Design Example Report

Title	*5 W Non-Isolated Flyback Converter Using LinkSwitch™-XT2SR LNK3771D-H003*
Specification	85 VAC – 265 VAC Input; 5 V, 1 A Output
Application	Small Appliance
Author	Applications Engineering Department
Document Number	DER-963
Date	September 10, 2023
Revision	1.0

Summary and Features

- 725 V maximum drain voltage
- Highly integrated solution
- Lowest possible component count
- Integrated synchronous rectifier (SR) MOSFET driver
- < 5mW no load input power at 265 VAC
- >87% efficiency at full load
- <±5% load regulation
- Integrated 3.3V LDO supply (µVCC)
- Capable to operate at full load up to 50 ºC ambient
- Thermal overload protection with automatic recovery

Power Integrations
5245 Hellyer Avenue, San Jose, CA 95138 USA.
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

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 engineering report describes a non-isolated 5 V, 1 A power supply utilizing a LNK3771D-H003 from Power Integrations. The document contains the power supply specification, schematic, bill-of-materials, printed circuit layout, and performance data.

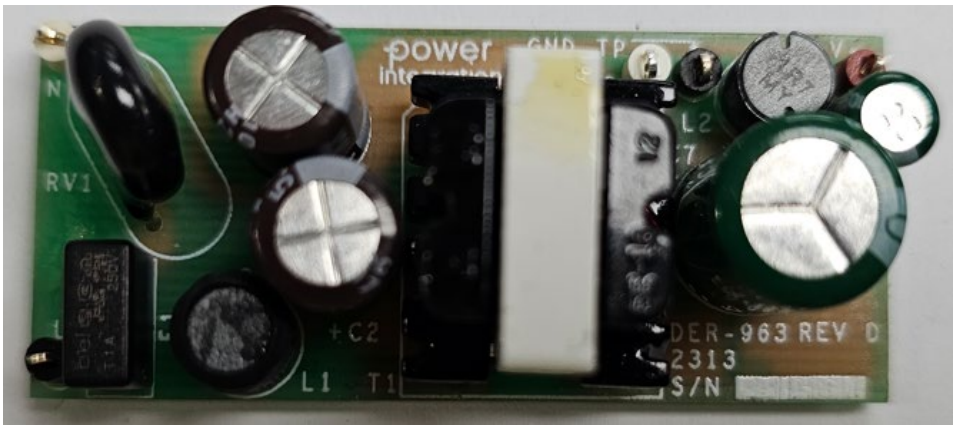


Figure 1 – Populated Circuit Board Photograph, Top.

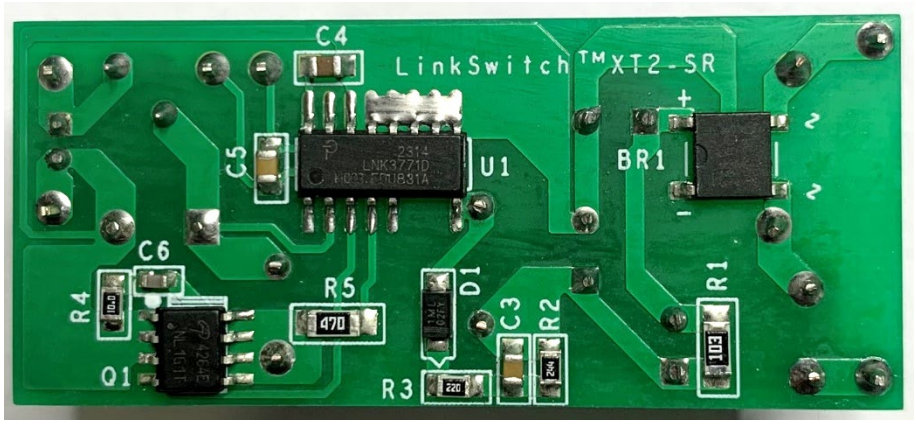


Figure 2 – Populated Circuit Board Photograph, Bottom.

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		265	VAC	2 Wire Input.
Frequency	f_{LINE}		50/60		Hz	
Output						
Output Voltage	V_{OUT}	4.75	5	5.25	V	±5 %
Output Ripple Voltage	V_{RIPPLE}			80	mV	20 MHz Bandwidth.
Output Current	I_{OUT}	0		1	A	
Integrated LDO (µVCC)						
Integrated LDO	**µVCC**	3.135	3.3	3.465	V	±5 %
Integrated LDO Current	$I_{µVCC}$	0		20	mA	
Total Output Power						
Continuous Output Power	P_{OUT}			5.066	W	
Efficiency						
Full Load	η	87			%	At Nominal Input Voltage, Measured at Output Terminal, uVCC = 3.3 V / No-Load.
No-Load Input Power				5	mW	230 VAC.
Environmental						
Safety		Meets CISPR22B / EN55022B Designed to meet IEC950, UL1950 Class II				
Surge Differential		1			kV	1.2/50 µs surge, IEC 61000-4-5, Series Impedance: Differential Mode: 2 Ω.
EFT		2			kV	IEC 61000-4-4
Ambient Temperature	T_{AMB}	0		50	°C	Free Convection, Sea Level.

3 Schematic

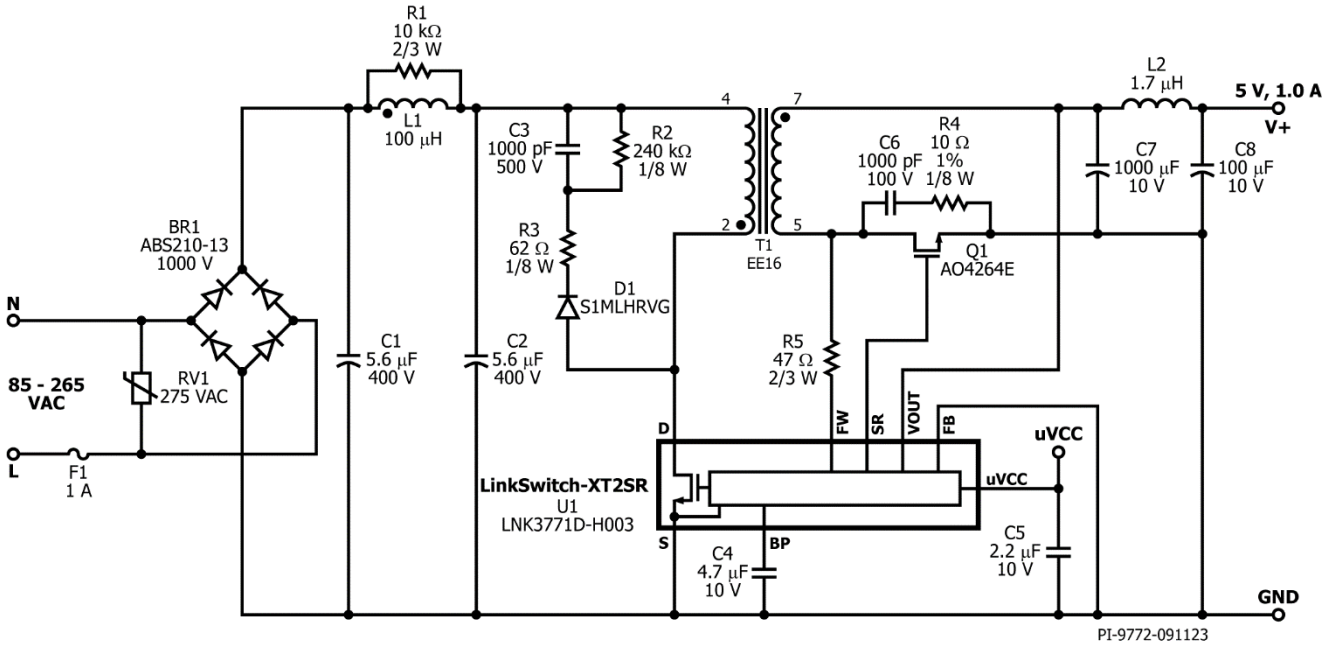


Figure 3 – Schematic.

4 Circuit Description

The LinkSwitch-XT2SR family of devices integrates a high-voltage (725 V rated) power MOSFET with an internal oscillator, synchronous rectifier (SR) MOSFET driver, integrated 3.3 V LDO (µVCC), integrated feedback, and ON/OFF controllers inside a single monolithic IC. Unlike conventional pulse width modulation (PWM) controllers, LinkSwitch-XT2SR devices utilize a simple ON/OFF control scheme combined with an internal current limit circuitry to regulate the output voltage. The LNK3771D-H003 IC has an integrated 5 V feedback that can deliver 1 A load current.

4.1 Input Rectifier and Filter

The AC input is rectified by bridge rectifier BR1 and filtered by the bulk storage capacitors C1 and C2. Fuse F1 isolates the circuit and provides protection from component failure. A pi-filter is formed from differential choke L1 and bulk capacitors C1 and C2 providing filtering for both common mode and differential mode noise. Varistor RV1 is used to clamp the voltage during line surge events.

4.2 LinkSwitch-XT2SR Primary-Side

The rectified and filtered input voltage is applied to the primary winding of flyback transformer T1. Transformer T1 is switched and connected to the IC via the DRAIN (D) pin. The D pin provides internal operating current during start-up. During steady-state operating conditions, the IC is bias via the output voltage.

During the power MOSFET turn-on time, current ramps up in the primary winding, storing energy inside the transformer core, while the output side remains cut-off due to the SR FET is open. The primary winding current eventually exceeds the internal threshold (I_{LIMIT}), causing the power MOSFET to turn off for the remainder of the switching cycle. At the beginning of the next and all succeeding switching cycles, the IC decides whether to turn ON the power MOSFET or let it remain turned OFF. ON/OFF control is performed by monitoring the output voltage, resulting to the power MOSFET being enabled or disabled. Using ON/OFF control, voltage regulation is maintained by skipping cycles without using an error amplifier and ramp generator, as in traditional power supply controllers.

4.3 Primary RCD Clamp

A low-cost RCD clamp is connected across the primary winding of transformer T1. This is composed of resistors R2 and R3, capacitor C3 and diode D1. The clamp helps in dissipating the energy stored in the leakage inductance of T1.

4.4 Output Rectification

The secondary winding of the transformer is rectified by synchronous rectifier (SR) MOSFET Q1 and filtered by capacitors C7, C8 and inductor L2 which forms pi-filter configuration to achieve low output voltage ripple. RC snubber R4 and C6 connected to SR MOSFET Q1 helps reduce high frequency ringing during SR MOSFET switching.

The gate of Q1 is turned on based on the winding voltage sensed via R5 and the FWD pin of the IC. The IC controller ensures that the primary-side MOSFET will never turn-on at the same time with the synchronous rectifier MOSFET on time. The MOSFET drive signal is the output on the SR pin.

The output voltage powers the device then fed into VOUT pin to provide current for the controller. The FEEDBACK (FB) pin is shorted to the ground since the internal resistor divider network is utilized as output sensing. Input to the internal resistor divider network is taken from the VOUT pin.

The internal 3.3 V LDO (uVCC) is filtered by capacitor C5. This uVCC supply is used for external controller.

The schematic in Figure 3 shows an implementation of a flyback converter using LNK3771D-H003. The circuit provides a non-isolated 5 V, 1 A continuous output.

5 PCB Layout

Layers: One (1)
Board Materials: FR4
Board Thickness: 1.6 mm
Copper Weight: 2 oz

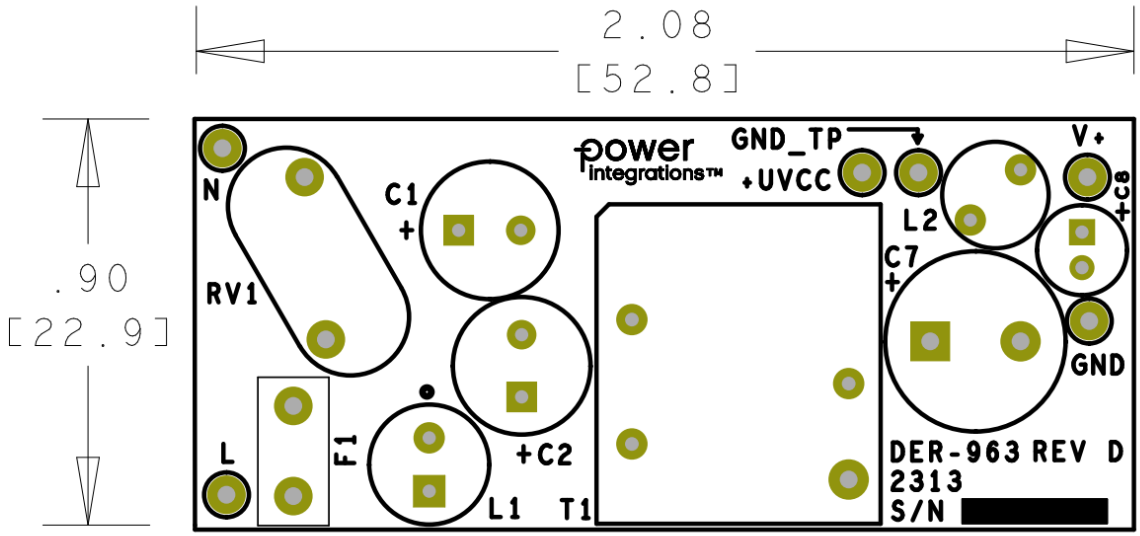


Figure 4 – Printed Circuit Layout, Top (2.08” [52.8 mm] L x 0.9” [22.9 mm] W).

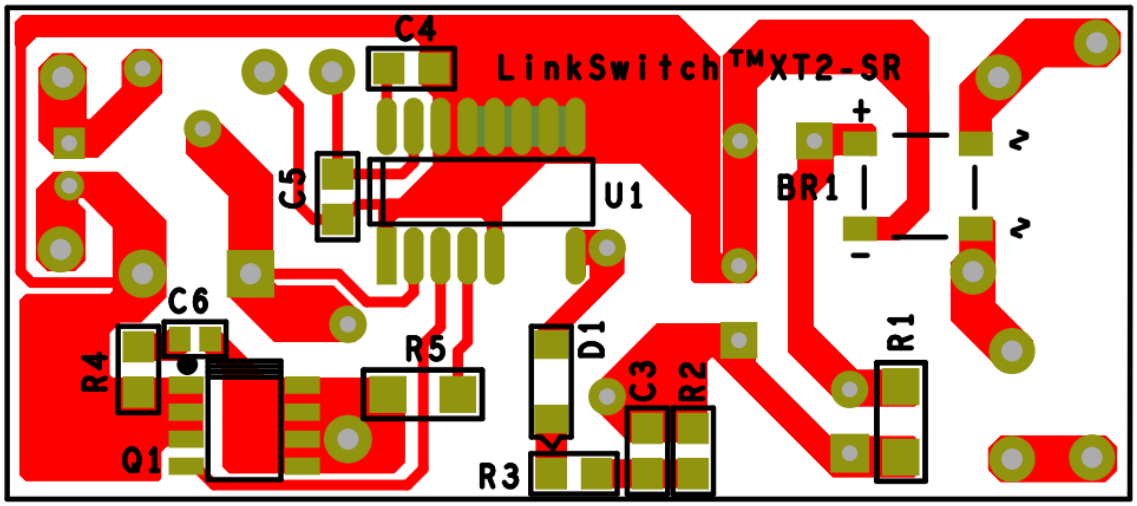


Figure 5 – Printed Circuit Layout, Bottom.

6 Bill of Materials

6.1 Main BOM

Item	Qty	Ref Des	Description	Mfg Part Number	Mfg
1	1	BR1	BRIDGE RECT, 1PH, 1 kV, 2A, 4SOPA, 4-SOPA, SOPA-4, SMD	ABS210-13	Diodes, Inc.
2	2	C1 C2	ALUM, 5.6 μF, 20%, 400V, RADIAL	UVC2G5R6MPD	Nichicon
3	1	C3	1000 pF, 10%, 500 V, Ceramic, X7R, 0805	C0805C102KCRACTU	Kemet
4	1	C4	4.7 μF ±10% 10V Ceramic X7R 0805	LMK212B7475KGHT	Taiyo Yuden
5	1	C5	2.2 μF, 10 V, Ceramic, X7R, 0805	C0805C225M8RACTU	Kemet
6	1	C6	1000 pF, 100 V, Ceramic, NP0, 0603	C1608C0G2A102J	TDK
7	1	C7	1000 μF, 10 V, Electrolytic, Very Low ESR, 38 mΩ, (10 x 16)	EKZE100ELL102MJ16S	Nippon Chemi-Con
8	1	C8	100 μF, 10 V, Electrolytic, Very Low ESR, 300 mΩ, (5 x 11)	EKZE100ELL101ME11D	Nippon Chemi-Con
9	1	D1	Diode, Standard, 1000 V, 1 A, SMT, Sub SMA	S1MLHRVG	TAIWAN SEMI
10	1	F1	1 A, 250 V, Slow, Long Time Lag, RST 1	RST 1	Belfuse
11	1	L1	100 μH, 0.490 A, 20%	RL-5480-2-100	Renco
12	1	L2	1.7 μH, Unshielded, Wirewound, Inductor, 3.52 A, 22.8 mΩ Max, Radial, 6.0 mm diam, 6.5 mm H, 4.0 mm LS	RCH664NP-1R7M	Sumida
13	1	Q1	N-Channel, 60 V, 13.5A (Ta), 3.1W (Ta), SMT 8-SO, 8-SOP, PG-DSO-8, 8-SOIC (0.154", 3.90 mm Width)	AO4264E	Alpha & Omega Semi
14	1	R1	RES, 10 kΩ, 5%, 2/3 W, Thick Film, 1206	ERJ-P08J103V	Panasonic
15	1	R2	RES, 240 kΩ, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ244V	Panasonic
16	1	R3	RES, 62 Ω, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ620V	Panasonic
17	1	R4	RES, 10 Ω, 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF10R0V	Panasonic
18	1	R5	RES, 47 Ω, 5%, 2/3 W, Thick Film, 1206	ERJ-P08J470V	Panasonic
19	1	RV1	275 VAC, 55 J, 10 mm, RADIAL	ERZ-V10D431	Panasonic
20	1	T1	Bobbin, EE16, Vertical, 10 pins (4 x 6)	EL-16 (YW-193-02B)	Yih-Hwa
21	1	U1	LinkSwitch-XT2SR, SO-16B, High voltage	LNK3771D-H003	Power Integrations

6.2 Miscellaneous Parts

Item	Qty	Ref Des	Description	Mfg Part Number	Mfg
1	2	+UVCCN	Test Point, WHT, Miniature THRU-HOLE MOUNT	5002	Keystone
2	3	GND GND_TPL	Test Point, BLK, Miniature THRU-HOLE MOUNT	5001	Keystone
3	1	V+	Test Point, RED, Miniature THRU-HOLE MOUNT	5000	Keystone

7 Design Spreadsheet

ACDC_LinkSwitchXT2SR_ Flyback_031623; Rev.0.8; Copyright Power Integrations 2023	INPUT	INFO	OUTPUT	UNIT	ACDC LinkSwitch-XT2SR Flyback Design Spreadsheet
ENTER APPLICATION VARIABLES					
LINE VOLTAGE RANGE			UNIVERSAL		AC line voltage range
VACMIN	85.00		85.00	V	Minimum AC line voltage
VACMAX			265.00	V	Maximum AC line voltage
fL			60.00	Hz	AC mains frequency
LINE RECTIFICATION TYPE	F		F		Line rectification type: select "F" if full wave rectification or "H" if half wave rectification
VOUT	5.00		5.00	V	Output voltage
IOUT	1.000		1.000	A	Average output current
EFFICIENCY (User Estimate)	0.88		0.88		Overall efficiency estimate
LOSS ALLOCATION FACTOR			0.50		The ratio of power losses during the primary switch off-state to the total system losses
POUT			5.00	W	Continuous output power
CIN	11.20		11.20	uF	Input capacitor
VMIN			90.53	V	Valley voltage of the rectified minimum AC line voltage
VMAX			374.77	V	Peak voltage of the maximum AC line voltage
FEEDBACK	INTERNAL		INTERNAL		Feedback type: select either "INTERNAL" or "EXTERNAL"
INPUT STAGE RESISTANCE			10.0	Ohms	Input stage resistance (includes thermistor, filtering components, etc)
PLOSS_INPUTSTAGE			0.039	W	Maximum input stage power loss
LINKSWITCH-XT2 VARIABLES					
DEVICE SERIES	LNK3771D		LNK3771D		Generic LinkSwitch-XT2SR device code
POUT_MAX			6	W	Power capability of the device based on thermal performance
ILIMITMIN			0.253	A	Minimum current limit of the device
ILIMITTYP			0.273	A	Typical current limit of the device
ILIMITMAX			0.292	A	Maximum current limit of the device
RDSON			15.6	Ohms	Switch on-state drain-to-source resistance at 100 degC
FSMIN			62000	Hz	Minimum switching frequency
FSTYP			66000	Hz	Typical switching frequency
FSMAX			70000	Hz	Maximum switching frequency
BVDSS			725	V	Device breakdown voltage
PRIMARY WAVEFORM PARAMETERS					
OPERATION MODE					
			CCM		Continuous mode of operation
VOR	80.0		80.0	V	Voltage reflected across the primary winding when the primary switch is off
VDSON			2.00	V	Primary switch on-time drain-to-source voltage
VDSOFF			524.8	V	Primary switch off-time drain-to-source voltage stress
KRP/KDP			0.931		Degree on how much the operation tend to be continuous or discontinuous
KP_TRANSIENT			0.403		KP value under transient conditions
DUTY			0.475		Maximum duty cycle
TIME_ON_MIN			1.836	us	Primary switch minimum on-time
IPEAK_PRIMARY			0.292	A	Maximum primary peak current
IPED_PRIMARY			0.017	A	Maximum primary pedestal current
IAVG_PRIMARY			0.064	A	Maximum primary average current
IRMS_PRIMARY			0.112	A	Maximum root-mean-squared value of the primary current
PLOSS_SWITCH			0.258	W	Maximum primary switch power loss
THERMAL RESISTANCE OF SWITCH			95	degC/W	Net thermal resistance of primary switch

T_RISE_SWITCH			24.5	degC	Maximum temperature rise of the switch in degrees Celsius
LPRIMARY_MIN			2704	uH	Minimum primary inductance
LPRIMARY_TYP			3005	uH	Typical primary inductance
LPRIMARY_MAX			3305	uH	Maximum primary inductance
LPRIMARY_TOL			10	%	Primary inductance tolerance
SECONDARY WAVEFORM PARAMETERS					
IPEAK_SECONDARY			4.112	A	Peak secondary current
IRMS_SECONDARY			1.656	A	Maximum root-mean-squared value of the secondary current
IRIPPLE_SECONDARY			4.112	A	Maximum ripple value of the secondary current
PIV_SECONDARY			31.5	V	Peak inverse voltage of the secondary rectifier
VF_SECONDARY			0.70	V	Forward voltage drop of the secondary rectifier
TRANSFORMER CONSTRUCTION PARAMETERS					
Core Selection					
CORE	EE16		EE16		Select the transformer core
CODE CODE			PC40EE16-Z		Core code
BOBBIN			B-EE16-H		Core code
AE			19.20	mm^2	Cross-sectional area of the core
LE			35.00	mm	Effective magnetic path length of the core
AL			1140.0	nH/(T^2)	Ungapped effective inductance of the core
VE			795.0	mm^3	Effective volume of the core
AW			20.50	mm^2	Window area of the bobbin
BW			8.50	mm	Width of the bobbin
MLT			25.10	mm	Mean length per turn of the bobbin
MARGIN			0.00	mm	Safety margin
Primary Winding					
NPRIMARY			169	turns	Primary winding number of turns
BMAX			2975	Gauss	Actual value of magnetic flux density (BMAX_TARGET = 3000 Gauss)
BAC			1487	Gauss	AC flux density
ALG			105	nH/(T^2)	Gapped core effective inductance
LG			0.208	mm	Core gap length
Secondary Winding					
NSECONDARY			12	turns	Secondary winding number of turns
FEEDBACK PARAMETERS					
RUPPER			N/A	Ohms	FB pin (Upper) Resistor
RLOWER			N/A	Ohms	FB pin (Lower) Resistor
MULTIPLE OUTPUT PARAMETERS					
Output 1 (SRFET)					
VOUT1			5.00	V	Output voltage 1
IOUT1			1.000	A	Output current 1
POUT1			5.00	W	Output power 1
VD1			0.70	V	Forward voltage drop of SRFET for output 1
NS1			12	turns	Number of turns for output 1
ISPEAK1			4.11	A	Instantaneous peak value of the secondary current for output 1
ISRMS1			1.656	A	Root-mean-squared value of the secondary current for output 1
ISRIPPLE1			4.112	A	Current ripple on the secondary current waveform for output 1
PIV1			39.3	V	Computed peak inverse voltage stress on the secondary SRFET for output 1
OUTPUT_RECTIFIER1	AUTO		SI2318CDS		Recommended SRFET for output 1.
VRRM1			40	V	Maximum repetitive peak reverse voltage of the SRFET for output 1

TRR1			15	ns	Reverse recovery time of the SRFET for output 1
IFM1			3.50	A	Maximum forward continuous current of the SRFET of output 1
PLOSS_SRFET1			0.258	W	Maximum SRFET power loss for output 1
VOUT1_RIPPLE			50	mV	Output voltage ripple for output 1
ESR_COUT1			12	mOhms	Equivalent series resistance of the output capacitor for output 1
IRMS_COUT1			1.320	A	Root-mean-squared value of the output capacitor current for output 1
PLOSS_COUT1			0.021	W	Maximum output capacitor power loss for output 1

8 Transformer Specification

8.1 Electrical Diagram

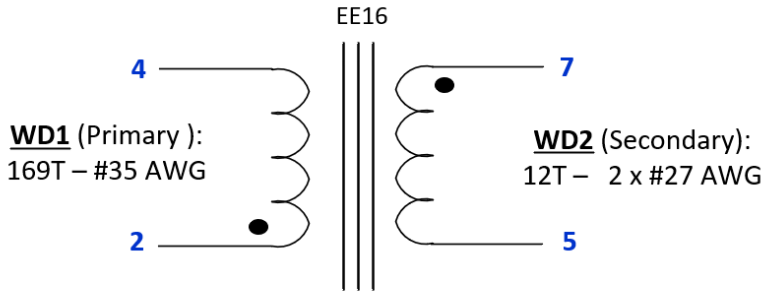


Figure 6 – Transformer Electrical Diagram.

8.2 Electrical Specifications

Parameter	Condition	Spec
Primary Inductance	Pins 2-4, all other windings open, measured at 100 kHz, 1 V_{RMS}.	3005 µH ±5%
Primary Leakage Inductance	Pins 2-4, all other windings short, measured at 100 kHz, 1 V_{RMS}.	<50 µH

8.3 Material List

Item	Description
[1]	Core: EE16, Gapped.
[2]	Bobbin: EE16, Vertical, 10 Pins.
[3]	Magnet Wire: #35 AWG.
[4]	Magnet Wire: #27 AWG.
[5]	Tape, 3M 1298 Polyester Film, 2.0 Mils Thick, 8.5 mm Wide.
[6]	Tape, 3M 1298 Polyester Film, 2.0 Mils Thick, 4.5 mm Wide.
[7]	Varnish.

8.4 Transformer Build Diagram

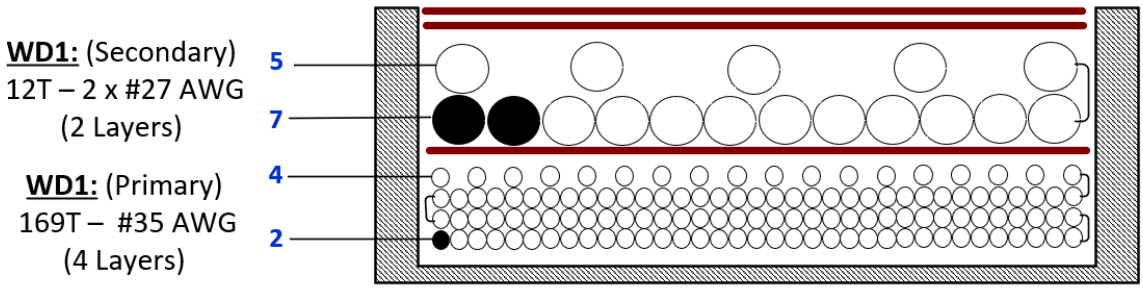
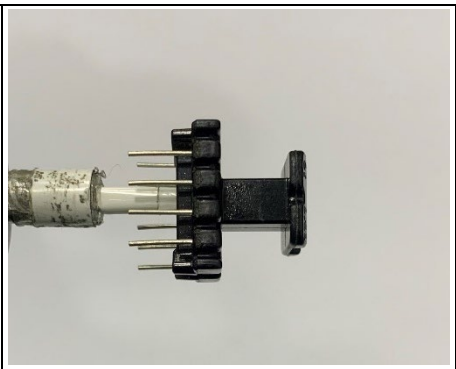
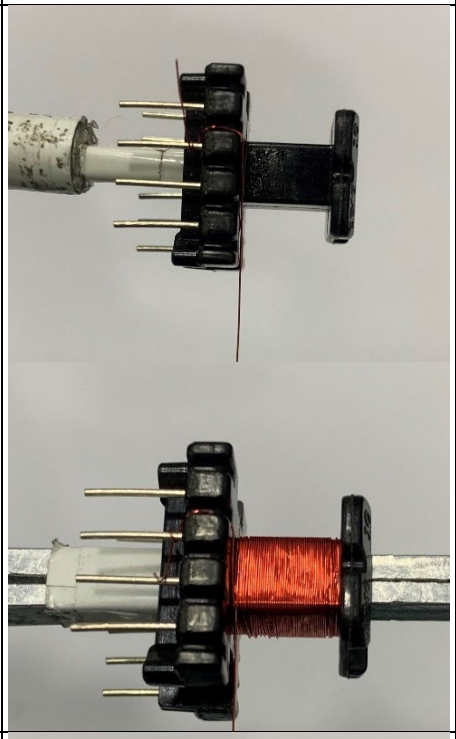
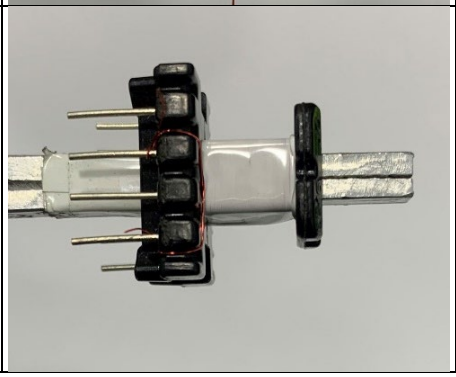


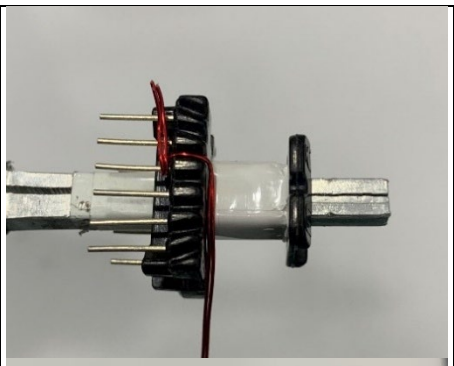
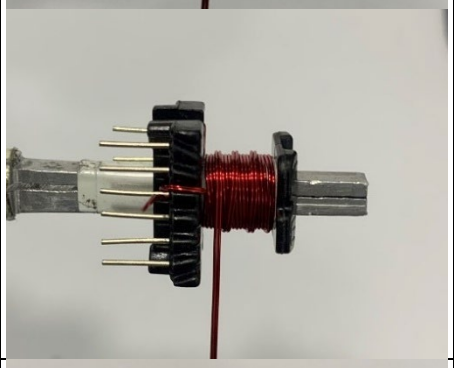
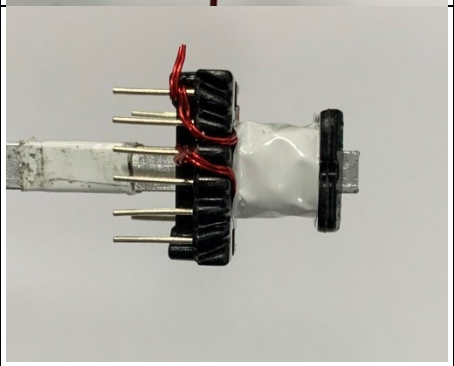
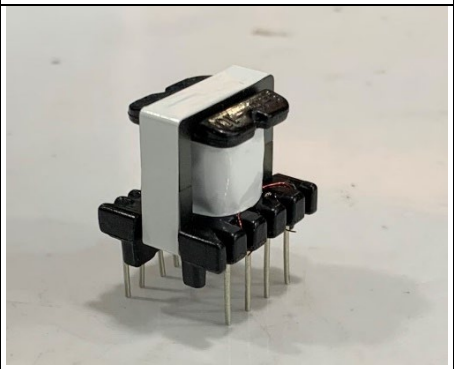
Figure 7 – Transformer Build Diagram.

