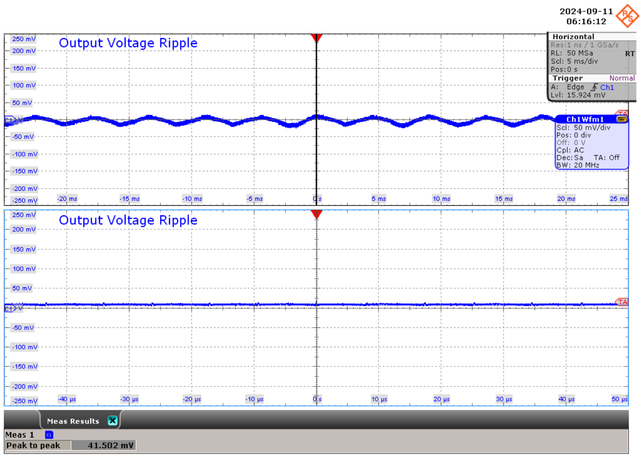



**Figure 90** – 85 VAC 60 Hz.
CH1: Output Ripple, 50 mV / div., 5 ms / div.
Zoom: 10 μs / div.
Output Ripple = 41.5 mV

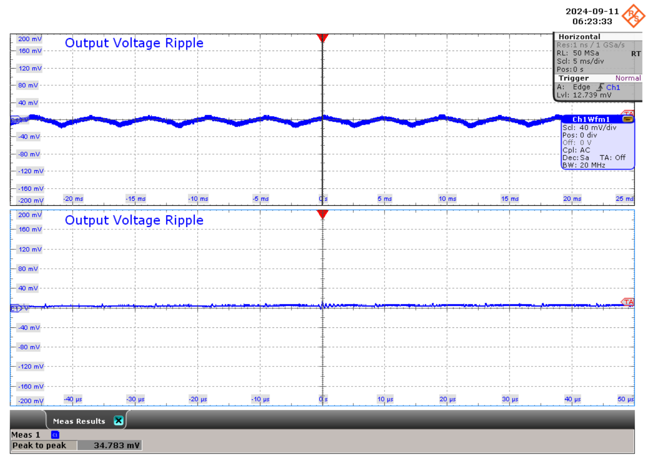



**Figure 91** – 115 VAC 60 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 μs / div.
Output Ripple = 34.8 mV

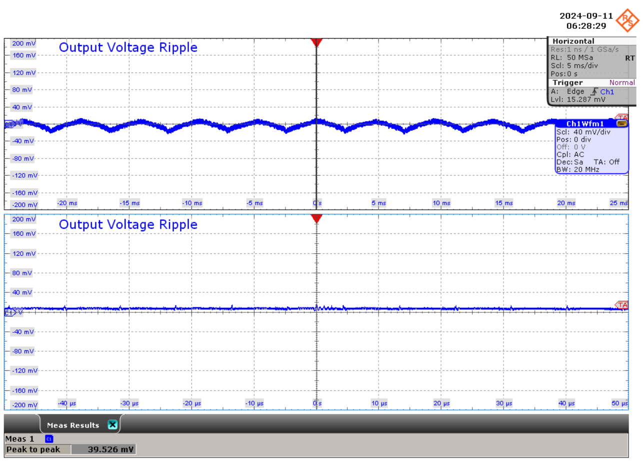



**Figure 92** – 230 VAC 50 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 μs / div.
Output Ripple = 39.5 mV

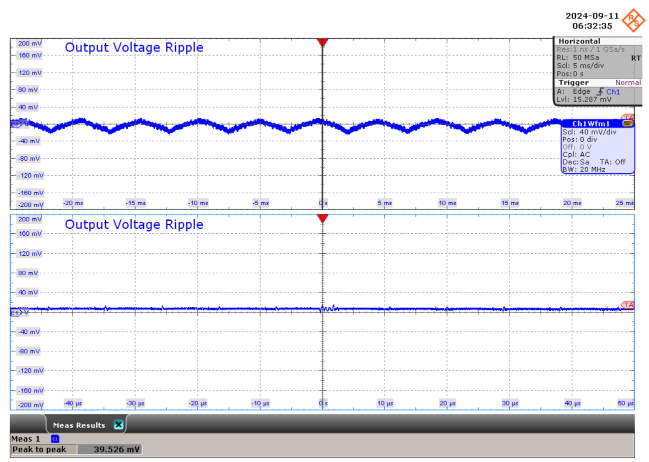



**Figure 93** – 265 VAC 50 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 μs / div.
Output Ripple = 39.5 mV

## 12.5.2.4 25% Load Condition

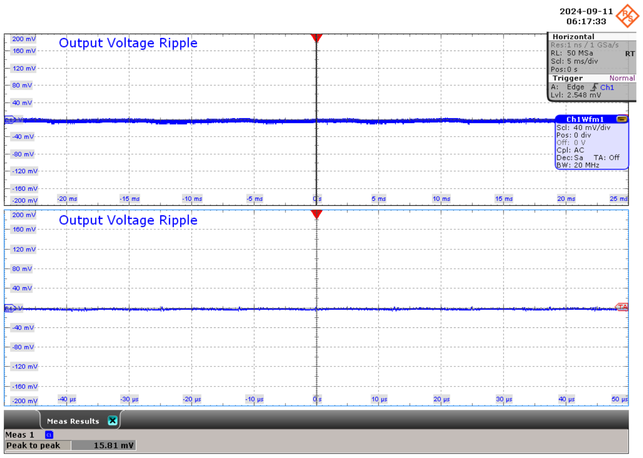



**Figure 94** – 85 VAC 60 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 µs / div.
Output Ripple = 15.8 mV

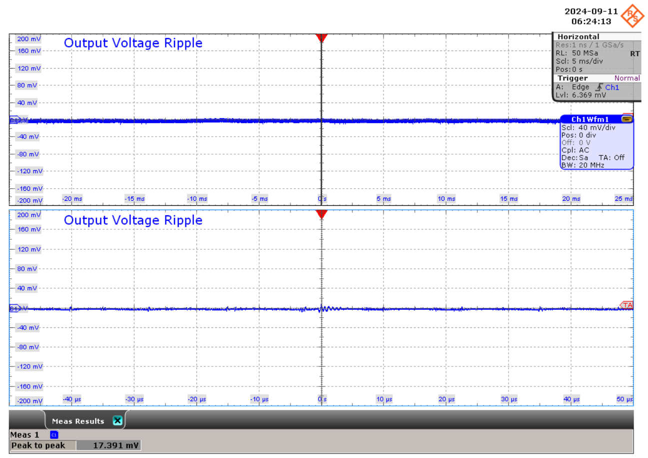



**Figure 95** – 115 VAC 60 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 µs / div.
Output Ripple = 17.4 mV

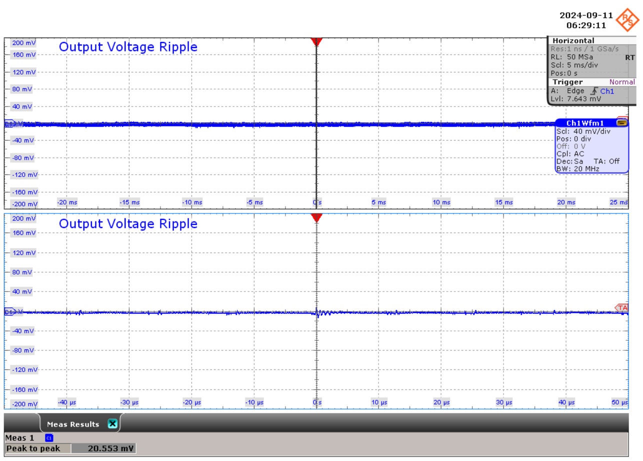



**Figure 96** – 230 VAC 50 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 µs / div.
Output Ripple = 20.6 mV

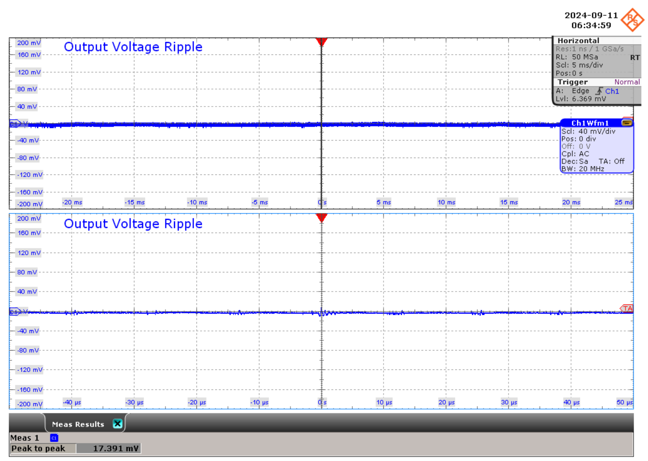



**Figure 97** – 265 VAC 50 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 µs / div.
Output Ripple = 17.4 mV

