iWatt
Intelligent AC-DC and LED Power™

LED Driver Design with iW1678

(AC input 180V~264Vac,Output 33 LEDs)

EBC882

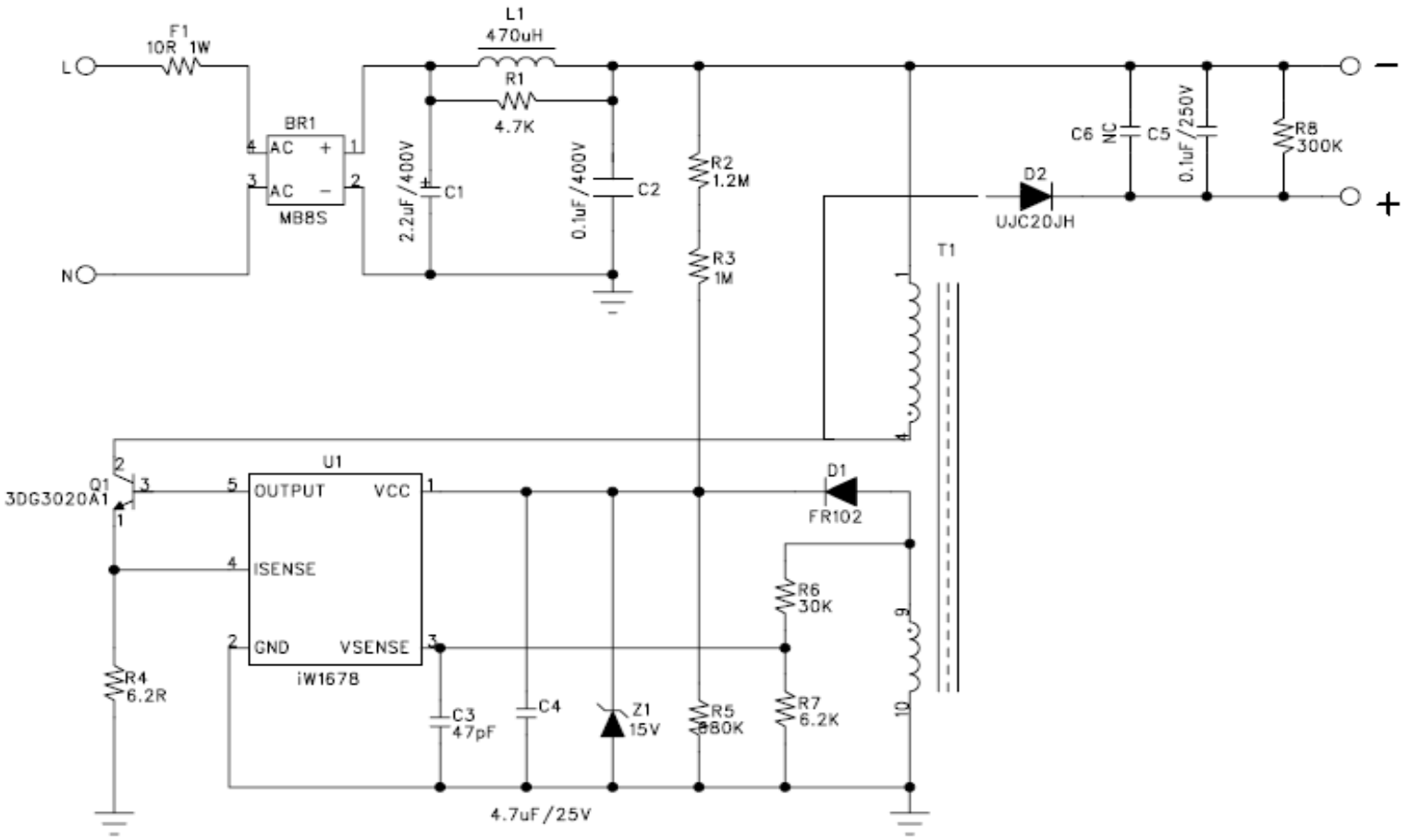
Summary and Features :

1. For candle LED lamp, LED driver for RC replacement
2. LED driver, 110V, CC@0.03A ; Wide range AC input range @180-264Vac
3. For Non-isolated Applications
4. High Efficiency and Minimum Parts count
5. Meet EMI EN55015B-QP limits

