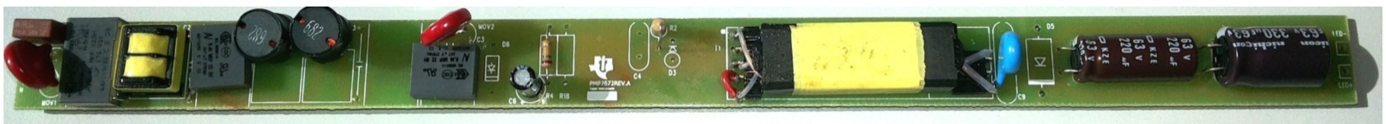
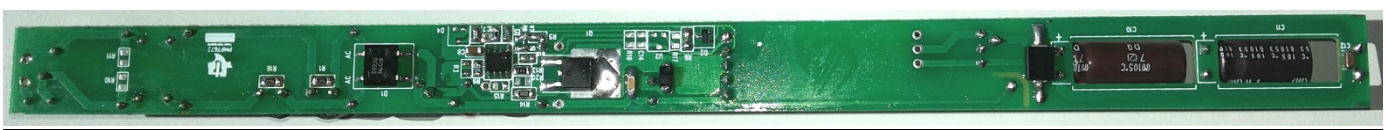
18W Primary Side Regulated Flyback LED Driver for T8 Fixtures

PMP7672





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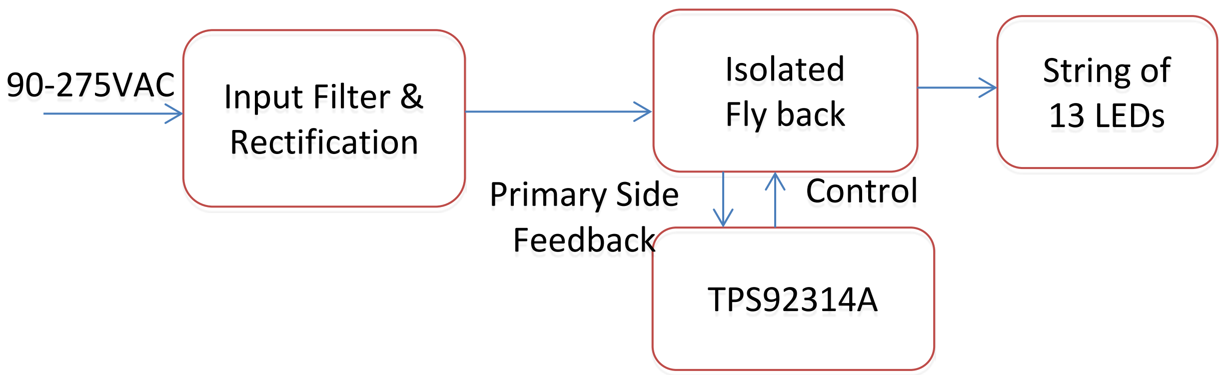
I. INTRODUCTION

The following document is a compilation of test results of the PMP7672, an 18W LED driver using TPS92314A in flyback configuration. The test results are taken over an input voltage range of 90VAC – 275VAC, driving a single string of 13 (3.3V) LEDs at 420mA.

II. DESCRIPTION

The PMP7672 is a reference design on the TPS92314A controller IC. The design is targeted at T8 fixtures, as a replacement to conventional tube lights. The PMP7672 has an operating efficiency of over 87%, with PFC over 95% at all conditions. THD is maintained to <18%.

III. BLOCK DIAGRAM



IV. SPECIFICATIONS

Input Voltage Range	90V-275V AC
Output Voltage	38V-42V DC
Output Current	420mA
Efficiency	>87%
Current Regulation	± 9%
PF	>0.95
THD	<18%
SURGE & EFT	4KV- IEC61000
EMC	CISPR22-ClassB-CE

V. TEST SETUP

Input conditions:
Vin – 90V – 275VAC Set Input current limit to 1A

Output:
Single string of 13 (3.3V) LEDs at 420mA

Equipment Used:
1. Isolated AC Power Supply California Instruments 1251P
2. Digital CRO LeCroy WAveSurfer 44Xs
3. Multimeters- Fluke 87 V TrueRMS meter
4. Power Analyzer PM100 Voltech
5. 2W LED strings load
6. PMM7010 All-in-one EMI Receiver for CISPR 22 Class B standards
7. EM test UCS500N for Surge and EFT tests

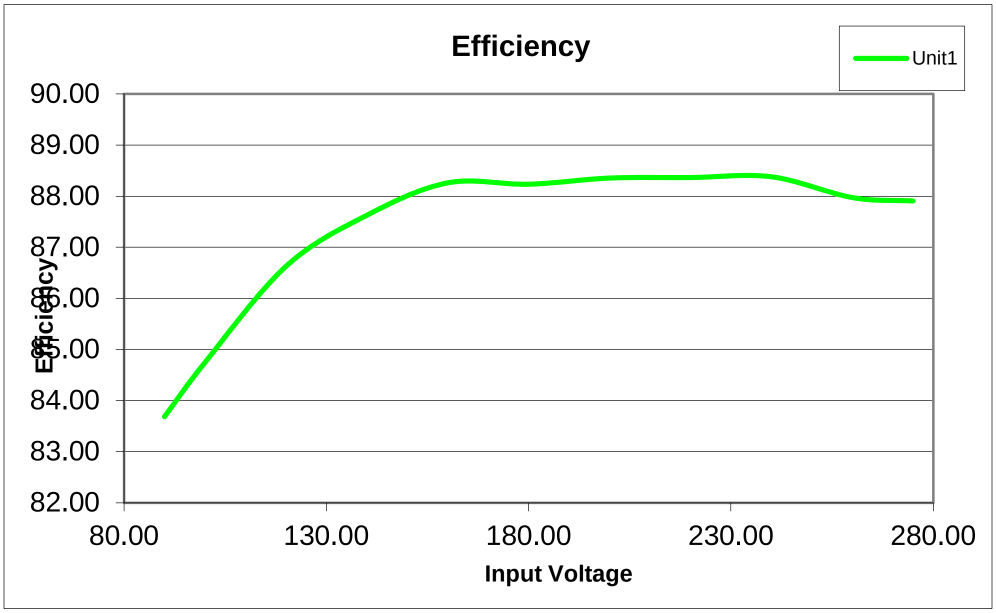
Procedure:
1. Connect input terminals of the PMP7672 reference board to the AC power supply
2. Connect output terminals with the LED string, maintaining correct polarity
3. Set a current limit of 1A on the power supply, and gradually increase the input voltage from 0V to Turn on voltage
4. Take necessary measurements across relevant testing points

VI. Performance Plots

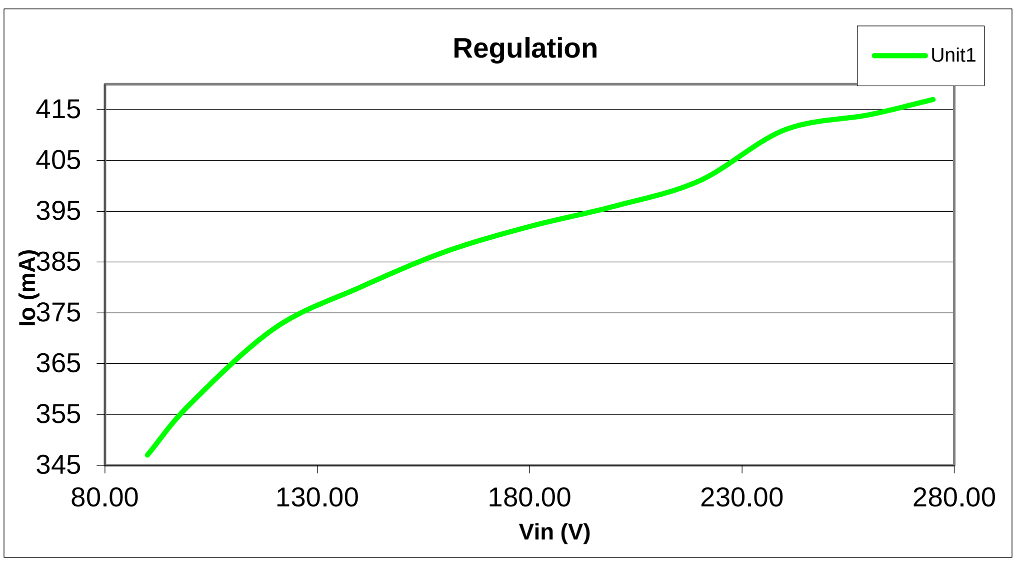
Tabulation –

Vin(V)	PF	THD(%)	Pin(W)	Vout(V)	Iout(mA)	Pout(W)	Efficiency (%)
90.00	0.999	2.9	16.35	39.4	347	13.68	83.68
100.00	0.999	3.4	16.64	39.5	357	14.10	84.74
120.00	0.997	6.5	17.01	39.6	372	14.73	86.63
140.00	0.994	7.5	17.16	39.6	380	15.04	87.63
160.00	0.991	9.1	17.37	39.6	387	15.33	88.26
180.00	0.987	10.1	17.62	39.7	392	15.55	88.23
200.00	0.981	12.5	17.78	39.7	396	15.71	88.35
220.00	0.975	13.6	18.02	39.7	401	15.92	88.36
240.00	0.967	14.9	18.49	39.8	411	16.34	88.38
260.00	0.958	15.9	18.73	39.8	414	16.48	87.97
275.00	0.952	16.6	18.88	39.8	417	16.60	87.91