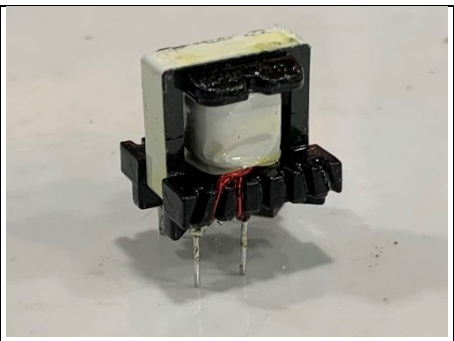
8.5 Transformer Construction

Winding Preparation	Place the bobbin Item [2] such that the pins are facing the winder. Winding direction is counter-clockwise.
W1 Primary	Starting at pin 2, wind 169 turns of wire Item [3] in four layers. At the last turn, bring the wire back across the windings and into pin 4.
Insulation	Apply one layer of tape Item [5] for insulation.
W2 Secondary	Start at pin 7, wind 12 turns of bifilar wire Item [4] in two layers. Terminate the wire at pin 5.
Insulation	Use 2 layers of tape Item [5] for insulation.
Assembly	Grind core halves for specified primary inductance, insert bobbin, and secure core halves with tape Item [6]. Remove pins 1, 3, 6, 8, 9 and 10. Dip varnish Item [7].

8.6 Transformer Winding Illustrations

Winding Preparation		Place the bobbin Item [2] such that the pins are facing the winder. Winding direction is counter-clockwise.
W1 Primary		Starting at pin 2, wind 169 turns of wire Item [3] in four layers. At the last turn, bringthe wire back across the windings and into pin 4.
Insulation		Apply one layer of tape Item [5] for insulation.

W2 Secondary	 	Start at pin 7, wind 12 turns of bifilar wire Item [4] in two layers. Terminate the wire at pin 5.
Insulation		Use 2 layers of tape Item [5] for insulation.
Assembly		Grind core halves for specified primary inductance, insert bobbin, and secure core halves with tape Item [6]. Remove pins 1, 3, 6, 8, 9 and 10. Dip varnish Item [7].

9 Performance Data

All measurements were performed at room temperature.

9.1 Efficiency vs. Line

9.1.1 uVCC = 3.3 V / No-Load

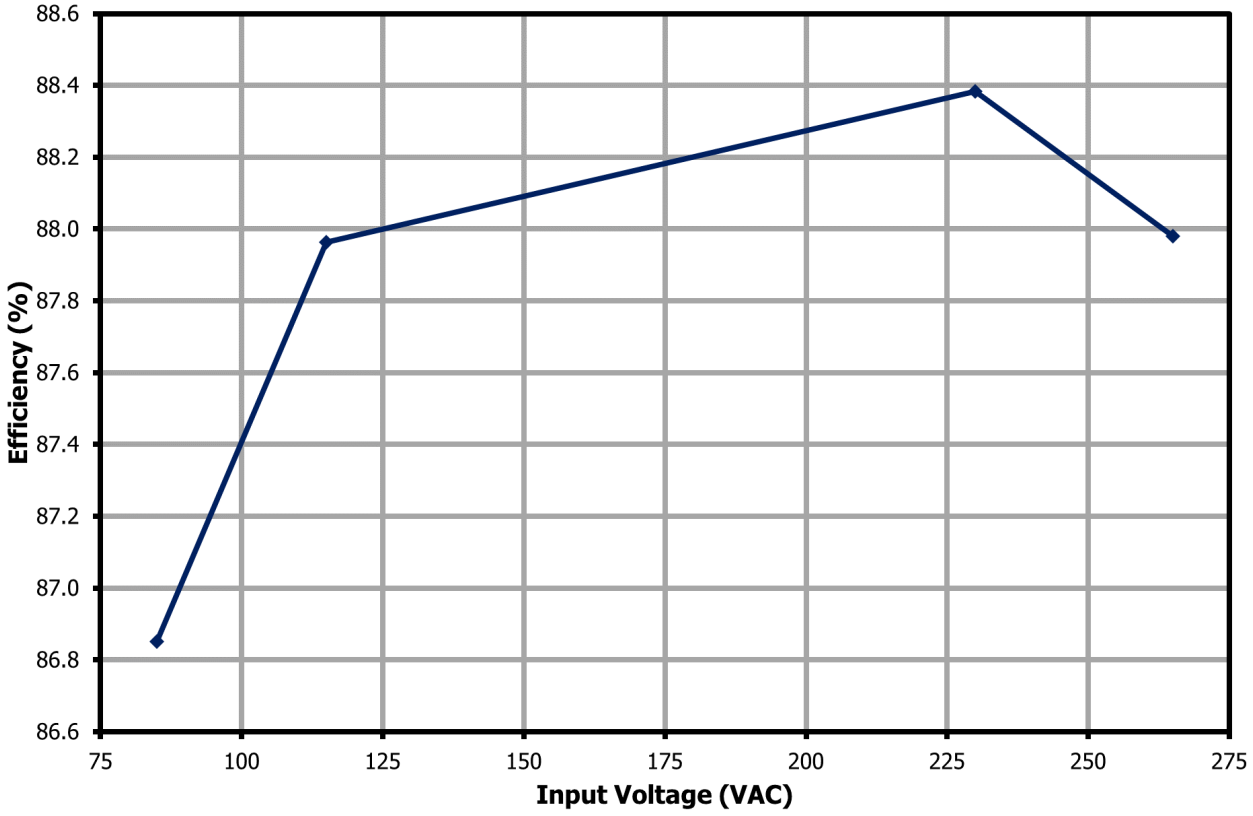


Figure 8 – Full Load (1 A) Efficiency vs. Line Voltage, Room Temperature.

9.1.2 uVCC = 3.3 V / 20 mA

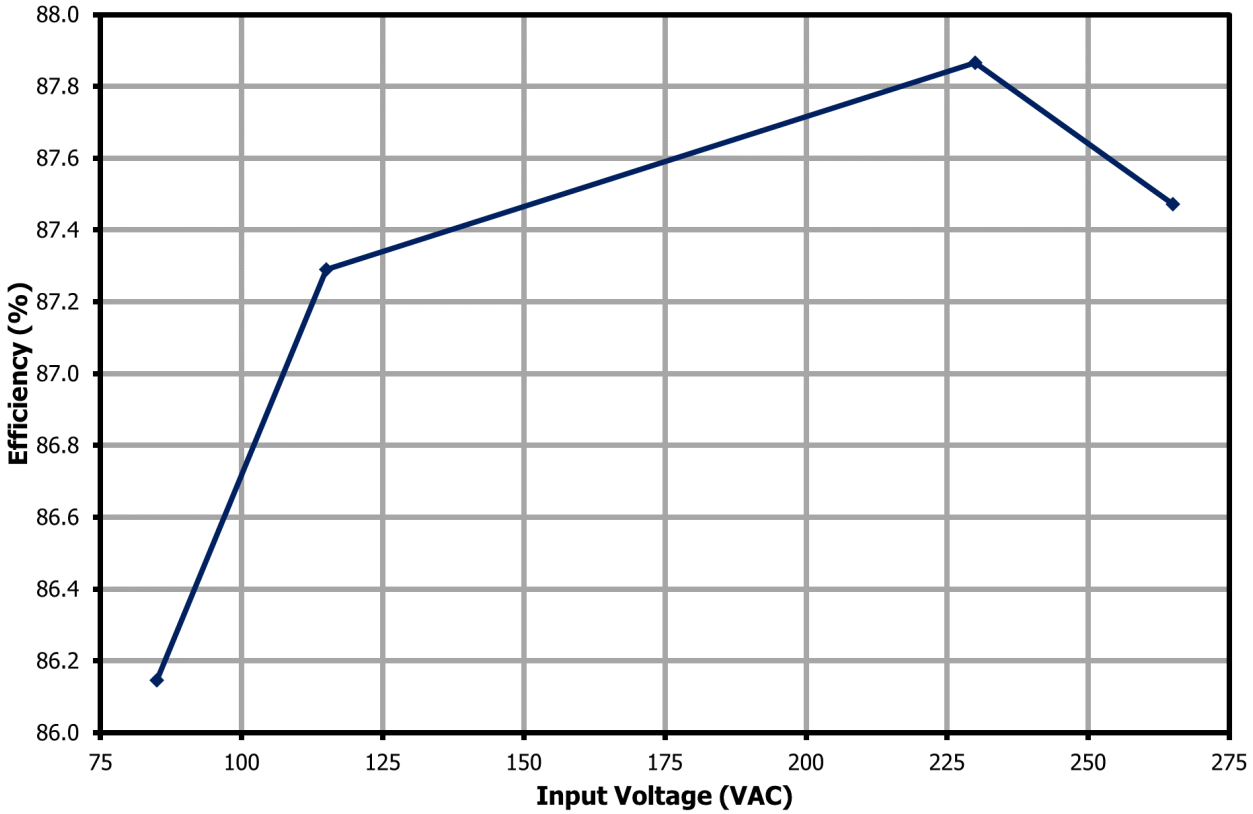


Figure 9 – Full Load (1 A) Efficiency vs. Line Voltage, Room Temperature.

9.2 Efficiency vs. Load

9.2.1 uVCC = 3.3 V / No-Load

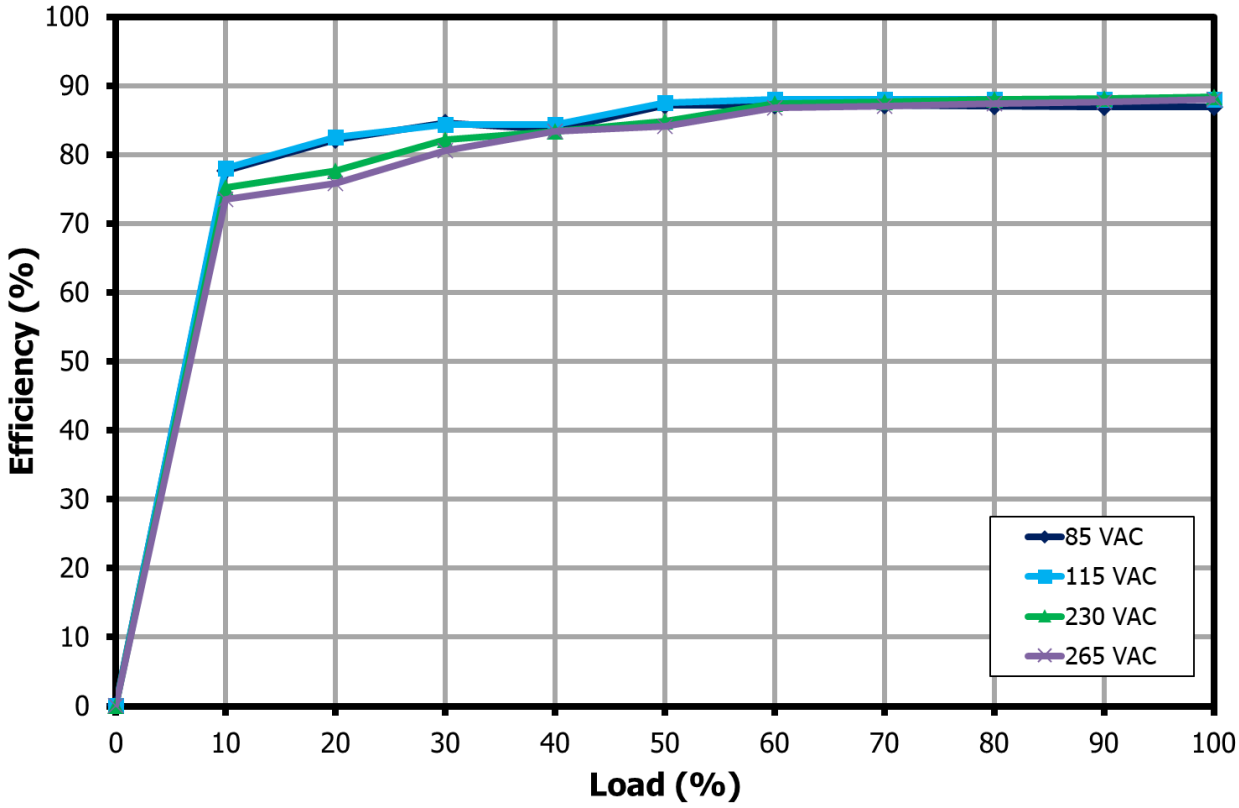


Figure 10 – Efficiency vs. Load, Room Temperature.

9.2.2 uVCC = 3.3 V / 20 mA

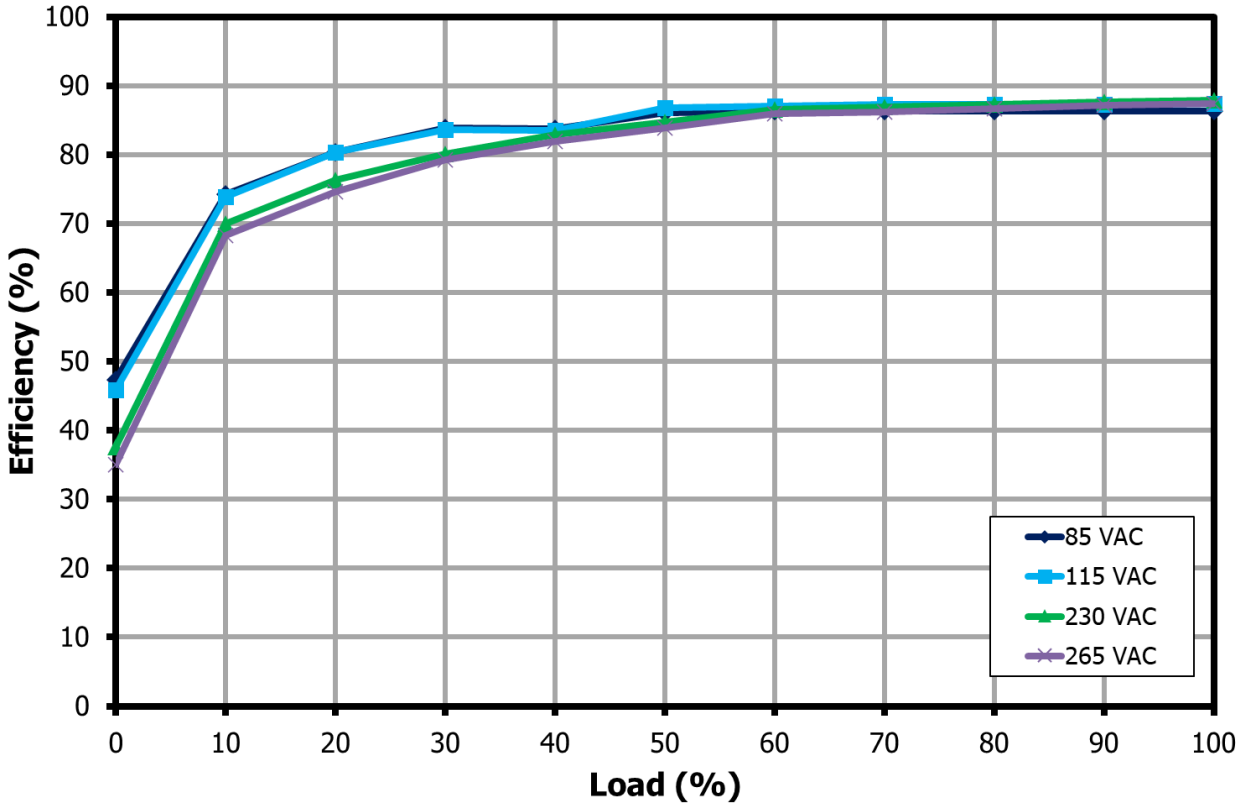


Figure 11 – Efficiency vs. Load, Room Temperature.

9.3 Average Efficiency

9.3.1 85 VAC / 60 Hz

	Input Measurement			Output Measurement			
Load (A)	**V_{IN} (V_{RMS})**	**I_{IN} (mA_{RMS})**	**P_{IN} (W)**	**V_{OUT} (V_{DC})**	**I_{OUT} (mA_{DC})**	**P_{OUT} (W)**	**Efficiency (%)**
100%	85	117.44	5.73	4.97	1000.00	4.97	86.71
75%	85	92.14	4.29	4.97	750.00	3.73	86.85
50%	85	66.47	2.88	5.00	500.00	2.50	86.96
25%	85	39.25	1.48	5.00	250.17	1.25	84.41
10%	85	20.46	0.65	5.00	100.17	0.50	77.58
				Average			**86.23**

9.3.2 115 VAC / 60 Hz

	Input Measurement			Output Measurement			
Load (A)	**V_{IN} (V_{RMS})**	**I_{IN} (mA_{RMS})**	**P_{IN} (W)**	**V_{OUT} (V_{DC})**	**I_{OUT} (mA_{DC})**	**P_{OUT} (W)**	**Efficiency (%)**
100%	115	95.47	5.67	4.98	1000.00	4.98	87.86
75%	115	75.80	4.25	4.98	750.10	3.73	87.86
50%	115	55.21	2.85	5.00	500.10	2.50	87.75
25%	115	33.19	1.49	5.00	250.20	1.25	83.85
10%	115	17.10	0.64	5.00	100.20	0.50	77.70
				Average			**86.83**

9.3.3 230 VAC / 50 Hz

	Input Measurement			Output Measurement			
Load (A)	**V_{IN} (V_{RMS})**	**I_{IN} (mA_{RMS})**	**P_{IN} (W)**	**V_{OUT} (V_{DC})**	**I_{OUT} (mA_{DC})**	**P_{OUT} (W)**	**Efficiency (%)**
100%	230	61.64	5.65	4.99	1000.00	4.99	88.27
75%	230	49.53	4.27	4.99	750.10	3.75	87.65
50%	230	36.62	2.91	5.00	500.10	2.50	85.95
25%	230	22.34	1.57	5.00	250.21	1.25	79.91
10%	230	11.15	0.68	5.00	100.22	0.50	74.16
				Average			**85.45**

9.3.4 265 VAC / 50 Hz

	Input Measurement			Output Measurement			
Load (A)	**V_{IN} (V_{RMS})**	**I_{IN} (mA_{RMS})**	**P_{IN} (W)**	**V_{OUT} (V_{DC})**	**I_{OUT} (mA_{DC})**	**P_{OUT} (W)**	**Efficiency (%)**
100%	265	57.31	5.68	4.99	1000.10	4.99	87.84
75%	265	46.11	4.31	5.00	750.10	3.75	87.00
50%	265	34.05	2.93	5.00	500.10	2.50	85.33
25%	265	20.95	1.60	5.00	250.23	1.25	78.22
10%	265	10.31	0.69	5.00	100.24	0.50	72.35
				Average			**84.60**

9.4 Standby Mode Efficiency

Test Condition: Soak at full load for 5 minutes and decrease load to standby mode for 5 minutes for each line step.

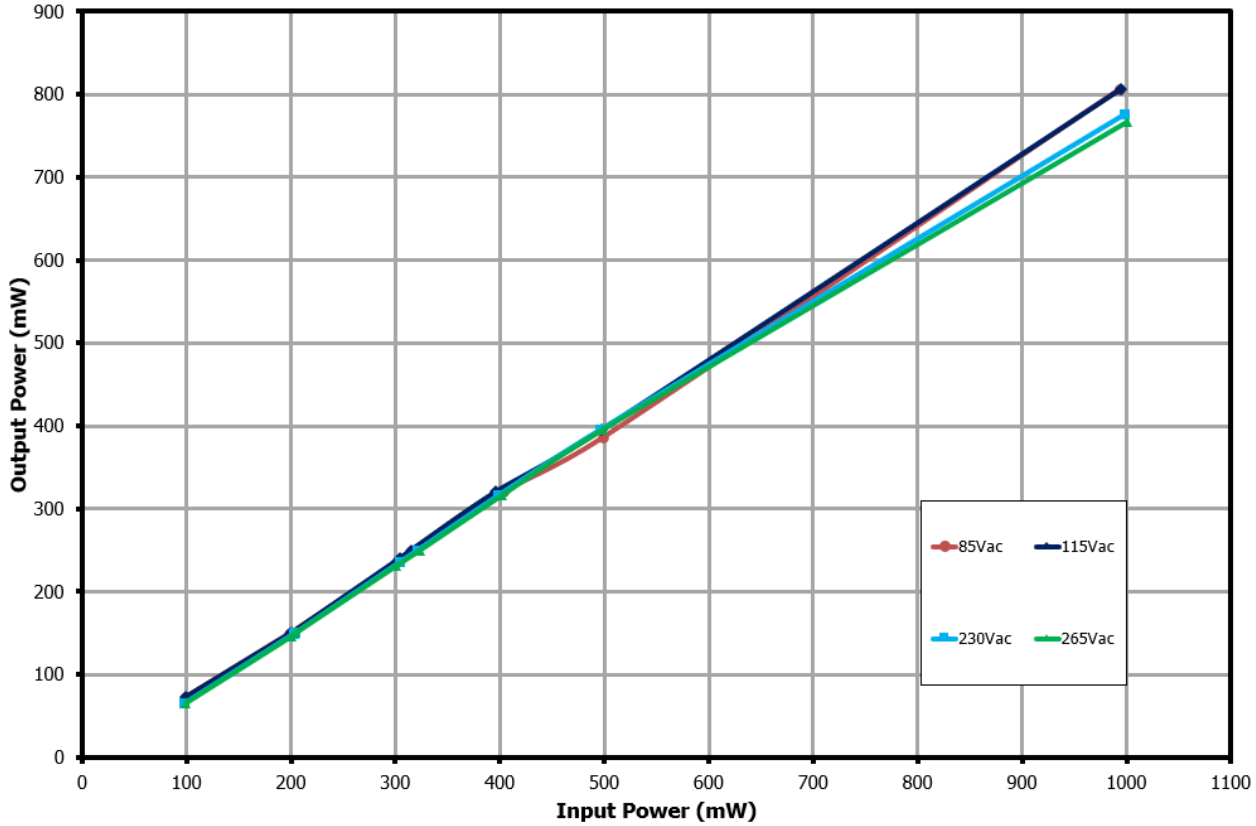


Figure 12 – Available Output Power per Input Power.

9.4.1 0.1 W Input Power

Input Measurement			Output Measurement			
V_{IN} (V_{RMS})	I_{IN} (mA_{RMS})	P_{IN} (W)	V_{OUT} (V_{DC})	I_{OUT} (mA_{DC})	P_{OUT} (W)	Efficiency (%)
85	4.94	0.10	5.00	14.60	0.073	73.51
115	4.02	0.10	5.00	14.61	0.073	73.62
230	2.38	0.10	5.01	13.13	0.066	66.90
265	2.11	0.10	5.01	13.15	0.066	65.98

9.4.2 0.2 W Input Power

Input Measurement			Output Measurement			
V_{IN} (V_{RMS})	I_{IN} (mA_{RMS})	P_{IN} (W)	V_{OUT} (V_{DC})	I_{OUT} (mA_{DC})	P_{OUT} (W)	Efficiency (%)
85	8.21	0.20	5.00	30.04	0.150	75.29
115	6.82	0.20	5.00	30.05	0.150	74.90
230	4.23	0.20	5.00	30.07	0.150	73.82
265	3.74	0.20	5.00	29.16	0.146	72.80

9.4.3 0.3 W Input Power

Input Measurement			Output Measurement			
V_{IN} (V_{RMS})	I_{IN} (mA_{RMS})	P_{IN} (W)	V_{OUT} (V_{DC})	I_{OUT} (mA_{DC})	P_{OUT} (W)	Efficiency (%)
85	11.26	0.30	5.00	47.20	0.236	78.46
115	9.47	0.30	5.00	48.11	0.241	79.04
230	5.92	0.30	5.00	47.16	0.236	77.60
265	5.29	0.30	5.00	46.09	0.231	76.71

9.4.4 0.4 W Input Power

Input Measurement			Output Measurement			
V_{IN} (V_{RMS})	I_{IN} (mA_{RMS})	P_{IN} (W)	V_{OUT} (V_{DC})	I_{OUT} (mA_{DC})	P_{OUT} (W)	Efficiency (%)
85	14.14	0.40	5.00	64.17	0.321	79.63
115	11.67	0.40	5.00	64.14	0.321	80.95
230	7.40	0.40	5.00	63.16	0.316	79.40
265	6.79	0.40	5.00	63.15	0.316	78.58

9.4.5 0.5 W Input Power

Input Measurement			Output Measurement			
V_{IN} (V_{RMS})	I_{IN} (mA_{RMS})	P_{IN} (W)	V_{OUT} (V_{DC})	I_{OUT} (mA_{DC})	P_{OUT} (W)	Efficiency (%)
85	16.68	0.50	5.00	77.14	0.386	77.39
115	13.96	0.50	5.00	79.11	0.396	79.45
230	8.89	0.50	5.00	79.08	0.396	79.76
265	8.15	0.50	5.00	79.08	0.396	79.26

9.4.6 1 W Input Power

Input Measurement			Output Measurement			
V_{IN} (V_{RMS})	I_{IN} (mA_{RMS})	P_{IN} (W)	V_{OUT} (V_{DC})	I_{OUT} (mA_{DC})	P_{OUT} (W)	Efficiency (%)
85	28.62	0.99	5.00	161.11	0.806	81.14
115	24.15	0.99	5.00	161.13	0.806	81.08
230	15.80	1.00	5.00	155.17	0.776	77.78
265	14.60	1.00	5.00	153.16	0.766	76.54

9.4.7 0.15 W Output Power

Input Measurement			Output Measurement			
V_{IN} (V_{RMS})	I_{IN} (mA_{RMS})	P_{IN} (W)	V_{OUT} (V_{DC})	I_{OUT} (mA_{DC})	P_{OUT} (W)	Efficiency (%)
85	8.16	0.20	5.00	29.93	0.15	75.44
115	6.76	0.20	5.00	29.94	0.15	75.04
230	4.19	0.20	5.01	29.94	0.15	73.87
265	3.79	0.20	5.01	29.95	0.15	73.35

9.4.8 0.25 W Output Power

Input Measurement			Output Measurement			
V_{IN} (V_{RMS})	I_{IN} (mA_{RMS})	P_{IN} (W)	V_{OUT} (V_{DC})	I_{OUT} (mA_{DC})	P_{OUT} (W)	Efficiency (%)
85	11.67	0.32	5.00	49.97	0.25	79.20
115	9.69	0.31	5.00	49.99	0.25	79.43
230	6.16	0.32	5.01	50.00	0.25	77.92
265	5.63	0.32	5.01	49.99	0.25	77.19

9.5 No-Load Input Power

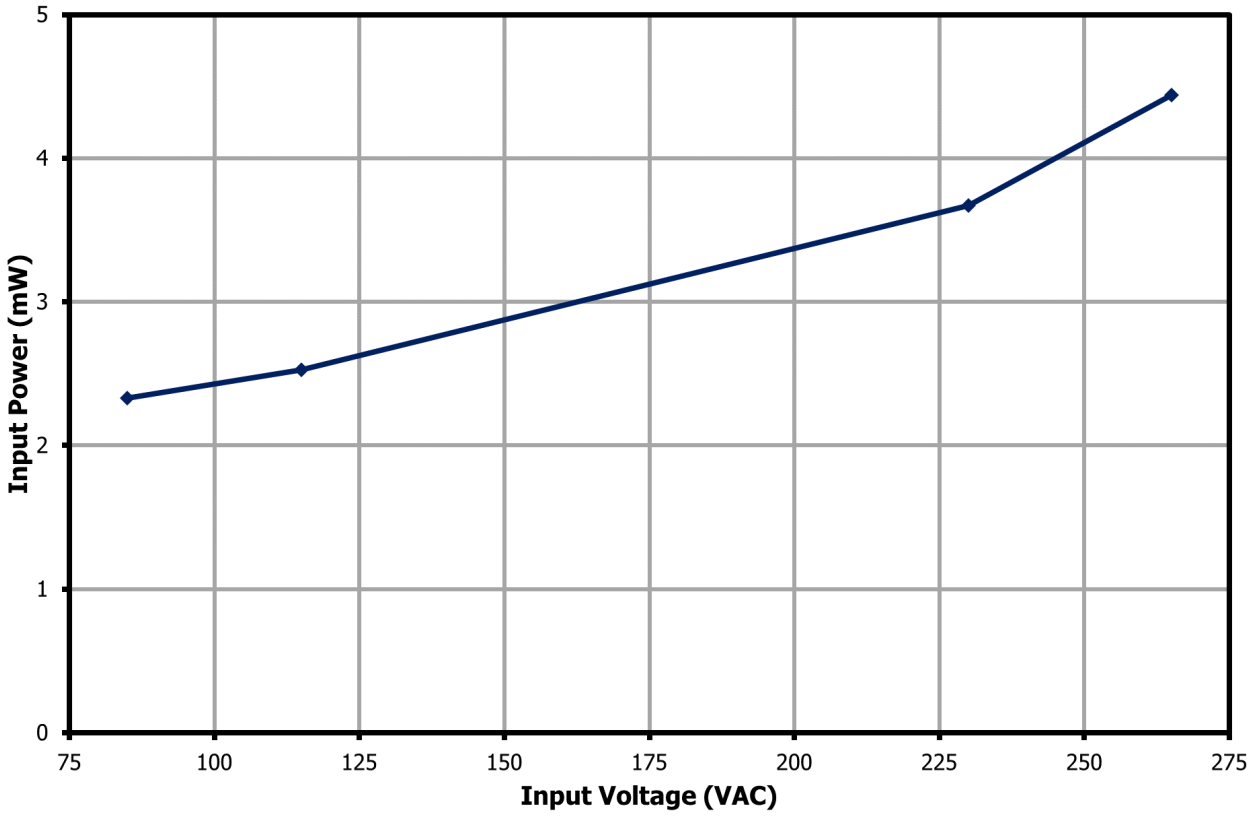


Figure 13 – No-Load Input Power vs. Input Line Voltage, Room Temperature.

