iWatt
Power Management Simplified Digitally™

Zero Ripple Current and Low THD With iW3623 for T8 LED driver

General Design Specification:

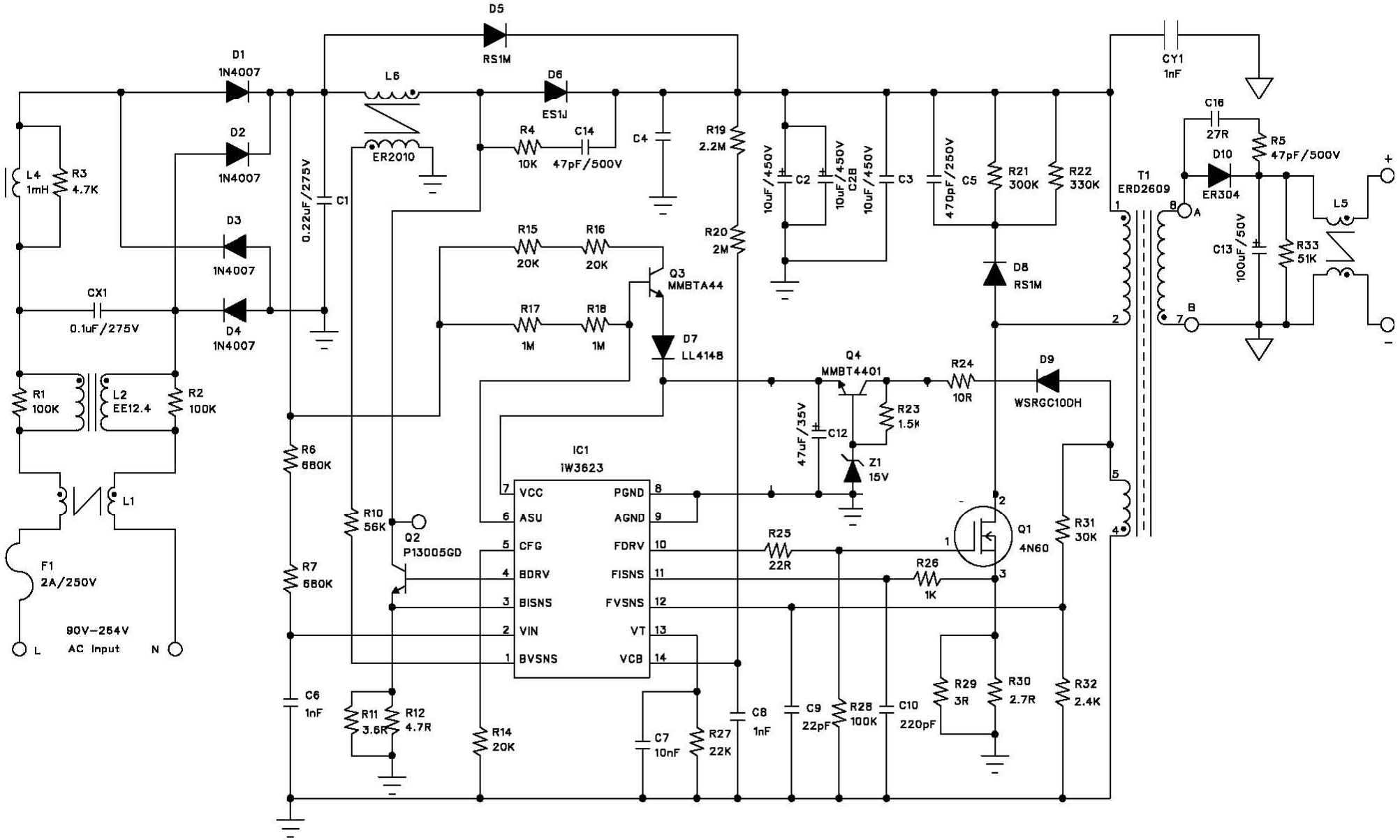
1. AC Input Range 90-264Vac, Isolated ac-dc offline, 12LEDS,Output 450mA
2. For Isolated Applications
3. High Efficiency, High power Factor and Least Parts Solution
4. Temperature degrade control to adjust the LED.
5. Primary-only Sensing eliminates opto-isolator feedback and simplifies design

iWatt CONFIDENTIAL

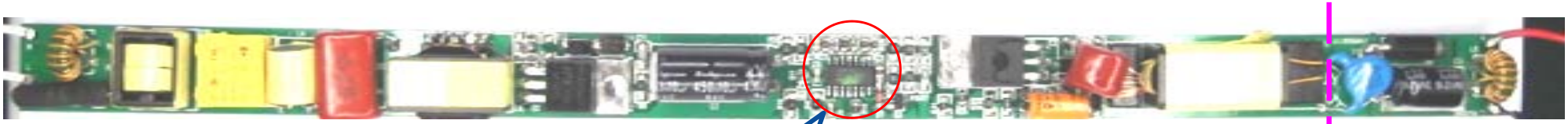
1. Specification

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}		40		V	Measured at the end of PCB
Output Current	I_{OUT}		0.45		A	
Output Ripple Current	I_{RIPPLE}		30		mA_{P_P}	Set oscilloscope at 20MHz bandwidth.
Total Output Power						
Continuous Output Power	P_{OUT}		18		W	
Performance Factor	PF	0.9			A	
Active Mode Efficiency	η		86		%	Measured at end of PCB, V_{IN} = 230VAC (T_{AMB} = 25 ℃).
Environmental						
THD	THD			15	%	
Conducted EMI		Meets CISPR22B / EN55022B				
Safety		Designed to meet IEC950, UL1950 Class II				
Ambient Temperature	T_{AMB}	0		40	° C	Free convection, sea level

2. Schematic


D5
RS1M
D1
1N4007
L6
D6
ES1J
CY1
1nF
C16
27R
R5
47pF/500V
D2
1N4007
ER2010
R4
10K
C14
47pF/500V
C4
R19
2.2M
C2
C2B
C3
C5
470pF/250V
R21
300K
R22
330K
T1
ERD2609
D10
ER304
L4
1mH
R3
4.7K
D3
1N4007
R15
20K
R16
20K
R20
2M
Q3
MMBTA44
C13
100uF/50V
R33
51K
L5
0.22uF/275V
C1
CX1
0.1uF/275V
D4
1N4007
R17
1M
R18
1M
D7
LL4148
D8
RS1M
R1
100K
L2
EE12.4
R2
100K
Q4
MMBT4401
R24
10R
D9
WSRGC10DH
R23
1.5K
C12
47uF/35V
Z1
15V
IC1
iW3623
R6
680K
L1
R10
56K
Q2
P13005GD
R25
22R
Q1
4N60
R31
30K
R7
680K
R26
1K
F1
2A/250V
90V-264V
AC Input
L
N
VCC
ASU
CFG
BDRV
BISNS
VIN
BVSNS
PGND
AGND
FDRV
FISNS
FVSNS
VT
VCB
C6
1nF
R11
3.6R
R12
4.7R
R14
20K
C7
10nF
R27
22K
C8
1nF
C9
22pF
R28
100K
C10
220pF
R29
3R
R30
2.7R
R32
2.4K

3. Circuit Board Photograph



AC
Input

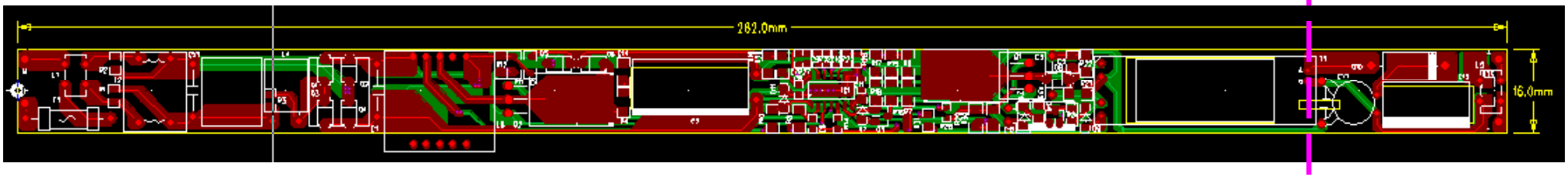
iW3623

DC
output

To LED

Primary

Secondary

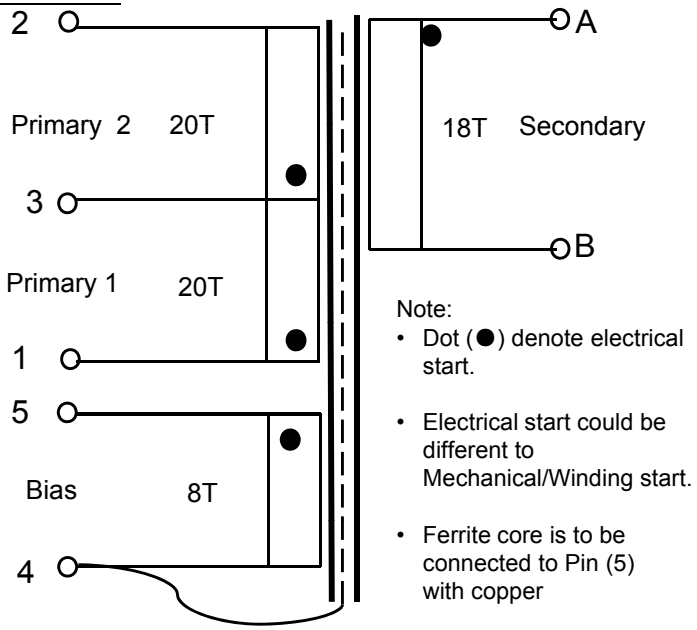


4.BOM

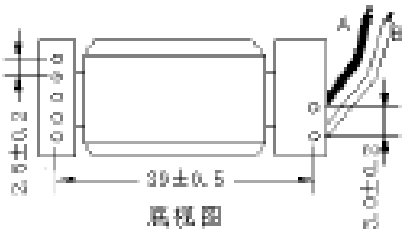
Item	Reference	Description	Qty	Item	Reference	Description	Qty
1	IC1	iW3623-00, Digital PWM Controller,Dimmable, SO-14	1	27	R6	21Ω,±5%, SMD-1206	1
2	CX1	0.1uF,275V, X2	1	28	R20	2MΩ,±5%, SMD-1206	1
3	C1	0.22uF,400V,CBB21	1	29	R21,R22	330KΩ,±5%, SMD-1206	2
4	C3	0.1uF,400V,CBB21	1	30	R23	1.0KΩ ±5%, SMD-0603	1
5	C2	10uF,450V, E-CAP	1	31	R24	10Ω ±5%, SMD-0603	1
6	C12	47uF,35V, E-CAP	1	32	R28	100KΩ ±5%, SMD-0603	1
7	C13	100uF,50V,E-CAP	1	33	R29,R30	2.7Ω ±1%, SMD-1206	2
8	C9	22pF, 25V, X7R, SMD-0603	1	34	R31	30KΩ ±1%, SMD-0603	1
9	C6,C8	1nF, 25V, X7R, SMD-0603	2	35	R32	2.4KΩ ±1%, SMD-0603	1
10	C4	10nF, 500V, X7R, SMD-1206	1	36	F1	T2A250V	1
11	C7	10nF,25V, X7R, SMD-0603	1	37	D1,D2,D3,D4	1N4007,DO-41(M7)	4
12	C5	470pF,250V, X7R, SMD-0805	1	38	D9	SRGC10DH(FR102),1A,200V, 1206-S	1
13	C4, C16	47pF,500V, X7R, SMD-1206	2	39	D5,D8	RS1M,1A,1000V, S0D-123	2
14	R1,R2	100KΩ ±5%, SMD-1206	2	40	D6	ES1J,1A,600V,SMA	1
15	R3	4.7KΩ ±5%, SMD-0805	1	41	D10	ER304,2A,400V,DO-201	1
16	R6	680KΩ ±5%, SMD-1206	1	42	D7	LL4148,0.15A,100V,LL-34	1
17	R7	620KΩ±5%, SMD-1206	1	43	Z1	Zener, ZMM15B,15V, LL-34	1
18	R8	0Ω ±5%, SMD-1206	1	44	Q1	4N60.4A,600V,TO-220	1
19	R10	56KΩ ±5%, SMD-0805	1	45	Q3	MMBTA44, NPN, 400V, SOT-23	1
20	R11	3.6Ω±5%, SMD-1206	1	46	Q2	3DD13005ED,NPN,4A 700V,T0-126	1
21	R4	20kΩ±5%, SMD-1206	1	47	L1	Common Mode Inductor T8*3*3 15uH	1
22	R14,R27	20kΩ±5%, SMD-0603	2	48	L2	EE12.4, 25mH	1
23	R15,R16	20KΩ±5%, SMD-1206	2	49	L4	8*10,1.0mH	1
24	R17,R18	1MΩ±5%, SMD-1206	2	50	L6	ER2010, L=0.9mH	1
25	R19	2.2MΩ,±5%, SMD-1206	1	51	L5	Common Mode Inductor T8*4*3 17uH	1
26	R26	470Ω ±5%, SMD-0603	1	52	T1	Transformer ERD2610 L=1.0~1.1mH	1

