iWatt

iW1710-01 for 12V@1.5A Adapter Design

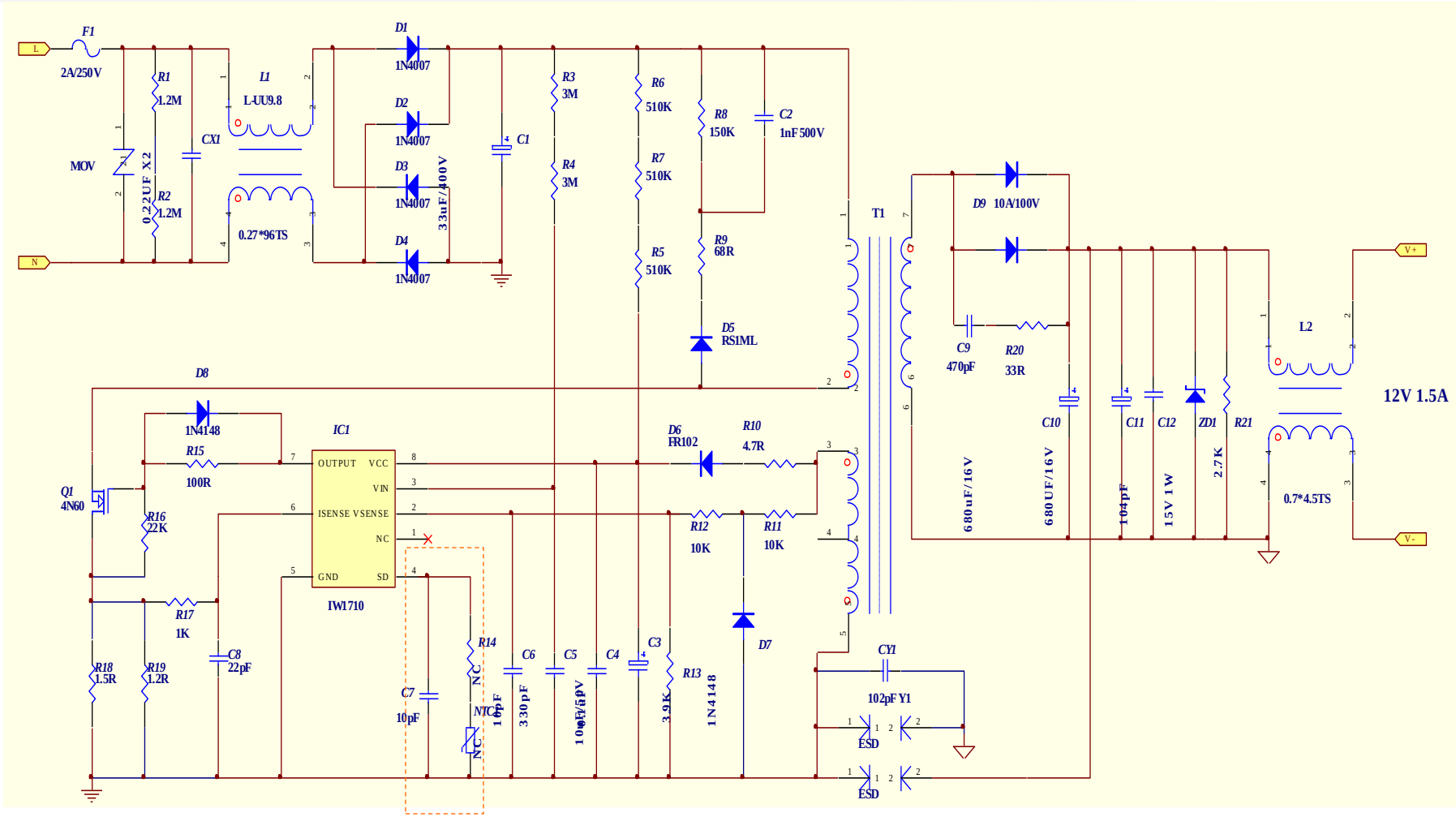
General Design Specification :

1. **AC Input Range 90-264Vac**
2. **DC Output 12V, 1.5A**
3. **Meet *"EPA_2.0"* Requirement with 20AWG/1.8m DC-Cable**
4. **Max Ripple <240mV$_{P_P}$**

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	
No-load Input Power (230V_{AC})				0.3	W	
Output						
Output Voltage	V_{OUT}	11.4	12	12.6	V	Measured at the end of Cable(20AWG,1.8M)
Output Current	I_{OUT}	0		1.5	A	
Output Ripple Voltage	V_{RIPPLE}			240	mV_{P_P}	Measured at the End of DC Output cable I_{OUT}=3A @20 MHz Bandwidth
Total Output Power						
Continuous Output Power	P_{OUT}			18	W	
Over Current Protection	I_{OUT_OCP}			2.3	A	Auto-restart
Efficiency	η	80.3			%	Measured at end of PCB, V_{IN} = 115V_{AC} and 230Vac, I_{OUT}= 3A. (T_A = 25 ℃)
Environmental						
Conducted EMI		Meets CISPR22B / EN55022B				
Safety		Designed to meet IEC60950, UL60950 Class II				
Ambient Temperature	T_{AMB}	0		40	° C	Free convection, sea level

2.Schematic Circuit

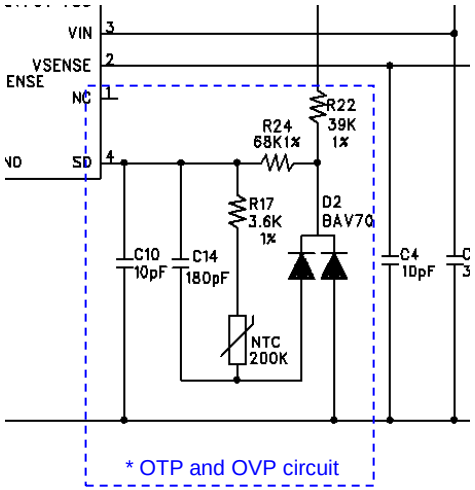


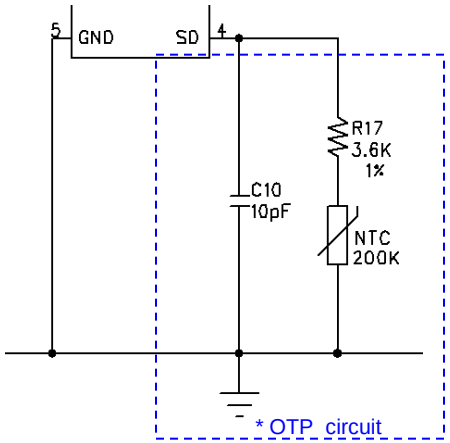
Optional:

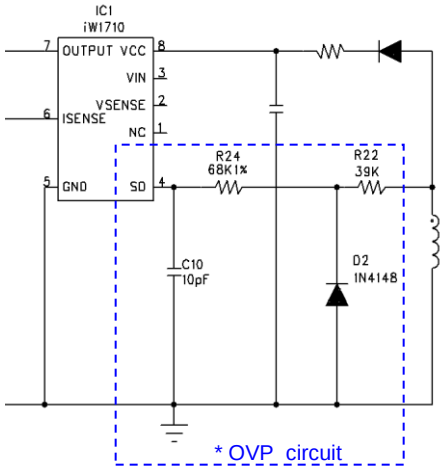
OVP and OTP circuit

3. Option Circuit for OTP&OVP

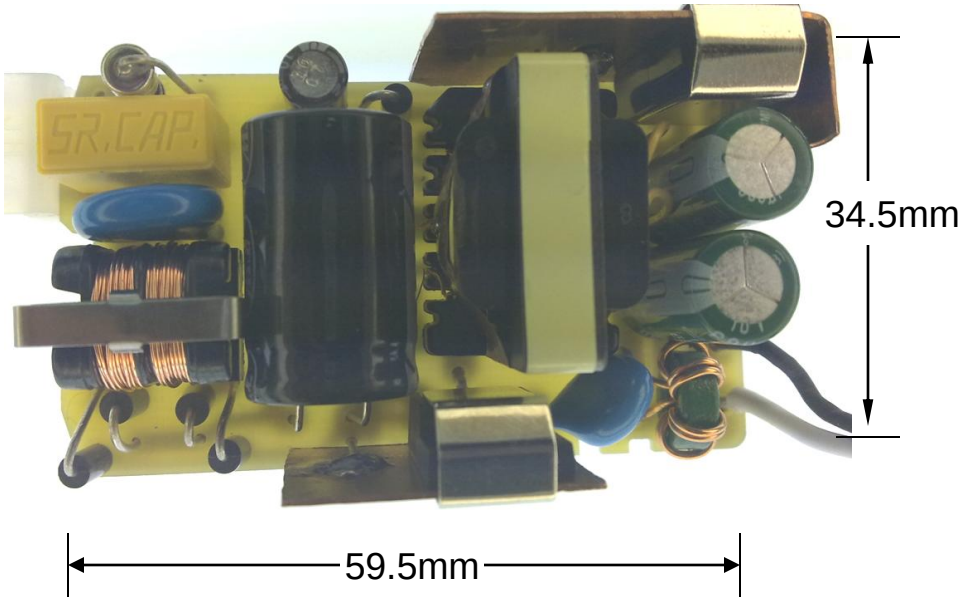
Option-1: Both OTP and OVP	Option-2: OTP Only	Option-3: OVP Only