9.6 Load Regulation

9.6.1 uVCC = 3.3 V / No-Load

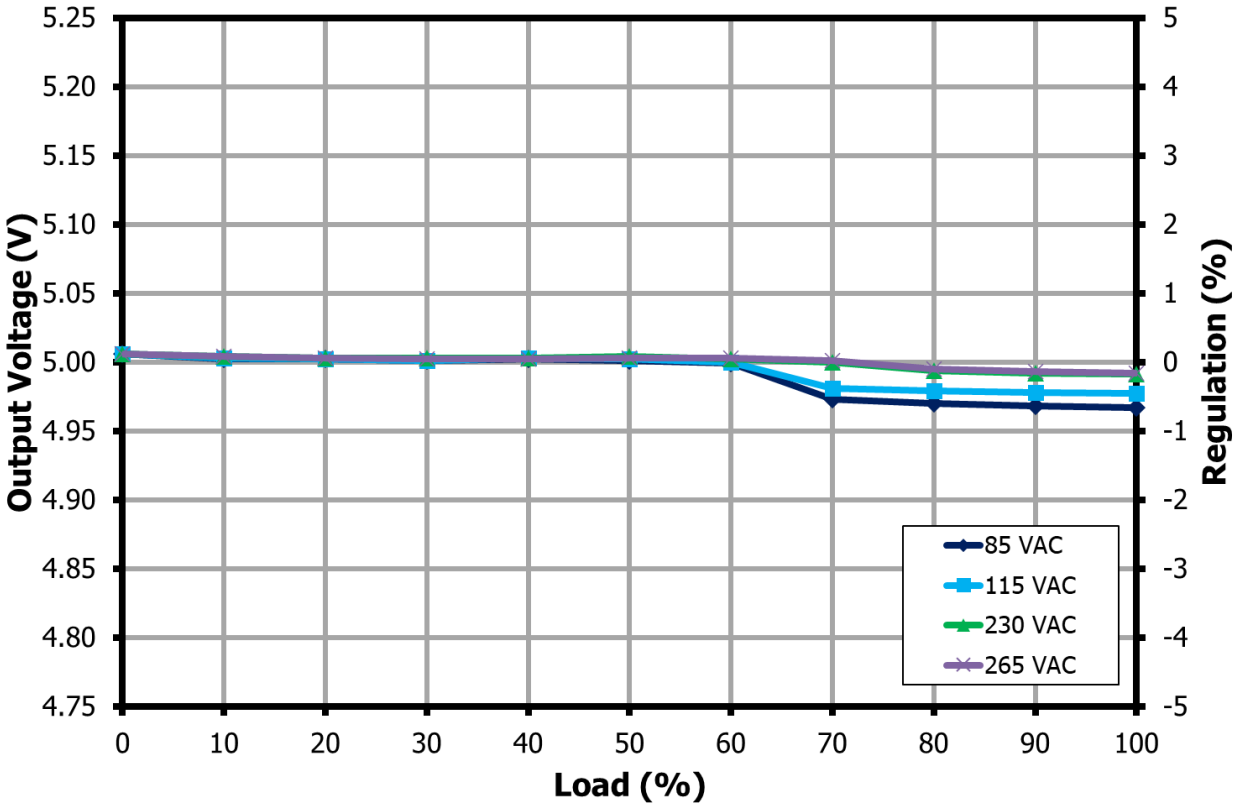


Figure 14 – Output Voltage vs. Output Current, Room Temperature.

9.6.2 uVCC = 3.3 V / 20 mA

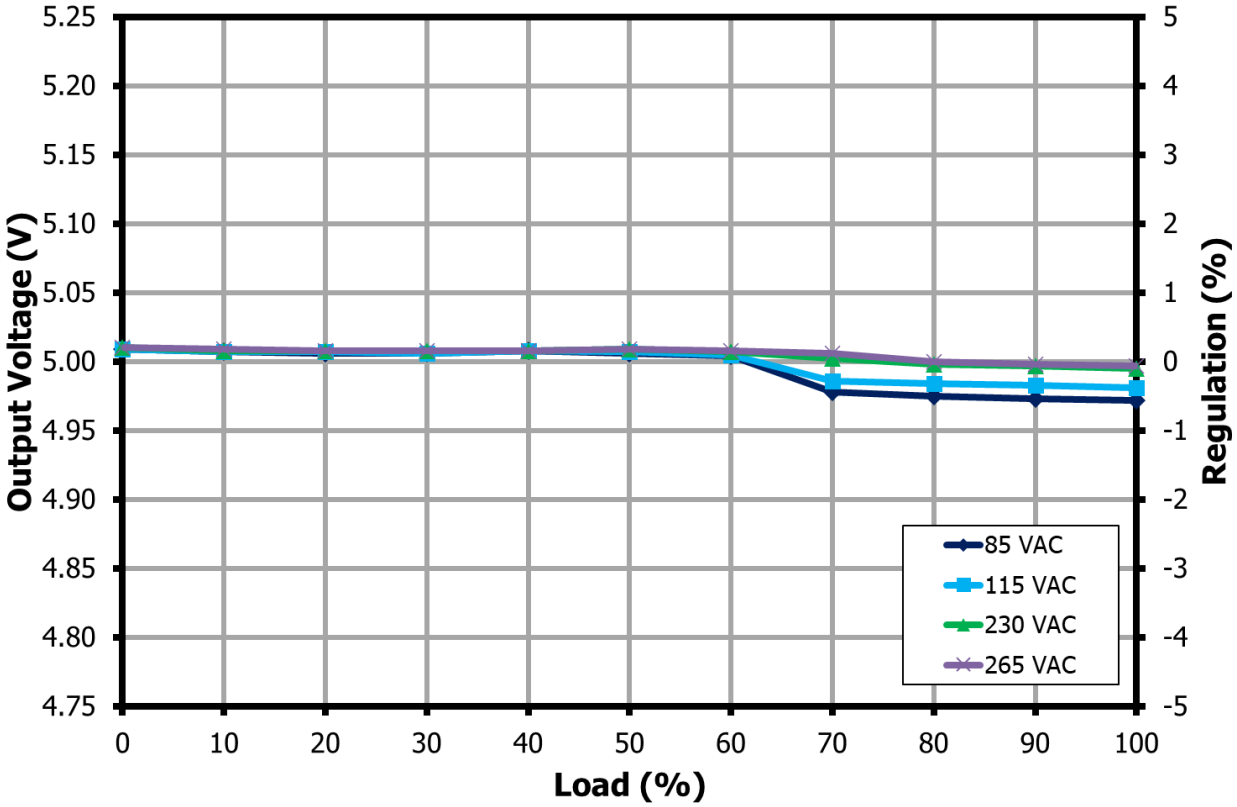


Figure 15 – Output Voltage vs. Output Current, Room Temperature.

9.7 Line Regulation at Full Load

9.7.1 uVCC = 3.3 V / No-Load

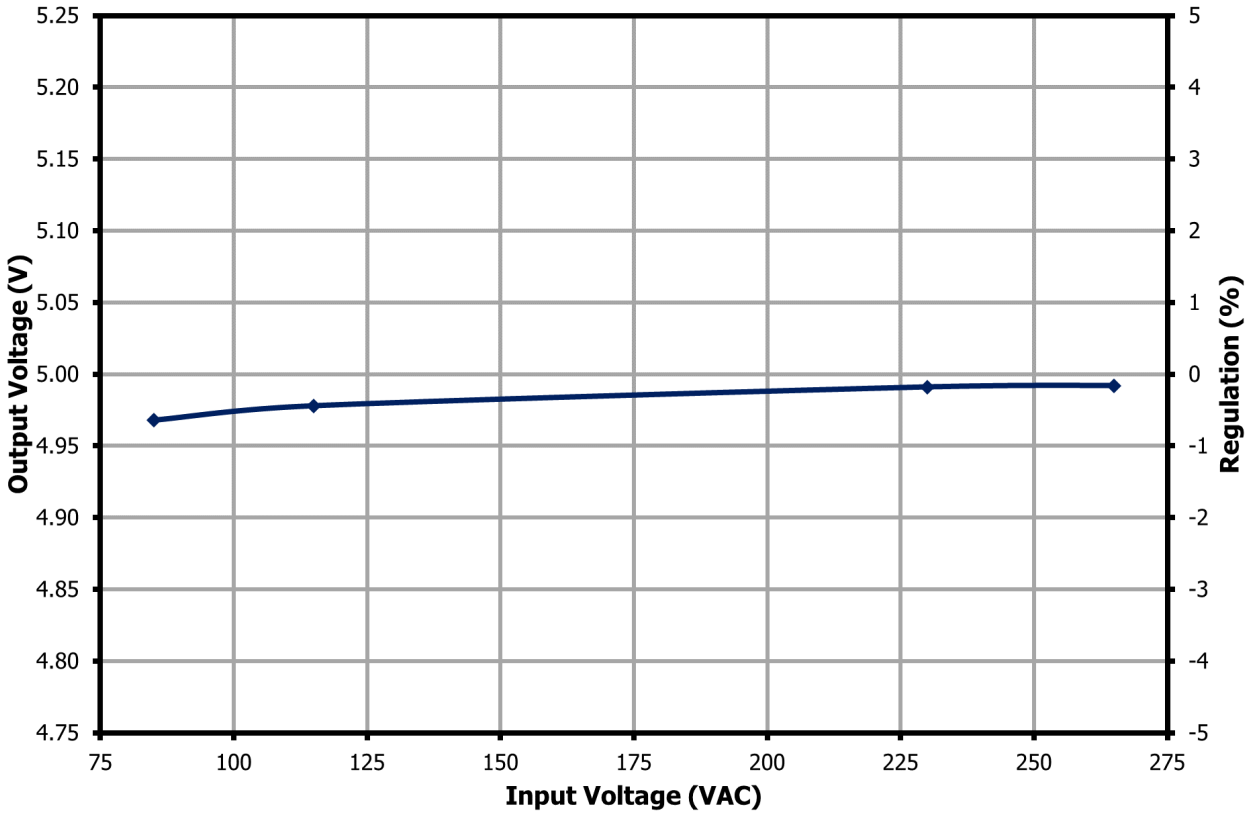


Figure 16 – Output Voltage vs. Input Voltage, Room Temperature.

9.7.2 uVCC = 3.3 V / 20 mA

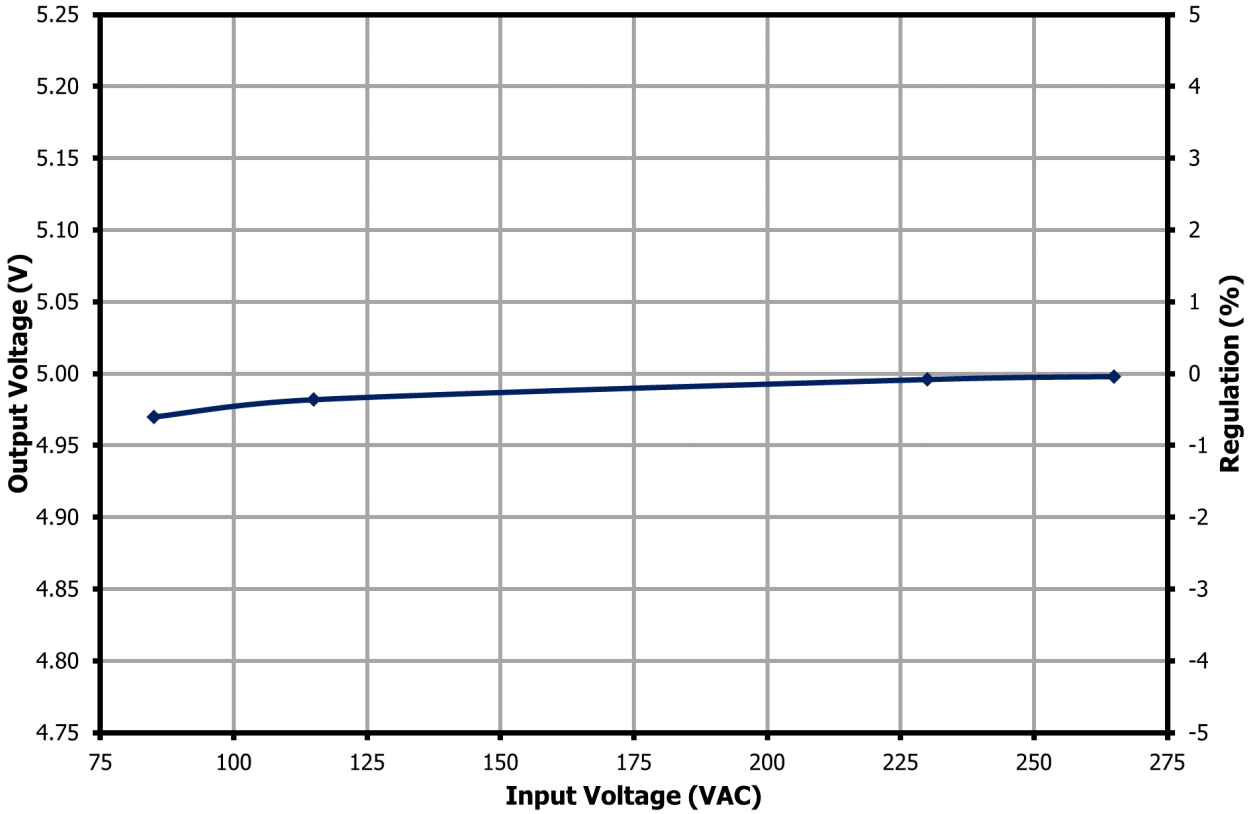


Figure 17 – Output Voltage vs. Input Voltage, Room Temperature.

10 Thermal Performance

10.1 Ambient Thermal Performance

10.1.1 uVCC = 3.3 V / 20 mA

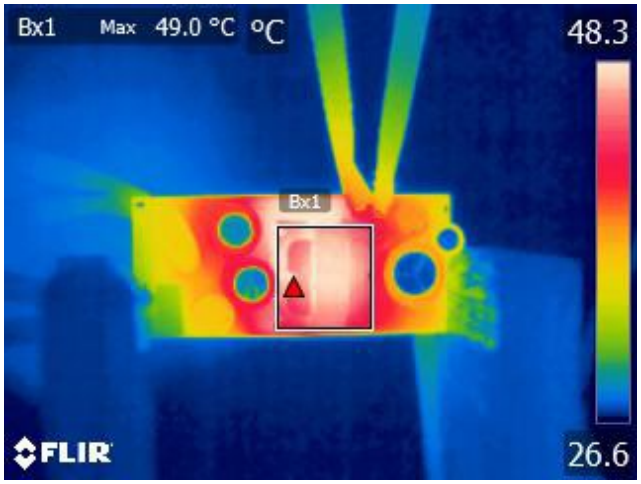


Figure 18 – Transformer (Bx1), 49.0 ºC.
85 VAC, 1 A Output.

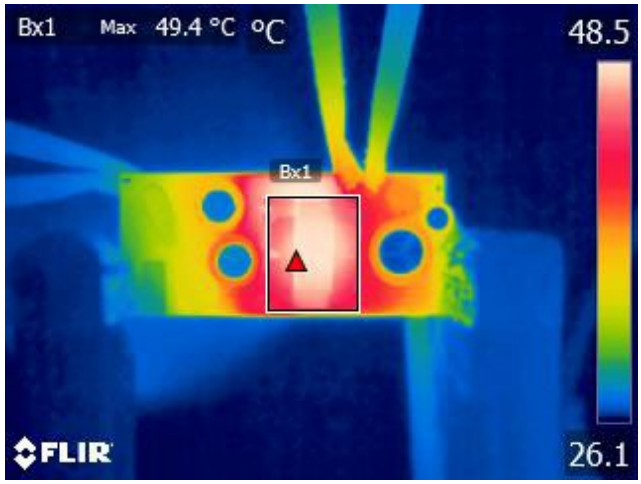


Figure 19 – Transformer (Bx1), 49.4 ºC.
265 VAC, 1 A Output.

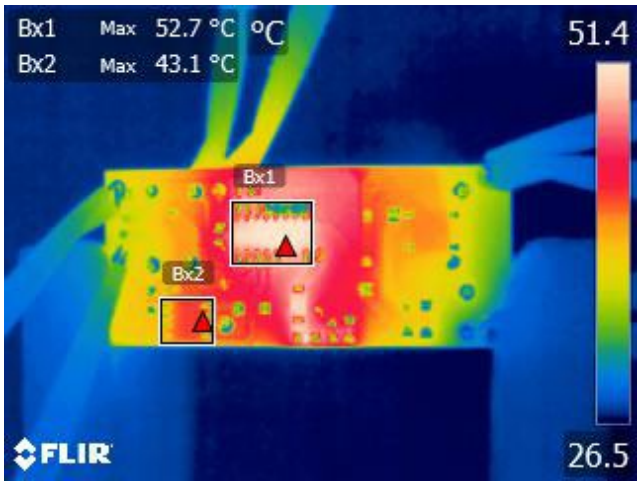


Figure 20 – LNK3771D (Bx1), 52.7 ºC.
SR FET (Bx2), 43.1 ºC.
85 VAC, 1 A Output.

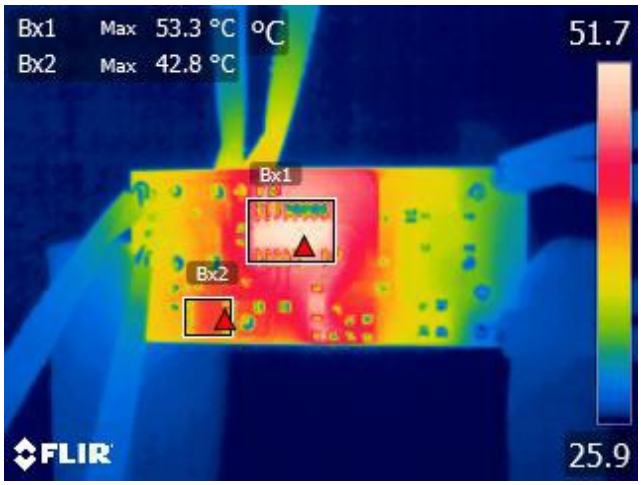


Figure 21 – LNK3771D (Bx1), 53.3 ºC.
SR FET (Bx2), 42.8 ºC.
265 VAC, 1 A Output.

10.2 50 ºC Thermal Performance

10.2.1 uVCC = 3.3 V / 20 mA

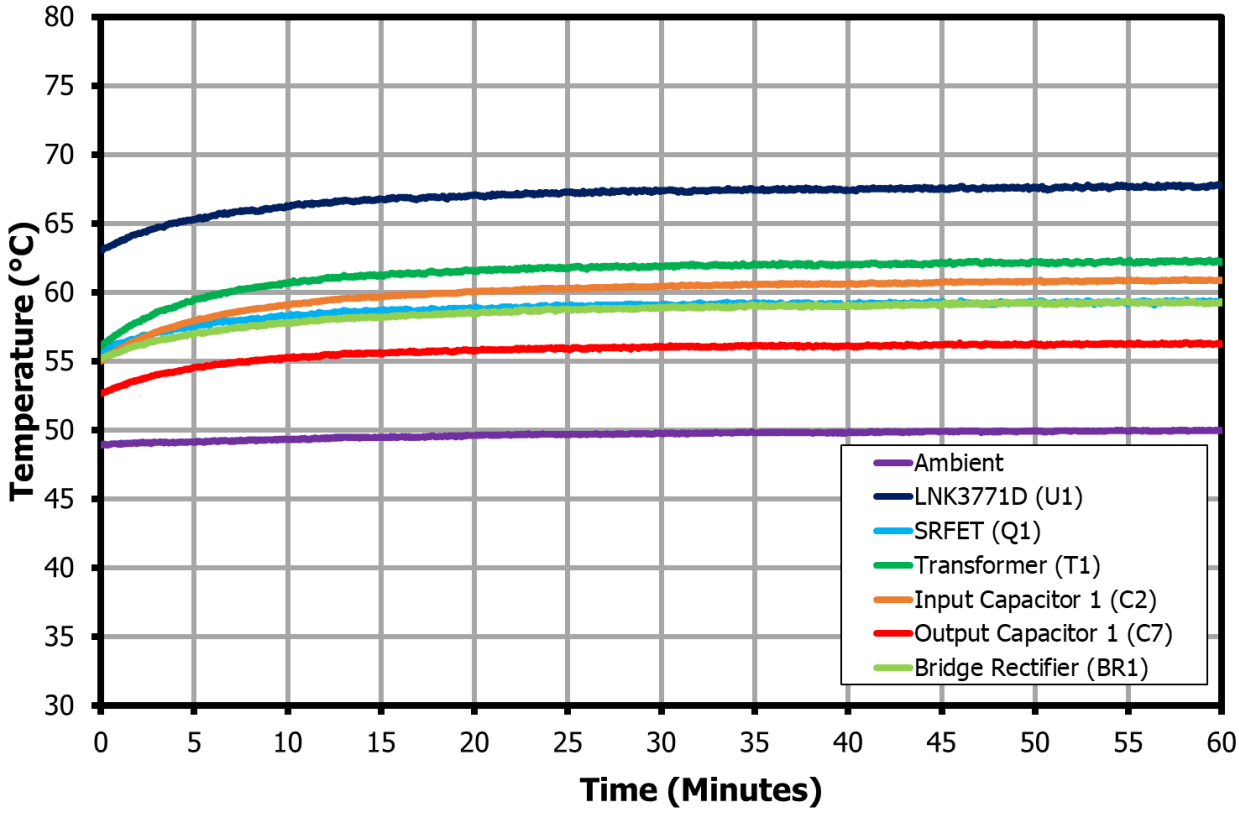


Figure 22 – 85 VAC Thermal Performance at Full Load, uVCC = 3.3 V / 20 mA.

Component	Temperature (°C)
LinkSwitch-XT2SR, U1	67.75
SRFET, Q1	59.3
TRF Core, T1	62.25
Input Capacitor, C2	60.85
Output Capacitor, C7	56.15
Bridge Rectifier, BR1	59.25
Ambient	50

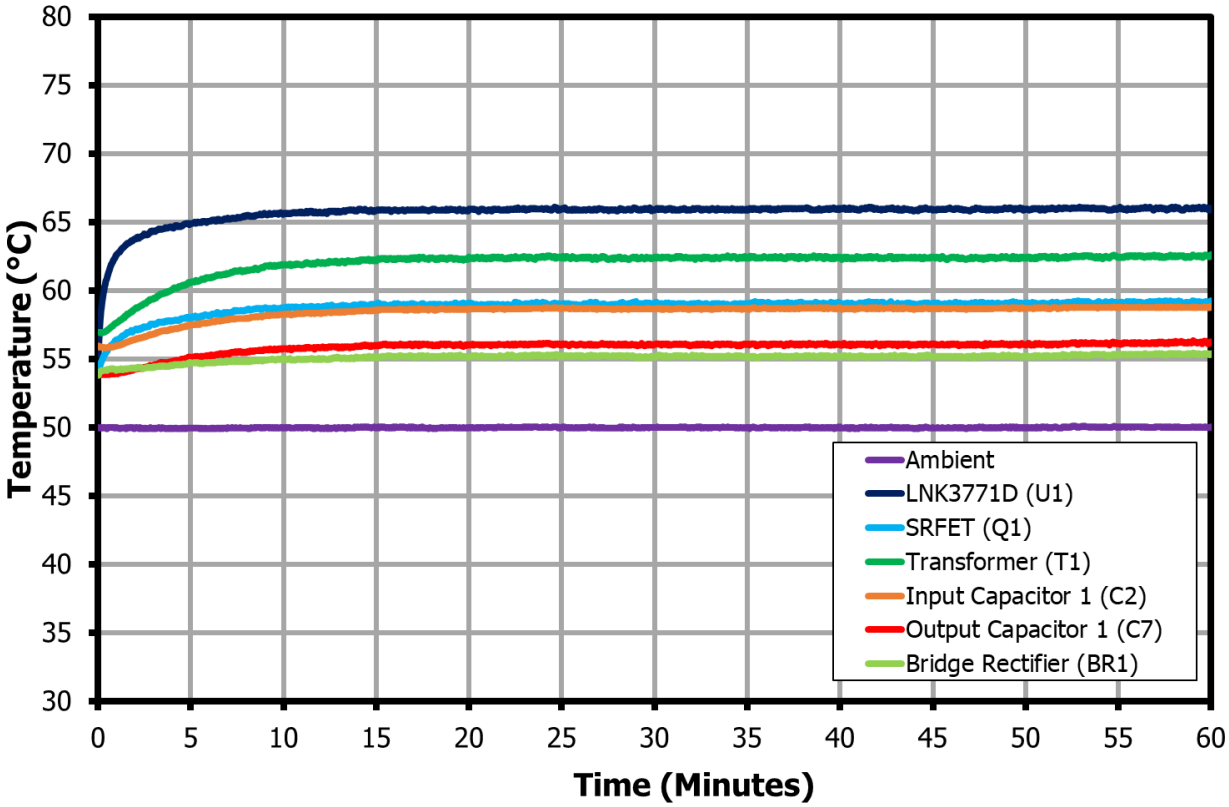


Figure 23 – 265 VAC Thermal Performance at Full Load, uVCC = 3.3 V / 20 mA.

Component	Temperature (°C)
LinkSwitch-XT2SR, U1	65.95
SRFET, Q1	59.1
TRF Core, T1	62.5
Input Capacitor, C2	58.8
Output Capacitor, C7	56.25
Bridge Rectifier, BR1	55.4
Ambient	50

10.3 Thermal Shutdown and Hysteresis

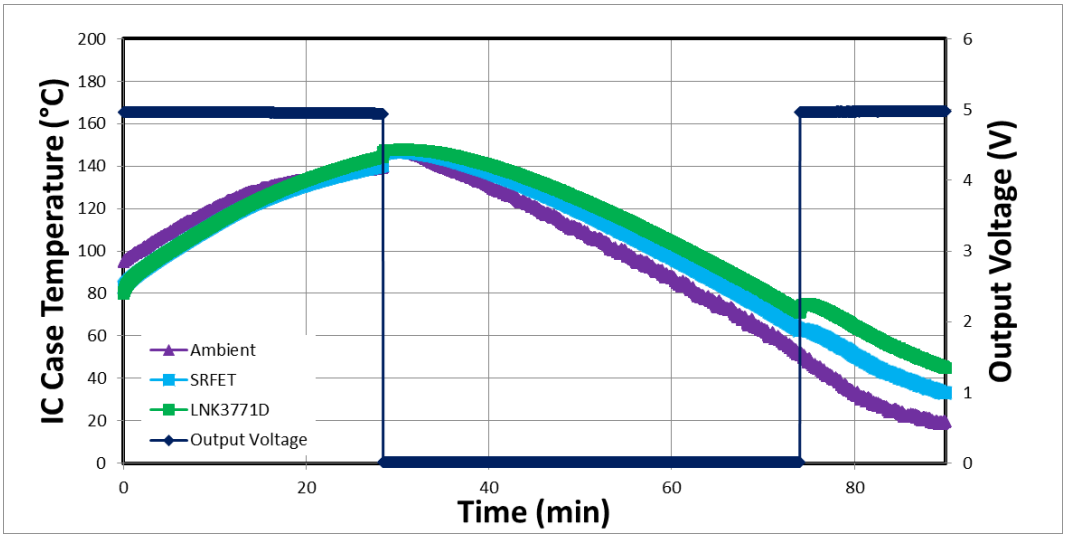


Figure 24 – 85 VAC Thermal Performance at Full Load.

Component	OTP (°C)	Recovery (°C)
LNKXT2 SR, U1	144.4	70.8
SRFET, Q1	140.3	62.5
Ambient	139.3	51.5

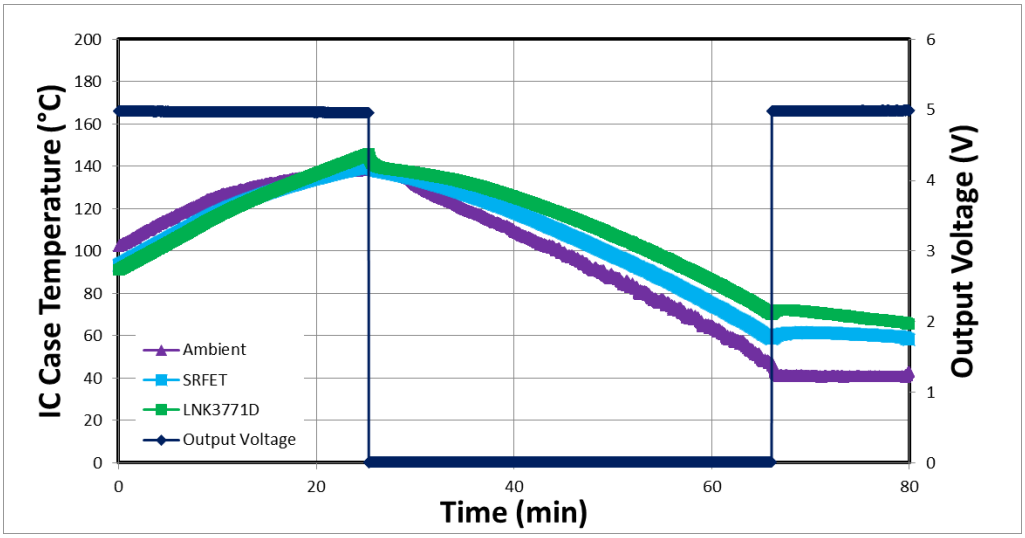


Figure 25 – 265 VAC Thermal Performance at Full Load.