5. Transformer Construction

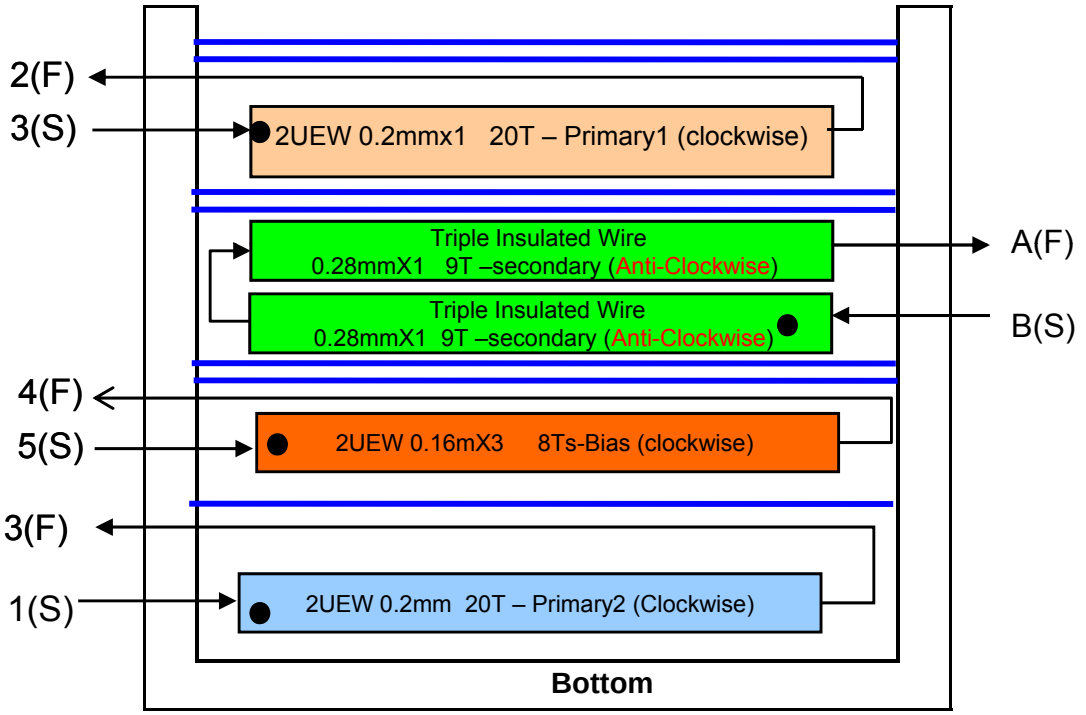
SCHEMATIC



Note:
- Dot (●) denote electrical start.
- Electrical start could be different to Mechanical/Winding start.
- Ferrite core is to be connected to Pin (5) with copper



Rotating direction of winding machine



ELECTRICAL SPECIFICATIONS:

1. Primary Inductance (Lp) = 1.1mH @10KHz
2. Primary Leakage Inductance (Lk)< = 50uH @10KHz
3. Electrical Strength = 3KV, 50/60Hz,1Min

MATERIALS:

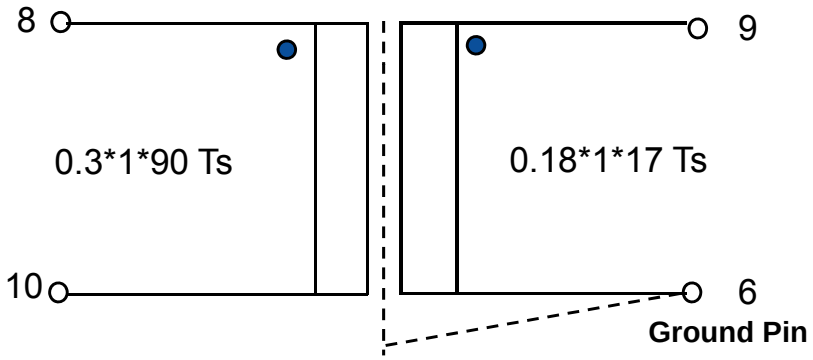
1. Core : ERD26 (Ferrite Material TDK PC40 or equivalent)
2. Bobbin : ERD26,Horizontal, Primary=5, Secondary=2
3. Magnet Wires (Pri) : Type 2-UEW
4. Magnet Wire (Sec) : Triple Insulated Wires
5. Layer Insulation Tape :3M1298 or equivalent.

FINISHED :

1. Cut remained of ½ Pin3,after wires termination
2. Core is connected to PRI-GND pin4.
3. Varnish the complete assembly

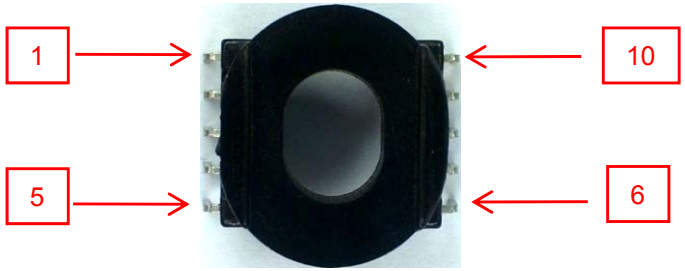
6.PFC Inductor

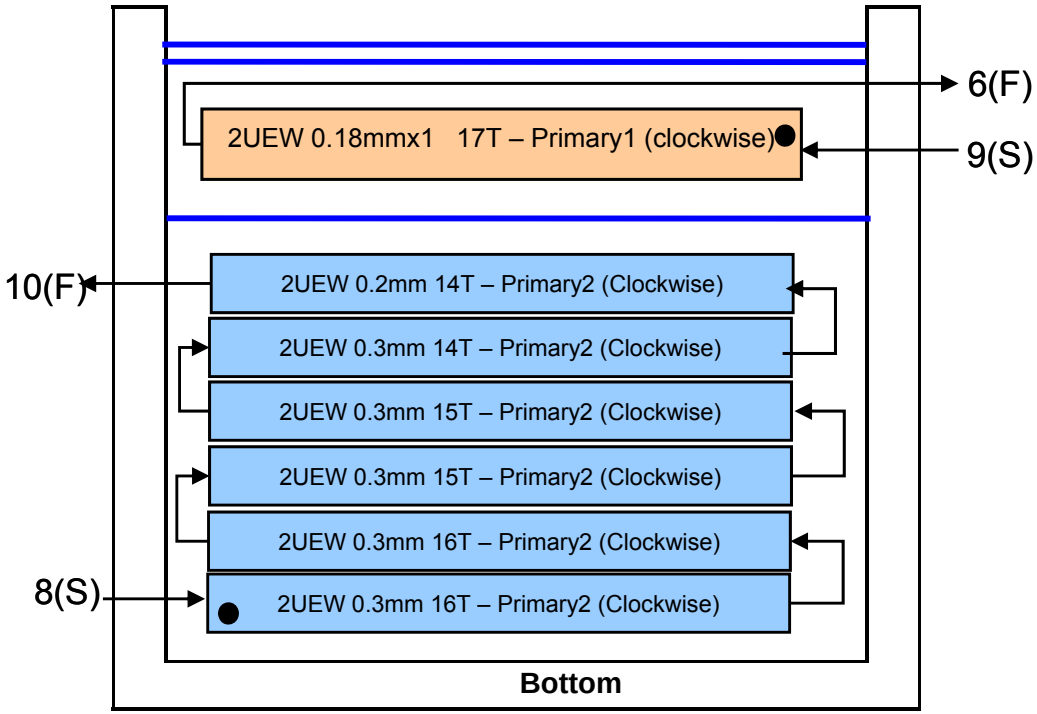
SCHEMATIC

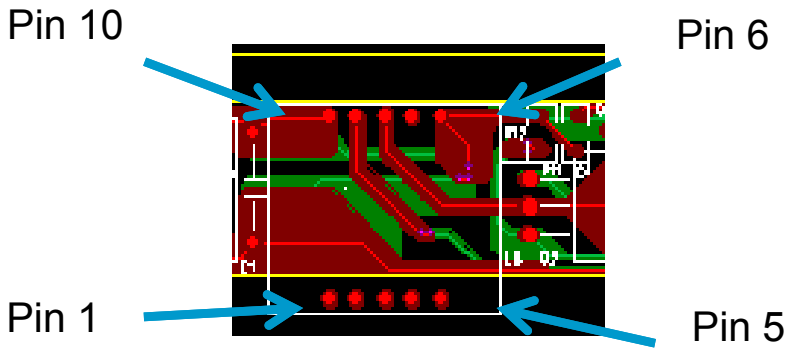


ELECTRICAL SPECIFICATIONS:

1. Inductance (Lp8-10) = 0.9mH @10KHz
2. Core : ER2010 (Ferrite Material TDK PC40 or equivalent)
3. Bobbin : ER2010, Horizontal
4. Ferrite core is connected to Pin 6 after assembling
5. Cut Pin 1,2,3 ,4,5,7,9 after wires termination
6. Varnish the complete assembly





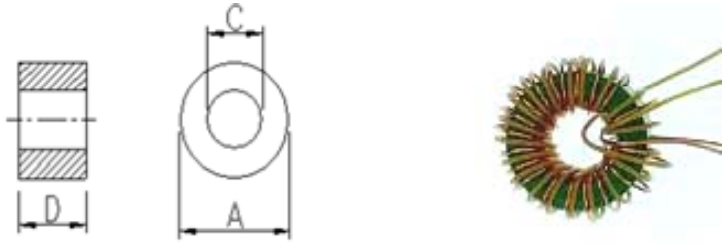


7. Common Mode Inductor L1

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

Material	μi	Bms(Gs)	Hc(Oe)	Br(Gs)	Tc(℃)	ρ(Ω-cm)	Frequency (MHz)	α ur x 10^{-6}/℃
B29	800	2900	0.30	1420	150	$1*10^{7}$	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

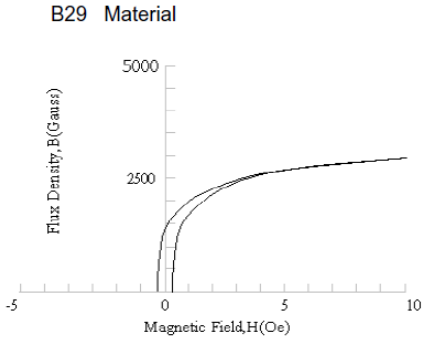
Ferrite core : Ni -Zn T8*4*3

Wire gauge: 0.3mm, 8Turns (Triple Insulated Wire)

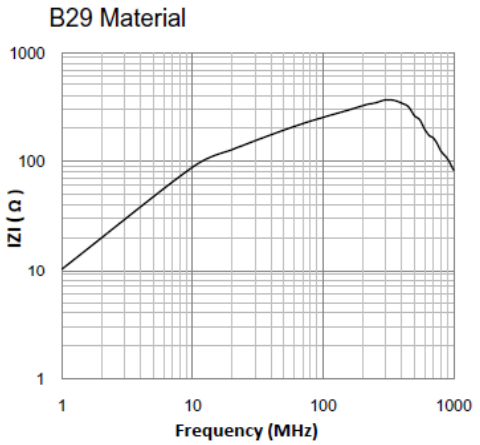
Inductance @10kHz, 1V: 25uH +/10%

DCR: 0.12 OHM +/-20%

Saturation Flux Density (Ni-Zn)



Impedance Vs Frequency Curve (Ni-Zn)



B.F.