### 12.5.2.5 10% Load Condition

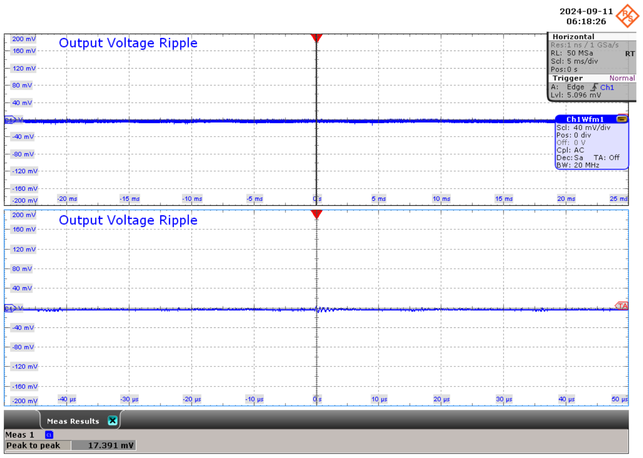



**Figure 98** – 85 VAC 60 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 µs / div.
Output Ripple = 17.4 mV

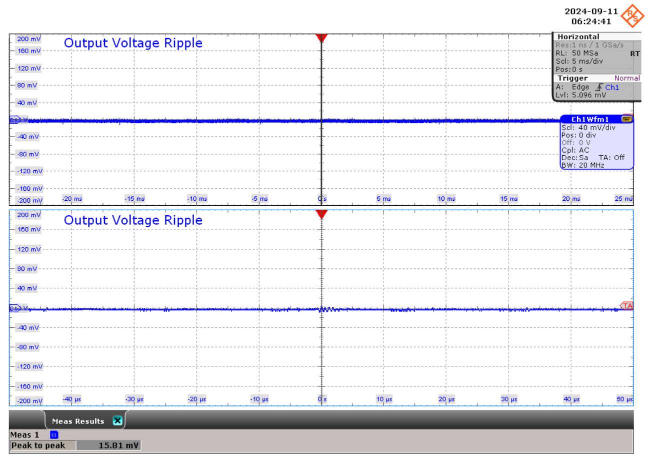



**Figure 99** – 115 VAC 60 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 µs / div.
Output Ripple = 15.8 mV

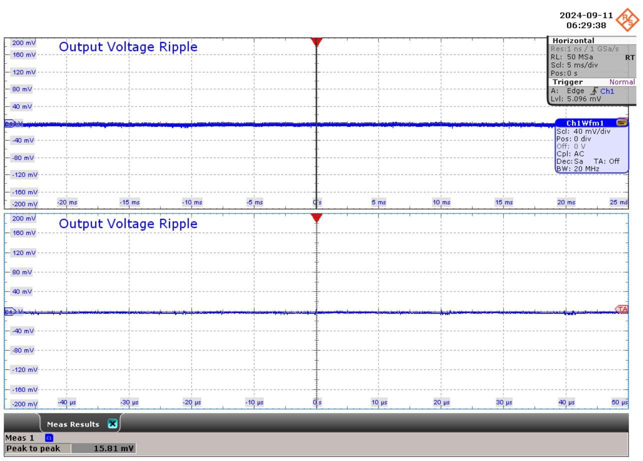



**Figure 100** – 230 VAC 50 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 µs / div.
Output Ripple = 15.8 mV

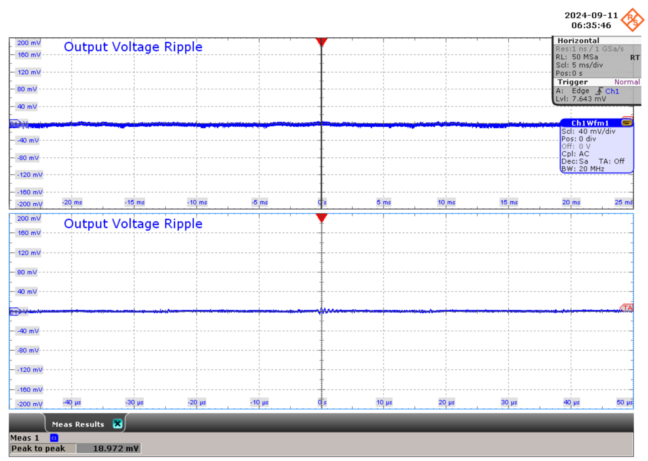



**Figure 101** – 265 VAC 50 Hz.
CH1: Output Ripple, 40 mV / div., 5 ms / div.
Zoom: 10 µs / div.
Output Ripple = 19 mV

### 12.5.3 Output Ripple Voltage Graph

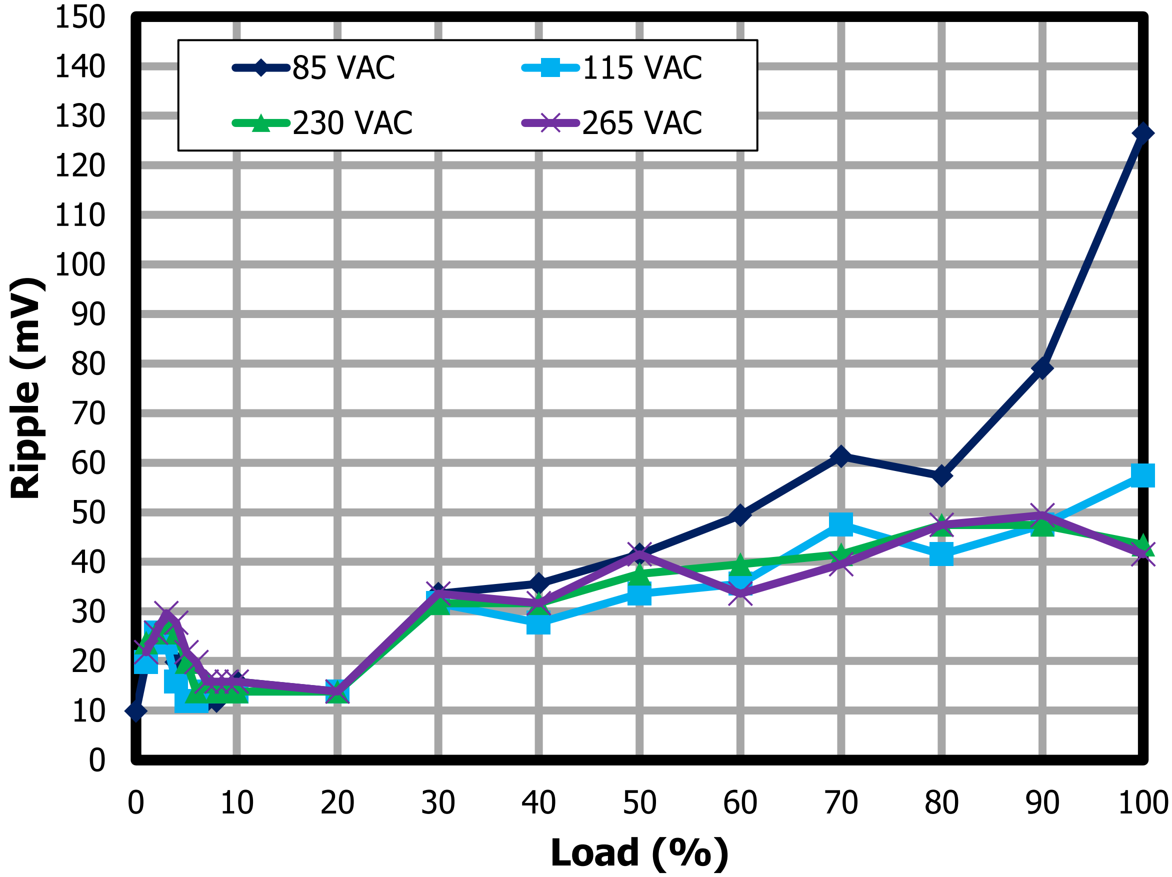



**Figure 102** – Voltage Ripple (Measured at PCB End at Room Temperature).

# 13 Thermal Performance

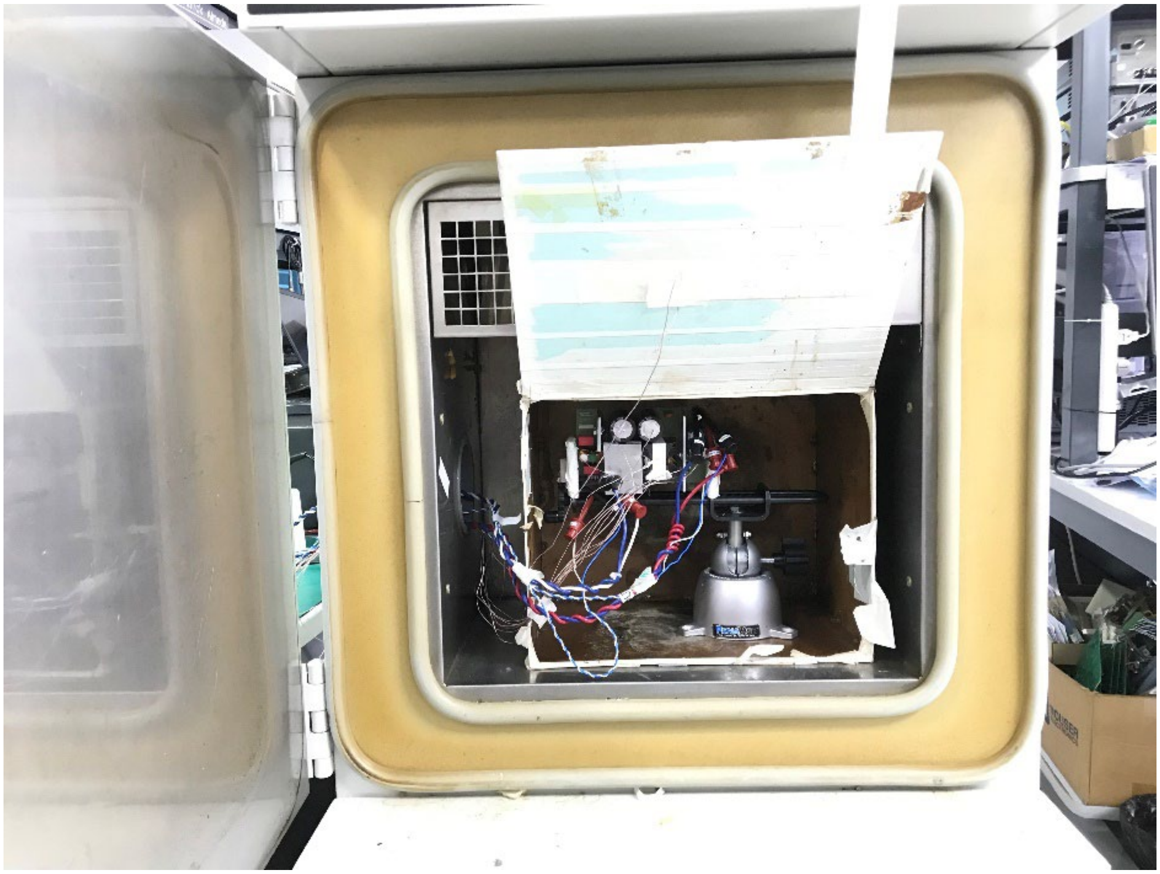


**Figure 103** – Thermal Performance Set-up Using Thermal Chamber.

## 13.1 25 °C Ambient Thermals

To measure the temperature of components U2, T1, BR1, D3, C2, C15, and L2, T-type thermocouples were attached to each. The thermal data was then fed to the data logger. A thermal chamber was utilized to maintain a constant ambient temperature of 25 °C.

