

iW1780-03 For 12V/1A, 9V/1.2A, 5V/2A QC2.0 Design

General Design Specification:

1. AC Input Range 90-264V_{AC}
2. DC Output 12V/1A, 9V/1.2A, 5V/2A
3. Meet “100mW@5V” No-Load standby Power Consumption Requirement
4. Max Output Ripple & Noise < 100mV

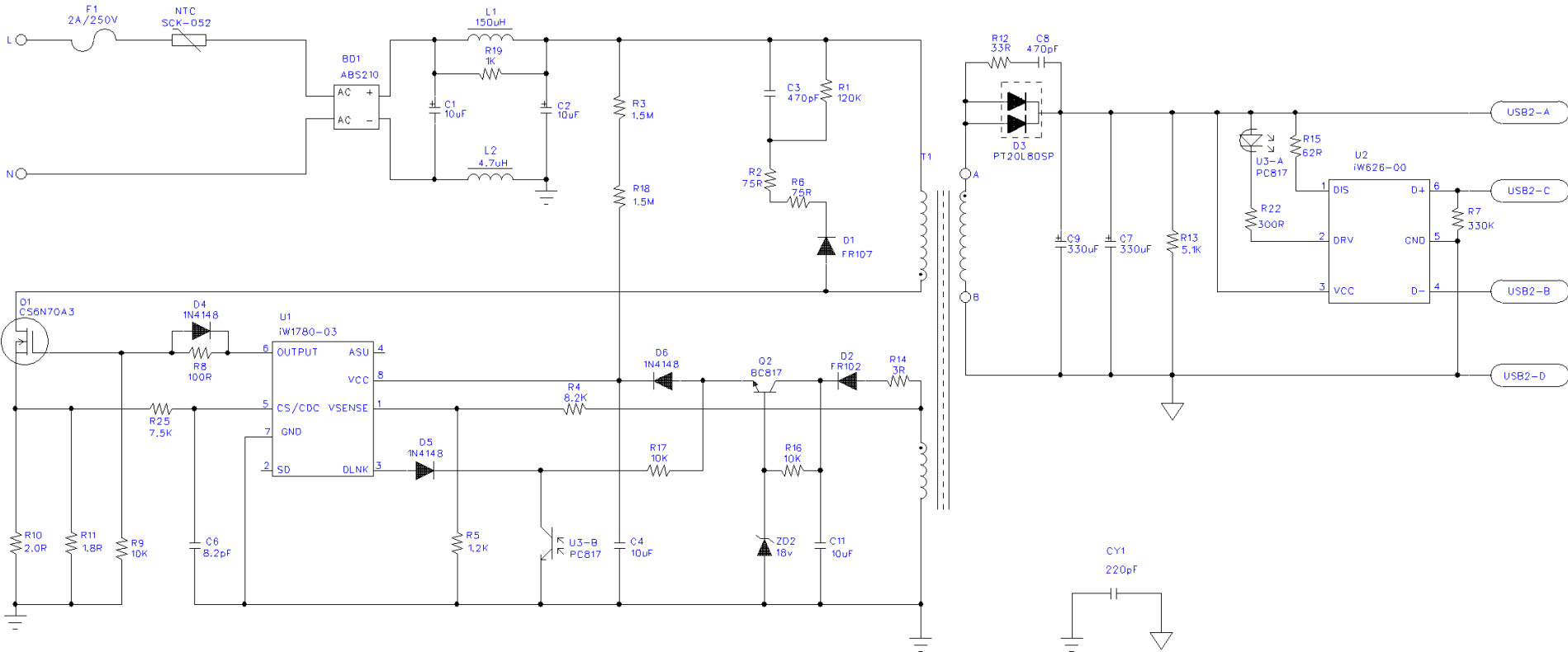
1. Specification

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})					100	mW	Measured under 5V output
Output							
5V/2A	Output Voltage	V_{OUT}	4.75	5.0	5.25	V	Measured at the end of USB-A
	Output Current	I_{OUT}	0		2.0	A	
	Over Current Protection	I_{OCP}		2.3		A	
	Ripple & Noise	V_{RIPPLE}			80	mV _{P-P}	Note1
	Average Efficiency	η	78.70			%	Refer to DOE
9V1.2A	Output Voltage	V_{OUT}	8.55	9.0	9.45	V	Measured at the end of USB-A
	Output Current	I_{OUT}	0		1.2	A	
	Over Current Protection	I_{OCP}		1.7		A	
	Ripple & Noise	V_{RIPPLE}			100	mV _{P-P}	Note1
	Average Efficiency	η	77.10			%	Refer to EPA2.0
12V1A	Output Voltage	V_{OUT}	11.4	12.0	12.6	V	Measured at the end of USB-A
	Output Current	I_{OUT}	0		1.0	A	
	Over Current Protection	I_{OCP}		1.3		A	
	Ripple & Noise	V_{RIPPLE}			120	mV _{P-P}	Note1
	Average Efficiency	η	77.76			%	Refer to EPA2.0
Environmental							
Conducted EMI			Meets CISPR22B / EN55022B				Output (-) is connected to Earth
Safety			Designed to meet IEC60950, UL1950 Class II				
Ambient Temperature		T_{AMB}	0		40	° C	Free convection, sea level

Note1: Add 0.1uF Ceramic capacitor and 10uF E-cap at the end of connector and set oscilloscope at 20MHz bandwidth.



2. Schematic

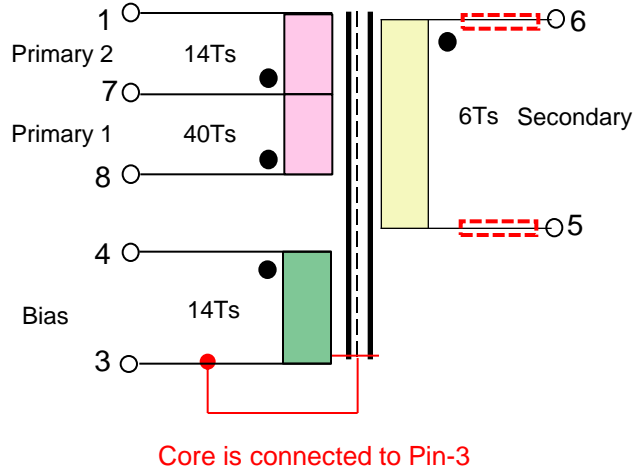