Contacts Information

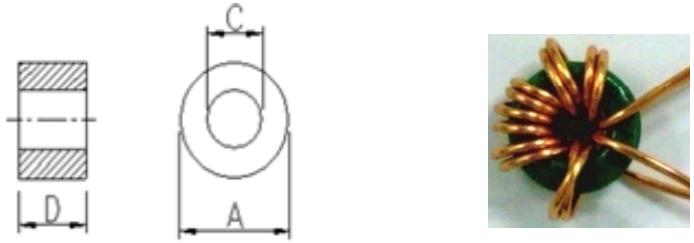
Company Name	:	Bead & Ferrite Electronics (HK) Ltd.
Telephone No.	:	(852) 2601 0833
Fax No.	:	(852) 2693 6202
Email Address	:	bf@bnf.com.hk
Home Page	:	www.bnf.com.hk
Address	:	RM. 16-17, 15/F., Block C, Goldfield Ind. Centre, No.1 Sui Wo Road, Fo Tan, N.T. Hong Kong

8. Common Mode Inductor L5

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

Material	μi	Bms(Gs)	Hc(Oe)	Br(Gs)	Tc(℃)	ρ(Ω-cm)	Frequency (MHz)	α ur x 10^{-6}/℃
B29	800	2900	0.30	1420	150	$1*10^{7}$	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

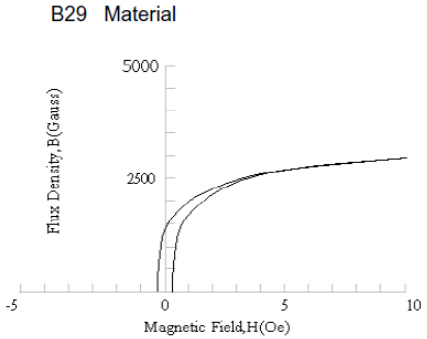
Ferrite core : Ni -Zn T8*4*3

Wire gauge: 0.45mm, 6Turns

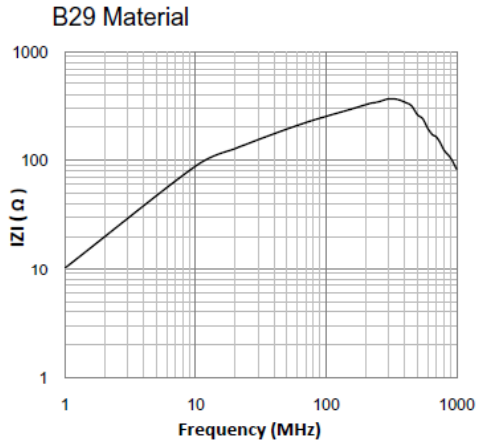
Inductance @10kHz, 1V: 17uH +/-10%

DCR: 0.1 OHM +/-20%

Saturation Flux Density (Ni-Zn)



Impedance Vs Frequency Curve (Ni-Zn)



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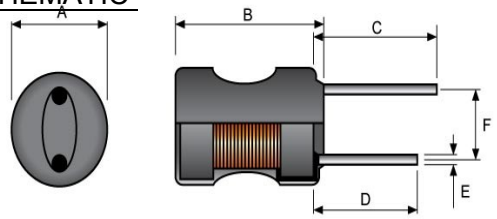
9.EMI Inductor

1. Differential Mode Inductor L4

SCHEMATIC



Ferrite core size : AxB 8x10mm

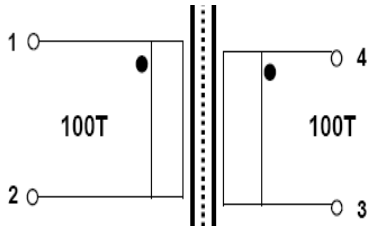
Wire gauge: 0.23mm, 185 Turns

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

DCR: 1.4 OHM +/-20%

2.Common Choke L1 for EMI

SCHEMATIC

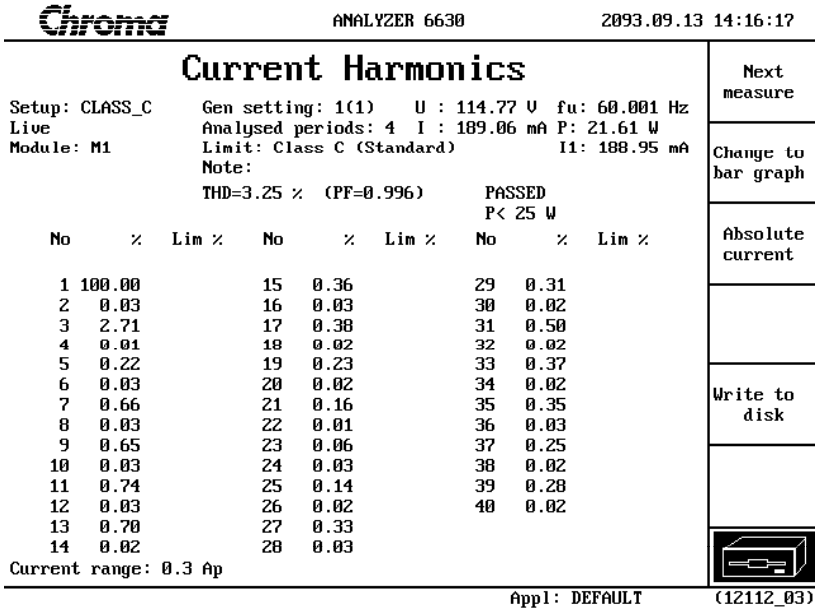


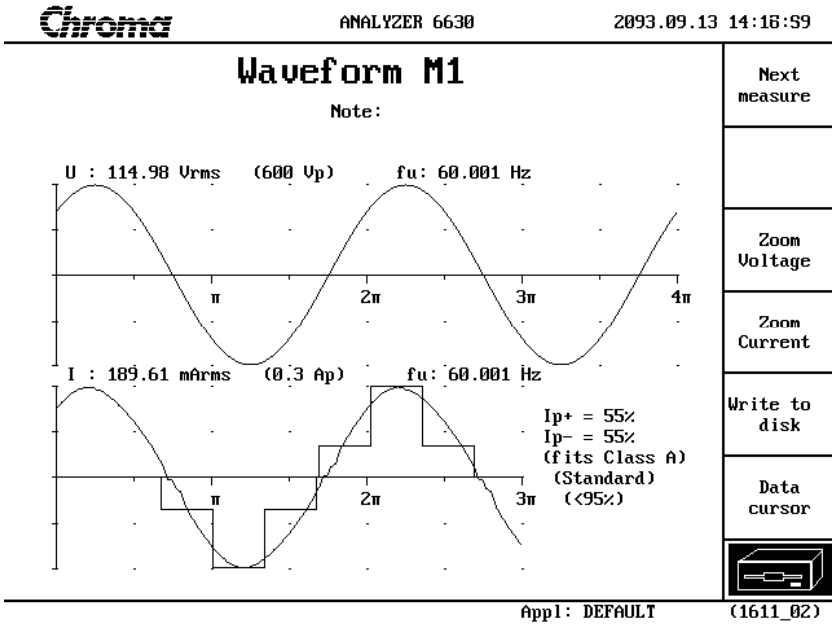
Ferrite core : EE12.4 u>=10k
Wire gauge: 0.2mm, 110Turns
Inductance @10kHz, 1V: 25mH +/-20%
DCR: 1.2OHM +/-20%

10. Regulation, Ripple and Efficiency Measurement

Vin (V)	Pin (W)	Vout (V)	Iout (mA)	Ripple(PK) (mA)	efficiency	PF	Vbulk_Max (V)	THD (%)
90	21.96	41.76	437	26.0	83.10%	0.999	215	3.25
100	21.34	41.24	437	26.0	84.45%	0.998	215	2.94
110	21.04	41.16	437	26.0	85.48%	0.997	215	3.43
115	20.86	41.12	437	26.0	86.14%	0.995	215	4.31
120	20.84	41.07	438	26.0	86.32%	0.996	213	4.80
130	20.72	41.06	438	26.0	86.80%	0.992	215	3.98
140	20.65	41.03	438	26.0	87.03%	0.990	228	4.18
150	20.62	41.01	438	26.0	87.11%	0.990	242	4.52
160	20.56	41.03	440	26.0	87.81%	0.988	255	4.74
170	20.63	41.00	439	26.0	87.25%	0.985	268	5.32
180	20.63	40.99	439	26.0	87.23%	0.982	282	5.83
190	20.58	40.97	439	26.0	87.39%	0.978	295	7.07
200	20.66	40.96	440	26.0	87.23%	0.974	308	6.49
210	20.78	40.97	440	26.0	86.75%	0.971	334	8.70
220	20.80	40.96	441	26.0	86.84%	0.966	348	8.27
230	20.86	40.95	441	26.0	86.57%	0.960	361	8.63
240	20.90	40.94	441	26.0	86.39%	0.955	374	8.96
250	21.03	40.94	441	26.0	85.85%	0.948	380	10.72
264	21.09	40.90	441	26.0	85.52%	0.934	388	15.42

