

LED Driver Design with iW3620

Summary and Features :

1. LED driver, 36V, 700mA ; Wide AC input range: 90Vac-264Vac
2. For Isolated Applications
3. High Efficiency, High Power Factor and Least Parts Solution
4. Meet EMI Requirement (EN55015BQP&AV scan)
5. Fully Protection Against AC input UV/OV,O/P Short &Open, Component single fault

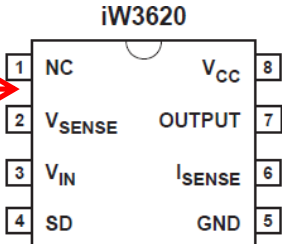
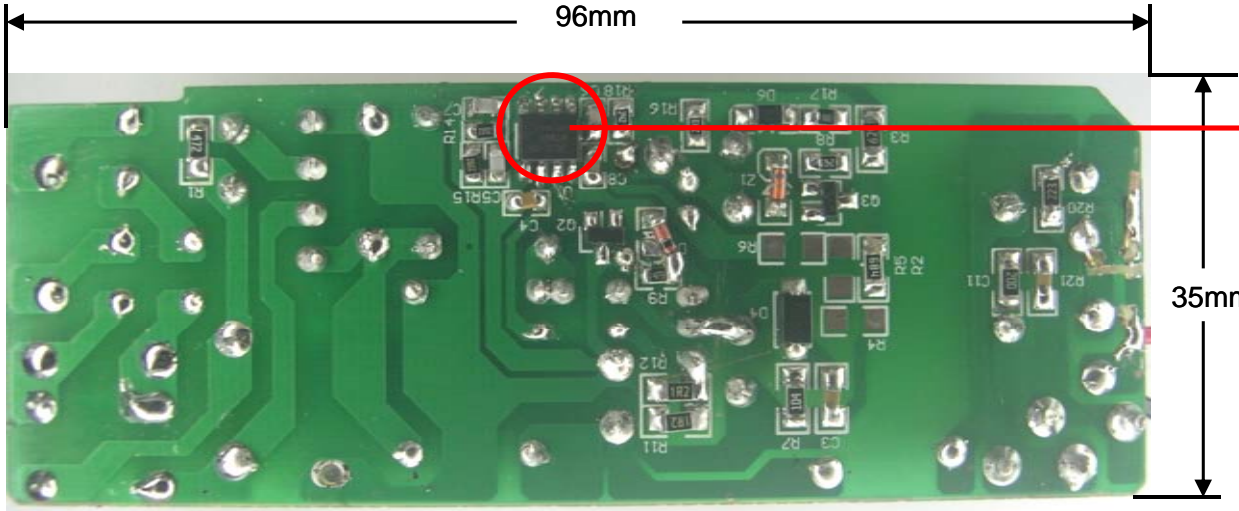
1. Specification

Description		Symbol	Min	Typ	Max	Units	Comment
Input							
Voltage		V	90	100-230	264	V _{AC}	2 Wire
Frequency		f_{LINE}	47	50	63	Hz	
Open-load Input Power (264V _{AC})						W	
Output							
Const Voltage	Output Voltage	V_{OUT_CV}		36		V	Measured at the PCB connector
	Output Current	I_{OUT_CV}				A	
Const Current	Output Voltage	V_{OUT_CV}				V	Min Vout is depend on Vcc
	Output Current	I_{OUT_CV}		0.7		A	
Total Output Power							
Continuous Output Power		P_{OUT}		22.4		W	
Over Current Protection		I_{OUT_MAX}				A	Auto-restart
Efficiency		η	85			%	Measured at end of PCB
Power Fact		PF		0.9			Harmonic meet IEC61000-3-2
Turn on Delay Time						Sec	
Conducted EMI			Meets EN55015B				
Hi-pot test				3		KV	
Operation temperature		T_{opr}		40		° C	Free convection, sea level

2.Circuit Board Photograph



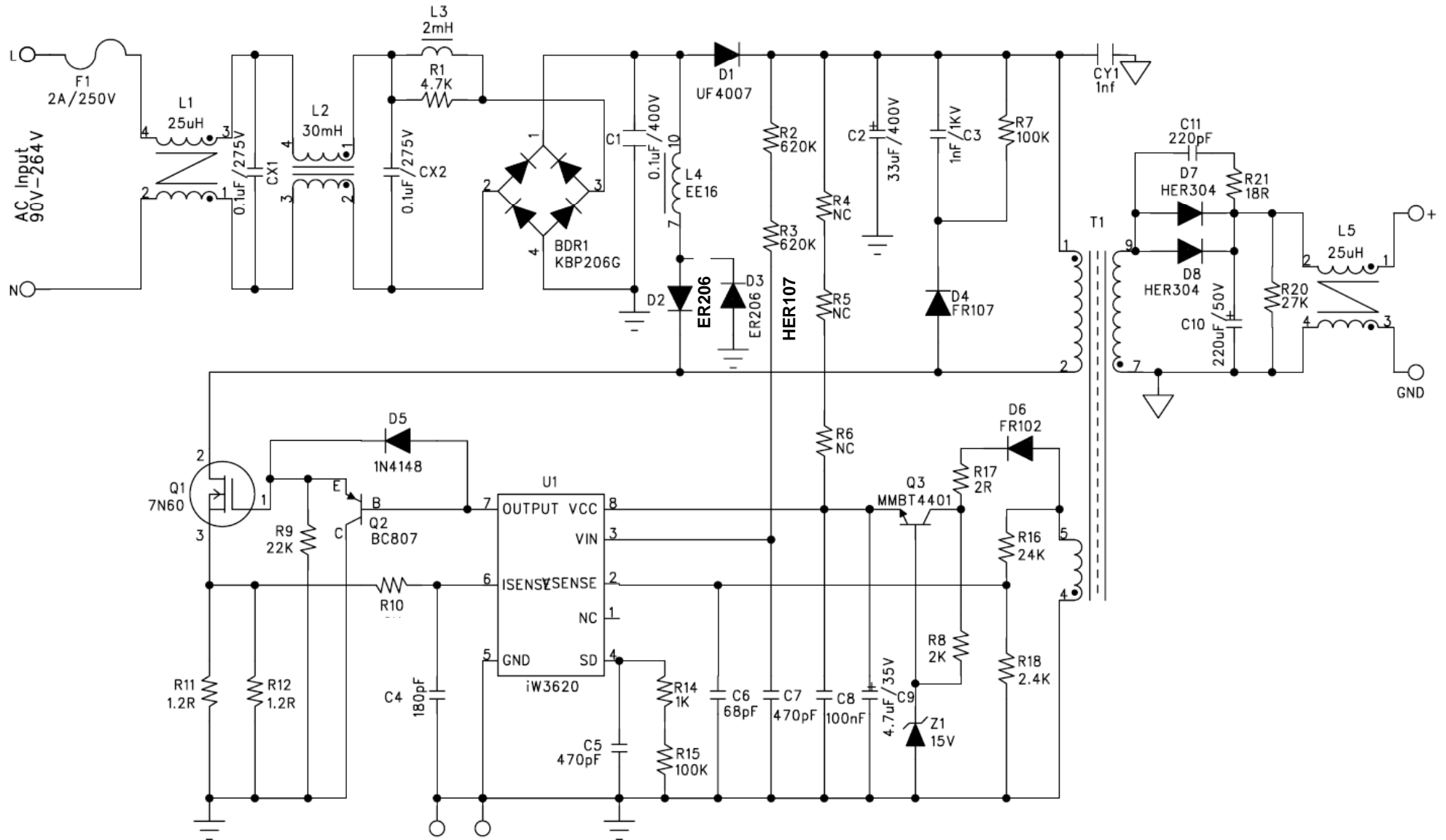
Bottom side



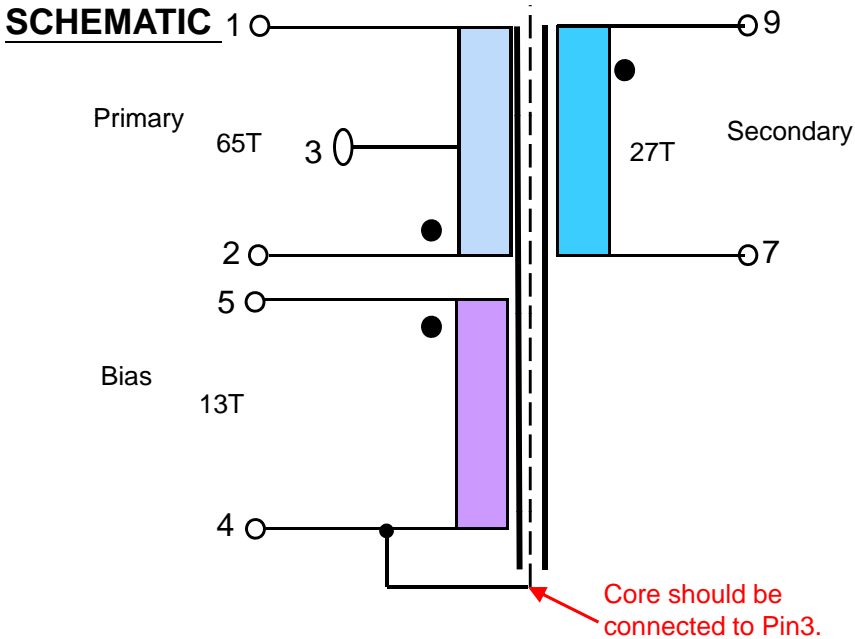
Top side

L x W x H= 96x35x18mm

3. Schematic



4. Transformer Design (36V 700mA)



ELECTRICAL SPECIFICATIONS:

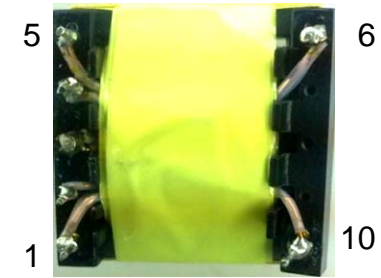
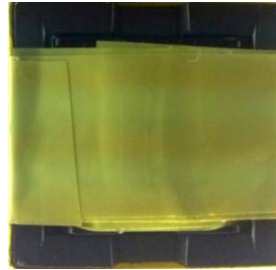
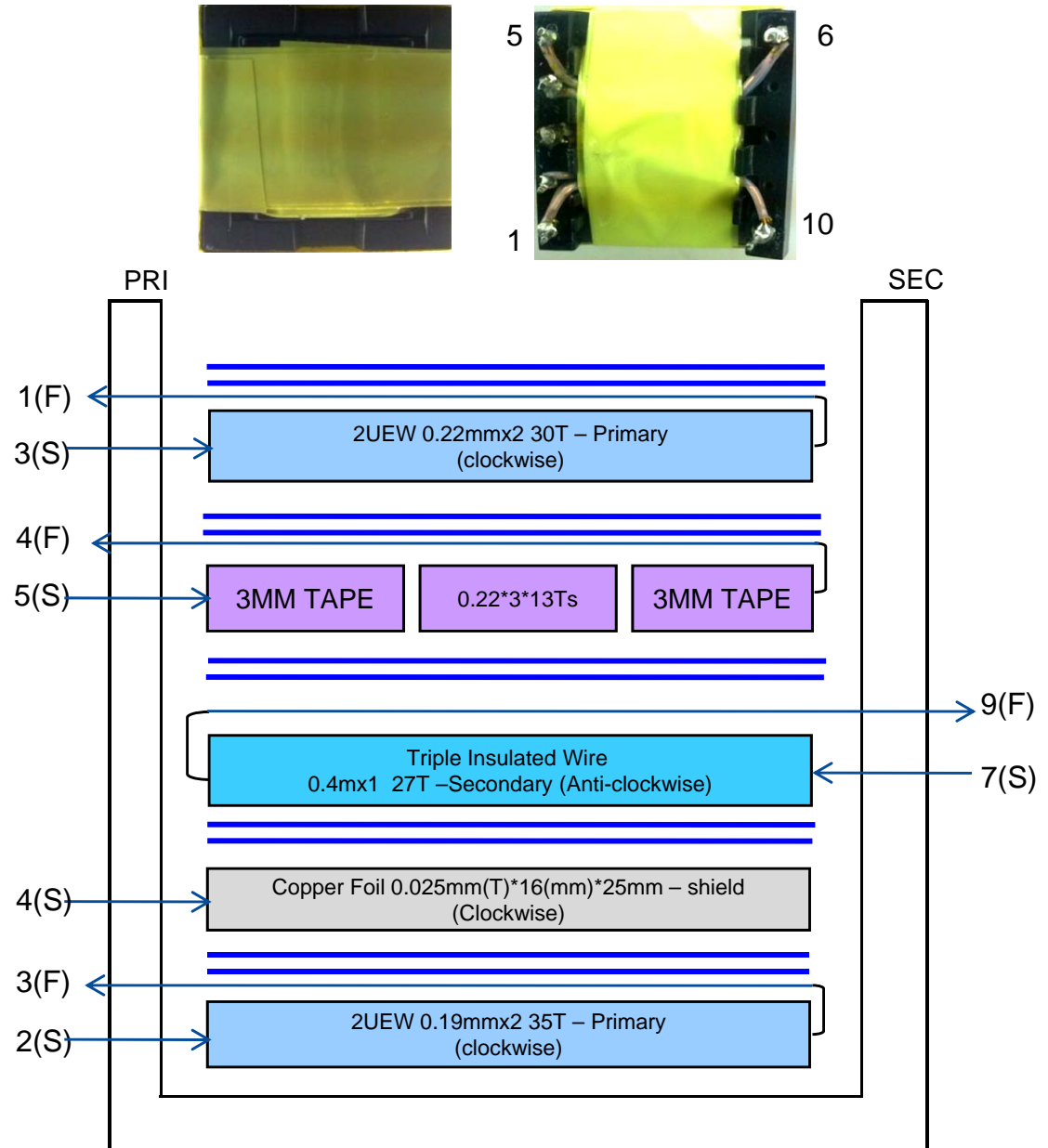
1. Primary Inductance (L_p) = 0.85mH @10KHz
2. Electrical Strength = 3KV, 50/60Hz, 1Min(pins1~5 to pins 8~10)

MATERIALS:

- 1.Core:EFD25 $A_e=58mm^2$ (Ferrite Material TDK PC40 or equivalent)
- 2.Bobbin : EFD25 Pin5+5 Horizontal
- 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 Pin6,8,10 after wires termination
2. Shield core to Pin4 with bare tin-coated wire
3. Varnish the complete assembly



5. Bill of Material

Item	Qty.	Ref.	Description	Type specification	suppliers
1	2	CX1,CX1	0.1uF,275V	PX104K3IC39H200D9H	CARLI 凯励
2	1	C2	33uF,450V,E-CAP,105°C	φ 12*20	CARLI 凯励
3	1	C3	2.2nF,1kV,NPO	SMD 1206	TDK
2	1	C1	0.047uF,400V,CBB	PF104J2G109L270D9R	CARLI 凯励
5	1	C4	180pF,50V,X7R,	SMD 0805	TDK
6	1	C5,C7	470pF,50V,NPO,	SMD 0805	TDK
7	1	C6	68pF,50V,	SMD 0805	TDK
8	1	C8	100nF,50V,X7R,	SMD 0805	TDK
9	1	C9	4.7uF,25V,	SMD 1206	TDK
10	1	C10	220uF,50V,E-CAP,105°C	φ 10*15	Rubycon 红宝石
	1	C11	220PF,250V,X7R,	SMD 1206	TDK
10	1	CY1	Y-CAP1nF 250V		Vishay
11	1	BDR1	KBP206G		TAIWAN SEMICONDUCTOR 台半
12	3	D1,D2,D3	ER206	DO-41	TAIWAN SEMICONDUCTOR 台半
13	1	D4	RS1M/FR107	SMD	TAIWAN SEMICONDUCTOR 台半
14	1	D6	FR102	SMD	TAIWAN SEMICONDUCTOR 台半
15	1	D7,D8	HER304		TAIWAN SEMICONDUCTOR 台半
16	1	D5	IN4148	SMD	TAIWAN SEMICONDUCTOR 台半
17	1	Z1	15V	SMD ZMM15	ST
18	1	F1	2A/250Vac Fuse	2A	LITTELFUSE