4. Bill of Material

Item	Qty.	Ref.	Description
1	1	U1	iW1780-03, Off-line Digital PSR & PWM & VMS Controller, SOIC-8
2	1	U2	iW626-00,SOT23
3	1	U3	Light coupling,PC817
4	1	F1	2A/250V, Fuse
5	1	NTC	NTC,SCK-052
6	1	L1	150uH,DM-inductor, Core: 4*6, Wire: 0.16mmX90Ts
7	1	L2	4.7uH,MPH201210S4R7MT,SUNLORD
8	1	BD1	Bridge,ABS15M,1.5A/800V
9	1	Q1	CS6N70A3,6A700V, TO-251
10	1	Q2	BC817,NPN Transistor, SOT-23
11	1	T1	EE16L Transformer Vertical Type
12	2	C1,C2	10uF, 400V, Low-ESR E-Cap, Φ8mm X 12mm Aishi
13	1	C3	470pF, 250V, X7R, SMD-0805
14	1	C4	10uF, 25V, X7R, SMD-0805
15	1	C6	8.2pF, 25V, X7R, SMD-0603
16	2	C7,C9	330uF,16V, Solid-Cap, ULR 6.3*11,艾华科技
17	1	C8	470pF, 100V, X7R, SMD-0805
18	1	C11	10uF, 50V, X7R, SMD-1206
19	1	CY1	220pF,Y-Cap
20	1	D1	FR107, 1A1000V,Fast Recovery Rectifier (Trr=500ns), SMD-1206S
21	1	D2	FR102, 1A200V, Fast switching diode(Trr=150nS), SMD-1206S
22	1	D3	PT20L80SP, 20A80V, Schottky Diode, TO-227 PFC
23	3	D4,D5,D6	1N4148, Fast Rectifier Diode,,SMD-323
24	1	ZD2	ZVS,18±5%V,SMD
25	1	R1	120KΩ ±5%, SMD-1206
26	2	R2,R6	75Ω ±5%, SMD-1206
27	2	R3,R18	1.5MΩ ±5%, SMD-1206
28	1	R4	8.2KΩ ±1%, SMD-0603
29	1	R5	1.2KΩ ±1%, SMD-0603
30	1	R7	330KΩ ±5%, SMD-0603
31	1	R8	100Ω ±5%, SMD-0603
32	3	R9,R16,R17	10KΩ ±5%, SMD-0603
33	1	R10	1.8Ω ±1%, SMD-0805
34	1	R11	2.0Ω ±1%, SMD-0805
35	1	R12	33Ω ±5%, SMD-0805
36	1	R13	5.1KΩ ±5%, SMD-0805
37	1	R14	3Ω ±5%, SMD-0603
38	1	R15	62Ω ±5%, SMD-1206
39	1	R22	300Ω ±5%, SMD-0603
40	1	R25	7.5KΩ ±5%, SMD-0603
41	1	USB	USB,Horizontal,2A current
42	1	PCB	Double Side Board, FR-4,41X31mm