11.Harmonic and current waveform





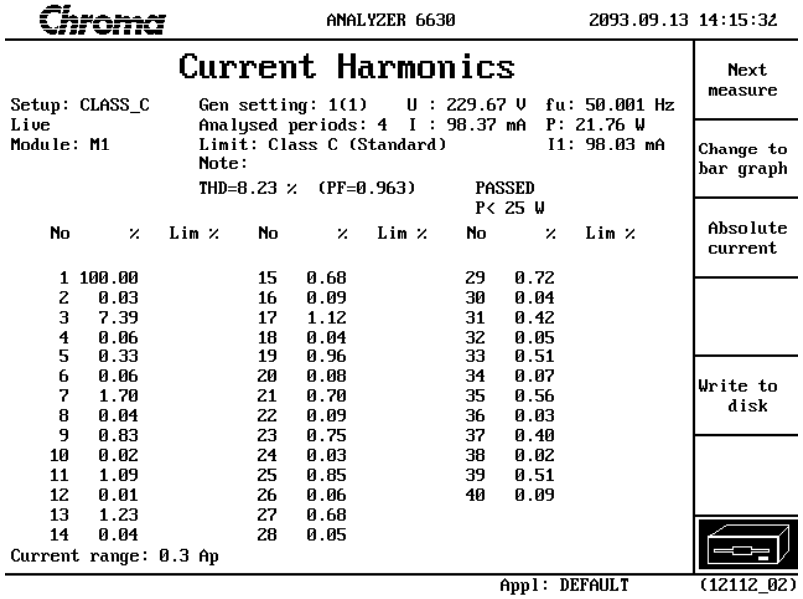
Harmonics current @115Vac \

THD=3.25%

AC current waveform @115Vac

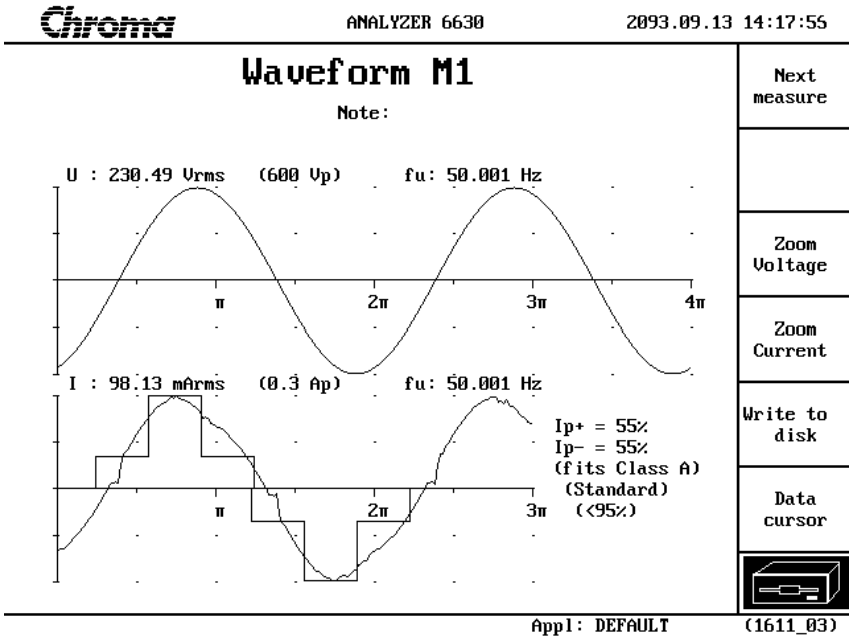
PF=0.996

12.Harmonic and current waveform



Harmonics current @230Vac

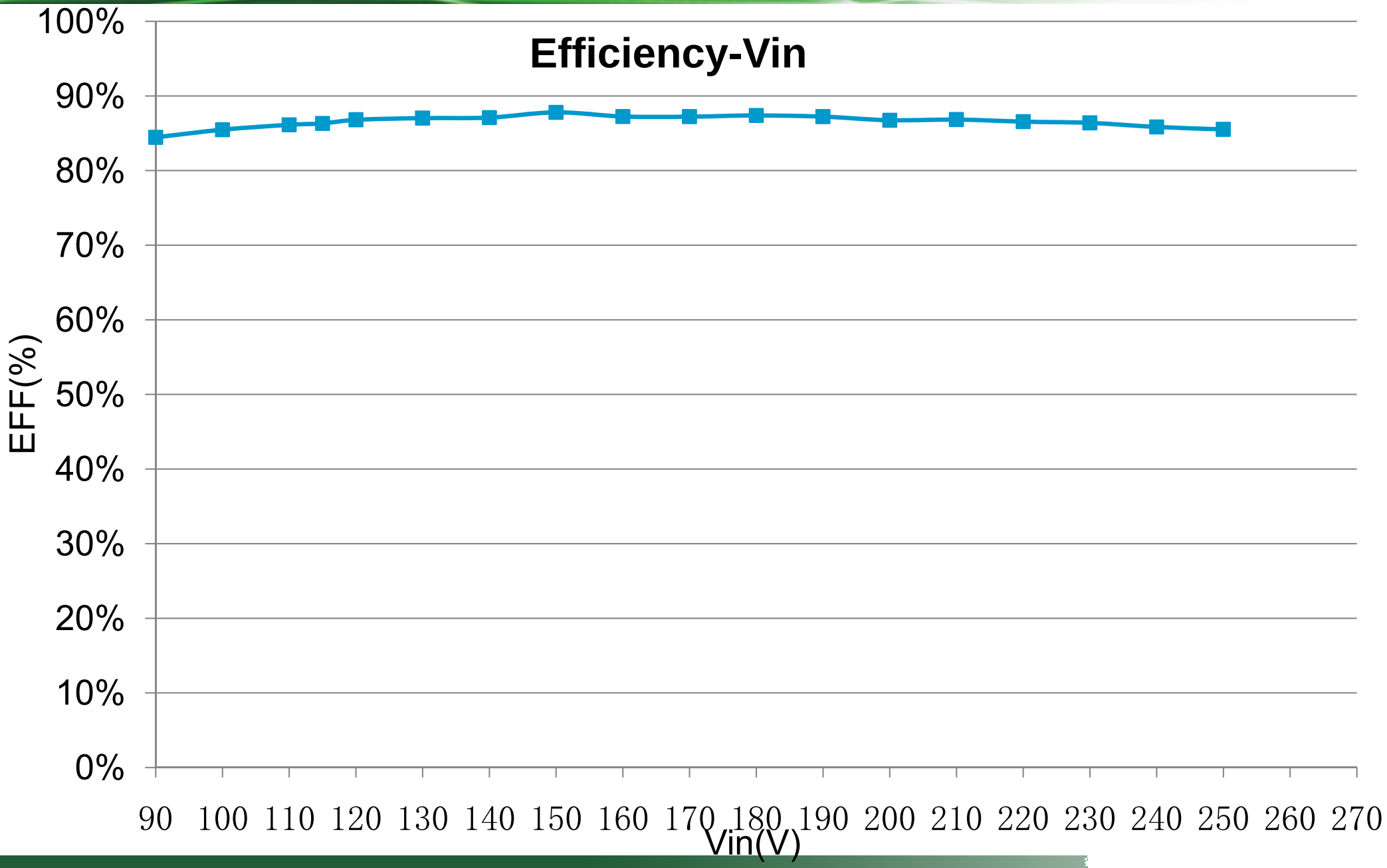
THD=8.23%



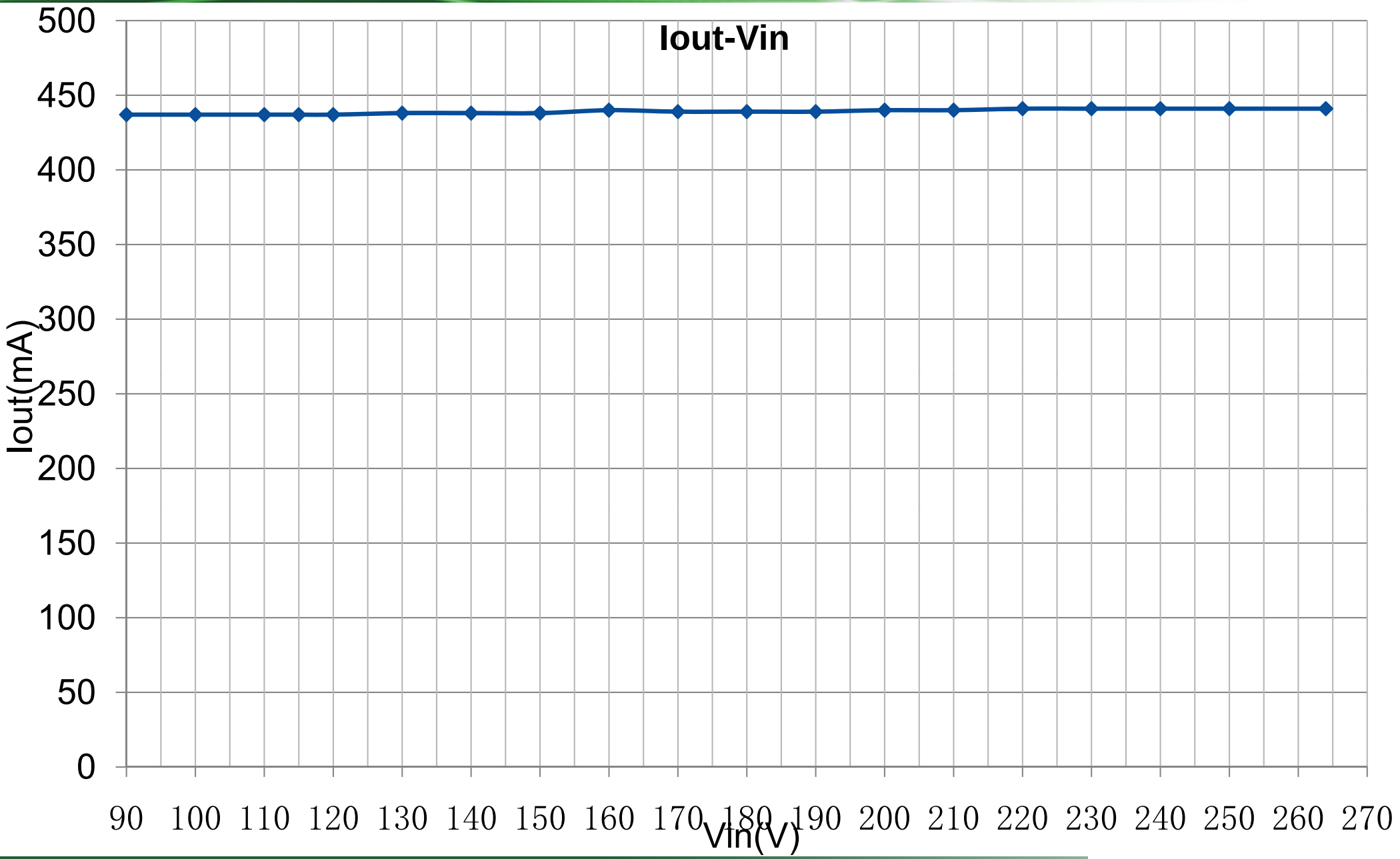
AC current waveform @230Vac

PF=0.963

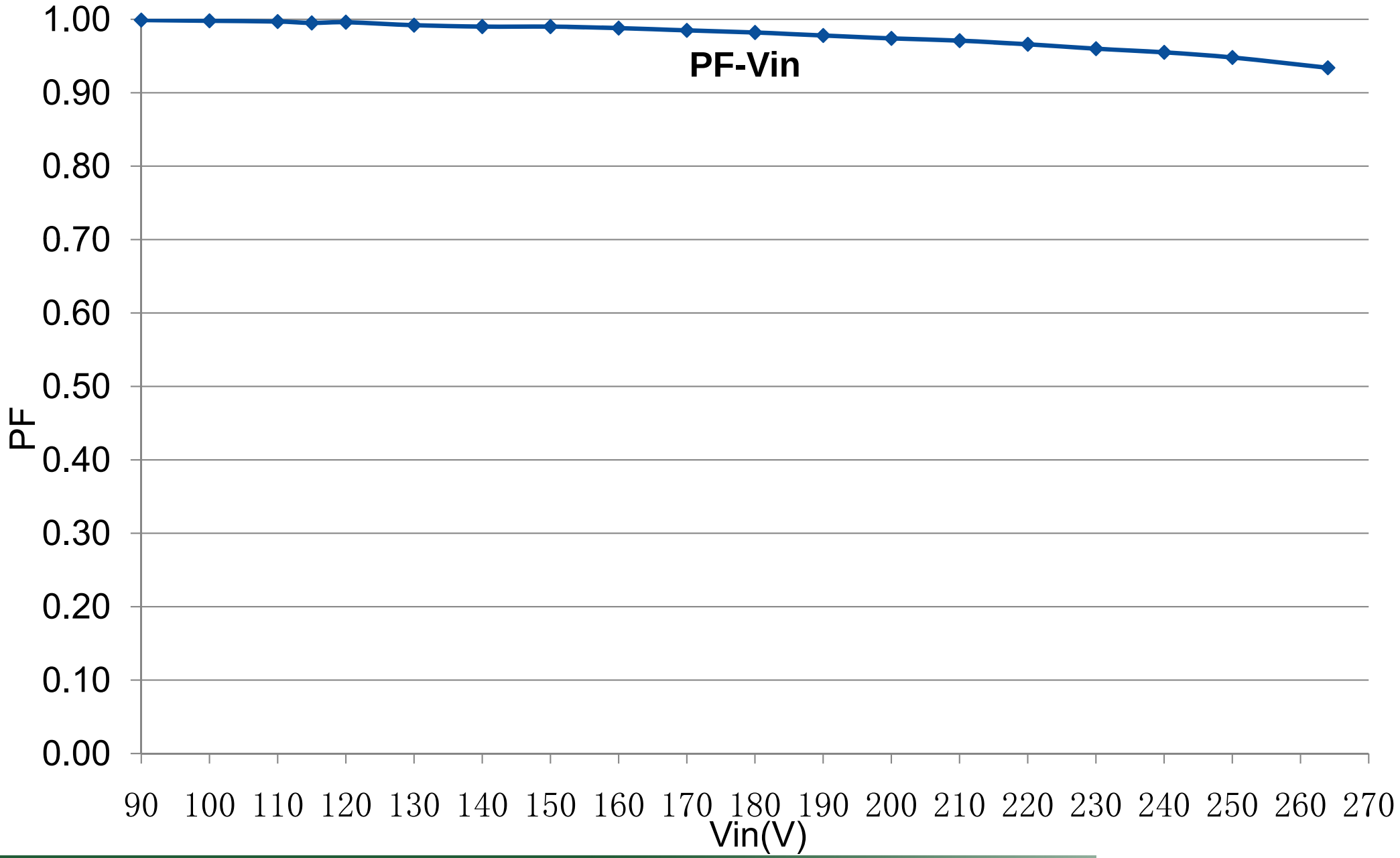
13. Variable Input Vs. Efficiency Measurement