1. Specification

Description		Symbol	Min	Typ	Max	Units	Comment
Input							
Voltage		V_{IN}	180	230	264	V_{AC}	2 Wire
Frequency		f_{LINE}			50	Hz	
Open-load Input Power (264V_{AC})						W	
Output							
Const Voltage	Output Voltage	V_{OUT_CV}		110		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}		30		mA	
Total Output Power							
Continuous Output Power		P_{OUT}		3		W	
Over Current Protection		I_{OUT_MAX}				A	Auto-restart
Efficiency		η		87		%	Measured at end of PCB
Power Fact		*PF*		0.5			Harmonic meet IEC61000-3-2
Turn on Delay Time						Sec	
Conducted EMI				Meets EN55015B			
Hi-pot test				⌣		KV	
Operation temperature		T_{opr}		40		° C	Free convection, sea level

2.Schematic circuit

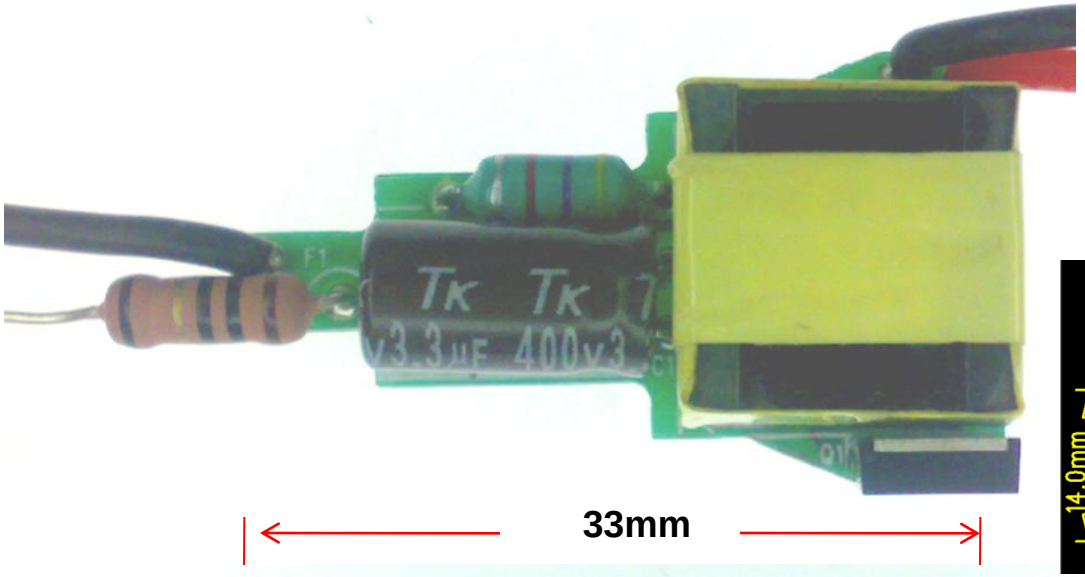


3.Bill of Material

Item	Qty.	Ref.	Description
1	1	C2	0.1uF,400V,CBB
2	1	C1	2.2uF,400V E-CAP,105℃
3	1	C3	47pF,50V,SMD-0603
4	1	C4	4.7uF,25V,SMD-1206
5	1	C5	0.1uF,250V,CBB
6	1	D1	FR102,1A,100V,SMD,
7	1	D2	UGC20GH;2A/600V;SMD
8	1	R1	4.7KΩ+/-5%,SMD-0805
9	1	R2	1.2MΩ+/-5%,SMD-1206
10	1	R3	1MΩ+/-5%,SMD-1206
11	1	FR1	10Ω FUSE Resistor-1W
12	1	R4	6.2Ω+/-5%,SMD-0805
13	1	R5	680KΩ+/-5%,SMD-0805
14	1	R6	30KΩ+/-1%,SMD-0805
15	1	R7	6.2KΩ+/-1%,SMD-0805
16	1	R8	300KΩ+/-5%,SMD-0805
17	1	L1	470uH ,1/2W
18	1	U1	iw1678-00 SOT23-5
19	1	T1	EPC13 Transformer
20	1	Q1	3DD3020A1 TO-251
21	1	BR1	ABS8