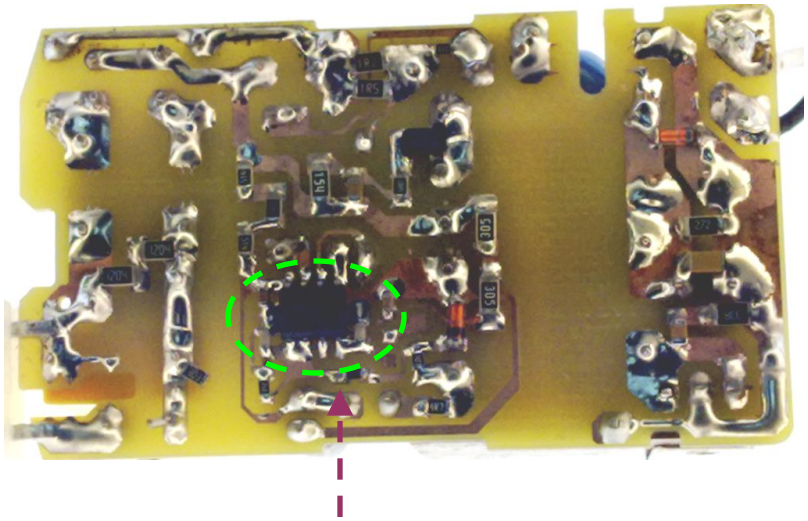


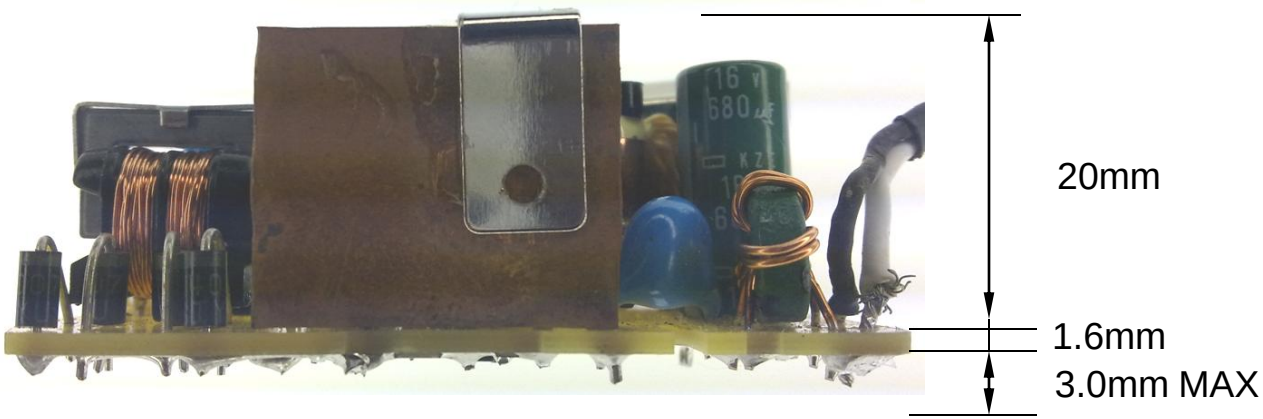




4. Circuit Board Photograph







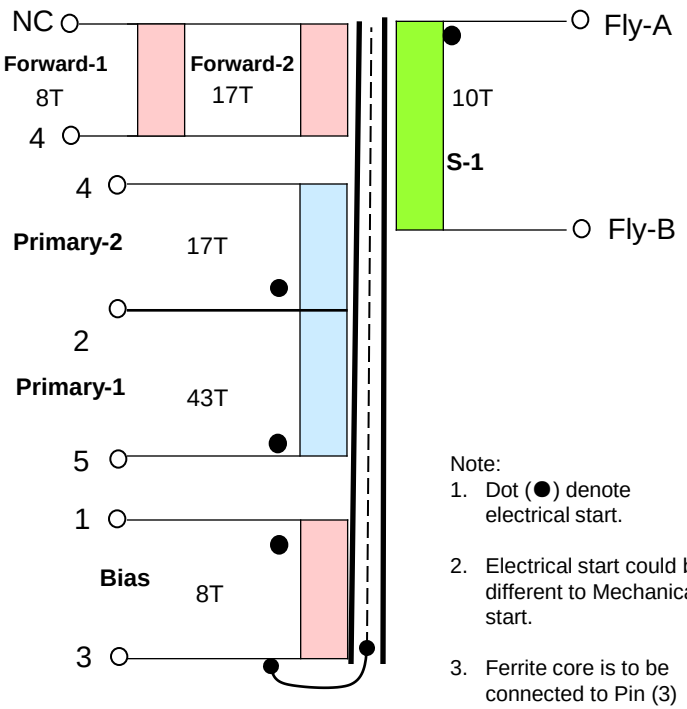
5. Bill of Material

Item	Qty.	Ref.	Description
1	1	IC1	iW1710-01, Off-line digital QR Mode Controller, SO-8
2	1	C1	33uF, 400V, E-CAP 13x21
3	1	C2	1nF,500V, SMD-0805
4	1	C3	10uF,50V,E-CAP,5x11.5, low ESR
5	1	C4	0.1uF,25V, SMD-0603
6	1	C5	330pF,25V, SMD-0603
7	1	C6	10pF,25V, SMD-0603
8	1	C7	10pF,25V, SMD-0603
9	1	C8	22pF,25V, SMD-0603
10	1	C9	470pF, 100V, SMD-0805
11	1	C10.C11	680uF 16V,8x20,low ESR
12	2	C12	104pF,25V, SMD-1206
13	1	CX1	0.22uF, 275V,X2
14	1	CY1	Y-CAP, 1nF,Y1
15	4	D1,D2,D3,D4	1N4007, Rectifier Diode DO-41
16	1	D5	RS1ML,Fast Rectifier Diode,SMD
17	1	D6	FR102, Fast Rectifier Diode DO-41
18	2	D7,D8	1N4148,Fasr Recifier Diode LL-34
19	1	D9	MBR10100, schottcky, TO-220
20	1	F1	2A/250V, Fuse
21	1	L1	UU9.8, 15mH,CM-chock Inductor,
22	1	L2	150uH,CM-chock Inductor,T8.5X4.5X3

Item	Qty.	Ref.	Description
23	1	ZD1	15V 1W 5%
24	1	Q1	STB4NK60, 4A/600V, MOSFET, TO-220
25	2	R1,R2	1.2MΩ ±5%, SMD-1206
26	1	R3	3.0MΩ±5%,SMD-1206
27	1	R4	3.0MΩ ±5%, SMD-1206
28	3	R5,R6,R7	510KΩ ±5%, SMD-0805
29	1	R8	150KΩ ±5%, SMD-1206
30	1	R9	68Ω ±5%, SMD-1206
31	1	R10	4.7Ω ±5%,SMD-0805
32	1	R11	10KΩ ±1%,SMD-0805
33	1	R12	10KΩ ±1%,SMD-0603
34	1	R13	3.9K ±1%, SMD-0603
35	1	R14	NC
36	1	R15	10Ω ±5%,1/8W
37	1	R16	22KΩ ±5%,SMD-0603
38	1	R17	1KΩ ±5%,1/8W
39	2	R18,	1.5Ω ±1%,SMD-1206
40	1	R19	1.2Ω ±1%,SMD-1206
41	1	R20	33Ω ±5%, SMD-1206
42	1	R21	2.7KΩ ±5%, SMD-1206
43	1	T1	EE22, Transformer
44	1	PCB	single side PCB, 94V0

6. Transformer Drawing

SCHEMATIC



Note:
1. Dot (●) denote electrical start.
2. Electrical start could be different to Mechanical start.
3. Ferrite core is to be connected to Pin (3)

ELECTRICAL SPECIFICATIONS:

1. Primary Inductance (Lp) =580uH± 7% @10KHz
2. Electrical Strength = 3KV, 50/60Hz,1Min(pins1~5 to pins A~B)

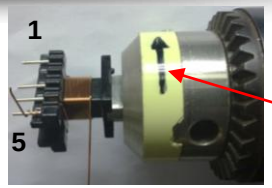
MATERIALS:

1. Core : EE22(Ferrite Material TDK PC40 or equivalent)
2. Bobbin : EE22 Vertical
3. Magnet Wires : Type 2-UEW
4. Layer Insulation Tape :3M1298 or equivalent.

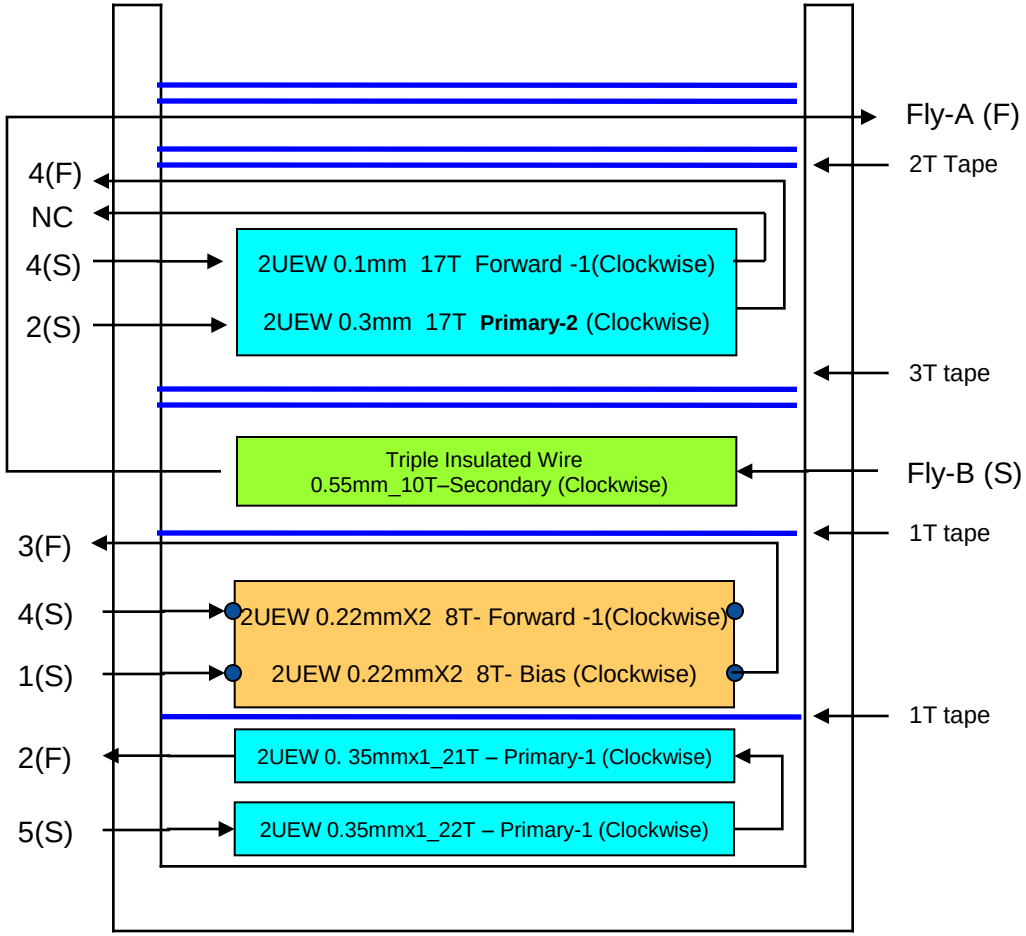
FINISHED :

1. Varnish the complete assembly

Winding Start pin-5 & End pin-2 in "Clockwise" direction – looking from Pin 1/5 side of the Bobbin.