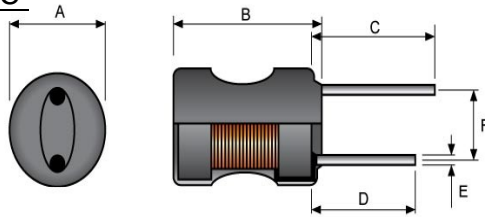
6. Bill of Material

Item	Qty.	Ref.	Description	Type specification	suppliers
21	1	L2	UU9.8 (0.25*1 100T)	Horizontal	
22	2	L3	10*12 (0.25*1 285T)	RIK	
23	1	L4	EE16 (0.25*1 168T)		
24	1	Q1	7N60C3	T0-220	infineon 英飞凌
25	1	Q3	4401(NPN)	BC807 SOT-23	ON 安森美
26	1	Q2	BC807(PNP)	BC807 SOT-23	
26	2	R1	4.7K,+/-5%,	SMD-1206	
27	2	R2,R3.	680K Ω +/-5%,	SMD-1206	YAGEO 国巨
28	2	R7	100K Ω +/-5%,	SMD-1206	YAGEO 国巨
29	1	R8	2K Ω +/-5%,	SMD-0805	YAGEO 国巨
30	1	R9	22K Ω +/-5%,	SMD-0805	YAGEO 国巨
31	1	R10	2K Ω +/-1%,	1/8W	YAGEO 国巨
32	1	R11,R12	1.2R+/-1%,	SMD-1206	YAGEO 国巨
33	1	R14	1K+/-1%,	SMD-0805	YAGEO 国巨
34	1	R15	100K Ω +/-5%,	SMD-0805	YAGEO 国巨
35	1	R16	24K+/-5%,	SMD-0805	YAGEO 国巨
36	1	R17	2 Ω +/-1%,	SMD-0805	YAGEO 国巨
37	1	R18	2.4k Ω +/-1%,	SMD-0805	YAGEO 国巨
38	1	R20	27K Ω +/-5%,	SMD-1206	YAGEO 国巨
39	1	R21	18 Ω +/-5%,	SMD-1206	YAGEO 国巨

7. EMI choke 36V 700MA

1. Differential Mode Inductor L3,L4

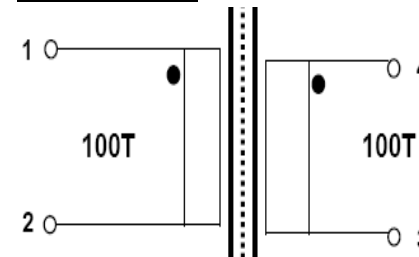
SCHEMATIC



Ferrite core size : Ax B 10x12mm
 Wire gauge: 0.25mm, 285 Turns
 Inductance @10kHz, 1V: 2mH +/-10%
 DCR: 2.1 OHM +/-20%

2. Common Choke L1 for EMI

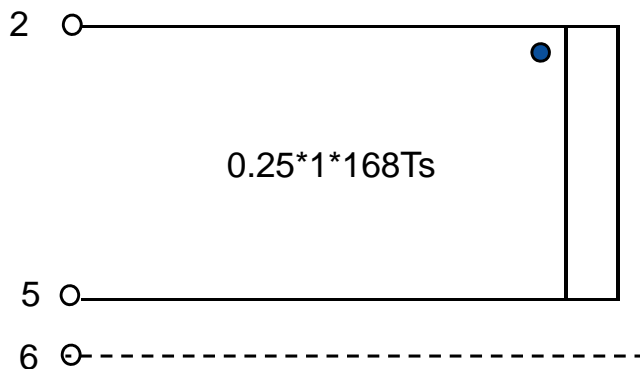
SCHEMATIC



Ferrite core : UU9.8 $\mu \geq 10k$
 Wire gauge: 0.25mm, 100 Turns
 Inductance @10kHz, 1V: 25mH +/-20%
 DCR: 1.2OHM +/-20%

3. PFC Inductor L4 Design

SCHEMATIC



ELECTRICAL SPECIFICATIONS:

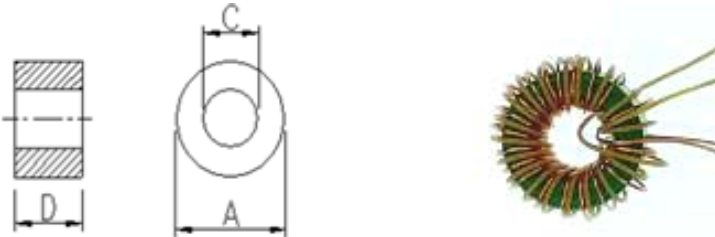
1. Inductance (L_p) = 0.7mH @10KHz
2. Core : EE16 (Ferrite Material TDK PC40 or equivalent)
3. Bobbin : EE16 Vertical
4. Ferrite core is connected to Pin 6 after assembling
5. Cut remained of Pin 1, 3, 4, 7, 8, 9, 10, after wires termination
6. Varnish the complete assembly

8. Common Mode Inductor L1

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

Material	μ_i	Bms(Gs)	Hc(Oe)	Br(Gs)	Tc(°C)	ρ (Ω -cm)	Frequency (MHz)	α ur x 10 ⁻⁶ /°C
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

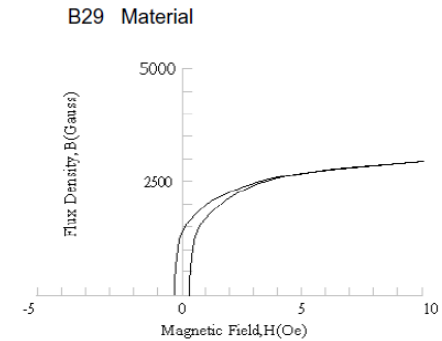
Ferrite core : Ni -Zn T8*4*3

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

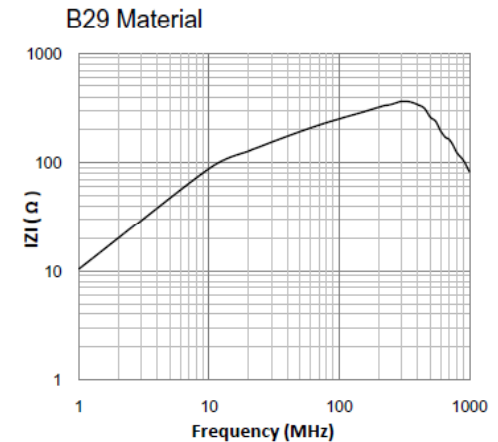
Inductance @10kHz, 1V: 25uH +/-10%

DCR: 0.12 OHM +/-20%

Saturation Flux Density (Ni-Zn)



Impedance Vs Frequency Curve (Ni-Zn)