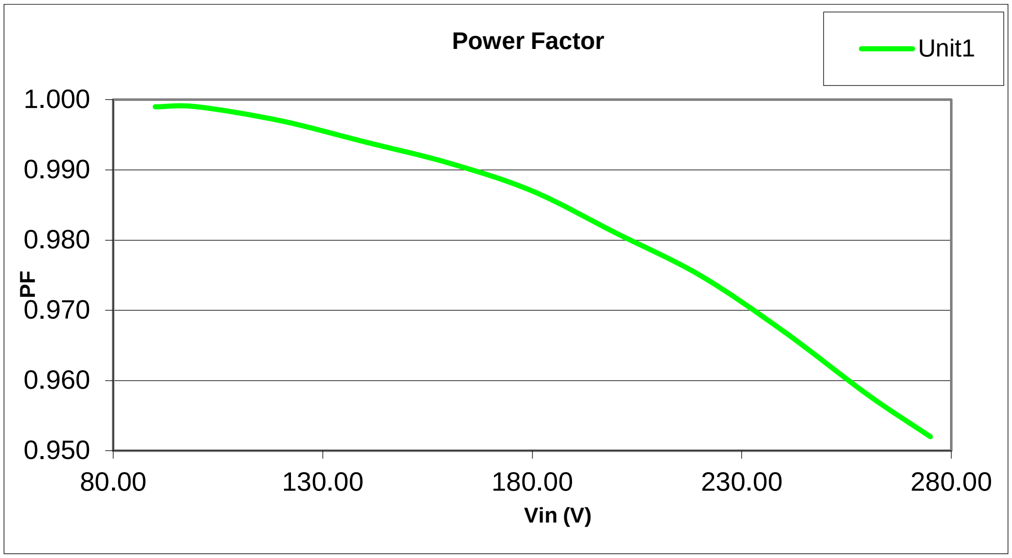
a. Efficiency



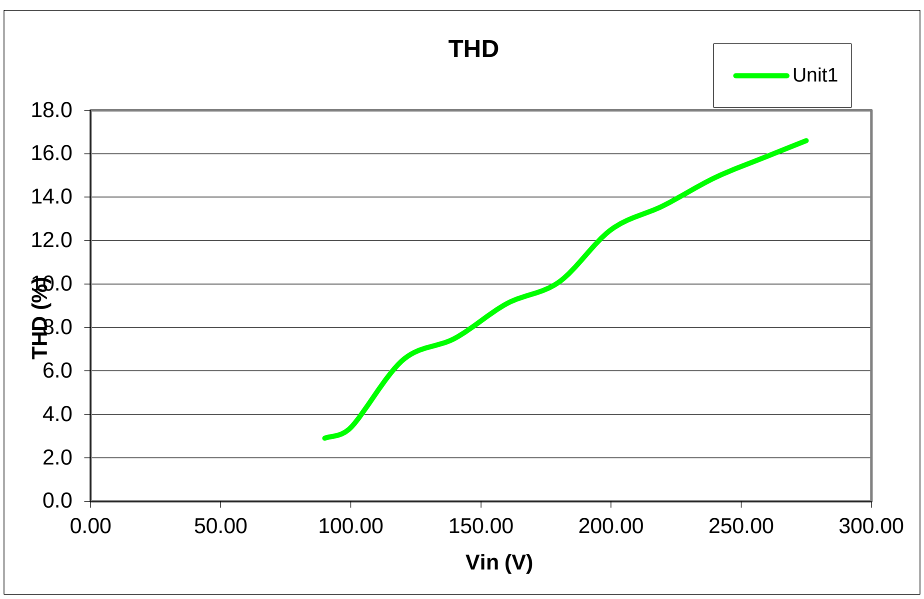
b. Regulation



c. Power Factor



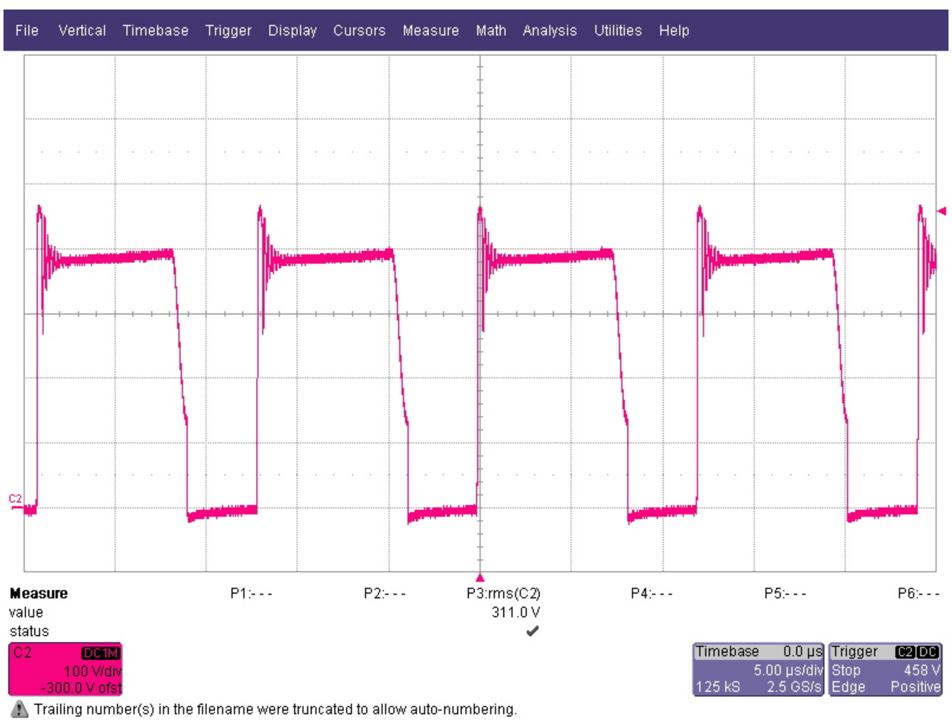
d. Total Harmonic Distortion



VII. WAVEFORMS (Constant Load of 13 (3.3V) LEDs)

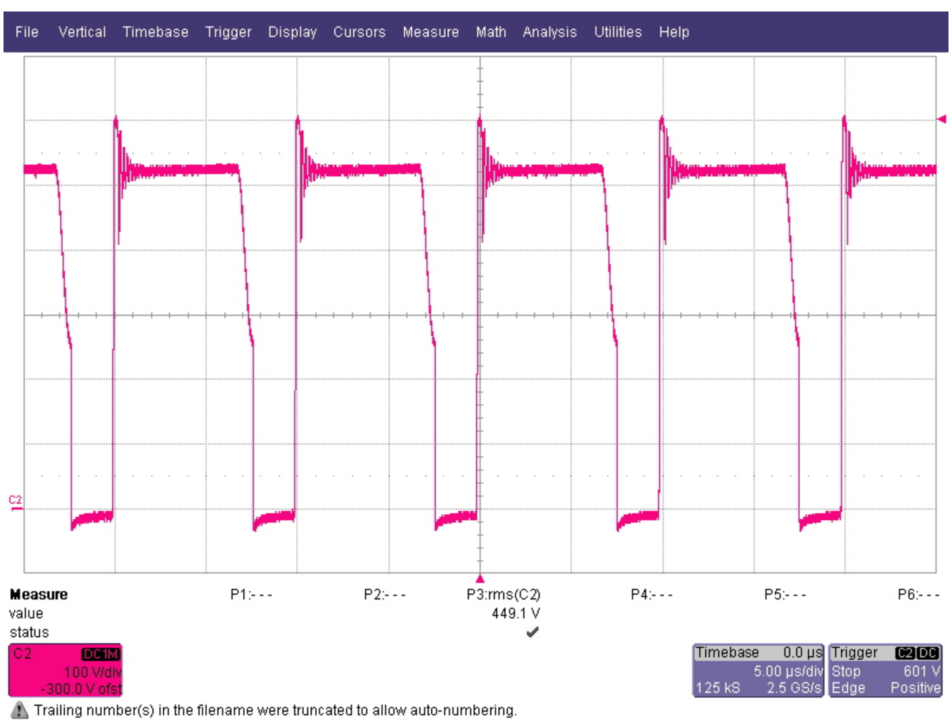
