Design Example Report

Title	***40 W Dual Output Power Supply Using InnoSwitch3™-CE INN3168C-H101***
Specification	90 VAC – 265 VAC Input; 5 V, 3 A and 18 V, 1.4 A Outputs
Application	LED Monitors
Author	Applications Engineering Department
Document Number	DER-544
Date	July 2, 2018
Revision	1.1

Summary and Features

- InnoSwitch3-CE - industry first AC/DC ICs with isolated, safety rated integrated feedback
- Built in synchronous rectification for >89% efficiency without NTC at nominal AC input
- All the benefits of secondary-side control with the simplicity of primary-side regulation
  - Insensitive to transformer variation
  - Extremely fast transient response independent of load timing
- Primary sensed output overvoltage protection (OVP) eliminates optocoupler for fault protection
- Accurate thermal protection with hysteretic shutdown
- Input voltage monitor with accurate brown-in/brown-out and overvoltage protection

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.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

1 Introduction

This document is an engineering report describing a 3 A, 5 V and 1.4 A, 18 V dual output embedded power supply utilizing INN3168C-H101 from the InnoSwitch3-CE family of ICs.

This design shows the high power density and efficiency that is possible due to the high level of integration while still providing exceptional performance.

The document contains the power supply specification, schematic, bill of materials, transformer documentation, printed circuit layout, and performance data.

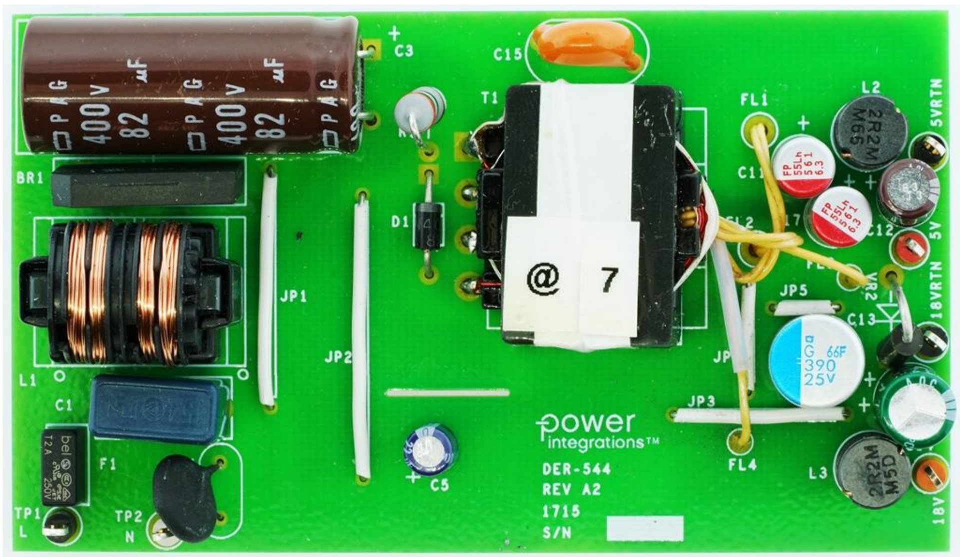


Figure 1 – Populated Circuit Board Photograph, Top.

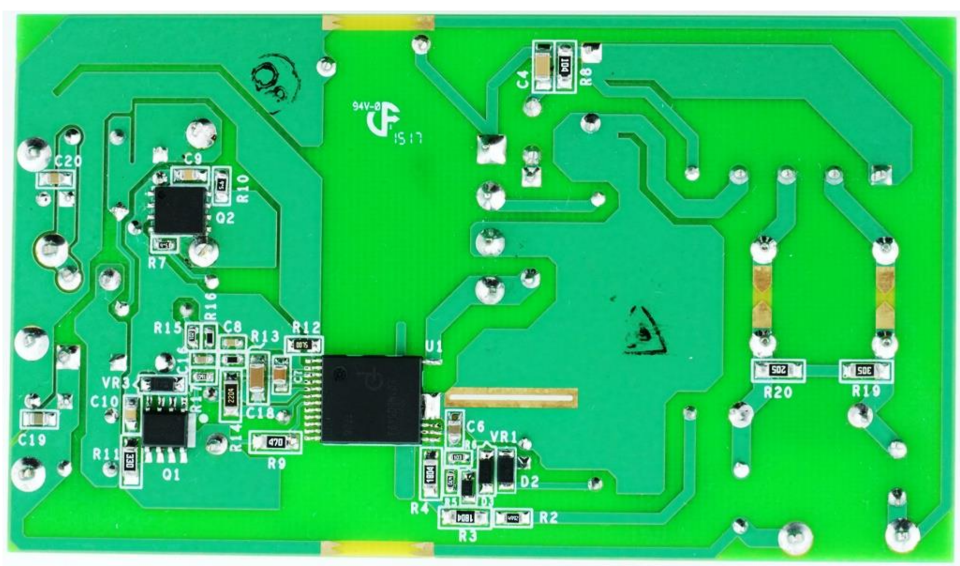


Figure 2 – Populated Circuit Board Photograph, Bottom.

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}	90		265	VAC	3 Wire Input.
Frequency	f_{LINE}	47	50/60	64	Hz	
Output						
Output Voltage 1	V_{OUT1}	4.75	5	5.25	V	±5%.
Output Ripple Voltage 1	$V_{RIPPLE1}$			50	mV	20 MHz Bandwidth.
Output Current 1	I_{OUT1}	0.01		3	A	*Max Load on 5 V and No-Load on 18 V.
Output Voltage 2	V_{OUT2}	17	18	*23	V	
Output Ripple Voltage 2	$V_{RIPPLE2}$			200	mV	20 MHz Bandwidth.
Output Current 2	I_{OUT2}	0		1.4	A	
Total Output Power						
Continuous Output Power	P_{OUT}			40	W	
Efficiency						
Full Load	η	88			%	Measured at 110 / 230 VAC, P_{OUT} 25 ºC.
No Load Input Power				45	mW	V_{IN} at 230 VAC with 150 nF X Capacitor.
Environmental						
Conducted EMI		Meets CISPR22B / EN55022B				
Safety		Designed to meet IEC950, UL1950 Class II				
Surge Common mode Ring Wave		4			kV	100 kHz Ring Wave, 12 Ω Common Mode.
Ambient Temperature	T_{AMB}	0		40	°C	Free Convection, Sea Level.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

3 Schematic

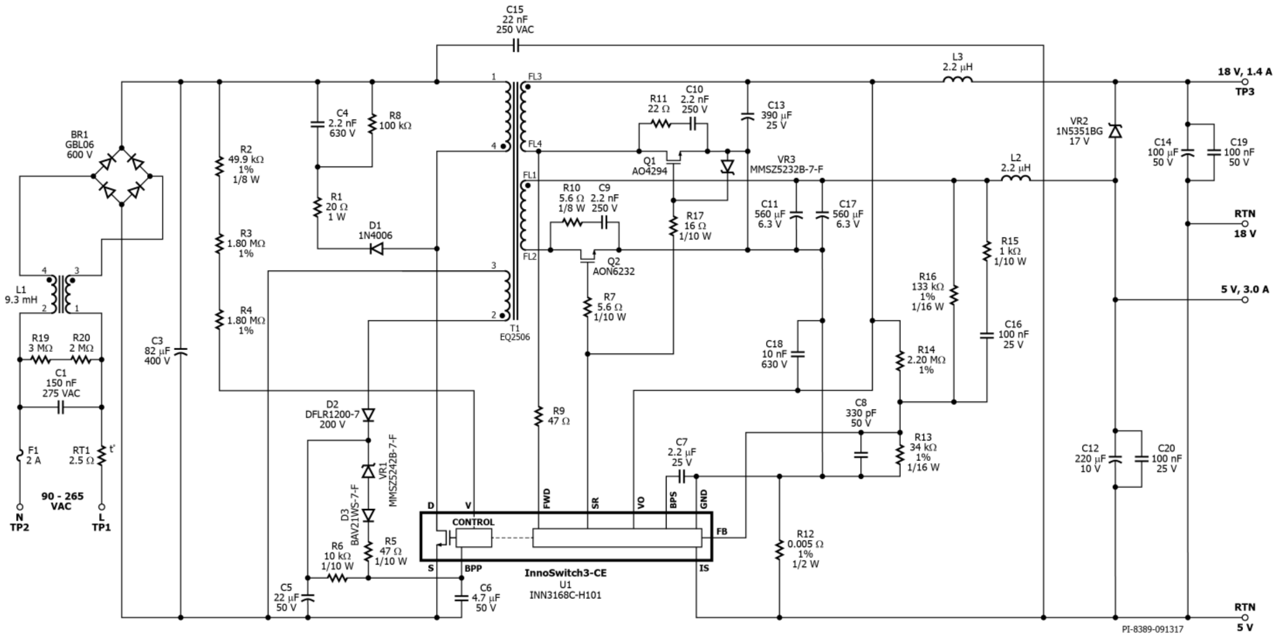


Figure 3 – Schematic.

4 Circuit Description

4.1 Input EMI Filtering

Fuse F1 isolates the circuit and provides protection from component failure and the common mode choke L1 with capacitors, C1 and C15, provides attenuation for EMI. Bridge rectifier BR1 rectifies the AC line voltage and provides a full wave rectified DC across the input capacitor C3.

4.2 InnoSwith3-CE Primary

One side of the transformer primary is connected to the rectified DC bus, the other is connected to the integrated 650 V power MOSFET inside the INN3168C IC (U1).

A low cost RCD clamp formed by D1, R1, R8 and C4 limits the peak drain voltage due to the effects of transformer leakage reactance and output trace inductance.

The IC is self-starting, using an internal high-voltage current source to charge the BPP pin capacitor, C6, when AC is first applied. During normal operation the primary-side block is powered from an auxiliary winding on the transformer. The output of this is configured as a flyback winding which is rectified and filtered using diode D2 and capacitor C5, and fed in the BPP pin via a current limiting resistor R6. The primary-side overvoltage protection is obtained using Zener diode VR1. Blocking diode D3 prevents reverse current from flowing U1 to C5 during start up. In the event of overvoltage at output, the increased voltage at the output of the bias winding cause the Zener diode VR1 to conduct and triggers the OVP protection in the primary-side controller of the INN3168C IC. Resistor R2, R3, and R4 provide line voltage sensing and provide a current to U1, which is proportional to the DC voltage across capacitor C3. At approximately 100 V DC, the current through these resistors exceeds the line under-voltage threshold, which results in enabling of U1. At approximately 450 V DC, the current through these resistors exceeds the line over-voltage threshold, which results in disabling of U1.

4.3 InnoSwitch3-CE Secondary

The secondary-side of the INN3168C provides reference of the output voltage feedback, output current sensing and drive to MOSFET's providing synchronous rectification.

Output rectification for the 5 V output is provided by SR MOSFET Q2. Very low ESR capacitors, C11 and C17, provide filtering, and inductor L2 and capacitor C12 form a second stage filter that significantly attenuates the high frequency ripple and noise at the 5 V output. Output rectification for the 18 V output is provided by SR MOSFET Q1. Very low ESR capacitor, C13, provide filtering, and inductor L3 and capacitor C14 form a second stage filter that significantly attenuates the high frequency ripple and noise at the 18 V output. Capacitors, C19 and C20, reduce the radiation EMI noise.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

RC snubber networks comprising R11 and C10 for Q1, R10 and C9 for Q2 damp high frequency ringing across SR MOSFETs, which results from leakage inductance of the transformer windings and the secondary trace inductances.

The gates of Q1 and Q2 are turned on based on the winding voltage sensed via R9 and the FWD pin of the IC. In continuous conduction mode operation, the power MOSFET is turned off just prior to the secondary-side controller commanding a new switching cycle from the primary. In discontinuous mode the MOSFET is turned off when the voltage drop across the MOSFET falls below a threshold ($V_{SR(TH)}$). Secondary-side control of the primary-side MOSFET ensures that it is never on simultaneously with the synchronous rectification MOSFET. The MOSFET drive signal is output on the SR pin. The secondary-side of the IC is self-powered from either the secondary winding forward voltage or the output voltage. The output voltage powers the device, fed into the VO pin and charges the decoupling capacitor C7 via an internal regulator. The unit enters auto-restart when the sensed output voltage is lower than 3 V.

Resistors R13, R14 and R16 form a voltage divider network that senses the output voltage from both outputs for better cross-regulation. The INN3168C IC has an internal reference of 1.265 V. Feed forward RC networks comprising capacitor C16 and resistor R15 reduce the output ripple voltage. Capacitor C8 provides decoupling from high frequency noise affecting power supply operation. Total output current is sensed by R12 with a threshold of approximately 35 mV to reduce losses. Once the current sense threshold across these resistors is exceeded, the device adjusts the number of switch pulses to maintain a fixed output current. Zener diode VR3 protects Q1 gate from any common mode surge, and capacitor C18 on the VOUT pin protects U1 secondary from ESD.

5 PCB Layout

PCB copper thickness is 2 oz (2.8 mils / 70 μm) unless otherwise stated

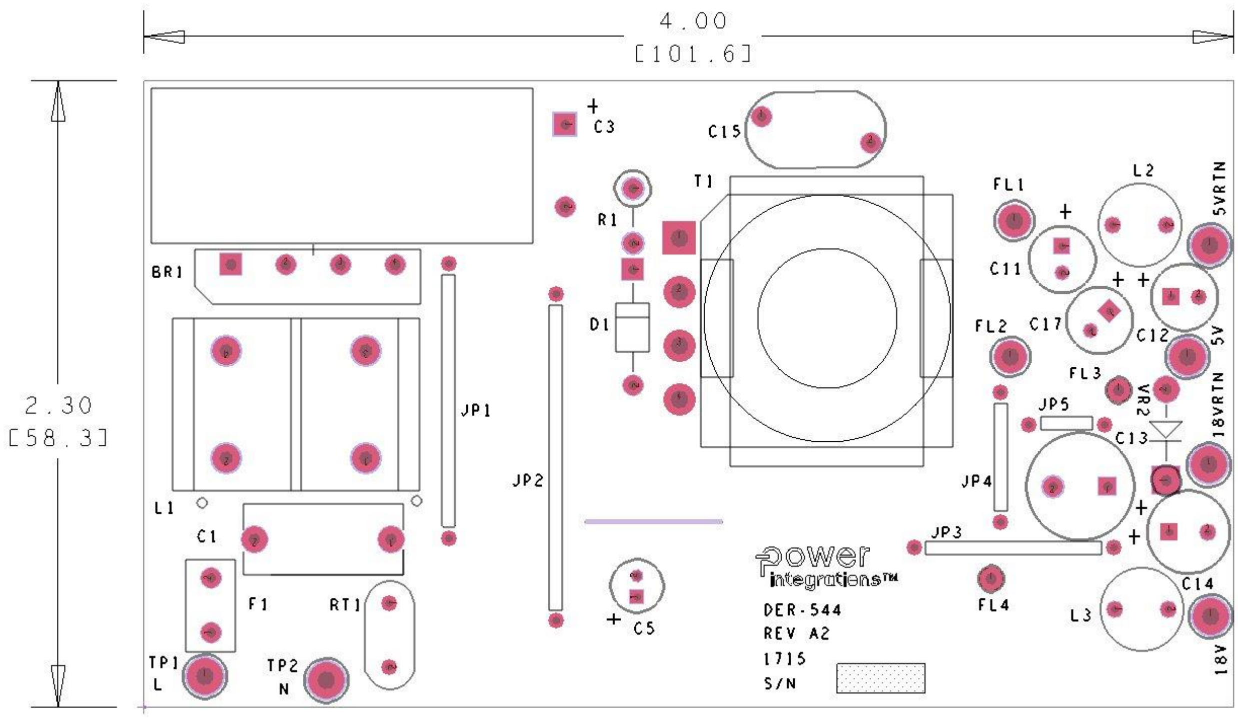


Figure 4 – Printed Circuit Layout, Top.