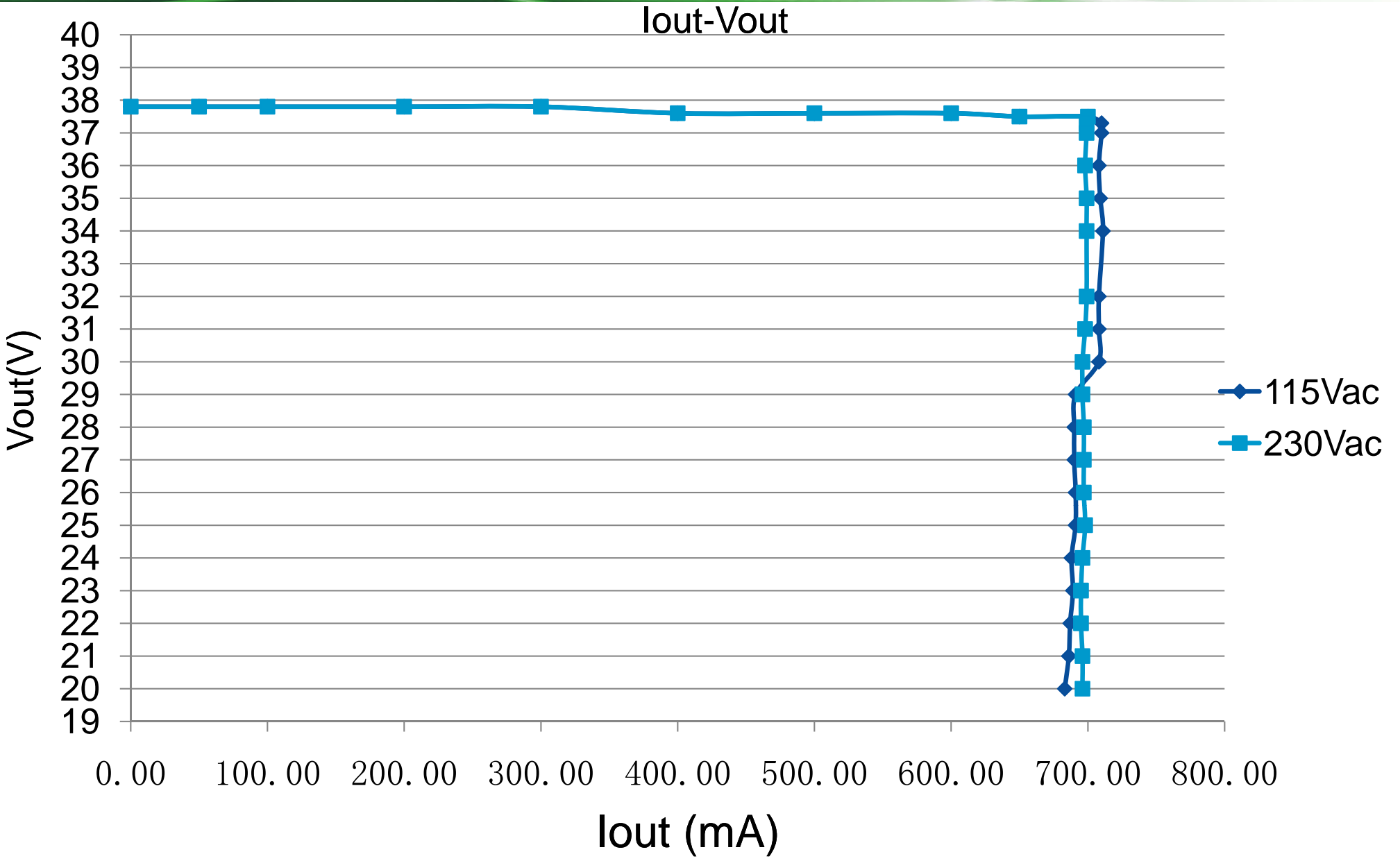


B.F.