14. Variable Input Vs. Iout Measurement

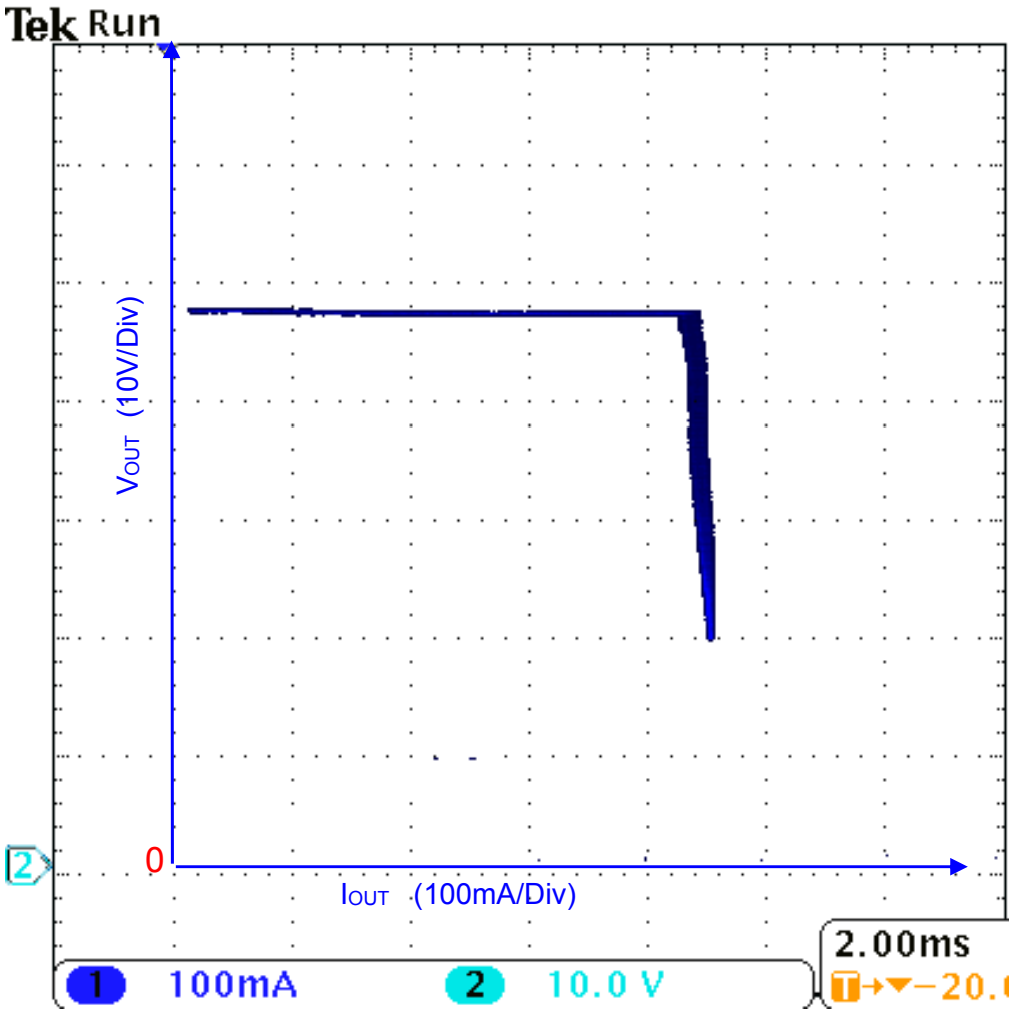


15. Variable Input Vs. PF Measurement

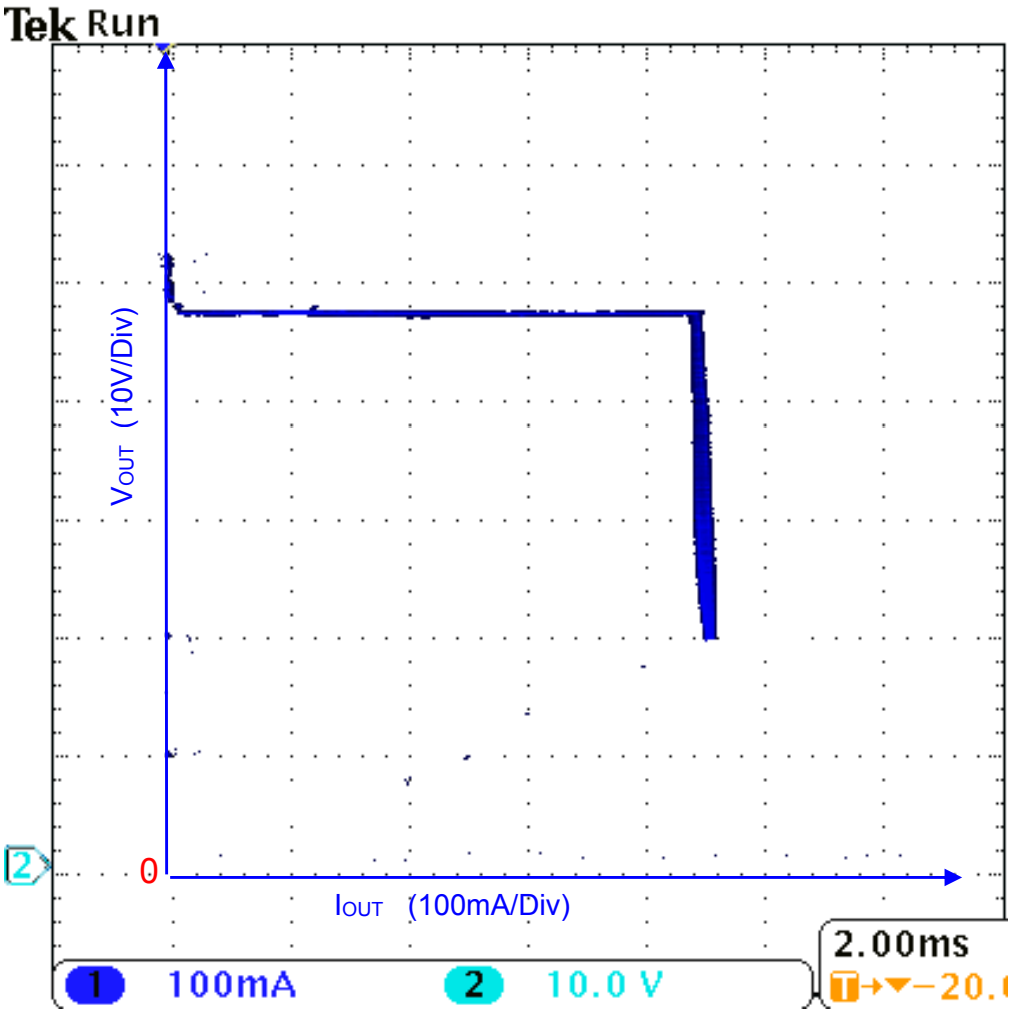


16.Output VI Characteristics(CR Mode)