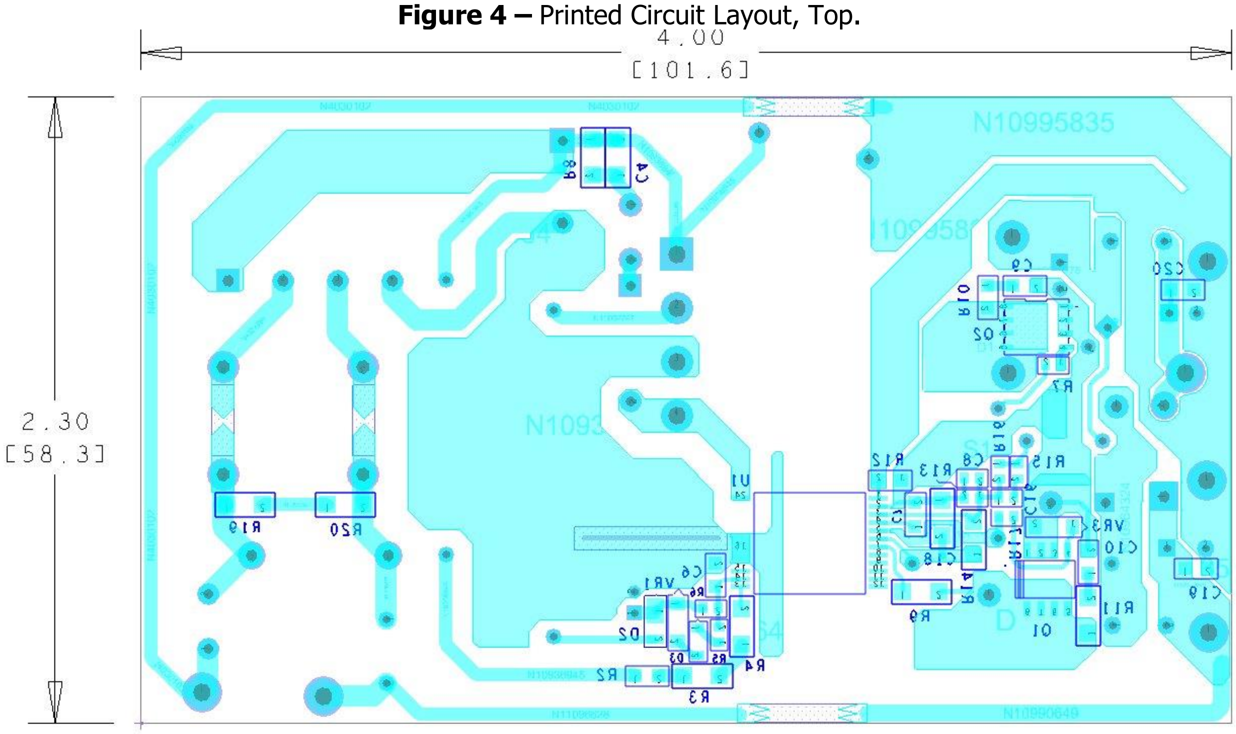


Figure 5 – Printed Circuit Layout, Bottom.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

6 Bill of Materials

Item	Qty	Part Ref	Description	Mfg Part Number	Mfg
1	1	BR1	DIODE BRIDGE 600 V 4 A GB	GBL06	Genesic Semi
2	1	C1	150 nF, 275 VAC, Film, X2	LE154-M	OKAYA
3	1	C3	82 μF, 400 V, Electrolytic, Low ESR, (14.5 x 35)	EPAG401ELL820MU35S	Nippon Chemi-Con
4	1	C4	2.2 nF, 630 V, Ceramic, X7R, 1206	C3216X7R2J222K	TDK
5	1	C5	22 μF, 50 V, Electrolytic, (5 x 11)	UPW1H220MDD	Nichicon
6	1	C6	4.7 μF, 50 V, Ceramic, X5R, 0805	CL21A475KBQNNNE	Samsung
7	1	C7	2.2 μF, 25 V, Ceramic, X7R, 0805	C2012X7R1E225M	TDK
8	1	C8	330 pF 50 V, Ceramic, X7R, 0603	CC0603KRX7R9BB331	Yageo
9	2	C9, C10	2.2 nF, 250 V, Ceramic, X7R, 0805	C2012X7R2E222K085AA	TDK
10	2	C11 C17	560 μF, 6.3 V, Al Organic Polymer, Gen. Purpose, 20%	RS80J561MDN1JT	Nichicon
11	1	C12	220 μF, 10 V, Electrolytic, Very Low ESR, 130 mΩ, (6.3 x 11)	EKZE100ELL221MF11D	Nippon Chemi-Con
12	1	C13	390 μF, 25 V, Al Organic Polymer, Gen. Purpose, 20% 10 x 11.5	APSG250ELL391MJB5S	United Chemi-Con
13	1	C14	100 μF, 50 V, Electrolytic, Very Low ESR, 74 mΩ, (8 x 11.5)	EKZE500ELL101MHB5D	Nippon Chemi-Con
14	1	C15	2.2 nF, Ceramic, Y1	440LD22-R	Vishay
15	1	C16	100 nF, 25 V, Ceramic, X7R, 0603	VJ0603Y104KNXAO	Vishay Vitramon
16	1	C18	10 nF, 630 V, Ceramic, X7R, 1206	C1206C103KBRACTU	Kemet
17	1	C19	100 nF, 50 V, Ceramic, X7R, 0805	CC0805KRX7R9BB104	Yageo
18	1	C20	100 nF, 25 V, Ceramic, X7R, 0805	08053C104KAT2A	AVX
19	1	D1	800 V, 1 A, GP, Rectifier, DO-41	1N4006-E3/54	Vishay
20	1	D2	200 V, 1 A, Rectifier, Glass Passivated, POWERDI123	DFLR1200-7	Diodes, Inc.
21	1	D3	250 V, 0.2 A, Fast Switching, 50 ns, SOD-323	BAV21WS-7-F	Diodes, Inc.
22	1	F1	2 A, 250 V, Slow, Long Time Lag, RST	RST 2	Belfuse
23	1	L1	9.3 mH @ 1 kHz, 2 Line CMC, TH, 1 A, DCR 440 mΩ	SS11V-R10093-CH LF-610	KEMET Premier Magnetics
24	2	L2 L3	2.2 μH, 3.0 A, 5.8Asat, 13.7 mΩ 0.307" Dia (7.80 mm), 0.295" (7.50 mm) H	RCH875NP-2R2M PM-R392R2	Sumida America Premier Magnetics
25	1	Q1	MOSFET, N-CH, 100V, 11.5A, 8SOIC,	AO4294	Alpha & Omega Semi
26	1	Q2	40 V, 85A N-Channel, DFN5X6	AON6232	Alpha & Omega Semi
27	1	R1	RES, 20 Ω, 5%, 1 W, Metal Oxide	RSF100JB-20R	Yageo
28	1	R2	RES, 49.9 kΩ, 1%, 1/8 W, Thick Film, 0805	ERJ-6ENF4992V	Panasonic
29	2	R3 R4	RES, 1.80 MΩ, 1%, 1/4 W, Thick Film, 1206	ERJ-8ENF1804V	Panasonic
30	1	R5	RES, 47 Ω, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ470V	Panasonic
31	1	R6	RES, 10 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ103V	Panasonic
32	1	R7	RES, 5.6 Ω, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ5R6V	Panasonic
33	1	R8	RES, 100 kΩ, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ104V	Panasonic
34	1	R9	RES, 47 Ω, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ470V	Panasonic
35	1	R10	RES, 5.6 Ω, 5%, 1/8 W, Thick Film, 0805	ERJ-6GEYJ5R6V	Panasonic
36	1	R11	RES, 22 Ω, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ220V	Panasonic
37	1	R12	RES, 0.005 Ω, 0.5 W, 1%, 0805	PMR10EZPFU5L00	Rohm
38	1	R13	RES, 34 kΩ, 1%, 1/16 W, Thick Film, 0603	ERJ-3EKF3402V	Panasonic
39	1	R14	RES, 2.20 MΩ, 1%, 1/4 W, Thick Film, 1206	ERJ-8ENF2204V	Panasonic
40	1	R15	RES, 1 kΩ, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ102V	Panasonic
41	1	R16	RES, 133 kΩ, 1%, 1/16 W, Thick Film, 0603	ERJ-3EKF1333V	Panasonic
42	1	R17	RES, 16 Ω, 5%, 1/10 W, Thick Film, 0603	ERJ-3GEYJ160V	Panasonic
43	1	R19	RES, 3 MΩ, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ305V	Panasonic

44	1	R20	RES, 2 MΩ, 5%, 1/4 W, Thick Film, 1206	ERJ-8GEYJ205V	Panasonic
45	1	RT1	NTC Thermistor, 2.5 Ohms, 5 A	SL10 2R505	Ametherm
46	1	T1	Bobbin, EQ2506, 4 pins, 4pri, 0sec Transformer	EQ-2506 POL-INN029	Shen Zhen Xin Yu Jia Premier Magnetics
47	1	U1	InnoSwitch3-CE	INN3168C-H101	Power Integrations
48	1	VR1	DIODE ZENER 12 V 500 mW SOD123	MMSZ5242B-7-F	Diodes, Inc.
49	1	VR2	17 V, 5%, 5 W, DO-41	1N5354BG	Micro Commercial
50	1	VR3	DIODE ZENER 5.6 V 500 mW SOD123	MMSZ5232B-7-F	Diodes, Inc.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

7 Transformer (T1) Specification

7.1 Electrical Diagram

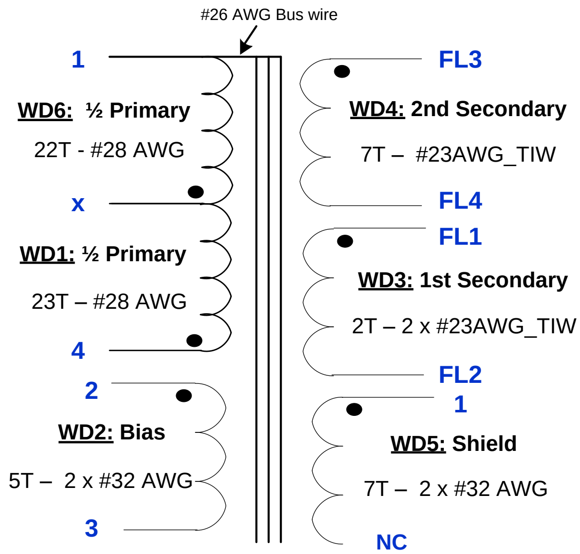


Figure 6 – Transformer Electrical Diagram.

7.2 Electrical Specifications

Parameter	Condition	Spec.
Nominal Primary Inductance	Measured at 1 V_{PK-PK}, 100 kHz switching frequency, between pin 1 and 4, with all other windings open.	660 μH ±10%
Resonant Frequency	Between pin 1 and 4, other windings open.	1,000 kHz (Min.)
Primary Leakage Inductance	Between pin 1 and 4, with all secondary fly leads FL1-FL4 shorted.	16 μH (Max.)

7.3 Materials List

Item	Description
[1]	Core: EQ27, Shen Zhen Xin Yu Tech Ltd.
[2]	Bobbin: EQ2506-V-4 Pins (4/0); Shen Zhen Xin Yu Tech Ltd., PI#: 25-01095-00.
[3]	Magnet Wire: **#**28 AWG, Double Coated.
[4]	Magnet Wire: **#**32 AWG, Double Coated.
[5]	Magnet Wire: #23 AWG, Triple Insulated Wire.
[6]	Barrier Tape: 3M 1298 Polyester Film, 1 mil thickness, 4.5 mm Wide.
[7]	Bus Wire: #26 AWG.
[8]	Varnish: Dolph BC-359.

7.4 Build Diagram

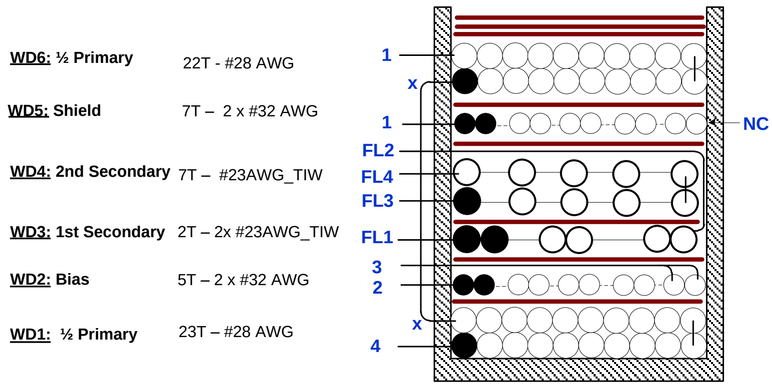


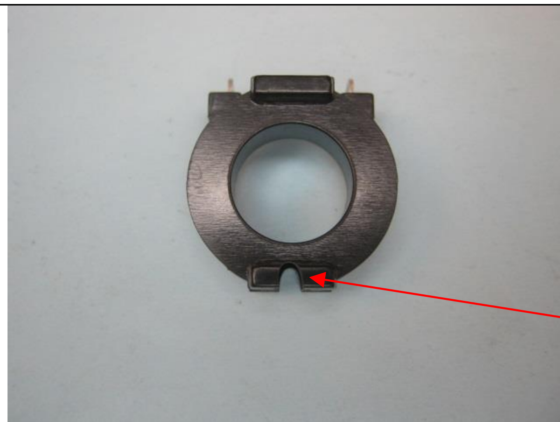
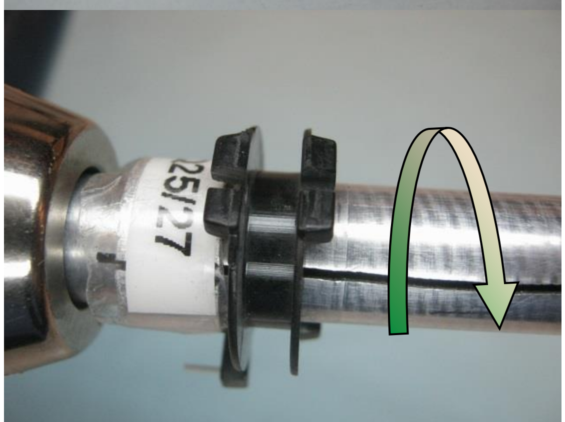
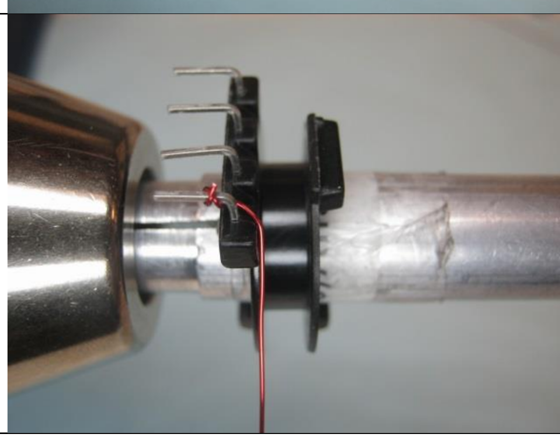
Figure 7 – Transformer Build Diagram.

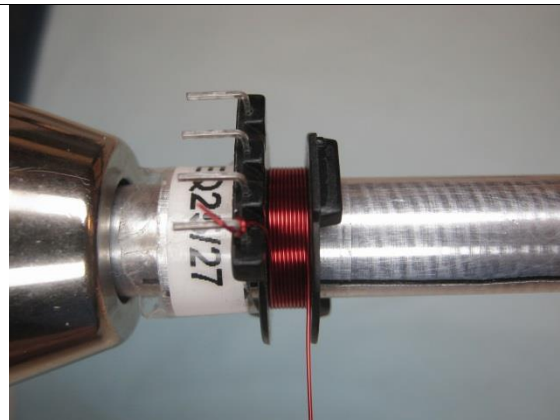
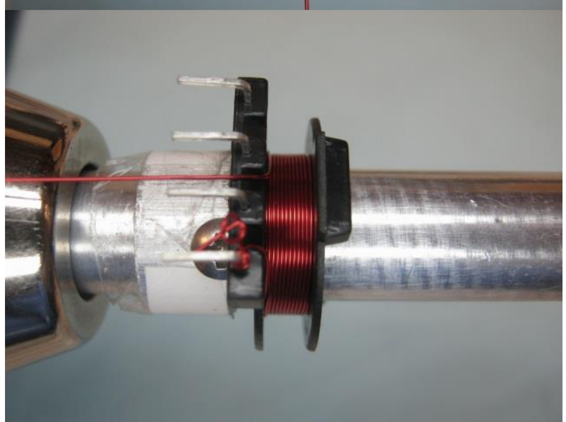
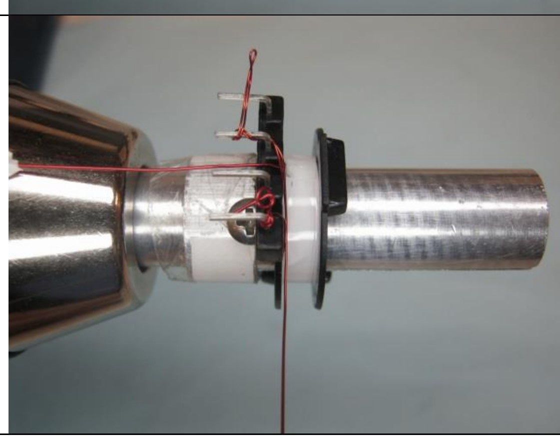
7.5 Construction

Winding Preparation	Make 2 slots ~2 mm width x 2.5 mm depth on the secondary flanges of the bobbin Item [2]. (see picture below). Then place the bobbin on the mandrel with the pin side is on the left side. Winding direction is clockwise direction.
WD1 ½ Primary	Start at pin 4, wind 23 turns of wire Item [3] in 2 layers with tight tension, at the last turn leave ~5 ft of wire for the WD6. (Note: this winding might have ½ turn on the next layer).
Insulation	Place 1 layer of tape Item [6] for insulation.
WD2 Bias	Start at pin 2, wind 5 bifilar turns of wire Item [4] in 1 layer, spread the wire evenly. At the last turn, bring the wire back to terminate at pin 2.
Insulation	Place 1 layer of tape Item [6] for insulation.
WD3 1st Secondary	Use 2 wires Item [5], leave ~1" floating and mark as FL1. Enter the wires on the left slot, wind 2 turns in 1 layer, and leave the end of wires floating on the right slot will terminate after the WD4.
Insulation	Place 1 layer of tape Item [6] to secure this winding.
WD4 2nd Secondary	Use 1 wire Item [5], leave ~1" floating and mark as FL3. Enter the wire on the left slot, wind 7 turns in 2 layers, exit the wire on left slot, leave ~1" floating and mark as FL4. By this time, bring 2 wires floating from WD3 to exit on the left slot, leave ~1" floating and mark as FL2.
Insulation	Place 1 layer of tape Item [6] for insulation.
WD5 Shield	Start at pin 1, wind 7 bifilar turns of wire Item [4] in 1 layer, spread the wires evenly. At the last turn, cut the wires to leave as no-connect (NC).
Insulation	Place 1 layer of tape Item [6] for insulation.
WD6 ½ Primary	Continue winding 22 turns of wire left from WD1in 2 layers with tight tension and finish at pin 1.
Insulation	Place 3 layers of tape Item [6] for insulation and to secure the windings.
Finish Assembly	Gap core halves to 660 μH inductance. Connected bus wire Item [7] to pin 1, lean on the core halves, and secure all together with tape. (see picture below) Varnish Item [8].