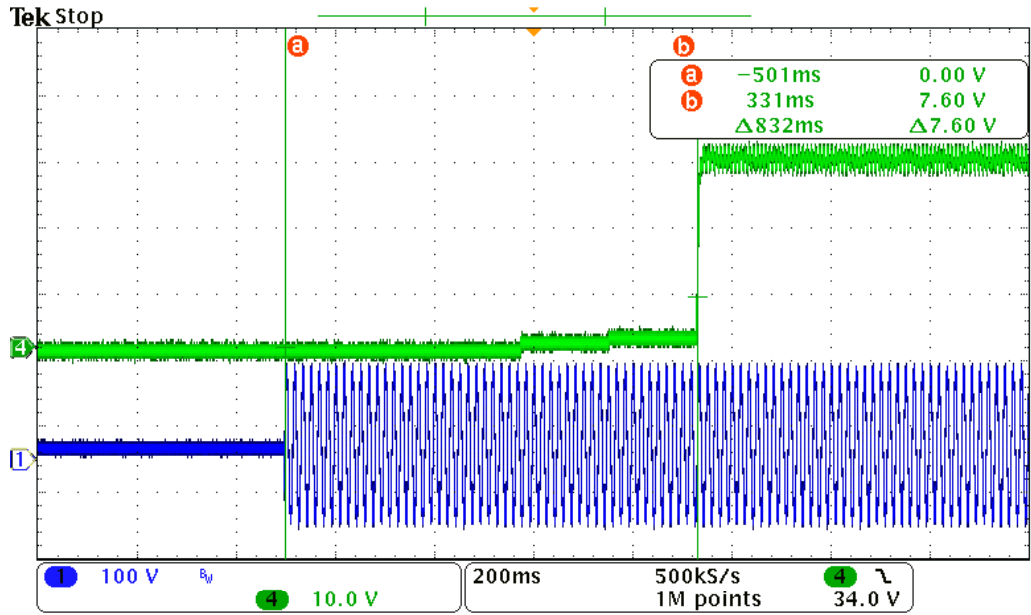
Contacts Information

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

9. Regulation, Iout Measurement

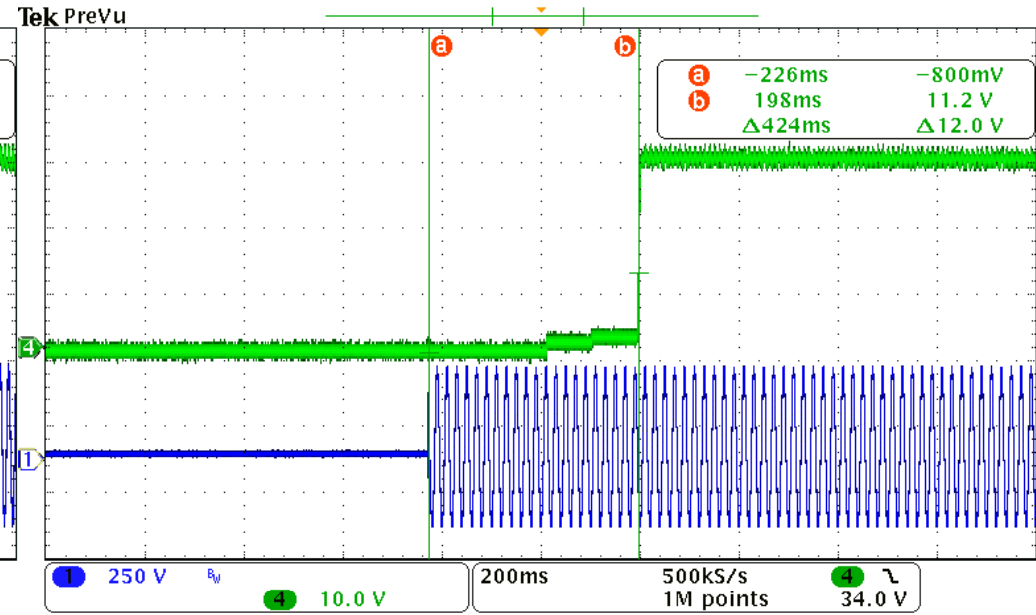


10. Start up and turn on delay time



90V_{AC}, Full Load

T_{ST_DELAY} = 832mS

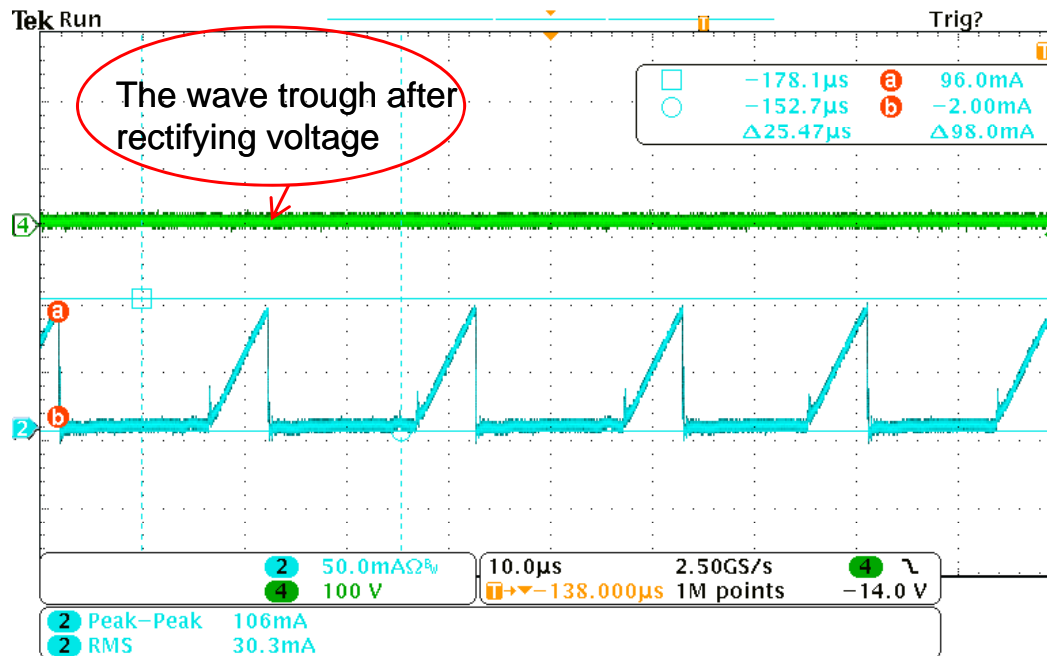


230V_{AC}, Full Load

T_{ST_DELAY} = 424mS

11. Transformer Flux Density

(N_p=65Ts, L_m=0.95mH, A_e=58mm EFD25



I_p is monitored at 90Vac and 700mA load

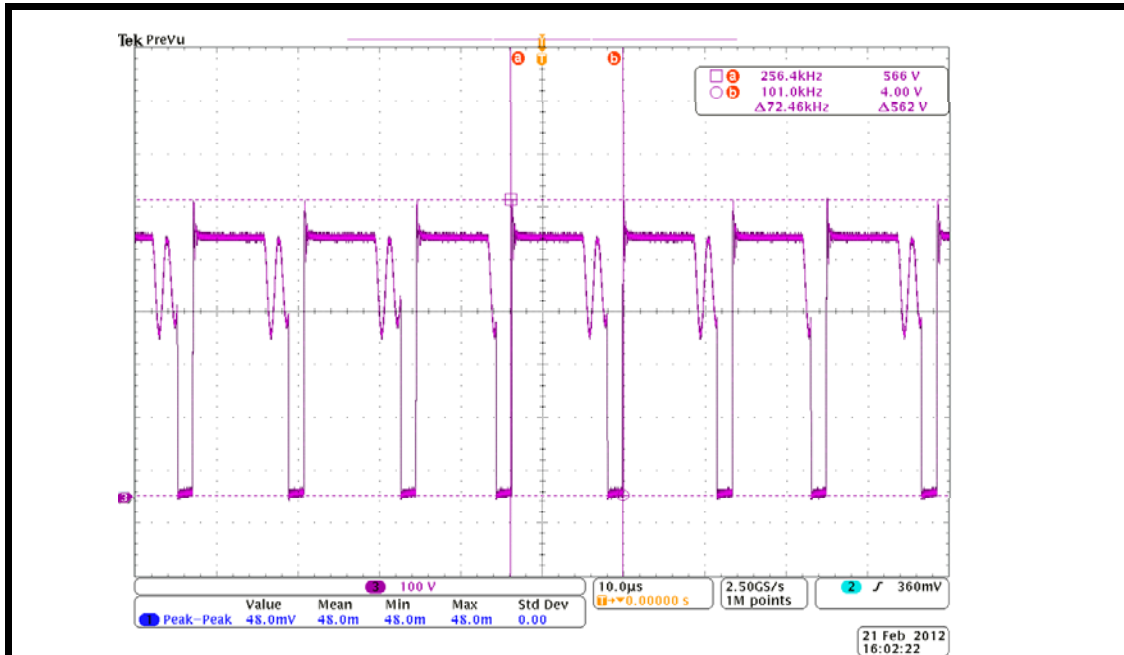
I_p=0.98A

$$B_{MAX} = I_P * L_m / (N_P * A_e)$$

$$= (980 * 0.95) / (58 * 65)$$

$$= \underline{0.234} \text{ Tesla}$$

12. V_{DS} Waveform MOSFET



Test Condition:

$V_{in}=264V_{ac}$, $I_{OUT}=0.7A$, $V_{out}=36V$

Result:

$V_{DS_MAX}=562V$

7N60C3

Parameter	Value	Unit
$V_{DS} @ I_{j,max}$	650	V
$R_{DS(on),max}$	0.95	Ω
$Q_{g,typ}$	13	nC
$I_{D,pulse}$	12	A
$E_{oss} @ 400V$	1.3	μJ
Body diode di/dt	500	A/ μs

13. V_R waveform Output Diode



Test Condition:

$V_{IN}=264VAC$, $I_{out}=700mA$, $V_{out}=36V$

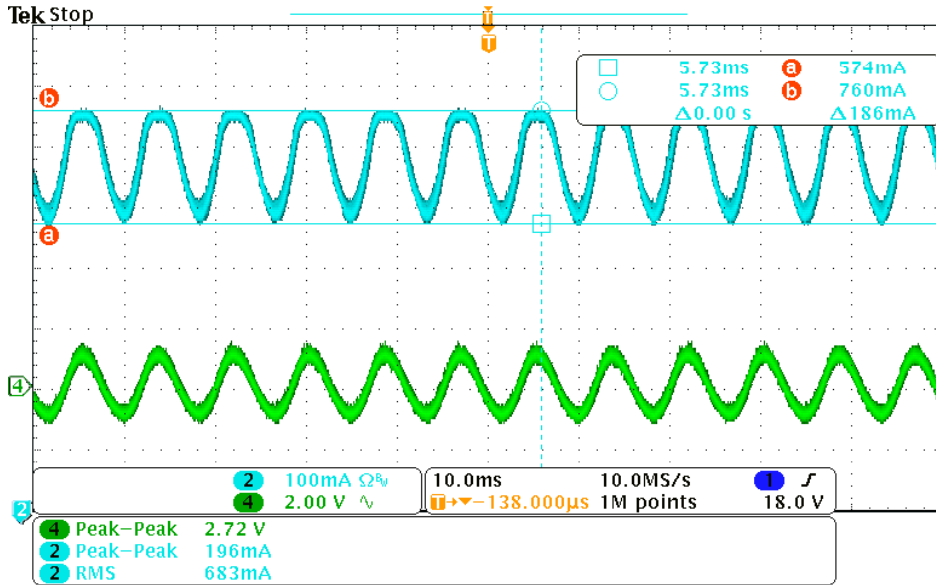
Result:

$V_R (pk-pk)=237V$

Output rectifier diode: HER304

Type Number	Symbol	HER 601G	HER 602G	HER 603G	HER 604G	HER 605G	HER 606G	HER 607G	HER 608G	Units
Maximum Recurrent Peak Reverse Voltage	V_{RRM}	50	100	200	300	400	600	800	1000	V
Maximum RMS Voltage	V_{RMS}	35	70	140	210	280	420	560	700	V
Maximum DC Blocking Voltage	V_{DC}	50	100	200	300	400	600	800	1000	V
Maximum Average Forward Rectified Current .375 (9.5mm) Lead Length @ $T_A = 55^{\circ}C$	$I_{(AV)}$	6.0								A
Peak Forward Surge Current, 8.3 ms Single Half Sine-wave Superimposed on Rated Load (JEDEC method)	I_{FSM}	150								A
Maximum Instantaneous Forward Voltage @ 6.0A	V_F	1.0			1.3		1.7			V
Maximum DC Reverse Current @ $T_A=25^{\circ}C$ at Rated DC Blocking Voltage @ $T_A=125^{\circ}C$	I_R	10.0 200								uA uA
Maximum Reverse Recovery Time (Note 1)	T_{rr}	50				75				nS
Typical Junction Capacitance (Note 2)	C_j	80				65				pF
Typical Thermal Resistance (Note 3)	$R_{\theta JA}$	37								$^{\circ}C/W$
Operating Temperature Range	T_J	-65 to +150								$^{\circ}C$
Storage Temperature Range	T_{STG}	-65 to +150								$^{\circ}C$

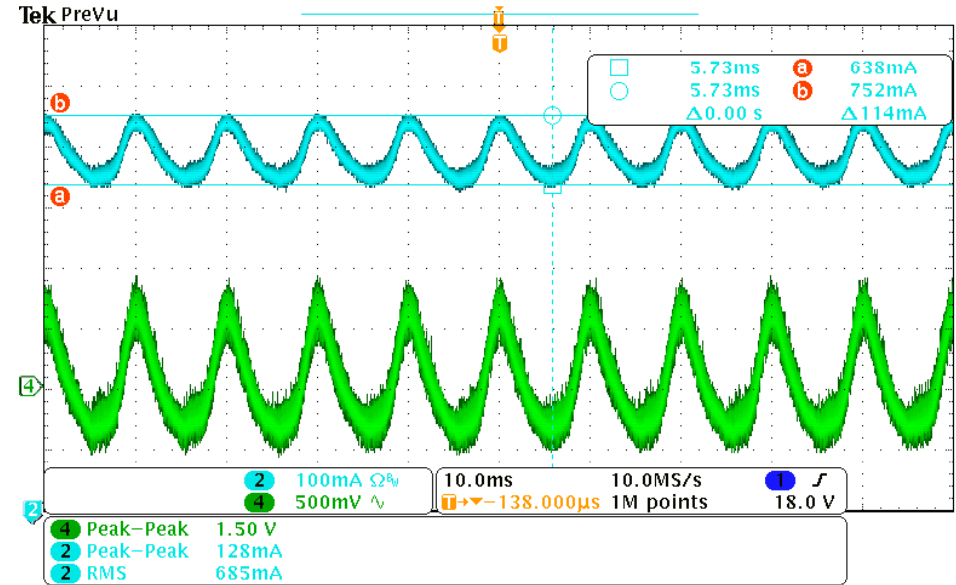
14. Voltage ripple and Current ripple



90V_{AC}, Full Load

CH1:current ripple 186mA (PK-PK)

CH2:voltage ripple 2.72V (PK-PK)