V_{IN}=90Vac/60Hz

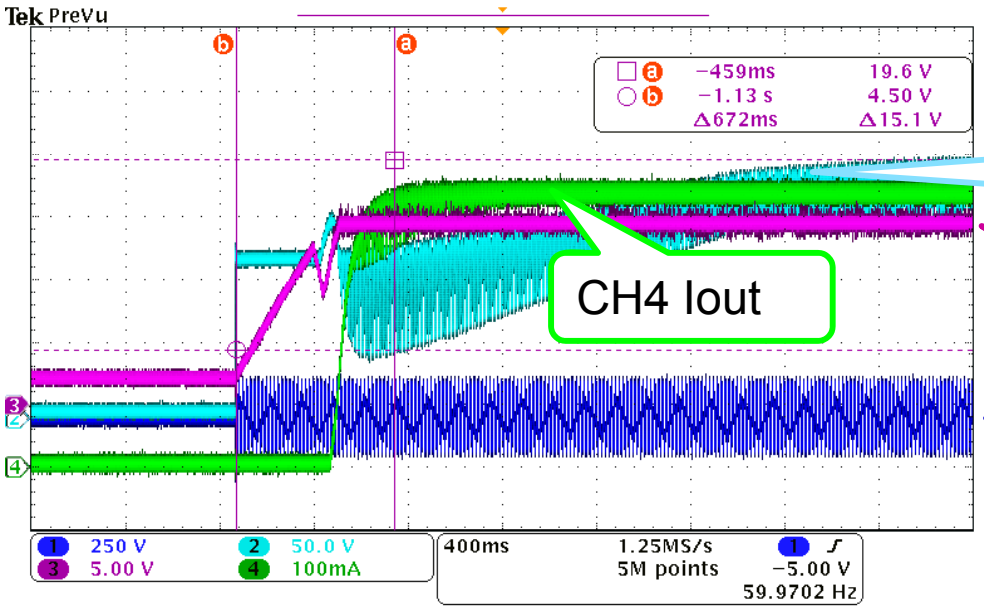


V_{IN}=264Vac/50Hz



* Note: Output voltage is monitored at end of PCB

17. Turn-on Delay Time and Output current overshoot



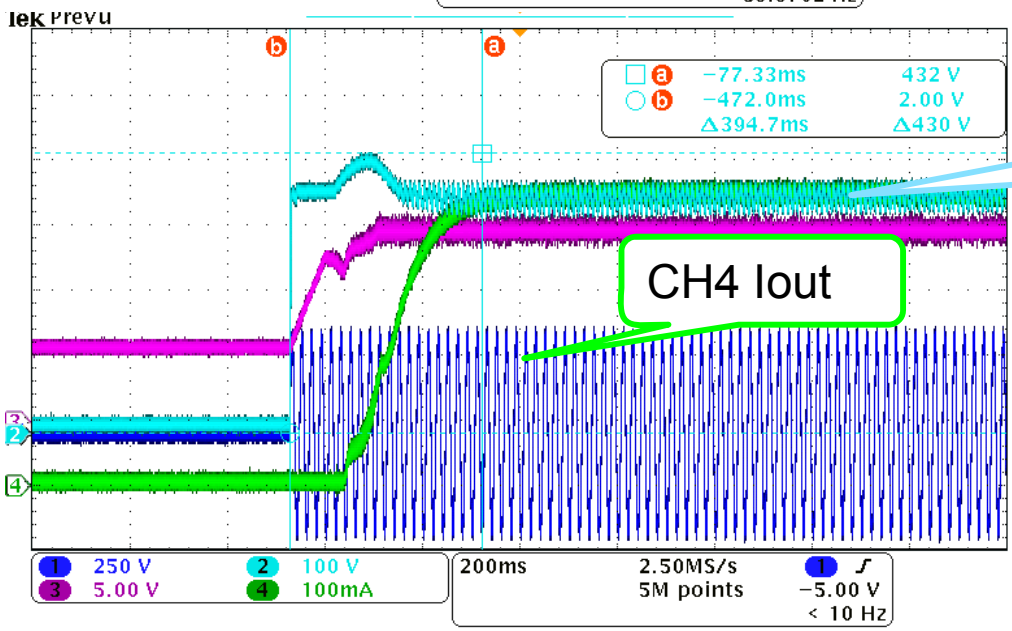
E- CAP VOLTAGE

CH3 VCC

CH1 Vin AC

90V_{AC},Full Load

T_{ST_DELAY}=672mS



E- CAP VOLTAGE

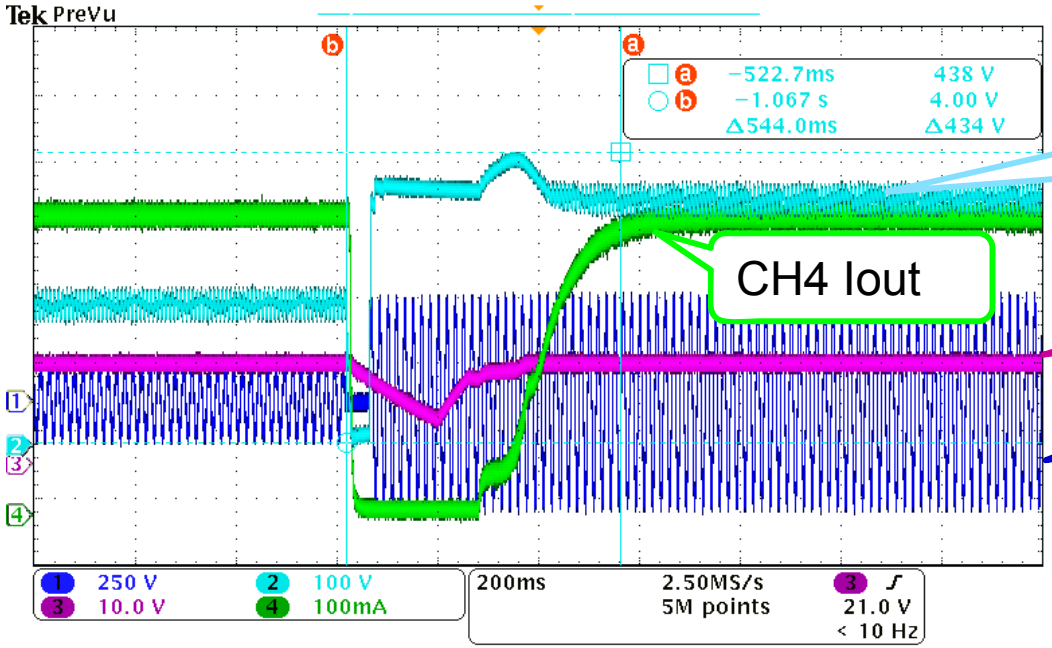
CH3 VCC

CH1 Vin AC

264V_{AC},Full Load

T_{ST_DELAY}=394.7mS

18. Voltage transient ，overshoot on voltage on bulk-cap



E-CAP VOLTAGE

CH4 Iout

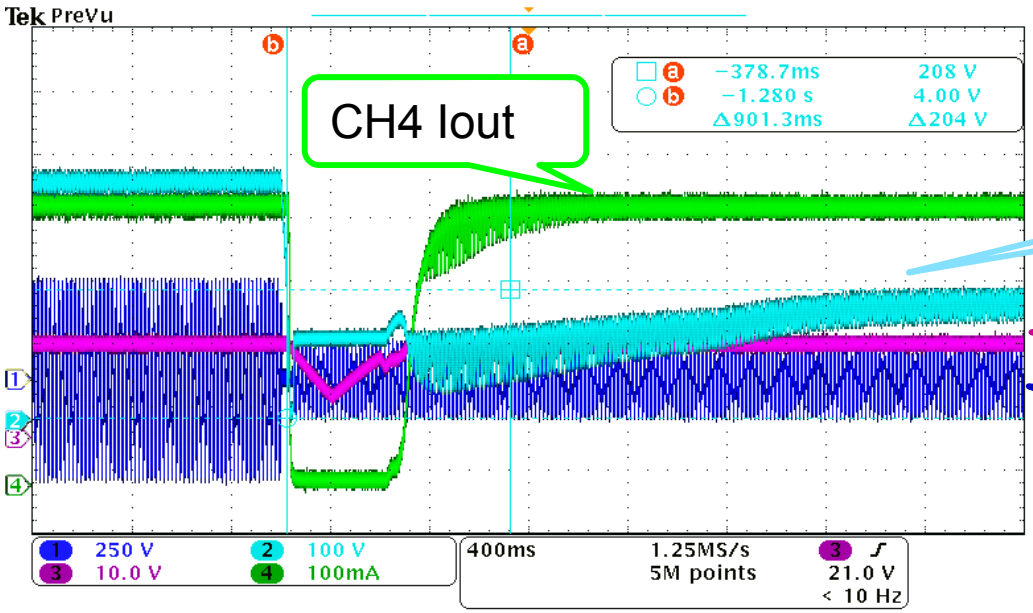
CH3 VCC

CH1 Vin AC

90 to 264V_{AC},Full Load

The bulk cap voltage is

434Vmax



CH4 Iout

E-CAP VOLTAGE

CH3 VCC

CH1 Vin AC

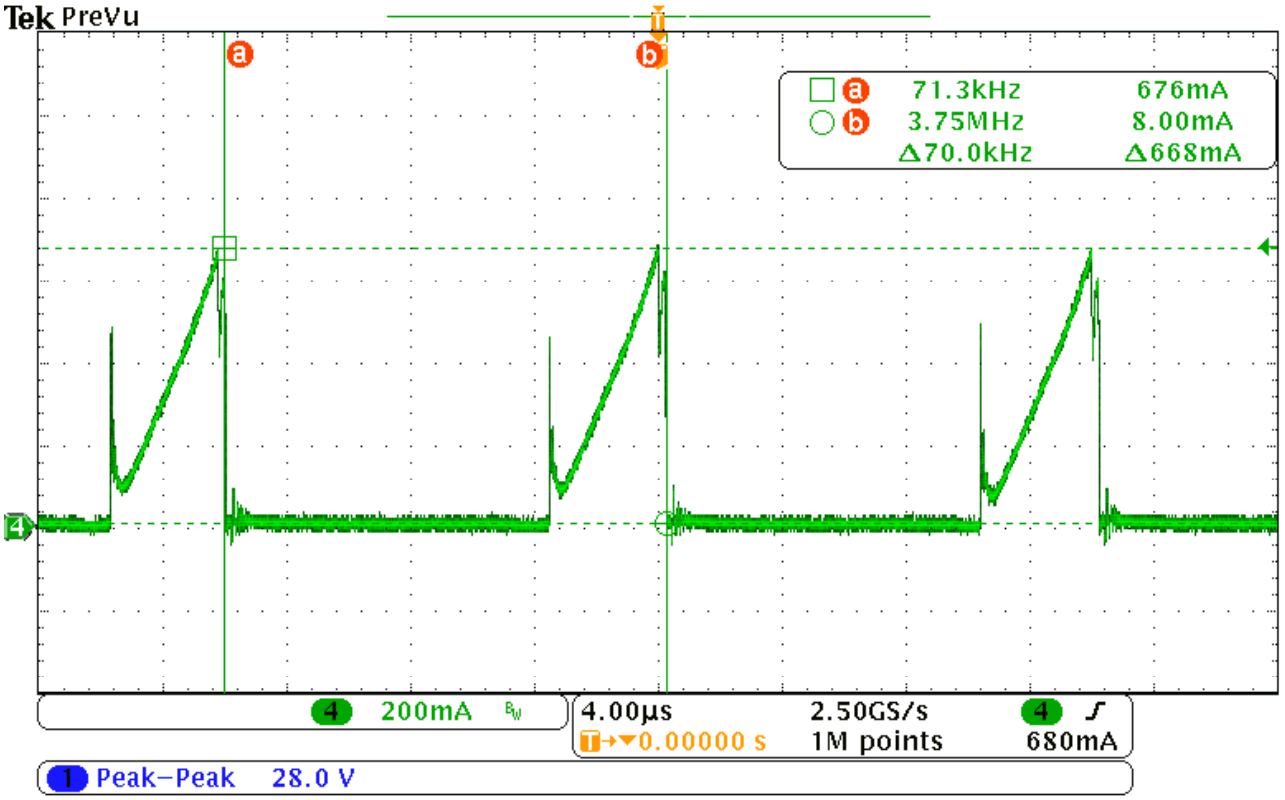
264 to 90V_{AC},Full Load

The bulk cap voltage is

204max

19. Transformer Flux Density

(Np=40Ts, Lm=1.1mH, Ae=60mm^2-ER26)



I_{PRI} is monitored at 90Vac and *0.440A* load

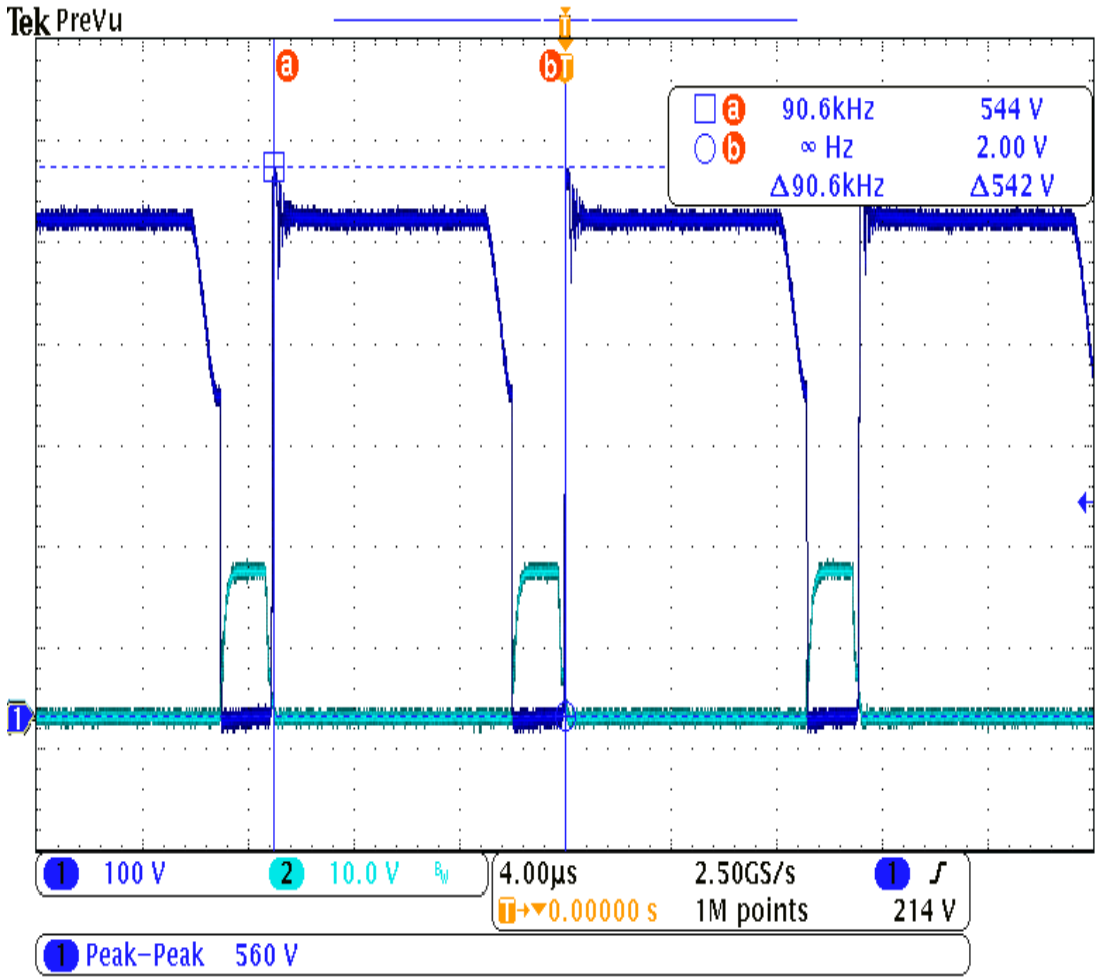
I_{PRI}=668mA

$B_{MAX} = I_{PRI} * L_{PRI} / (N_P * A_e)$

=(668*1.1)/(40*60)

=0.306Tesla

20. Q1 MOSFET V_{DS} Waveform



Test Condition:

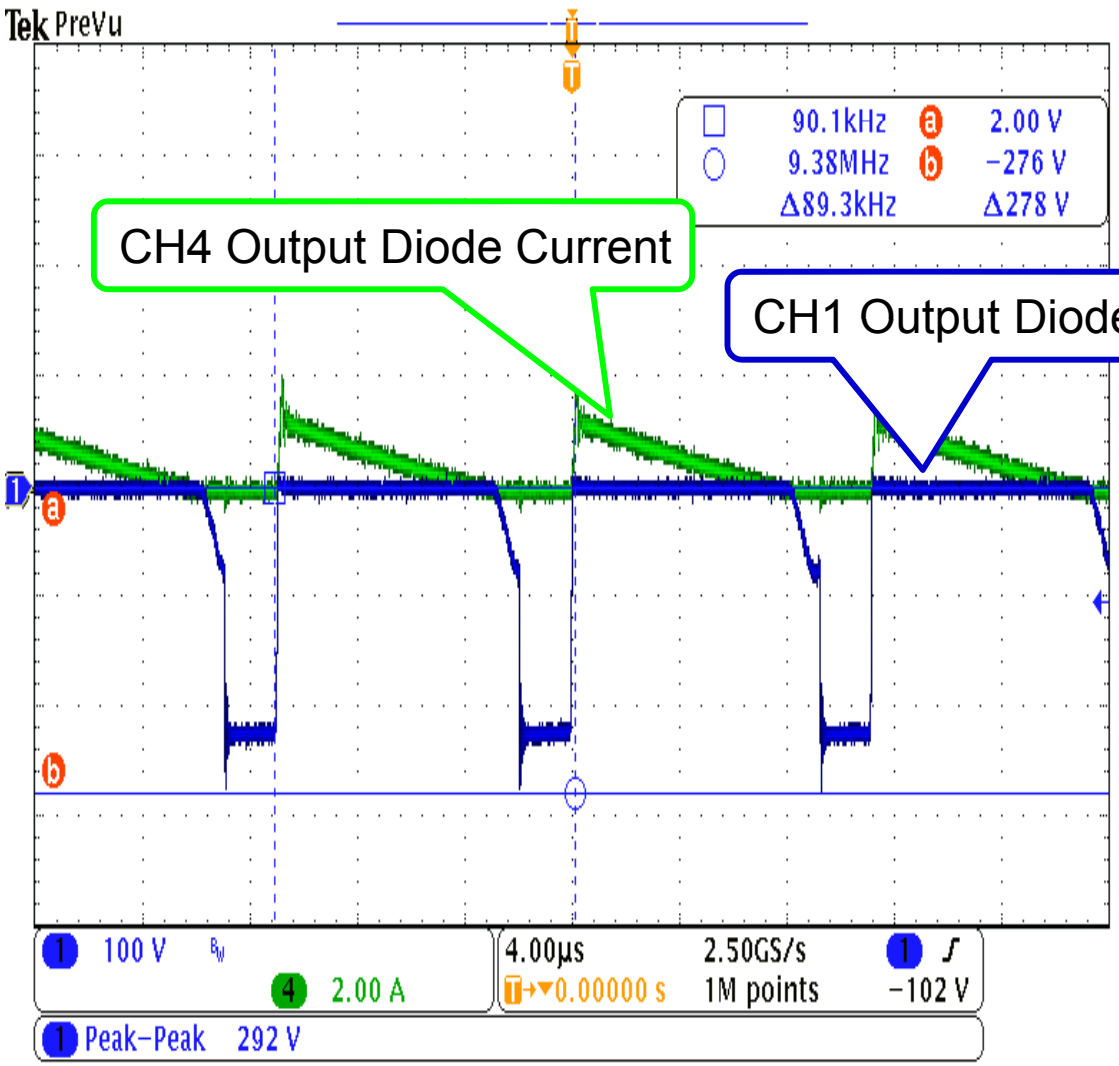
V_{IN}=264VAC, V_{OUT}=41.5V

Result:

V_{DS_MAX}=542V

Remark: Mosfet Spec__4A 600V

21. Output Diode Waveform



Test Condition:

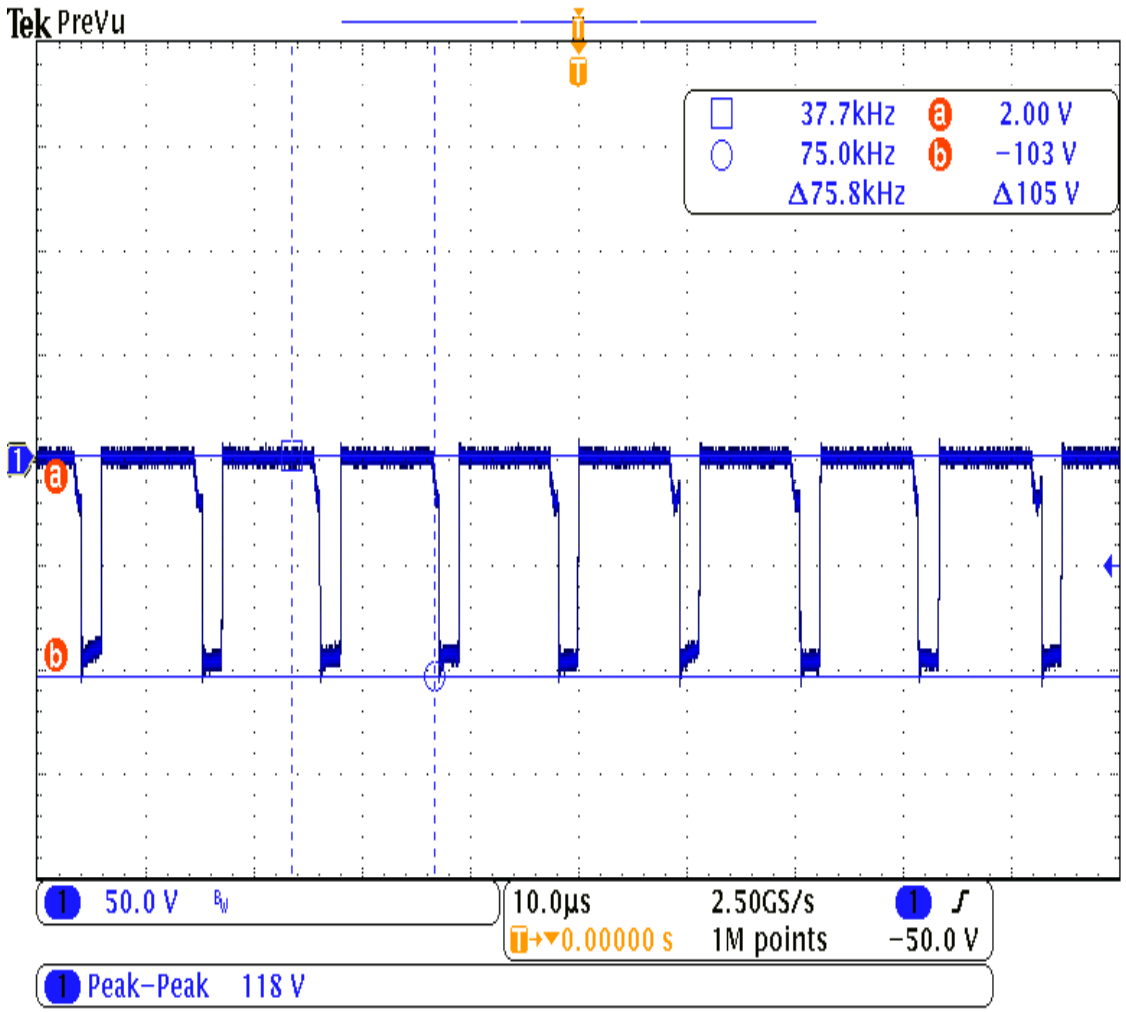
V_{IN}=264VAC, V_{OUT}=41.5V

Result:

V_{RRM_MAX}=278V

Remark: Diode Spec__3A 300V

22. Vcc Diode waveform



Test Condition:

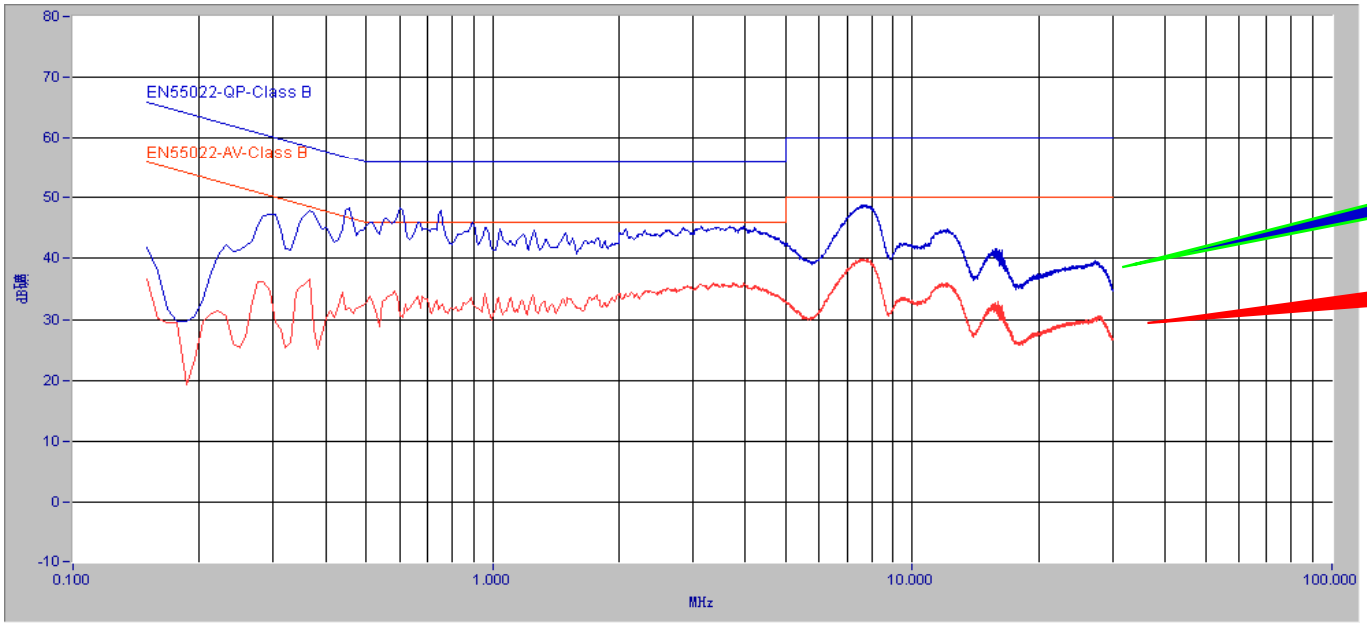
V_{IN}=264VAC, V_{OUT}=41.5V

Result:

V_{RRM_MAX}=105V

Remark: Diode Spec__1A 200V

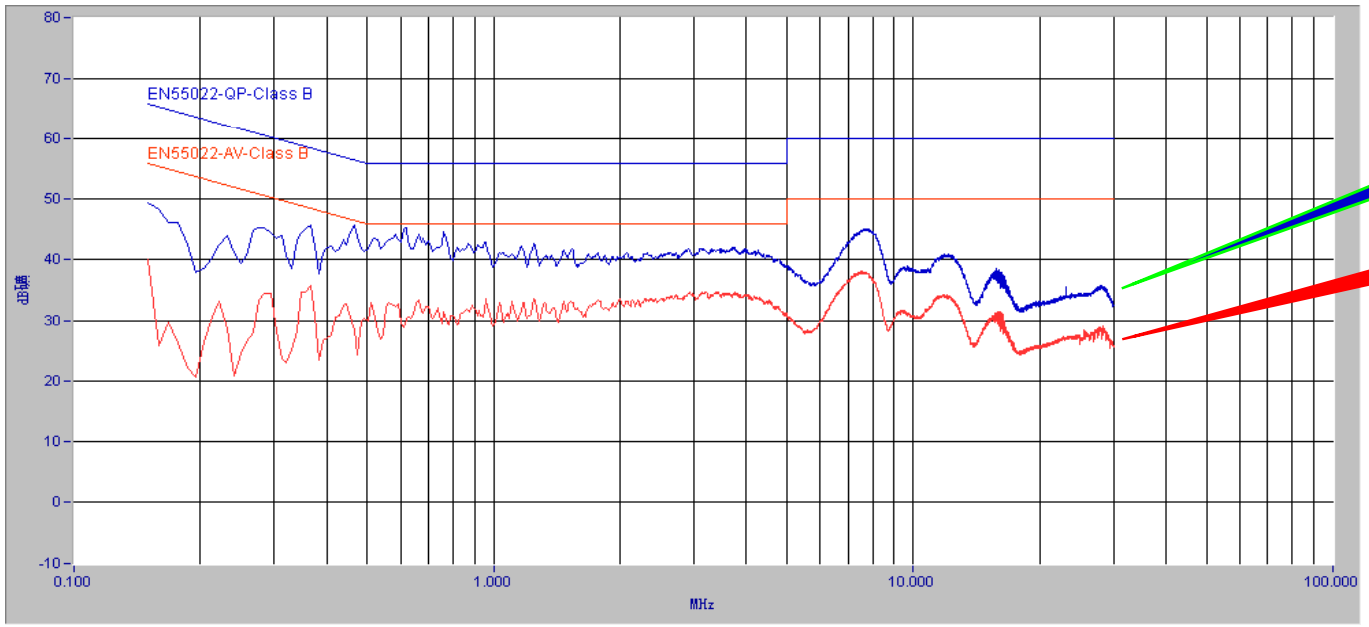
23. Conducted EMI (Full Load)