Component	OTP (°C)	Recovery (°C)
LNKXT2 SR, U1	145.8	70.2
SRFET, Q1	140.2	58.6
Ambient	138.8	47.5

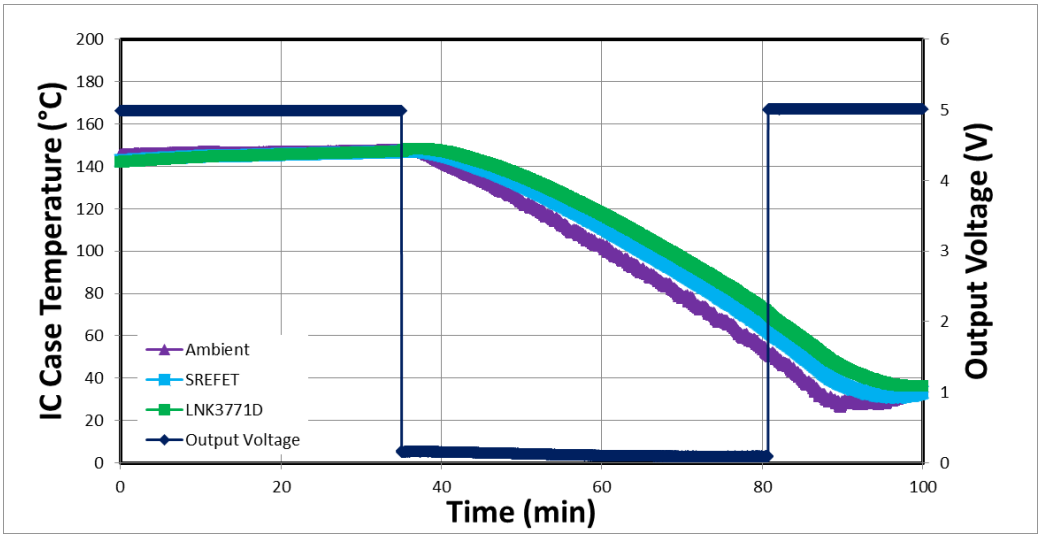


Figure 26 – 85 VAC Thermal Performance at No-Load.

Component	OTP (°C)	Recovery (°C)
LinkSwtich-XT2SR, U1	147.0	70.9
SRFET, Q1	146.9	62.5
Ambient	147.8	52.4

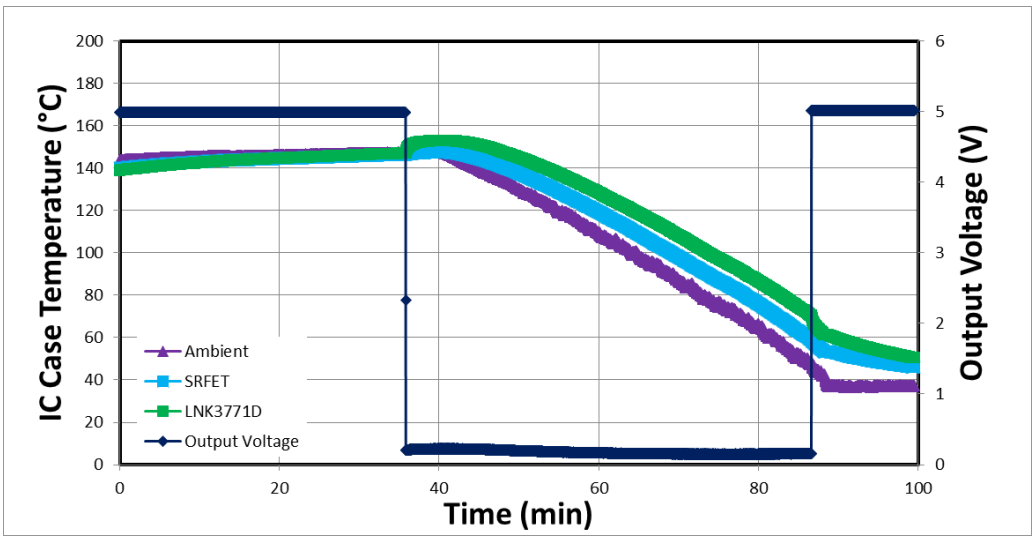


Figure 27 – 265 VAC Thermal Performance at No-Load.

Component	OTP (°C)	Recovery (°C)
LinkSwtich-XT2SR, U1	147.1	70.3
SRFET, Q1	146.5	58.9
Ambient	147.4	48.3

11 Waveforms

11.1 Switching Waveforms

11.1.1 V_{DS} and I_{DS} Waveforms Normal Operation

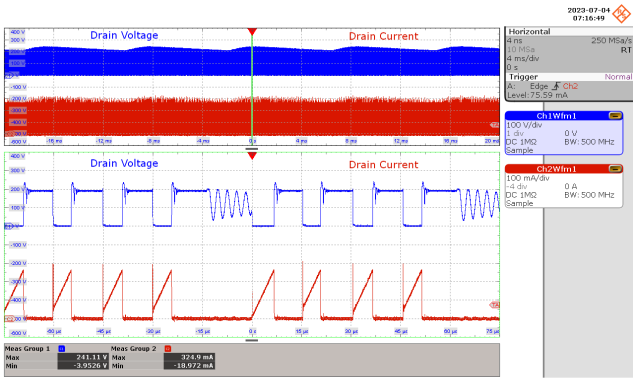


Figure 28 – Drain Voltage and Current Waveforms.
85 VAC, 1 A Output.
Drain Voltage: 100 V / div., 4 ms / div.
Drain Current: 100 mA /div., 4 ms / div.
Zoom = 15 µs / div.
$I_{DS(MAX)}$ = 324.9 mA, $V_{DS(MAX)}$ = 241.11 V.

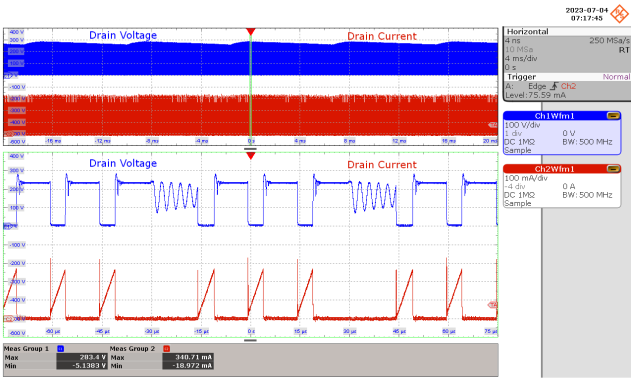


Figure 29 – Drain Voltage and Current Waveforms.
115 VAC, 1 A Output.
Drain Voltage: 100 V / div., 4 ms / div.
Drain Current: 100 mA /div., 4 ms / div.
Zoom = 15 µs / div.
$I_{DS(MAX)}$ = 340.71 mA, $V_{DS(MAX)}$ = 283.4 V.

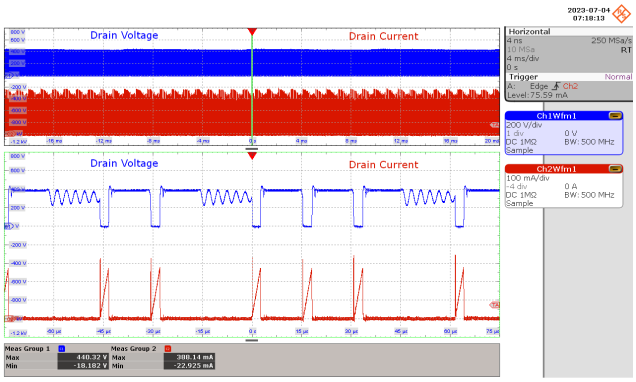


Figure 30 – Drain Voltage and Current Waveforms.
230 VAC, 1 A Output.
Drain Voltage: 200 V / div., 4 ms / div.
Drain Current: 100 mA /div., 4 ms / div.
Zoom = 15 µs / div.
$I_{DS(MAX)}$ = 388.14 mA, $V_{DS(MAX)}$ = 440.32 V.

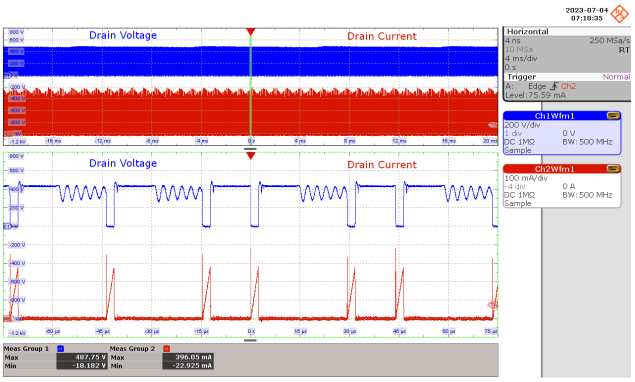


Figure 31 – Drain Voltage and Current Waveforms.
265 VAC, 1 A Output.
Drain Voltage: 200 V / div., 4 ms / div.
Drain Current: 100 mA /div., 4 ms / div.
Zoom = 15 µs / div.
$I_{DS(MAX)}$ = 396.05 mA, $V_{DS(MAX)}$ = 487.75 V.

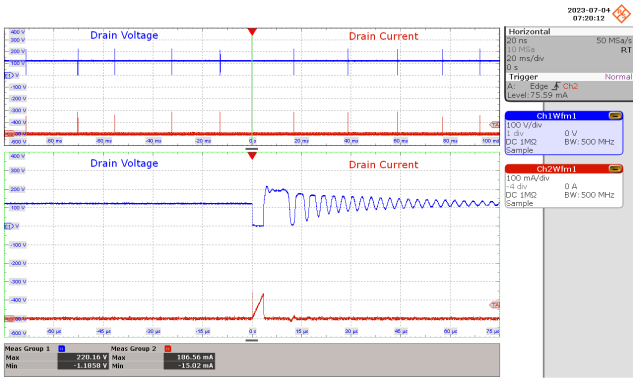


Figure 32 – Drain Voltage and Current Waveforms.
85 VAC, 0 A Output.
Drain Voltage: 100 V / div., 20 ms / div.
Drain Current: 100 mA /div., 20 ms / div.
Zoom = 15 μs / div.
$I_{DS(MAX)}$ = 186.56 mA, $V_{DS(MAX)}$ = 220.16 V.

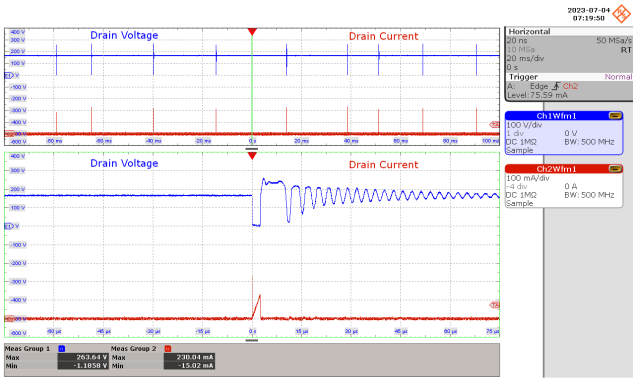


Figure 33 – Drain Voltage and Current Waveforms.
115 VAC, 0 A Output.
Drain Voltage: 100 V / div., 20 ms / div.
Drain Current: 100 mA /div., 20 ms / div.
Zoom = 15 μs / div.
$I_{DS(MAX)}$ = 230.04 mA, $V_{DS(MAX)}$ = 263.64 V.

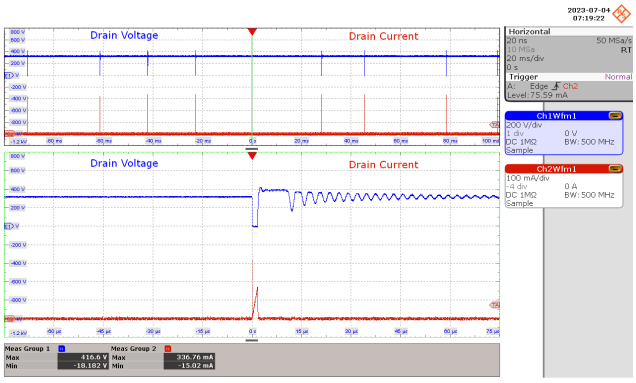


Figure 34 – Drain Voltage and Current Waveforms.
230 VAC, 0 A Output.
Drain Voltage: 200 V / div., 20 ms / div.
Drain Current: 100 mA /div., 20 ms / div.
Zoom = 15 μs / div.
$I_{DS(MAX)}$ = 336.76 mA, $V_{DS(MAX)}$ = 416.6 V.

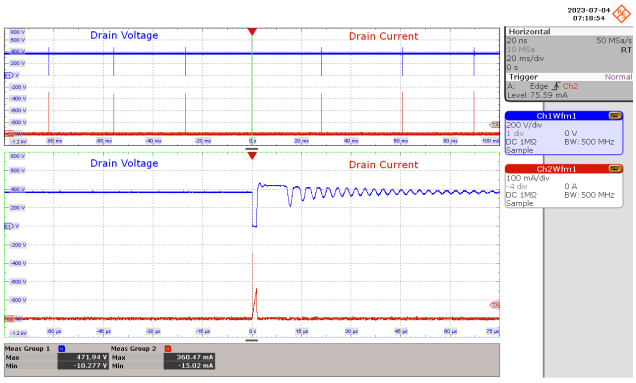


Figure 35 – Drain Voltage and Current Waveforms.
265 VAC, 0 A Output.
Drain Voltage: 200 V / div., 20 ms / div.
Drain Current: 100 mA /div., 20 ms / div.
Zoom = 15 μs / div.
$I_{DS(MAX)}$ = 360.47 mA, $V_{DS(MAX)}$ = 471.94 V.

11.1.2 Drain Voltage and Current Waveforms During Start-Up

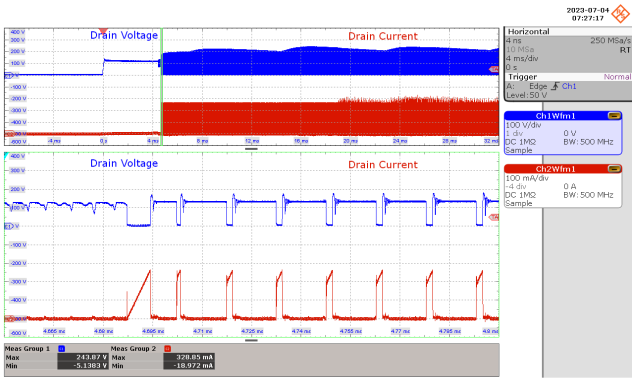


Figure 36 – Drain Voltage and Current Waveforms.
85 VAC, 1 A Output.
Drain Voltage: 100 V / div., 4 ms / div.
Drain Current: 100 mA /div., 4 ms / div.
Zoom = 15 µs / div.
$I_{DS(MAX)}$ = 328.85 mA, $V_{DS(MAX)}$ = 243.87 V.

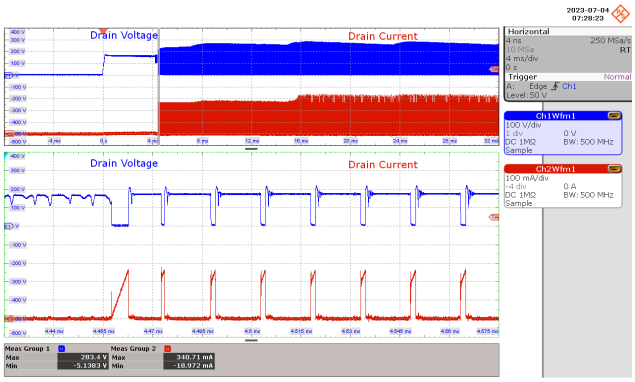


Figure 37 – Drain Voltage and Current Waveforms.
115 VAC, 1 A Output.
Drain Voltage: 100 V / div., 4 ms / div.
Drain Current: 100 mA /div., 4 ms / div.
Zoom = 15 µs / div.
$I_{DS(MAX)}$ = 340.71 mA, $V_{DS(MAX)}$ = 283.4 V.

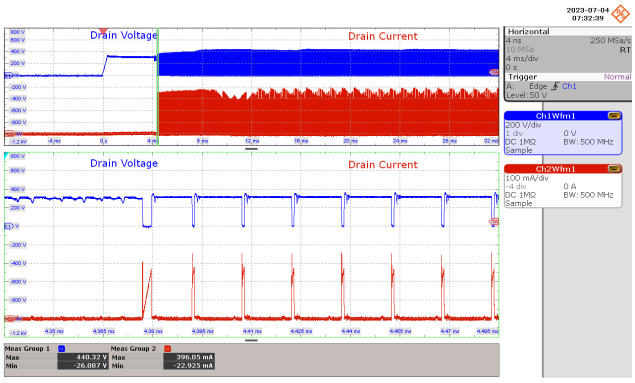


Figure 38 – Drain Voltage and Current Waveforms.
230 VAC, 1 A Output.
Drain Voltage: 200 V / div., 4 ms / div.
Drain Current: 100 mA /div., 4 ms / div.
Zoom = 15 µs / div.
$I_{DS(MAX)}$ = 396.05 mA, $V_{DS(MAX)}$ = 440.32 V.

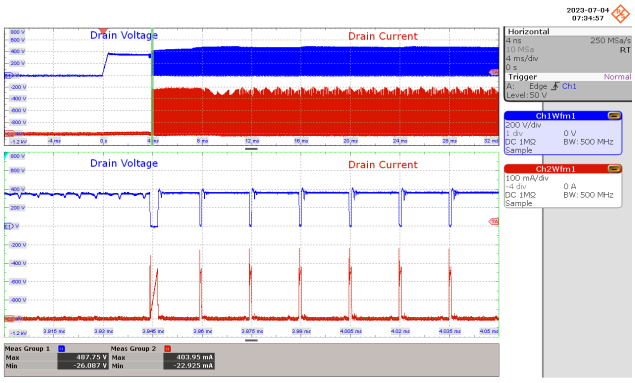


Figure 39 – Drain Voltage and Current Waveforms.
265 VAC, 1 A Output.
Drain Voltage: 200 V / div., 4 ms / div.
Drain Current: 100 mA /div., 4 ms / div.
Zoom = 15 µs / div.
$I_{DS(MAX)}$ = 403.95 mA, $V_{DS(MAX)}$ = 487.75 V.

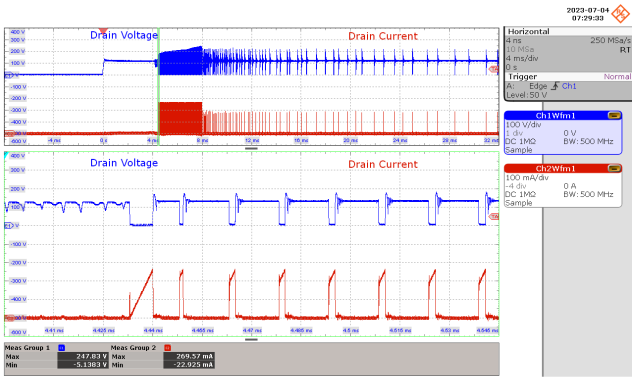


Figure 40 – Drain Voltage and Current Waveforms.
85 VAC, 0 A Output.
Drain Voltage: 100 V / div., 4 ms / div.
Drain Current: 100 mA /div., 4 ms / div.
Zoom = 15 μs / div.
$I_{DS(MAX)}$ = 269.57 mA, $V_{DS(MAX)}$ = 247.83 V.

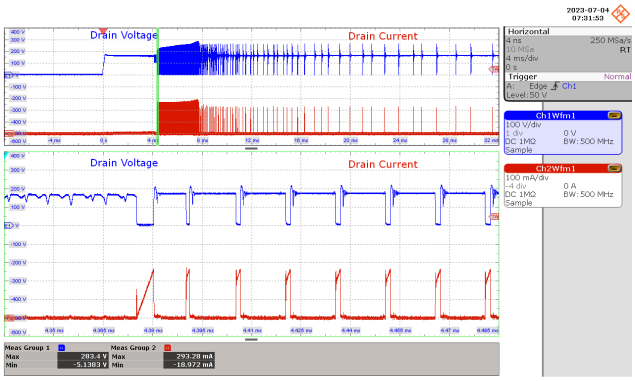


Figure 41 – Drain Voltage and Current Waveforms.
115 VAC, 0 A Output.
Drain Voltage: 100 V / div., 4 ms / div.
Drain Current: 100 mA /div., 4 ms / div.
Zoom = 15 μs / div.
$I_{DS(MAX)}$ = 293.28 mA, $V_{DS(MAX)}$ = 283.4 V.

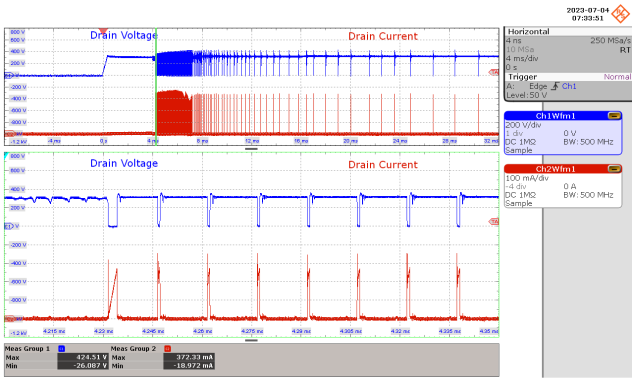


Figure 42 – Drain Voltage and Current Waveforms.
230 VAC, 0 A Output.
Drain Voltage: 200 V / div., 4 ms / div.
Drain Current: 100 mA /div., 4 ms / div.
Zoom = 15 μs / div.
$I_{DS(MAX)}$ = 372.33 mA, $V_{DS(MAX)}$ = 424.51 V.

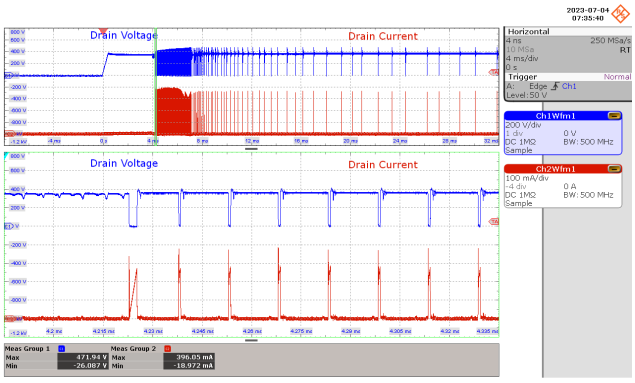


Figure 43 – Drain Voltage and Current Waveforms.
265 VAC, 0 A Output.
Drain Voltage: 200 V / div., 4 ms / div.
Drain Current: 100 mA /div., 4 ms / div.
Zoom = 15 μs / div.
$I_{DS(MAX)}$ = 396.05 mA, $V_{DS(MAX)}$ = 471.94 V.

11.1.3 Drain Voltage and Current Waveform During Output Short and Recovery

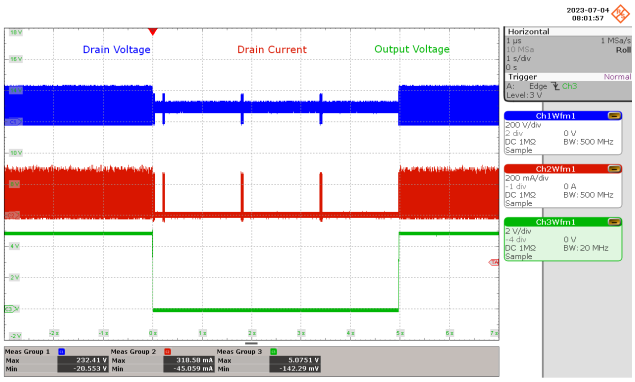


Figure 44 – Drain Current and Output Waveforms.
85 VAC Input.
Drain Voltage: 200 V / div., 1 s / div.
Drain Current: 200 mA / div., 1 s / div.
Output Voltage: 2 V / div, 1 s / div.

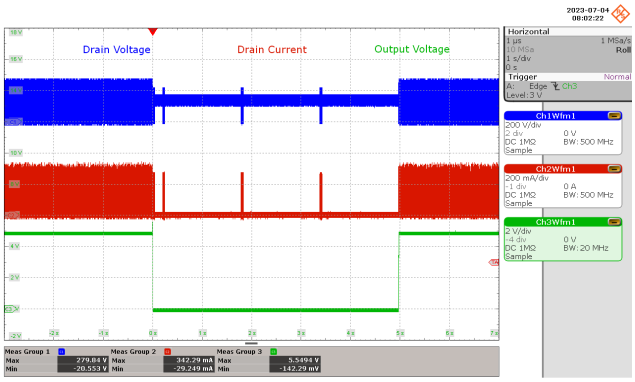


Figure 45 – Drain Current and Output Waveforms.
115 VAC Input.
Drain Voltage: 200 V / div., 1 s / div.
Drain Current: 200 mA / div., 1 s / div.
Output Voltage: 2 V / div, 1 s / div.

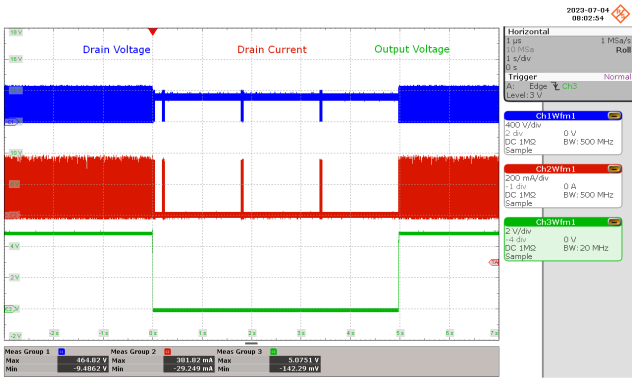


Figure 46 – Drain Current and Output Waveforms.
230 VAC Input.
Drain Voltage: 400 V / div., 1 s / div.
Drain Current: 200 mA / div., 1 s / div.
Output Voltage: 2 V / div, 1 s / div.

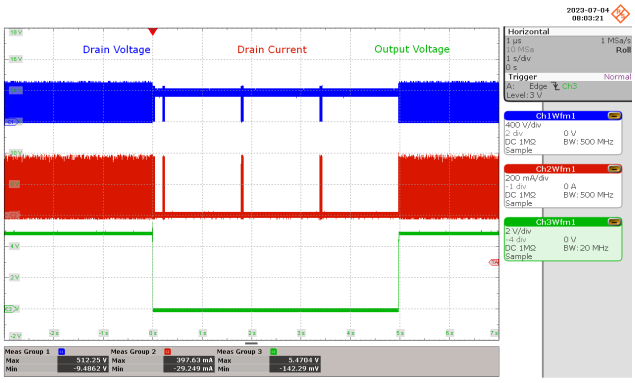


Figure 47 – Drain Current and Output Waveforms.
265 VAC Input.
Drain Voltage: 400 V / div., 1 s / div.
Drain Current: 200 mA / div., 1 s / div.
Output Voltage: 2 V / div, 1 s / div.

11.1.4 SR FET Waveforms Normal Operation

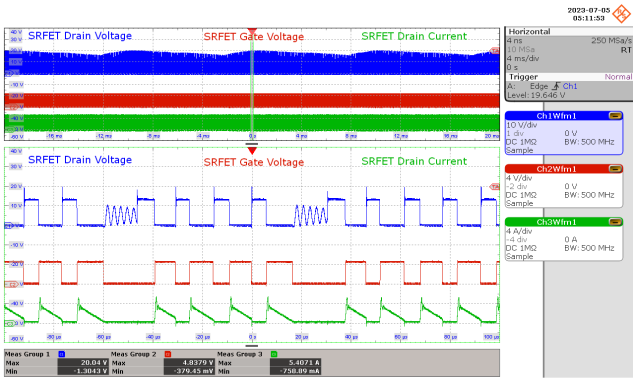


Figure 48 – SRFET Waveforms.
85 VAC, 1 A Output.
$SRFET_{Drain\ Voltage}$: 10 V / div., 4 ms / div.
$SRFET_{Gate\ Voltage}$: 4 V / div., 4 ms / div.
$SRFET_{Drain\ Current}$: 4 A / div, 4 ms / div.
Zoom: 20 µs / div.
SRFET $V_{DS(MAX)}$: 20.04 V.

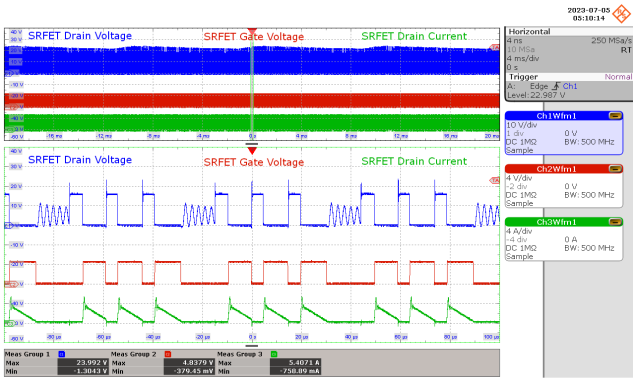


Figure 49 – SRFET Waveforms.
115 VAC, 1 A Output.
$SRFET_{Drain\ Voltage}$: 10 V / div., 4 ms / div.
$SRFET_{Gate\ Voltage}$: 4 V / div., 4 ms / div.
$SRFET_{Drain\ Current}$: 4 A / div, 4 ms / div.
Zoom: 20 µs / div.
SRFET $V_{DS(MAX)}$: 23.992 V.

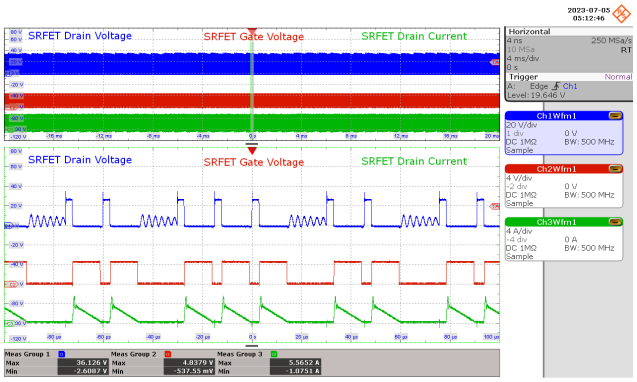


Figure 50 – SRFET Waveforms.
230 VAC, 1 A Output.
$SRFET_{Drain\ Voltage}$: 20 V / div., 4 ms / div.
$SRFET_{Gate\ Voltage}$: 4 V / div., 4 ms / div.
$SRFET_{Drain\ Current}$: 4 A / div, 4 ms / div.
Zoom: 20 µs / div.
SRFET $V_{DS(MAX)}$: 36.126 V.