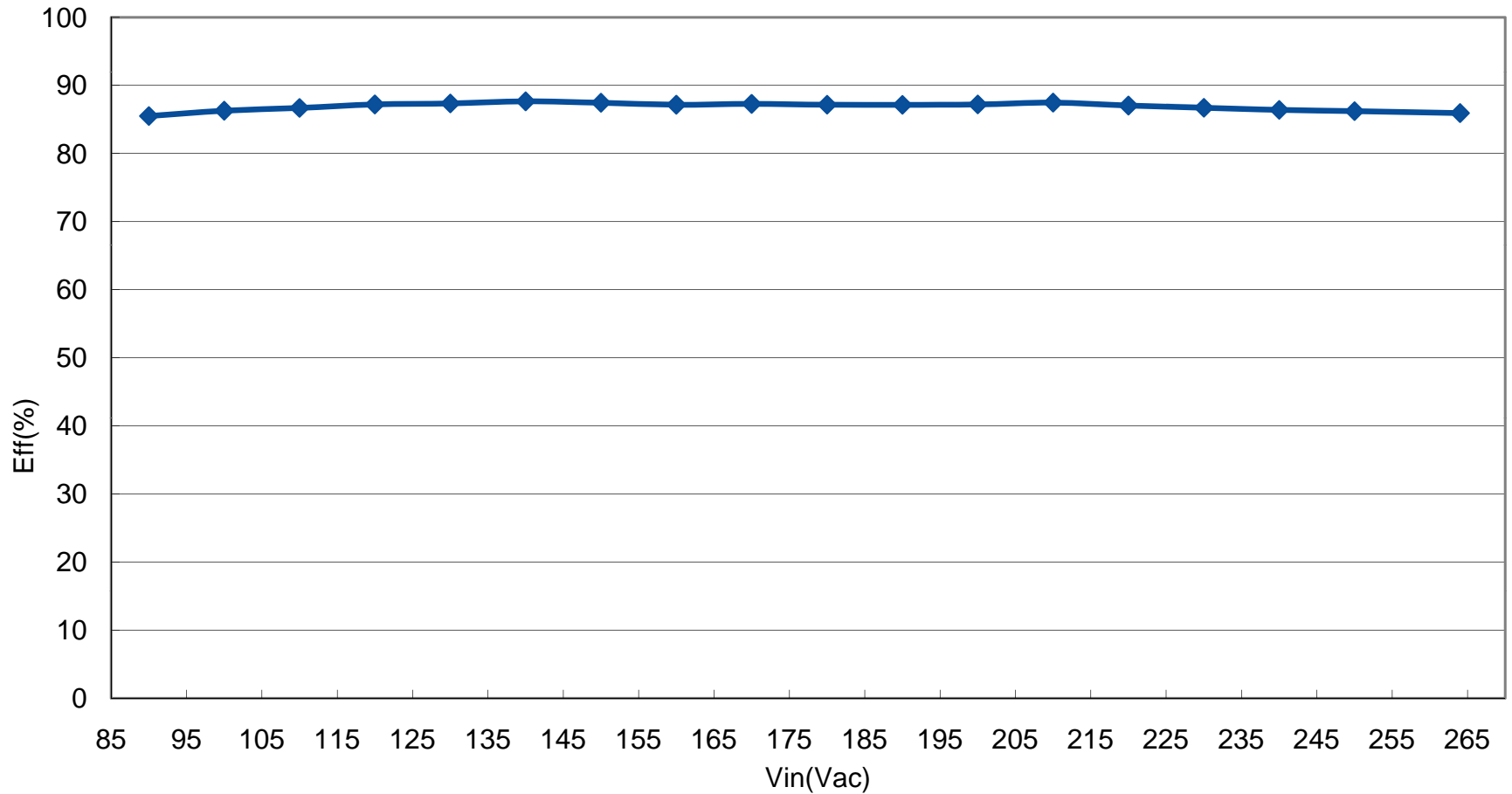


230V_{AC}, Full Load

CH1:current ripple 114mA (PK-PK)

CH2:voltage ripple 1.5V (PK-PK)

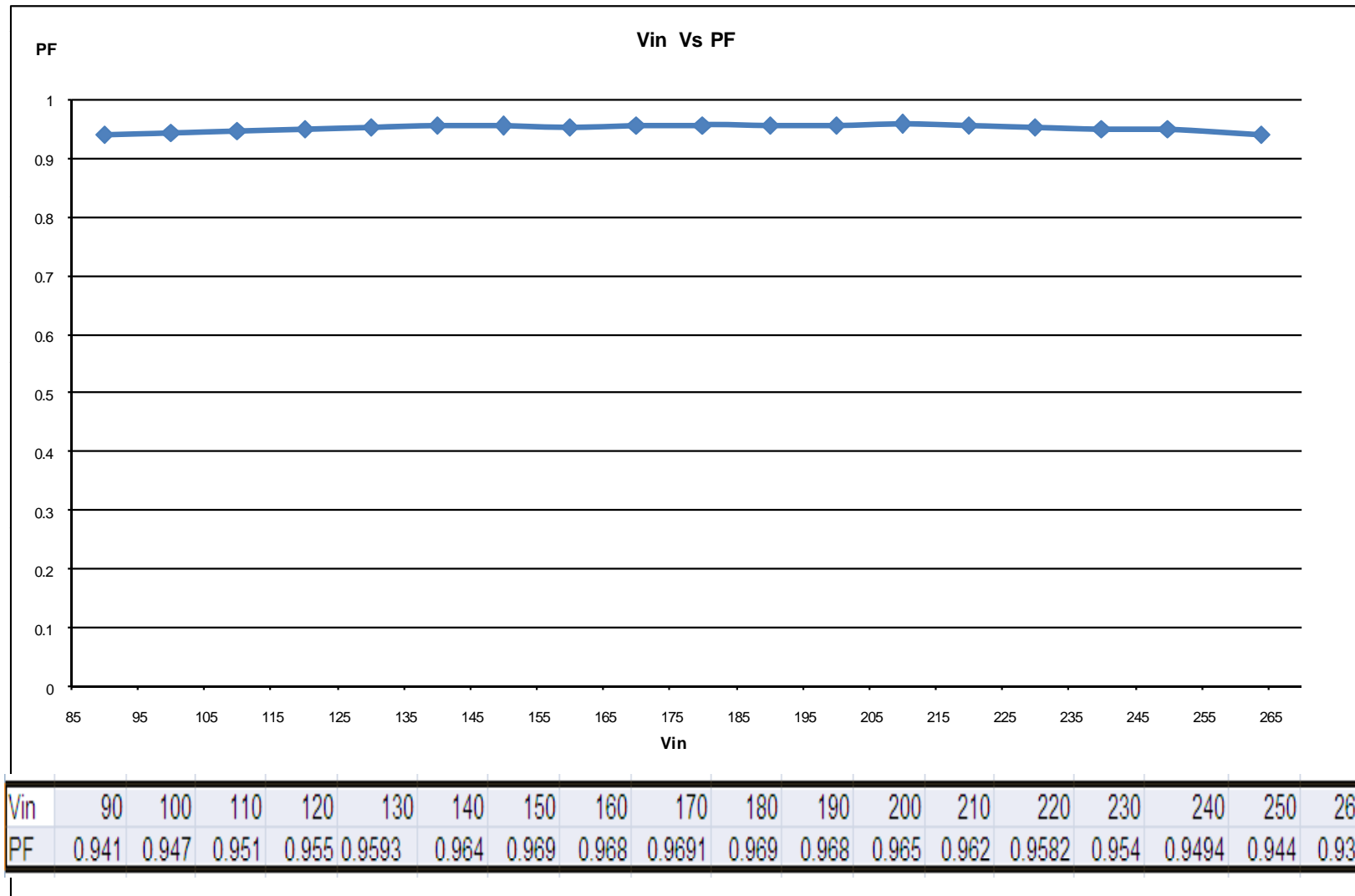
15. Efficiency Measurement



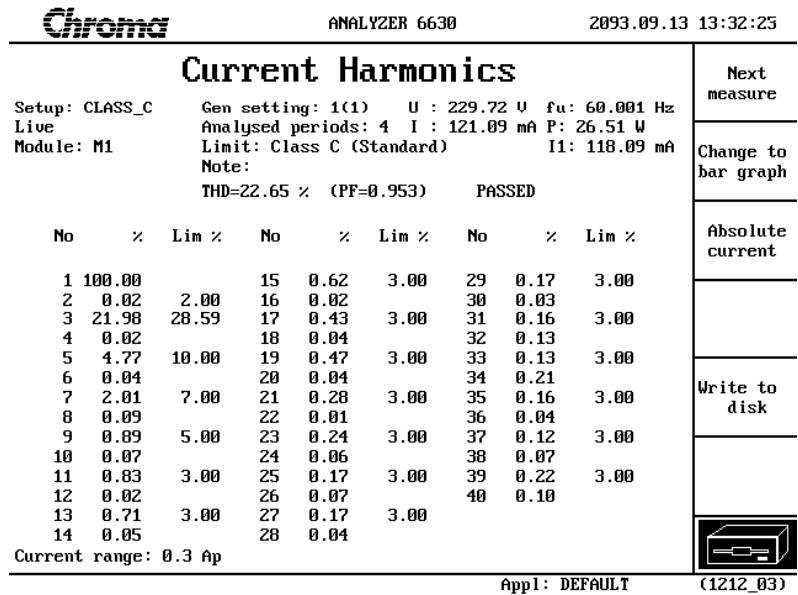
Vin	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	264
Eff	0.855	0.862	0.867	0.872	0.873	0.876	0.875	0.872	0.873	0.872	0.871	0.872	0.875	0.871	0.867	0.864	0.863	0.86