5. Transformer Design

SCHEMATIC



ELECTRICAL SPECIFICATIONS:

1. Primary Inductance (L_p) = $560 \pm 7\% \mu\text{H}$ @ 10KHz
2. Electrical Strength = 3KV, 50/60Hz, 1Min (pins 1~5 to pins A~B)

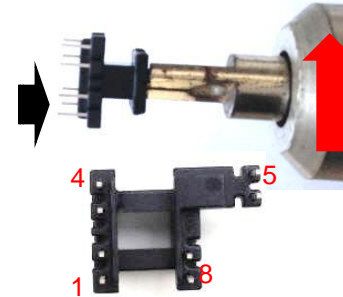
MATERIALS:

1. Core : EE16L (Ferrite Material JP95 or equivalent)
2. Bobbin : EE16L Vertical
3. Magnet Wires (pri): Type 2-U EW
4. Magnet wires (sec): Triple Insulated Wire
5. Layer Insulation Tape : 3M1298 or equivalent.

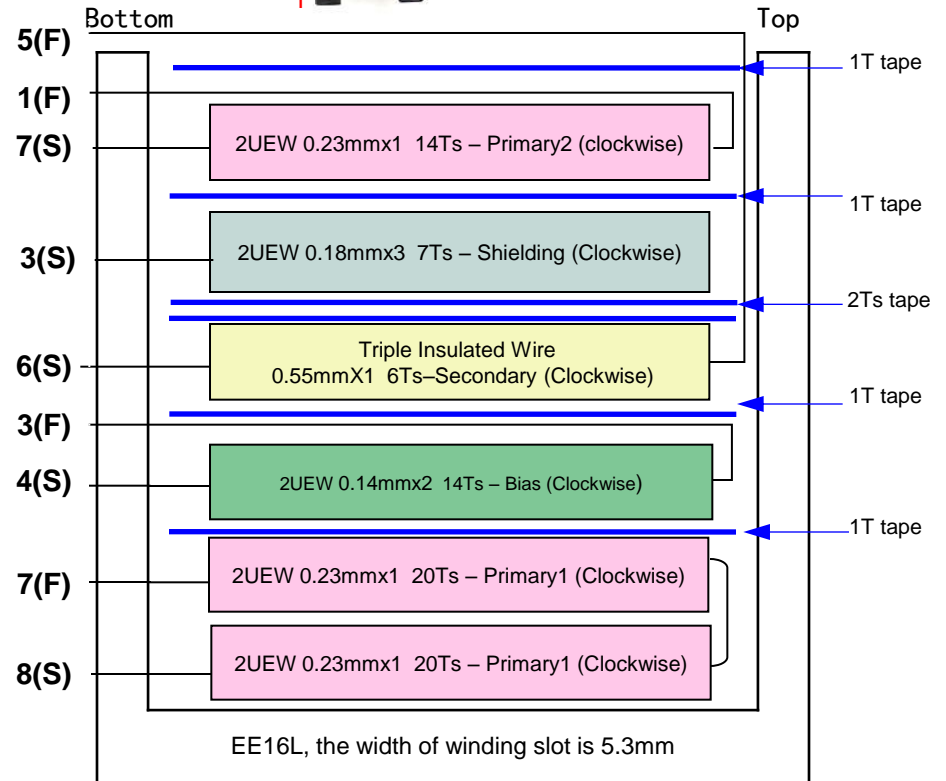
FINISHED :