### 13.1.1 85 VAC Full Load at 25 °C Ambient

Test result after 2 hours running continuously at 85 VAC full load.

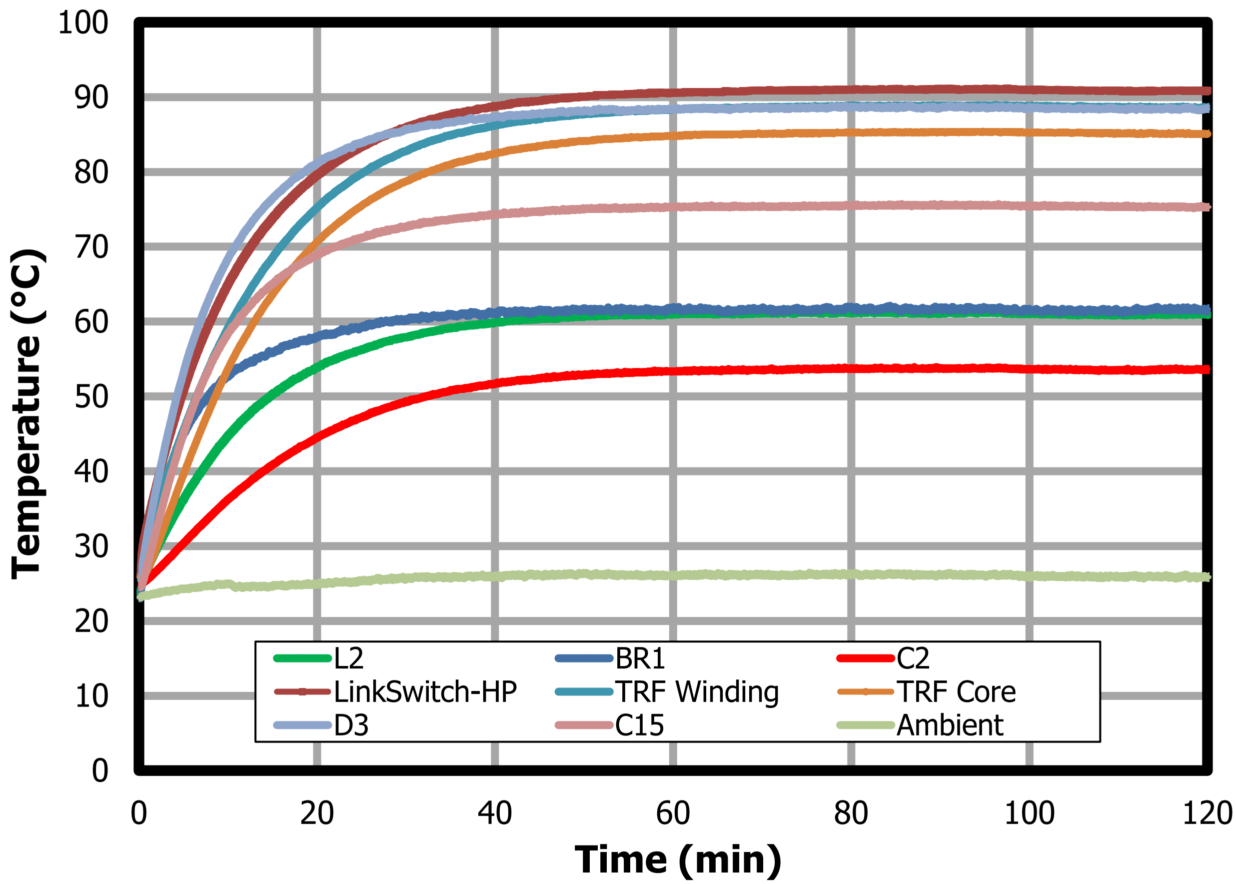



**Figure 104** – 85 VAC 60 Hz. Top Side Discrete Component Temperatures.

| Component | Temperature (°C) |
|---|---|
| Ambient | 25.9 |
| LNK6779E (U2) | 90.8 |
| Transformer Core (T1) | 85.1 |
| Transformer Winding (T1) | 88.6 |
| Bridge (BR1) | 61.6 |
| Secondary Diode (D3) | 88.4 |
| Bulk Capacitor (C2) | 53.5 |
| Output Capacitor (C15) | 75.2 |
| CMC (L2) | 61 |

**Table 13** – 85 VAC 60 Hz. Top Side Discrete Component Temperatures.

### 13.1.2 265 VAC Full Load at 25 °C Ambient

Test result after 2 hours running continuously at 265 VAC full load.

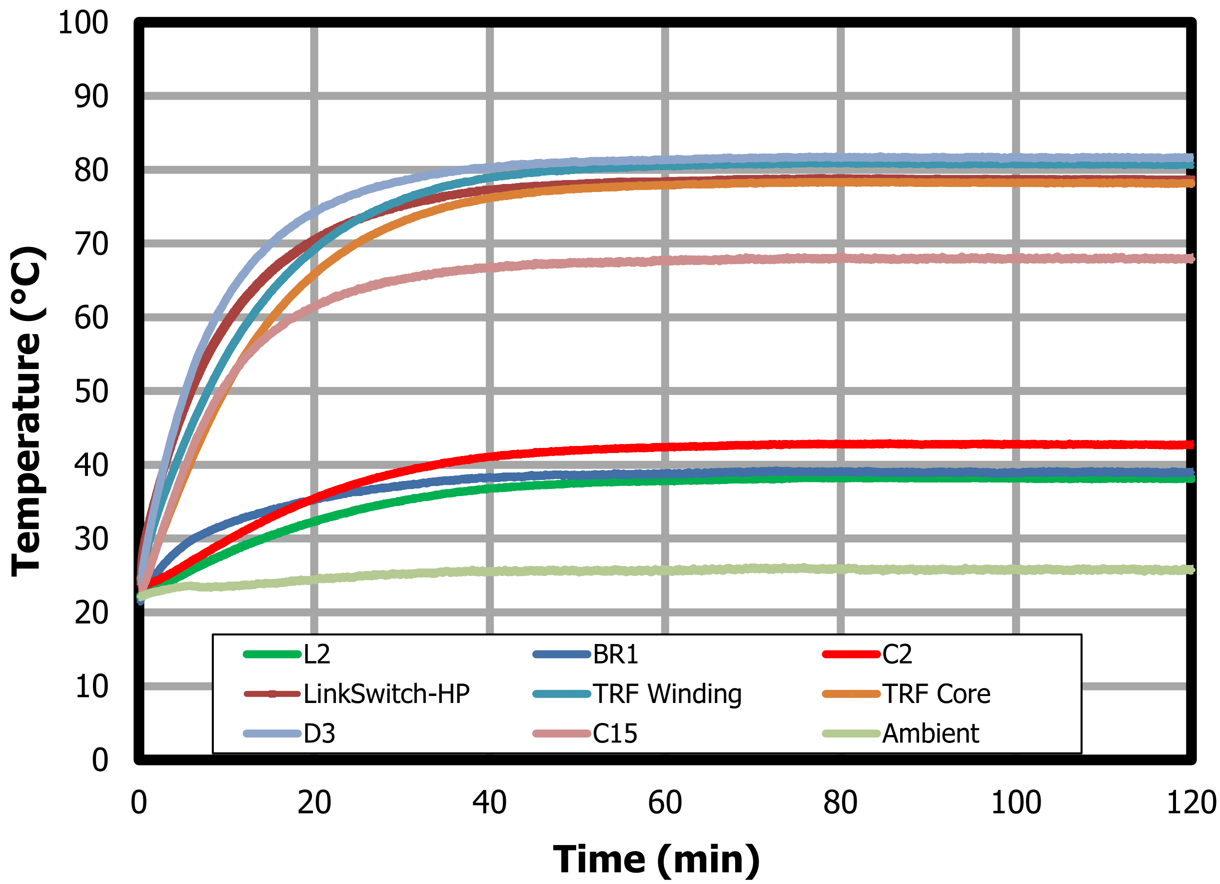



**Figure 105** – 265 VAC 50 Hz. Top Side Discrete Component Temperatures.

| Component | Temperature (°C) |
|---|---|
| Ambient | 25.8 |
| LNK6779E (U2) | 78.7 |
| Transformer Core (T1) | 78.1 |
| Transformer Winding (T1) | 80.7 |
| Bridge (BR1) | 38.9 |
| Secondary Diode (D3) | 81.5 |
| Bulk Capacitor (C2) | 42.7 |
| Output Capacitor (C15) | 67.9 |
| CMC (L2) | 38.1 |

**Table 14** – 265 VAC 50 Hz. Top Side Discrete Component Temperatures.

## 13.2 40 °C Ambient Thermals

A thermal chamber was utilized to maintain a constant ambient temperature at 40 °C. To measure the temperature of the top side discrete components U2, T1, BR1, D3, C2, C15, and L2, T-type thermocouples were attached to each. The thermal data was then fed to the data logger.

### 13.2.1 85 VAC Full Load at 40 ºC Ambient (Thermal Chamber)

Test result after 2 hours running continuously at 85 VAC full load.