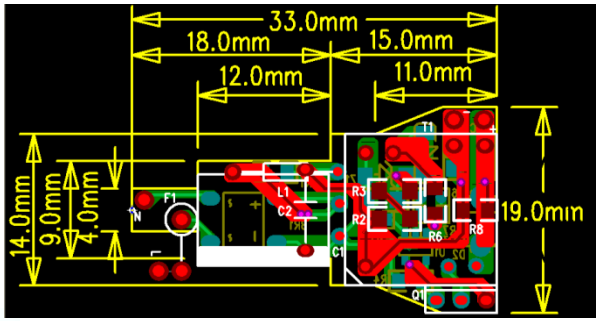
4.PCB Layout

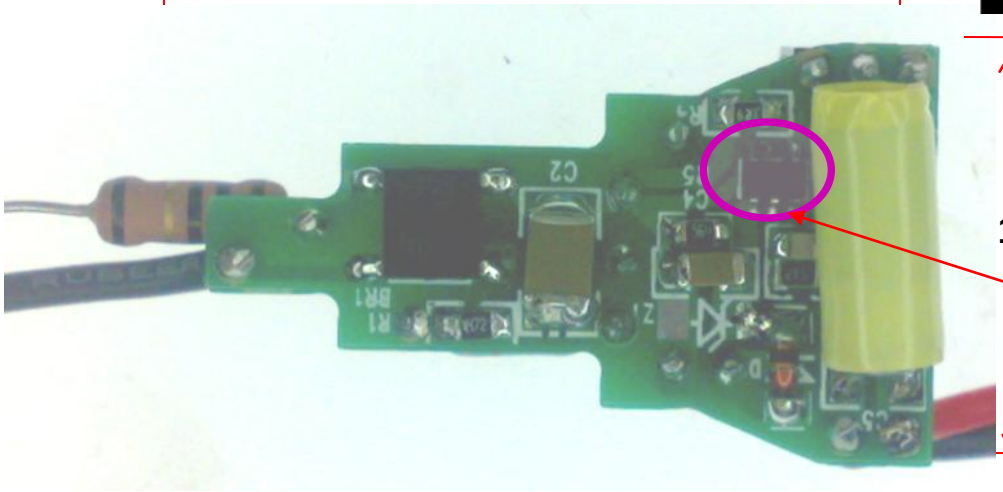
AC Input



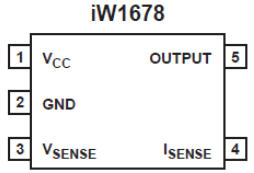
DC output

To LED



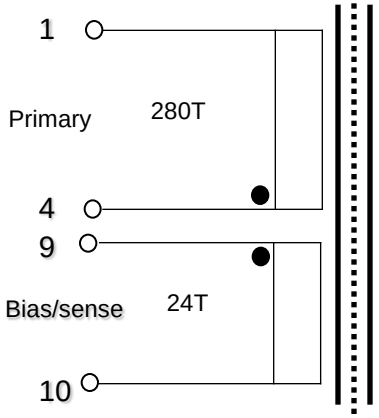


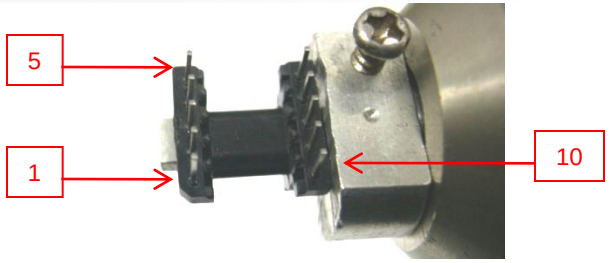
iw1678-00

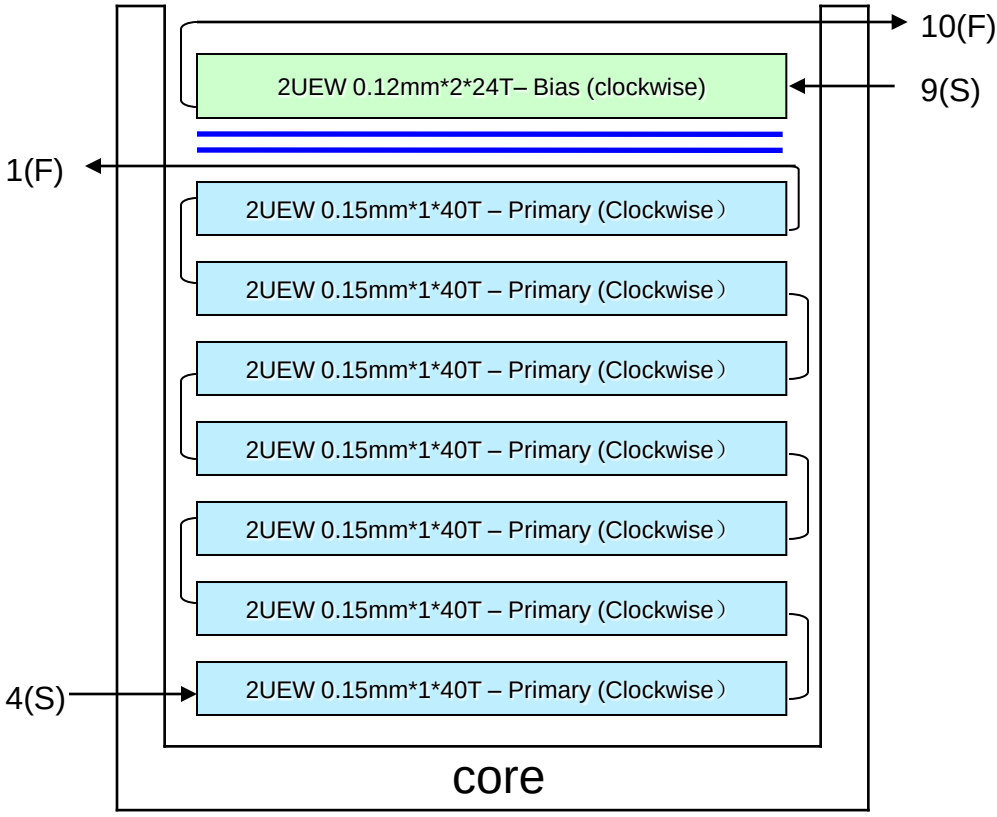


SOT-23 Package

5. Transformer Design







ELECTRICAL SPECIFICATIONS:

1. Primary Inductance (Lp) = 5.7mH @10KHz