QP Scan
QP Limit line

AV Scan
AV Limit line

Input=115VAC
L line QP&AV scan

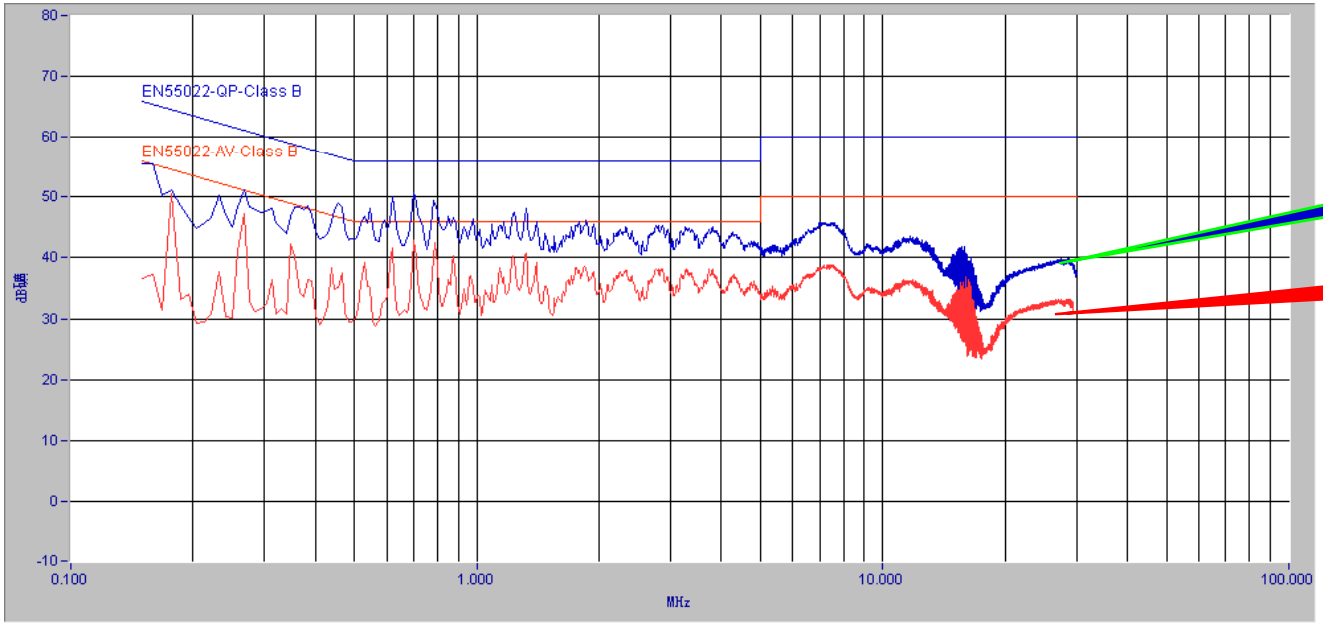


QP Scan
QP Limit line

AV Scan
AV Limit line

Input=115VAC
N line QP&AV scan

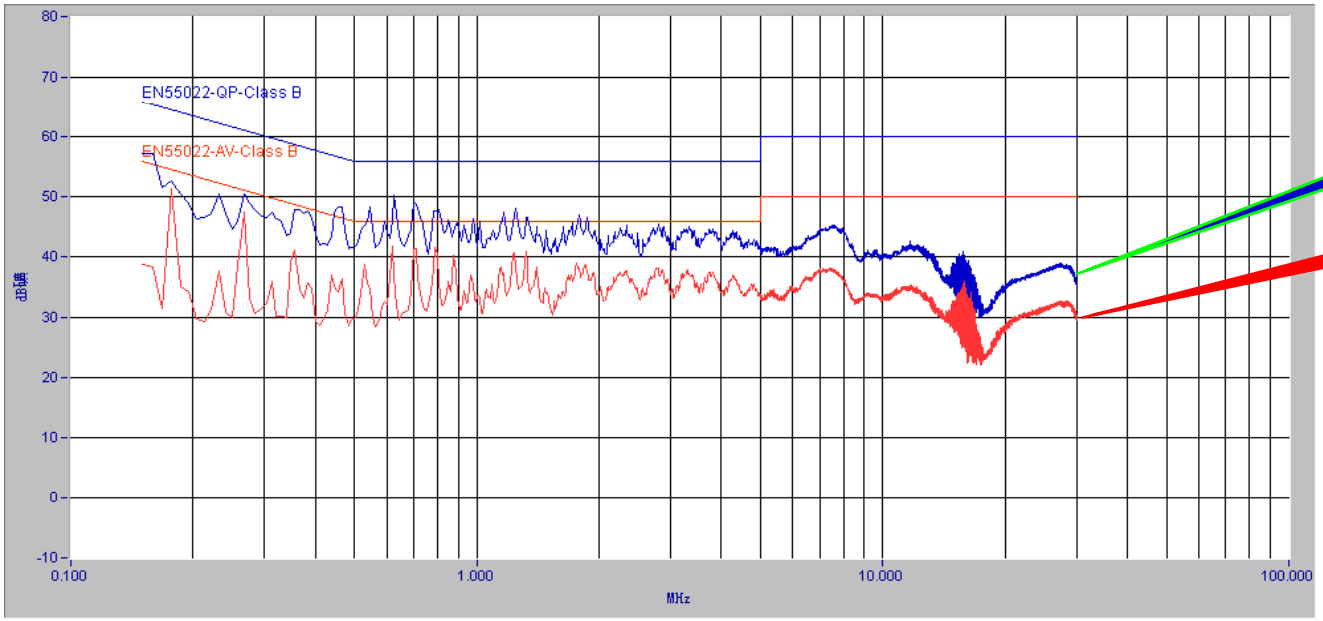
24. Conducted EMI (Full Load)



QP Scan
QP Limit line

AV Scan
AV Limit line

Input=230VAC
L line QP&AV scan

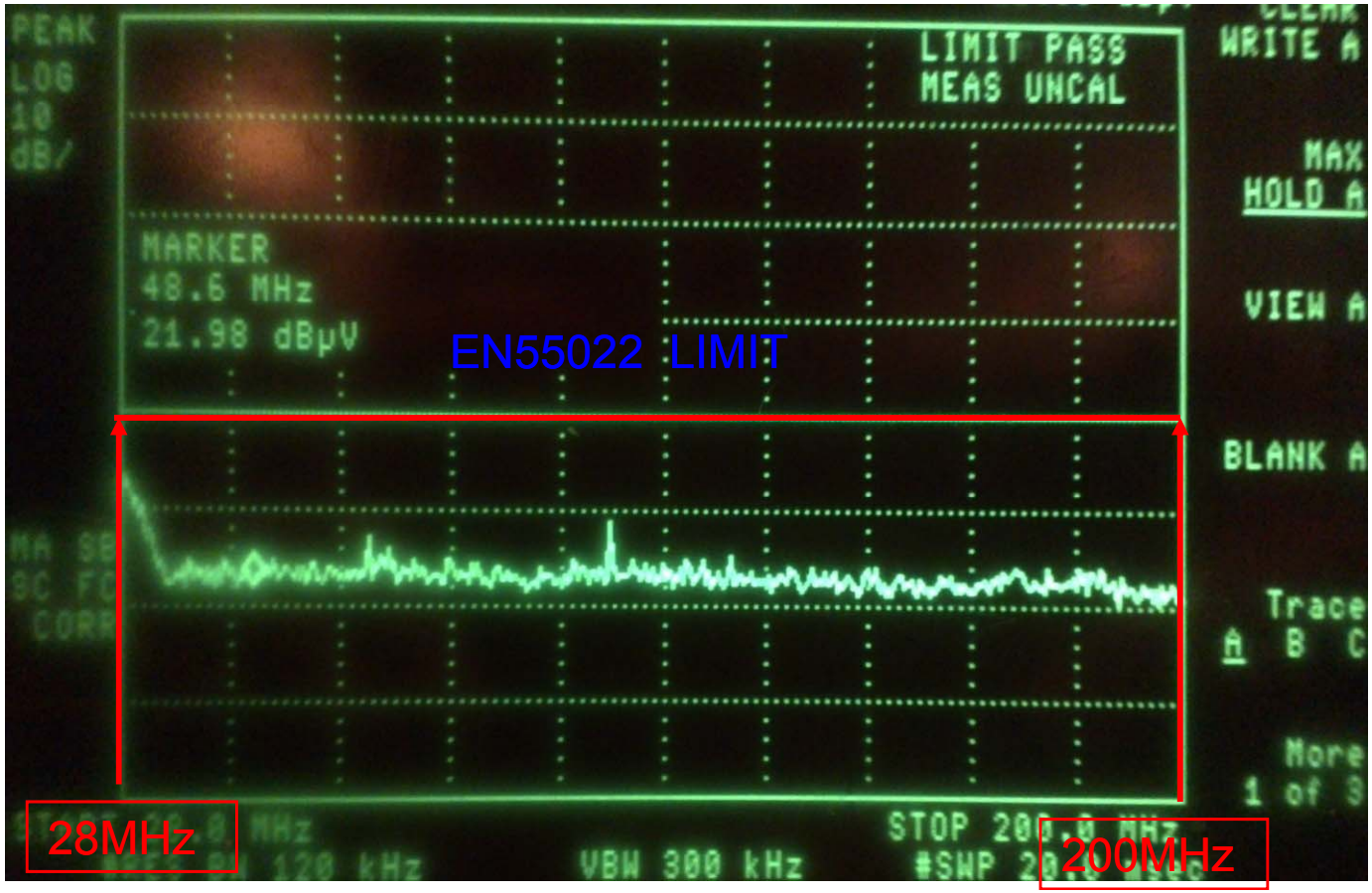


QP Scan
QP Limit line

AV Scan
AV Limit line

Input=230VAC
N line QP&AV scan

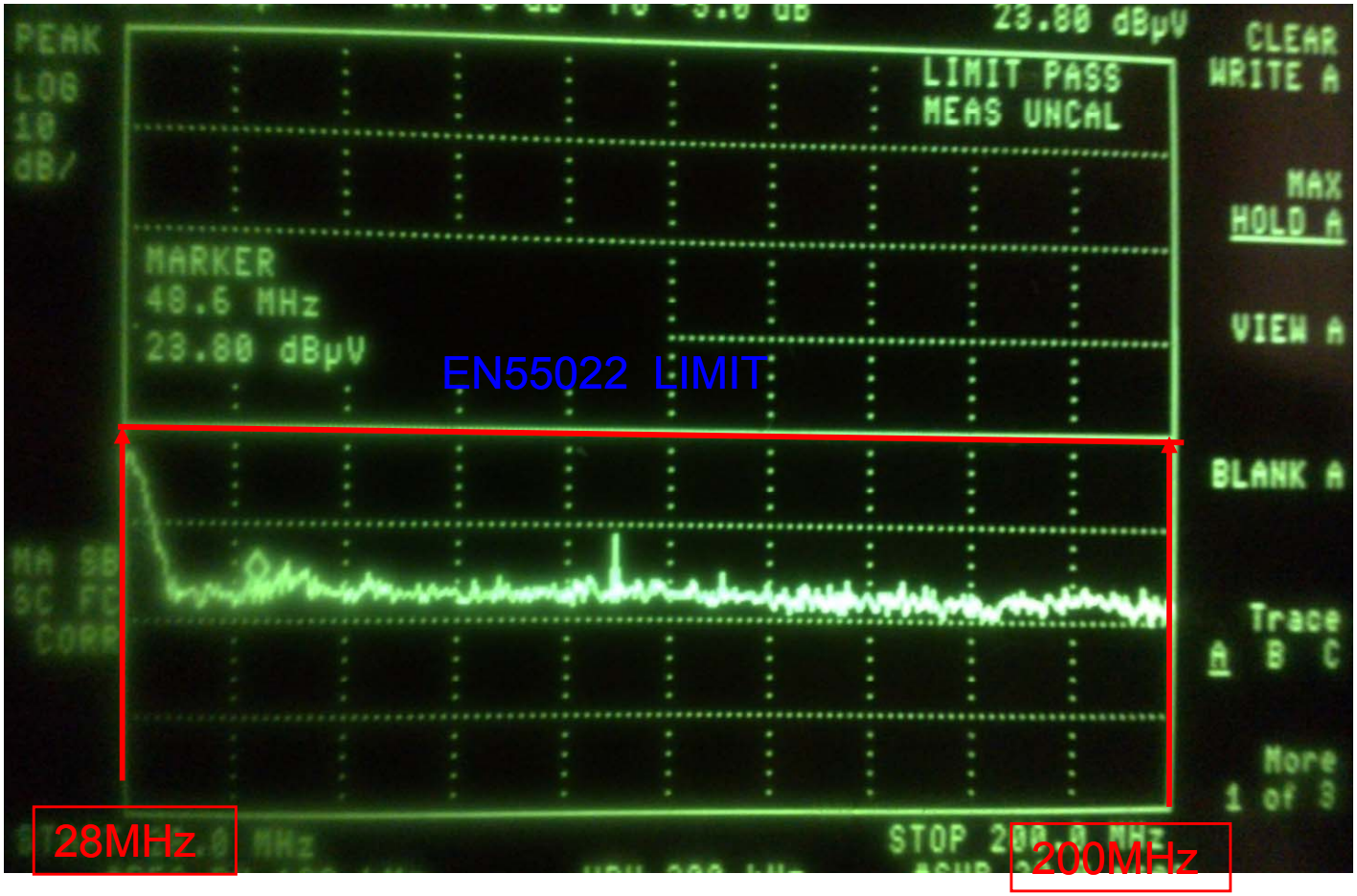
25. Radiated EMI (Reference only)



Note: 1, Vin=115Vac

2, Output is floating

26. Radiated EMI (Reference only)



Note: 1, Vin=230Vac

2, Output is floating