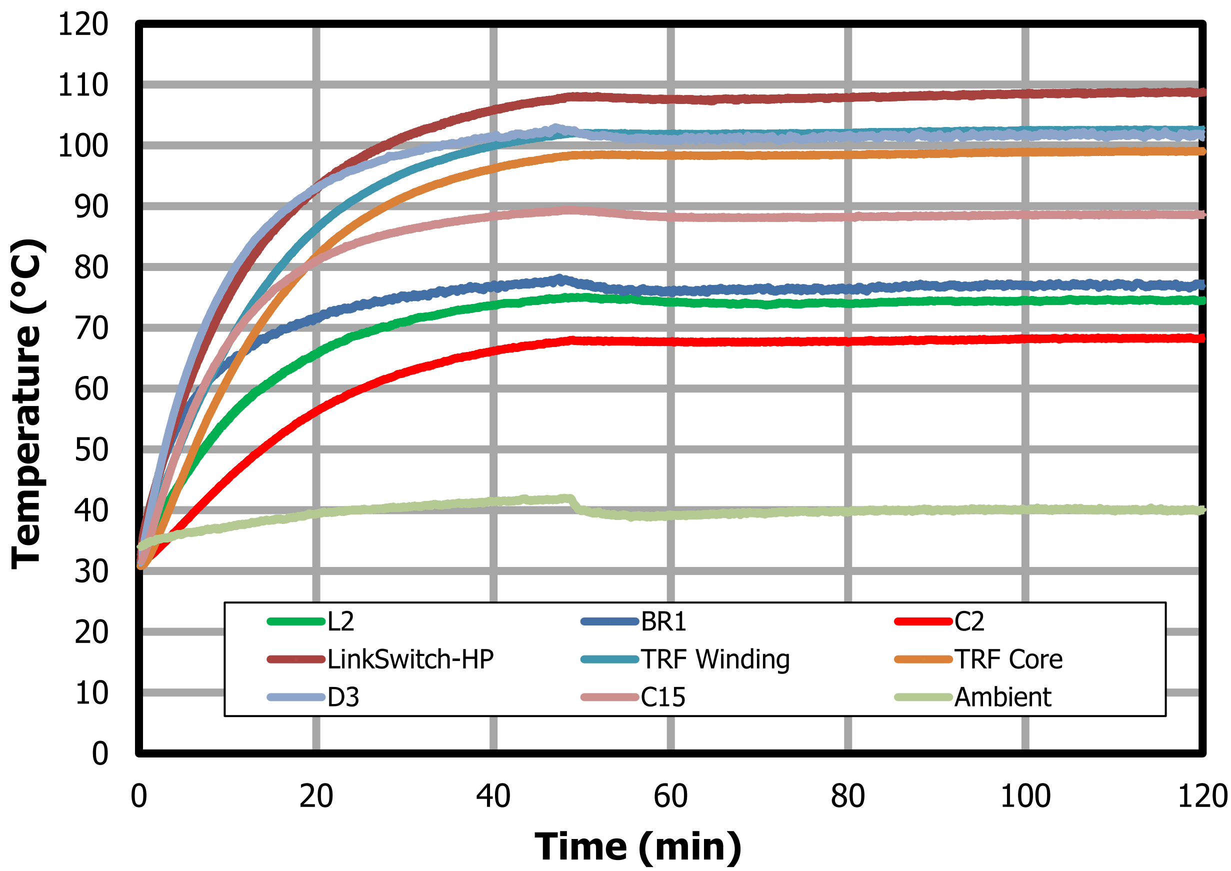



**Figure 106** – 85 VAC 60 Hz. Temperatures at 40 ºC Ambient.

| Component | Temperature (°C) |
|---|---|
| Ambient | 40.1 |
| LNK6779E (U2) | 109 |
| Transformer Core (T1) | 99.1 |
| Transformer Winding (T1) | 103 |
| Bridge (BR1) | 77.5 |
| Secondary Diode (D3) | 102 |
| Bulk Capacitor (C2) | 68.3 |
| Output Capacitor (C15) | 88.7 |
| CMC (L2) | 74.6 |

**Table 15** – 85 VAC 60 Hz. Temperatures at 40 ºC Ambient.

### 13.2.2 265 VAC Full Load at 40 ºC Ambient (Thermal Chamber)

Test result after 2 hours running continuously at 265 VAC full load.

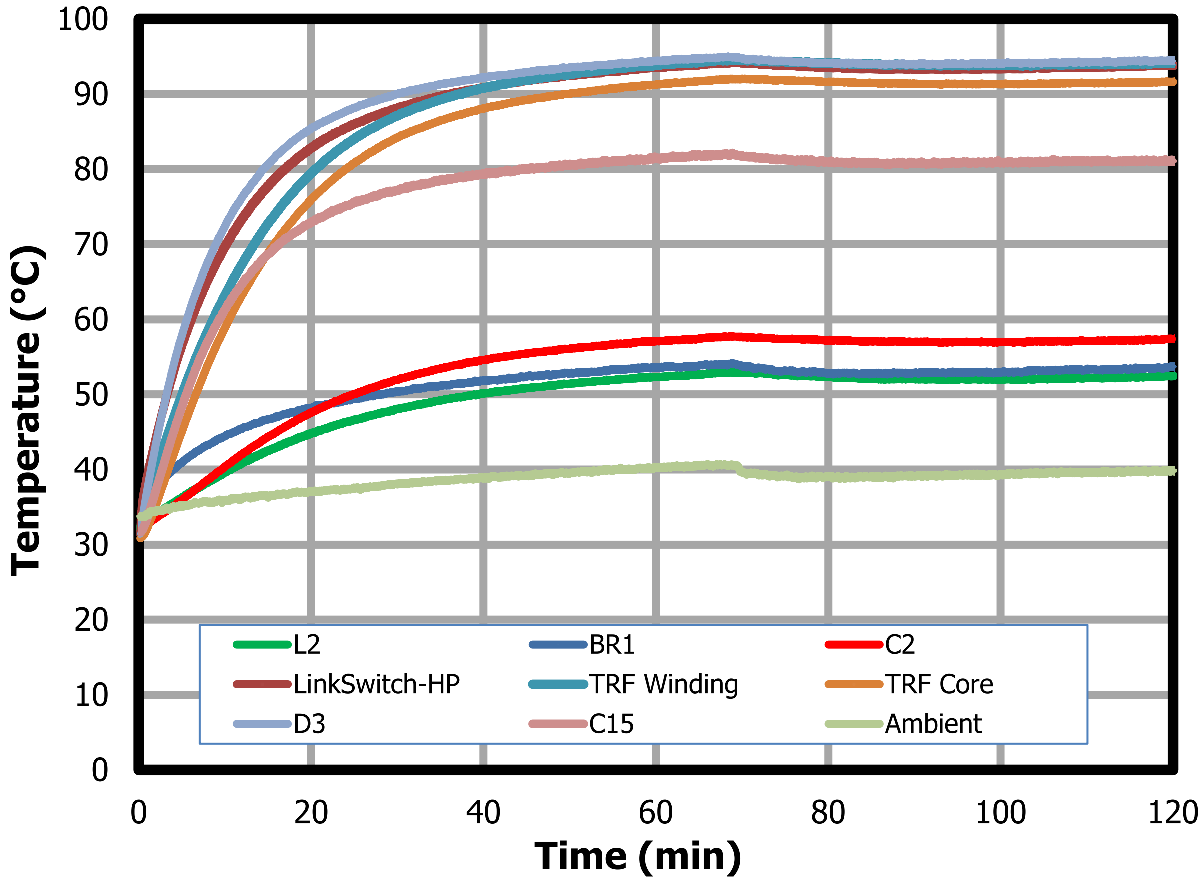



**Figure 107** – 265 VAC 50 Hz. Temperatures at 40 ºC Ambient.

| Component | Temperature (°C) |
|---|---|
| Ambient | 40.3 |
| LNK6779E (U2) | 94.1 |
| Transformer Core (T1) | 91.9 |
| Transformer Winding (T1) | 94.3 |
| Bridge (BR1) | 53.9 |
| Secondary Diode (D3) | 94.8 |
| Bulk Capacitor (C2) | 57.6 |
| Output Capacitor (C15) | 81.4 |
| CMC (L2) | 52.7 |

**Table 16** – 265 VAC 50 Hz. Temperatures at 40 ºC Ambient.

# 14 Fault Condition

## 14.1 Output Short-Circuit Protection

### 14.1.1 Start-Up Short

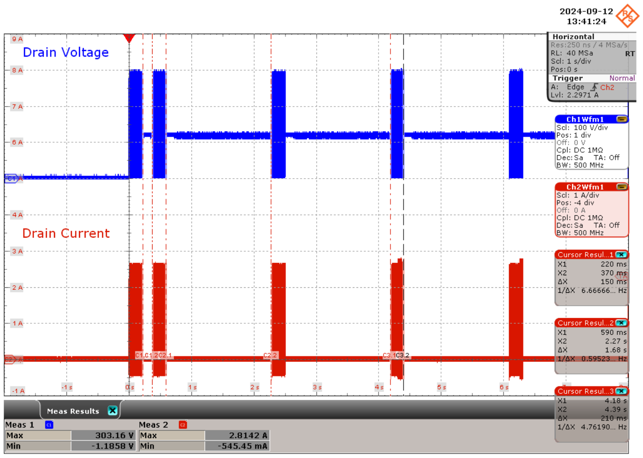



**Figure 108** – 85 VAC 60 Hz. Output Short.
CH1: Drain Voltage, 100 V / div., 1 s / div.
CH2: Drain Current, 1 A / div., 1 s / div.
Drain Voltage$_{(MAX)}$ = 303 V
Drain Current$_{(MAX)}$ = 2.81 A
$t_{AR\_(OFF)1}$ = 150 ms
$t_{AR\_(OFF)2}$ = 1.68 s
$t_{AR(ON)}$ = 210 ms