2. Primary Leakage Inductance (Lk)< = 150uH @10KHz

MATERIALS:

1. Core : EPC13 (Ferrite Material TDK PC40 or equivalent)
2. Bobbin : EPC13,Horizontal. Primary=5, Secondary=5
3. Magnet Wires (Pri) : Type 2-UEW
4. Layer Insulation Tape :3M1298 or equivalent.

FINISHED :

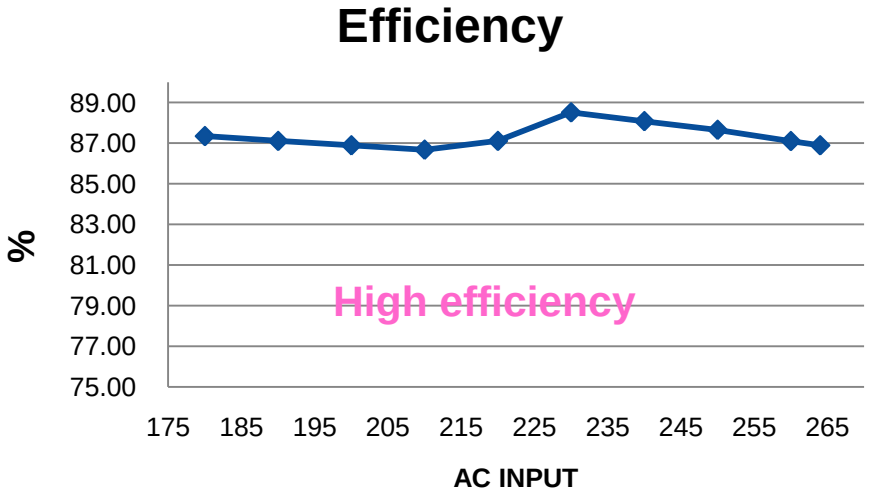
1. Cut Pin 2,3,5,6,7,8
2. Varnish the complete assembly

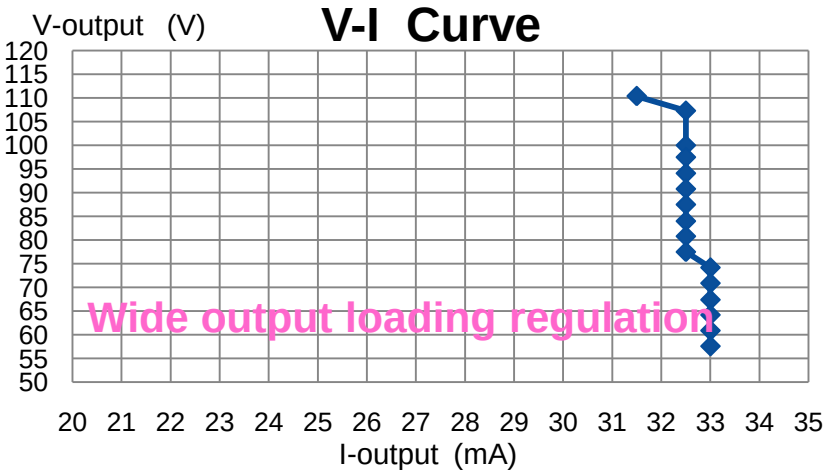
6. Efficiency and V-I Curve .

