

Zero Ripple Current and Low THD LED Driver With iW3623

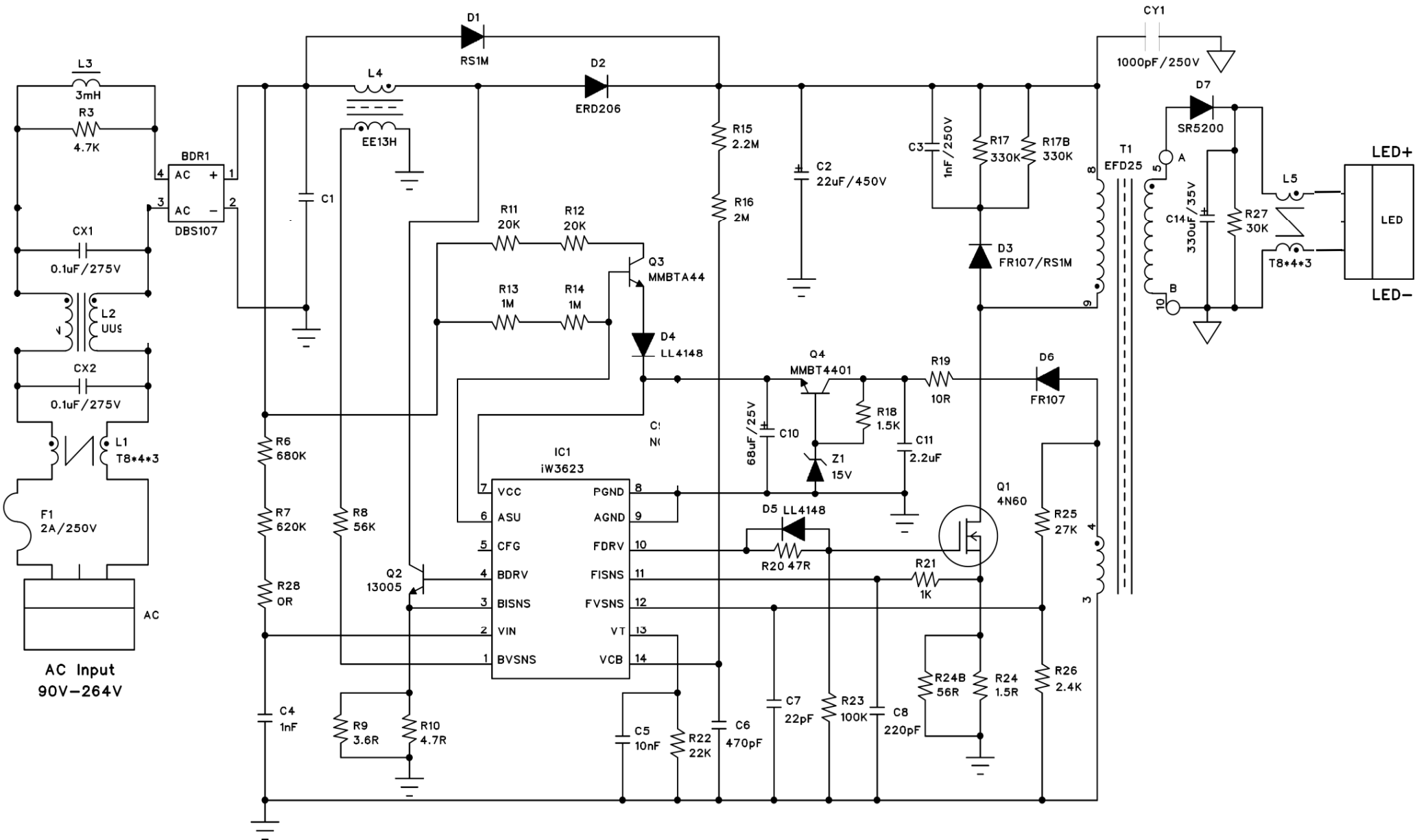
General Design Specification:

1. AC Input Range 90-264Vac, Isolated ac-dc offline, 8LEDS, Output 700mA
2. For Isolated Applications
3. High Efficiency, High power Factor and Least Parts Solution
4. Temperature degrade control to adjust the LED.
5. Primary-only Sensing eliminates opto-isolator feedback and simplifies design

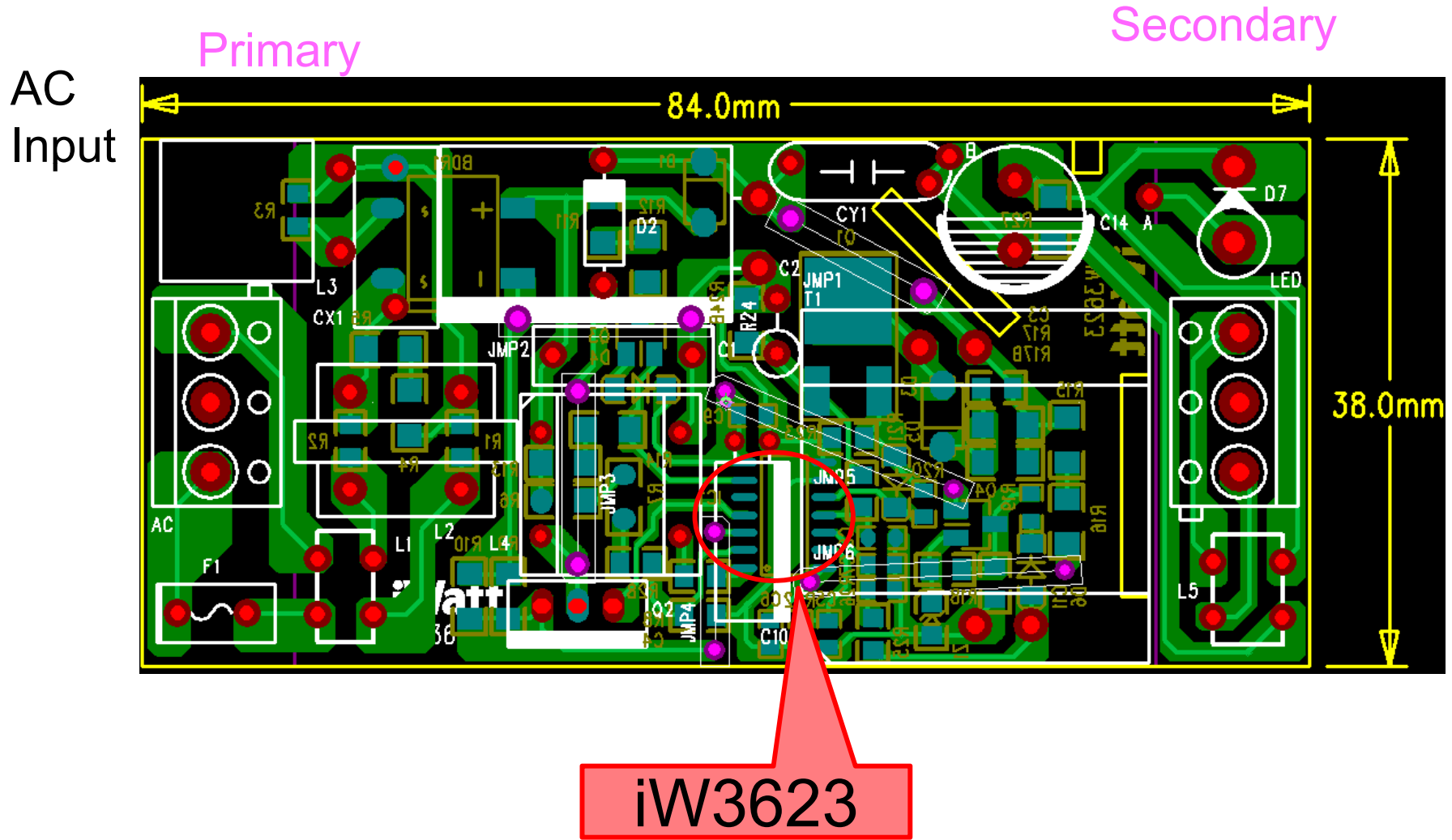
1. Specification

Description	Symbol	Min	Typ	Max	Units	Comment
Input						
Voltage	V_{IN}	90		264	V _{AC}	2 Wire
Frequency	f_{LINE}	47	50/60	63	Hz	
Output						
Output Voltage	V_{OUT}		24		V	Measured at the end of PCB
Output Current	I_{OUT}		0.7		A	
Output Ripple Current	I_{RIPPLE}		30		mA _{P-P}	Set oscilloscope at 20MHz bandwidth.
Total Output Power						
Continuous Output Power	P_{OUT}		17		W	
Performance Factor	PF	0.9			A	
Active Mode Efficiency	η		83		%	Measured at end of PCB, $V_{IN} = 230VAC$ ($T_{AMB} = 25\text{ }^{\circ}C$).
Environmental						
THD	THD			15	%	
Conducted EMI		Meets CISPR22B / EN55022B				
Safety		Designed to meet IEC950, UL1950 Class II				
Ambient Temperature	T_{AMB}	0		40	$^{\circ}C$	Free convection, sea level