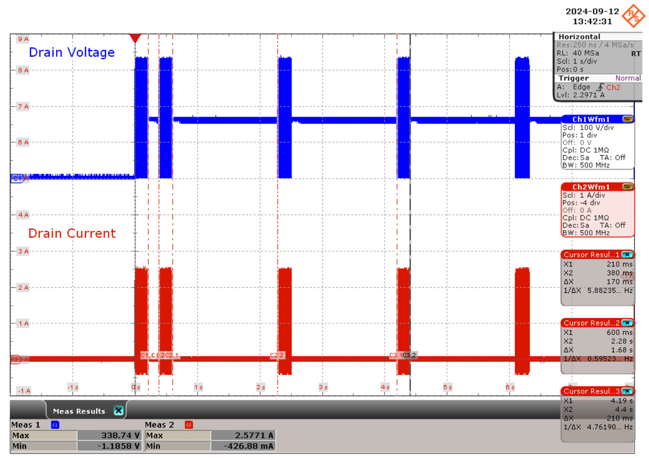



**Figure 109** – 115 VAC 60 Hz Output Short.
CH1: Drain Voltage, 100 V / div., 1 s / div.
CH2: Drain Current, 1 A / div., 1 s / div.
Drain Voltage$_{(MAX)}$ = 339 V
Drain Current$_{(MAX)}$ = 2.58 A
$t_{AR\_(OFF)1}$ = 170 ms
$t_{AR\_(OFF)2}$ = 1.68 s
$t_{AR(ON)}$ = 210 ms

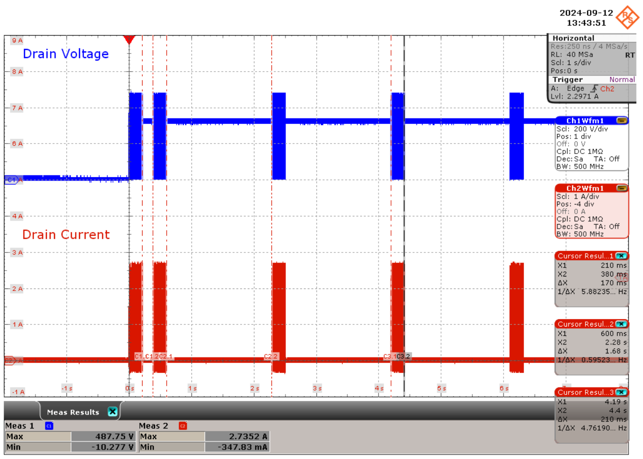



**Figure 110** – 230 VAC 50 Hz. Output Short.
CH1: Drain Voltage, 200 V / div., 1 s / div.
CH2: Drain Current, 1 A / div., 1 s / div.
Drain Voltage$_{(MAX)}$ = 488 V
Drain Current$_{(MAX)}$ = 2.74 A
$t_{AR\_(OFF)1}$ = 170 ms
$t_{AR\_(OFF)2}$ = 1.68 s
$t_{AR(ON)}$ = 210 ms

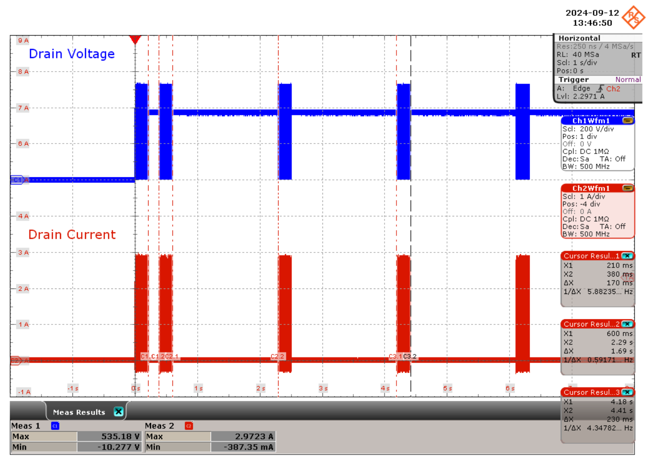



**Figure 111** –265 VAC 50 Hz. Output Short.
CH1: Drain Voltage, 200 V / div., 1 s / div.
CH2: Drain Current, 1 A / div., 1 s / div.
Drain Voltage$_{(MAX)}$ = 535 V
Drain Current$_{(MAX)}$ = 2.97 A
$t_{AR\_(OFF)1}$ = 170 ms
$t_{AR\_(OFF)2}$ = 1.69 s
$t_{AR(ON)}$ = 230 ms

### 14.1.1 Running Short

#### 14.1.1.1 Full Load

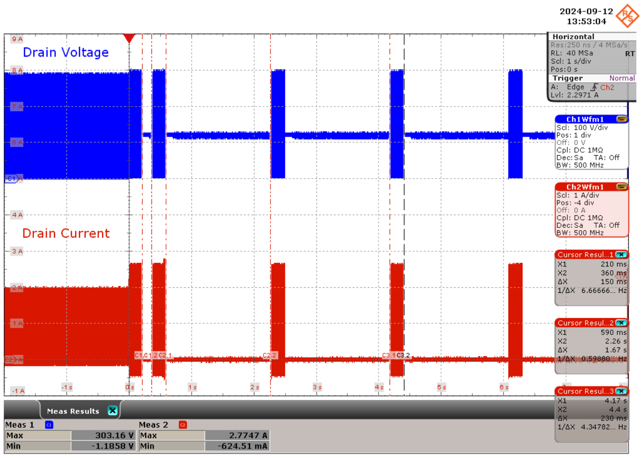



**Figure 112** – 85 VAC 60 Hz. Output Short.
CH1: Drain Voltage, 100 V / div., 1 s / div.
CH2: Drain Current, 1 A / div., 1 s / div.
Drain Voltage$_{(MAX)}$ = 303 V
Drain Current$_{(MAX)}$ = 2.77 A
$t_{AR\_(OFF)1}$ = 150 ms
$t_{AR\_(OFF)2}$ = 1.67 s
$t_{AR(ON)}$ = 230 ms

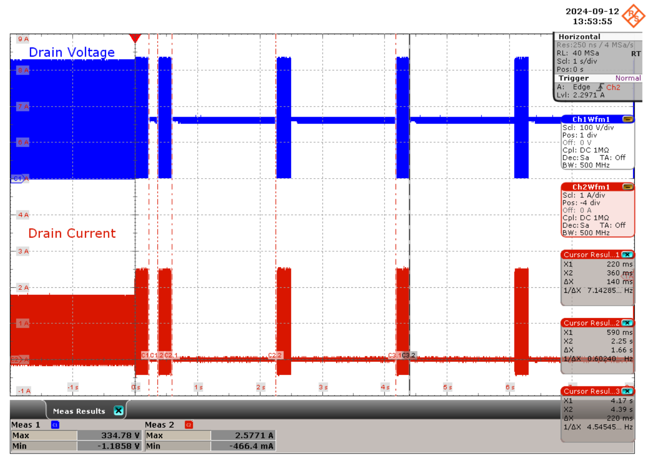



**Figure 113** – 115 VAC 60 Hz Output Short.
CH1: Drain Voltage, 100 V / div., 1 s / div.
CH2: Drain Current, 1 A / div., 1 s / div.
Drain Voltage$_{(MAX)}$ = 335 V
Drain Current$_{(MAX)}$ = 2.58 A
$t_{AR\_(OFF)1}$ = 140 ms
$t_{AR\_(OFF)2}$ = 1.66 s
$t_{AR(ON)}$ = 220 ms

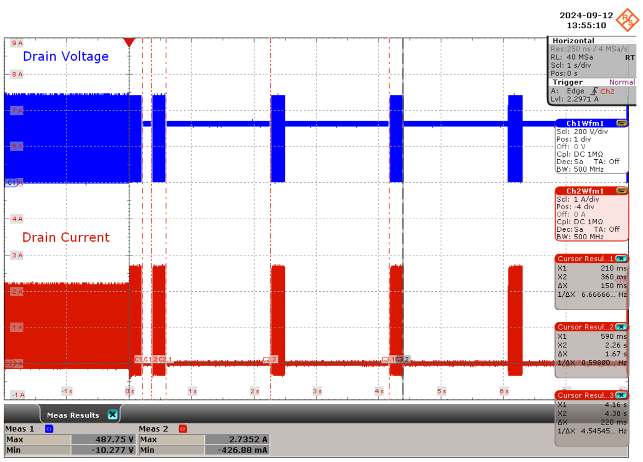



**Figure 114** – 230 VAC 50 Hz. Output Short.
CH1: Drain Voltage, 200 V / div., 1 s / div.
CH2: Drain Current, 1 A / div., 1 s / div.
Drain Voltage$_{(MAX)}$ = 488 V
Drain Current$_{(MAX)}$ = 2.74 A
$t_{AR\_(OFF)1}$ = 150 ms
$t_{AR\_(OFF)2}$ = 1.67 s
$t_{AR(ON)}$ = 220 ms

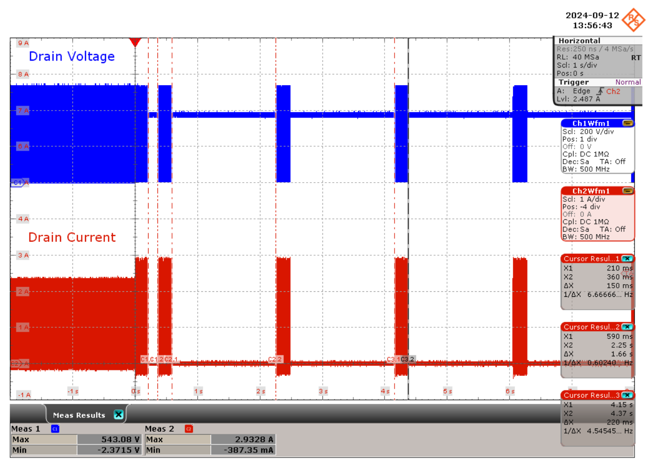



**Figure 115** –265 VAC 50 Hz. Output Short.
CH1: Drain Voltage, 200 V / div., 1 s / div.
CH2: Drain Current, 1 A / div., 1 s / div.
Drain Voltage$_{(MAX)}$ = 543 V
Drain Current$_{(MAX)}$ = 2.93 A
$t_{AR\_(OFF)1}$ = 150 ms
$t_{AR\_(OFF)2}$ = 1.66 s
$t_{AR(ON)}$ = 220 ms