(AC input 180~264Vac, Output 33 LEDs)

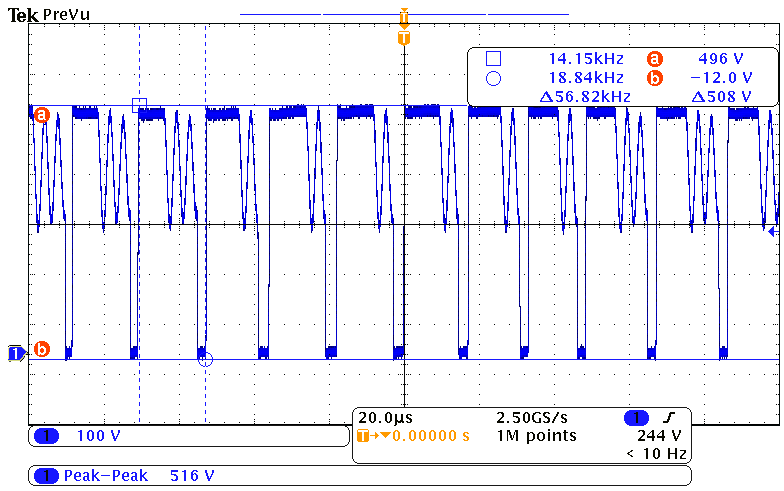
#of LEDS	Vin (V)	Pin (W)	Vout (V)	Iout (A)	efficiency %
16LEDS	180	4.03	110	0.032	87.34
	190	4.03	109.7	0.032	87.11
	200	4.04	109.7	0.032	86.89
	210	4.05	109.7	0.032	86.68
	220	4.03	109.7	0.032	87.11
	230	4.09	109.7	0.033	88.51
	240	4.11	109.7	0.033	88.08
	250	4.13	109.7	0.033	87.65
	260	4.16	109.8	0.033	87.10
	264	4.17	109.8	0.033	86.89

Best line regulation





7. V_{ce} Waveform



Test Condition:

Vin=264Vac, I_{OUT}=0.03A

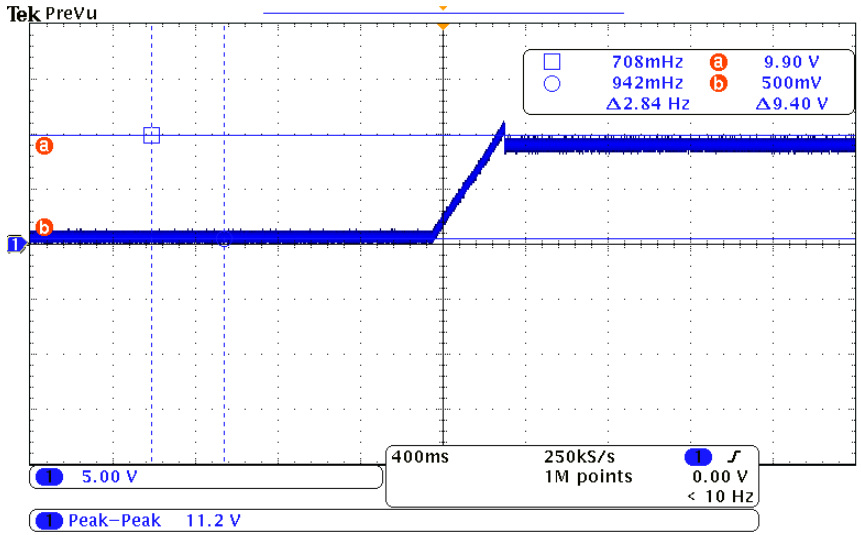
Result:

V_{CE_MAX}=**508V**

Appendix – Simple Specification for used transistor 3DD3020A1)

Parameter Note		Symbol	Rating	Unit
Collector-Base Breakdown Voltage		V_{CBO}	800	V
Collector-Emitter Breakdown Voltage		V_{CEO}	450	V
Emitter-Base Breakdown Voltage		V_{EBO}	9	V
Collector Current		I_C	1.5	A
Power Dissipation	T_a=25℃	P_{tot}	0.8	W
Junction Temperature		T_j	150	℃
Storage Temperature		T_{stg}	−55～150	℃

8. V_{CC} waveform



Test Condition:

V_{IN}=264VAC, Iout=30mA

Result:

V_{CC} MAX=9.4Vdc,

IW1678,VCC MAX=16.0Vdc.
Min=3.9Vdc

Above test result show all voltage measuring points is within normal operating range.