Rotating direction of winding machine



7. Regulation, Ripple and Efficiency Measurement

Spec. Vout(V): 9 Iout(mA) 2000

VIN (VAC)	PIN (W)	VOUT (V)	IOUT (A)	VRIPPLE (mVP-P)	POUT (W)	η (%)	OCP (A)	Average η (%)	EPA2.0 η (%)
90	0.110	11.88	0.000	15			1.970	84.96	
	5.270	11.88	0.375	32	4.46	84.54			
	10.390	11.91	0.750	32	8.93	85.97			
	15.720	11.91	1.125	54	13.40	85.23			
	21.240	11.91	1.500	110	17.87	84.11			
115	0.120	11.88	0.000	24			1.960	85.66	80.30
	5.270	11.89	0.375	30	4.46	84.61			
	10.370	11.90	0.750	30	8.93	86.07			
	15.540	11.91	1.125	40	13.40	86.22			
	20.830	11.91	1.500	50	17.87	85.77			
230	0.230	11.89	0.000	20			1.830	84.01	
	5.420	11.88	0.375	36	4.46	82.20			
	10.710	11.90	0.750	34	8.93	83.33			
	15.770	11.91	1.125	38	13.40	84.96			
	20.880	11.91	1.500	46	17.87	85.56			
264	0.280	11.89	0.000	22			1.760	82.90	
	5.510	11.89	0.375	42	4.46	80.92			
	10.900	11.90	0.750	34	8.93	81.88			
	15.960	11.91	1.125	38	13.40	83.95			
	21.070	11.92	1.500	52	17.88	84.86			

Note: Output voltage measured at end of PCB

8. EPA_2.0 Requirement

Table 1: Energy-Efficiency Criteria for Ac-Ac and Ac-Dc External Power Supplies in Active Mode: Standard Models

Nameplate Output Power (P_{no})	Minimum Average Efficiency in Active Mode (expressed as a decimal) [2]
0 to ≤ 1 watt	≥ 0.480 * P_{no} + 0.140
> 1 to ≤ 49 watts	≥ [0.0626 * Ln (P_{no})] + 0.622
> 49 watts	≥ 0.870

Table 2: Energy-Efficiency Criteria for Ac-Ac and Ac-Dc External Power Supplies in Active Mode: Low Voltage Models

Nameplate Output Power (P_{no})	Minimum Average Efficiency in Active Mode (expressed as a decimal) [2]
0 to ≤ 1 watt	≥ 0.497 * P_{no} + 0.067
> 1 to ≤ 49 watts	≥ [0.0750 * Ln (P_{no})] + 0.561
> 49 watts	≥ 0.860

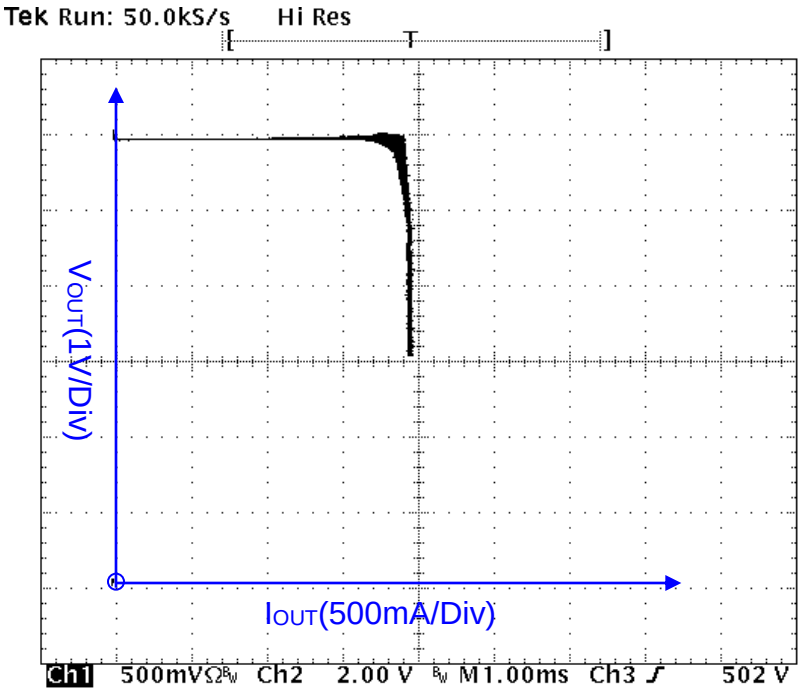
EPA2.0 (Final) for Standard Models (P_{no}=18W) :

V_{IN} (VAC)	I_{OUT} (mA)	P_{IN} (W)	Measure at end of PCB				Measure at end of Cable (22AWG/1.8m, R_{Cable}=0.23Ω)			
			V_{OUT_PCB} (V)	P_{OUT_PCB} (W)	$EFF_{\_PCB}$ (%)	$AV\text{-}EFF_{\_PCB}$ (%)	V_{OUT_Cable} (V)	P_{OUT_Cable} (W)	$EFF_{\_Cable}$ (%)	$AV\text{-}EFF_{\_Cable}$ (%)
115	0.375	5.27	11.89	4.46	84.61	85.66	11.80	4.43	83.99	84.11
	0.750	10.37	11.90	8.93	86.07		11.73	8.80	84.82	
	1.125	15.54	11.91	13.40	86.22		11.65	13.11	84.35	
	1.500	20.83	11.91	17.87	85.77		11.57	17.35	83.28	
230	0.375	5.42	11.88	4.46	82.20	84.01	11.79	4.42	81.60	82.48
	0.750	10.71	11.90	8.93	83.33		11.73	8.80	82.13	
	1.125	15.77	11.91	13.40	84.96		11.65	13.11	83.12	
	1.500	20.88	11.91	17.87	85.56		11.57	17.35	83.08	