e. Drain VoltageVin = 120VAC

Vin – 180VAC



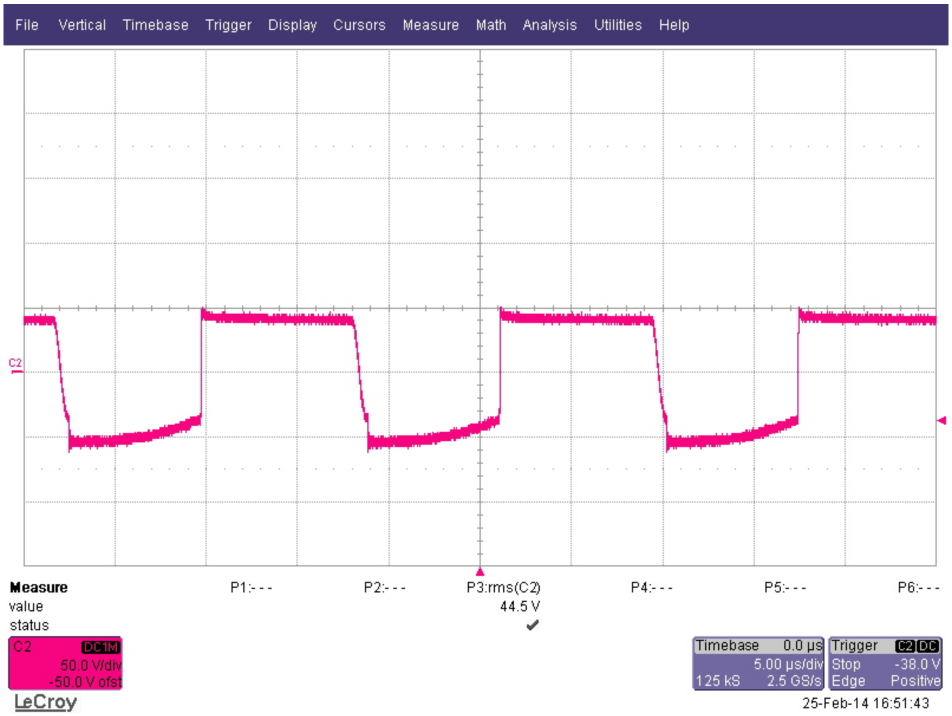
Vin = 220VAC

Vin = 270VAC

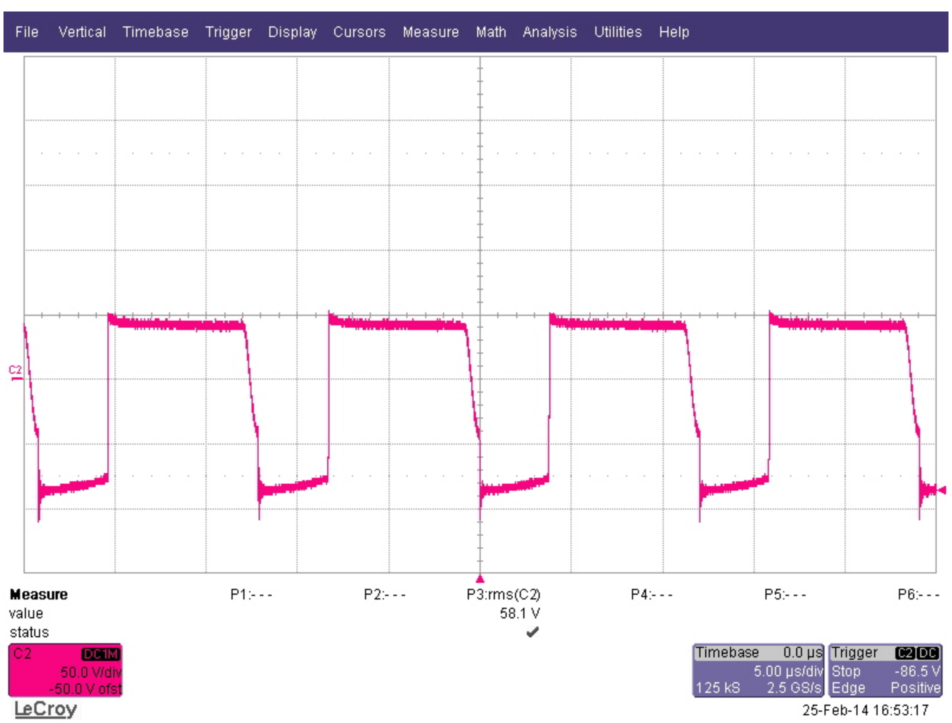


b. Output Diode Characteristics

Vin = 120VAC

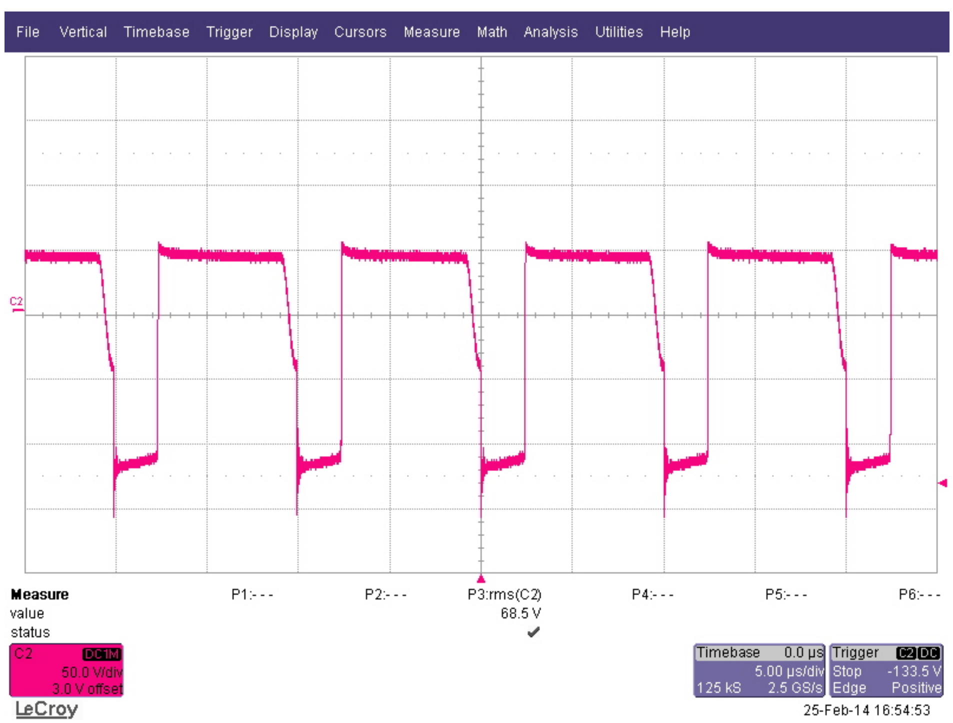


Vin = 180VAC