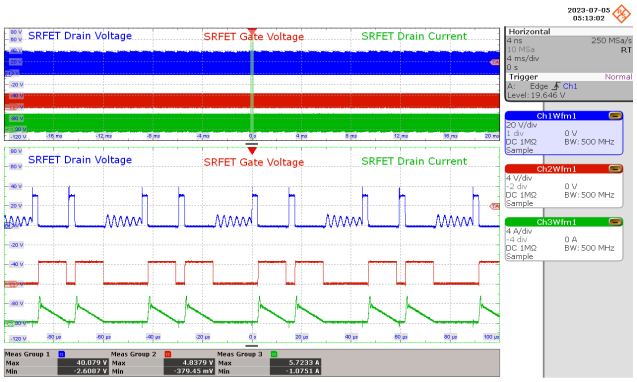


Figure 51 – SRFET Waveforms.
265 VAC, 1 A Output.
$SRFET_{Drain\ Voltage}$: 20 V / div., 4 ms / div.
$SRFET_{Gate\ Voltage}$: 4 V / div., 4 ms / div.
$SRFET_{Drain\ Current}$: 4 A / div, 4 ms / div.
Zoom: 20 µs / div.
SRFET $V_{DS(MAX)}$: 40.079 V.

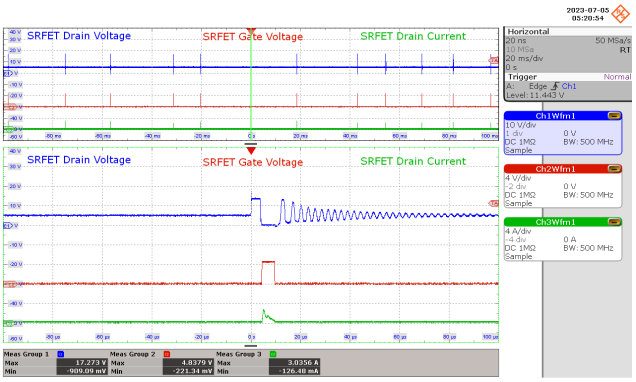


Figure 52 – SRFET Waveforms.
85 VAC, 0 A Output.
$SRFET_{Drain\ Voltage}$: 10 V / div., 20 ms / div.
$SRFET_{Gate\ Voltage}$: 4 V / div., 20 ms / div.
$SRFET_{Drain\ Current}$: 4 A / div, 20 ms / div.
Zoom: 20 µs / div.
SRFET $V_{DS(MAX)}$: 17.273 V.

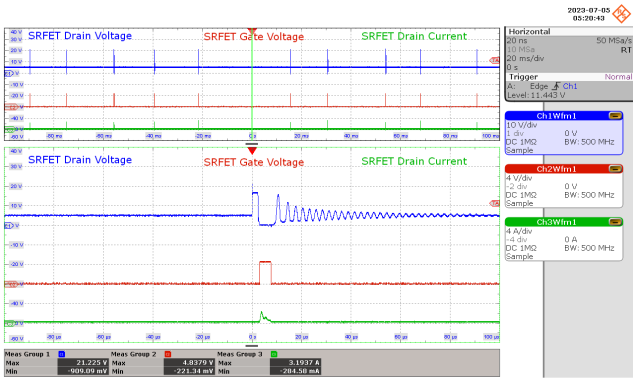


Figure 53 – SRFET Waveforms.
115 VAC, 0 A Output.
$SRFET_{Drain\ Voltage}$: 10 V / div., 20 ms / div.
$SRFET_{Gate\ Voltage}$: 4 V / div., 20 ms / div.
$SRFET_{Drain\ Current}$: 4 A / div, 20 ms / div.
Zoom: 20 µs / div.
SRFET $V_{DS(MAX)}$: 21.225 V.

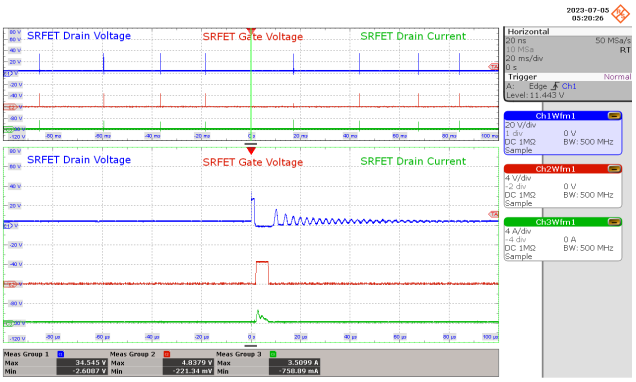


Figure 54 – SRFET Waveforms.
230 VAC, 0 A Output.
$SRFET_{Drain\ Voltage}$: 20 V / div., 20 ms / div.
$SRFET_{Gate\ Voltage}$: 4 V / div., 20 ms / div.
$SRFET_{Drain\ Current}$: 4 A / div, 20 ms / div.
Zoom: 20 µs / div.
SRFET $V_{DS(MAX)}$: 34.545 V.

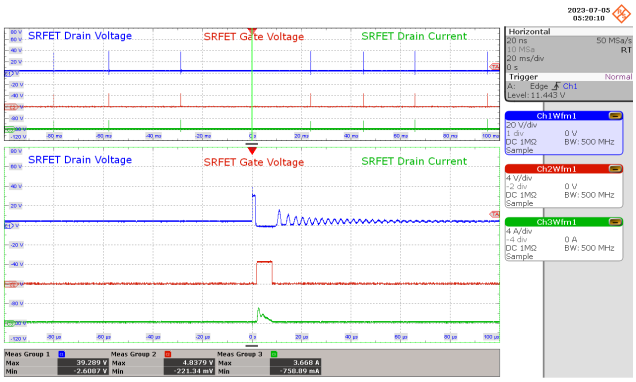


Figure 55 – SRFET Waveforms.
265 VAC, 0 A Output.
$SRFET_{Drain\ Voltage}$: 20 V / div., 20 ms / div.
$SRFET_{Gate\ Voltage}$: 4 V / div., 20 ms / div.
$SRFET_{Drain\ Current}$: 4 A / div, 20 ms / div.
Zoom: 20 µs / div.
SRFET $V_{DS(MAX)}$: 39.289 V.

11.1.5 SR FET Waveforms During Start-Up

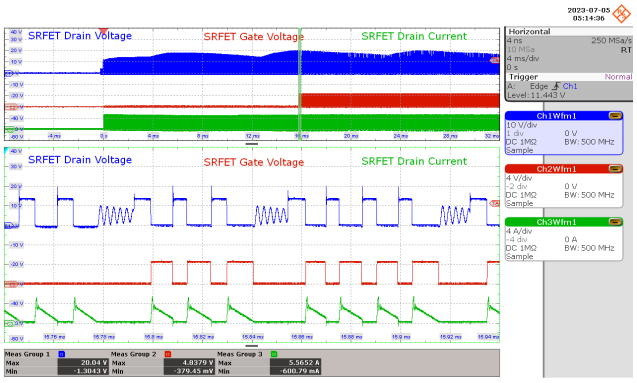


Figure 56 – SRFET Waveforms.
85 VAC, 1 A Output.
$SRFET_{Drain\ Voltage}$: 10 V / div., 4 ms / div.
$SRFET_{Gate\ Voltage}$: 4 V / div., 4 ms / div.
$SRFET_{Drain\ Current}$: 4 A / div, 4 ms / div.
Zoom: 20 µs / div.
SRFET $V_{DS(MAX)}$: 20.04 V.

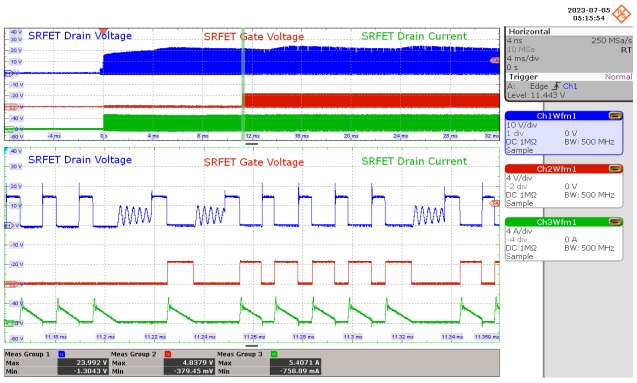


Figure 57 – SRFET Waveforms.
115 VAC, 1 A Output.
$SRFET_{Drain\ Voltage}$: 10 V / div., 4 ms / div.
$SRFET_{Gate\ Voltage}$: 4 V / div., 4 ms / div.
$SRFET_{Drain\ Current}$: 4 A / div, 4 ms / div.
Zoom: 20 µs / div.
SRFET $V_{DS(MAX)}$: 23.992 V.

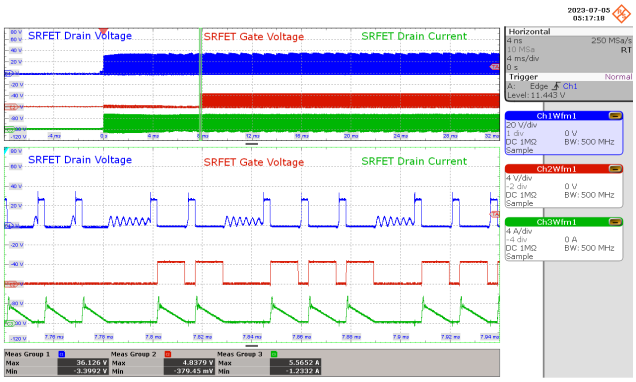


Figure 58 – SRFET Waveforms.
230 VAC, 1 A Output.
$SRFET_{Drain\ Voltage}$: 20 V / div., 4 ms / div.
$SRFET_{Gate\ Voltage}$: 4 V / div., 4 ms / div.
$SRFET_{Drain\ Current}$: 4 A / div, 4 ms / div.
Zoom: 20 µs / div.
SRFET $V_{DS(MAX)}$: 36.126 V.

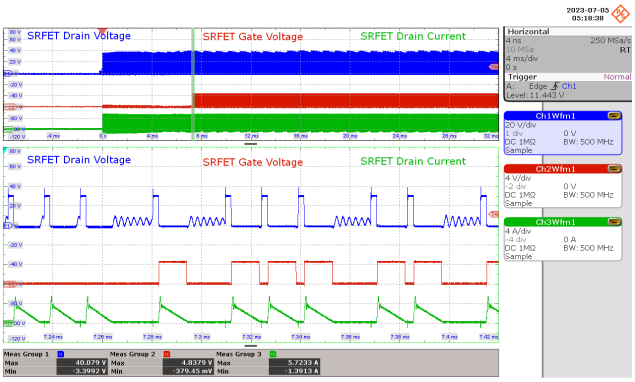


Figure 59 – SRFET Waveforms.
265 VAC, 1 A Output.
$SRFET_{Drain\ Voltage}$: 20 V / div., 4 ms / div.
$SRFET_{Gate\ Voltage}$: 4 V / div., 4 ms / div.
$SRFET_{Drain\ Current}$: 4 A / div, 4 ms / div.
Zoom: 20 µs / div.
SRFET $V_{DS(MAX)}$: 40.079 V.

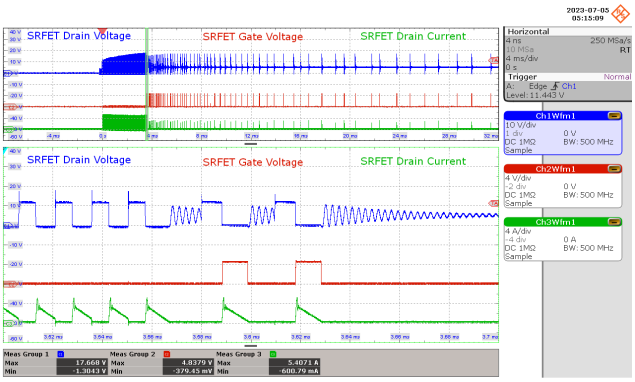


Figure 60 – SRFET Waveforms.
85 VAC, 0 A Output.
$SRFET_{Drain\ Voltage}$: 10 V / div., 4 ms / div.
$SRFET_{Gate\ Voltage}$: 4 V / div., 4 ms / div.
$SRFET_{Drain\ Current}$: 4 A / div, 4 ms / div.
Zoom: 20 µs / div.
SRFET $V_{DS(MAX)}$: 17.668 V.

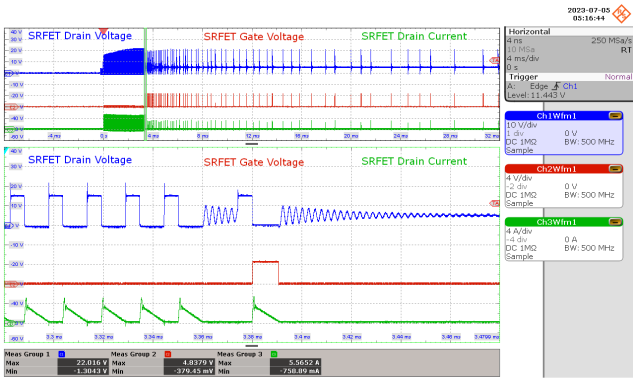


Figure 61 – SRFET Waveforms.
115 VAC, 0 A Output.
$SRFET_{Drain\ Voltage}$: 10 V / div., 4 ms / div.
$SRFET_{Gate\ Voltage}$: 4 V / div., 4 ms / div.
$SRFET_{Drain\ Current}$: 4 A / div, 4 ms / div.
Zoom: 20 µs / div.
SRFET $V_{DS(MAX)}$: 22.016 V.

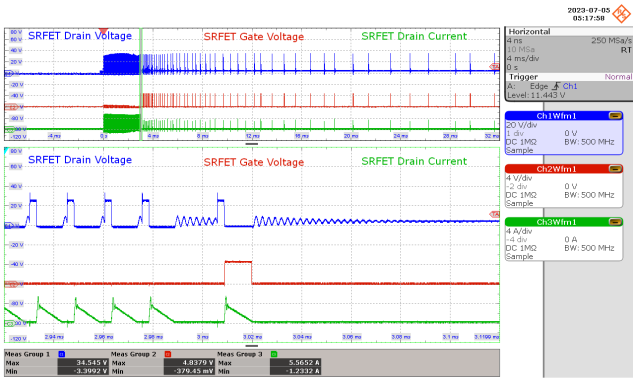


Figure 62 – SRFET Waveforms.
230 VAC, 0 A Output.
$SRFET_{Drain\ Voltage}$: 20 V / div., 4 ms / div.
$SRFET_{Gate\ Voltage}$: 4 V / div., 4 ms / div.
$SRFET_{Drain\ Current}$: 4 A / div, 4 ms / div.
Zoom: 20 µs / div.
SRFET $V_{DS(MAX)}$: 34.545 V.

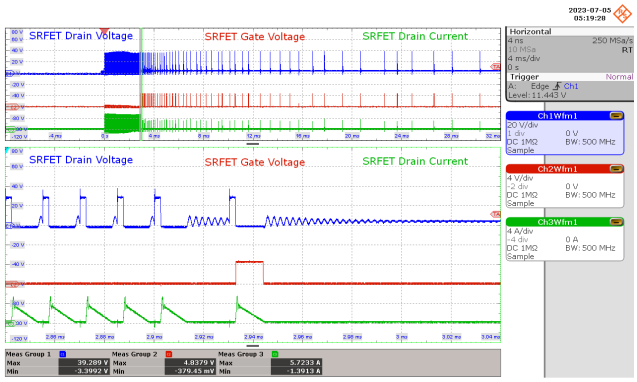


Figure 63 – SRFET Waveforms.
265 VAC, 0 A Output.
$SRFET_{Drain\ Voltage}$: 20 V / div., 4 ms / div.
$SRFET_{Gate\ Voltage}$: 4 V / div., 4 ms / div.
$SRFET_{Drain\ Current}$: 4 A / div, 4 ms / div.
Zoom: 20 µs / div.
SRFET $V_{DS(MAX)}$: 39.289 V.

11.1.6 Output Voltage and Current Waveforms During Start-Up (CC mode)

11.1.6.1 uVCC = 3.3 V / No-Load

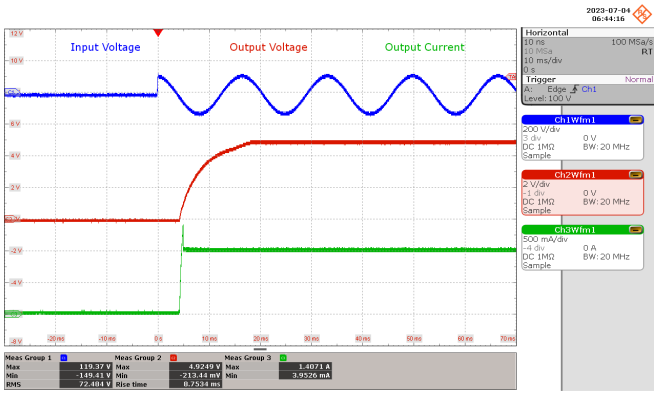


Figure 64 – Output Voltage and Current Waveforms.
85 VAC, 5 Vo Load 1 A.
Input Voltage: 200 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 4.9249 V
Rise Time = 8.7534 ms

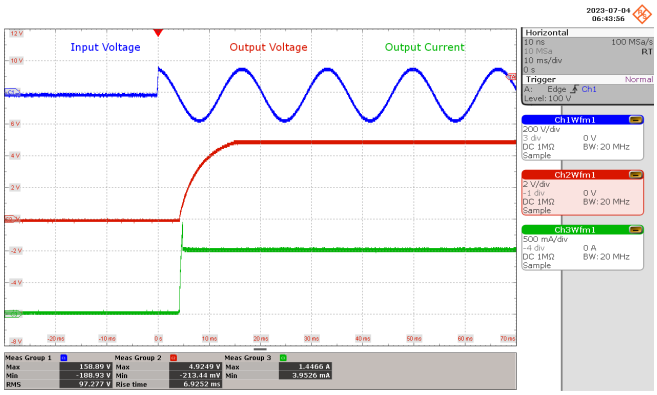


Figure 65 – Output Voltage and Current Waveforms.
115 VAC, 5 Vo Load 1 A.
Input Voltage: 200 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 4.9249 V
Rise Time = 6.9252 ms

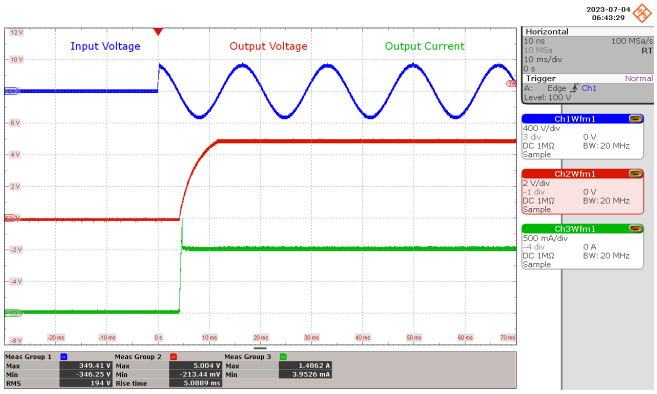


Figure 66 – Output Voltage and Current Waveforms.
230 VAC, 5 Vo Load 1 A.
Input Voltage: 400 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 5.004 V
Rise Time = 5.0889 ms

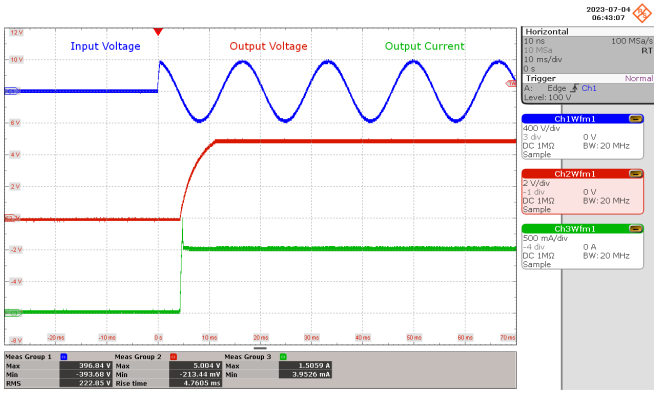


Figure 67 – Output Voltage and Current Waveforms.
265 VAC, 5 Vo Load 1 A.
Input Voltage: 400 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 5.004 V
Rise Time = 4.7605 ms

11.1.6.2 uVCC = 3.3 V / 20 mA

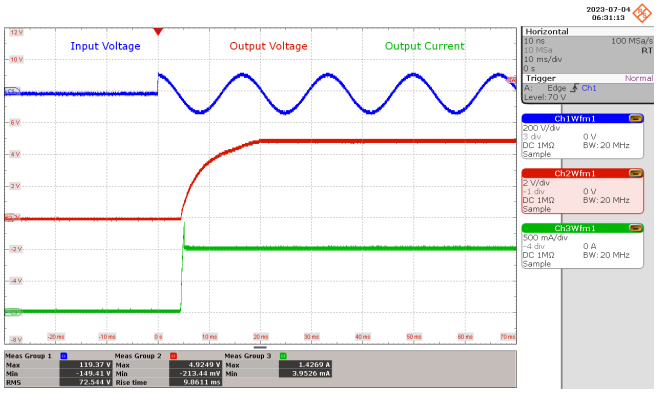


Figure 68 – Output Voltage and Current Waveforms.
85 VAC, 5 Vo Load 1 A.
Input Voltage: 200 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 4.9249 V
Rise Time = 9.8611 ms

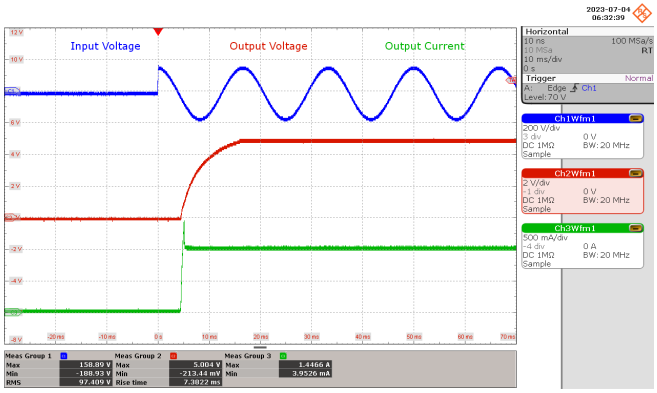


Figure 69 – Output Voltage and Current Waveforms.
115 VAC, 5 Vo Load 1 A.
Input Voltage: 200 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 5.004 V
Rise Time = 7.3822 ms

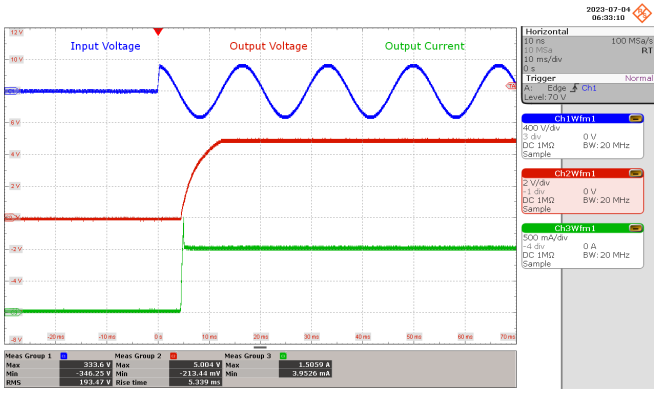


Figure 70 – Output Voltage and Current Waveforms.
230 VAC, 5 Vo Load 1 A.
Input Voltage: 400 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 5.004 V
Rise Time = 5.339 ms

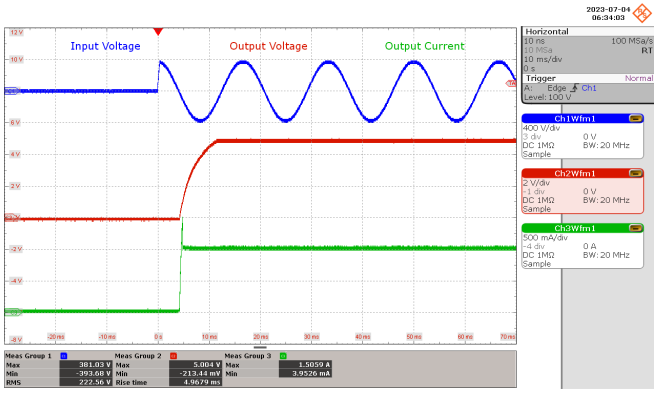


Figure 71 – Output Voltage and Current Waveforms.
265 VAC, 5 Vo Load 1 A.
Input Voltage: 400 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 5.004 V
Rise Time = 4.9679 ms

11.1.7 Output Voltage and Current Waveforms During Start-Up (CR mode)

11.1.7.1 uVCC = 3.3 V / No-Load

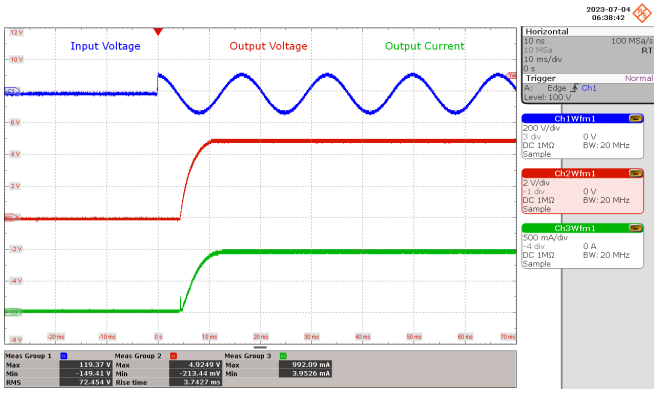


Figure 72 – Output Voltage and Current Waveforms.
85 VAC, 5 Vo 5 Ω Load.
Input Voltage: 200 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 4.9249 V
Rise Time = 3.7427 ms

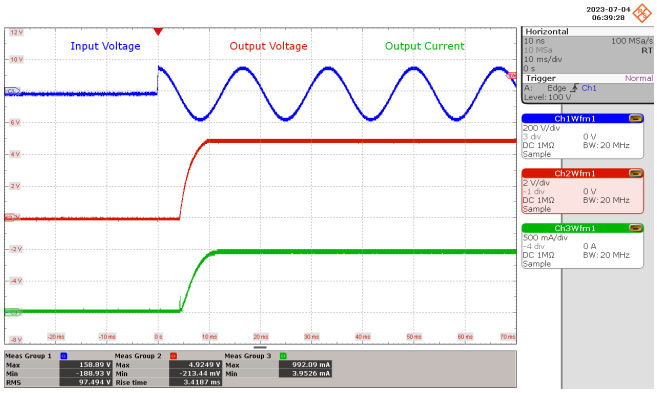


Figure 73 – Output Voltage and Current Waveforms.
115 VAC, 5 Vo 5 Ω Load.
Input Voltage: 200 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 4.9249 V
Rise Time = 3.4187 ms

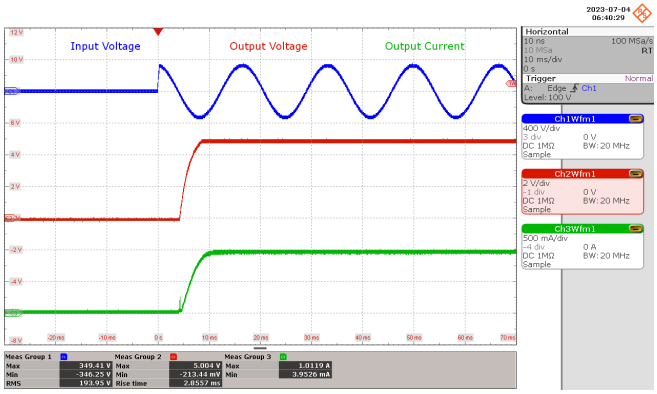


Figure 74 – Output Voltage and Current Waveforms.
230 VAC, 5 Vo 5 Ω Load.
Input Voltage: 400 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 5.004 V
Rise Time = 2.8557 ms

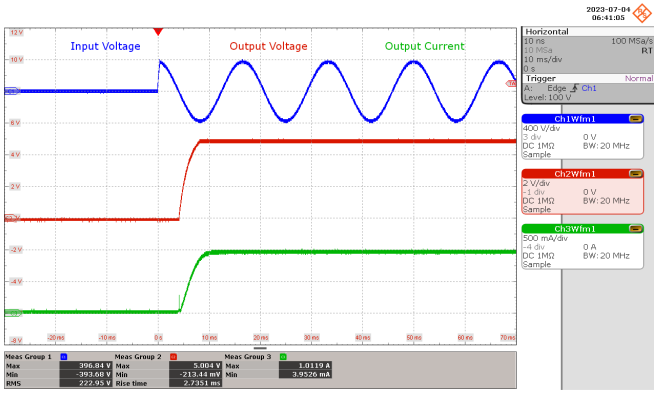


Figure 75 – Output Voltage and Current Waveforms.
265 VAC, 5 Vo 5 Ω Load.
Input Voltage: 400 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 5.004 V
Rise Time = 2.7351 ms

11.1.7.2 uVCC = 3.3 V / 20 mA

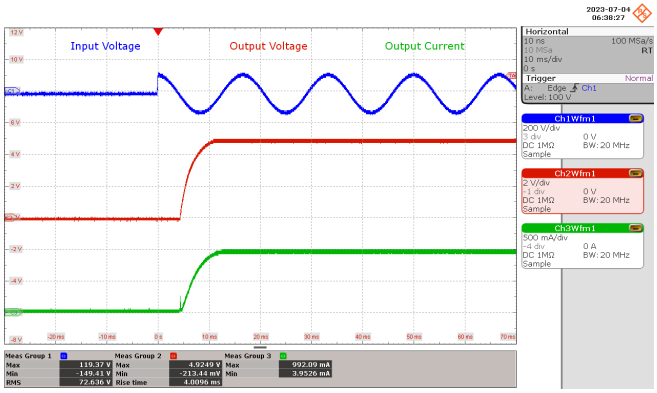


Figure 76 – Output Voltage and Current Waveforms.
85 VAC, 5 Vo 5 Ω Load.
Input Voltage: 200 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage(MAX) = 4.9249 V
Rise Time = 4.0096 ms