iW1678

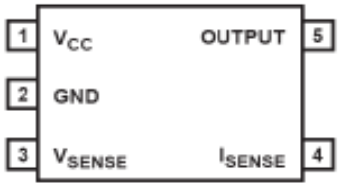
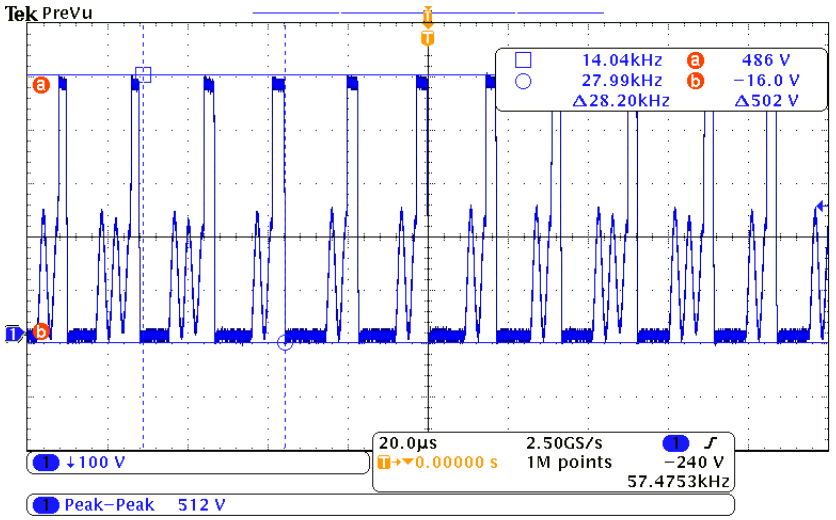


Figure 4.1: 5 Lead SOT-23 Package

V_{CC} SECTION (Pin 1)						
Maximum operating voltage (Note 1)	$V_{CC(MAX)}$				16	V
Start-up threshold	$V_{CC(ST)}$	V_{CC} rising	9.5	10.5	11.5	V
Undervoltage lockout threshold	$V_{CC(UVL)}$	V_{CC} falling	3.9	4.1	4.3	V
Start-up Current	$I_{IN(ST)}$	V_{CC} = 10 V		8	15	µA
Quiescent current	I_{CCQ}	No I_B current		2.5	3.5	mA
Zener breakdown voltage	V_{ZB}	Zener current = 1 mA T_A=25°C	18	19	20.5	V

9. V_{diode} waveform



Test Condition:

V_{IN}=264VAC, Iout=30mA

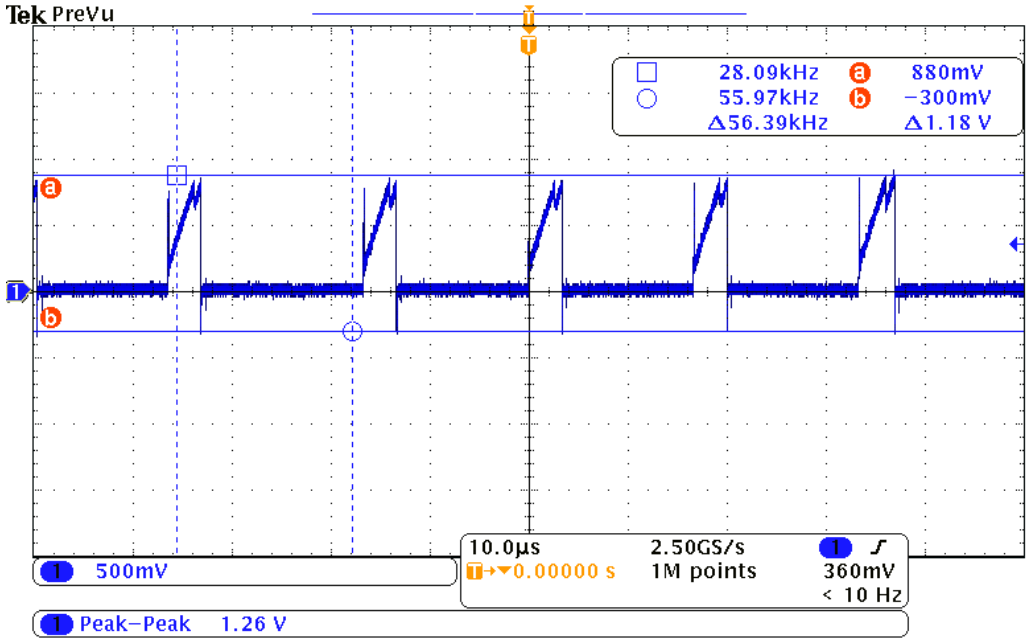
Result:

$V_{R\ (pk—pk)}$=502V

Output rectifier diode:
UGC20JH,1A,600V

10.Transformer Flux Density

(Np=280Ts,Lm=5.7mH,Ae=12mm^2,EPC13,5+5.)