1. Varnish the complete assembly
2. Core is connected to pin3

Winding Start pin-8 & End pin-7 in "Clockwise" direction – looking from Top side of the Bobbin



Rotating direction of winding machine



6.1. Regulation, Ripple and Efficiency Measurement

V_{IN} (V_{AC})	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (A)	V_{RIPPLE} (mV_{P-P})	P_{OUT} (W)	η (%)	OCP (A)	Average η (%)	DOE η (%)
90	0.020	5.055	0	25			2.24	82.27	78.70
	3.04	5.003	0.5	32	2.50	82.29			
	6.05	5.012	1.0	33	5.01	82.84			
	9.13	5.015	1.5	40	7.52	82.39			
	12.29	5.012	2.0	47	10.02	81.56			
115	0.024	5.050	0	32			2.23	82.76	
	3.04	5.004	0.5	36	2.50	82.30			
	6.03	5.014	1.0	30	5.01	83.15			
	9.06	5.015	1.5	40	7.52	83.03			
	12.15	5.016	2.0	52	10.03	82.57			
230	0.055	5.035	0	32			2.15	81.52	
	3.15	5.005	0.5	33	2.50	79.44			
	6.15	5.011	1.0	29	5.01	81.48			
	9.12	5.015	1.5	44	7.52	82.48			
	12.14	5.017	2.0	46	10.03	82.65			
264	0.068	5.032	0	35			2.14	80.74	
	3.20	5.009	0.5	35	2.50	78.27			
	6.22	5.011	1.0	30	5.01	80.56			
	9.19	5.015	1.5	40	7.52	81.86			
	12.20	5.020	2.0	50	10.04	82.30			

* Note: Output voltage is monitored at end of PCB



6.2. Regulation, Ripple and Efficiency Measurement

V_{IN} (V_{AC})	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (A)	V_{RIPPLE} (mV_{P-P})	P_{OUT} (W)	η (%)	OCP (A)	Average η (%)	EPA2.0 η (%)
90	0.052	9.253	0	18	/	/	1.78	83.72	77.10
	3.33	9.085	0.3	37	2.73	81.85			
	6.48	9.075	0.6	52	5.45	84.03			
	9.62	9.047	0.9	52	8.14	84.64			
	12.80	9.000	1.2	72	10.80	84.38			
115	0.056	9.242	0	18	/	/	1.77	84.20	
	3.33	9.092	0.3	36	2.73	81.91			
	6.47	9.083	0.6	42	5.45	84.23			
	9.56	9.061	0.9	51	8.15	85.30			
	12.68	9.020	1.2	60	10.82	85.36			
230	0.083	9.197	0	20	/	/	1.70	83.00	
	3.42	9.089	0.3	46	2.73	79.73			
	6.62	9.092	0.6	64	5.46	82.40			
	9.65	9.065	0.9	45	8.16	84.54			
	12.70	9.032	1.2	38	10.84	85.34			
264	0.092	9.183	0	20	/	/	1.69	82.20	
	3.46	9.080	0.3	42	2.72	78.73			
	6.70	9.095	0.6	54	5.46	81.45			
	9.74	9.066	0.9	46	8.16	83.77			
	12.78	9.035	1.2	40	10.84	84.84			