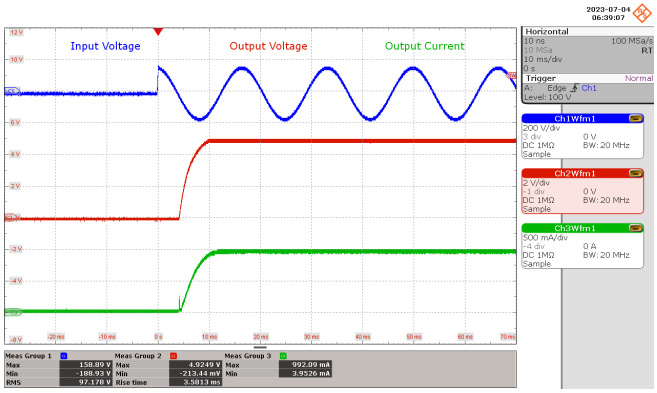


Figure 77 – Output Voltage and Current Waveforms.
115 VAC, 5 Vo 5 Ω Load.
Input Voltage: 200 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage(MAX) = 4.9249 V
Rise Time = 3.5813 ms

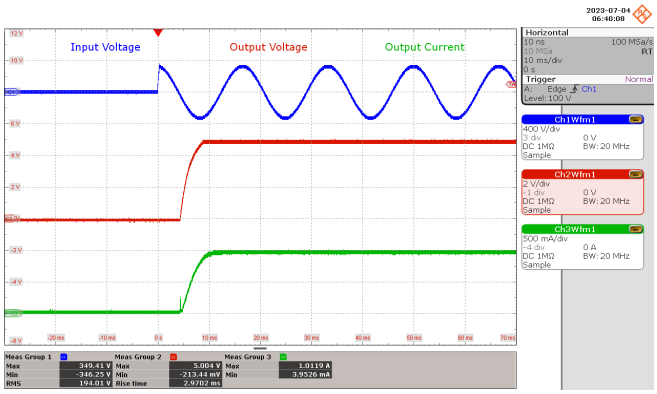


Figure 78 – Output Voltage and Current Waveforms.
230 VAC, 5 Vo 5 Ω Load.
Input Voltage: 400 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage(MAX) = 5.004 V
Rise Time = 2.9702 ms

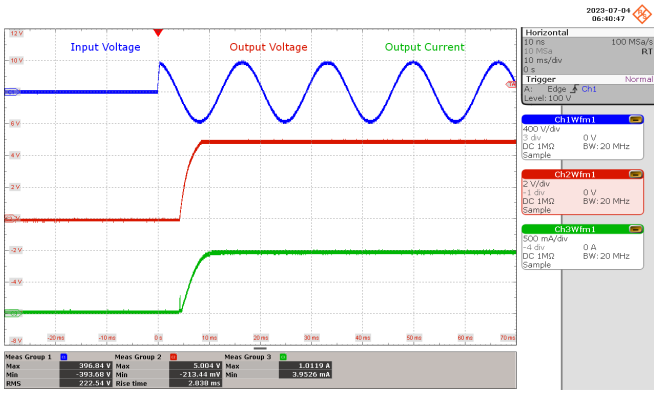


Figure 79 – Output Voltage and Current Waveforms.
265 VAC, 5 Vo 5 Ω Load.
Input Voltage: 400 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage(MAX) = 5.004 V
Rise Time = 2.838 ms

11.1.8 Output Voltage and Current Waveforms During Start-Up (No-Load)

11.1.8.1 uVCC = 3.3 V / No-Load

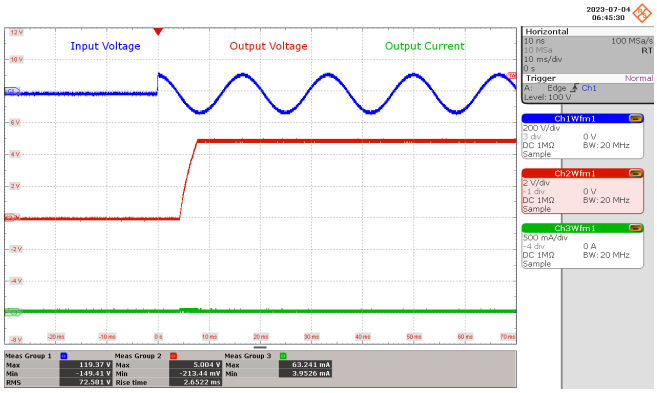


Figure 80 – Output Voltage and Current Waveforms.
85 VAC, 5 Vo Load 0 A.
Input Voltage: 200 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 5.004 V
Rise Time = 2.6522 ms

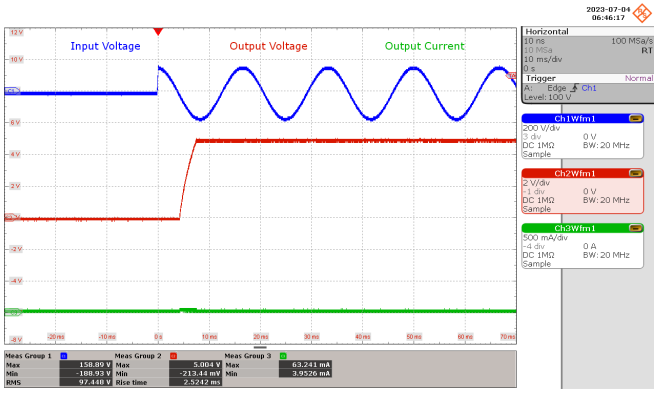


Figure 81 – Output Voltage and Current Waveforms.
115 VAC, 5 Vo Load 0 A.
Input Voltage: 200 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 5.004 V
Rise Time = 2.5242 ms

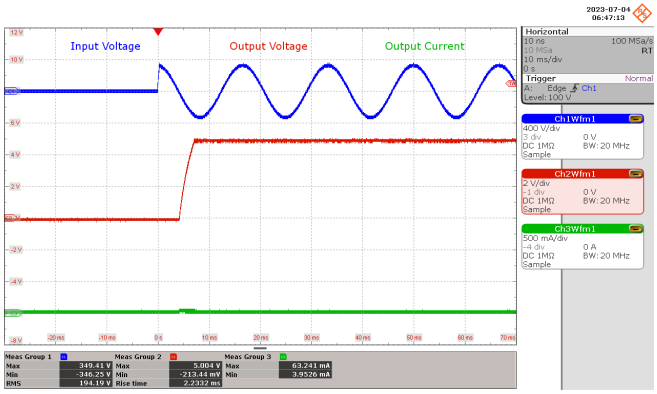


Figure 82 – Output Voltage and Current Waveforms.
230 VAC, 5 Vo Load 0 A.
Input Voltage: 400 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 5.004 V
Rise Time = 2.2332 ms

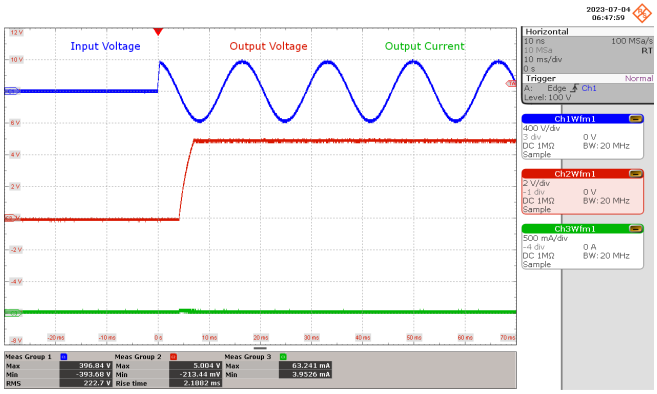


Figure 83 – Output Voltage and Current Waveforms.
265 VAC, 5 Vo Load 0 A.
Input Voltage: 400 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 5.004 V
Rise Time = 2.1882 ms

11.1.8.2 uVCC = 3.3 V / 20 mA

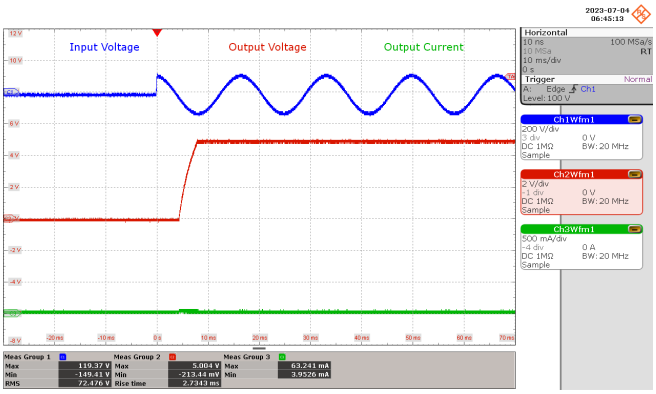


Figure 84 – Output Voltage and Current Waveforms.
85 VAC, 5 Vo Load 0 A.
Input Voltage: 200 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 5.004 V
Rise Time = 2.7343 ms

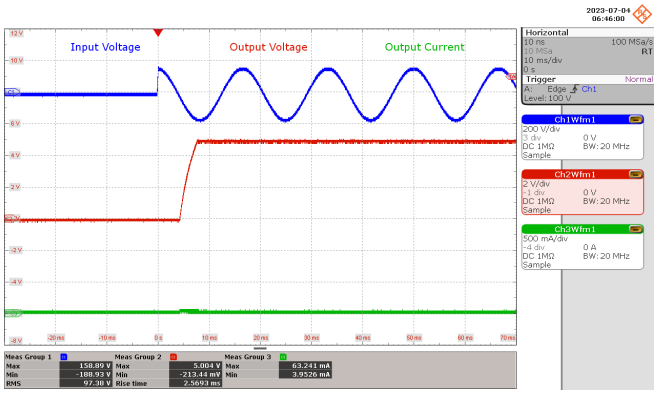


Figure 85 – Output Voltage and Current Waveforms.
115 VAC, 5 Vo Load 0 A.
Input Voltage: 200 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 5.004 V
Rise Time = 2.5693 ms

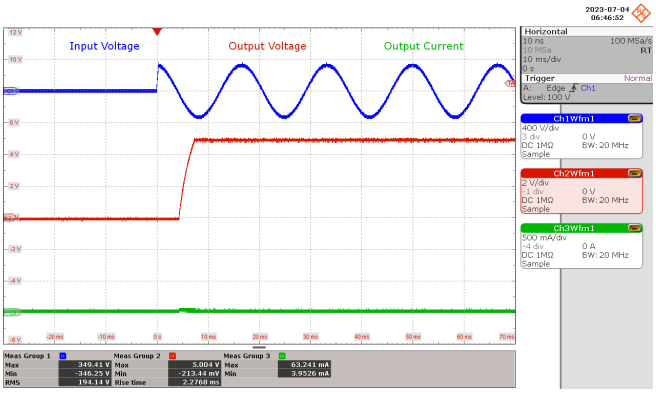


Figure 86 – Output Voltage and Current Waveforms.
230 VAC, 5 Vo Load 0 A.
Input Voltage: 400 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 5.004 V
Rise Time = 2.2768 ms

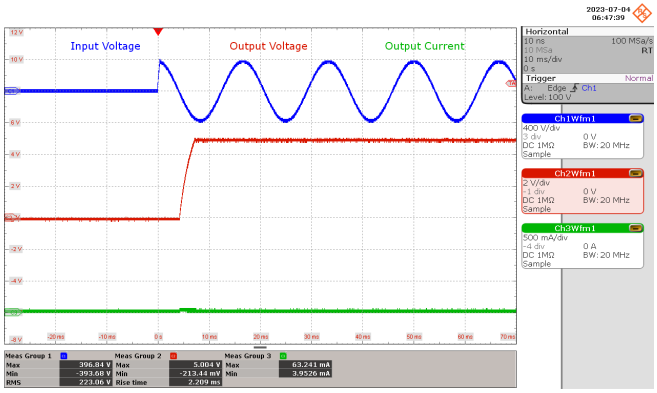


Figure 87 – Output Voltage and Current Waveforms.
265 VAC, 5 Vo Load 0 A.
Input Voltage: 400 V / div., 10 ms / div.
Output Voltage: 2 V / div., 10 ms / div.
Output Current: 500 mA / div., 10 ms / div.
Output Voltage$_{(MAX)}$ = 5.004 V
Rise Time = 2.209 ms

11.1.9 uVCC Voltage During Start-up

11.1.9.1 uVCC = 3.3 V / No-Load

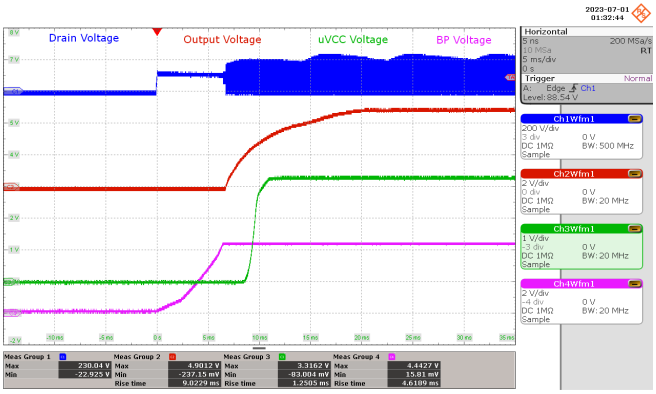


Figure 88 – uVcc Start-up Waveforms.
85 VAC, 5 Vo Load 1 A.
Drain Voltage: 200 V / div., 5 ms / div.
Output Voltage: 2 V / div., 5 ms / div.
uVCC Voltage: 1 V / div., 5 ms / div.
BP Voltage: 2 V / div., 5 ms / div.
$uVCC_{max}$ = 3.3162 V

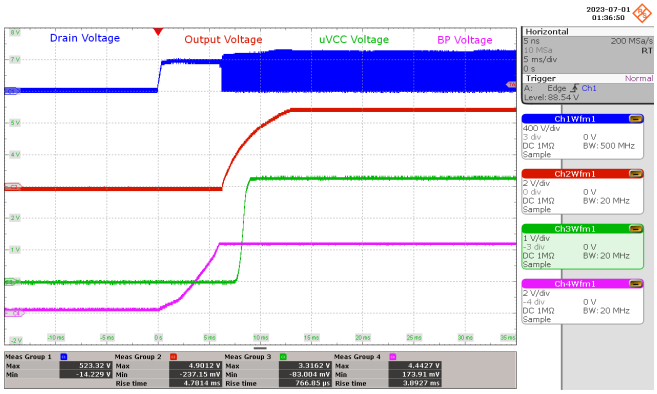


Figure 89 – uVcc Start-up Waveforms.
265 VAC, 5 Vo Load 1 A.
Drain Voltage: 400 V / div., 5 ms / div.
Output Voltage: 2 V / div., 5 ms / div.
uVCC Voltage: 1 V / div., 5 ms / div.
BP Voltage: 2 V / div., 5 ms / div.
$uVCC_{max}$ = 3.3162 V

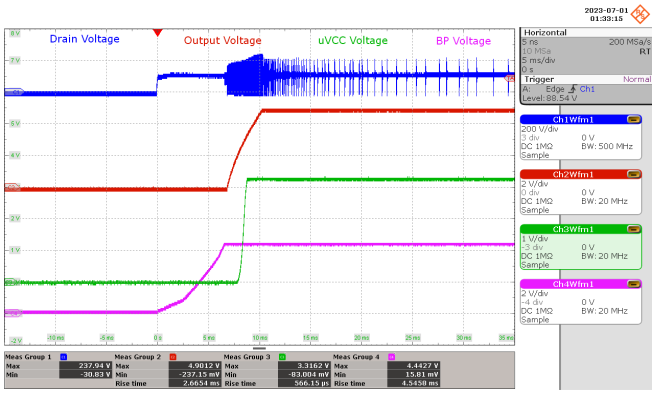


Figure 90 – uVcc Start-up Waveforms.
85 VAC, 5 Vo Load 0 A.
Drain Voltage: 200 V / div., 5 ms / div.
Output Voltage: 2 V / div., 5 ms / div.
uVCC Voltage: 1 V / div., 5 ms / div.
BP Voltage: 2 V / div., 5 ms / div.
$uVCC_{max}$ = 3.3162 V

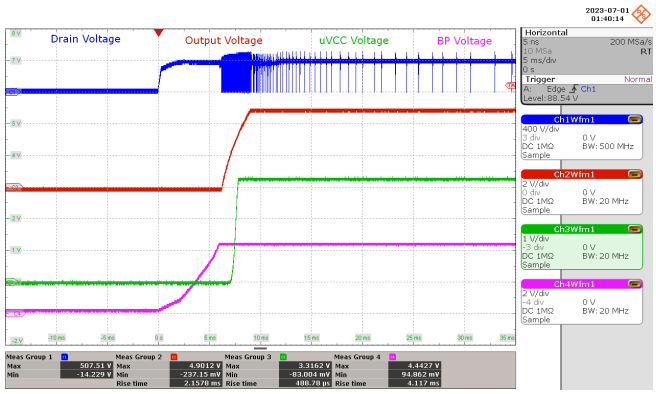


Figure 91 – uVcc Start-up Waveforms.
265 VAC, 5 Vo Load 0 A.
Drain Voltage: 400 V / div., 5 ms / div.
Output Voltage: 2 V / div., 5 ms / div.
uVCC Voltage: 1 V / div., 5 ms / div.
BP Voltage: 2 V / div., 5 ms / div.
$uVCC_{max}$ = 3.3162 V

11.1.9.2 uVCC = 3.3 V / 20 mA

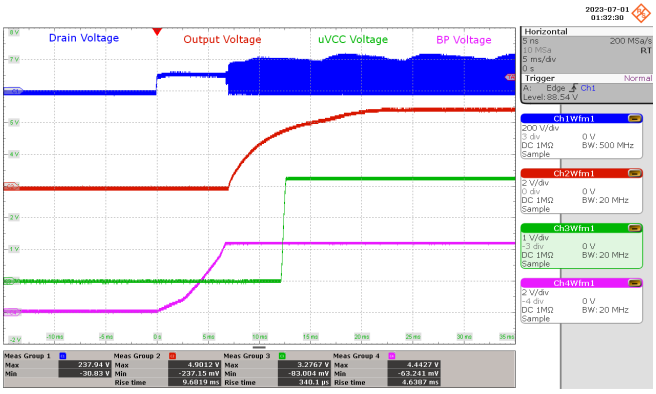


Figure 92 – uVcc Start-up Waveforms.
85 VAC, 5 Vo Load 1 A.
Drain Voltage: 200 V / div., 5 ms / div.
Output Voltage: 2 V / div., 5 ms / div.
uVCC Voltage: 1 V / div., 5 ms / div.
BP Voltage: 2 V / div., 5 ms / div.
$uVCC_{max}$ = 3.2767 V

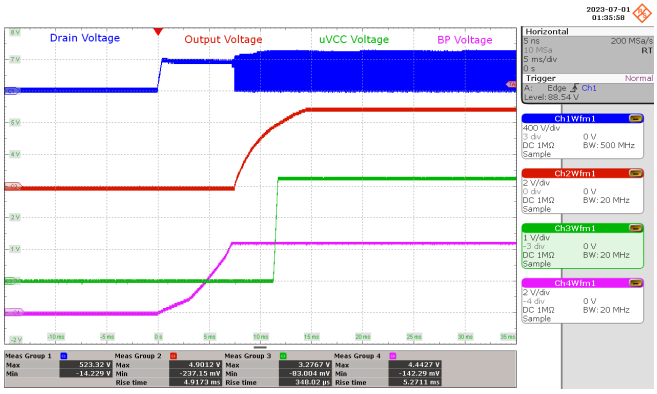


Figure 93 – uVcc Start-up Waveforms.
265 VAC, 5 Vo Load 1 A.
Drain Voltage: 400 V / div., 5 ms / div.
Output Voltage: 2 V / div., 5 ms / div.
uVCC Voltage: 1 V / div., 5 ms / div.
BP Voltage: 2 V / div., 5 ms / div.
$uVCC_{max}$ = 3.2767 V

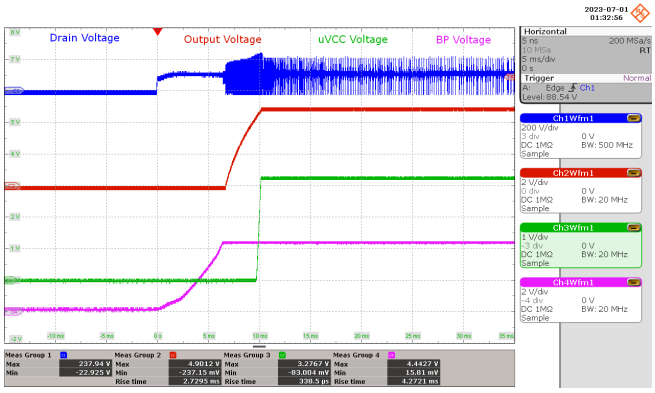


Figure 94 – uVcc Start-up Waveforms.
85 VAC, 5 Vo Load 0 A.
Drain Voltage: 200 V / div., 5 ms / div.
Output Voltage: 2 V / div., 5 ms / div.
uVCC Voltage: 1 V / div., 5 ms / div.
BP Voltage: 2 V / div., 5 ms / div.
$uVCC_{max}$ = 3.2767 V

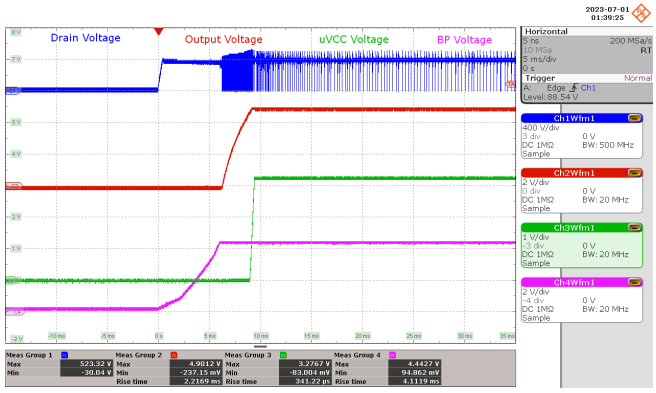


Figure 95 – uVcc Start-up Waveforms.
265 VAC, 5 Vo Load 0 A.
Drain Voltage: 400 V / div., 5 ms / div.
Output Voltage: 2 V / div., 5 ms / div.
uVCC Voltage: 1 V / div., 5 ms / div.
BP Voltage: 2 V / div., 5 ms / div.
$uVCC_{max}$ = 3.2767 V

11.1.10 uVCC Voltage During Normal Operation

11.1.10.1 uVCC = 3.3 V / No-Load

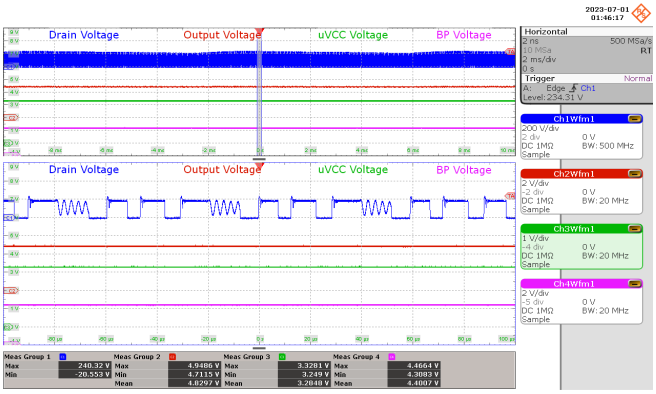


Figure 96 – uVcc Normal Operation Waveforms.
85 VAC, 5 Vo Load 1 A.
Drain Voltage: 200 V / div., 2 ms / div.
Output Voltage: 2 V / div., 2 ms / div.
uVCC Voltage: 1 V / div., 2 ms / div.
BP Voltage: 2 V / div., 2 ms / div.
$uVCC_{max}$ = 3.3281 V

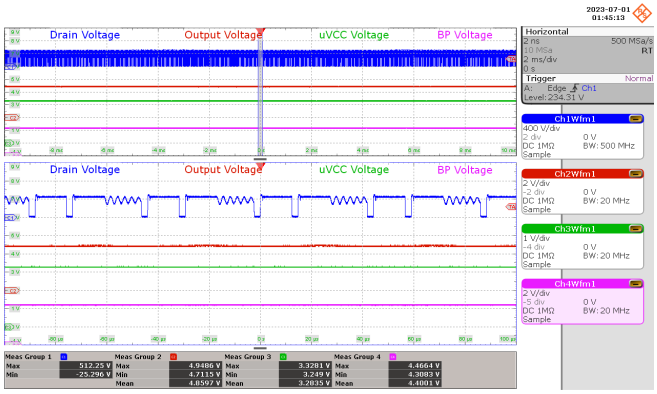


Figure 97 – uVcc Normal Operation Waveforms.
265 VAC, 5 Vo Load 1 A.
Drain Voltage: 400 V / div., 2 ms / div.
Output Voltage: 2 V / div., 2 ms / div.
uVCC Voltage: 1 V / div., 2 ms / div.
BP Voltage: 2 V / div., 2 ms / div.
$uVCC_{max}$ = 3.3281 V

Figure 98 – uVcc Normal Operation Waveforms.
85 VAC, 5 Vo Load 0 A.
Drain Voltage: 200 V / div., 2 ms / div.
Output Voltage: 2 V / div., 2 ms / div.
uVCC Voltage: 1 V / div., 2 ms / div.
BP Voltage: 2 V / div., 2 ms / div.
$uVCC_{max}$ = 3.3281 V

Figure 99 – uVcc Normal Operation Waveforms.
265 VAC, 5 Vo Load 0 A.
Drain Voltage: 400 V / div., 2 ms / div.
Output Voltage: 2 V / div., 2 ms / div.
uVCC Voltage: 1 V / div., 2 ms / div.
BP Voltage: 2 V / div., 2 ms / div.
$uVCC_{max}$ = 3.3281 V

11.1.10.2 uVCC = 3.3 V / 20 mA

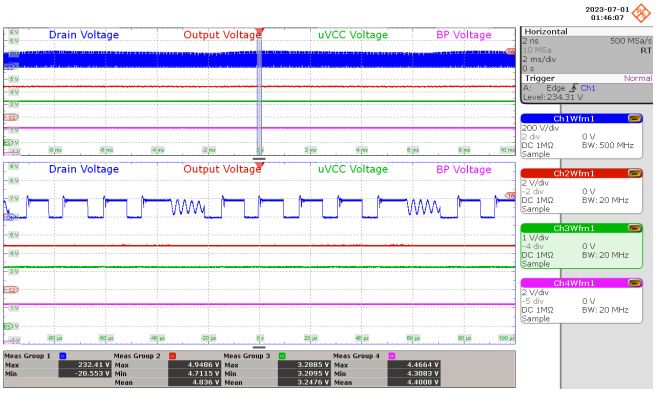


Figure 100 – uVcc Normal Operation Waveforms.
85 VAC, 5 Vo Load 1 A.
Drain Voltage: 200 V / div., 2 ms / div.
Output Voltage: 2 V / div., 2 ms / div.
uVCC Voltage: 1 V / div., 2 ms / div.
BP Voltage: 2 V / div., 2 ms / div.
$uVCC_{max}$ = 3.2885 V

Figure 101 – uVcc Normal Operation Waveforms.
265 VAC, 5 Vo Load 1 A.
Drain Voltage: 400 V / div., 2 ms / div.
Output Voltage: 2 V / div., 2 ms / div.
uVCC Voltage: 1 V / div., 2 ms / div.
BP Voltage: 2 V / div., 2 ms / div.
$uVCC_{max}$ = 3.2885 V

Figure 102 – uVcc Normal Operation Waveforms.
85 VAC, 5 Vo Load 0 A.
Drain Voltage: 200 V / div., 2 ms / div.
Output Voltage: 2 V / div., 2 ms / div.
uVCC Voltage: 1 V / div., 2 ms / div.
BP Voltage: 2 V / div., 2 ms / div.
$uVCC_{max}$ = 3.2885 V

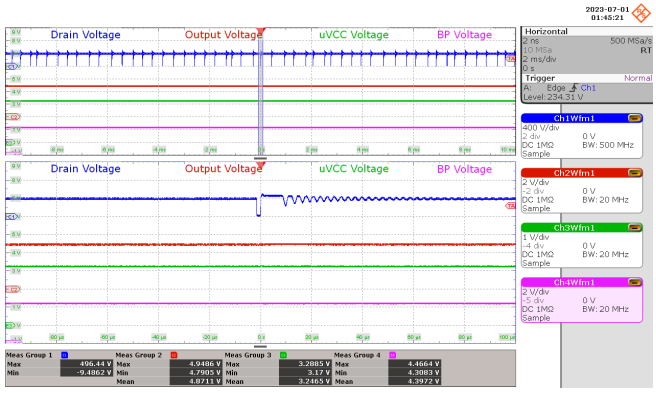


Figure 103 – uVcc Normal Operation Waveforms.
265 VAC, 5 Vo Load 0 A.
Drain Voltage: 400 V / div., 2 ms / div.
Output Voltage: 2 V / div., 2 ms / div.
uVCC Voltage: 1 V / div., 2 ms / div.
BP Voltage: 2 V / div., 2 ms / div.
$uVCC_{max}$ = 3.2885 V

11.2 Output Ripple Measurements

11.2.1 Ripple Measurement Technique

For DC output ripple measurements, a modified oscilloscope test probe must be utilized in order to reduce 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 include 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).

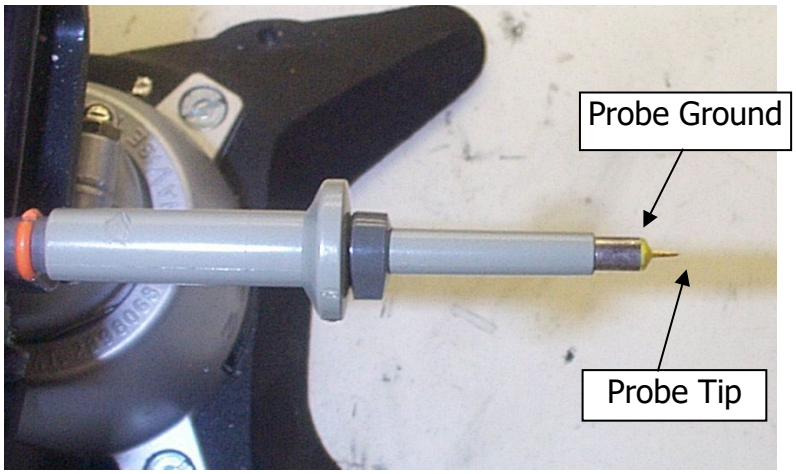


Figure 104 – Oscilloscope Probe Prepared for Ripple Measurement. (End Cap and Ground Lead Removed.)