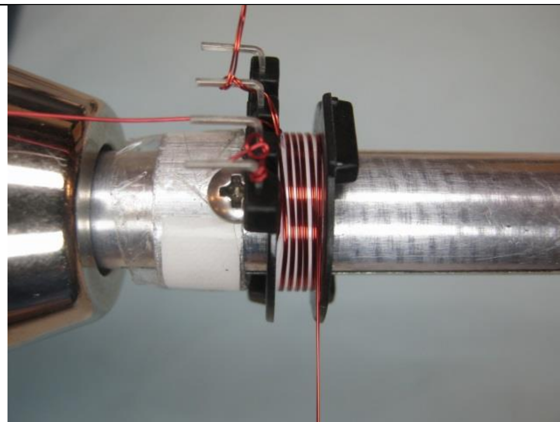
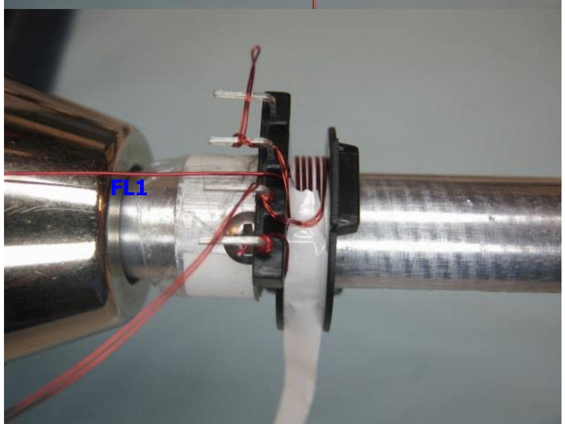
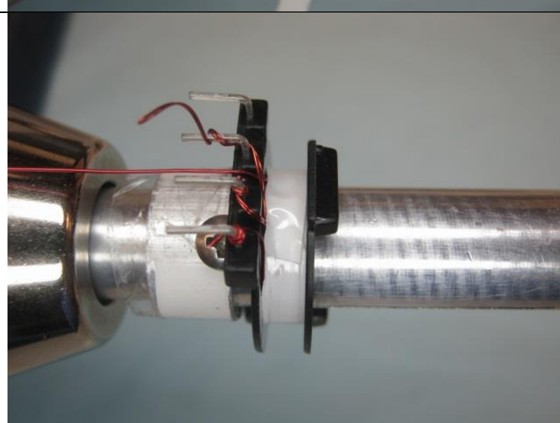
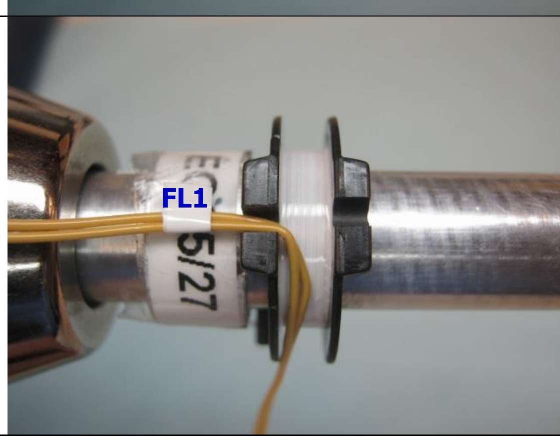
Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

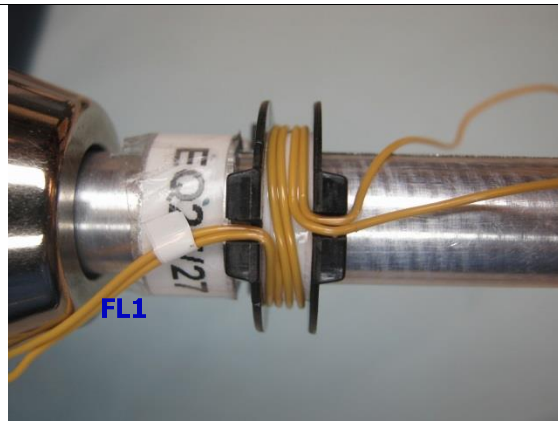
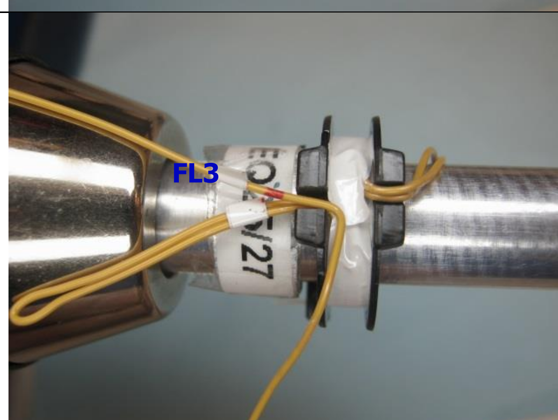
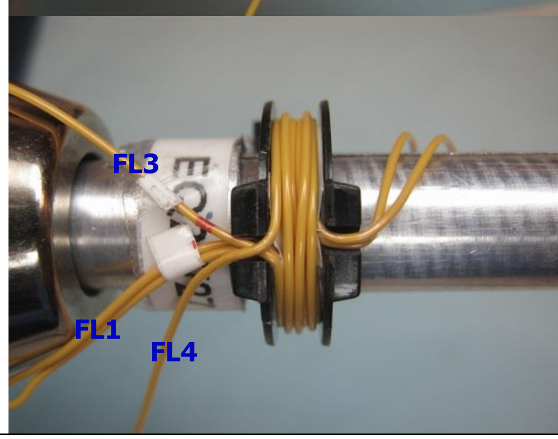
7.6 Winding Illustration

Winding Preparation	 	Make 2 slots ~2 mm width x 2.5 mm depth on the secondary flanges of the bobbin Item [2]. Then place the bobbin on the mandrel with the pin side is on the left side. Winding direction is clockwise direction.
WD1 **½ Primary**		Start at pin 4, wind 23 turns of wire Item [3] in 2 layers with tight tension, at the last turn leave ~5 ft of wire for the WD6. (Note: this winding might have ½ turn on the next layer).

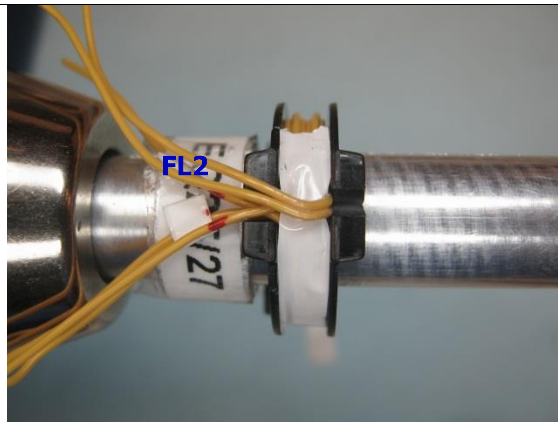
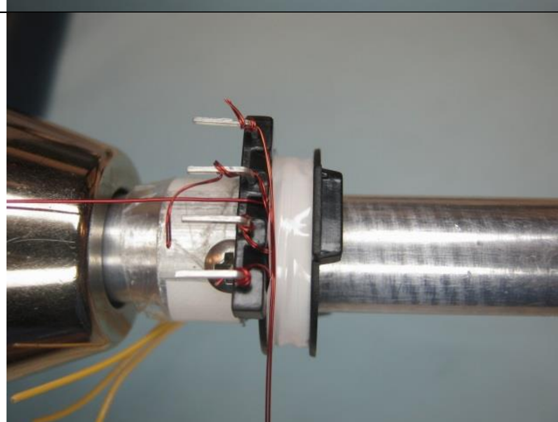
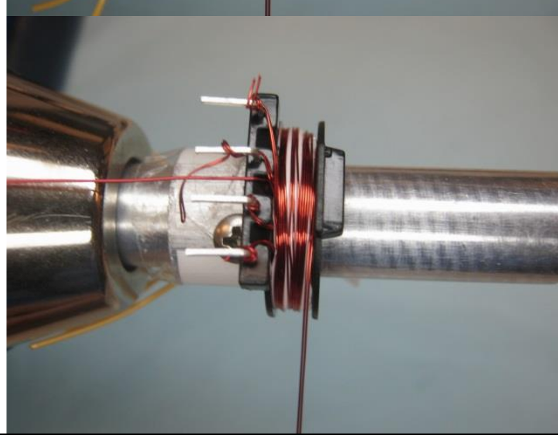
	 	
Insulation		Place 1 layer of tape Item [6] for insulation.
WD2 **Bias**		Start at pin 2, wind 5 bifilar turns of wire Item [4] in 1 layer, spread the wire evenly. At the last turn, bring the wire back to terminate at pin 2.

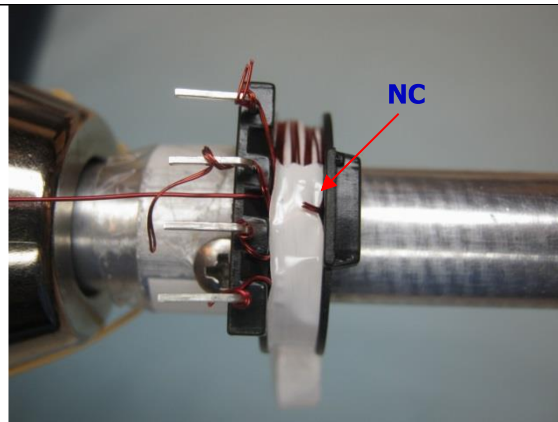
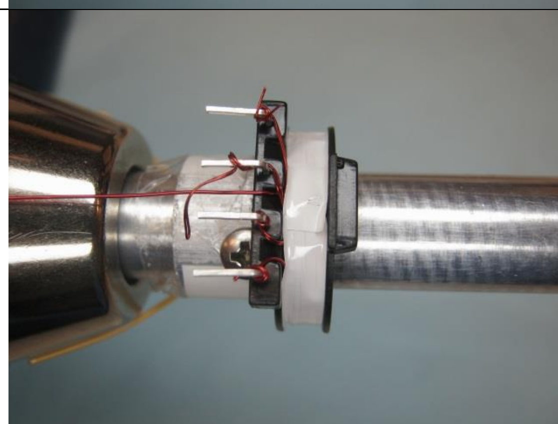
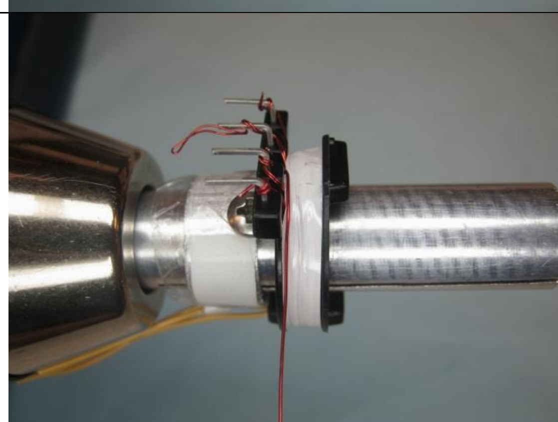
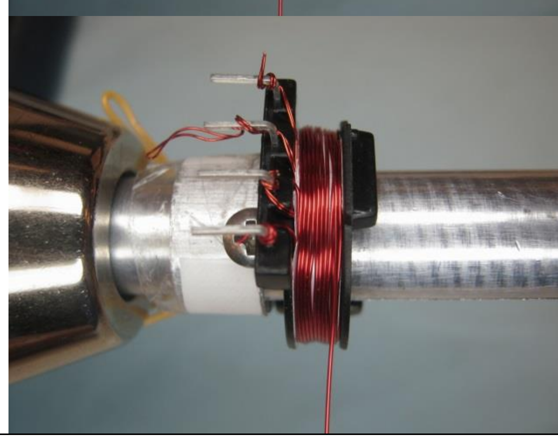
Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

	 	
Insulation		Place 1 layer of tape Item [6] for insulation.
WD3 **1st Secondary**		Use 2 wires Item [5], leave ~1" floating and mark as FL1. Enter the wires on the left slot, wind 2 turns in 1 layer, and leave the end of wires floating on the right slot will terminate after the WD4.

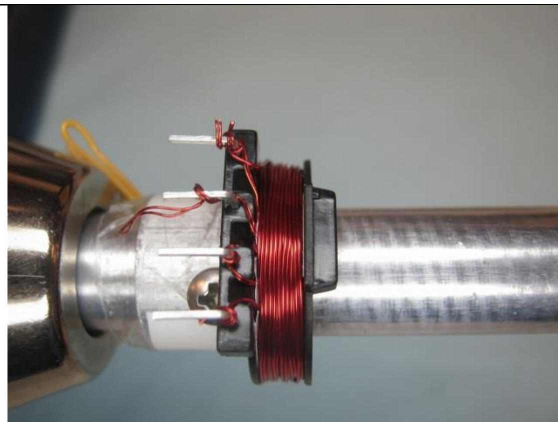
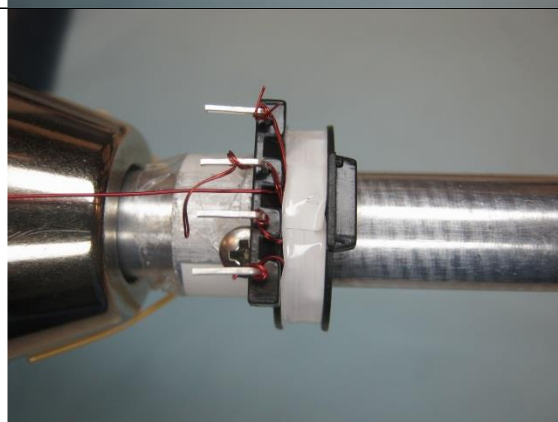
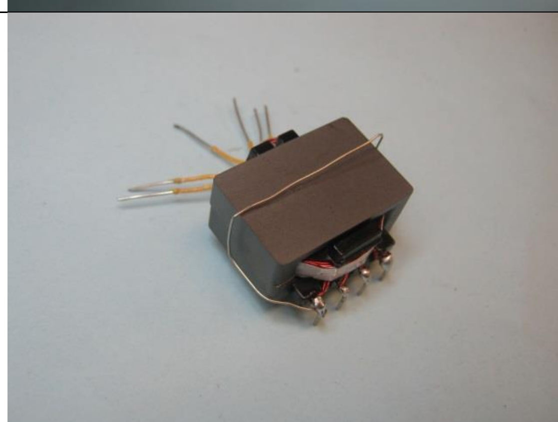
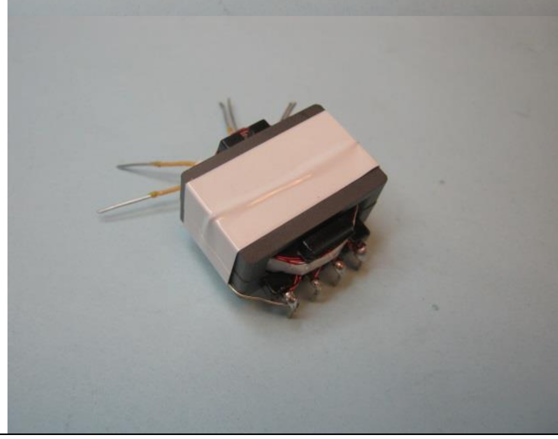
		
Insulation		Place 1 layer of tape Item [6] to secure this winding.
WD4 **2nd Secondary**	 	Use 1 wire Item [5], leave ~ 1” floating and mark as FL3. Enter the wire on the left slot, wind 7 turns in 2 layers, exit the wire on left slot, leave ~1” floating and mark as FL4. By this time, bring 2 wires floating from WD3 to exit on the left slot, leave ~1” floating and mark as FL2.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

		
Insulation		Place 1 layer of tape Item [6] for insulation.
WD5 **Shield**	 	Start at pin 1, wind 7 bifilar turns of wire Item [4] in 1 layer, spread the wires evenly. At the last turn, cut the wires to leave as no-connect (NC).

		
Insulation		Place 1 layer of tape Item [6] for insulation.
WD6 **½ Primary**		Continue winding 22 turns of wire left from WD1 in 2 layers with tight tension and finish at pin 1.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

		
Insulation		Place 3 layers of tape Item [6] for insulation and to secure the windings.
Finish Assembly	 	Gap core halves to 660 μH inductance. Connected bus wire Item [7] to pin 1, lean on the core halves, and secure all together with tape. Varnish Item [8].