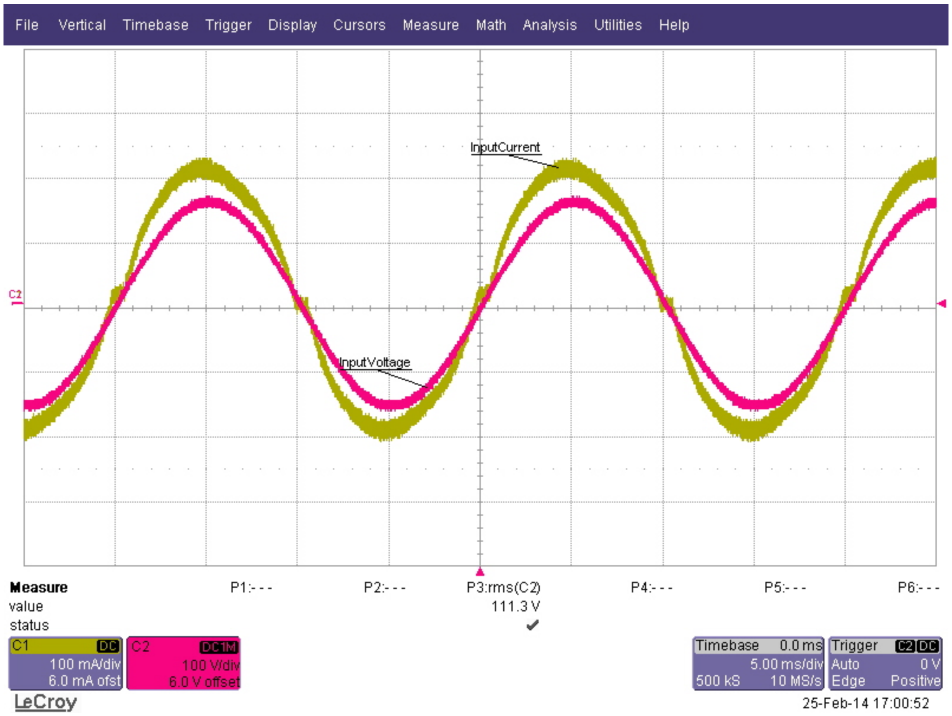
Vin = 220VAC

Vin = 270VAC

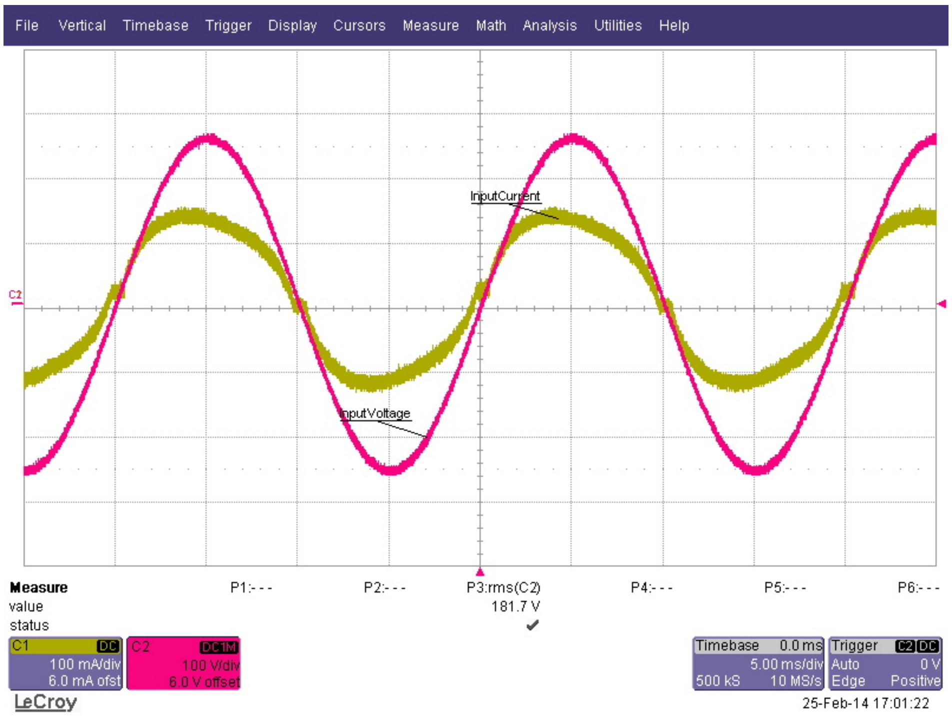


c. Input Waveforms

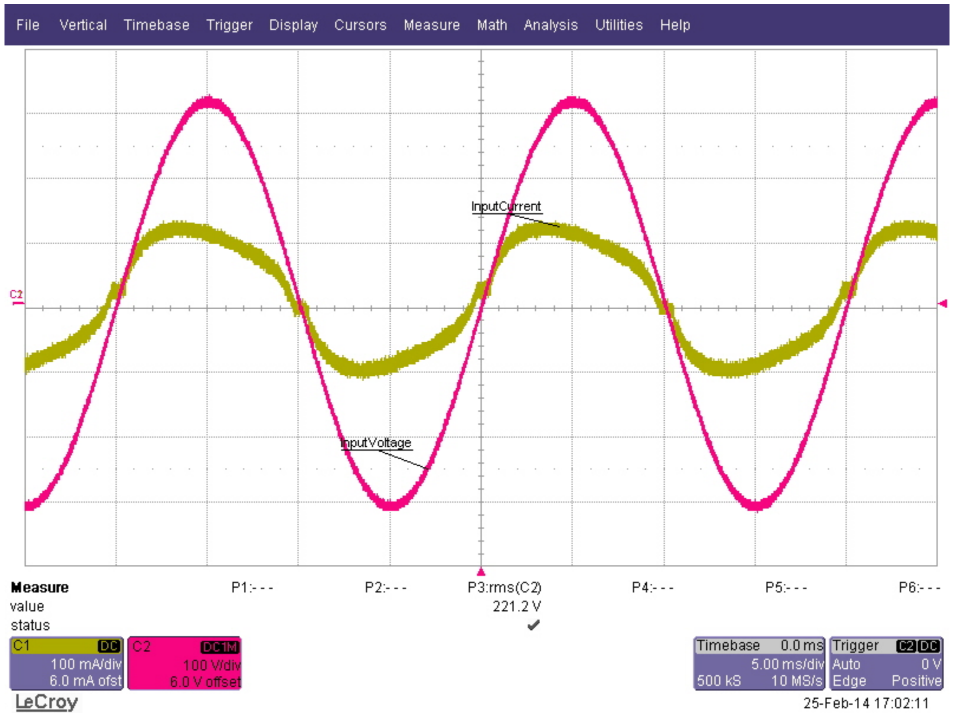
Vin = 120VAC



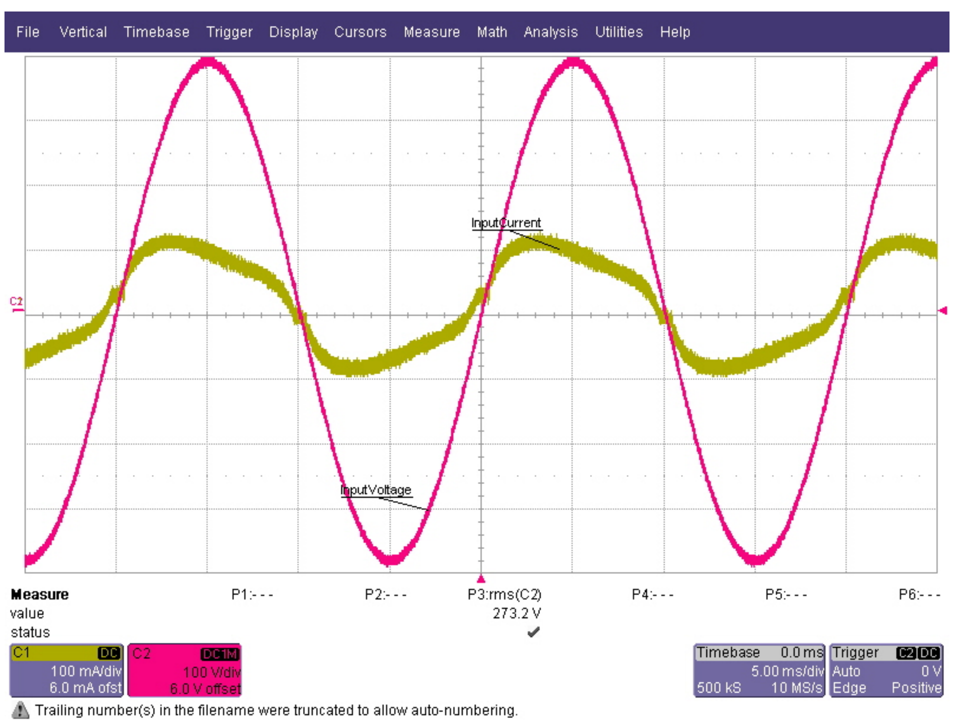
Vin = 180VAC



Vin = 220VAC

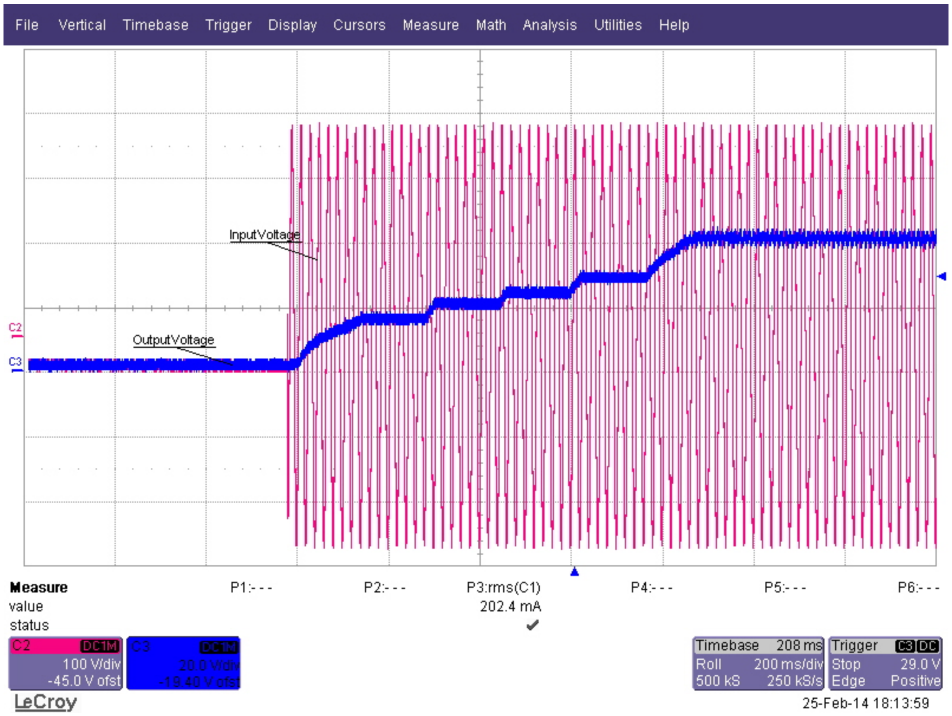