2. Schematic



3. Circuit Board Photograph



4.BOM-1

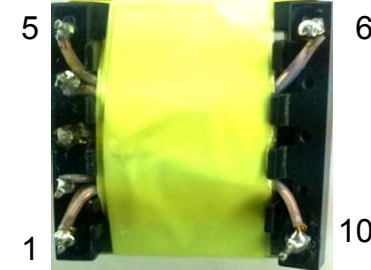
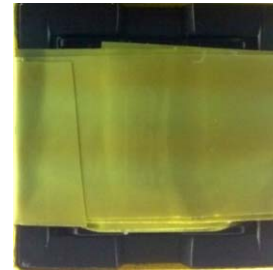
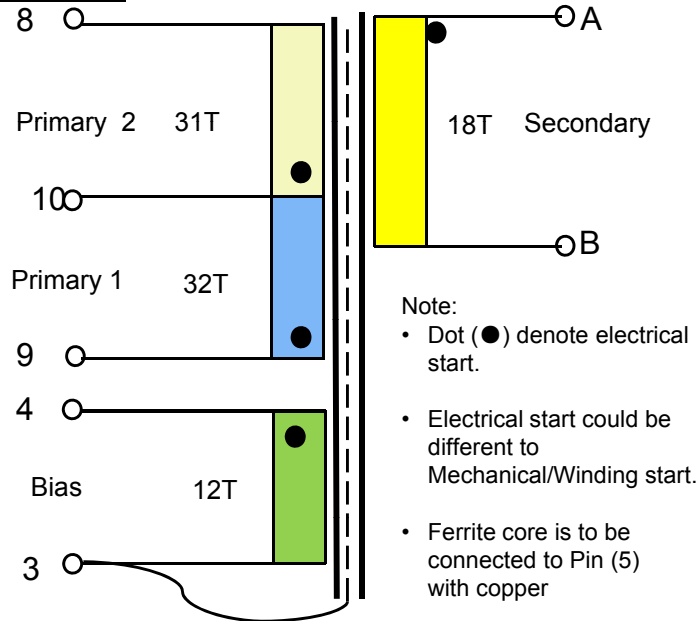
Qty	Ref.	Description			Size	Part Number	Manufacturer	Cost(RMB)	Total(RMB)	Cost(USD)
1	U1				SO-14	IW3623-00	iWatt, Inc.	0	0	0
2	CX1,CX2	0.1uF	275V	X2	PIN=10.5MM	PI104K3IC39H200D9R	Carli	0.21	0.42	0.065625
1	C1	0.1uF	450V	CBB	PIN=10.5MM	PX104K3IC39H200D9R	Carli	0.16	0.16	0.025
1	C11	2.2UF	25V		SMD-0805	C2012X7R1E225J	TDK Corp.	0.12	0.12	0.01875
1	C7	22pF	50V		SMD-0805	C2012X7R1E220J	TDK Corp.	0.009	0.009	0.00140625
1	C5	10nF	50V		SMD-0805	C2012X7R1E103J	TDK Corp.	0.009	0.009	0.00140625
1	C4	1nF	50V		SMD-0805	C2012X7R1E102J	TDK Corp.	0.009	0.009	0.00140625
1	C6	470pF	50V		SMD-0805	C2012X7R1E471J	TDK Corp.	0.009	0.009	0.00140625
1	C3	1NF	250V		SMD-0805	C2012X7R1E102J	TDK Corp.	0.01	0.01	0.0015625
1	C8	220pF	50V		SMD-0805	C2012X7R1E221J	TDK Corp.	0.009	0.009	0.00140625
1	C14	330UF	35V	E-CAP,105°C	8X10MM	35LK330M	Yongming	0.5	0.5	0.078125
1	C10	68UF	25V	E-CAP,105°C	5X11MM	25LK68M	Yongming	0.1	0.1	0.015625
1	C2	22UF	450V	E-CAP,105°C	13X20MM	450LK22M	Yongming	1.25	1.25	0.1953125
1	BR1	1A	1000V	DI1010S		DI1010S	PANJIT Semiconductor	0.55	0.55	0.0859375
1	D1	1A	1000V	RS1M	SMD	SREGC10MH/FR107	ZOWEI	0.07	0.07	0.0109375
1	D2	,2A	600V	ER206	DO-15	ER206	PANJIT Semiconductor	0.23	0.23	0.0359375
2	D3,D6	1A	1000V	FR107	SMD	SREGC10DH/FR102	ZOWEI	0.06	0.12	0.01875
1	D7	5A	200V		DO-201	MBR5200	PANJIT Semiconductor	0.5	0.5	0.078125
2	D4,D5				LL34	1N4148	PANJIT Semiconductor	0.03	0.06	0.009375
1	Q1	4A	600V	mosfet	TO-252	FTD04N60BG	ARK	0.8	0.8	0.125
1	Q2	4A	700V	mosfet	TO-220F	BTR13005GD	IPS	0.68	0.68	0.10625
1	Q3					MMBA44	NXP	0.2	0.2	0.03125
1	Q4					MMBT4401	ON	0.035	0.035	0.00546875
1	R24	1.5R		MOF	1W			0.02	0.02	0.003125
2	R4,R5	300KΩ	+/-5%		SMD-1206	RC1206JR-07300KL	YAGEO	0.009	0.018	0.0028125
1	R6	680KΩ	+/-5%		SMD-1206	RC1206JR-07680KL	YAGEO	0.009	0.009	0.00140625
1	R7	620KΩ	+/-5%		SMD-1206	RC1206JR-07620KL	YAGEO	0.009	0.009	0.00140625
1	R28	0R			SMD-06805	RC0805JR-070RL	YAGEO	0.009	0.009	0.00140625

4.BOM-2

Qty	Ref.	Description		Size	Part Number	Manufacturer	Cost(RMB)	Total(RMB)	Cost(USD)	
1	R9	3.6Ω	+/-5%		SMD-1206	RC1206JR-073R6L	YAGEO	0.009	0.009	0.00140625
1	R10	4.7Ω	+/-5%		SMD-1206	RC1206JR-074R7L	YAGEO	0.009	0.009	0.00140625
1	R24B	56Ω	+/-5%		SMD-1206	RC1206JR-0756RL	YAGEO	0.009	0.009	0.00140625
2	R11,R12	20KΩ			SMD-1206	RC1206JR-0720KL	YAGEO	0.009	0.018	0.0028125
2	R13,R14	1MΩ			SMD-1206	RC1206JR-071ML	YAGEO	0.009	0.018	0.0028125
1	R15	2.2MΩ			SMD-1206	RC1206JR-072M2L	YAGEO	0.009	0.009	0.00140625
1	R16	2MΩ			SMD-1206	RC1206JR-072ML	YAGEO	0.009	0.009	0.00140625
2	R17,R17B	330KΩ	+/-5%		SMD-1206	RC1206JR-07330KL	YAGEO	0.009	0.018	0.0028125
1	R3	4.7KΩ	+/-1%		SMD-0805	RC0805FR-074K7L	YAGEO	0.007	0.007	0.00109375
1	R28	30KΩ	+/-1%		SMD-0805	RC0805FR-0730KL	YAGEO	0.007	0.007	0.00109375
1	R8	56KΩ	+/-1%		SMD-0805	RC0805FR-0756KL	YAGEO	0.007	0.007	0.00109375
1	R18	1.5KΩ	+/-1%		SMD-0805	RC0805FR-071K5L	YAGEO	0.007	0.007	0.00109375
1	R19	10Ω	+/-1%		SMD-0805	RC0805FR-0710RL	YAGEO	0.007	0.007	0.00109375
1	R22	22KΩ	+/-1%		SMD-0805	RC0805FR-0722KL	YAGEO	0.007	0.007	0.00109375
1	R23	100KΩ	+/-1%		SMD-0805	RC0805FR-07100KL	YAGEO	0.007	0.007	0.00109375
1	R26	2.4KΩ	+/-1%		SMD-0805	RC0805FR-072K4L	YAGEO	0.007	0.007	0.00109375
1	R25	27KΩ	+/-1%		SMD-0805	RC0805FR-071KL	YAGEO	0.007	0.007	0.00109375
1	R21	1KΩ	+/-1%		SMD-0805	RC0805FR-0730KL	YAGEO	0.007	0.007	0.00109375
1	R20	47Ω	+/-1%		SMD-0805	RC0805FR-0747RL	YAGEO	0.007	0.007	0.00109375
1	F1	2A	250V			MST2A250V	GONGDE	0.28	0.28	0.04375
2	L1,L5	20uH		B29	Common Mode inductor	T8X4X3	BIFU	0.46	0.92	0.14375
1	L2				UU9.8			0.6	0.6	0.09375
1	L3				8X10MM			0.3	0.3	0.046875
1	L4	1MH			EE13			0.9	0.9	0.140625
1	Z1	15V			SOD-323		ZV-15V	0.05	0.05	0.0078125
1	CY1						1NF250V	0.12	0.12	0.01875
1	T1	Transformer	L=25mH		EFD25		(TDK Corp.)	3.5	3.5	0.546875
1	PCB	PCB						1	1	0.15625
							TOTAL	12.965	13.761	2.15015625

5. Transformer Construction

SCHEMATIC



ELECTRICAL SPECIFICATIONS:

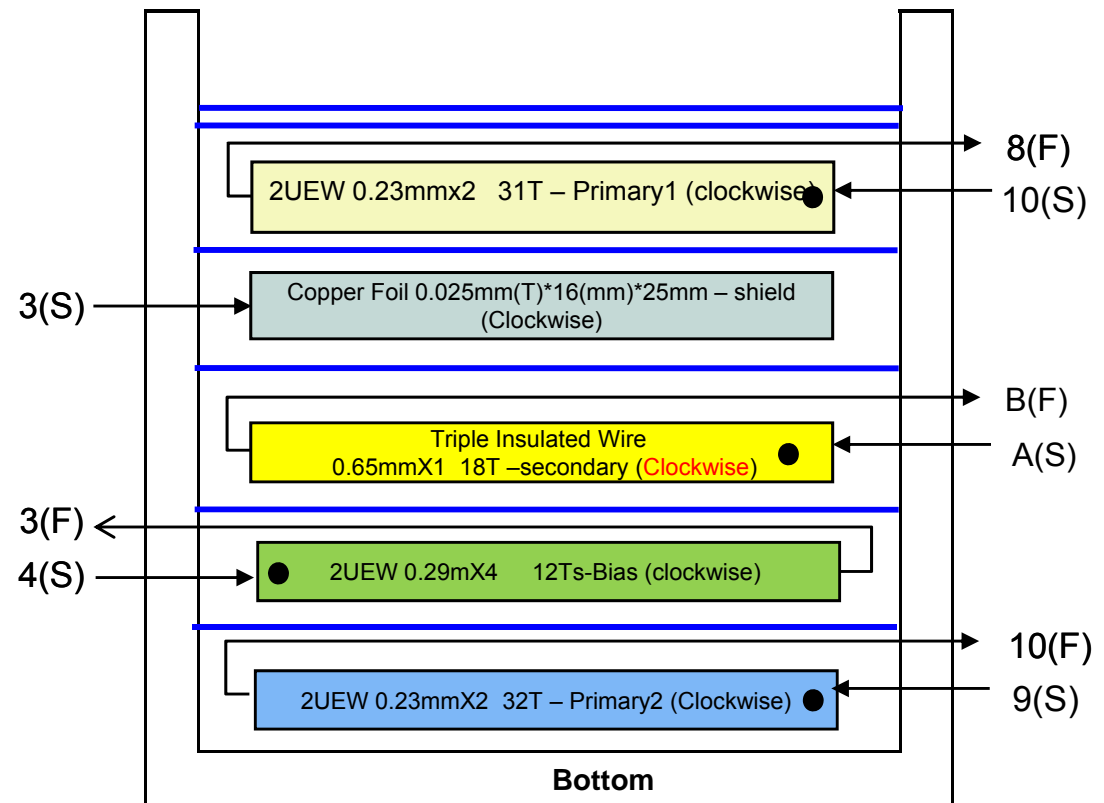
1. Primary Inductance (L_p) = 1.4mH @10KHz
2. Primary Leakage Inductance (L_k) <= 50uH @10KHz
3. Electrical Strength = 3KV, 50/60Hz, 1Min

MATERIALS:

1. Core : ERD26 (Ferrite Material TDK PC40 or equivalent)
2. Bobbin : ERD26, Horizontal, Primary=5, Secondary=2
3. Magnet Wires (Pri) : Type 2-UEW
4. Magnet Wire (Sec) : Triple Insulated Wires
5. Layer Insulation Tape : 3M1298 or equivalent.

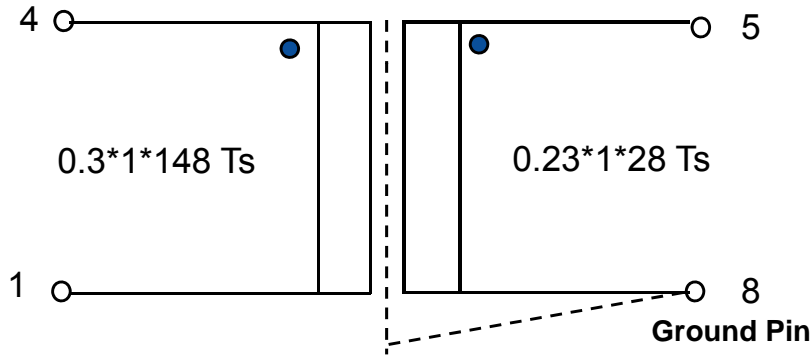
FINISHED :

1. Cut remained of 1/2 Pin3, after wires termination
2. Core is connected to PRI-GND pin4.
3. Varnish the complete assembly



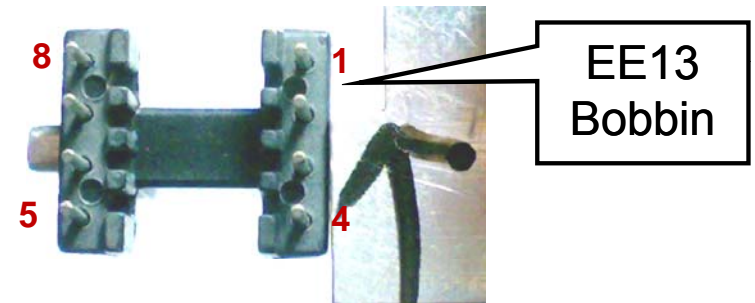
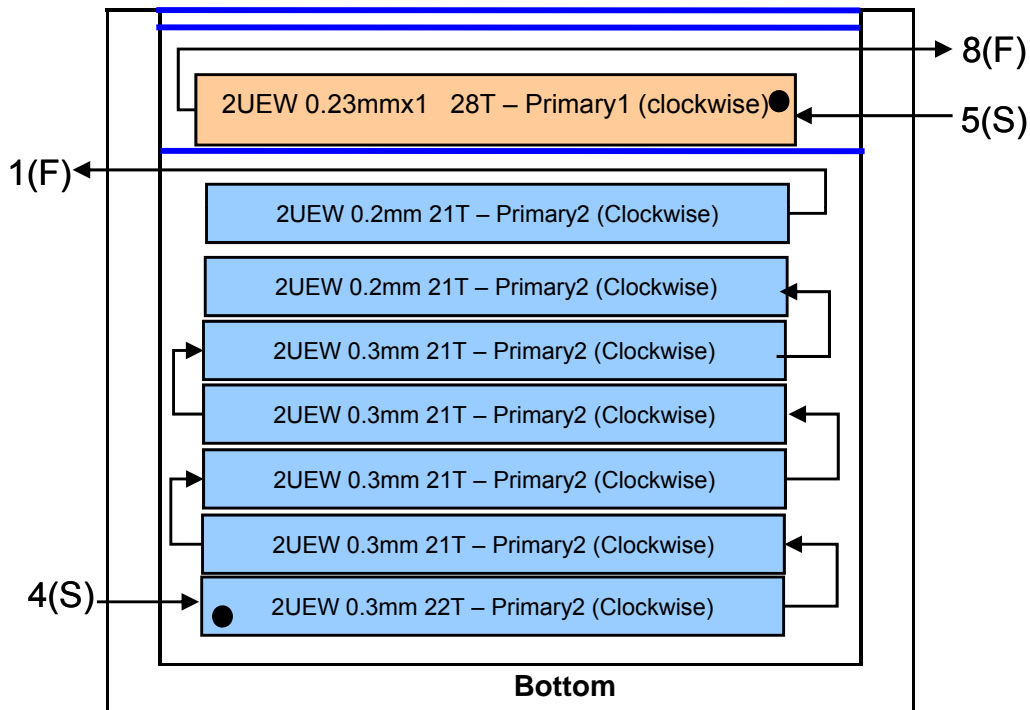
6.PFC Inductor

SCHEMATIC



ELECTRICAL SPECIFICATIONS:

1. Inductance (L_{p8-10}) = 0.9mH @10KHz
2. Core : EE13 (Ferrite Material TDK PC40 or equivalent)
3. Bobbin : EE13, Horizontal
4. Ferrite core is connected to Pin 8 after assembling
5. Cut Pin 2,3 ,6,7after wires termination
6. Varnish the complete assembly

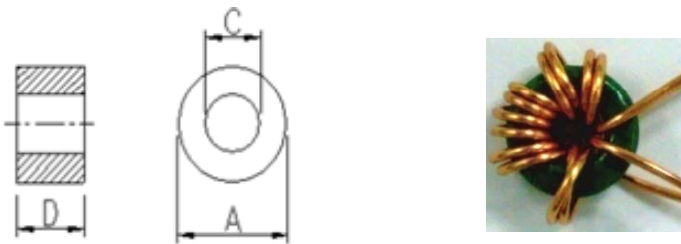


7. Common Mode Inductor L1、L5

Properties of B&F Ferrite - Nickel Zinc (Ni-Zn)

Material	μ_i	Bms(Gs)	Hc(Oe)	Br(Gs)	Tc(°C)	$\rho (\Omega \cdot \text{cm})$	Frequency (MHz)	$\alpha \text{ ur } \times 10^{-6}/^\circ\text{C}$
B29	800	2900	0.30	1420	150	$1 \cdot 10^7$	0.1~0.7	25~45

EMI Toroidal Core (T Type)



Dimensions 尺寸 (mm)