8 Transformer Design Spreadsheet

ACDC_InnoSwitch3-CE_Flyback_083017; Rev.1.0; Copyright Power Integrations 2017	INPUT	INFO	OUTPUT	UNITS	InnoSwitch3 CE Flyback Design Spreadsheet
APPLICATION VARIABLES					
VIN_MIN	90		90	V	Minimum AC input voltage
VIN_MAX			265	V	Maximum AC input voltage
VIN_RANGE			UNIVERSAL		Range of AC input voltage
LINEFREQ			60	Hz	AC Input voltage frequency
CAP_INPUT	82.0		82.0	uF	Input capacitor
VOUT	18.00		18.00	V	Output voltage at the board
PERCENT_CDC	0%		0%		Percentage (of output voltage) cable drop compensation desired at full load
IOUT	2.50		2.50	A	Output current
POUT			45.00	W	Output power
EFFICIENCY	0.85		0.85		AC-DC efficiency estimate at full load given that the converter is switching at the valley of the rectified minimum input AC voltage
FACTOR_Z	0.50		0.50		Z-factor estimate
ENCLOSURE	OPEN FRAME		OPEN FRAME		Power supply enclosure
PRIMARY CONTROLLER SELECTION					
ILIMIT_MODE	INCREASED		INCREASED		Device current limit mode
DEVICE_GENERIC	INN31X8		INN31X8		Generic device code
DEVICE_CODE			INN3168C		Actual device code
POUT_MAX			55	W	Power capability of the device based on thermal performance
RDSON_100DEG			1.53	Ω	Primary MOSFET on time drain resistance at 100 degC
ILIMIT_MIN			1.68	A	Minimum current limit of the primary MOSFET
ILIMIT_TYP			1.85	A	Typical current limit of the primary MOSFET
ILIMIT_MAX			2.02	A	Maximum current limit of the primary MOSFET
VDRAIN_BREAKDOWN			650	V	Device breakdown voltage
VDRAIN_ON_MOSFET			0.84	V	Primary MOSFET on time drain voltage
VDRAIN_OFF_MOSFET			557.4	V	Peak drain voltage on the primary MOSFET during turn-off
WORST CASE ELECTRICAL PARAMETERS					
FSWITCHING_MAX	66000		66000	Hz	Maximum switching frequency at full load and valley of the rectified minimum AC input voltage
VOR	114.0		114.0	V	Seconday voltage reflected to the primary when the primary MOSFET turns off
VMIN			90.14	V	Valley of the rectified minimum AC input voltage at full power
KP			0.76		Measure of continuous/discontinuous mode of operation
MODE_OPERATION			CCM		Mode of operation
DUTYCYCLE			0.561		Primary MOSFET duty cycle
TIME_ON			12.24	us	Primary MOSFET on-time
TIME_OFF			6.66	us	Primary MOSFET off-time
LPRIMARY_MIN			609.2	uH	Minimum primary inductance
LPRIMARY_TYP			641.3	uH	Typical primary inductance
LPRIMARY_TOL	5.0		5.0	%	Primary inductance tolerance
LPRIMARY_MAX			673.4	uH	Maximum primary inductance
PRIMARY CURRENT					
IPEAK_PRIMARY			1.82	A	Primary MOSFET peak currrent
IPEDESTAL_PRIMARY			0.37	A	Primary MOSFET current pedestal
IAVG_PRIMARY			0.55	A	Primary MOSFET average current

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

IRIPPLE_PRIMARY			1.68	A	Primary MOSFET ripple current
IRMS_PRIMARY			0.82	A	Primary MOSFET RMS current
SECONDARY CURRENT					
IPEAK_SECONDARY			11.68	A	Secondary winding peak current
IPEDESTAL_SECONDARY			2.40	A	Secondary winding current pedestal
IRMS_SECONDARY			5.08	A	Secondary winding RMS current
TRANSFORMER CONSTRUCTION PARAMETERS					
CORE SELECTION					
CORE	Custom		Custom		Core selection
CORE CODE	EQ27		EQ27		Core code
AE	108.00		108.00	mm^2	Core cross sectional area
LE	36.30		36.30	mm	Core magnetic path length
AL	7700		7700	nH/turns^2	Ungapped core effective inductance
VE	3920.0		3920.0	mm^3	Core volume
BOBBIN	ER2506		ER2506		Bobbin
AW	62.00		62.00	mm^2	Window area of the bobbin
BW	4.25		4.25	mm	Bobbin width
MARGIN	0.0		0.0	mm	Safety margin width (Half the primary to secondary creepage distance)
PRIMARY WINDING					
NPRIMARY			45		Primary turns
BPEAK			2860	Gauss	Peak flux density
BMAX			2479	Gauss	Maximum flux density
BAC			947	Gauss	AC flux density
ALG			317	nH/turns^2	Typical gapped core effective inductance
LG			0.411	mm	Core gap length
LAYERS_PRIMARY			4		Number of primary layers
AWG_PRIMARY	27		27	AWG	Primary winding wire AWG
OD_PRIMARY_INSULATED			0.418	mm	Primary winding wire outer diameter with insulation
OD_PRIMARY_BARE			0.361	mm	Primary winding wire outer diameter without insulation
CMA_PRIMARY			247	Cmil/A	Primary winding wire CMA
SECONDARY WINDING					
NSECONDARY	7		7		Secondary turns
AWG_SECONDARY			20	AWG	Secondary winding wire AWG
OD_SECONDARY_INSULATED			1.118	mm	Secondary winding wire outer diameter with insulation
OD_SECONDARY_BARE			0.812	mm	Secondary winding wire outer diameter without insulation
CMA_SECONDARY			220	Cmil/A	Secondary winding wire CMA
BIAS WINDING					
NBIAS			5		Bias turns
PRIMARY COMPONENTS SELECTION					
Line undervoltage					
BROWN-IN REQURED			76.5	V	Required AC RMS line voltage brown-in threshold
RLS			4.52	MΩ	Connect two 2.26 MOhm resistors to the V-pin for the required UV/OV threshold
BROWN-IN ACTUAL			77.0	V	Actual AC RMS brown-in threshold
BROWN-OUT ACTUAL			70.6	V	Actual AC RMS brown-out threshold
Line overvoltage					
OVERVOLTAGE_LINE			339.2	V	Actual AC RMS line over-voltage threshold
Bias diode					
VBIAS			12.0	V	Rectified bias voltage
VF_BIAS			0.70	V	Bias winding diode forward drop
VREVERSE_BIASDIODE			53.49	V	Bias diode reverse voltage (not accounting parasitic voltage ring)
CBIAS			22	uF	Bias winding rectification capacitor
CBPP			4.70	uF	BPP pin capacitor
SECONDARY COMPONENTS					

RFB_UPPER			100.00	kΩ	Upper feedback resistor (connected to the first output voltage)
RFB_LOWER			7.50	kΩ	Lower feedback resistor
CFB_LOWER			330	pF	Lower feedback resistor decoupling capacitor
MULTIPLE OUTPUT PARAMETERS					
OUTPUT 1					
VOUT1			18.00	V	Output 1 voltage
IOUT1	1.40		1.40	A	Output 1 current
POUT1			25.20	W	Output 1 power
IRMS_SECONDARY1			2.60	A	Root mean squared value of the secondary current for output 1
IRIPPLE_CAP_OUTPUT1			2.20	A	Current ripple on the secondary waveform for output 1
AWG_SECONDARY1			22	AWG	Wire size for output 1
OD_SECONDARY1_INSULATED			0.947	mm	Secondary winding wire outer diameter with insulation for output 1
OD_SECONDARY1_BARE			0.644	mm	Secondary winding wire outer diameter without insulation for output 1
CM_SECONDARY1			521	Cmils	Bare conductor effective area in circular mils for output 1
NSECONDARY1			7		Number of turns for output 1
VREVERSE_RECTIFIER1			76.08	V	SRFET reverse voltage (not accounting parasitic voltage ring) for output 1
SRFET1	Auto		AO4482		SRFET selection for output 1
VF_SRFET1			0.059	V	SRFET on-time drain voltage for output 1
VBREAKDOWN_SRFET1			100	V	SRFET breakdown voltage for output 1
RDSON_SRFET1			42.0	mΩ	SRFET on-time drain resistance at 25degC and VGS=4.4V for output 1
OUTPUT 2					
VOUT2	5.00		5.00	V	Output 2 voltage
IOUT2	3.00		3.00	A	Output 2 current
POUT2			15.00	W	Output 2 power
IRMS_SECONDARY2			5.58	A	Root mean squared value of the secondary current for output 2
IRIPPLE_CAP_OUTPUT2			4.70	A	Current ripple on the secondary waveform for output 2
AWG_SECONDARY2			19	AWG	Wire size for output 2
OD_SECONDARY2_INSULATED			1.217	mm	Secondary winding wire outer diameter with insulation for output 2
OD_SECONDARY2_BARE			0.912	mm	Secondary winding wire outer diameter without insulation for output 2
CM_SECONDARY2			1116	Cmils	Bare conductor effective area in circular mils for output 2
NSECONDARY2			2		Number of turns for output 2
VREVERSE_RECTIFIER2			21.59	V	SRFET reverse voltage (not accounting parasitic voltage ring) for output 2
SRFET2	Auto		AON7534		SRFET selection for output 2
VF_SRFET2			0.026	V	SRFET on-time drain voltage for output 2
VBREAKDOWN_SRFET2			30	V	SRFET breakdown voltage for output 2
RDSON_SRFET2			8.5	mΩ	SRFET on-time drain resistance at 25degC and VGS=4.4V for output 2
OUTPUT 3					
VOUT3			0.00	V	Output 3 voltage
IOUT3			0.00	A	Output 3 current
POUT3			0.00	W	Output 3 power
IRMS_SECONDARY3			0.00	A	Root mean squared value of the secondary current for output 3
IRIPPLE_CAP_OUTPUT3			0.00	A	Current ripple on the secondary waveform for output 3
AWG_SECONDARY3			0	AWG	Wire size for output 3
OD_SECONDARY3_INSULATED			0.000	mm	Secondary winding wire outer diameter with insulation for output 3

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

OD_SECONDARY3_BARE			0.000	mm	Secondary winding wire outer diameter without insulation for output 3
CM_SECONDARY3			0	Cmils	Bare conductor effective area in circular mils for output 3
NSECONDARY3			0		Number of turns for output 3
VREVERSE_RECTIFIER3			0.00	V	SRFET reverse voltage (not accounting parasitic voltage ring) for output 3
SRFET3	Auto		NA		SRFET selection for output 3
VF_SRFET3			NA	V	SRFET on-time drain voltage for output 3
VBREAKDOWN_SRFET3			NA	V	SRFET breakdown voltage for output 3
RDSON_SRFET3			NA	mΩ	SRFET on-time drain resistance at 25degC and VGS=4.4V for output 3
PO_TOTAL		Info	40.20	W	The total power of all outputs does not add up to the total power of the design
NEGATIVE OUTPUT	N/A		N/A		If negative output exists, enter the output number; e.g. If VO2 is negative output, select 2
TOLERANCE ANALYSIS					
CORNER_VAC			90	V	Input AC RMS voltage corner to be evaluated
CORNER_ILIMIT	TYP		1.85	A	Current limit corner to be evaluated
CORNER_LPRIMARY	TYP		641.3	uH	Primary inductance corner to be evaluated
MODE_OPERATION			CCM		Mode of operation
KP			0.850		Measure of continuous/discontinuous mode of operation
FSWITCHING			54056	Hz	Switching frequency at full load and valley of the rectified minimum AC input voltage
DUTYCYCLE			0.561		Steady state duty cycle
TIME_ON			10.37	us	Primary MOSFET on-time
TIME_OFF			8.13	us	Primary MOSFET off-time
IPEAK_PRIMARY			1.70	A	Primary MOSFET peak currrent
IPEDESTAL_PRIMARY			0.26	A	Primary MOSFET current pedestal
IAVERAGE_PRIMARY			0.55	A	Primary MOSFET average current
IRIPPLE_PRIMARY			1.44	A	Primary MOSFET ripple current
IRMS_PRIMARY			0.80	A	Primary MOSFET RMS current
CMA_PRIMARY			253	Cmil/A	Primary winding wire CMA
BPEAK			2499	Gauss	Peak fux density
BMAX			2244	Gauss	Maximum flux density

9 Performance Data

9.1 Full Load Efficiency vs. Line

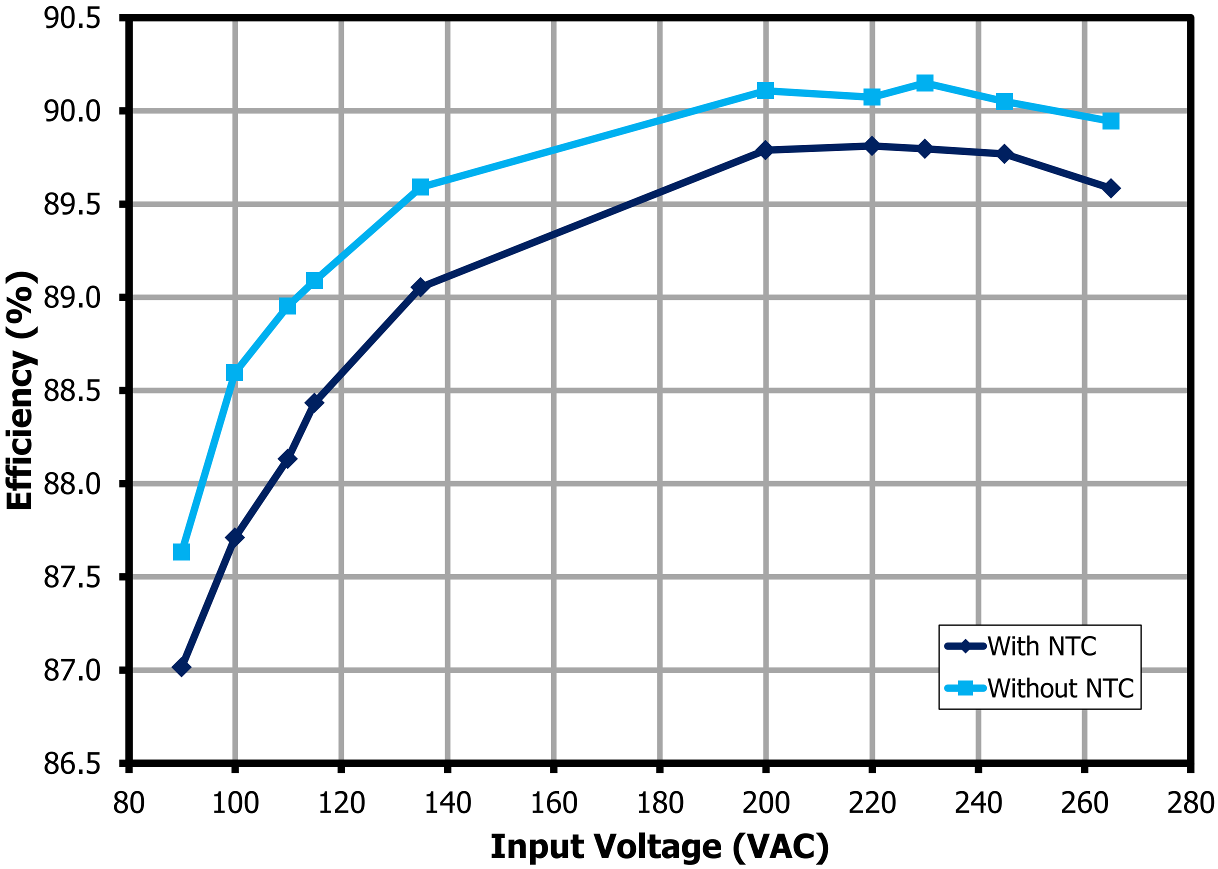


Figure 8 – Full Load Efficiency vs. Line Voltage, Room Temperature.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

Line Regulation at Full Load

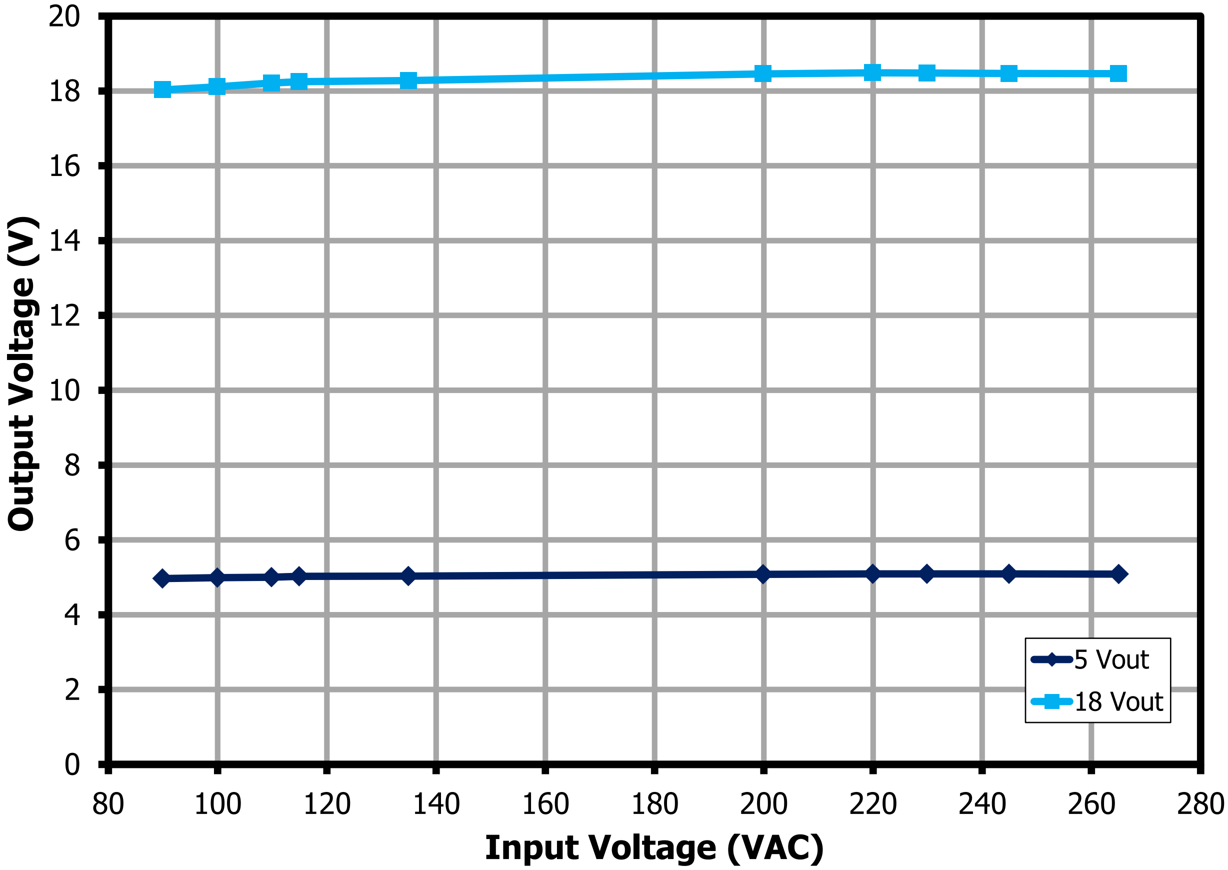


Figure 9 – Output Voltage vs. Line, Room Ambient.