Vin = 270VAC



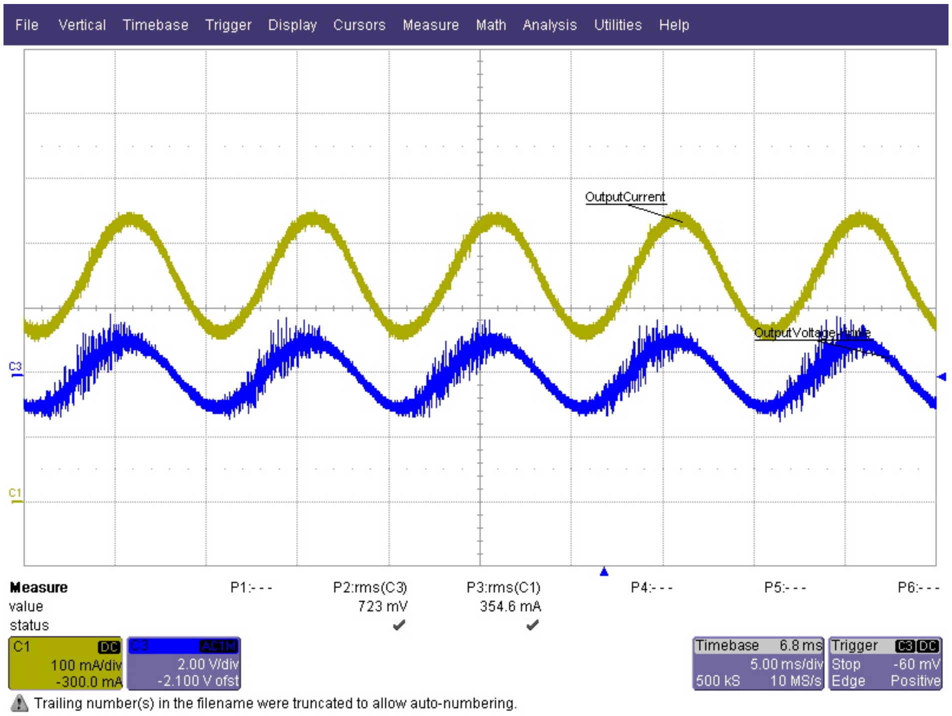
d. Startup waveform

Vin = 230VAC

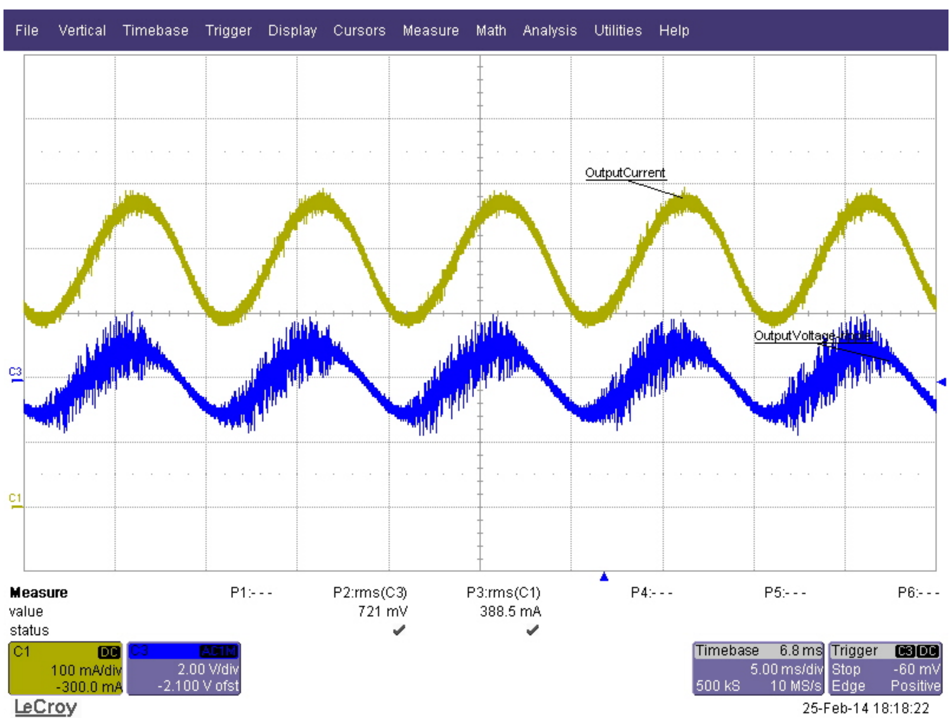


e. Output Ripple Current

Vin = 120VAC

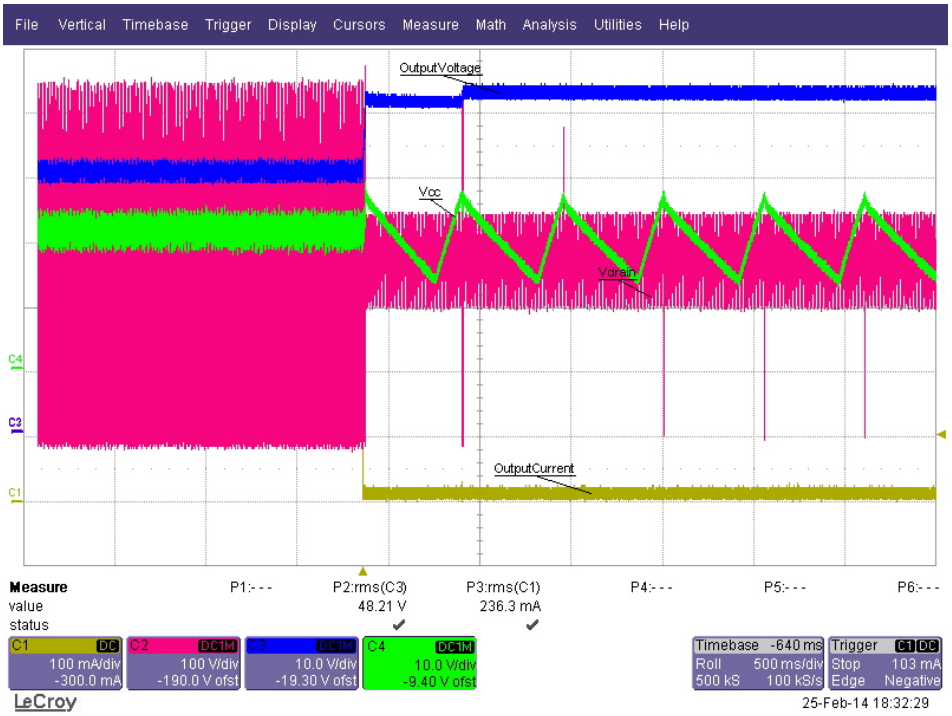


Vin = 220VAC

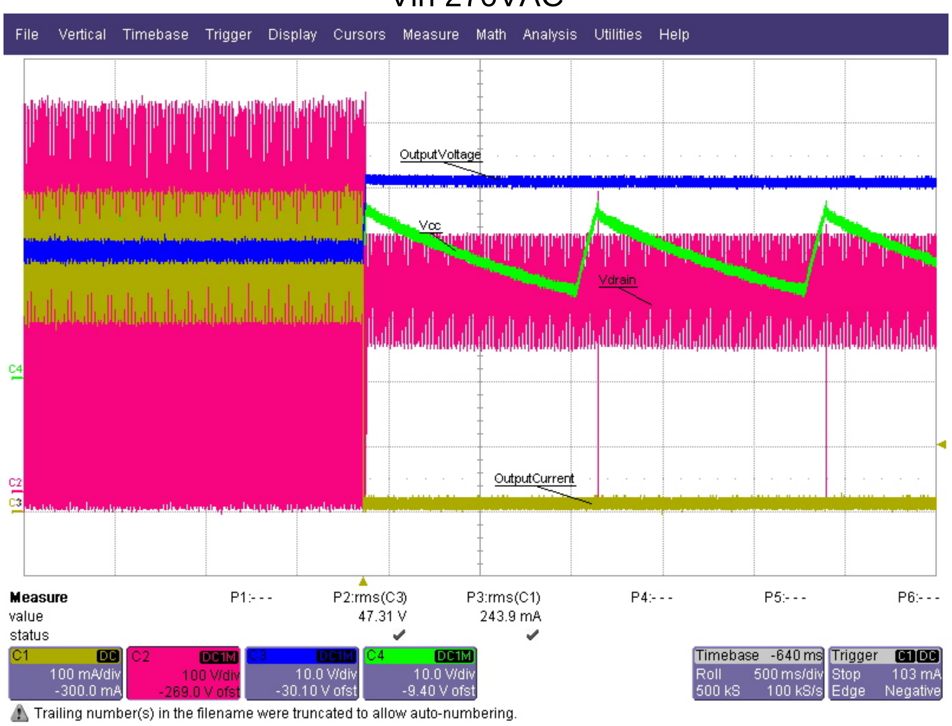