* Note: Output voltage is monitored at end of PCB

6.3. Regulation, Ripple and Efficiency Measurement

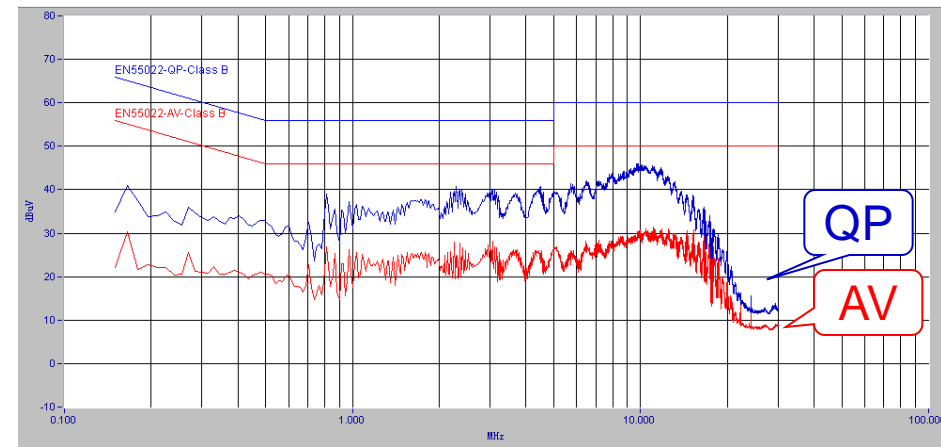
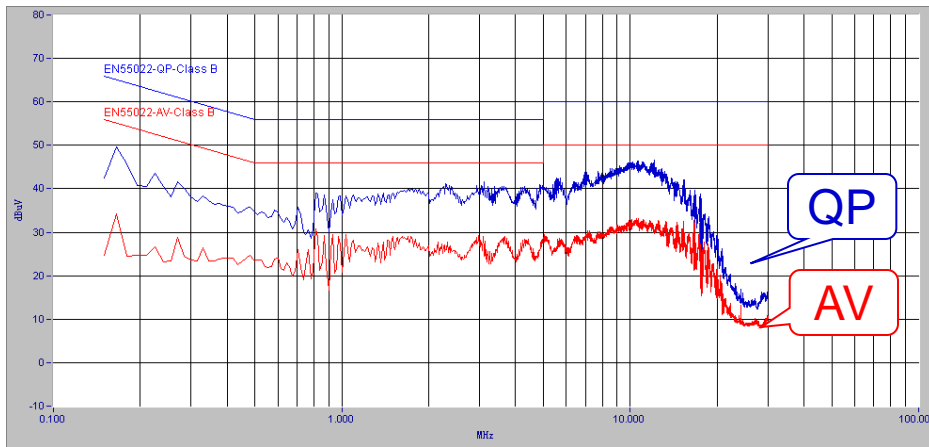
V_{IN} (V_{AC})	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (A)	V_{RIPPLE} (mV_{P-P})	P_{OUT} (W)	η (%)	OCP (A)	Average η (%)	EPA2.0 η (%)
90	0.14	12.43	0	20	/	/	1.36	83.02	77.76
	3.83	12.27	0.25	38	3.07	80.05			
	7.32	12.21	0.5	44	6.11	83.40			
	10.81	12.15	0.75	58	9.11	84.30			
	14.37	12.12	1.0	72	12.12	84.34			
115	0.14	12.45	0	24	/	/	1.35	83.59	
	3.83	12.27	0.25	38	3.07	80.09			
	7.30	12.22	0.5	40	6.11	83.70			
	10.73	12.17	0.75	62	9.13	85.07			
	14.20	12.14	1.0	48	12.14	85.49			
230	0.16	12.34	0	22	/	/	1.30	82.68	
	3.93	12.28	0.25	48	3.07	78.12			
	7.44	12.23	0.5	36	6.12	82.19			
	10.80	12.19	0.75	40	9.14	84.65			
	14.18	12.16	1.0	38	12.16	85.75			
264	0.17	12.36	0	40	/	/	1.30	81.94	
	3.98	12.28	0.25	43	3.07	77.14			
	7.52	12.23	0.5	38	6.12	81.32			
	10.88	12.19	0.75	36	9.14	84.03			
	14.26	12.16	1.0	40	12.16	85.27			