9.2 5 V Output Load Regulation

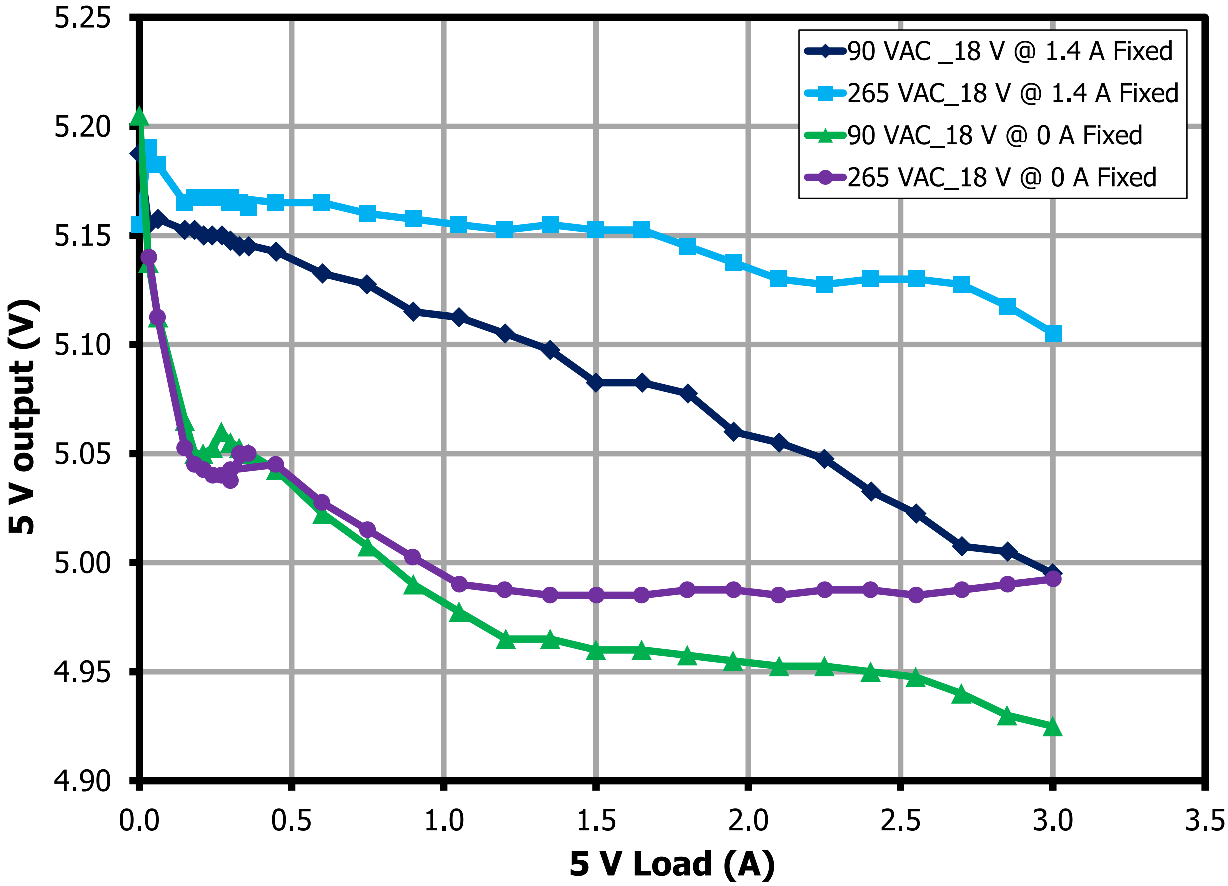


Figure 10 – 5 V Output vs. 5 V Load, Room Ambient.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

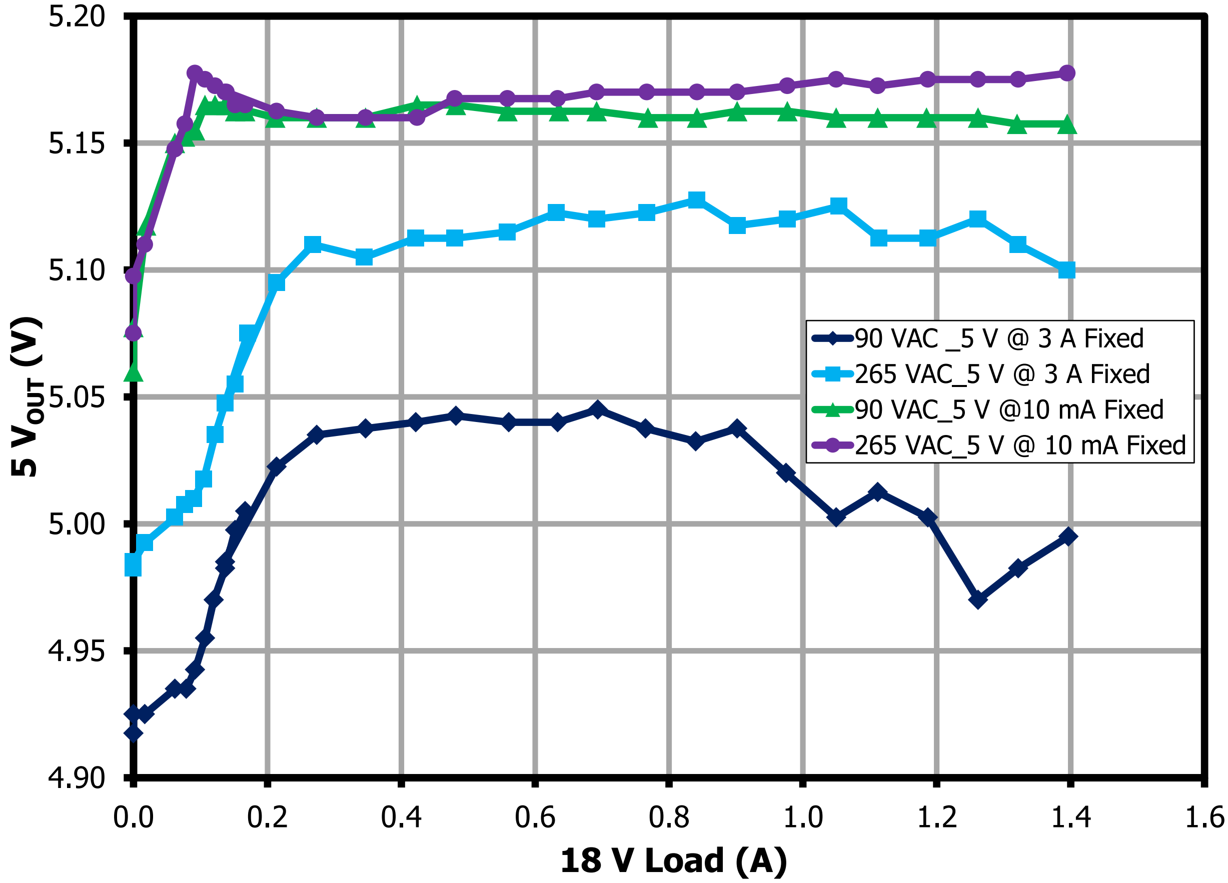


Figure 11 – 5 V Output vs.18 V Load, Room Ambient.

9.3 18 V Output Load Regulation

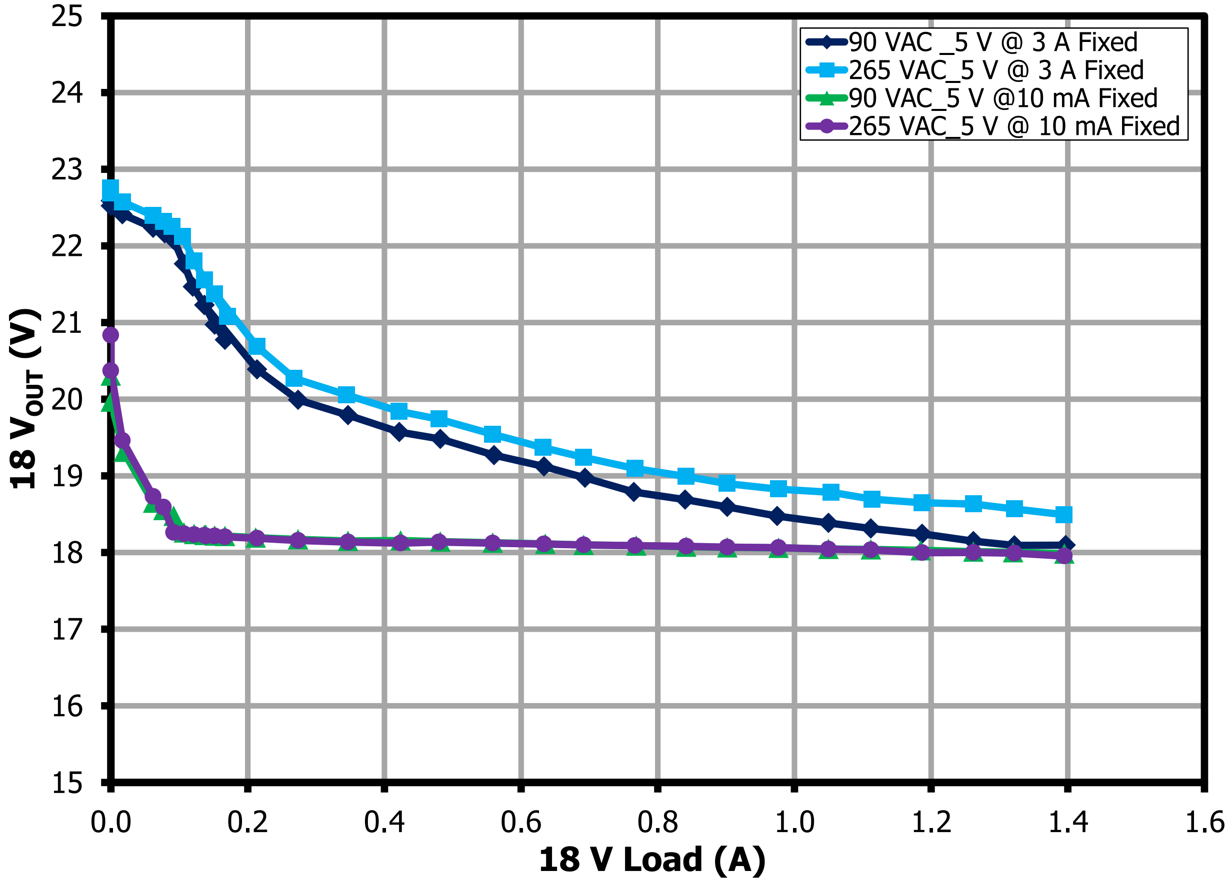


Figure 12 – 18 V vs.18 V Load.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

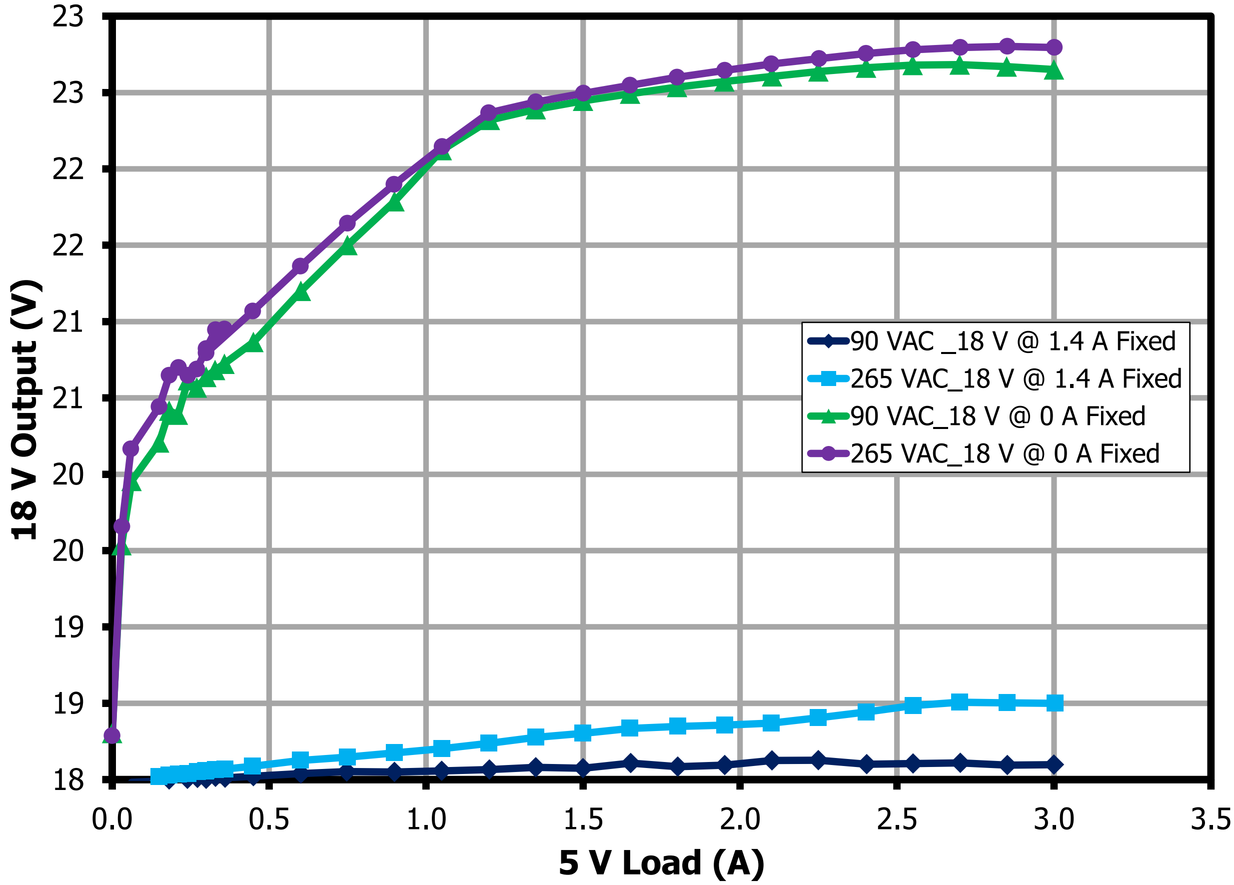


Figure 13 – 18 V vs. 5 V Load.

9.4 Input Power No-Load and with 10 mA Load on 5 V

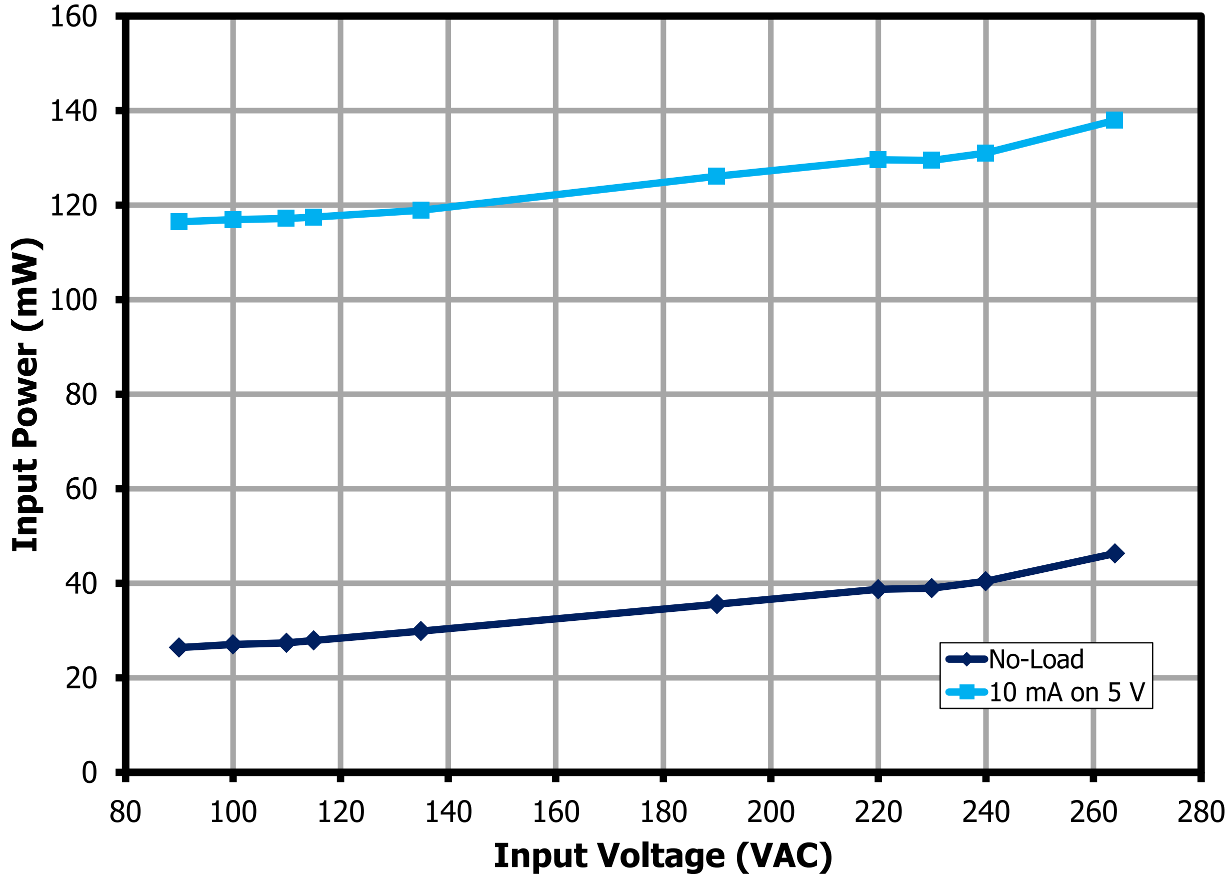


Figure 14 – Input Power vs. Input Voltage, Room Temperature.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

10 Thermal Performance

10.1 90 VAC

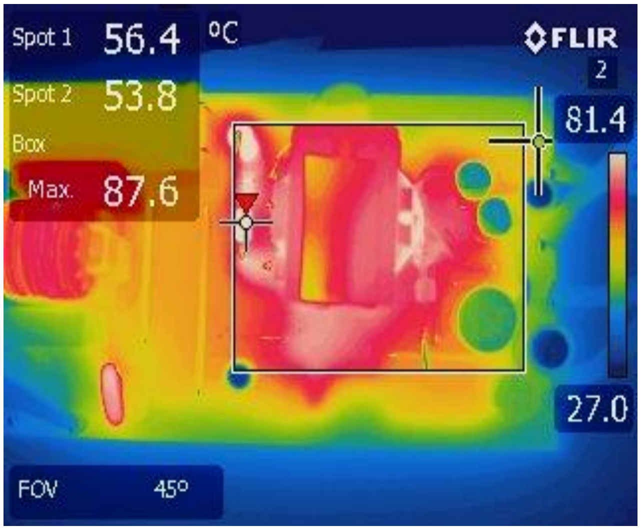


Figure 15 – Transformer Side. 90 VAC, Full Load.