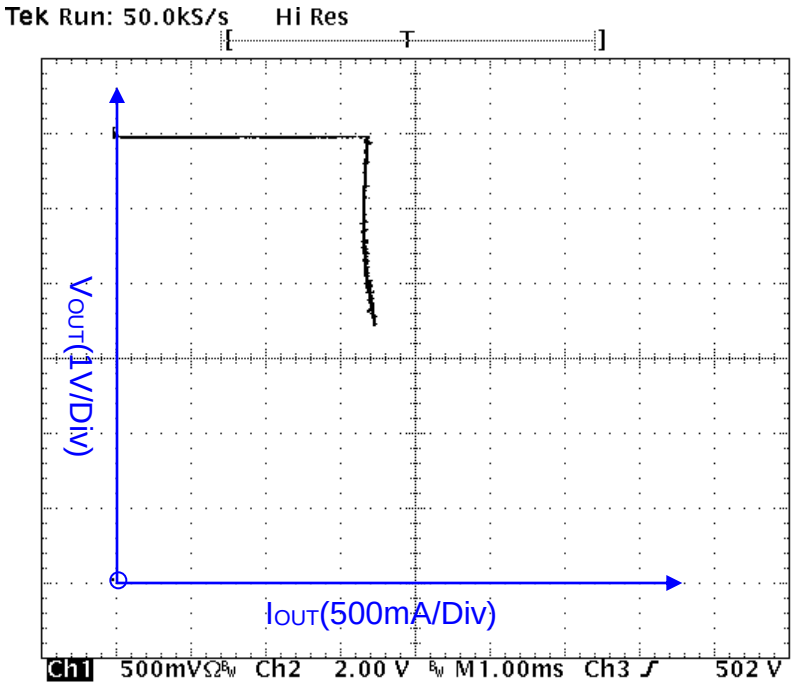
9. Output VI Characteristics

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

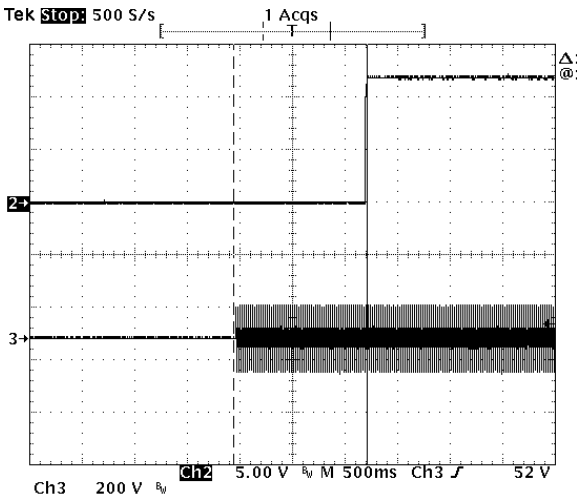
V_{IN}=90Vac/50Hz



V_{IN}=264Vac/50Hz

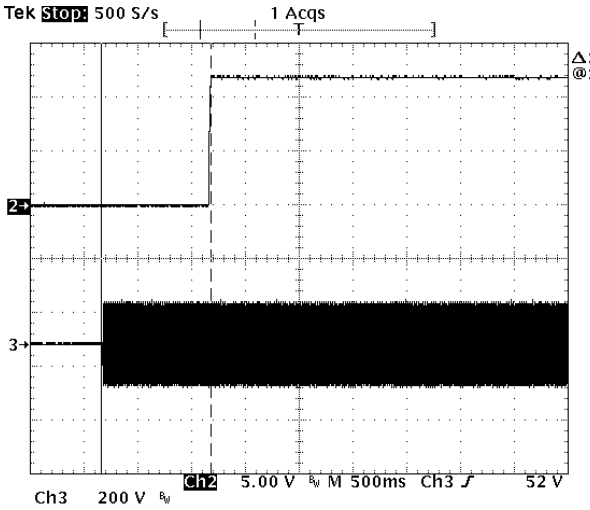


10. Turn On Delay Time



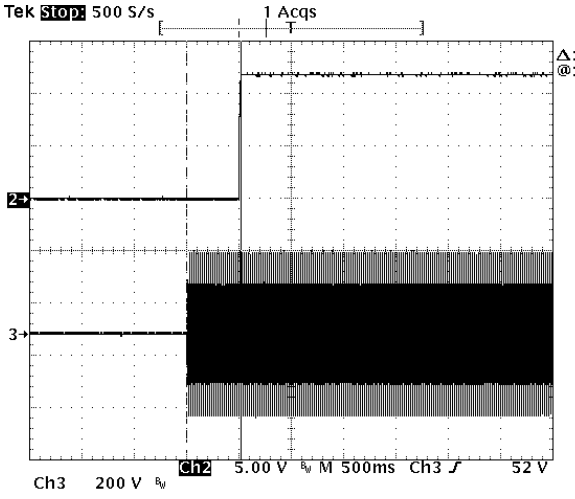
90V_{AC},Full Load

T_{ST_DELAY}=1.27S



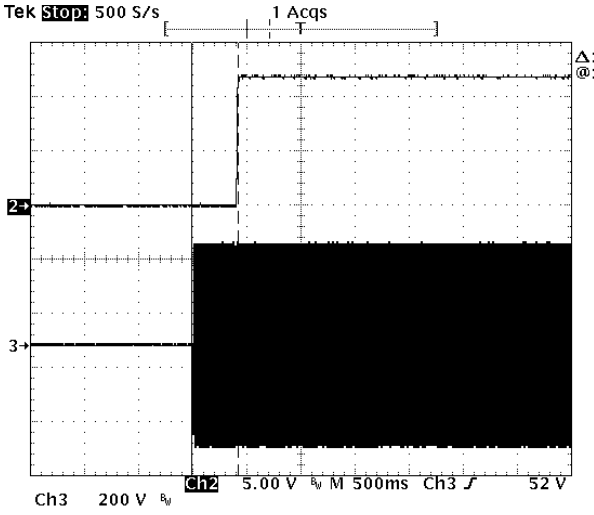
115V_{AC},Full Load

T_{ST_DELAY}=1.02S



230V_{AC},Full Load

T_{ST_DELAY}=0.52S

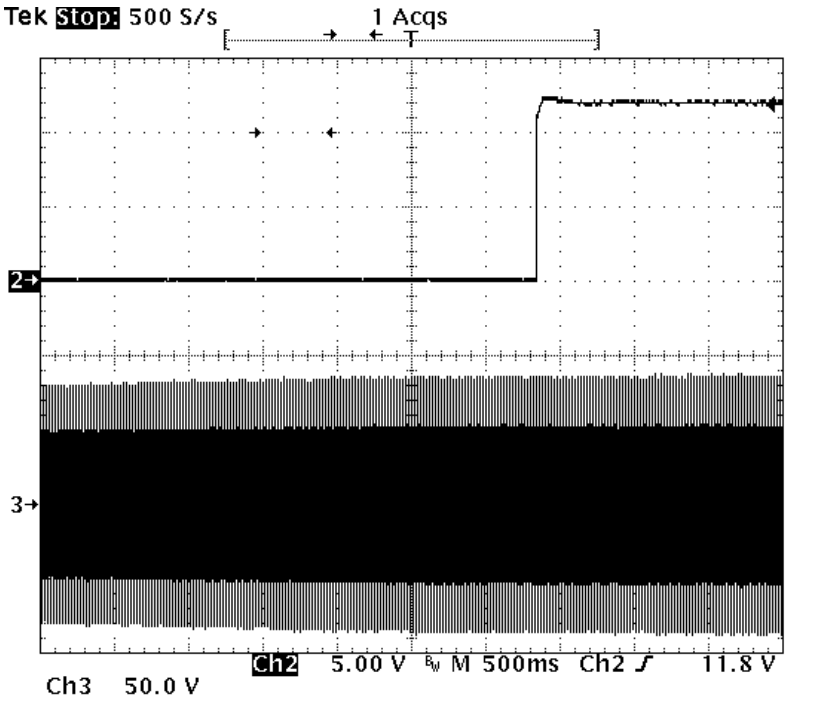


264V_{AC},Full Load

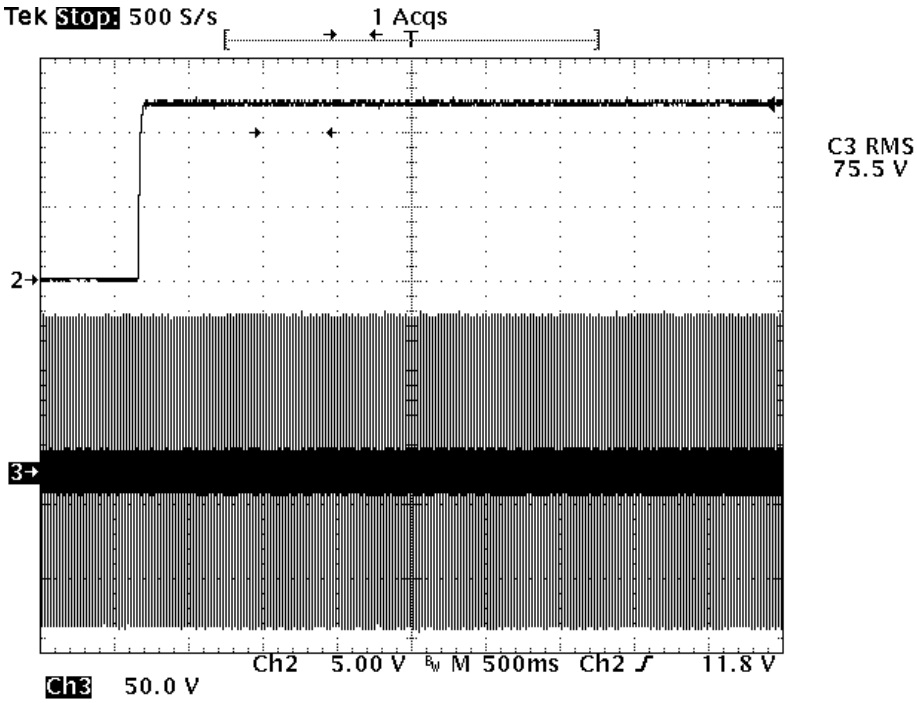
T_{ST_DELAY}=0.43S