* Note: Output voltage is monitored at end of PCB

13.1 Conducted EMI (@5V)

$V_{IN}=230V_{AC}/50Hz$, Live

$V_{IN}=230V_{AC}/50Hz$, Natural



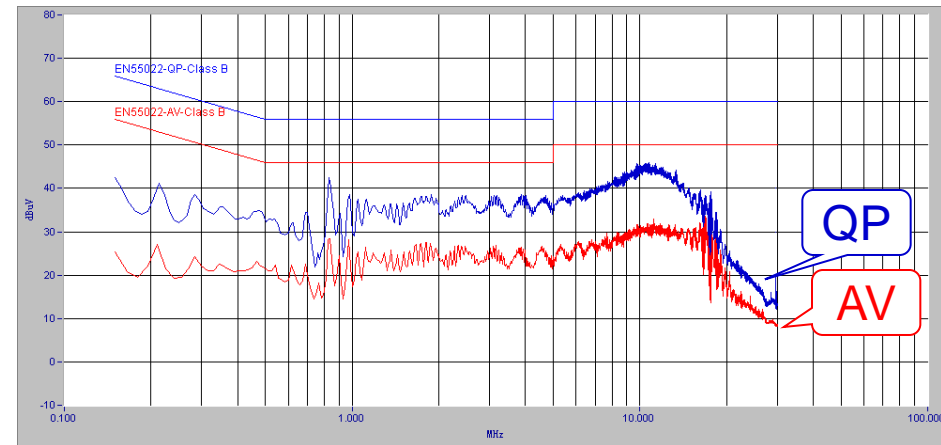
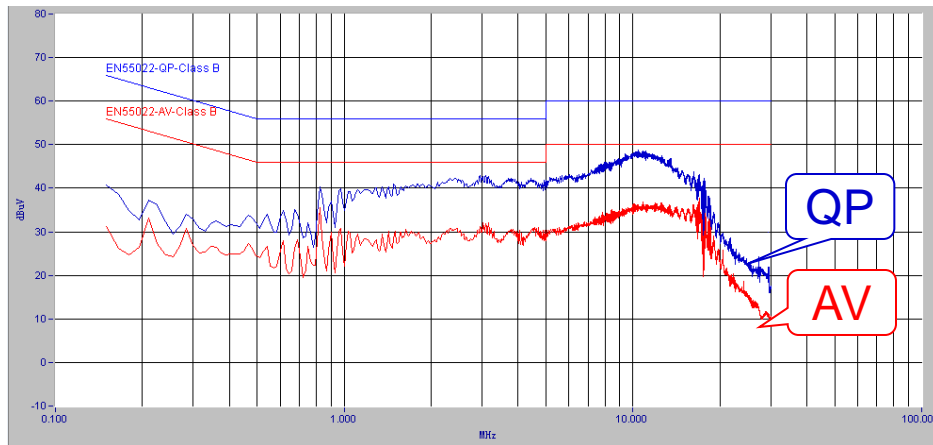
*Note: Resistive & Full load; output (-) is floating.