f. OverVoltage/Open LED protection

Vin = 230V



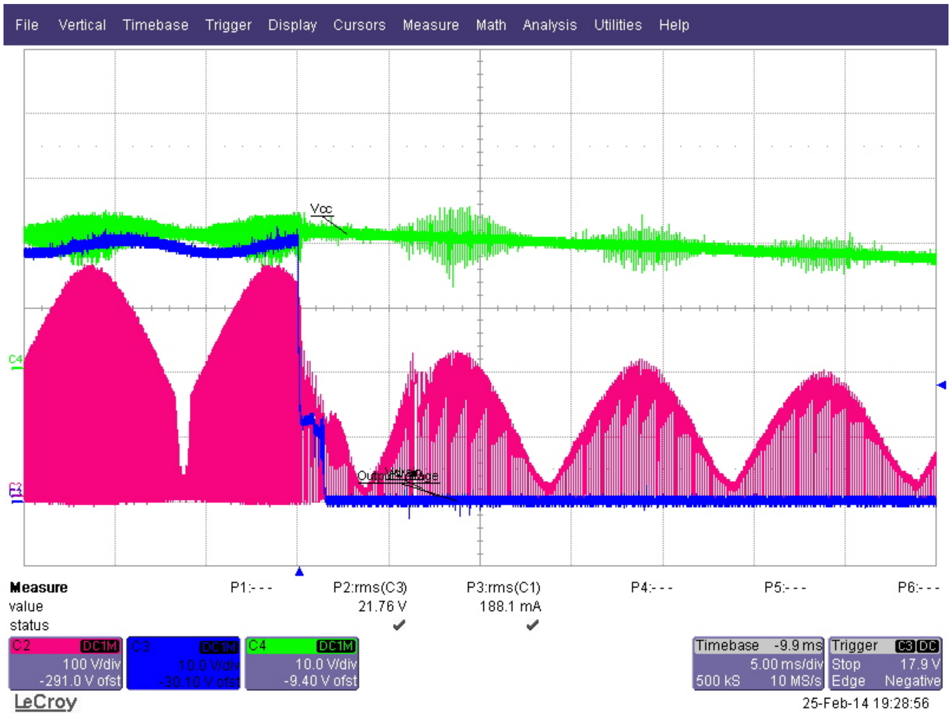
Vin 270VAC



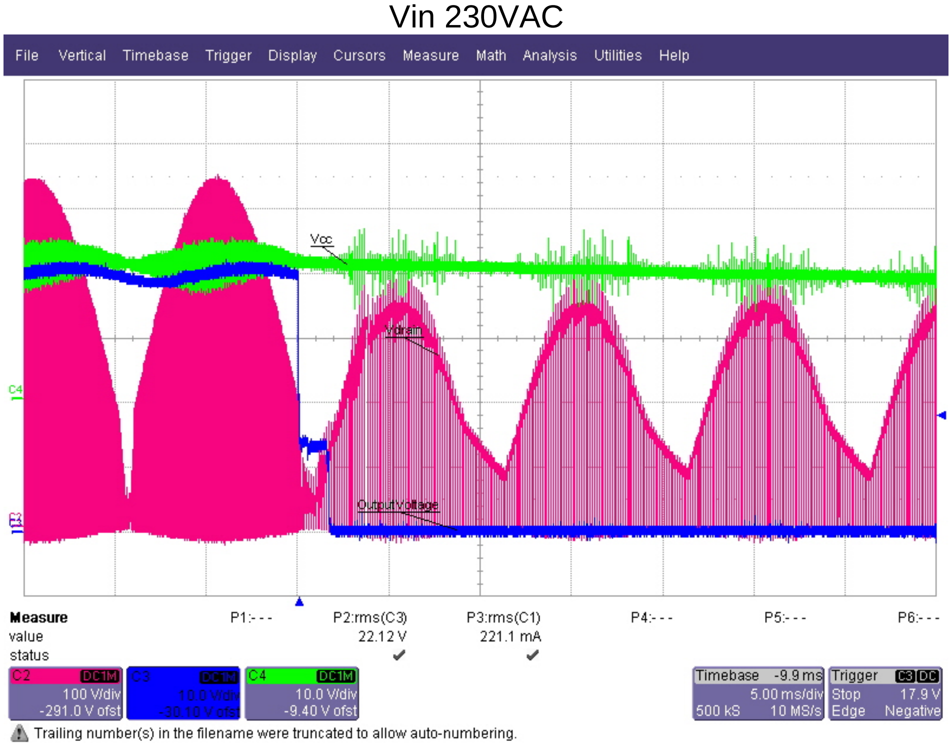
When an Open LED condition is detected, the device is not turned off. It continuously checks if the output has been brought under limits