11. AC Startup Voltage Characteristic

No Load, $V_{IN\_STARTUP}$ =61.4V_{AC}

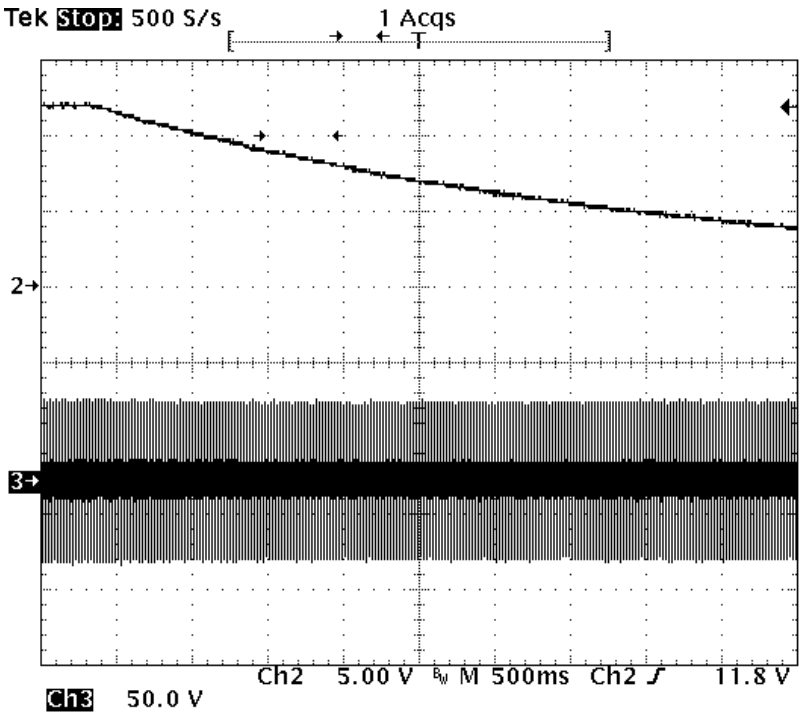


Full Load, $V_{IN\_STARTUP}$ =75.5V_{AC}

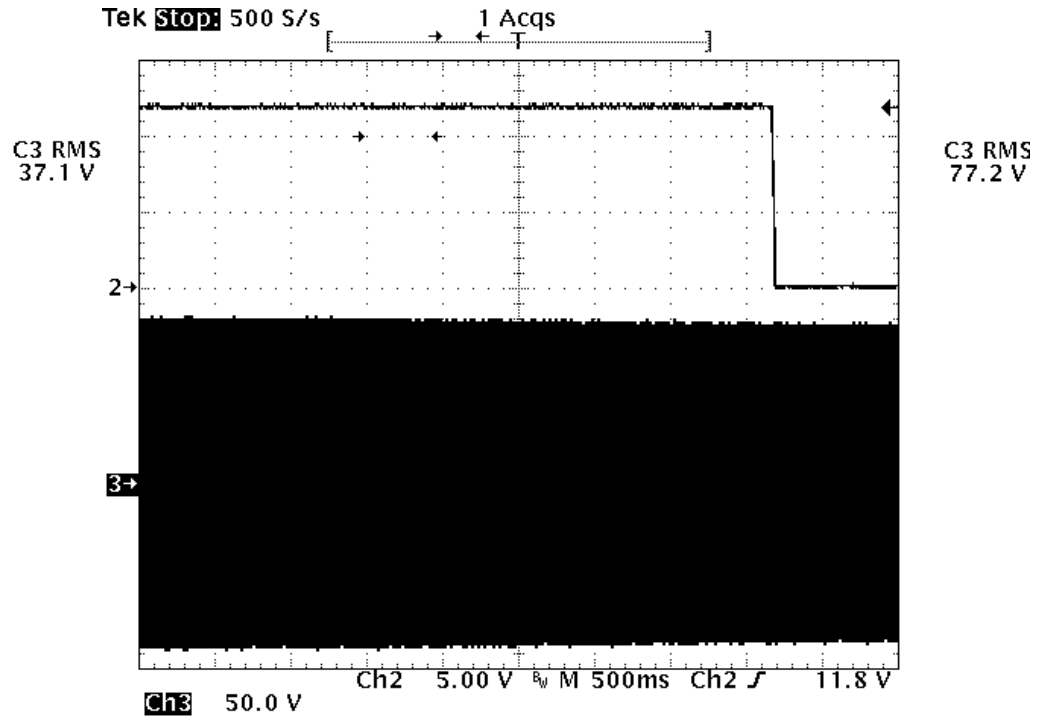


12. AC Brownout Voltage Characteristic

No Load, $V_{IN\_STARTUP}$ =37.1V_{AC}



Full Load, $V_{IN\_STARTUP}$ =77.2V_{AC}



13.1 Dynamic Load Response

Condition: 1). Load: 0A-0.75A-0A 2).Slew-Rate: 0.15A/uS 3).Freq.: 100Hz 4). Duty-Cycle: 50%

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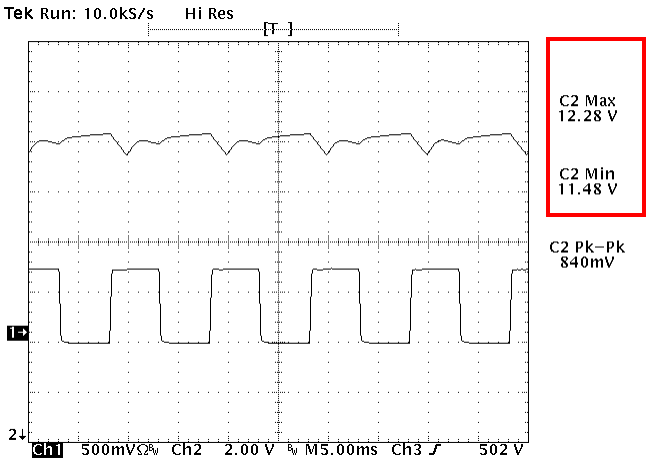
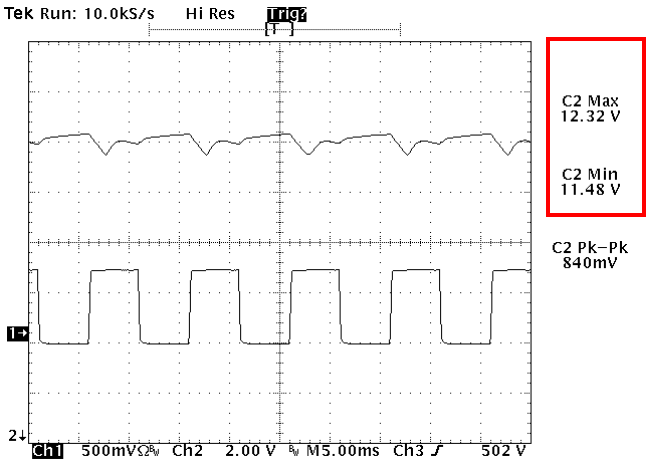
*** Note: Output voltage is monitored at end of PCB**