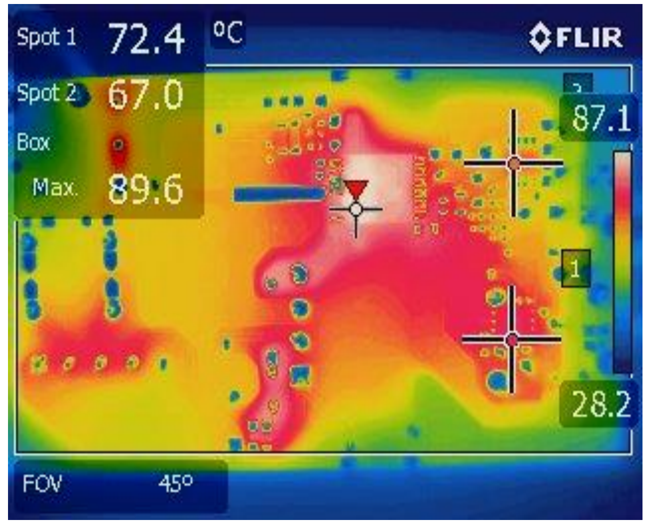


Figure 16 – INN3168C Side. 90 VAC, Full Load.

	Reference	ºC
Ambient		27.5
Transformer	T1	69
CMC	L1	70
Input Capacitor	C3	58
Primary Clamp	D1	87.6

	Reference	ºC
Ambient		29.5
INN3168C	U1	89.6
18 V SR MOSFET	Q1	67
5 V SR MOSFET	Q2	72.4

10.2 110 VAC

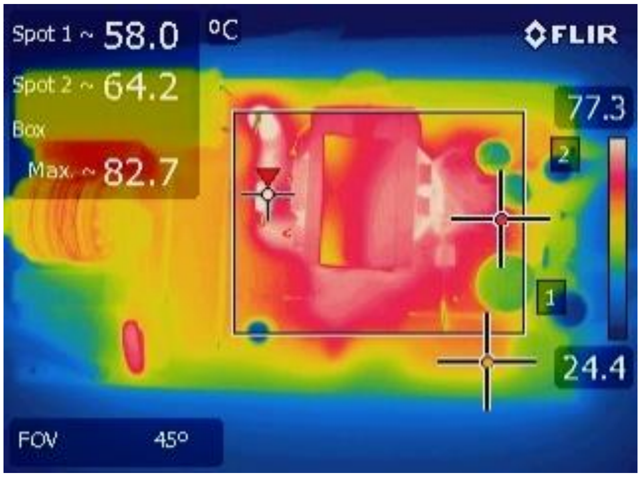


Figure 17 – Transformer Side. 110 VAC, Full Load.

	Reference	ºC
Ambient		27
Transformer	T1	71
CMC	L1	61
Input Capacitor	C3	53
Primary Clamp	D1	82.7

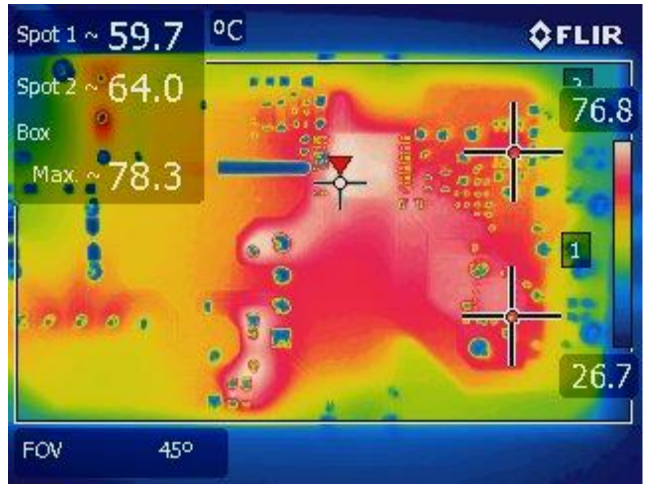


Figure 18 – INN3168C Side. 110 VAC, Full Load.

	Reference	ºC
Ambient		27
INN3168C	U1	78.3
18 V SR MOSFET	Q1	59.7
5 V SR MOSFET	Q2	64.0

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

10.3 230 VAC

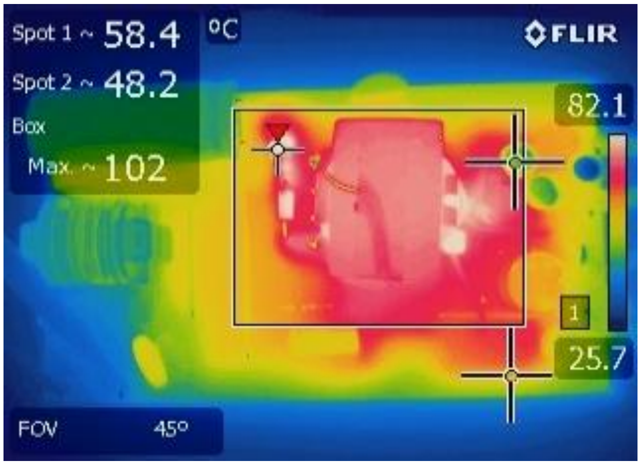


Figure 19 – Transformer Side. 230 VAC, Full Load.

	Reference	ºC
Ambient		28.1
Transformer	T1	76.1
CMC	L1	46.7
Input Capacitor	C3	48
Primary Clamp	D1	81

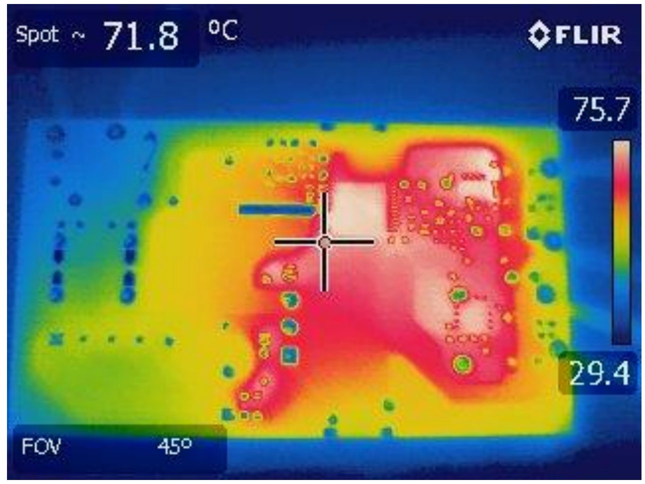


Figure 20 – INN3168C Side. 230 VAC, Full Load.

	Reference	ºC
Ambient		28
INN3168C	U1	76.9
18 V SR MOSFET	Q1	86.2
5 V SR MOSFET	Q2	72.4

10.4 265 VAC

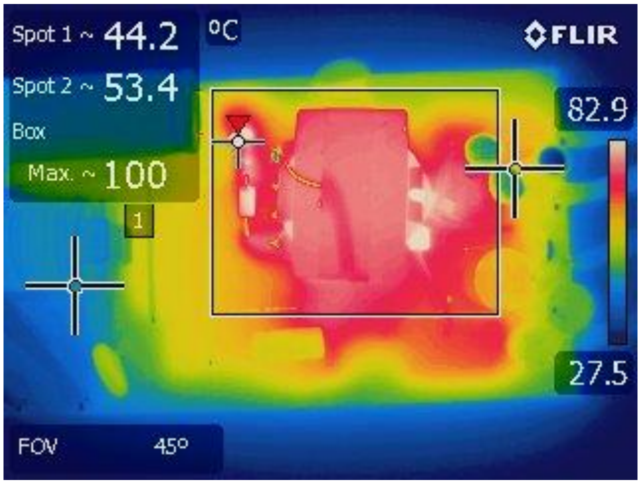


Figure 21 – Transformer Side. 265 VAC, Full Load.

	Reference	ºC
Ambient		28.1
Transformer	T1	75.8
CMC	L1	44.9
Input Capacitor	C3	45.8
Primary Clamp	D1	80

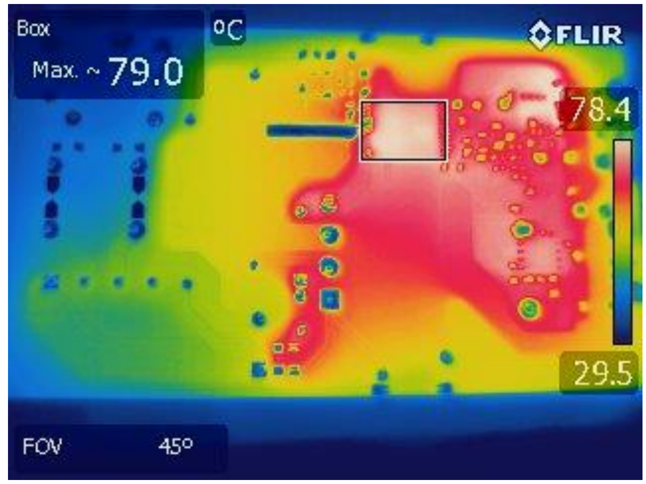


Figure 22 – INN3168C Side. 265 VAC, Full Load.

	Reference	ºC
Ambient		29.2
INN3168C	U1	74.8
18 V SR MOSFET	Q1	90.3
5 V SR MOSFET	Q2	74.5

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

11 Waveforms

11.1 Load Transient Response

11.1.1 18 V load Transient

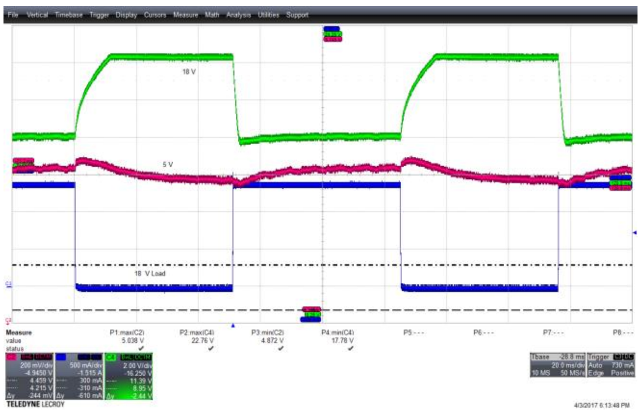


Figure 23 – 0 A – 1.4 A, 18 V Load Step Transient Response, 90 VAC. 5 V load fixed at 3 A.
5 V_{MIN}: 4.87 V. 5 V_{MAX}: 5.04 V.
18 V_{MIN}: 17.8 V. 18 V_{MAX}: 22.7 V.
Upper: 18 V_{OUT}, 2 V / div.
Middle: 5 V_{OUT}, 200 mV / div.
Lower: 18 V Load, 0.5 A, 20 ms / div

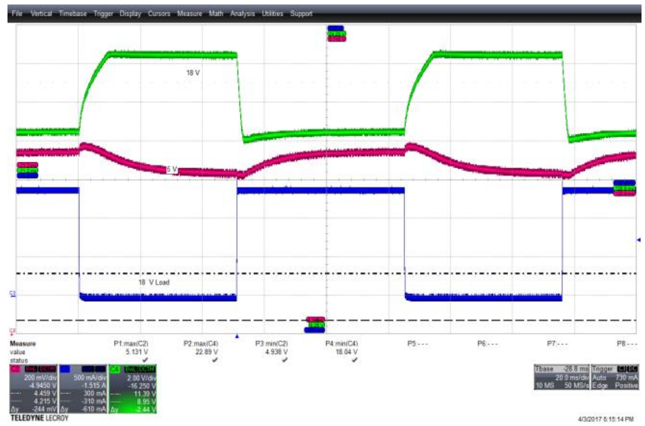


Figure 24 – 0 A – 1.4 A, 18 V Load Step Transient Response, 265 VAC. 5 V load fixed at 3 A.
5 V_{MIN}: 4.94 V. 5 V_{MAX}: 5.13 V.
18 V_{MIN}: 18.0 V. 18 V_{MAX}: 22.9 V.
Upper: 18 V_{OUT}, 2 V / div.
Middle: 5 V_{OUT}, 200 mV / div.
Lower: 18 V Load, 0.5 A, 20 ms / div

11.2 Switching Waveforms

11.2.1 INN3168C Voltage Waveforms

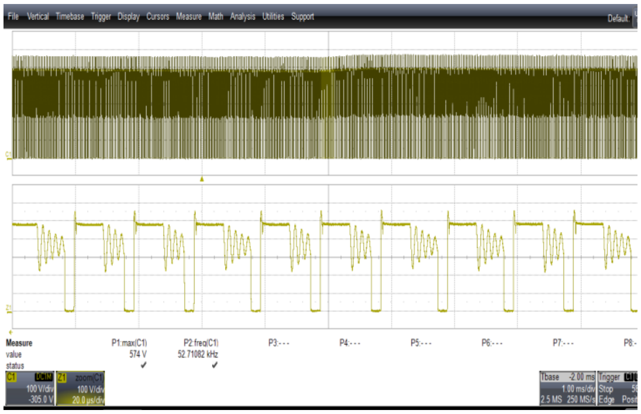


Figure 25 – Drain Voltage Waveforms.
265 VAC Input, Full Load, (574 V_{MAX}).
V_{DRAIN}, 100 V, 1 ms, 20 µs / div.

Figure 26 – Drain Voltage Waveforms During Start-Up.
265 VAC Input, Full Load, (577 V_{MAX}).
Upper: V_{DRAIN}, 100 V, 20 ms, 200 µs / div.

11.2.2 18 V SR MOSFET Voltage Waveforms

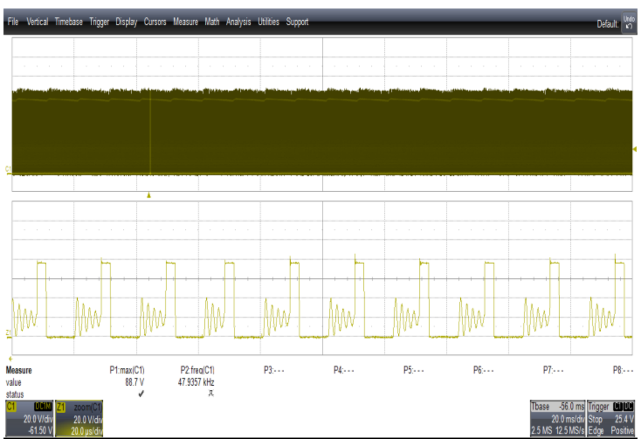


Figure 27 – 18 V SR MOSFET Voltage Waveforms.
265 VAC Input, Full Load, (88.7 V_{MAX}).
V_{DS}: 20 V / 20 ms, 20 µs / div.

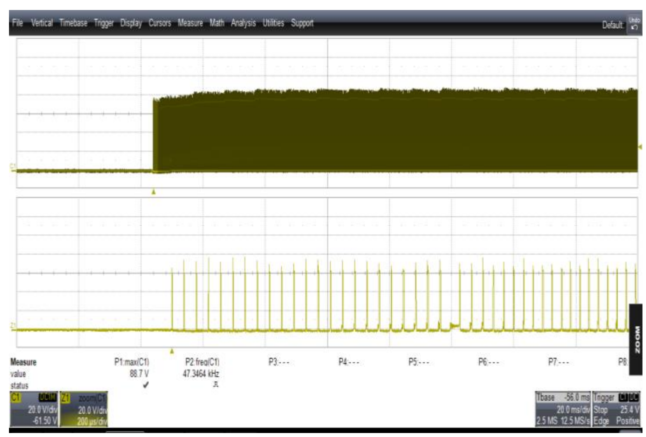


Figure 28 – 18 V SR MOSFET Waveforms During Start-Up.
265 VAC Input, Full Load, (88.7 V_{MAX}).
V_{DS}: 20 V / 20 ms, 200 µs / div.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

11.2.3 5 V SR MOSFET Voltage Waveforms

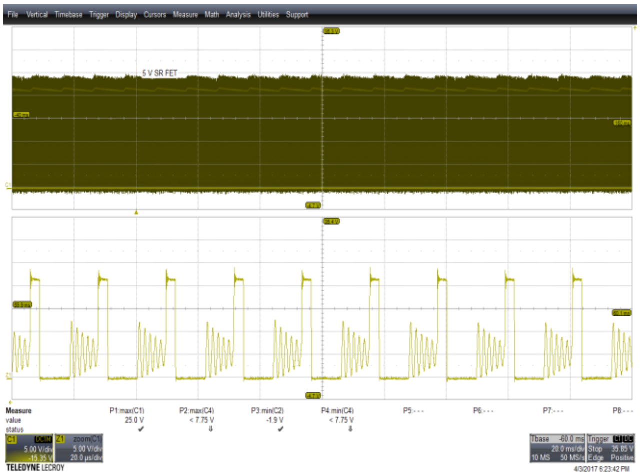


Figure 29 – SR MOSFET and Output Diode Voltage Waveforms.
265 VAC Input, Full Load (25 V_{MAX}).
V_{DS}: 5 V / 20 ms, 20 µs / div.