*** Note: Output voltage measured at end of PCB.**

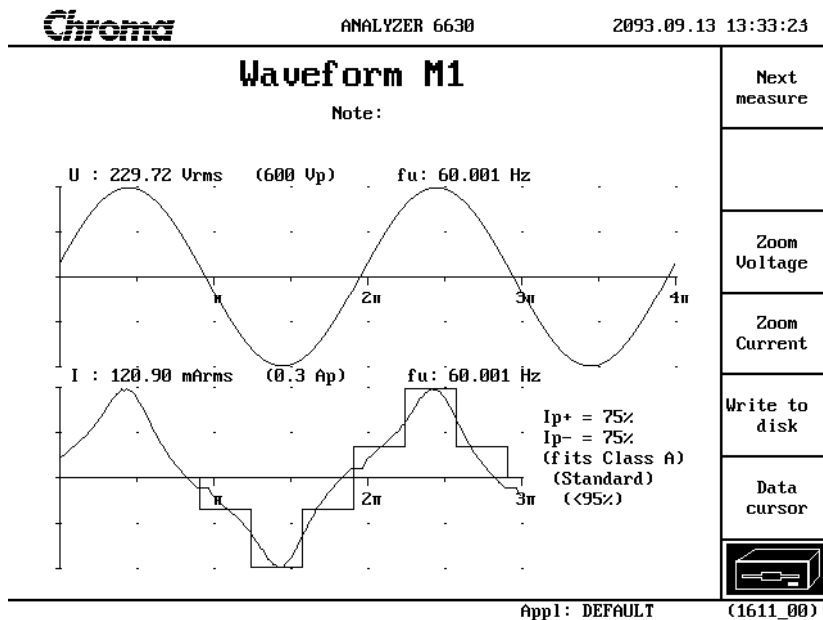
16. Input voltage VS Power Fact curve



18 . Harmonic and current waveform_ No dimmer _3620

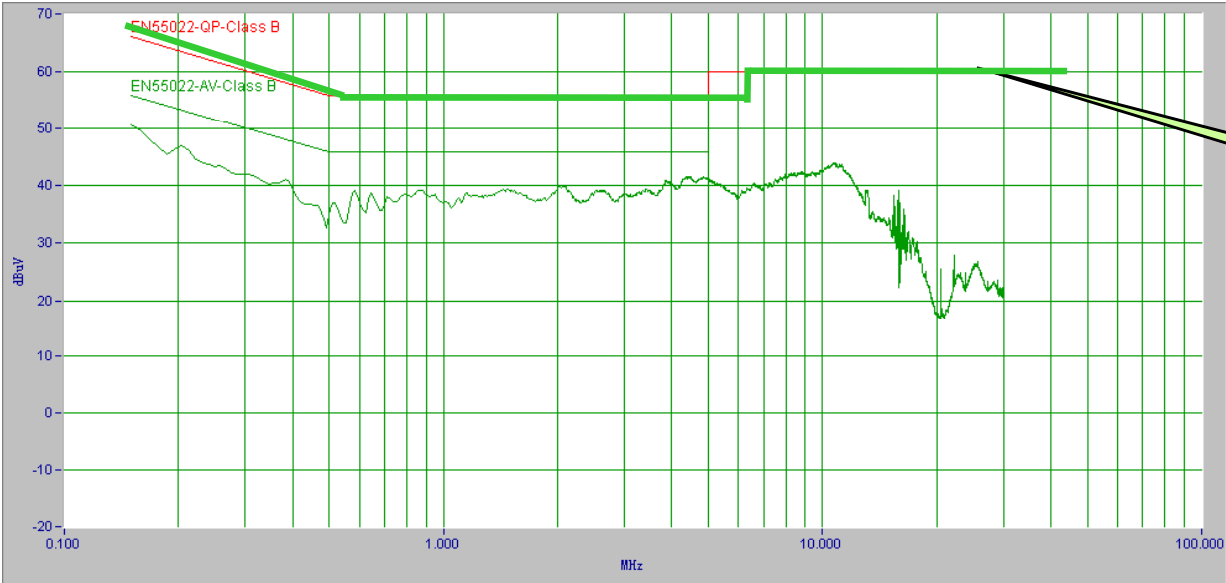


Harmonics current @230Vac
 Meet IEC61000-3-2 requirement



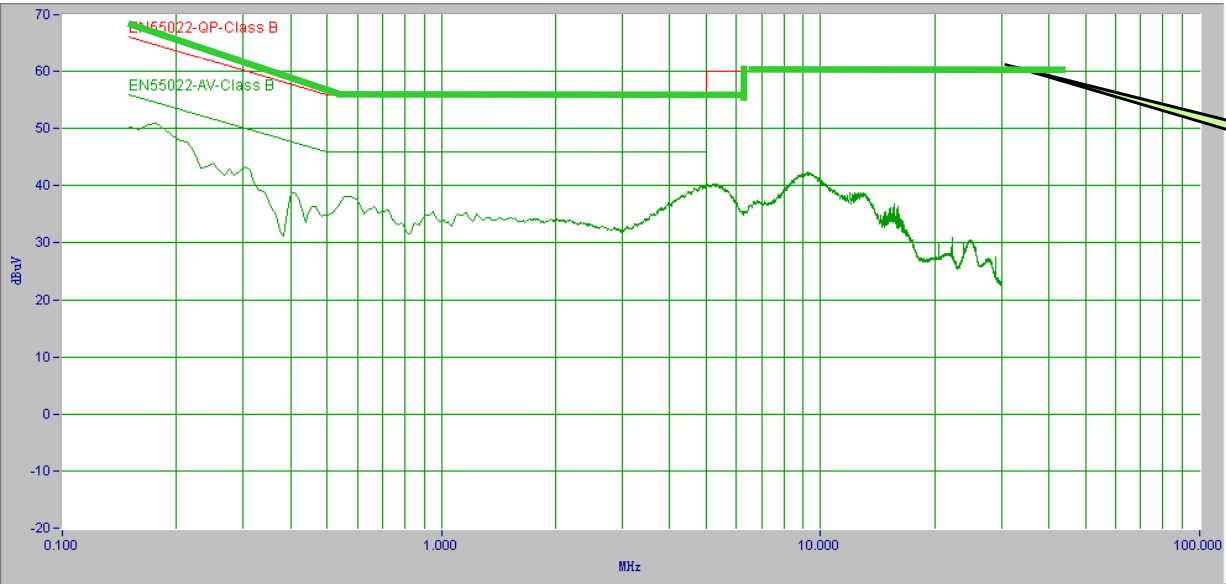
Ac current waveform @230Vac
 PF=0.953

19. Conducted EMI (Input 115Vac Full Load, output floating)



Peak Scan
QP Limit line

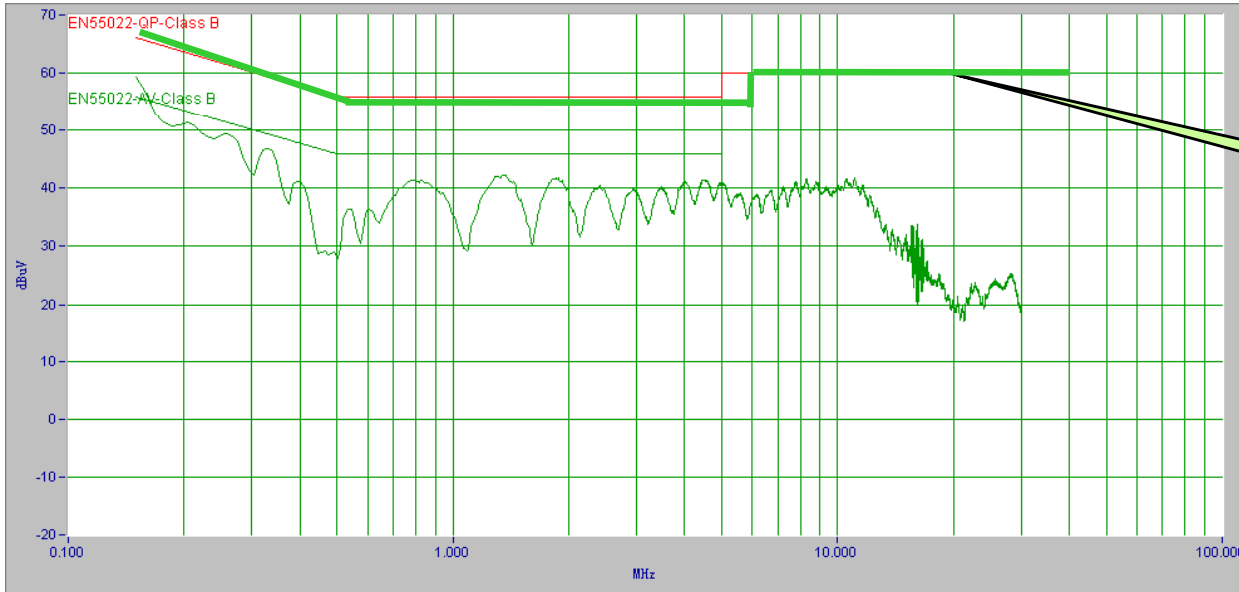
Peak scan N



Peak Scan
QP Limit line

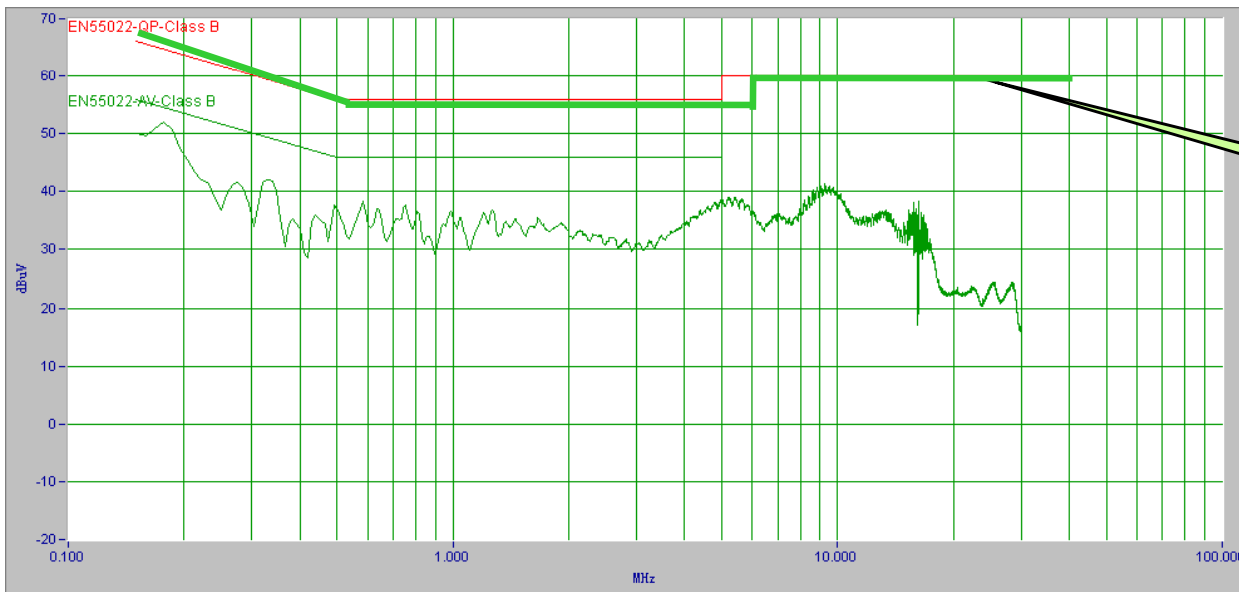