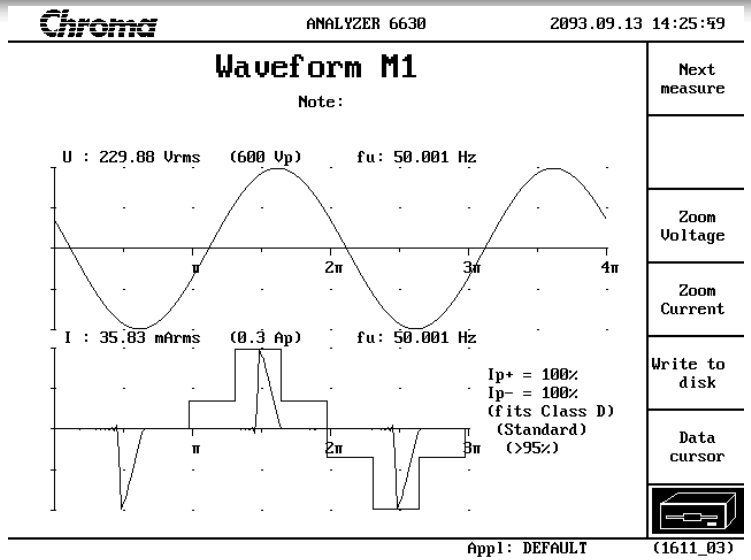


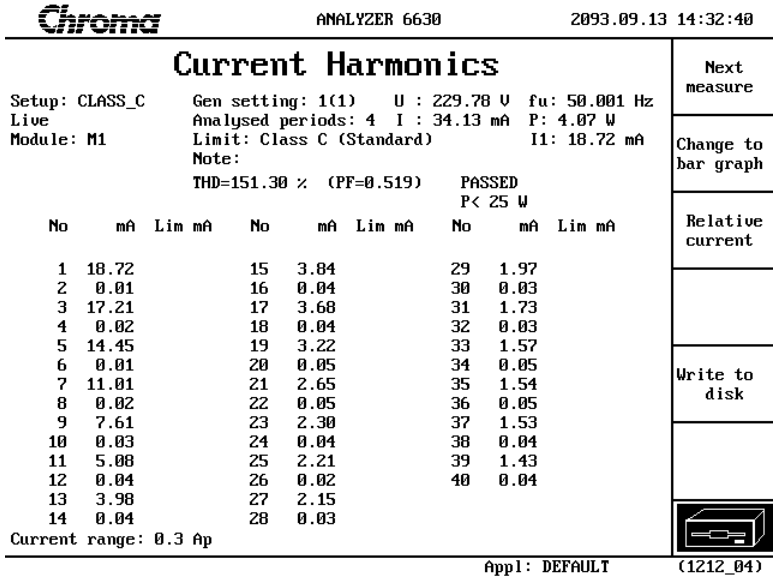
Ip is monitored at 180Vac and full Load.