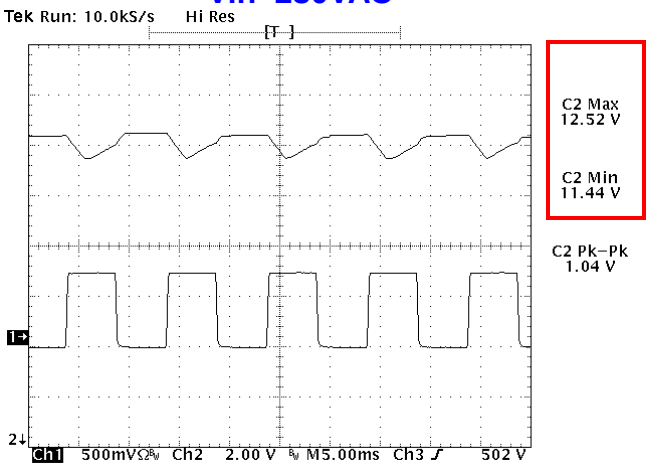
Vin=90VAC



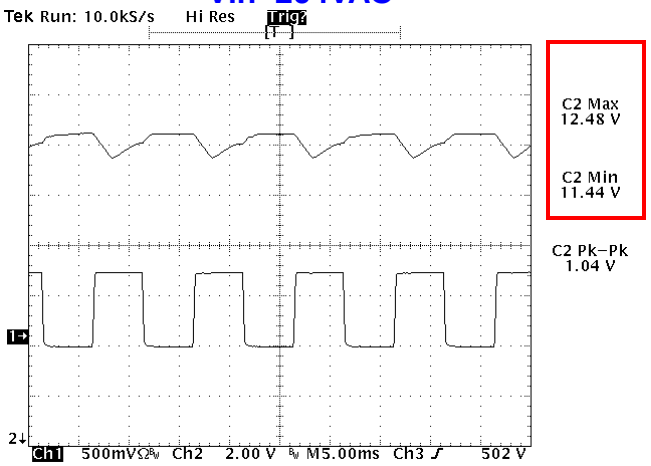
Vin=115VAC



Vin=230VAC



Vin=264VAC



13.2 Dynamic Load Response

Condition: 1). Load: 0.75A-1.5A-0.75A 2).Slew-Rate: 0.15A/uS 3).Freq.: 100Hz 4). Duty-Cycle: 50%

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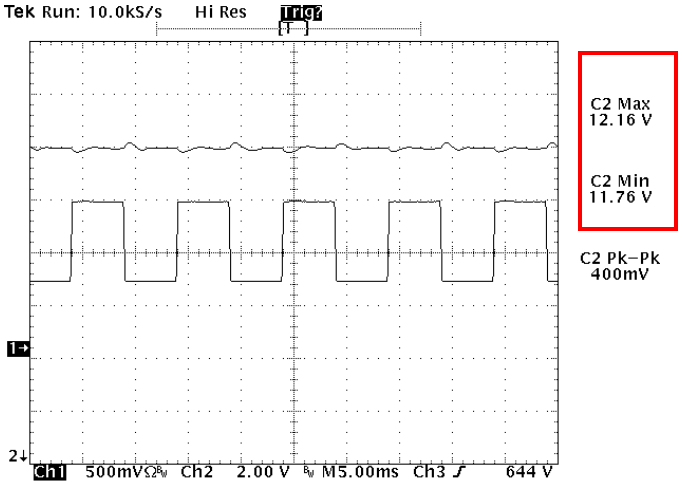
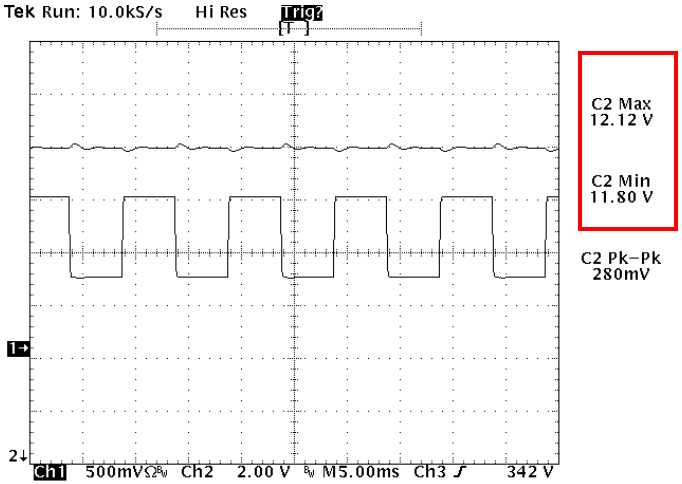
*** Note: Output voltage is monitored at end of PCB**