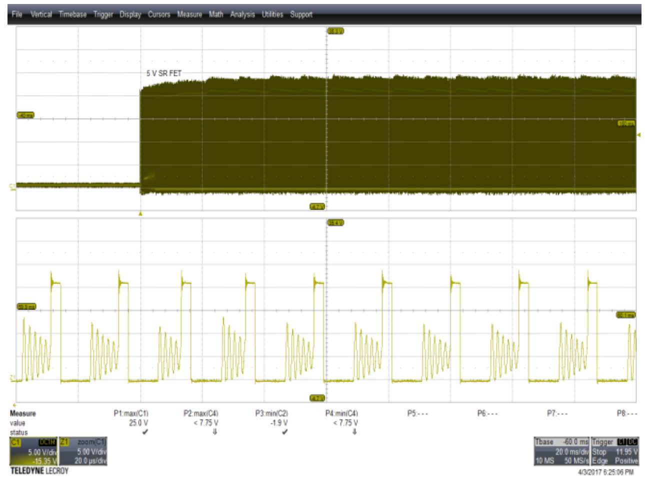


Figure 30 – SR MOSFET and Output Diode Voltage Waveforms During Start-Up.
265 VAC Input, Full Load (25 V_{MAX}).
Lower: 5 V / 20 ms, 20 µs / div.

11.2.4 Output Voltage and Current Waveforms at Start-up

11.2.4.1 Full load

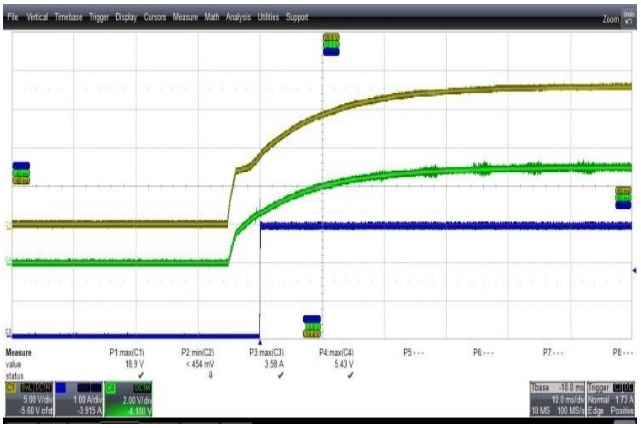


Figure 31 – Output Voltage and Current Waveforms.
90 VAC Input.
Upper: 18 V, 5 V / div.
Middle: 5 V, 2 V / div.
Lower: I_{OUT}, 1 A, 10 ms / div.

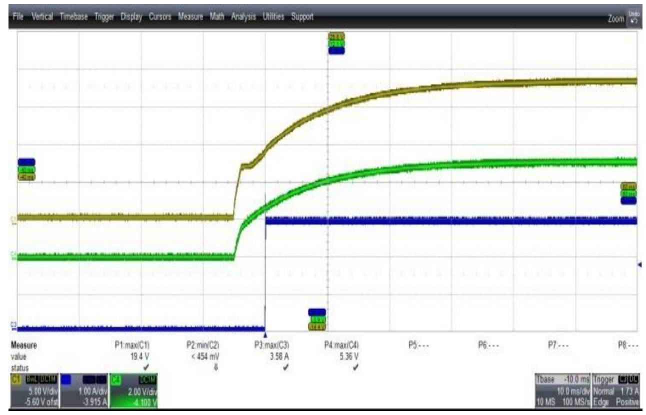


Figure 32 – Output Voltage and Current Waveforms.
265 VAC Input.
Upper: 18 V, 5 V / div.
Middle: 5 V, 2 V / div.
Lower: I_{OUT}, 1 A, 10 ms / div.

11.2.4.2 No-Load

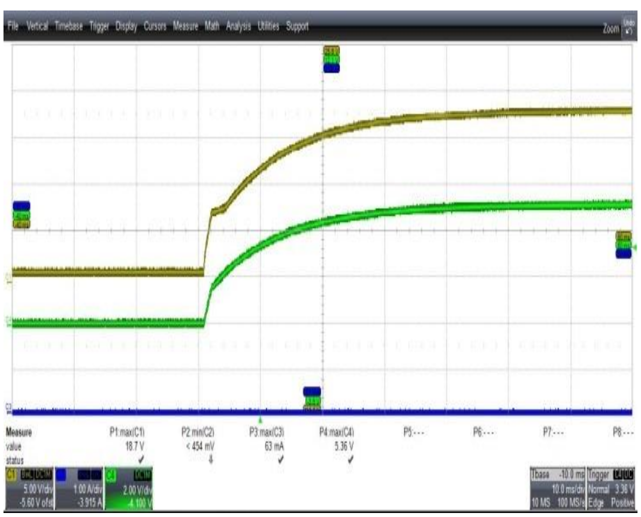


Figure 33 – Output Voltage and Current Waveforms.
90 VAC Input.
Upper: 18 V, 5 V / div.
Middle: 5 V, 2 V / div.
Lower: I_{OUT}, 1 A, 10 ms / div.

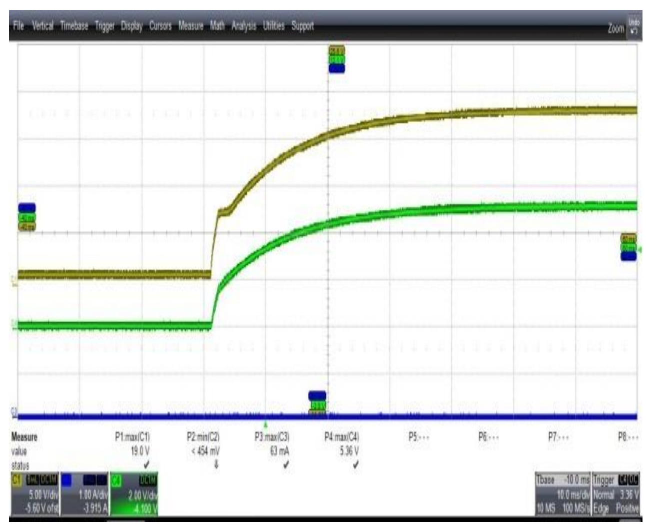


Figure 34 – Output Voltage and Current Waveforms.
265 VAC Input.
Upper: 18 V, 5 V / div.
Middle: 5 V, 2 V / div.
Lower: I_{OUT}, 1 A, 10 ms / div.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

11.2.5 Output Voltage and Current Waveforms with Shorted Output

Figure 35 – Output Voltage and Current Waveforms.
90 VAC Input.
Upper: 18 V, 5 V / div.
Middle: 5 V, 2 V / div.
Lower: I_{OUT}, 5 A, 1 s, 50 ms / div.

Figure 36 – Output Voltage and Current Waveforms.
265 VAC Input.
Upper: 18 V, 5 V / div.
Middle: 5 V, 2 V / div.
Lower: I_{OUT}, 5 A, 1 s, 50 ms / div.

11.2.6 Output Voltage and Current Waveforms with Open 5 V Feedback

Figure 37 – Output Voltage Waveform.
90 VAC Input.
Upper: 18 V, 5 V / div.
Lower: 5 V, 2 V / 1 s div.

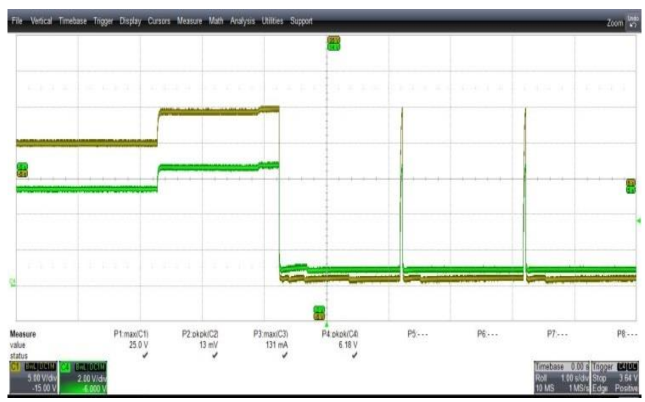


Figure 38 – Output Voltage Waveform.
265 VAC Input.
Upper: 18 V, 5 V / div.
Lower: 5 V, 2 V / 1 s div.

11.3 Brown-In and Brown-Out

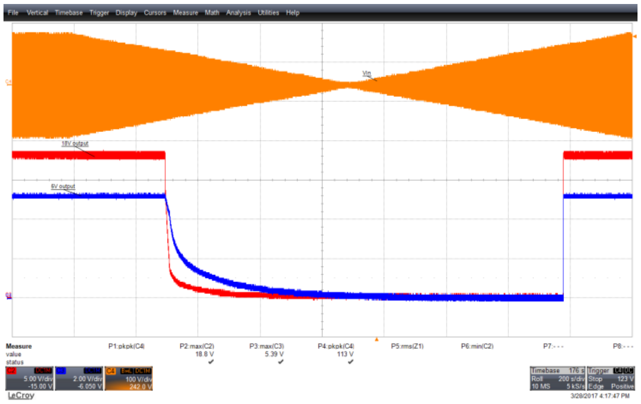


Figure 39 – Brown-In and Brown-Out at No-Load.
90 VAC Input, 6 V / min.
Upper: V_{IN}, 100 V / div.
Middle: 18 V, 5 V / div.
Lower: 5 V, 2 V / 200 s / div.

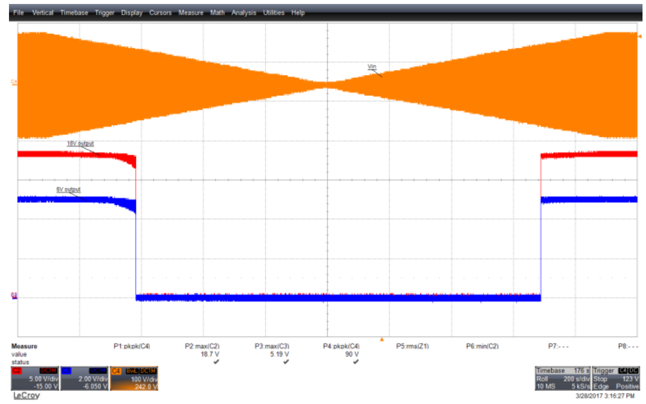


Figure 40 –Brown-In and Brown-Out at Full Load.
90 VAC Input, 6 V / min.
Upper: V_{IN}, 100 V / div.
Middle: 18 V, 5 V / div.
Lower: 5 V, 2 V / 200 s / div.

11.4 Line UV / OV

Figure 41 – DC_{IN} and 18 V Output Voltage.
Waveform for Line UV Test.
(V_{UV+}: 100.3 V, V_{UV-}: 79.8 V)
Upper: DC_{IN}, 20 V.
Lower: 18 V, 10 V, 5 s / div.

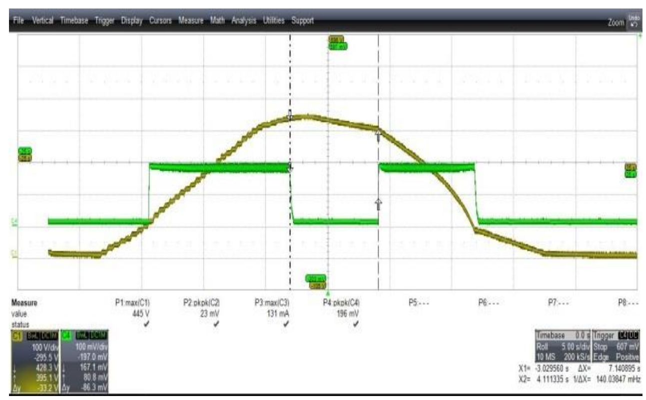


Figure 42 – DC_{IN} and 18 V Output Voltage.
Waveform for Line OV Test.
(V_{OV-}: 428.3 V, V_{OV+}: 395.1 V).
Upper: DC_{IN}, 20 V.
Lower: 18 V, 10 V, 5 s / div.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

11.5 Output Ripple Measurements

11.5.1 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/100 V ceramic type and one (1) 10 μF/50 V aluminum electrolytic. The aluminum electrolytic type capacitor is polarized, so proper polarity across DC outputs must be maintained (see below).

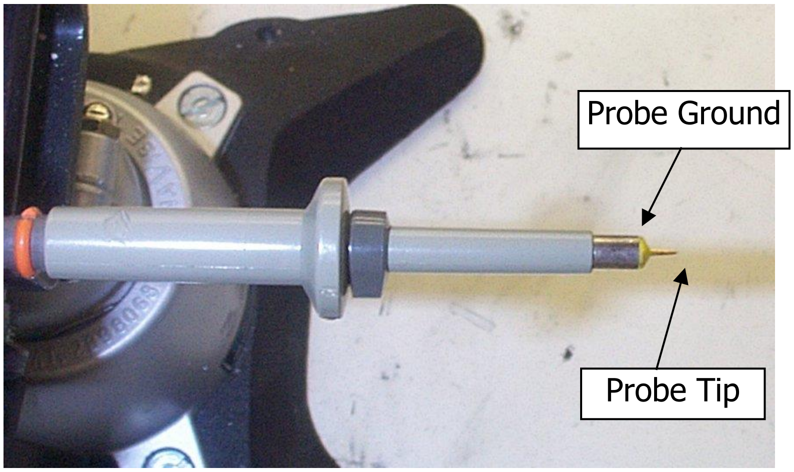


Figure 43 – Oscilloscope Probe Prepared for Ripple Measurement. (End Cap and Ground Lead Removed)

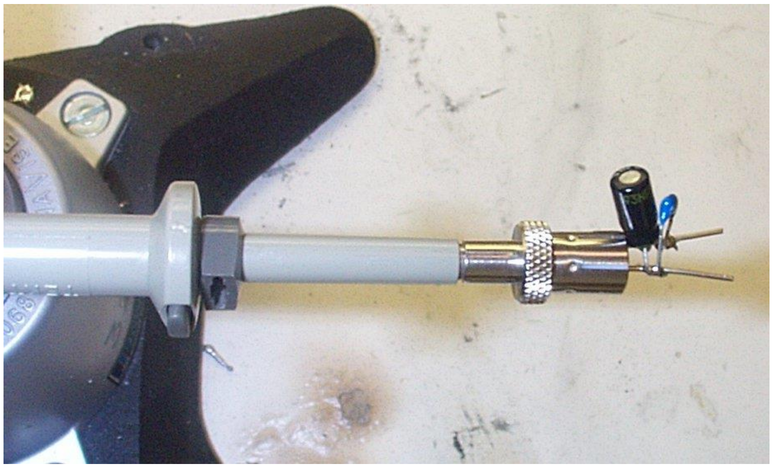


Figure 44 – Oscilloscope Probe with Probe Master (**www.probemaster.com**) 4987A BNC Adapter. (Modified with wires for ripple measurement, and two parallel decoupling capacitors added)

11.5.2 Ripple Voltage Waveforms

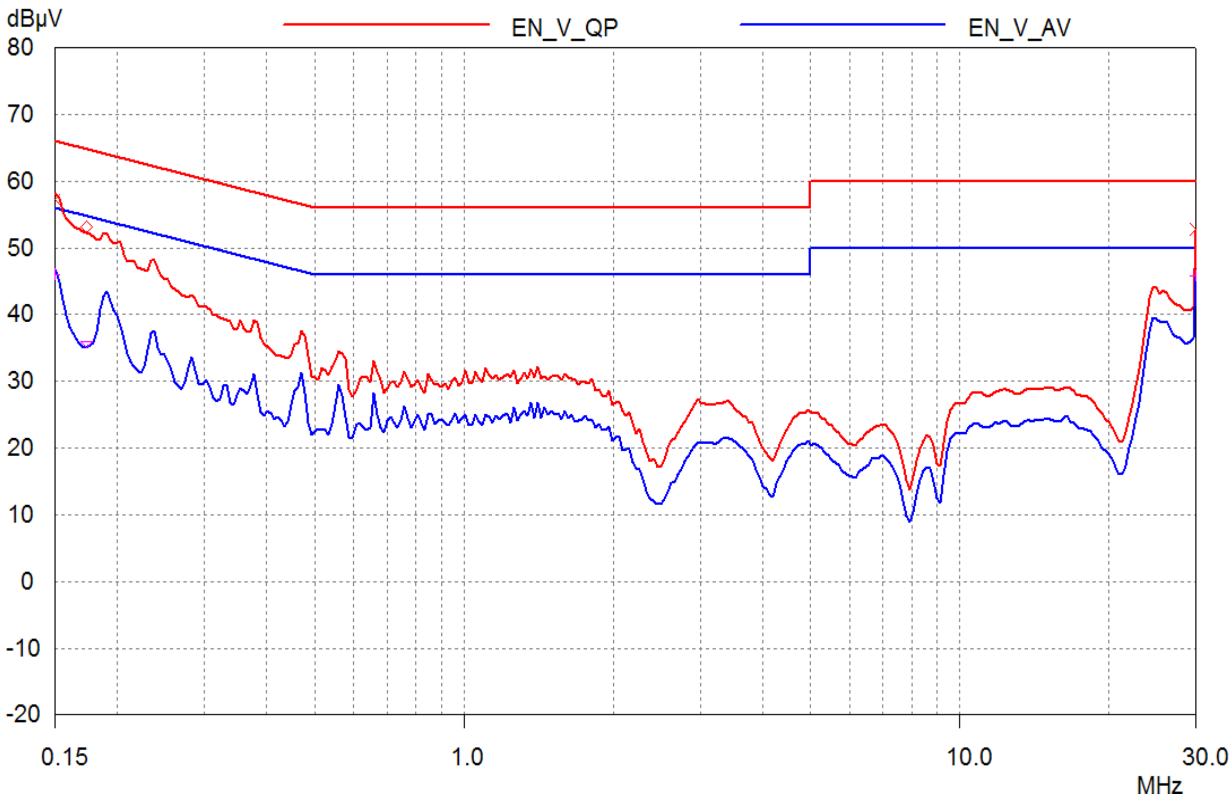
Figure 45 – Output Ripple Voltage Waveforms.
90 VAC Input. 3 A on 5 V and 1.4 A on 18 V.
Upper: 5 V, 50 mV / div.
Lower: 18 V, 100 mV, 20 ms / div.