Core Size	Conf.	A	D	C	Fig
T 8.0x4.0x3.0		8.0±0.3	4.0±0.3	3.0±0.2	1,2,3

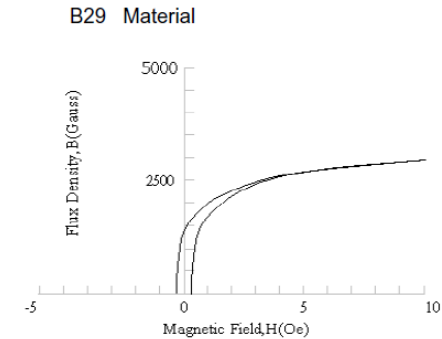
Ferrite core : Ni -Zn T8*4*3

Wire gauge: 0.45mm, 6Turns

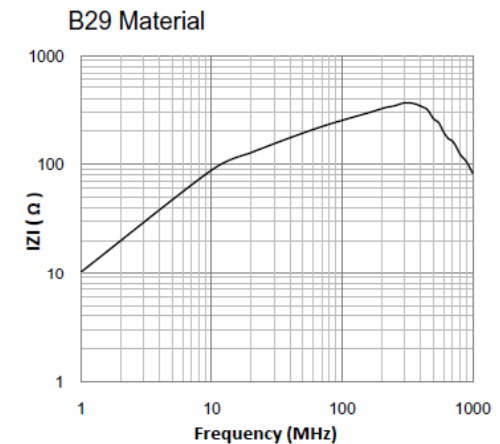
Inductance @10kHz, 1V: 17uH +/-10%

DCR: 0.1 OHM +/-20%

Saturation Flux Density (Ni-Zn)



Impedance Vs Frequency Curve (Ni-Zn)



B.F.

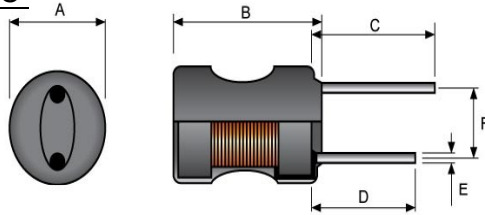
Contacts Information

Company Name : Bead & Ferrite Electronics (HK) Ltd.
 Telephone No. : (852) 2601 0833
 Fax No. : (852) 2693 6202
 Email Address : bf@bnf.com.hk
 Home Page : www.bnf.com.hk
 Address : RM. 16-17, 15/F., Block C, Goldfield Ind. Centre,
 No.1 Sui Wo Road, Fo Tan, N.T. Hong Kong

8. EMI choke 24V 700MA

1. Differential Mode Inductor L3

SCHEMATIC



Ferrite core size : Ax B 10x12mm

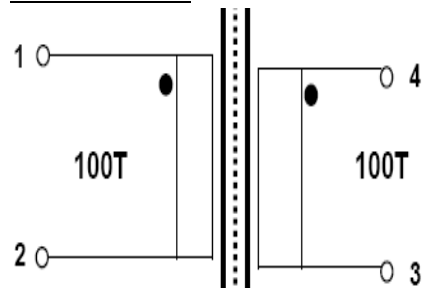
Wire gauge: 0.23mm, 265 Turns

Inductance @10kHz, 1V: 3mH +/-10%

DCR: 5.1OHM +/-20%

2. Common Choke L2 for EMI

SCHEMATIC



Ferrite core : UU9.8 μ >=10k

Wire gauge: 0.25mm, 100Turns

Inductance @10kHz, 1V: 25mH +/-20%

DCR: 1.2OHM +/-20%

10. Harmonic and current waveform

Chroma

ANALYZER 6630

2093.09.13

Current Harmonics

Setup: CLASS_C Gen setting: 1(1) U : 114.76 V fu: 60.001 Hz
Live Analysed periods: 4 I : 175.38 mA P: 20.05 W
Module: M1 Limit: Class C (Standard) I1: 175.27 mA

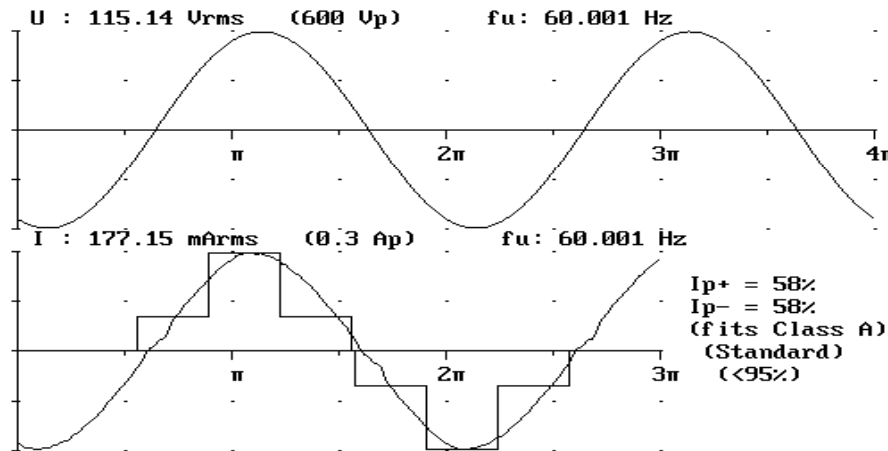
Note:
THD=3.13 % (PF=0.996) PASSED
P < 25 W

No	mA	Lim mA	No	mA	Lim mA	No	mA	Lim mA
1	175.27		15	1.31		29	0.33	
2	0.06		16	0.11		30	0.10	
3	4.08		17	0.64		31	0.50	
4	0.18		18	0.15		32	0.17	
5	0.46		19	0.45		33	0.63	
6	0.15		20	0.22		34	0.18	
7	0.83		21	0.51		35	0.76	
8	0.11		22	0.25		36	0.11	
9	1.55		23	0.27		37	0.46	
10	0.03		24	0.19		38	0.26	
11	1.43		25	0.48		39	0.70	
12	0.16		26	0.13		40	0.16	
13	1.59		27	0.46				
14	0.15		28	0.06				

Current range: 0.3 Ap

Waveform M1

Note:



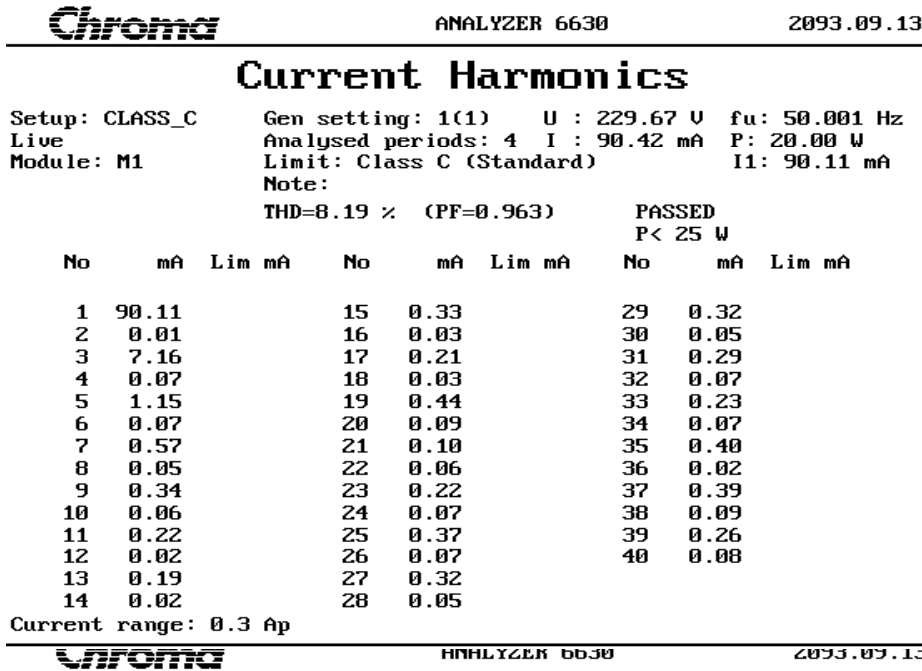
Harmonics current @115Vac

THD=3.13%

AC current waveform @115Vac

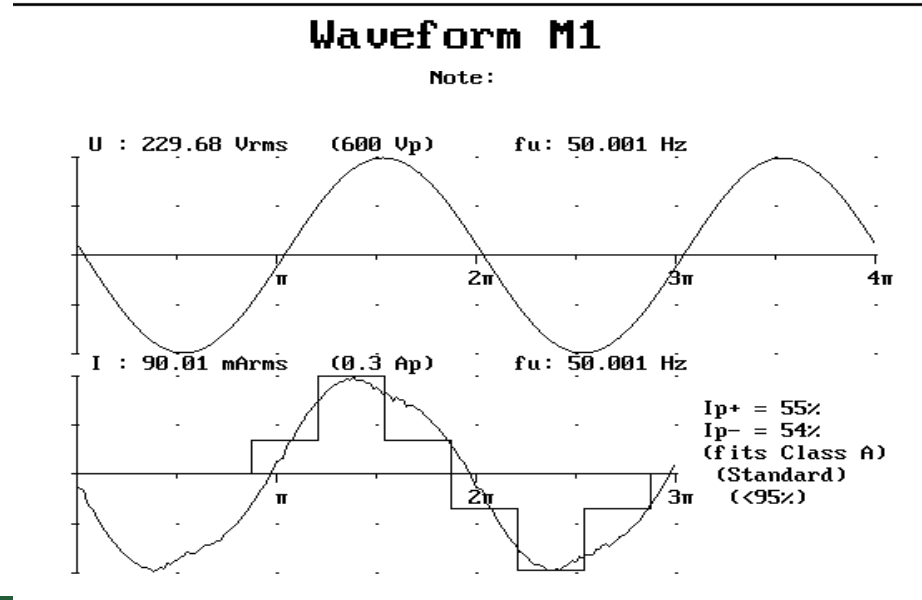
PF=0.996

11. Harmonic and current waveform



Harmonics current @230Vac