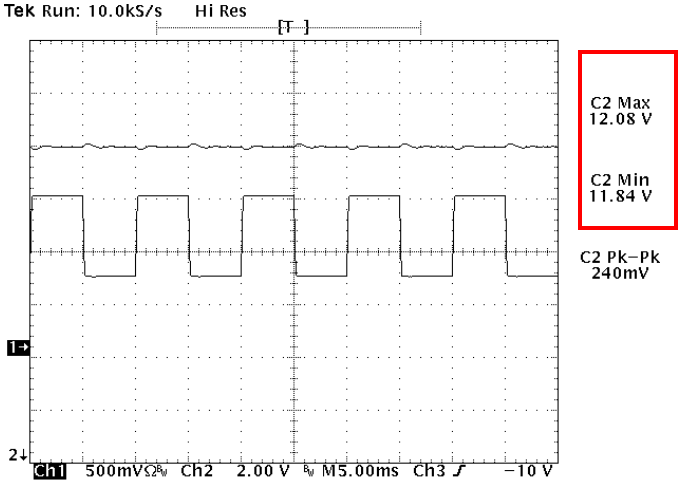
Vin=90VAC



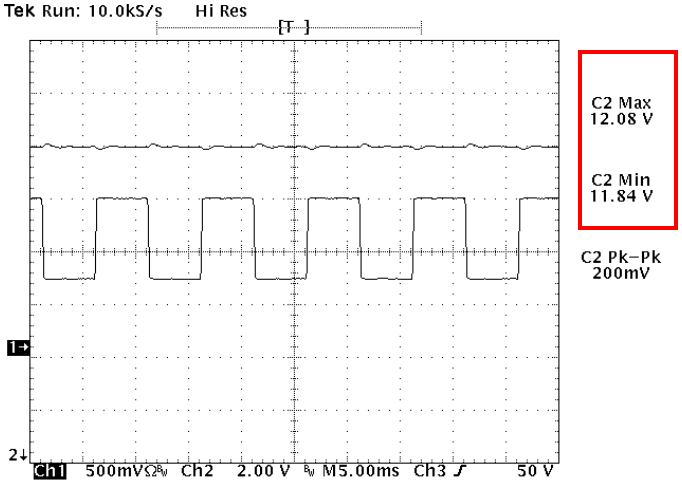
Vin=115VAC



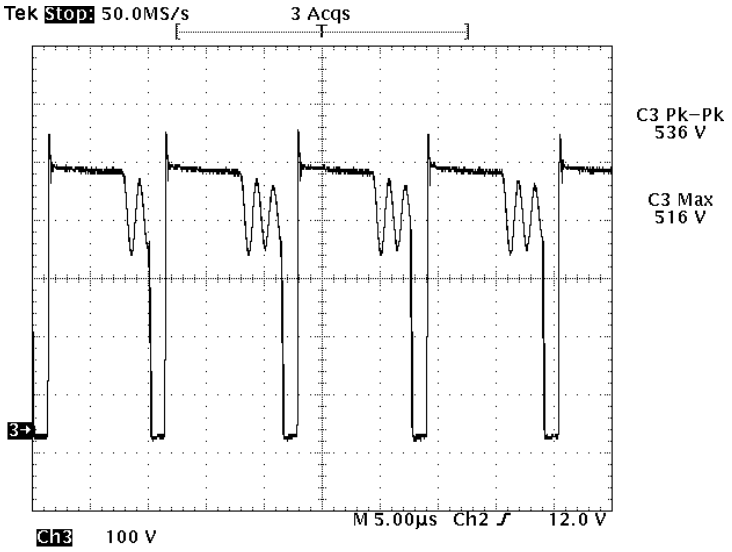
Vin=230VAC



Vin=264VAC



14. V_{DS} Waveform



Test Condition:

V_{IN}=264VAC,I_{OUT}=1.5A

Result:

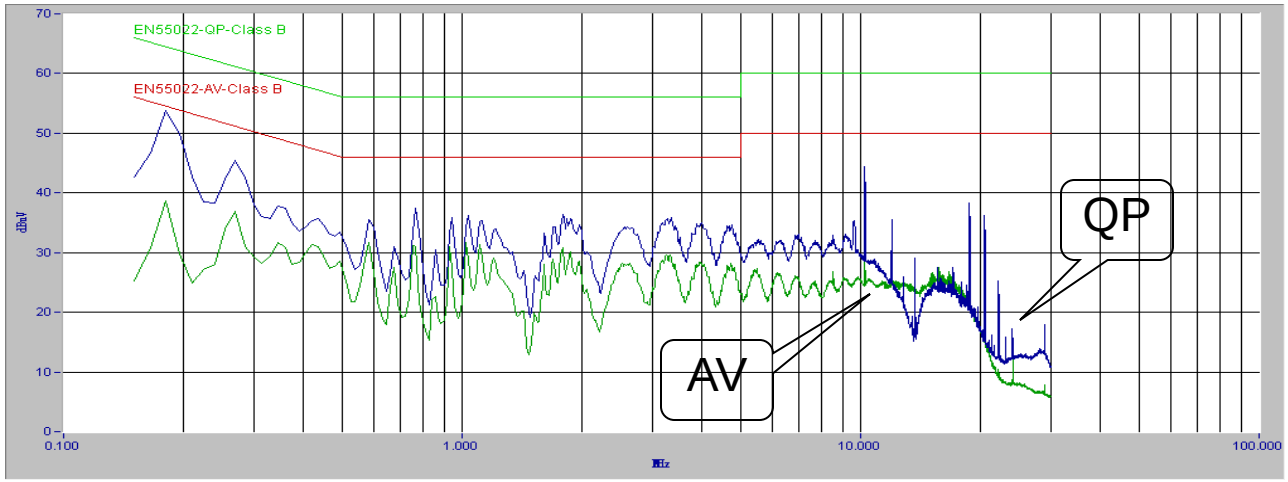
V_{DS_MAX}=536V

Appendix – Simple Specification for used Transistor (STB4NK60Z)

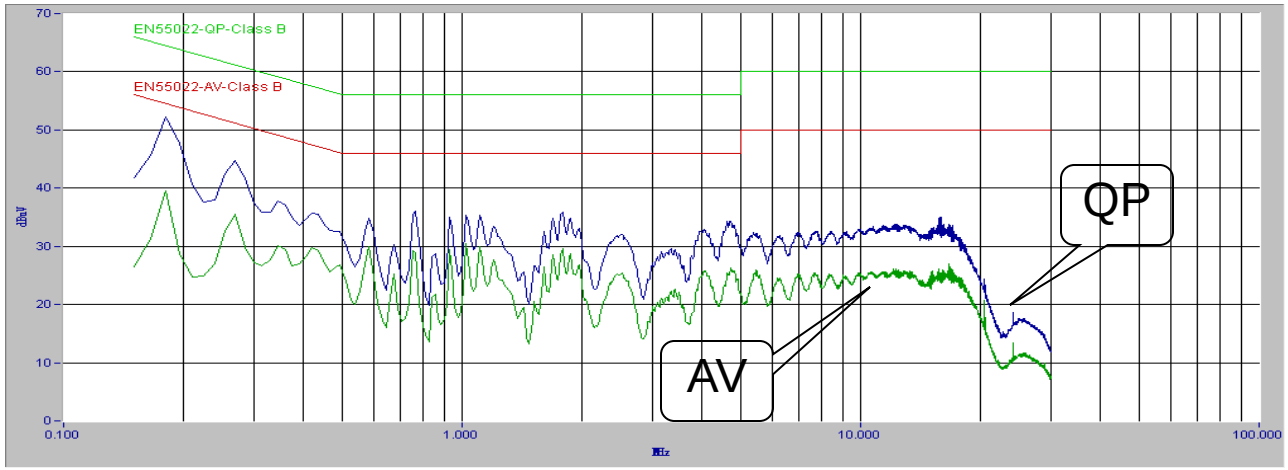
Symbol	Parameter	Value		Unit
		TO-220 - D²PAK DPAK-IPAK-I²PAK	TO-220FP	
V_{DS}	Drain-source voltage (V_{GS} = 0)	600		V
V_{GS}	Gate- source voltage	± 30		V
I_D	Drain current (continuous) at T_C = 25 °C	4	4 (1)	A
I_D	Drain current (continuous) at T_C = 100 °C	2.5	2.5 (1)	A
I_{DM} (2)	Drain current (pulsed)	16	16 (1)	A
P_{TOT}	Total dissipation at T_C = 25 °C	70	25	W
	Derating factor	0.56	0.2	W/°C
$V_{ESD(G-S)}$	Gate source ESD(HBM-C=100 pF, R=1.5 kΩ)	3000		V
dv/dt (3)	Peak diode recovery voltage slope	4.5		V/ns
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T_C = 25 °C)	-	2500	V
T_{stg}	Storage temperature	-55 to 150		°C
T_j	Max operating junction temperature	150		°C

15. Conducted EMI

V_{IN}=230Vac, Live



V_{IN}=230Vac, Neutral



Note: Full & Resistive Load and output is Grounded