## 14.1.1.2 No Load

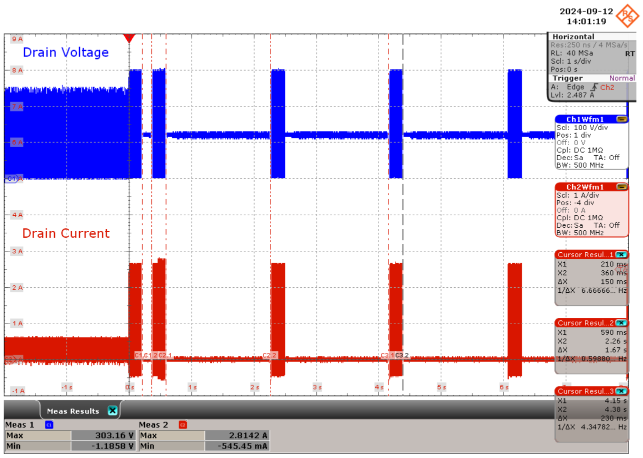



**Figure 116** – 85 VAC 60 Hz. Output Short.
CH1: Drain Voltage, 100 V / div., 1 s / div.
CH2: Drain Current, 1 A / div., 1 s / div.
Drain Voltage$_{(MAX)}$ = 303 V
Drain Current$_{(MAX)}$ = 2.81 A
$t_{AR\_(OFF)1}$ = 150 ms
$t_{AR\_(OFF)2}$ = 1.67 s
$t_{AR(ON)}$ = 230 ms

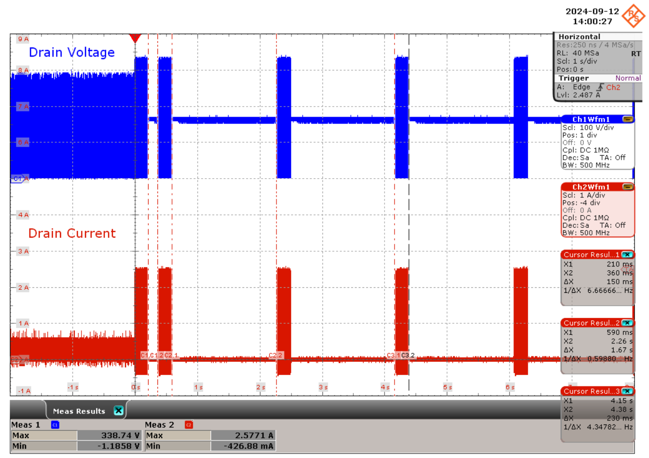



**Figure 117** – 115 VAC 60 Hz Output Short.
CH1: Drain Voltage, 100 V / div., 1 s / div.
CH2: Drain Current, 1 A / div., 1 s / div.
Drain Voltage$_{(MAX)}$ = 339 V
Drain Current$_{(MAX)}$ = 2.57 A
$t_{AR\_(OFF)1}$ = 150 ms
$t_{AR\_(OFF)2}$ = 1.67 s
$t_{AR(ON)}$ = 230 ms

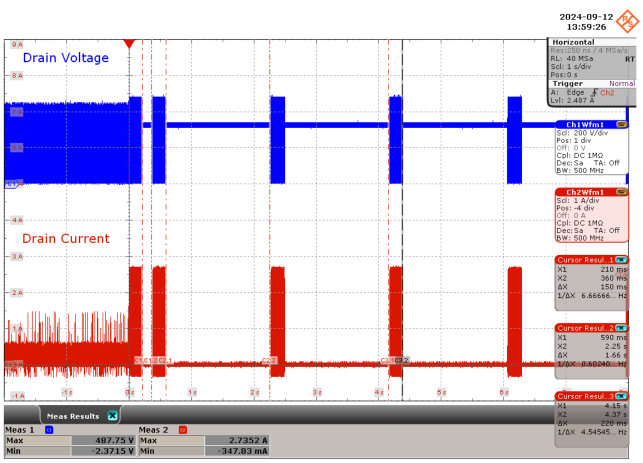



**Figure 118** – 230 VAC 60 Hz. Output Short.
CH1: Drain Voltage, 200 V / div., 1 s / div.
CH2: Drain Current, 1 A / div., 1 s / div.
Drain Voltage$_{(MAX)}$ = 488 V
Drain Current$_{(MAX)}$ = 2.74 A
$t_{AR\_(OFF)1}$ = 150 ms
$t_{AR\_(OFF)2}$ = 1.66 s
$t_{AR(ON)}$ = 220 ms

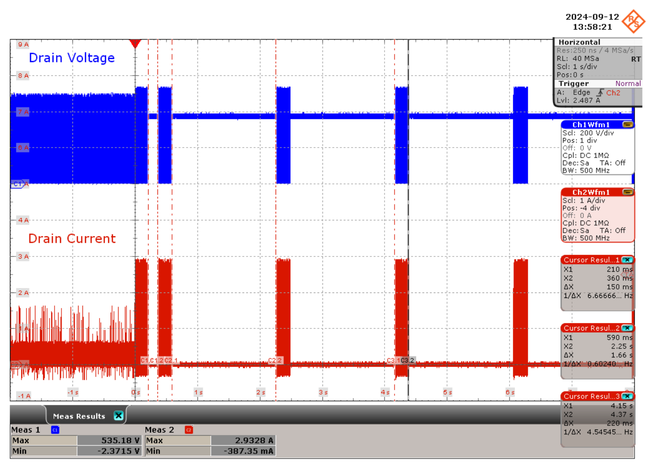



**Figure 119** –265 VAC 60 Hz. Output Short.
CH1: Drain Voltage, 200 V / div., 1 s / div.
CH2: Drain Current, 1 A / div., 1 s / div.
Drain Voltage$_{(MAX)}$ = 535 V
Drain Current$_{(MAX)}$ = 2.93 A
$t_{AR\_(OFF)1}$ = 150 ms
$t_{AR\_(OFF)2}$ = 1.66s
$t_{AR(ON)}$ = 220 ms

#### 14.1.1.3 Thermals

| Component | Temperature (°C) |
|---|---|
| Ambient | 26.3 |
| LNK6779E (U2) | 31.9 |
| Transformer Core (T1) | 39.9 |
| Transformer Winding (T1) | 39.2 |
| Bridge (BR1) | 27.7 |
| Secondary Diode (D3) | 49.6 |
| Bulk Capacitor (C2) | 28.5 |
| Output Capacitor (C15) | 44 |
| CMC (L2) | 27.1 |

**Table 17** – 85 VAC 60 Hz. Discrete Component Temperatures - Output Short (1hr. Soak).

| Component | Temperature (°C) |
|---|---|
| Ambient | 24.4 |
| LNK6779E (U2) | 30.5 |
| Transformer Core (T1) | 36.1 |
| Transformer Winding (T1) | 35.1 |
| Bridge (BR1) | 25.1 |
| Secondary Diode (D3) | 45.1 |
| Bulk Capacitor (C2) | 26.4 |
| Output Capacitor (C15) | 39.4 |
| CMC (L2) | 24.8 |