Ip=1.18V/6.2R=190mA,

Bmax=Lm*Ip/(Np*Ae)=5.7*190/(280*12)=0.322Tesla

11. Harmonic and current waveform





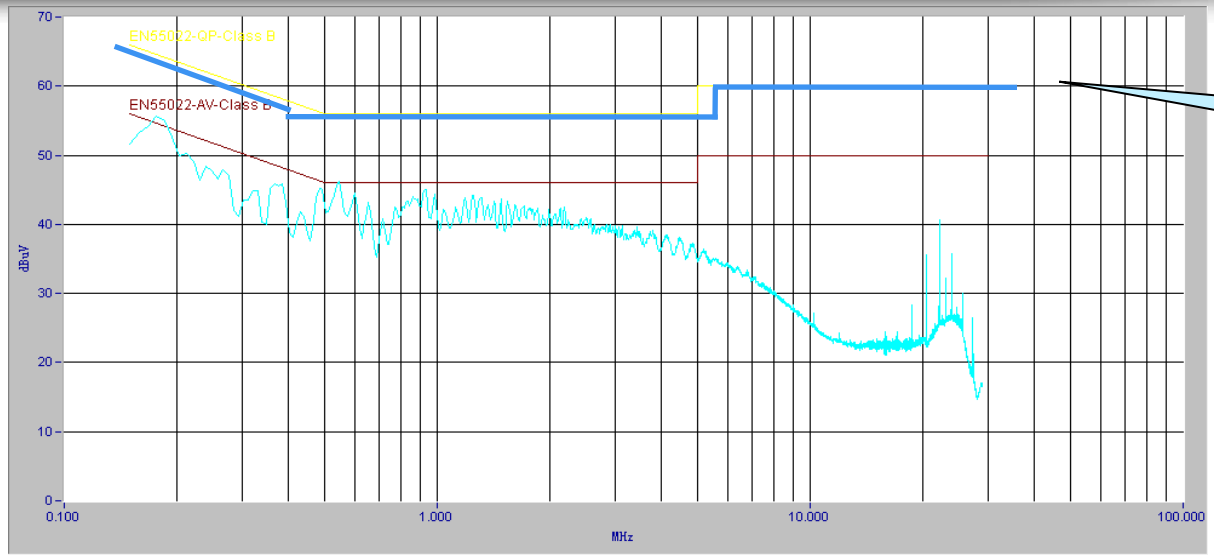
Harmonics current @230Vac

Meet IEC61000-3-2 requirement

Ac current waveform @230Vac

PF=0.519

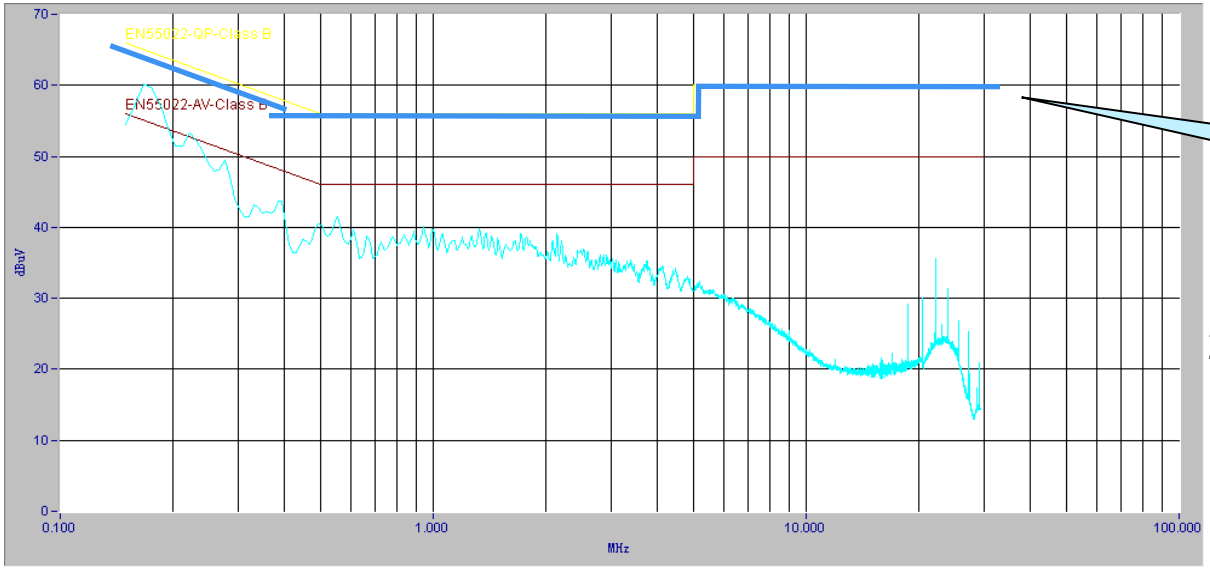
12.Conducted EMI (Input 230Vac)



Peak Scan
QP Limit line

QP scan L

230V/50Hz,16LEDS,30mA

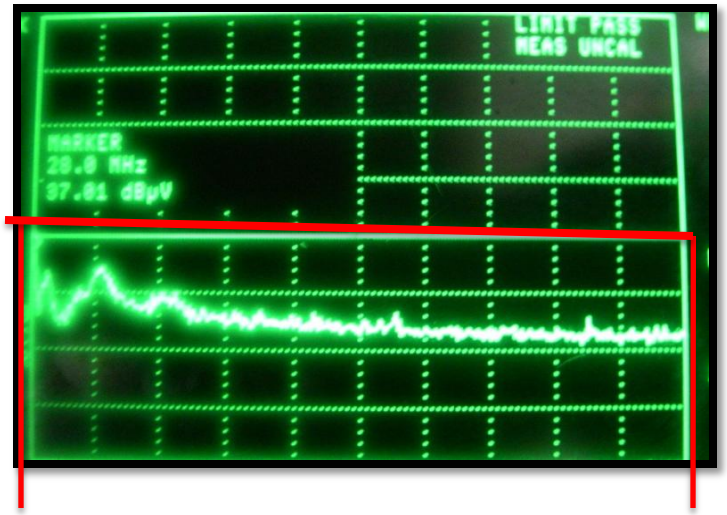


Peak Scan
QP Limit line

QP scan N

230V/50Hz,16LEDS,30mA

13.Radiated EMI (Input 230Vac)



limit

28MHz

200MHz

Input 230vac 50Hz
33LEDS,30mA