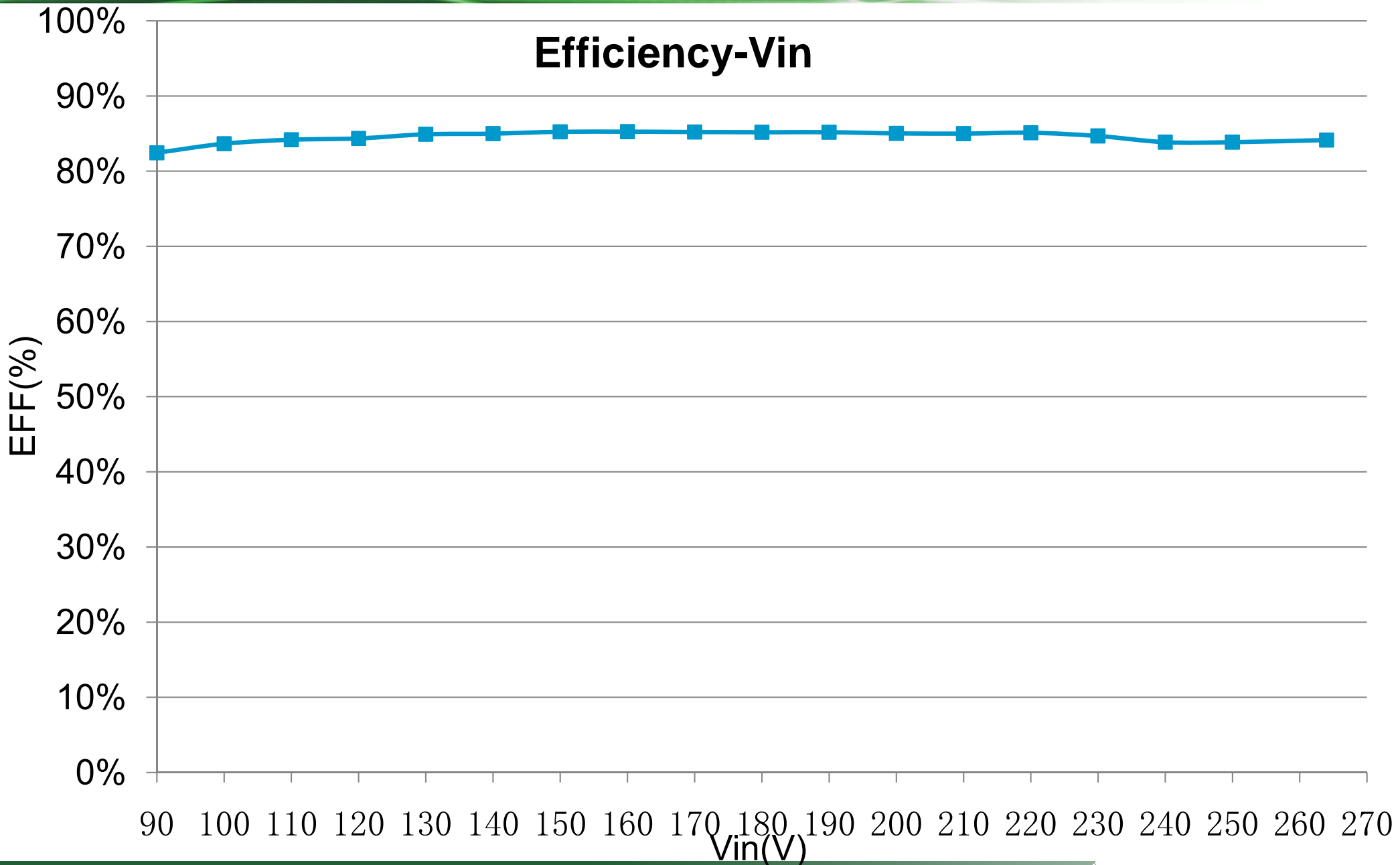
THD=8.19%



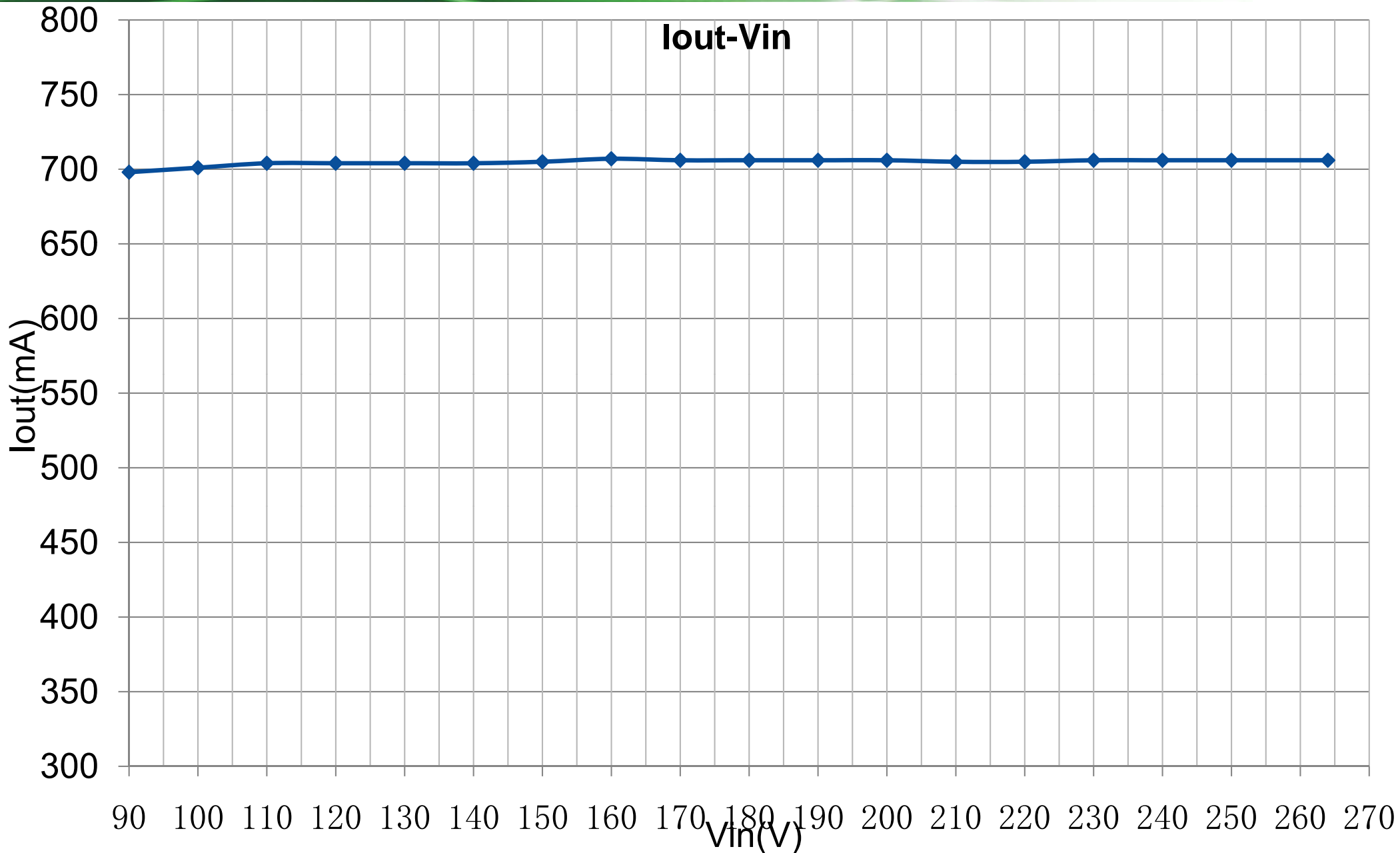
AC current waveform @230Vac

PF=0.963

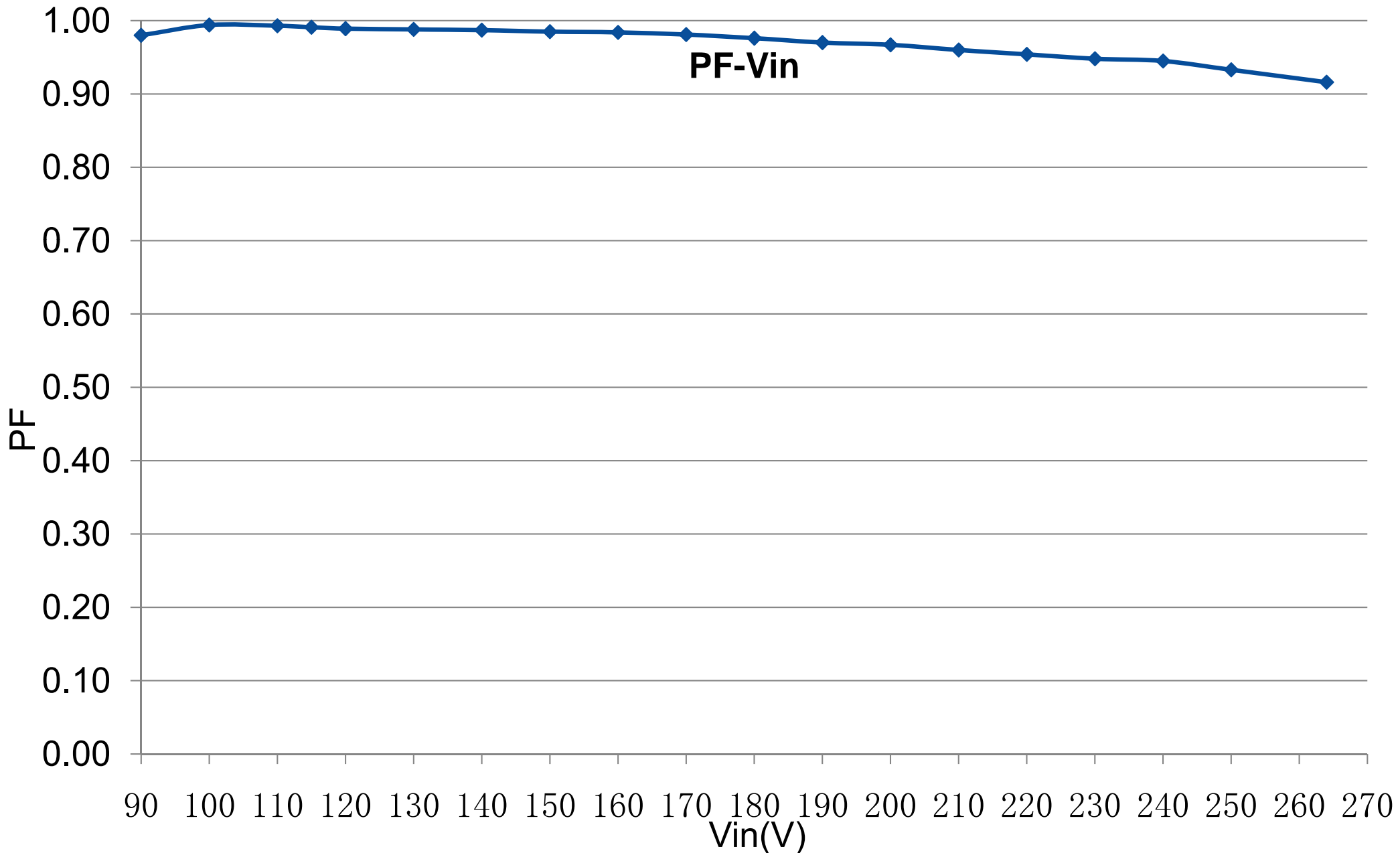
12. Variable Input Vs. Efficiency Measurement