**Table 18** – 265 VAC 50 Hz. Discrete Component Temperatures - Output Short (1hr. Soak).

## 14.2 Over Temperature Protection

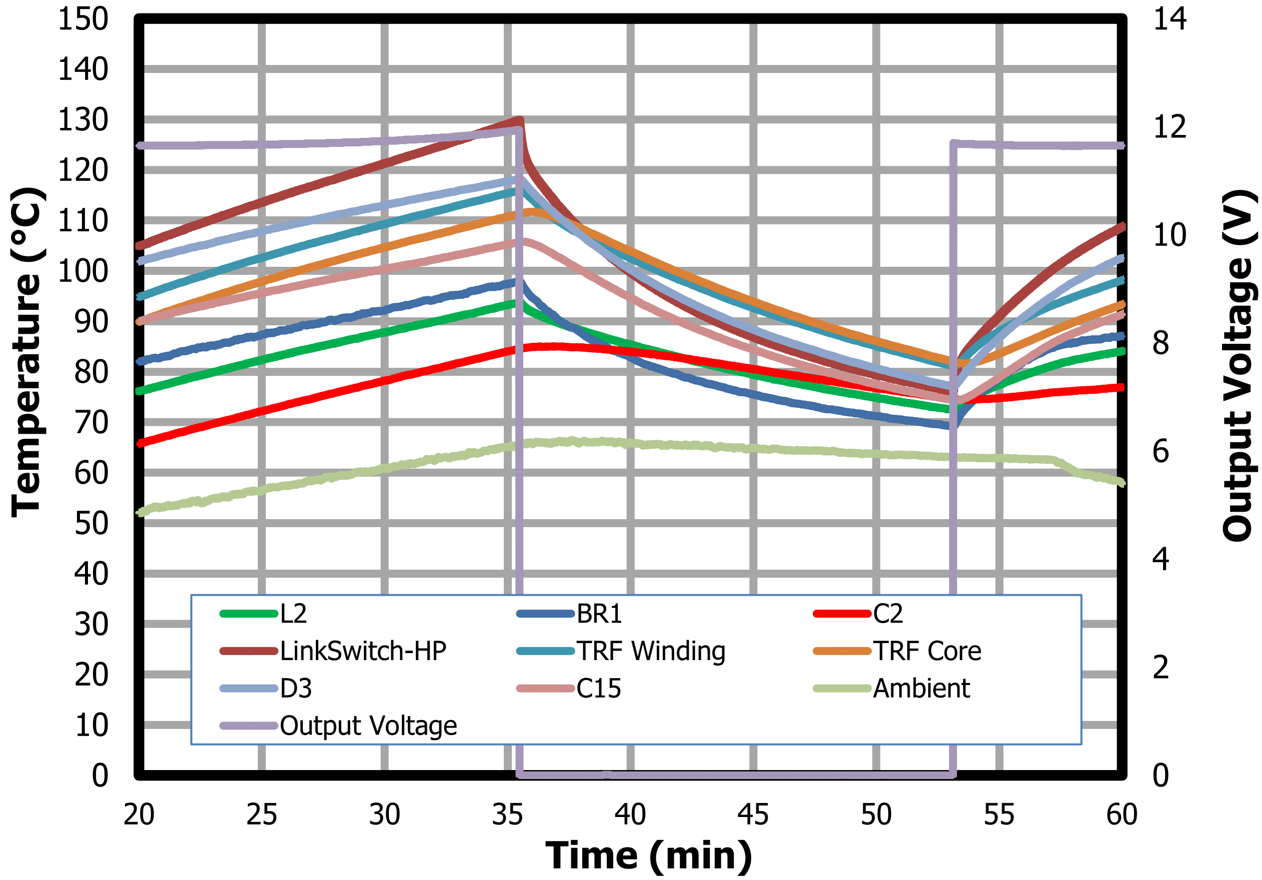



**Figure 120** – 85 VAC 60 Hz. Full Load OTP.

| Component | At OTP Trigger Temperature (°C) | At Recovery Temperature (°C) |
|---|---|---|
| Ambient | 65.4 | 63.1 |
| LNK6779E (U2) | 130 | 76.1 |
| Transformer Core (T1) | 111 | 82 |
| Transformer Winding (T1) | 116 | 81.1 |
| Bridge (BR1) | 97.9 | 69.1 |
| Secondary Diode (D3) | 118 | 77.1 |
| Bulk Capacitor (C2) | 84.6 | 74.6 |
| Output Capacitor (C15) | 106 | 74.4 |
| CMC (L2) | 93.8 | 72.5 |

**Table 19** – 85 VAC 60 Hz. Discrete Component Temperatures at Full Load OTP and Recovery.

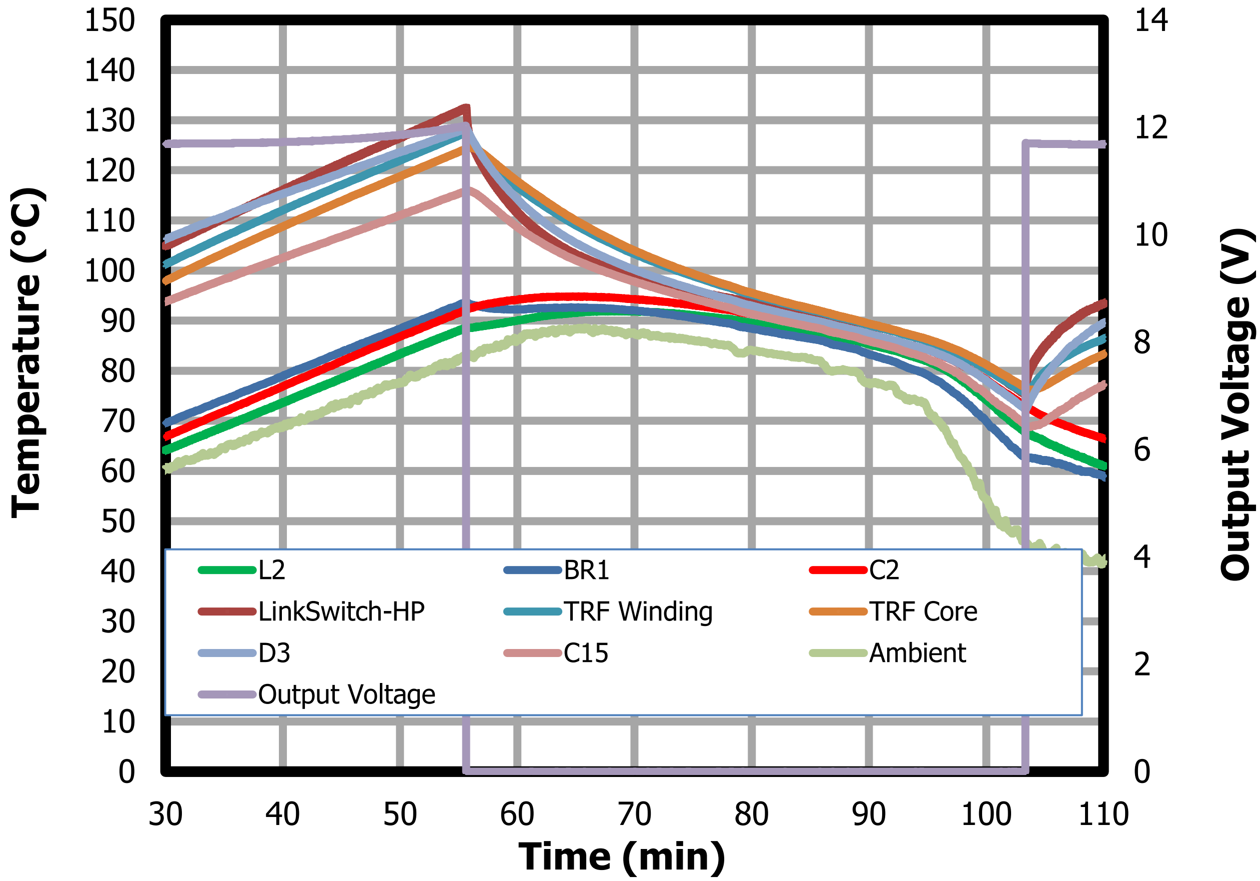



**Figure 121** – 265 VAC 60 Hz. Full Load OTP.

| Component | At OTP Trigger Temperature (°C) | At Recovery Temperature (°C) |
|---|---|---|
| Ambient | 83.4 | 45.8 |
| LNK6779E (U2) | 133 | 75.2 |
| Transformer Core (T1) | 124 | 76.6 |
| Transformer Winding (T1) | 128 | 75.5 |
| Bridge (BR1) | 93.7 | 62.5 |
| Secondary Diode (D3) | 128 | 72.4 |
| Bulk Capacitor (C2) | 92.2 | 72.9 |
| Output Capacitor (C15) | 116 | 69.2 |
| CMC (L2) | 88.7 | 67.7 |

**Table 20** – 265 VAC 50 Hz. Discrete Component Temperatures at Full Load OTP and Recovery.

| Input (VAC) | IC Temperature (°C) | |
|---|---|---|
| | OTP Shutdown | Recover |
| 85 | 130 | 76.1 |
| 265 | 133 | 75.2 |

**Table 21** – IC Temperature at OTP Shutdown and Recovery.

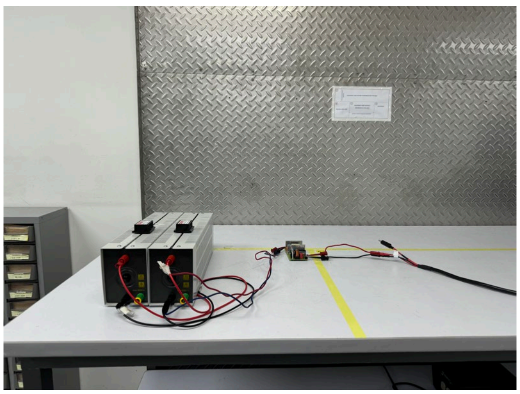
# 15 Conducted EMI

Conducted emissions tests were performed at 115 VAC and 230 VAC at full load (12V, 6A). Measurements were taken with floating ground.