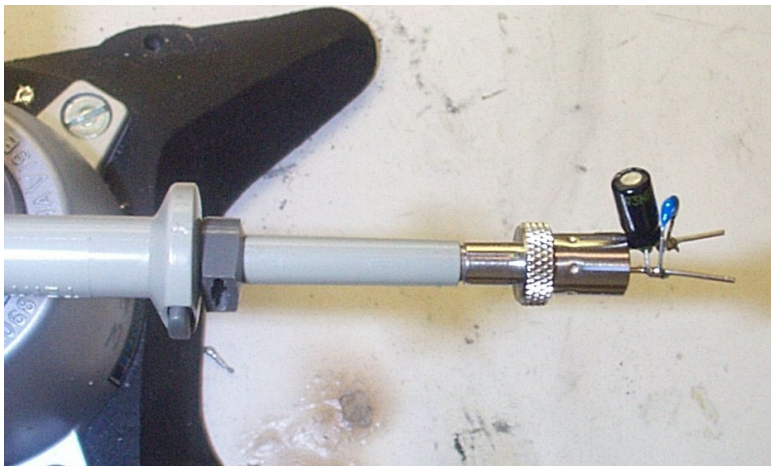


Figure 105 – Oscilloscope Probe with Probe Master (**www.probemaster.com**) 4987A BNC Adapter. (Modified with wires for ripple measurement, and two parallel decoupling capacitors added.)

11.2.2 Measurement Results

11.2.2.1 uVCC = 3.3 V / No-Load

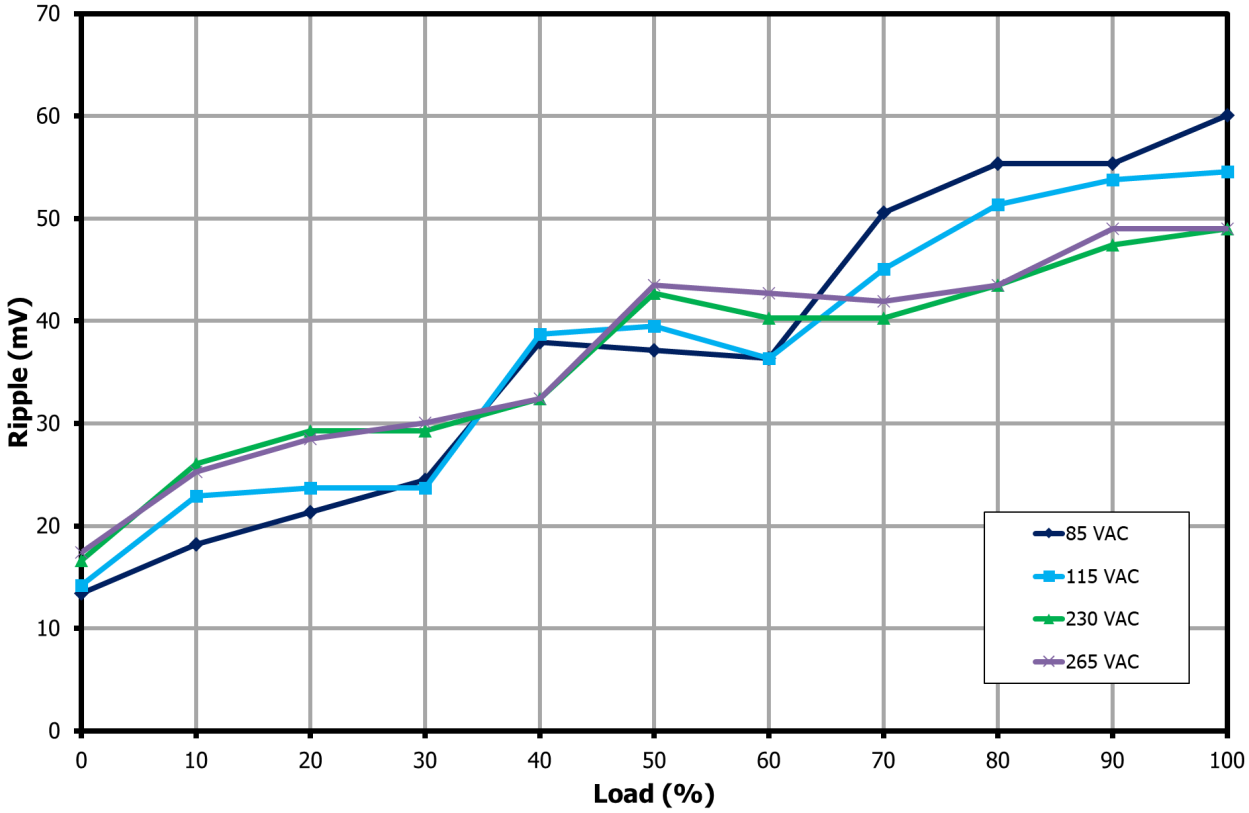


Figure 106 – Output Ripple Voltage.

11.2.2.2 uVCC = 3.3 V / 20 mA

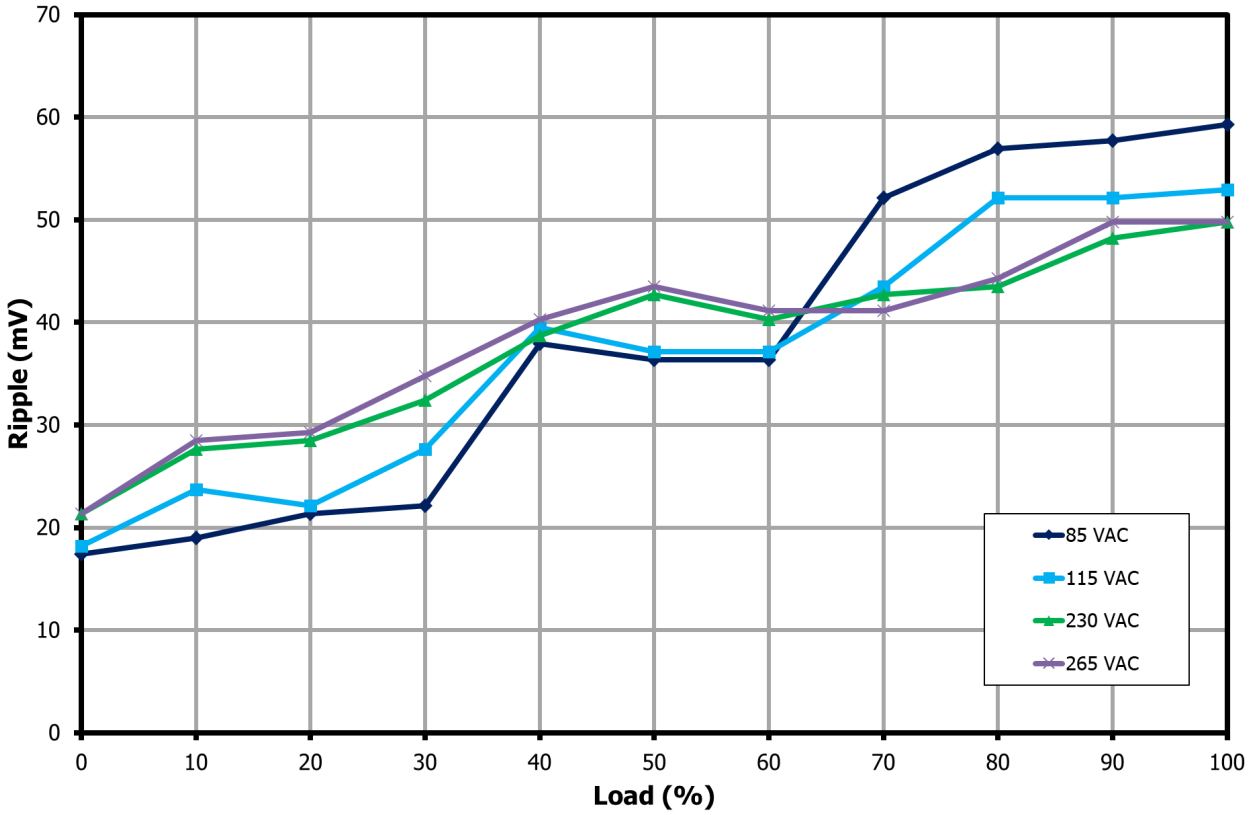


Figure 107 – Output Ripple Voltage.

11.3.1 Ripple Voltage Waveforms

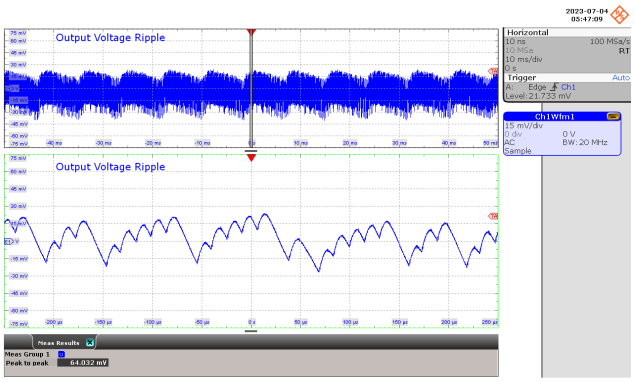


Figure 108 – Output Voltage Ripple Waveforms.
85 VAC, 1000 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 64.032 mV.

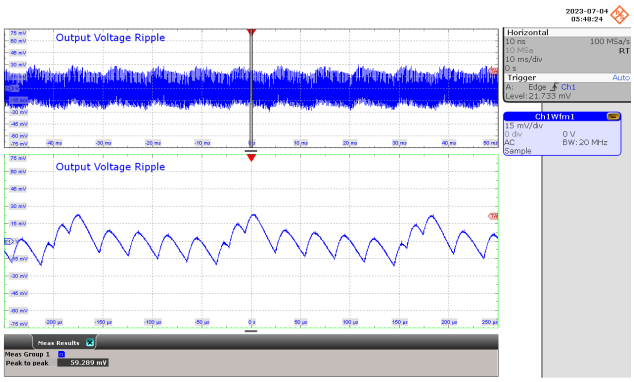


Figure 109 – Output Voltage Ripple Waveforms.
85 VAC, 750 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 59.289 mV.

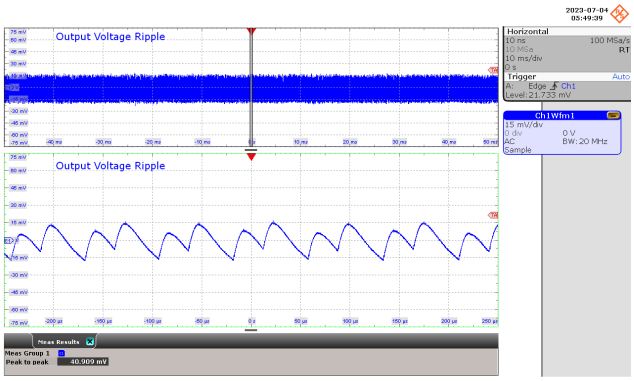


Figure 110 – Output Voltage Ripple Waveforms.
85 VAC, 500 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 40.909 mV.

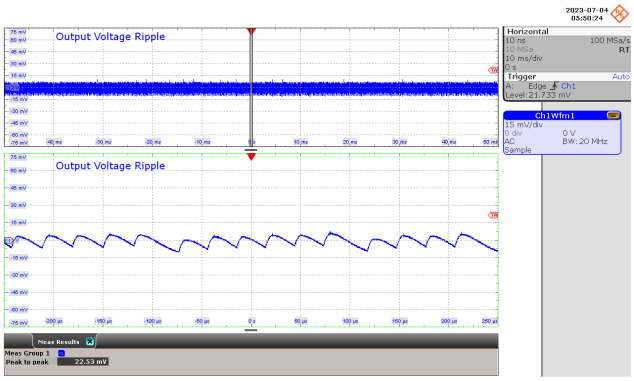


Figure 111 – Output Voltage Ripple Waveforms.
85 VAC, 250 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 22.53 mV.

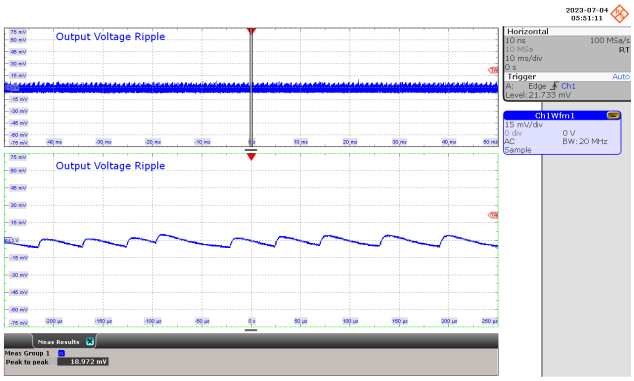


Figure 112 – Output Voltage Ripple Waveforms.
85 VAC, 100 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 μs / div.
V_{PK-PK}: 18.972 mV.

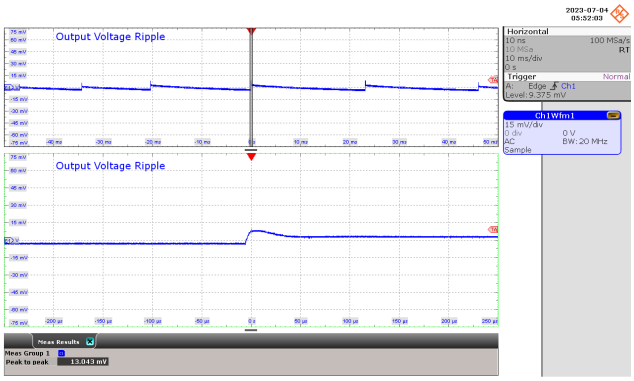


Figure 113 – Output Voltage Ripple Waveforms.
85 VAC, 0 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 μs / div.
V_{PK-PK}: 13.043 mV.

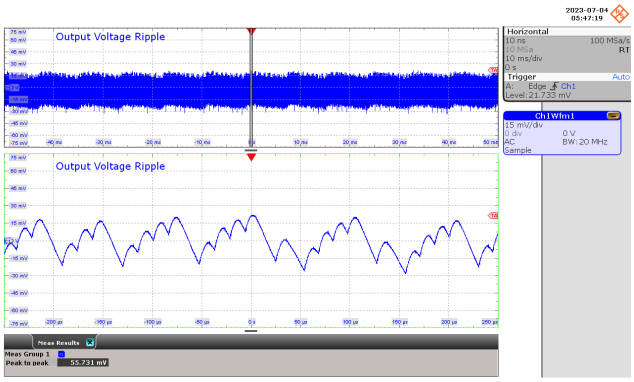


Figure 114 – Output Voltage Ripple Waveforms.
115 VAC, 1000 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 μs / div.
V_{PK-PK}: 55.731 mV.

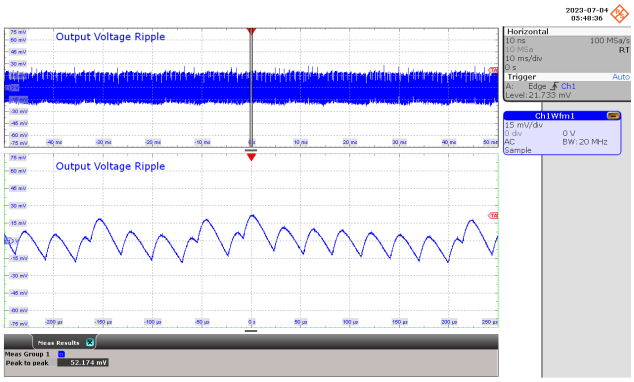


Figure 115 – Output Voltage Ripple Waveforms.
115 VAC, 750 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 μs / div.
V_{PK-PK}: 52.174 mV.

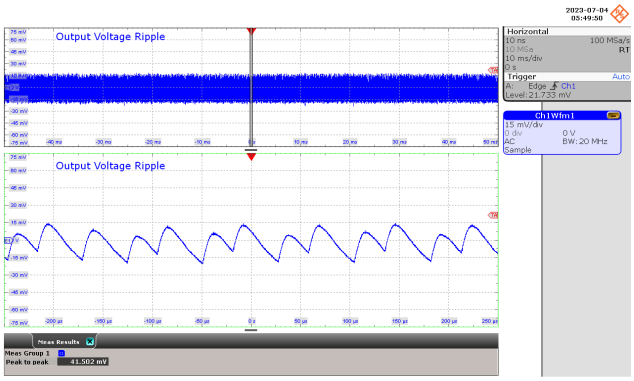


Figure 116 – Output Voltage Ripple Waveforms.
115 VAC, 500 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 41.502 mV.

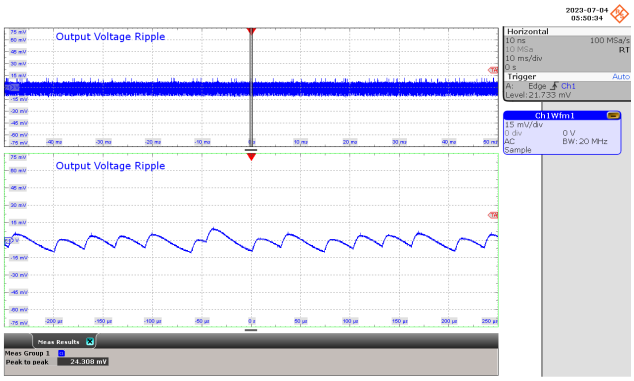


Figure 117 – Output Voltage Ripple Waveforms.
115 VAC, 250 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 24.308 mV.

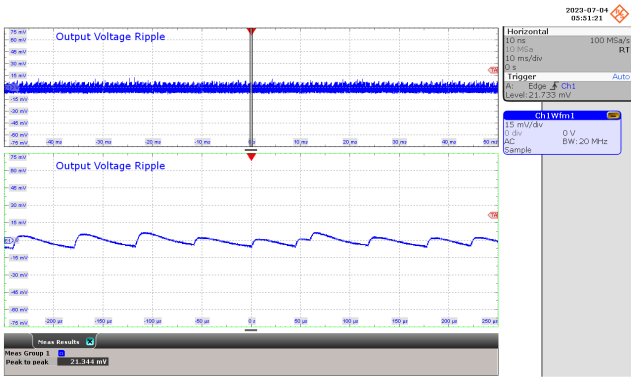


Figure 118 – Output Voltage Ripple Waveforms.
115 VAC, 100 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 21.344 mV.

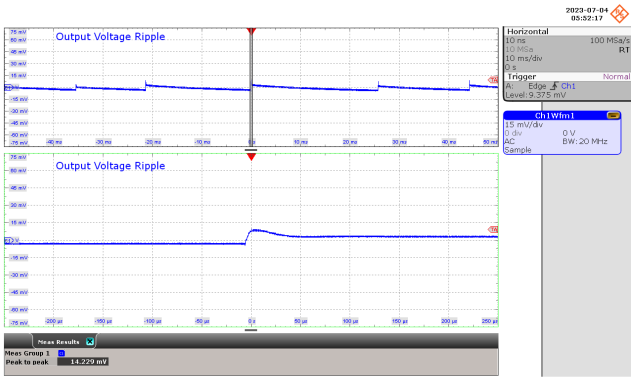


Figure 119 – Output Voltage Ripple Waveforms.
115 VAC, 0 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 14.229 mV.

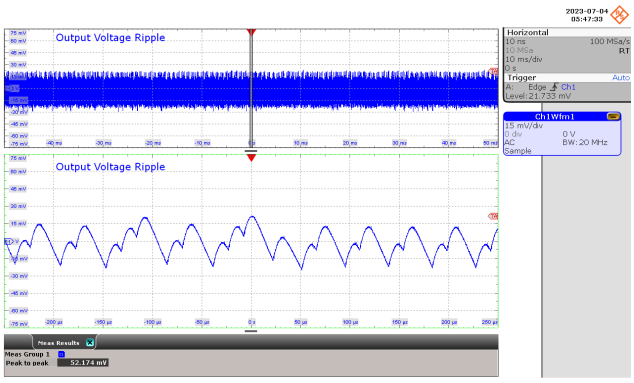


Figure 120 – Output Voltage Ripple Waveforms.
230 VAC, 1000 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 52.174 mV.

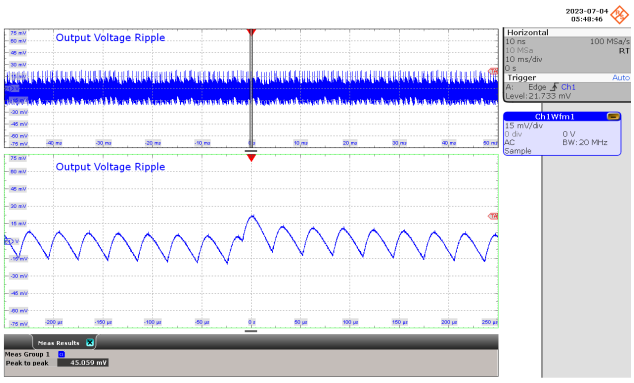


Figure 121 – Output Voltage Ripple Waveforms.
230 VAC, 750 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 45.059 mV.

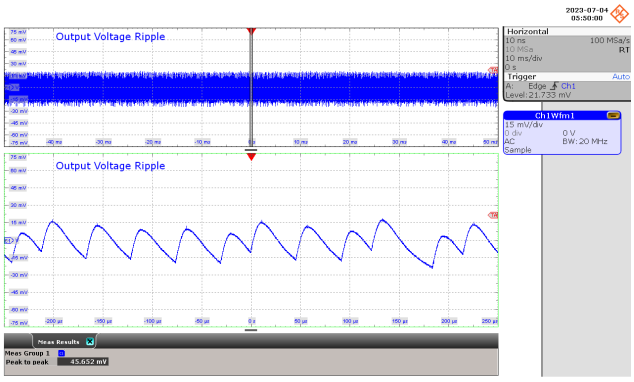


Figure 122 – Output Voltage Ripple Waveforms.
230 VAC, 500 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 45.652 mV.

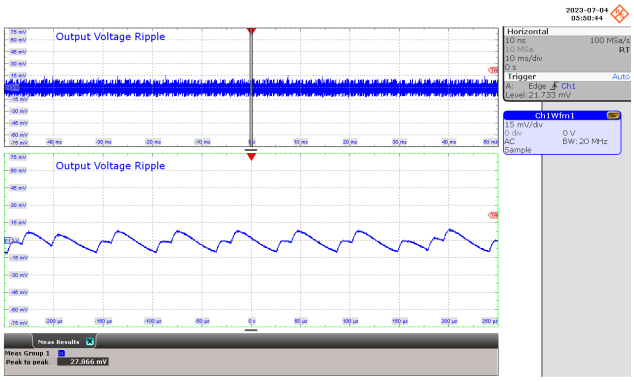


Figure 123 – Output Voltage Ripple Waveforms.
230 VAC, 250 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 27.866 mV.

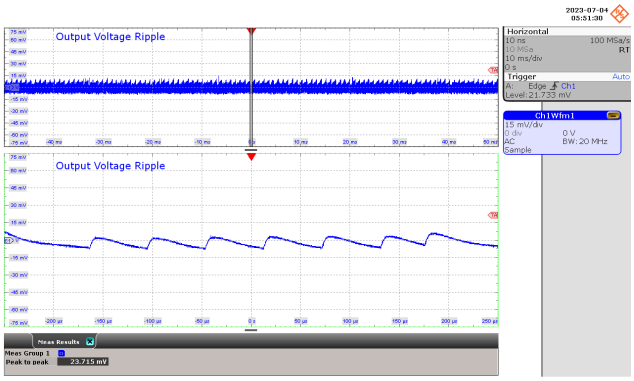


Figure 124 – Output Voltage Ripple Waveforms.
230 VAC, 100 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 23.715 mV.

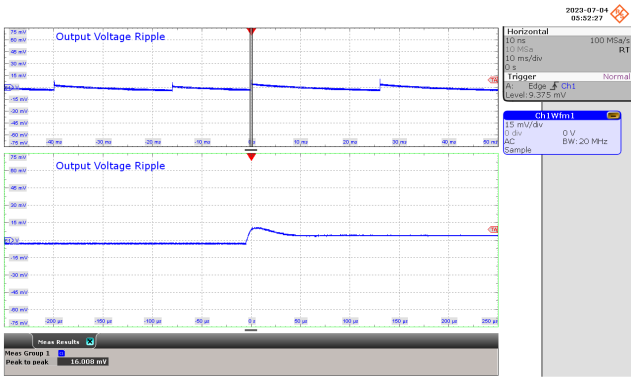


Figure 125 – Output Voltage Ripple Waveforms.
230 VAC, 0 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 16.008 mV.

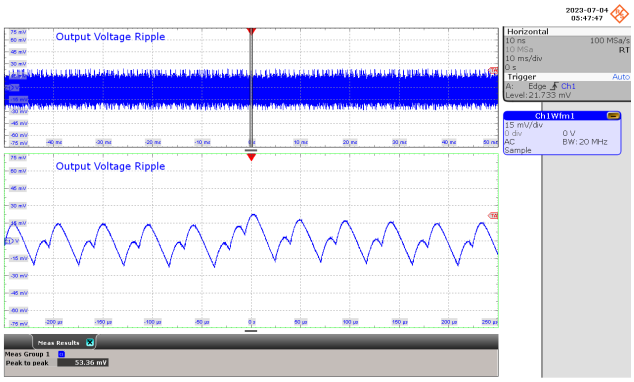


Figure 126 – Output Voltage Ripple Waveforms.
265 VAC, 1000 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 53.36 mV.

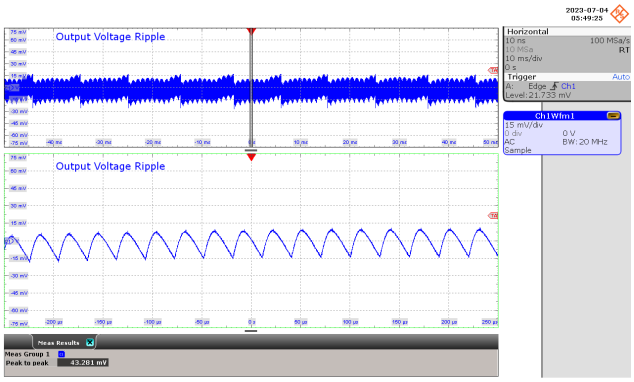


Figure 127 – Output Voltage Ripple Waveforms.
265 VAC, 750 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 43.281 mV.

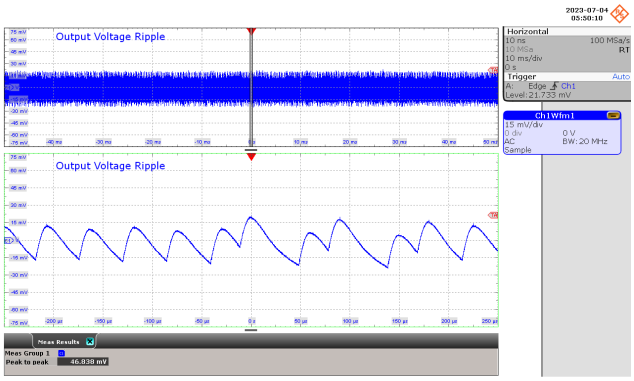


Figure 128 – Output Voltage Ripple Waveforms.
265 VAC, 500 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 46.838 mV.

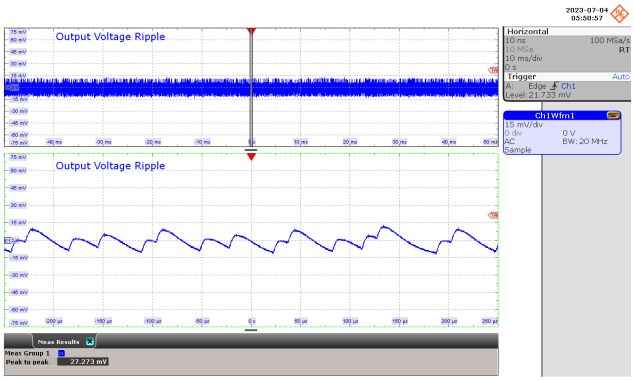


Figure 129 – Output Voltage Ripple Waveforms.
265 VAC, 250 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 27.273 mV.

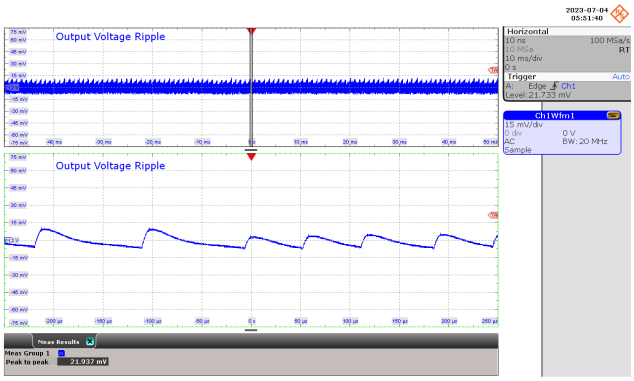


Figure 130 – Output Voltage Ripple Waveforms.
265 VAC, 100 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 21.937 mV.

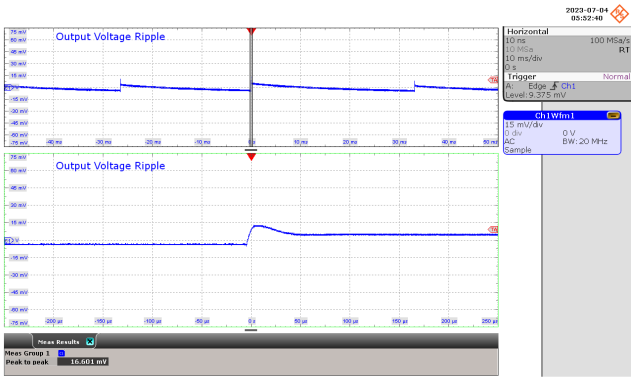


Figure 131 – Output Voltage Ripple Waveforms.
265 VAC, 0 mA Output.
Ripple: 15 mV / div., 10 ms / div.
Zoom: 50 µs / div.
V_{PK-PK}: 16.601 mV.

11.4 Transient Response

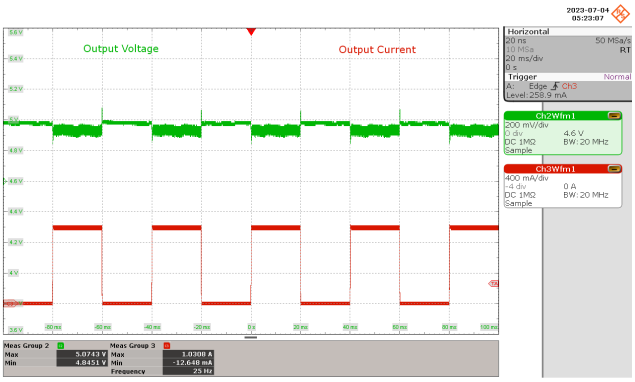


Figure 132 – Transient Output Waveforms.
85 VAC.
Output Voltage: 200 mV / div., 20 ms / div.
Output Current: 400 mA / div., 20 ms / div.
Load Transient: 0 % - 100%.
Duty Cycle, Slew Rate: 50%, 0.8 A / µs.
Frequency: 25 Hz.
V_{MAX}: 5.0743 V, V_{MIN}: 4.8451 V.