g. Short Circuit Protection

Vin 110VAC



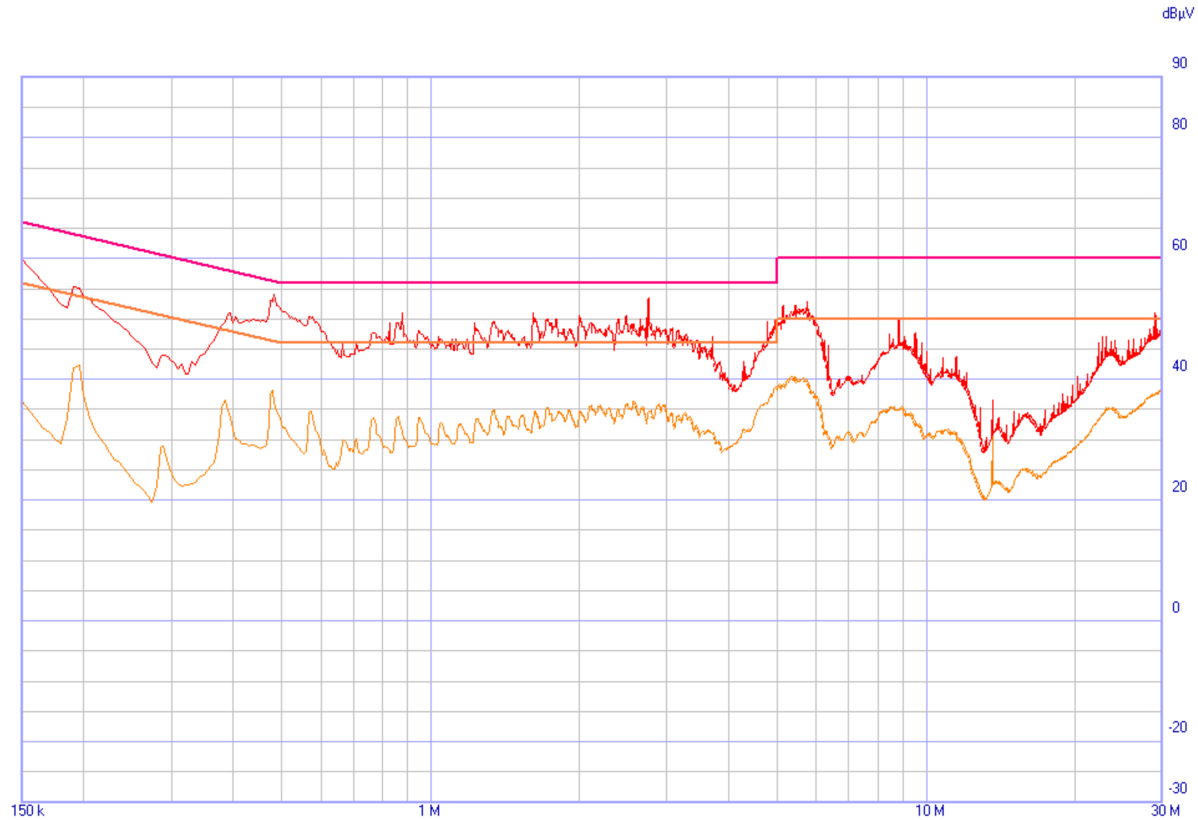
Vin 230VAC



When a short circuit condition occurs, the controller goes into a hiccup mode and reverts back once the short condition is removed.

h. EMI Test

Input Voltage: 230VAC
This test was conducted per CISPR22 Class B standard. Quasi peak and Average values were measured for both the lines (Line and Neutral). The settings for the test are seen in the tabular column in the figure below.



pmp7672-6-qp

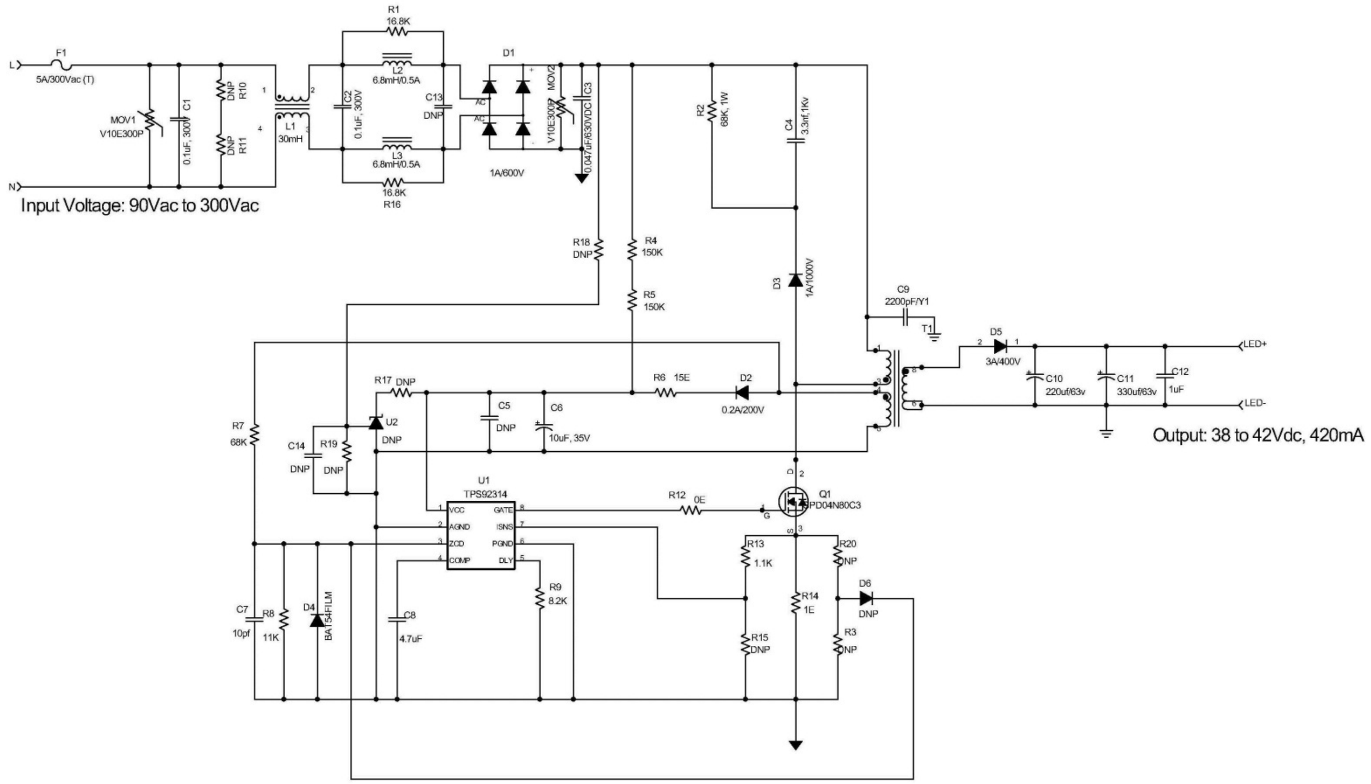
	Start [MHz]	Stop [MHz]	Step	Detector	Hold Time	RBW	Min Att	Pre Amp	Pre Sel	Prompt start	Ancillary
1	0.15	30	AUTO (5 kHz)	P Q A 022qp-b 022av-b	1000 ms	9 kHz	10	OFF	OFF	...	L1, L2

Pulse Limiter ON
Ancillary = L2 7010
Limits:
022qp-b
022av-b

QPeak
Avg

NOTES:

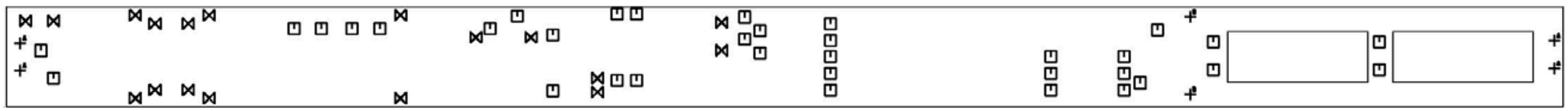
IX. SCHEMATIC

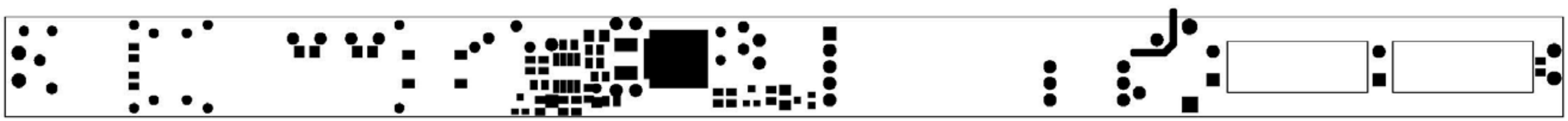


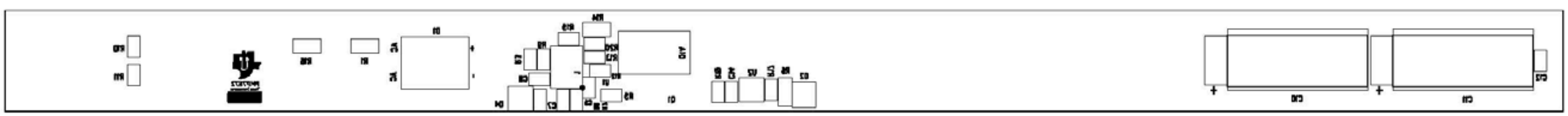
Schematic for PMP7672

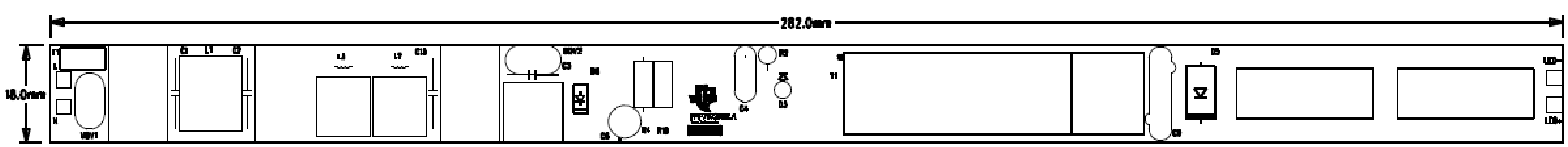
X. BOARD ASSEMBLY DRAWINGS

SIZE	QTY	SYM	PLATED	TOL
40	40	◻	NO	+/-0.0
30	18	⋈	NO	+/-0.0
50	4	+A	NO	+/-0.0
60	2	+B	NO	+/-0.0









Board Dimensions: 282mm x 18mm

XI. BILL OF MATERIALS

PMP7672 BOM

Qty	Value	RefDes	Part Number	Manufacturer	Description	Size
2	0.1uF/X2	C1 C2	B32922C3104M	Epcos	CAP FILM 0.1UF 630VDC RADIAL	18mm x 5mm x 10.5mm
1	220uF/63V	C10	EEU-FC1J221	Panasonic	CAP ALUM 220UF 63V 20% RADIAL,105DegC	12.5mm(dia.)x 22mm (height)
1	330uF/63V	C11	EEU-FC1J331	Panasonic	CAP ALUM 330UF 63V 20% RADIAL,105DegC	12.5mm(dia.)x20mm (height)
1	1uF/100v	C12	Std	Std	CAP CER 1UF 100V 20% X7R 1206	1206
1	DNP	C13	BFC233820104	Vishay	CAP FILM 0.1UF 630VDC RADIAL	Leaded, Size<12mm(L)X6mm(W)x12mm(H), Pin distance: 10mm
1	0.047uF/310 VAC	C3	BFC233820473	Vishay	CAP FILM 0.047UF 630VDC RADIAL	Leaded, Size<10mm(L)X5mm(W)x10.5mm (H), Pin distance: 7.5mm
1	3.3nF/630v	C4	FK26X7R2J332K	TDK	Capacitor, Ceramic, 630V, X7R,+/-10%	Leaded, Size<5.5mm(L)X3.5mm(W) x6mm(H), Pin distance: 5mm
1	DNP	C5	STD	STD	Capacitor, 100pF Ceramic Chip, 50V, ±10%	0805
1	10uF/35V	C6	Std	Std	CAP ALUM 10uF 35V 20% RADIAL	5mm(dia.)x7mm (height). Lead spacing 2.5mm
1	10pF	C7	Std	Std	CAP CER 22pF 16V 10% X7R 0805	0805
1	6.8uF/16V	C8	Std	Std	CAP CER 6.8uF 16V 10% X7R 0805	0805
1	2200pF/Y1	C9	Std	Std	Y1 CAP, 2200pF, 250VAC, -25to105DegC,	Lead space, 10mm, 11.5mm Dia
1	DNP	C14	Std	Std	Capacitor, 0.1uFCeramic Chip, 50V, ±10%	0805
1	1A/600V	D1	DF06S-T	Diodes Inc	Bridge Rectifier, 600V, 1A	DFS-4 Pin SMD Gullwing
1	0.2A, 200V	D2	BAS20LT1G	ON Semiconductor	DIODE SWITCHING 200V 200MA SOT23	SOT-23-3
1	1A, 1000V	D3	US1M-E3/61T	Vishay	Diode Ultrafast Rectifier, 1A, 1000V	SMA
1	SD101CW	D4	BAT54FILM	ST Micro	Diode, Schottky, 300mA, 40V	SOT-23-3
1	3A,400V	D5	ES3G-E3/57T	Vishay	Diode,ultra fast, 3A/400V	SMC
1	DNP	D6	1N4007	Std	Diode, General Purpose, 1A, 1000V	DO41
1	5A/300Vac (T)	F1	F5464CT-ND	Littlefuse	FUSE 5A 300V, SlowBlow, Radial	8.50mm(L) x 4.00mm(W) x 8.00mm(H)
1	30mH	L1	Custom	Custom	30mH/0.5A	EI-11.6
2	6.8mH/0.5A	L2-3	Custom	Custom	6.8mH/0.5A, size: 8mm*10mm	8mmx10mm
2	320VAC	MOV1-2	V10E300P	LittelFuse	VARISTR 300VRMS 2500A 10MM STRGT	10 mm
1	4A, 800V	Q1	SPD04N80C3	ST	MOSFET, N-ch, 800V, 4A	DPAK

2	16.2K	R1 R16	Std	Std	Resistor, Chip, 1/4 watt, ± 5%	1206
1	1.1K	R13	Std	Std	Resistor, Chip, 1/4 watt, ± 5%	0805
1	1R	R14	Std	Std	Resistor, Chip, 1/4 watt, ± 1%	1206
1	DNP	R15	Std	Std	Resistor, Chip, 1/4 watt, ± 1%	0805
1	68K 1W	R2	Std	Std	Resistor, Leaded,1/watt, ± 5%	Leaded 1W
1	150k	R4	Std	Std	Resistor, Leaded, 1/2 watt, ± 5%	Leaded 0.5W
1	150k	R5	Std	Std	Resistor, Chip, 1/4 watt, ± 5%	1206
1	0R	R12	Std	Std	Resistor, Chip, 1/4 watt, ± 5%	0805
1	15E	R6	Std	Std	Resistor, Chip, 1/4 watt, ± 5%	1206
1	68k	R7	Std	Std	Resistor, Chip, 1/4 watt, ± 1%	1206
1	11k	R8	Std	Std	Resistor, Chip, 1/4 watt, ± 1%	1206
1	6.8k	R9	Std	Std	Resistor, Chip, 1/4 watt, ± 5%	1206
2	DNP	R10 R11	Std	Std	Resistor, Chip, 1/4 watt, ± 5%	0805
2	DNP	R3 R20	Std	Std	Resistor, Chip, 1/4 watt, ± 5%	0805
2	DNP	R17 R19	Std	Std	Resistor, Chip, 1/4 watt, ± 5%	0805
1	DNP	R18	Std	Std	Resistor, Leaded, 1/2 watt, ± 5%	Leaded 0.5W
1	EDR3909	T1	EDR3909 10 Pin Horizontal	Custom	1.2mH CF139 core or equivalent	Custom
1	TPS92314A	U1	TPS92314A	TI	Off-Line Primary Side Sensing Controller with PFC	SOIC-8
1	DNP	U2	TL431CDBZR	TI	Analog Precision Shunt Regulator	SOT-23-3

XII. CONCLUSION

Thus the board is verified and found to be functionally working for the specifications given in section IV.

The board has passed EFT and Surge up to 4KV per IEC61000 standards and EMC for CISPR22 ClassB. Even though the quasi peak levels show close margin of 6-8 dBuV near 400-500KHZ region, the margin can be increased by further tuning the input filter.

XIII. APPENDIX

EVALUATION BOARD/KIT/MODULE (EVM) WARNINGS, RESTRICTIONS AND DISCLAIMER

For Feasibility Evaluation Only, in Laboratory/Development Environments. The EVM is not a complete product. It is intended solely for use for preliminary feasibility evaluation in laboratory / development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical / mechanical components, systems and subsystems. It should not be used as all or part of a production unit.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard.
3. Since the EVM is not a completed product, it may not meet all applicable regulatory and safety compliance standards (such as UL, CSA, VDE, CE, RoHS and WEEE) which may normally be associated with similar items. You assume full responsibility to determine and/or assure compliance with any such standards and related certifications as may be applicable. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.

Certain Instructions. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, some circuit components may have case temperatures greater than 60°C as long as the input and output ranges are maintained at nominal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be indentified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch.

Agreement to Defend, Indemnify and Hold Harmless. You agree to defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of or in connection with any use of the EVM that is not in accordance with the terms of this agreement. This obligation shall apply whether Claims arise under the law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate TI components for possible use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265