## 15.1 Test Set-up Equipment

### 15.1.1 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. 12 V RLOAD resistance is 2 ohms.



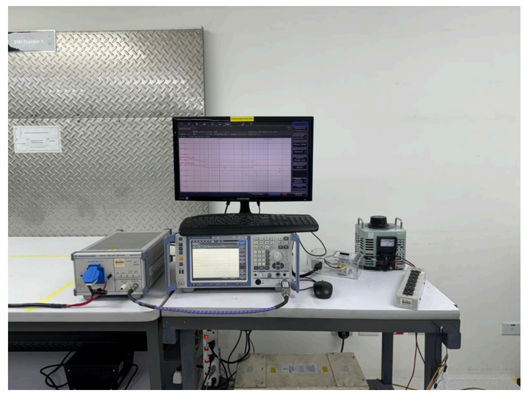


**Figure 122** – EMI Test Set-up.

## 15.2 Output Float

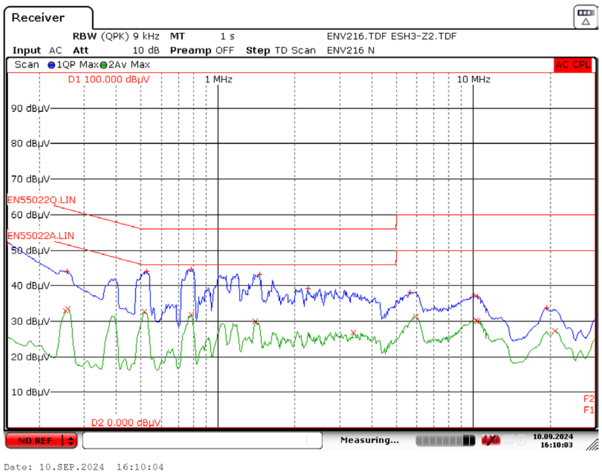



**Figure 123** – 115 VAC 60 Hz.
Line / Neutral - Floating

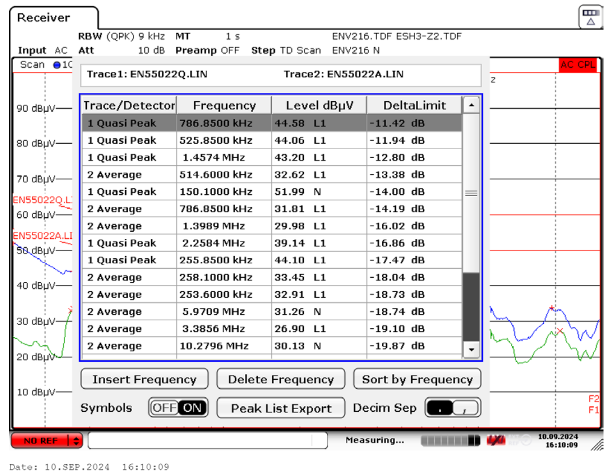



**Figure 124** – 115 VAC 60 Hz.
Line / Neutral – Floating (Delta Limit)

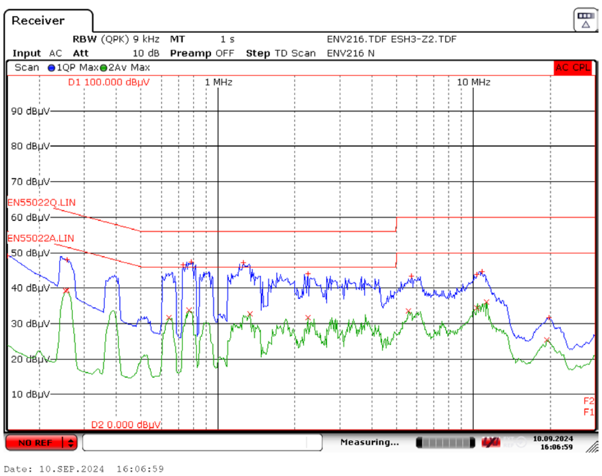



**Figure 125** – 230 VAC 50 Hz.
Line / Neutral – Floating

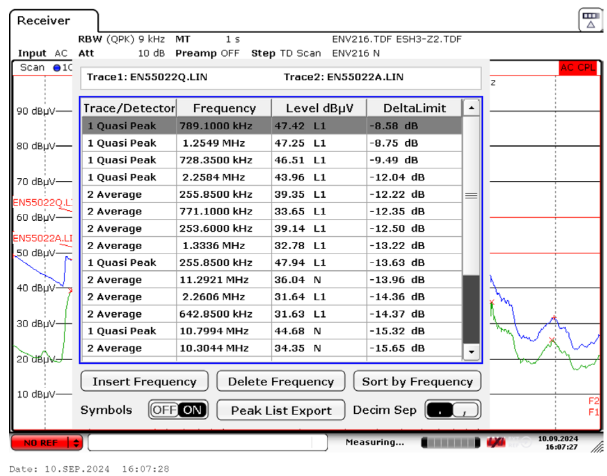



**Figure 126** – 230 VAC 50 Hz.
Line / Neutral – Floating (Delta Limit)

# 16 Line Surge

IEC61000-4-5 differential mode and common mode input line surge testing was completed on a single test unit. Input voltage was set at 230 VAC / 60 Hz. Output was loaded at full load and operation was verified following each surge event.

## 16.1 Differential Mode Surge

| DM Surge Level (V) | Input Voltage (VAC) | Injection Location | Injection Phase (º) | Test Result (Pass/Fail) |
|---|---|---|---|---|
| +1000 | 230 | L to N | 0 | Pass |
| -1000 | 230 | L to N | 0 | Pass |
| +1000 | 230 | L to N | 90 | Pass |
| -1000 | 230 | L to N | 90 | Pass |
| +1000 | 230 | L to N | 180 | Pass |
| -1000 | 230 | L to N | 180 | Pass |
| +1000 | 230 | L to N | 270 | Pass |
| -1000 | 230 | L to N | 270 | Pass |

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

**Table 22** – Differential Mode Surge at 230 VAC.

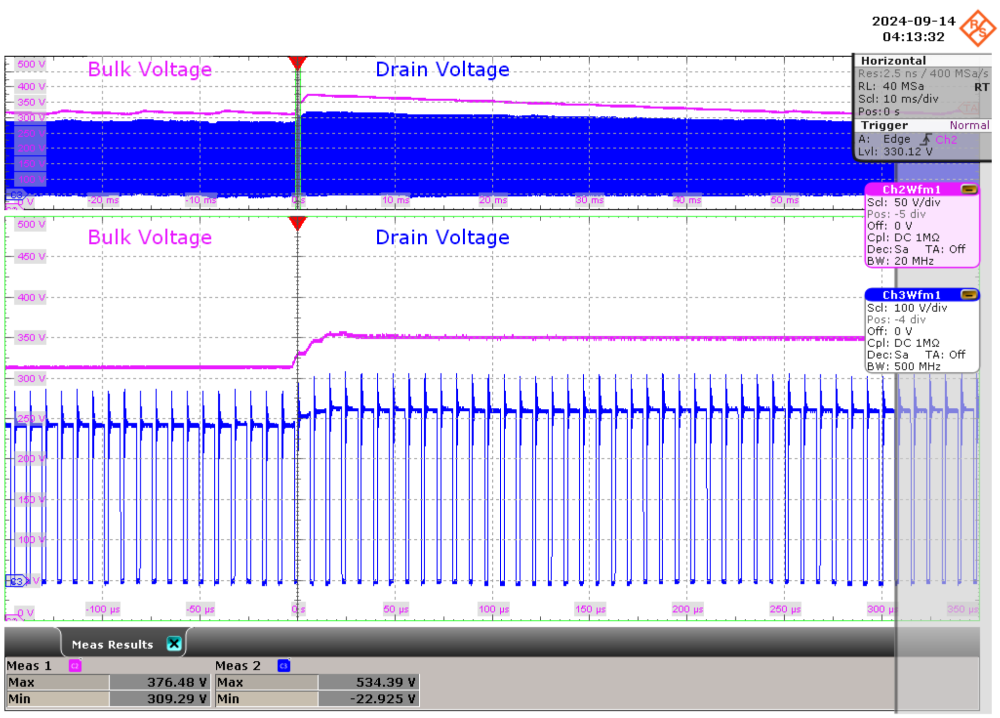



**Figure 127** – Differential Mode Surge – Bulk Voltage and Drain Voltage Waveform.
CH1: Bulk Voltage, 50 V / div., 10 ms / div.
CH2: Drain Voltage, 100 V / div., 10 ms / div.
Zoom: 50 µs / div.
Drain Voltage$_{(MAX)}$: 534 V

## 16.2 Common Mode Ring Wave Surge

| Surge Voltage | Phase Angle | IEC Coupling | Generator Impedance | Number Strikes | Result |
|---|---|---|---|---|---|
| +4000V | 0º | L,N → PE | 12 Ω | 10 | Pass |
| –4000V | 0º | L,N → PE | 12 Ω | 10 | Pass |
| +4000V | 90º | L,N → PE | 12 Ω | 10 | Pass |
| –4000V | 90º | L,N → PE | 12 Ω | 10 | Pass |
| +4000V | 270º | L,N → PE | 12 Ω | 10 | Pass |
| –4000V | 270º | L,N → PE | 12 Ω | 10 | Pass |

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

**Table 23** – Common Mode Ring Wave Surge at 230 VAC.

# 17 EFT

Input voltage was set at 230 VAC / 60 Hz. Output was loaded at full load and operation was verified following each surge event.

| Surge Voltage | Phase Angle | IEC Coupling | Frequency | Burst Time | Reception Time | Step Duration | Result |
|---|---|---|---|---|---|---|---|
| +4000V | 0º | L to N | 5 kHz | 15 ms | 300 ms | 120 s | Pass |
| –4000V | 0º | L to N | 5 kHz | 15 ms | 300 ms | 120 s | Pass |
| +4000V | 0º | L to N | 100 kHz | 750 µs | 300 ms | 120 s | Pass |
| –4000V | 0º | L to N | 100 kHz | 750 µs | 300 ms | 120 s | Pass |
| +4000V | 90º | L to N | 5 kHz | 15 ms | 300 ms | 120 s | Pass |
| –4000V | 90º | L to N | 5 kHz | 15 ms | 300 ms | 120 s | Pass |
| +4000V | 90º | L to N | 100 kHz | 750 µs | 300 ms | 120 s | Pass |
| –4000V | 90º | L to N | 100 kHz | 750 µs | 300 ms | 120 s | Pass |
| +4000V | 180º | L to N | 5 kHz | 15 ms | 300 ms | 120 s | Pass |
| –4000V | 180º | L to N | 5 kHz | 15 ms | 300 ms | 120 s | Pass |
| +4000V | 180º | L to N | 100 kHz | 750 µs | 300 ms | 120 s | Pass |
| –4000V | 180º | L to N | 100 kHz | 750 µs | 300 ms | 120 s | Pass |
| +4000V | 270º | L to N | 5 kHz | 15 ms | 300 ms | 120 s | Pass |
| –4000V | 270º | L to N | 5 kHz | 15 ms | 300 ms | 120 s | Pass |
| +4000V | 270º | L to N | 100 kHz | 750 µs | 300 ms | 120 s | Pass |
| –4000V | 270º | L to N | 100 kHz | 750 µs | 300 ms | 120 s | Pass |

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

**Table 24** – EFT at 230 VAC.

# 18 ESD

All ESD strikes were applied at end of cable with 230 VAC input voltage and 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 is still functional after the test.

**Table 25** – ±8.8 kV Contact Discharge at 230 VAC.

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 is still functional after the test.

**Table 26** – ±16.5 kV Air Discharge at 230 VAC.

# 19 Revision History

| Date | Author | Revision | Description and Changes | Reviewed |
|---|---|---|---|---|
| 11-July-25 | JA/CD/KP/JPM/ RPA | A | First Release | RPA |
| | | | | |
| | | | | |
| | | | | |

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