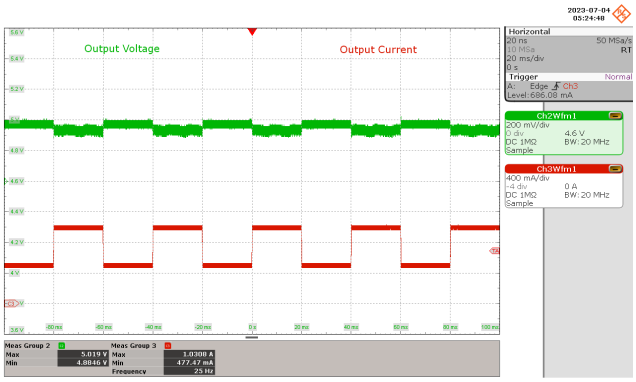


Figure 133 – Transient Output Waveforms.
85 VAC.
Output Voltage: 200 mV / div., 20 ms / div.
Output Current: 400 mA / div., 20 ms / div.
Load Transient: 50 % - 100%.
Duty Cycle, Slew Rate: 50%, 0.8 A / µs.
Frequency: 25 Hz.
V_{MAX}: 5.019 V, V_{MIN}: 4.8846 V.

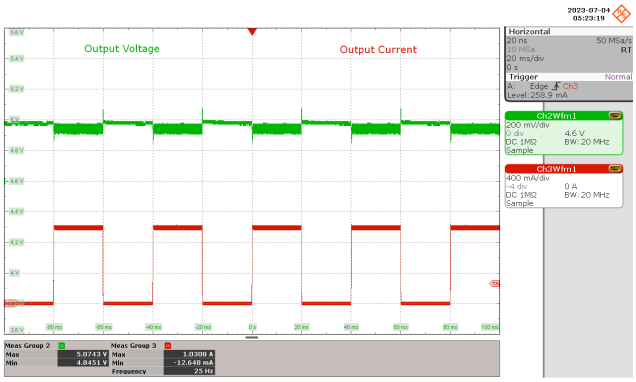


Figure 134 – Transient Output Waveforms.
115 VAC.
Output Voltage: 200 mV / div., 20 ms / div.
Output Current: 400 mA / div., 20 ms / div.
Load Transient: 0 % - 100%.
Duty Cycle, Slew Rate: 50%, 0.8 A / µs.
Frequency: 25 Hz.
V_{MAX}: 5.0743 V, V_{MIN}: 4.8451 V.

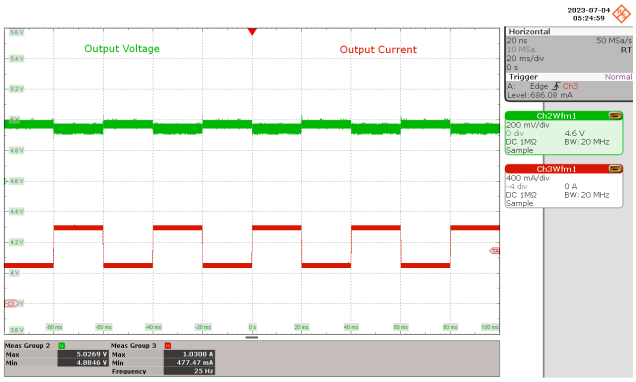


Figure 135 – Transient Output Waveforms.
115 VAC.
Output Voltage: 200 mV / div., 20 ms / div.
Output Current: 400 mA / div., 20 ms / div.
Load Transient: 50 % - 100%.
Duty Cycle, Slew Rate: 50%, 0.8 A / µs.
Frequency: 25 Hz.
V_{MAX}: 5.0269 V, V_{MIN}: 4.8846 V.

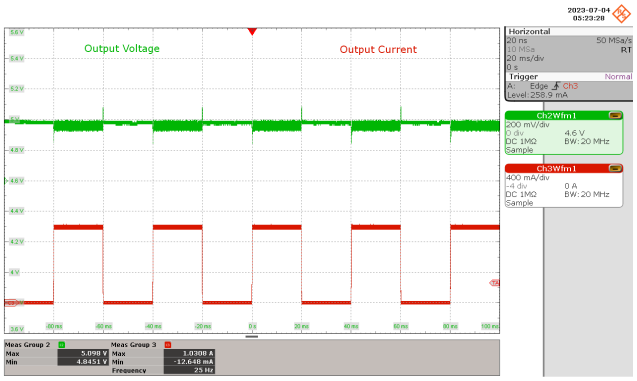


Figure 136 – Transient Output Waveforms.
230 VAC.
Output Voltage: 200 mV / div., 20 ms / div.
Output Current: 400 mA / div., 20 ms / div.
Load Transient: 0 % - 100%.
Duty Cycle, Slew Rate: 50%, 0.8 A / µs.
Frequency: 25 Hz.
V_{MAX}: 5.098 V, V_{MIN}: 4.8451 V.

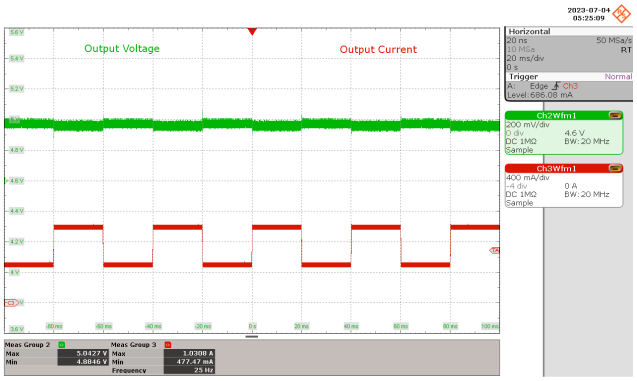


Figure 137 – Transient Output Waveforms.
230 VAC.
Output Voltage: 200 mV / div., 20 ms / div.
Output Current: 400 mA / div., 20 ms / div.
Load Transient: 50 % - 100%.
Duty Cycle, Slew Rate: 50%, 0.8 A / µs.
Frequency: 25 Hz.
V_{MAX}: 5.0427 V, V_{MIN}: 4.8846 V.

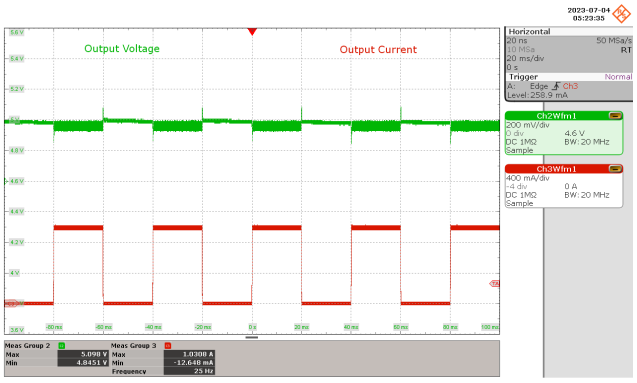


Figure 138 – Transient Output Waveforms.
265 VAC.
Output Voltage: 200 mV / div., 20 ms / div.
Output Current: 400 mA / div., 20 ms / div.
Load Transient: 0 % - 100%.
Duty Cycle, Slew Rate: 50%, 0.8 A / µs.
Frequency: 25 Hz.
V_{MAX}: 5.098 V, V_{MIN}: 4.8451 V.

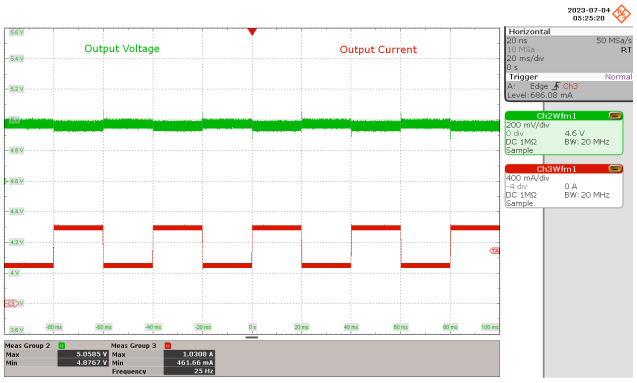


Figure 139 – Transient Output Waveforms.
265 VAC.
Output Voltage: 200 mV / div., 20 ms / div.
Output Current: 400 mA / div., 20 ms / div.
Load Transient: 50 % - 100%.
Duty Cycle, Slew Rate: 50%, 0.8 A / µs.
Frequency: 25 Hz.
V_{MAX}: 5.0585 V, V_{MIN}: 4.8767 V.

12 Conducted EMI

12.1 1 A Resistive Load, Floating Output (QPK / AV)

After running for 15 minutes.

12.1.1 115 VAC

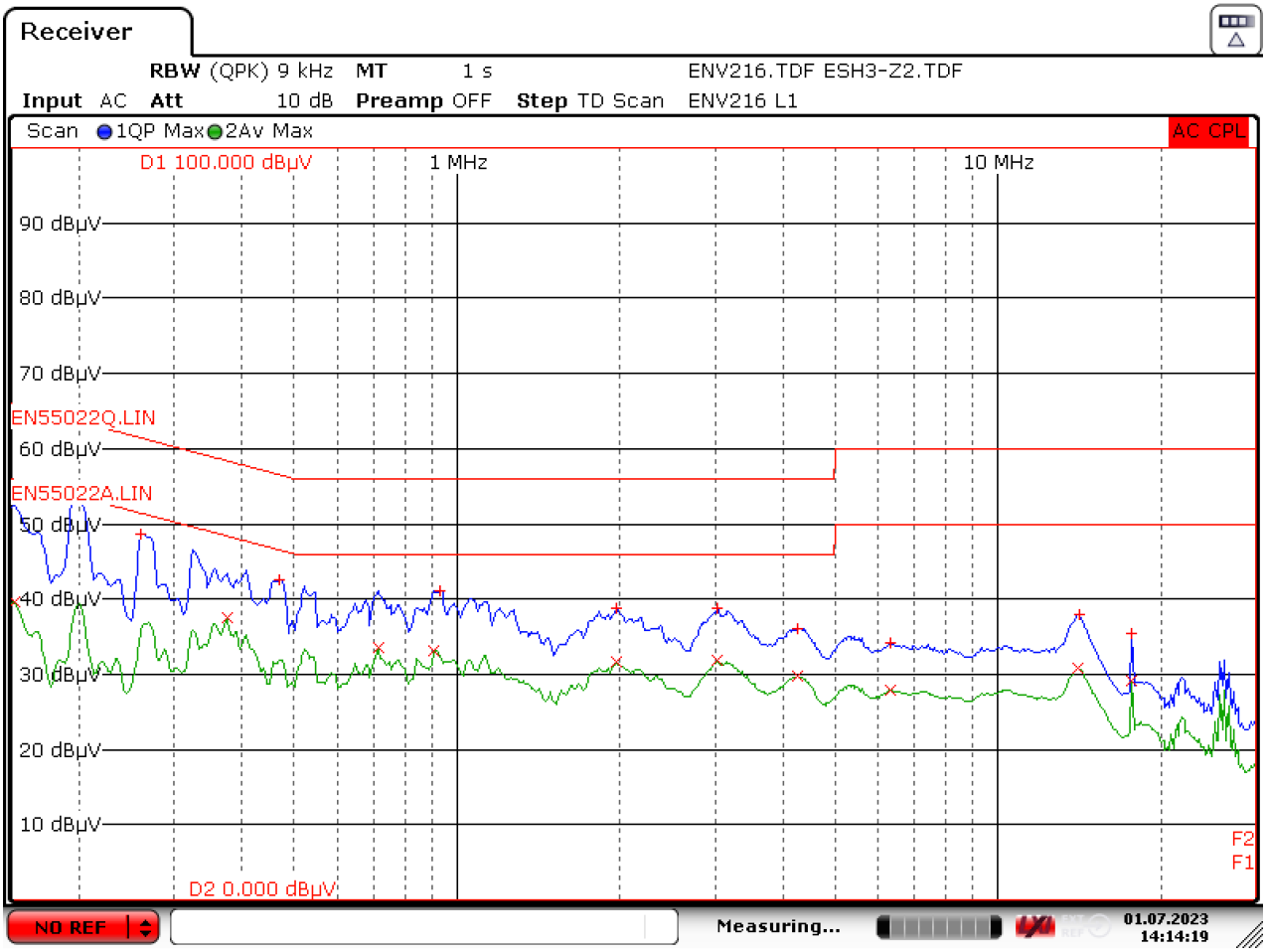


Figure 140 – Floating Ground EMI, Line at 115 VAC, uVCC = 3.3 V / 20 mA.

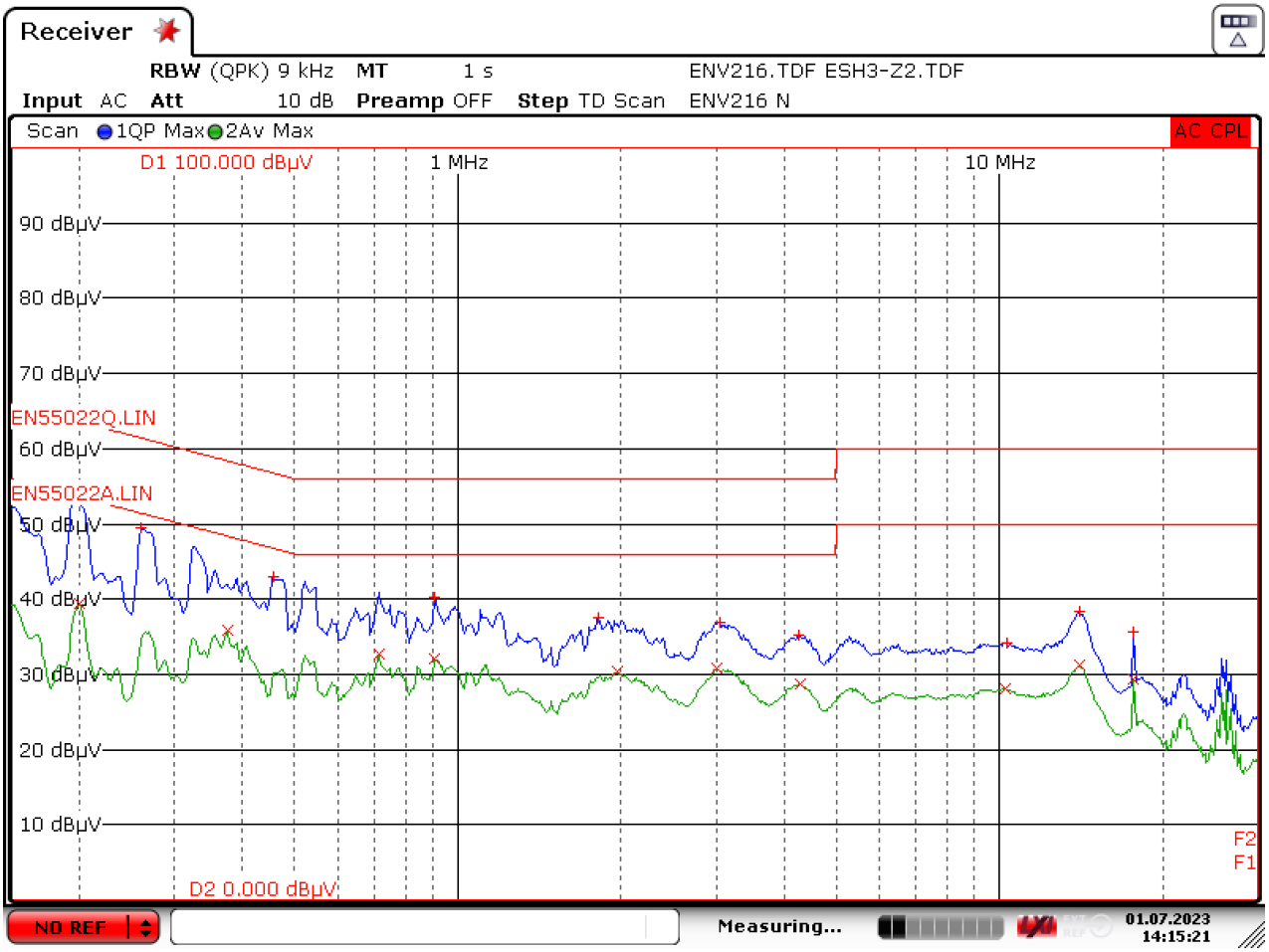


Figure 141 – Floating Ground EMI, Neutral at 115 VAC, uVCC = 3.3 V / 20 mA.

12.1.2 230 VAC

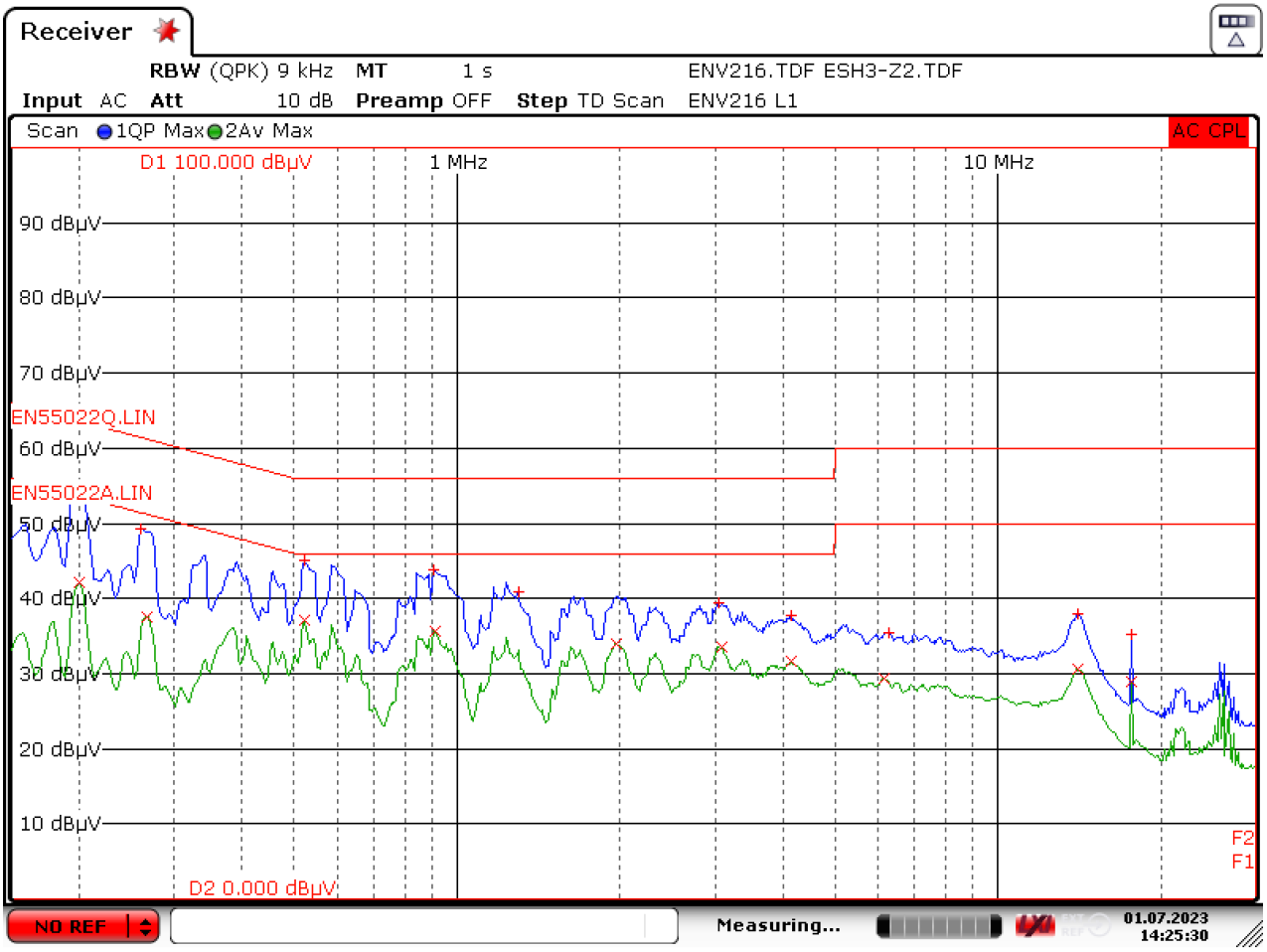


Figure 142 – Floating Ground, Line at 230 VAC, uVCC = 3.3 V / 20 mA.

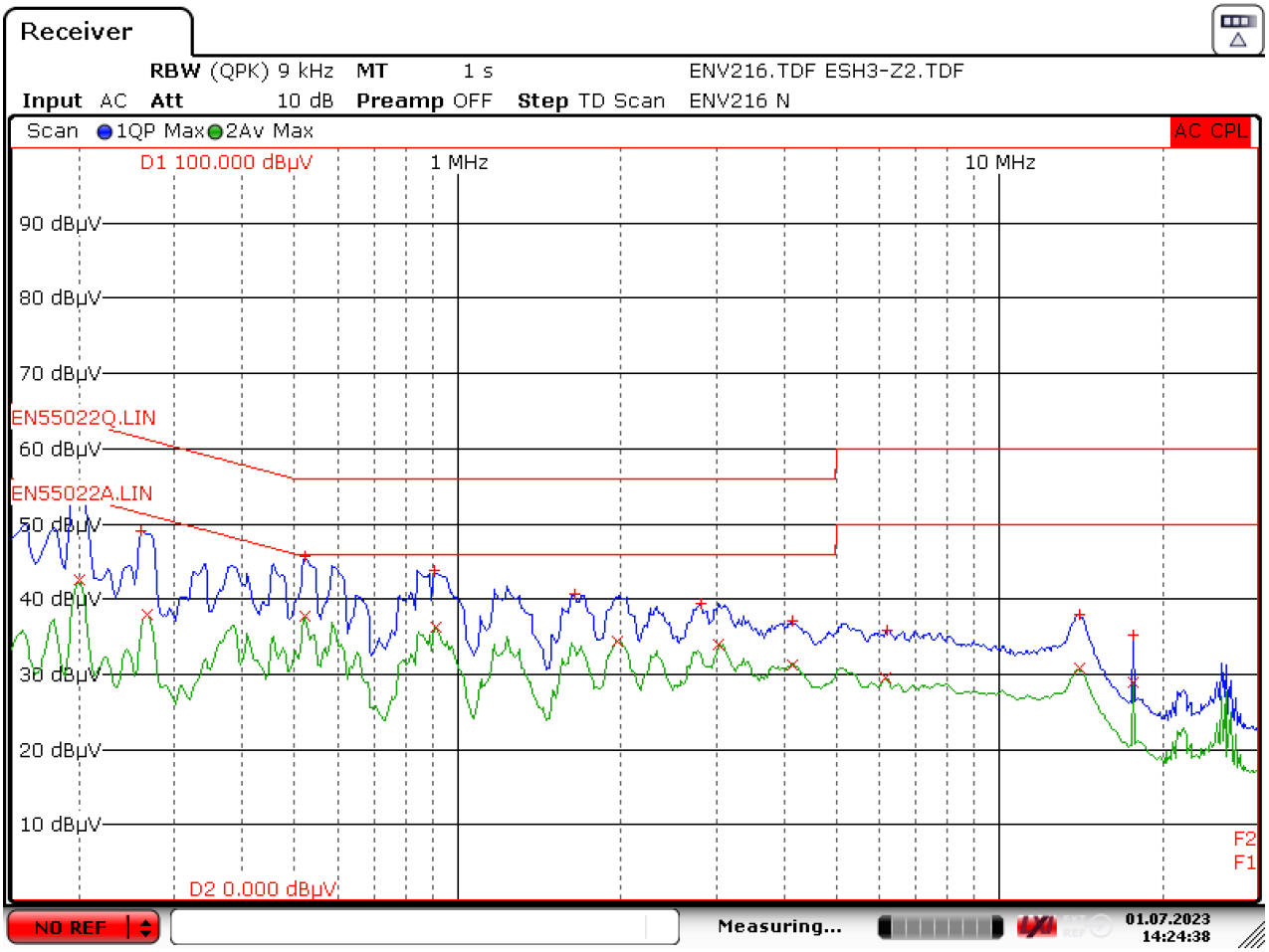


Figure 143 – Floating Ground, Neutral at 230 VAC, uVCC = 3.3 V / 20 mA.

13 Lightning Surge

13.1 Differential Mode Test

Passed ±1 kV surge test.

Surge Voltage (kV)	Phase Angle	IEC Coupling	Generator Impedance (Ω)	Number Strikes	Result	Remarks
+1	0	L1/L2	2	10	PASS	No Auto-restart
-1	0	L1/L2	2	10	PASS	No Auto-restart
+1	90	L1/L2	2	10	PASS	No Auto-restart
-1	90	L1/L2	2	10	PASS	No Auto-restart
+1	180	L1/L2	2	10	PASS	No Auto-restart
-1	180	L1/L2	2	10	PASS	No Auto-restart
+1	270	L1/L2	2	10	PASS	No Auto-restart
-1	270	L1/L2	2	10	PASS	No Auto-restart

1.1 Electrical Fast Transient Test

Passed ±2 kV EFT test.

EFT Voltage (kV)	Phase Angle (°)	Frequency (kHz)	T-Burst	T-Rep	T-Duration	Coupling	Test Result
2	0	5	15 ms	300 ms	120 s	L, N	PASS
-2	0	5	15 ms	300 ms	120 s	L, N	PASS
2	0	100	750 us	300 ms	120 s	L, N	PASS
-2	0	100	750 us	300 ms	120 s	L, N	PASS
2	90	5	15 ms	300 ms	120 s	L, N	PASS
-2	90	5	15 ms	300 ms	120 s	L, N	PASS
2	90	100	750 us	300 ms	120 s	L, N	PASS
-2	90	100	750 us	300 ms	120 s	L, N	PASS
2	180	5	15 ms	300 ms	120 s	L, N	PASS
-2	180	5	15 ms	300 ms	120 s	L, N	PASS
2	180	100	750 us	300 ms	120 s	L, N	PASS
-2	180	100	750 us	300 ms	120 s	L, N	PASS
2	270	5	15 ms	300 ms	120 s	L, N	PASS
-2	270	5	15 ms	300 ms	120 s	L, N	PASS
2	270	100	750 us	300 ms	120 s	L, N	PASS
-2	270	100	750 us	300 ms	120 s	L, N	PASS

14 Revision History

Date	Author	Revision	Description & Changes	Reviewed
10-Sep-23	MMT	1.0	Initial Release	Apps & Mktg

For the latest updates, visit our website: www.power.com

Reference Designs are technical proposals concerning how to use Power Integrations' gate drivers in particular applications and/or with certain power modules. These proposals are "as is" and are not subject to any qualification process. The suitability, implementation and qualification are the sole responsibility of the end user. The statements, technical information and recommendations contained herein are believed to be accurate as of the date hereof. All parameters, numbers, values and other technical data included in the technical information were calculated and determined to our best knowledge in accordance with the relevant technical norms (if any). They may base on assumptions or operational conditions that do not necessarily apply in general. We exclude any representation or warranty, express or implied, in relation to the accuracy or completeness of the statements, technical information and recommendations contained herein. No responsibility is accepted for the accuracy or sufficiency of any of the statements, technical information, recommendations or opinions communicated and any liability for any direct, indirect or consequential loss or damage suffered by any person arising therefrom is expressly disclaimed.

Power Integrations reserves the right to make changes to its products at any time to improve reliability or manufacturability. Power Integrations does not assume any liability arising from the use of any device or circuit described herein. POWER INTEGRATIONS MAKES NO WARRANTY HEREIN AND SPECIFICALLY DISCLAIMS ALL WARRANTIES INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF THIRD PARTY RIGHTS.

Patent Information
The products and applications illustrated herein (including transformer construction and circuits' external to the products) 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 Integrations' patents may be found at www.power.com. Power Integrations grants its customers a license under certain patent rights as set forth at http://www.power.com/ip.htm.

Power Integrations Worldwide Sales Support Locations

WORLD HEADQUARTERS
5245 Hellyer Avenue
San Jose, CA 95138, USA.
Main: +1-408-414-9200
Customer Service:
Worldwide: +1-65-635-64480
Americas: +1-408-414-9621
e-mail: usasales@power.com

CHINA (SHANGHAI)
Rm 2410, Charity Plaza, No. 88,
North Caoxi Road,
Shanghai, PRC 200030
Phone: +86-21-6354-6323
e-mail: chinasales@power.com

CHINA (SHENZHEN)
17/F, Hivac Building, No. 2, Keji Nan 8th Road, Nanshan District, Shenzhen, China, 518057
Phone: +86-755-8672-8689
e-mail: chinasales@power.com

GERMANY (AC-DC/LED Sales)
Einsteinring 24
85609 Dornach/Aschheim
Germany
Tel: +49-89-5527-39100
e-mail: eurosales@power.com

GERMANY (Gate Driver Sales)
HellwegForum 1
59469 Ense
Germany
Tel: +49-2938-64-39990
e-mail: igbt-driver.sales@power.com

INDIA
#1, 14th Main Road
Vasanthanagar
Bangalore-560052
India
Phone: +91-80-4113-8020
e-mail: indiasales@power.com

ITALY
Via Milanese 20, 3rd. Fl.
20099 Sesto San Giovanni (MI) Italy
Phone: +39-024-550-8701
e-mail: eurosales@power.com

JAPAN
Yusen Shin-Yokohama 1-chome Bldg.
1-7-9, Shin-Yokohama, Kohoku-ku
Yokohama-shi,
Kanagawa 222-0033 Japan
Phone: +81-45-471-1021
e-mail: japansales@power.com

KOREA
RM 602, 6FL
Korea City Air Terminal B/D,
159-6
Samsung-Dong, Kangnam-Gu,
Seoul, 135-728 Korea
Phone: +82-2-2016-6610
e-mail: koreasales@power.com

SINGAPORE
51 Newton Road,
#19-01/05 Goldhill Plaza
Singapore, 308900
Phone: +65-6358-2160
e-mail:
singaporesales@power.com

TAIWAN
5F, No. 318, Nei Hu Rd.,
Sec. 1
Nei Hu District
Taipei 11493, Taiwan R.O.C.
Phone: +886-2-2659-4570
e-mail: taiwansales@power.com

UK
Building 5, Suite 21
The Westbrook Centre
Milton Road
Cambridge
CB4 1YG
Phone: +44 (0) 7823-557484
e-mail: eurosales@power.com