Peak scan L

20. Conducted EMI (Input 230Vac Full Load, output floating)



Peak Scan
QP Limit line

Peak scan N

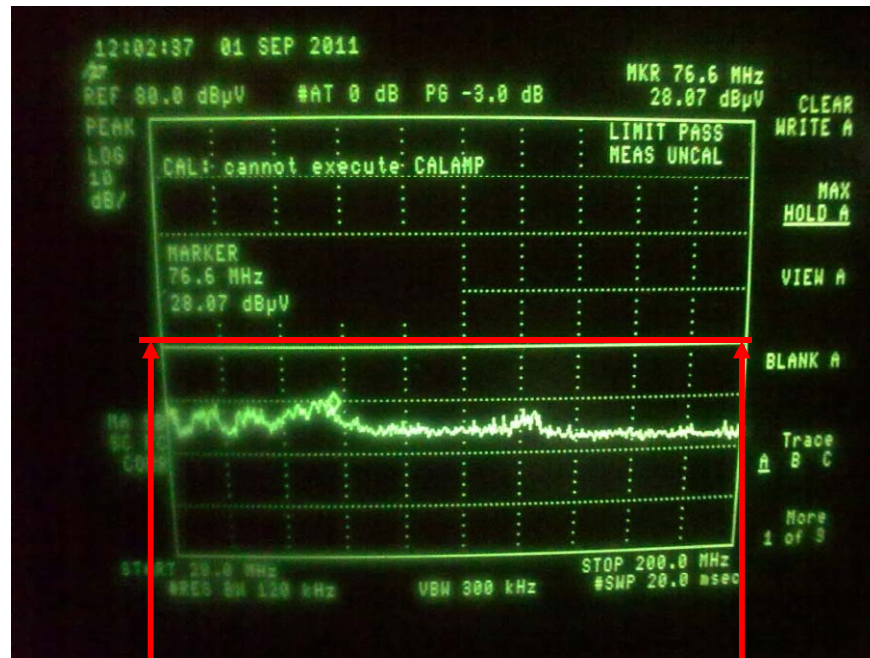


Peak Scan
QP Limit line

Peak scan L

21. Radiated IEM (for reference) 115Vac

EN55015 LIMIT



28MHz

200MHz

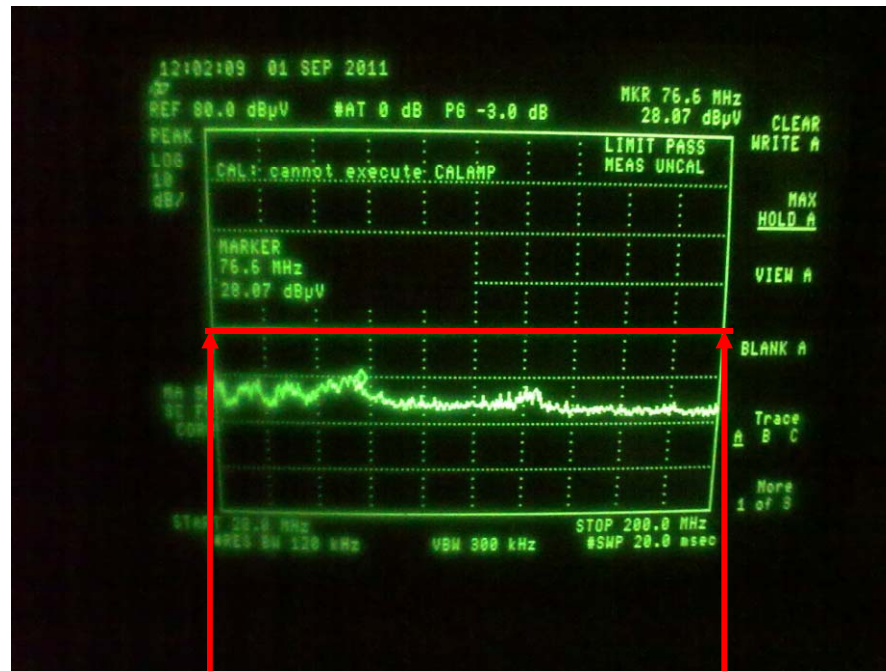
The radiated EMI margin is 8.9dBuV

Note: 1, Vin=115Vac

2, Output is floating, with LED load

22. Radiated IEM (for reference) 230Vac

EN55015 LIMIT



28MHz

200MHz

The radiated EMI margin is 8.9dBuV

Note: 1, V_{in} -230Vac

2, Output is floating, with LED load