Figure 46 – Output Ripple Voltage Waveforms**.**
265 VAC Input. 3 A on 5 V and 1.4 A on 18 V.
Upper: 5 V, 50 mV / div.
Lower: 18 V, 100 mV, 20 ms / div.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

12 Conductive EMI with Earth Grounded

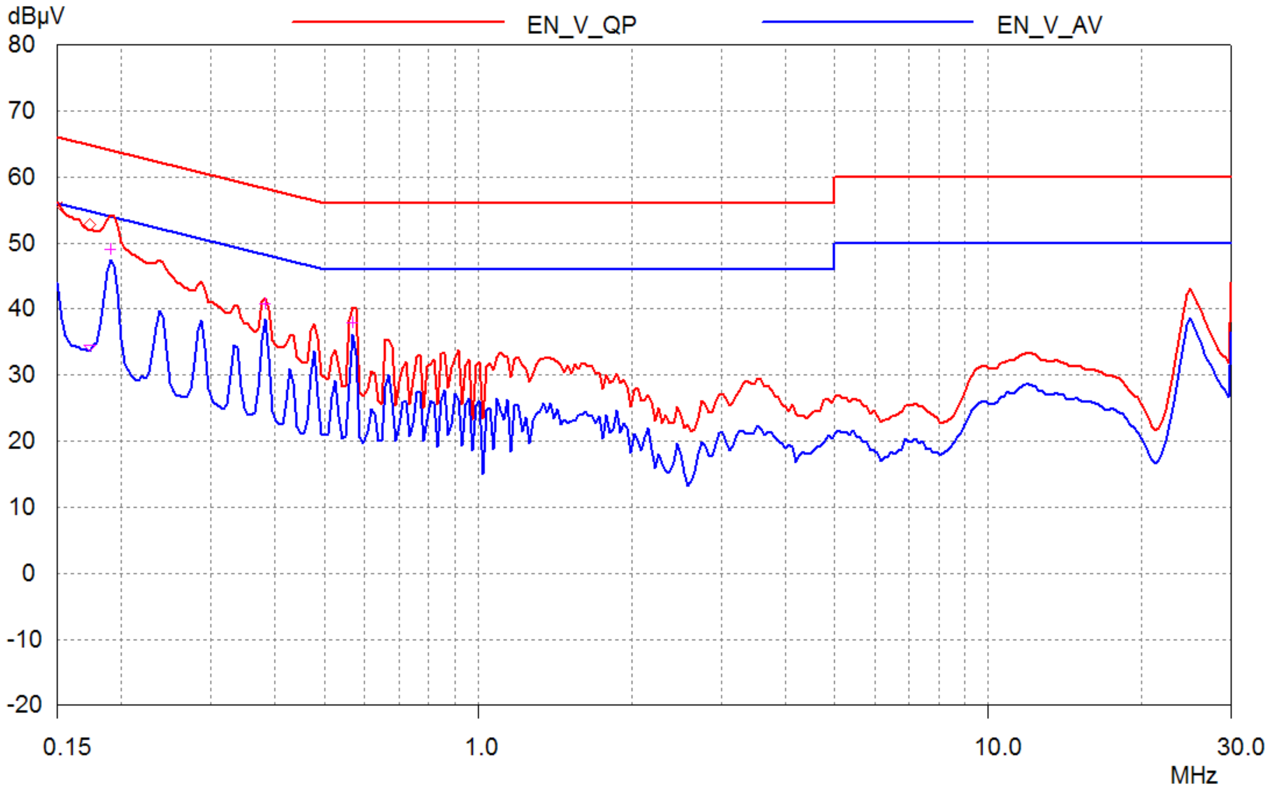
12.1 110 VAC



	Freq (MHz)	Measurement (dBuV)	Limit (dBuV)	Margin (dBuV)
QP	0.15	57.2	66	8.75
AVE	0.15	45.7	56	10

Figure 47 – Output Earth Ground at 110 VAC Input.

12.2 230 VAC



	Freq (MHz)	Measurement (dBuV)	Limit (dBuV)	Margin(dBuV)
QP	0.15	59.5	66	6.5
AVE	0.19	46.9	54.1	7.2

Figure 48 – Output Earth Grounded at 230 VAC Input.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

13 Lighting Surge Test

13.1 Differential Surge Test

Passed ±1 kV Differential test.

Ring Wave Voltage (kV)	Phase Angle (°)	Generator Impedance (W)	Number of Strikes	Test Result
1	90	2	10	PASS
-1	90	2	10	PASS
1	270	2	10	PASS
-1	270	2	10	PASS

13.2 Common mode Surge Test

Passed ±4 kV, 500 A ring wave test.

Ring Wave Voltage (kV)	Phase Angle (°)	Generator Impedance (W)	Number of Strikes	Test Result
4	90	12	10	PASS
-4	90	12	10	PASS
4	270	12	10	PASS
-4	270	12	10	PASS

14 ESD Test Results

Level (V)	Input Voltage (VAC)	Discharge	Number of Discharge	Test Result (Pass/Fail)
8000	230	Contact	10	Pass
-8000	230	Contact	10	Pass
Level (V)	**Input Voltage (VAC)**	**Discharge**	**Number of Discharge**	**Test Result (Pass/Fail)**
16500	230	Air	10	Pass
-16500	230	Air	10	Pass

15 Appendix

15.1 Board with Heat Sink

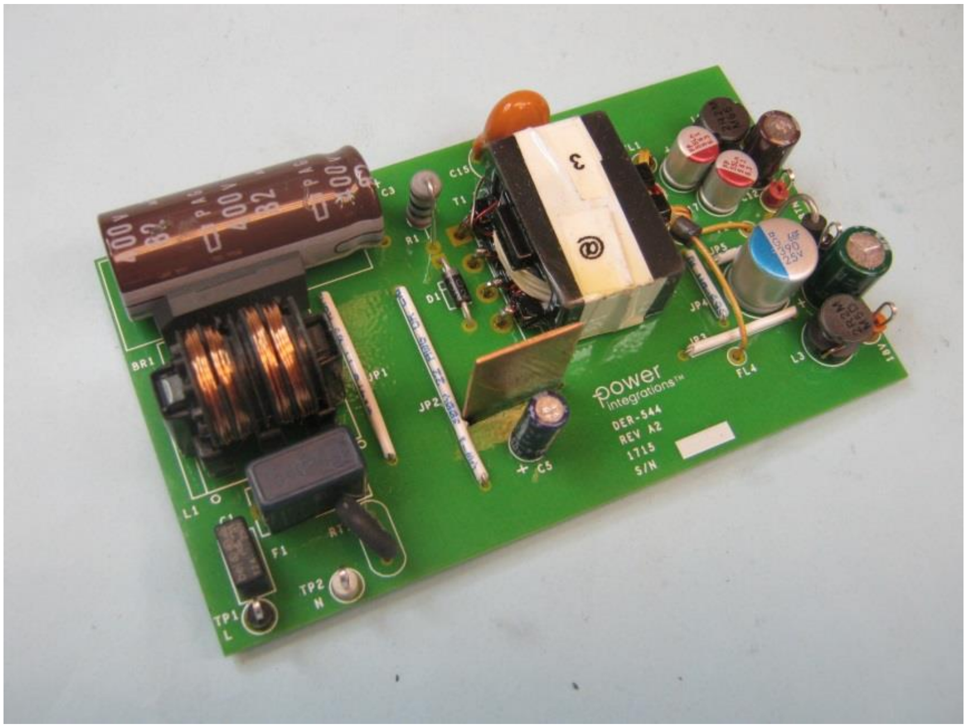


Figure 49 – Populated Circuit Board Photograph, with Heat Sink.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

15.2 Temperature of INN3168C with Heat Sink

Ambient temperature: 28 °C

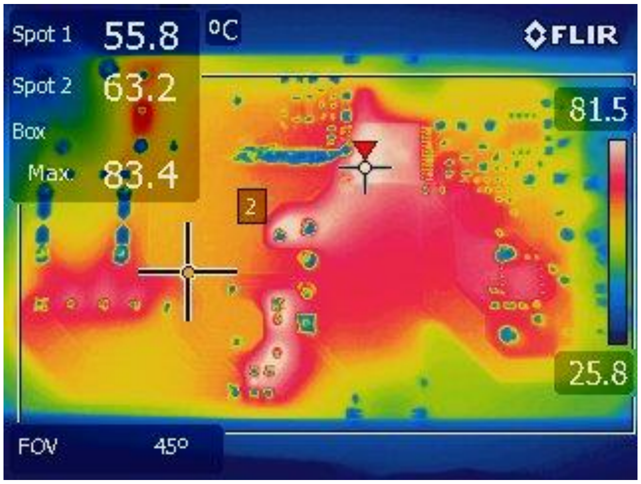


Figure 50 – V_{IN} = 90 VAC, Temp: 83.4 ºC.

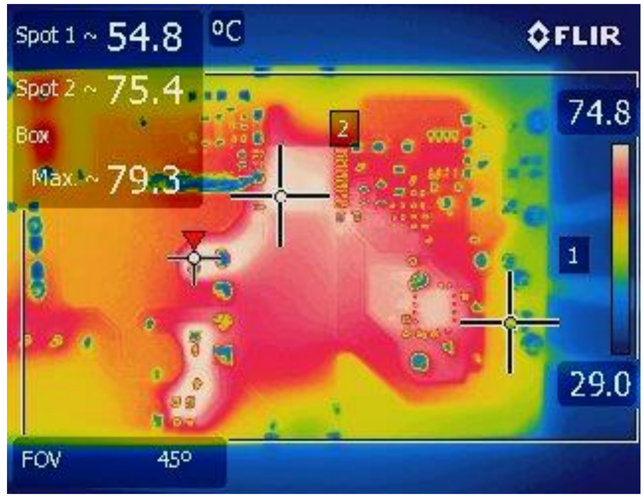


Figure 51 – V_{IN} = 110 VAC, Temp: 79.3 ºC.

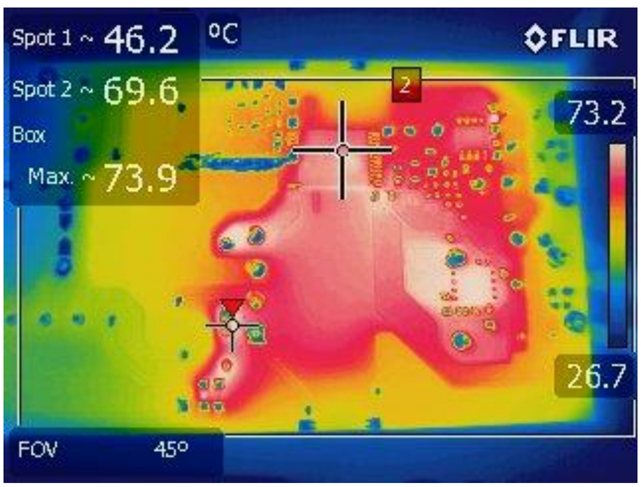


Figure 52 – V_{IN} = 230 VAC, Temp: 73.9 ºC.

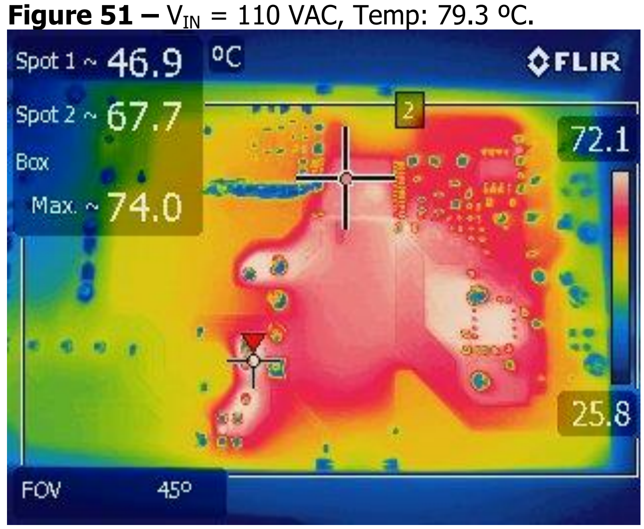


Figure 53 – V_{IN} = 265 VAC, Temp: 74 ºC.

15.3 Heat Sink Drawing

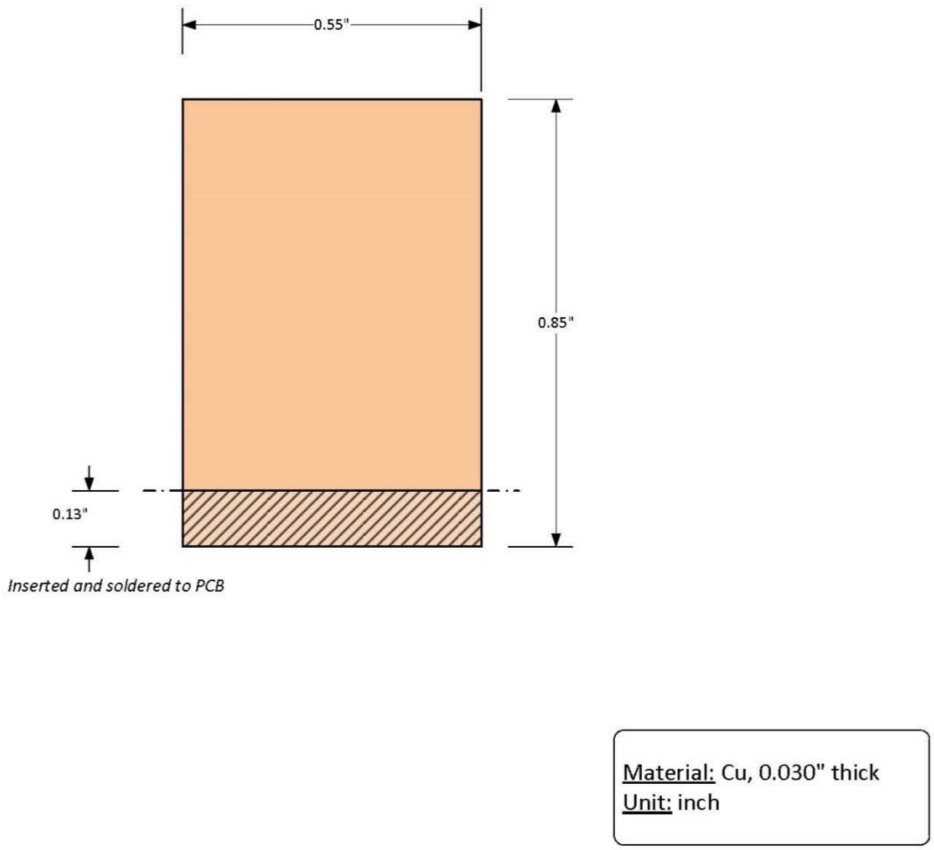


Figure 54 – Heat Sink Drawing.

Power Integrations
Tel: +1 408 414 9200 Fax: +1 408 414 9201
www.power.com

16 Revision History

Date	Author	Revision	Description & Changes	Reviewed
07-Sep-17	DK	1.0	Initial Release	Apps & Mktg
02-Jul-18	KM	1.1	Added Magnetics Supplier	

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

Power Integrations Worldwide Sales Support Locations

WORLD HEADQUARTERS
5245 Hellyer Avenue
San Jose, CA 95138, USA.
Main: +1-408-414-9200
Customer Service:
Phone: +1-408-414-9665
Fax: +1-408-414-9765
e-mail: usasales@power.com

CHINA (SHANGHAI)
Rm 2410, Charity Plaza, No. 88,
North Caoxi Road,
Shanghai, PRC 200030
Phone: +86-21-6354-6323
Fax: +86-21-6354-6325
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
Fax: +86-755-8672-8690
e-mail: chinasales@power.com

GERMANY (AC-DC/LED Sales)
Lindwurmstrasse 114
80337, Munich
Germany
Phone: +49-895-527-39110
Fax: +49-895-527-39200
e-mail: eurosales@power.com

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

INDIA
#1, 14th Main Road
Vasanthanagar
Bangalore-560052
India
Phone: +91-80-4113-8020
Fax: +91-80-4113-8023
e-mail: indiasales@power.com

ITALY
Via Milanese 20, 3rd. Fl.
20099 Sesto San Giovanni (MI) Italy
Phone: +39-024-550-8701
Fax: +39-028-928-6009
e-mail: eurosales@power.com

JAPAN
Kosei Dai-3 Building
2-12-11, Shin-Yokohama,
Kohoku-ku, Yokohama-shi,
Kanagawa 222-0033
Japan
Phone: +81-45-471-1021
Fax: +81-45-471-3717
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
Fax: +82-2-2016-6630
e-mail: koreasales@power.com

SINGAPORE
51 Newton Road,
#19-01/05 Goldhill Plaza
Singapore, 308900
Phone: +65-6358-2160
Fax: +65-6358-2015
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
Fax: +886-2-2659-4550
e-mail: taiwansales@power.com

UK
Cambridge Semiconductor,
a Power Integrations company
Westbrook Centre, Block 5,
2nd Floor
Milton Road
Cambridge CB4 1YG
Phone: +44 (0) 1223-446483
e-mail: eurosales@power.com