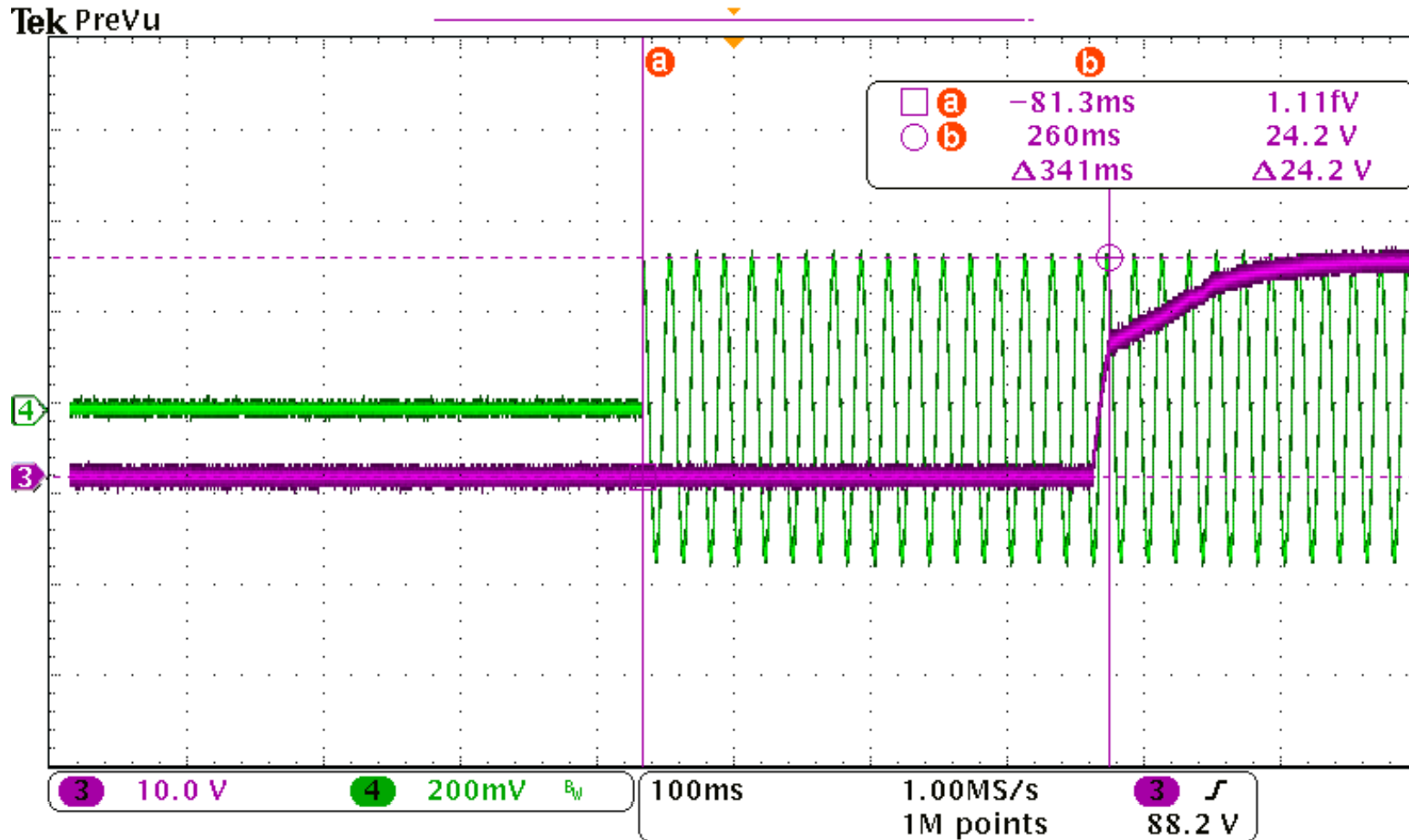
13. Variable Input Vs. Iout Measurement



14. Variable Input Vs. PF Measurement



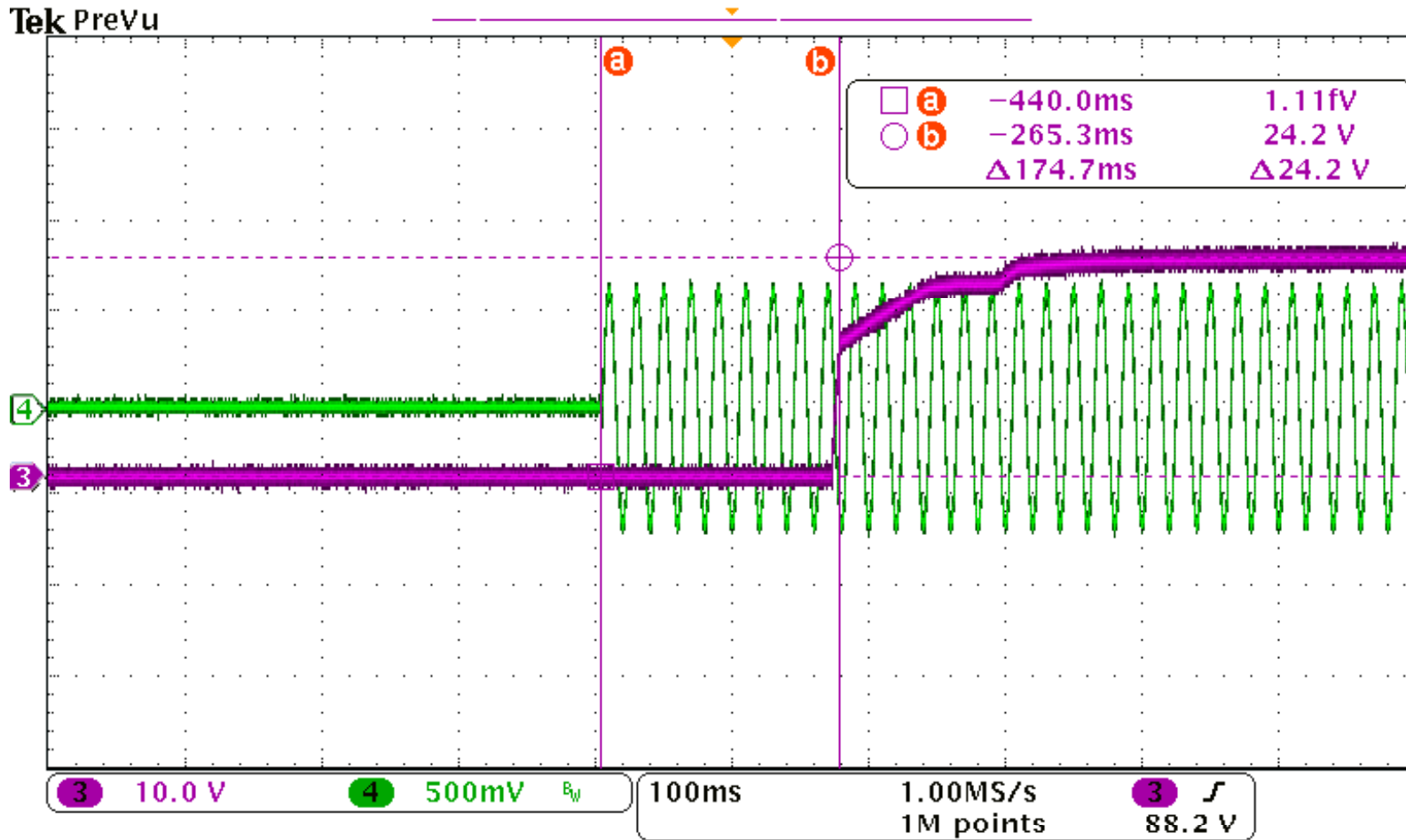
15. Start up and turn on delay time



115V_{AC}, Full Load

$T_{ST_DELAY} = 341ms$

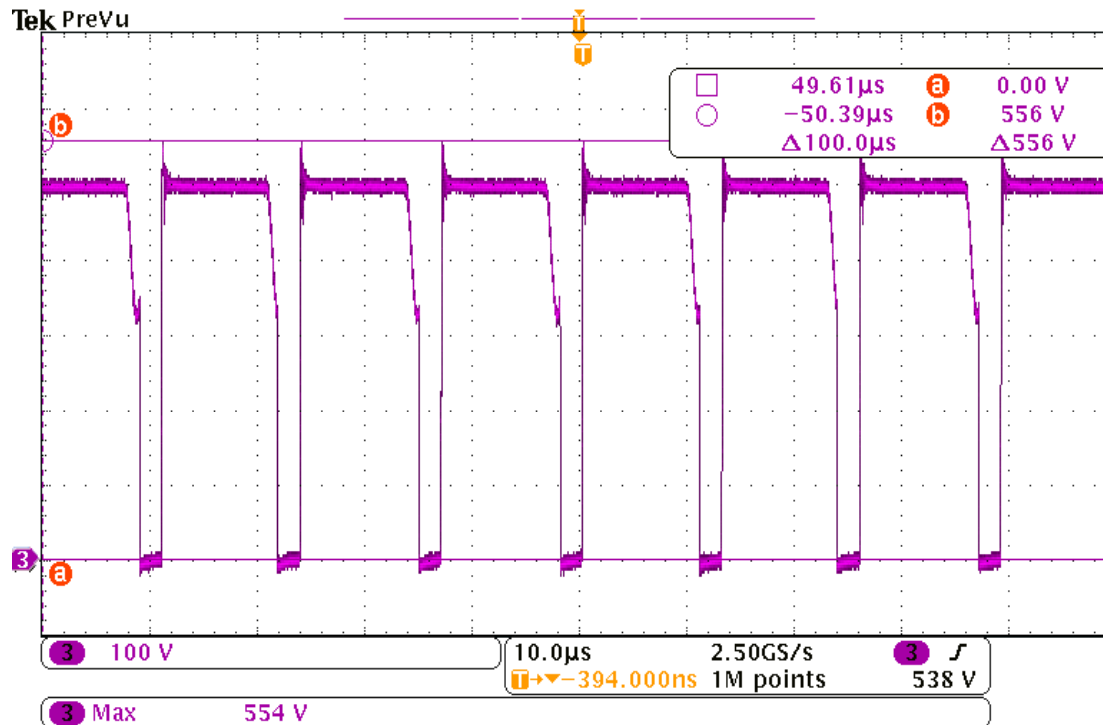
16. Start up and turn on delay time



230V_{AC}, Full Load

$T_{ST_DELAY} = 174.7\text{mS}$

17. Q1 MOSFET V_{DS} Waveform



Test Condition:

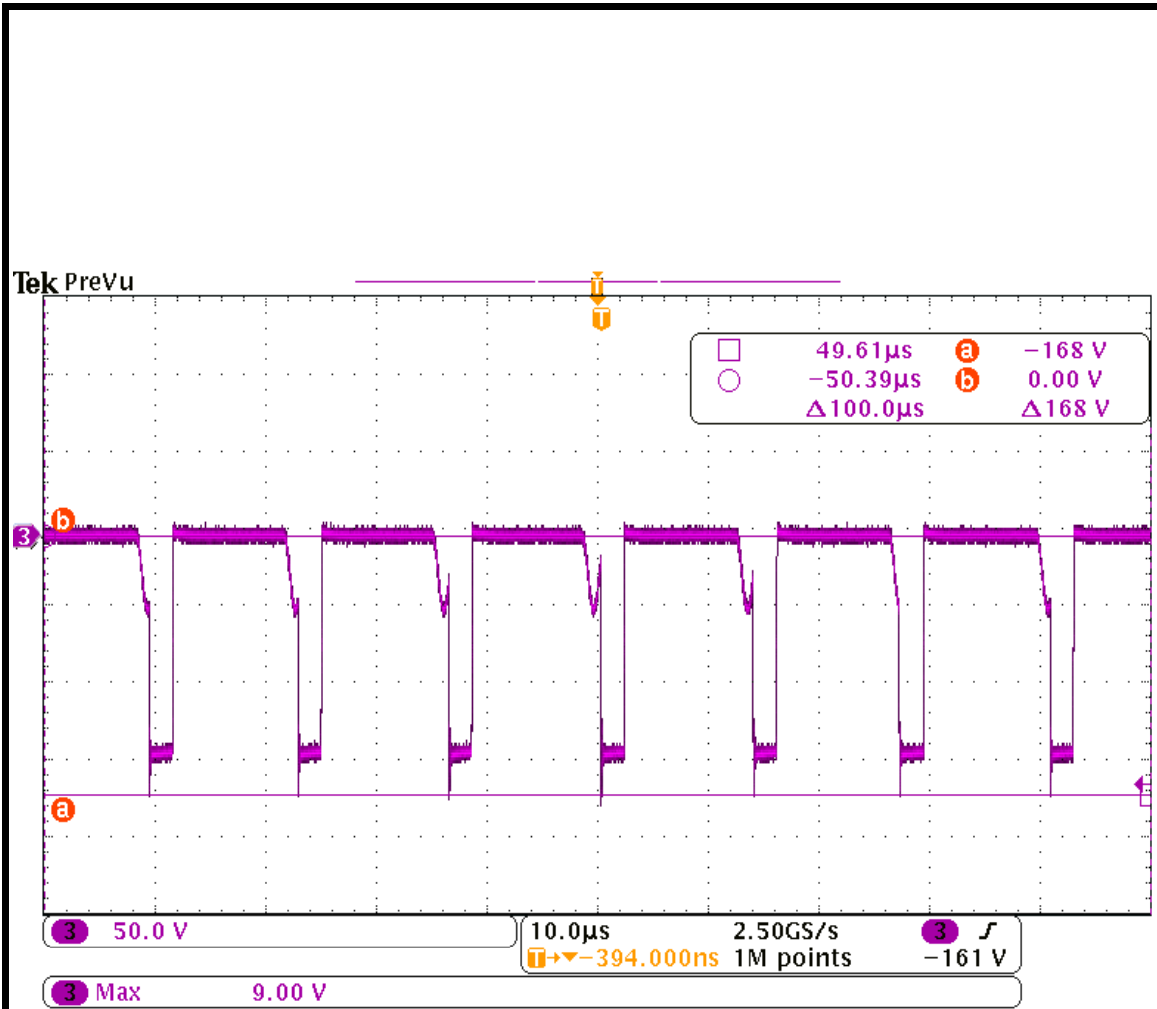
$V_{IN}=264VAC$, $V_{OUT}=24V$

Result:

$V_{DS_MAX}=556V$

Remark: Mosfet Spec__4A 600V

18. Output Diode Waveform



Test Condition:

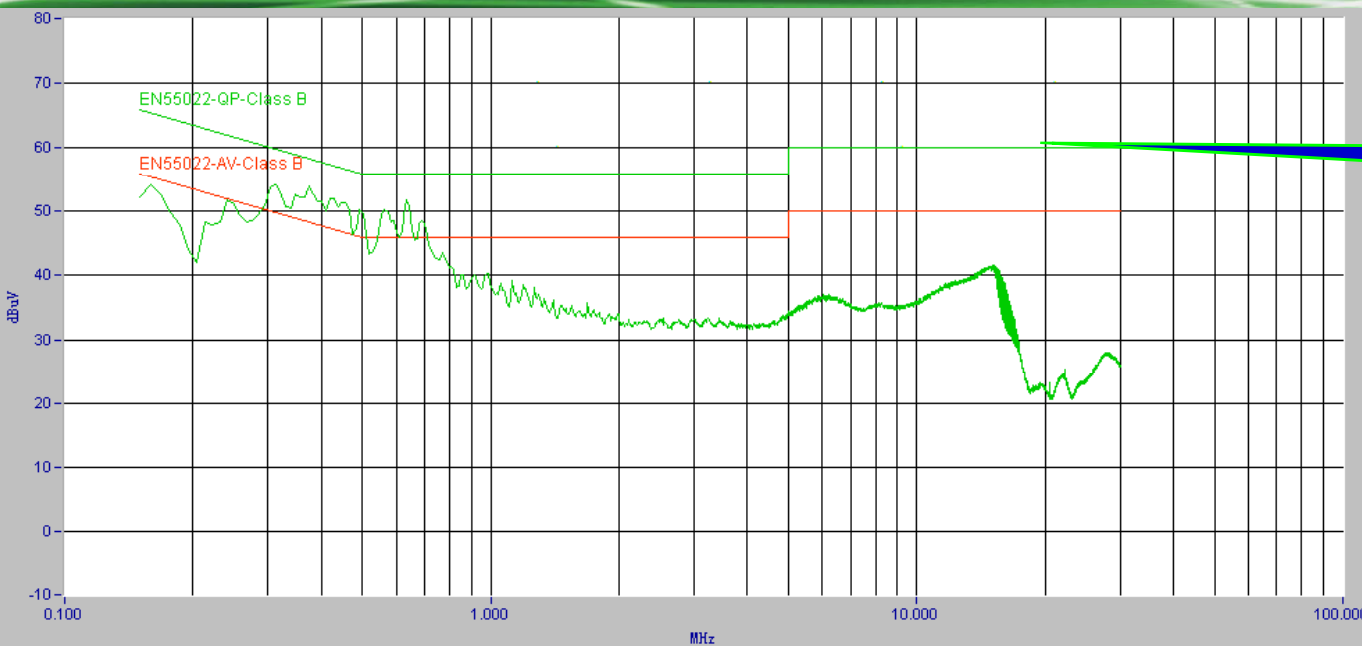
$V_{IN}=264VAC$, $V_{OUT}=24V$

Result:

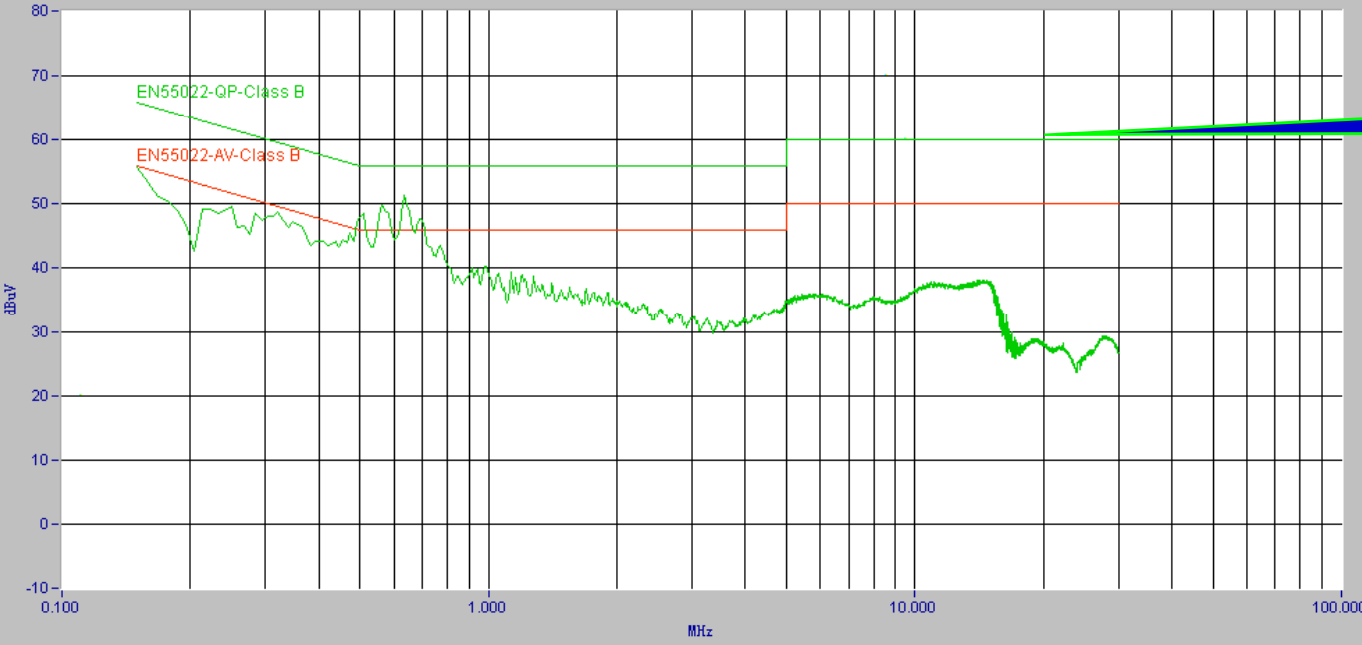
$V_{RRM_MAX}=168V$

Remark: Diode Spec__5A 200V

19. Conducted EMI (Full Load)

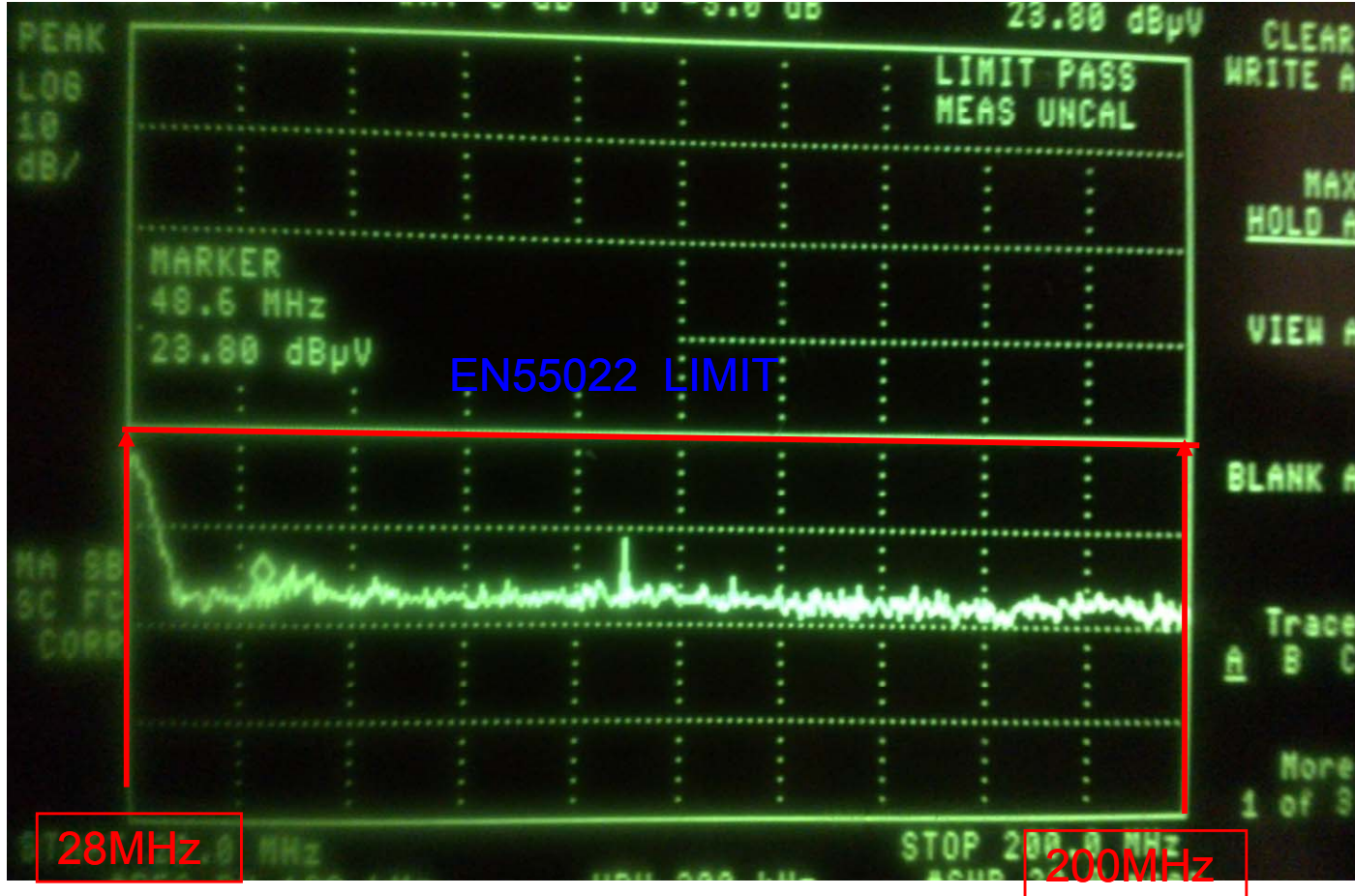


Input=230VAC
L line QP&AV scan



Input=230VAC
N line QP&AV scan

20. Radiated EMI (for reference)



Note: 1, $V_{in}=230V_{ac}$
2, Output is floating