13.2 Conducted EMI (@9V)

$V_{IN}=230V_{AC}/50Hz$, Live

$V_{IN}=230V_{AC}/50Hz$, Natural

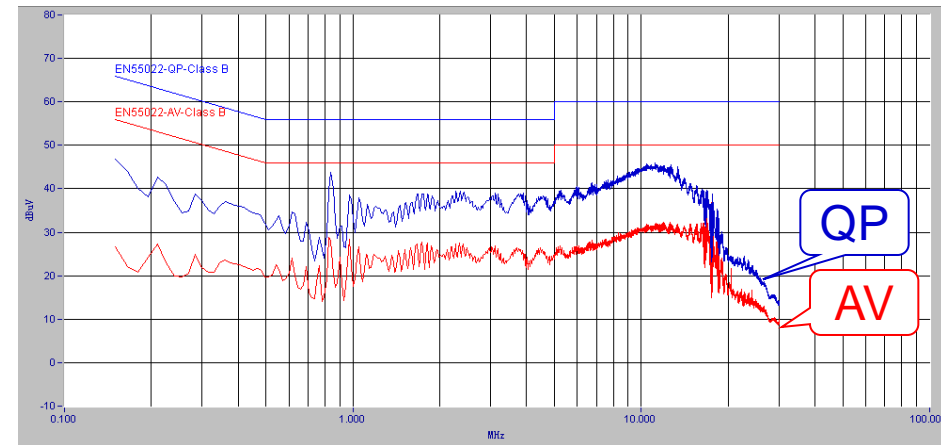
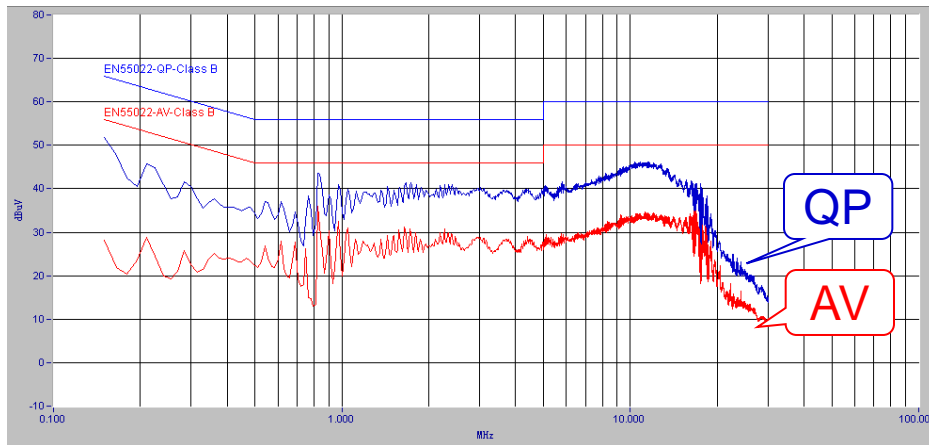


*Note: Resistive & Full load; output (-) is floating.

13.3 Conducted EMI (@12V)

$V_{IN}=230V_{AC}/50Hz$, Live

$V_{IN}=230V_{AC}/50Hz$, Natural

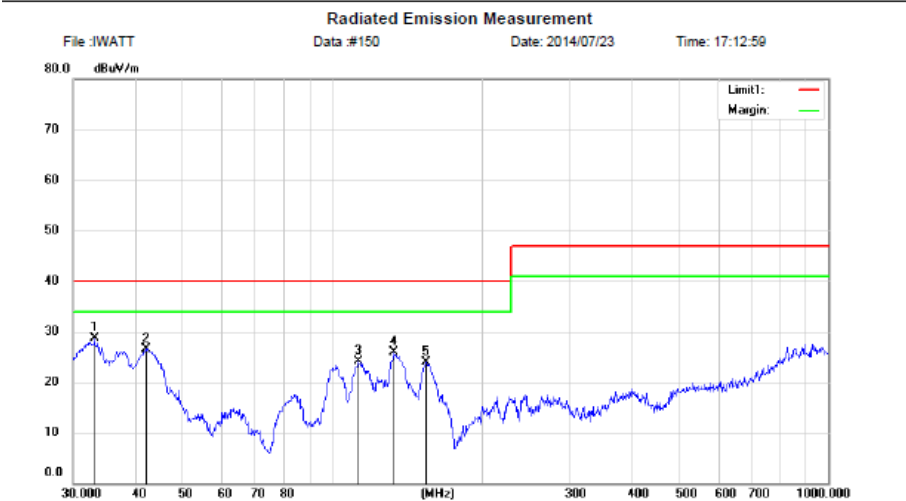


*Note: Resistive & Full load; output (-) is floating.

14.1 Radiated EMI(@5V)

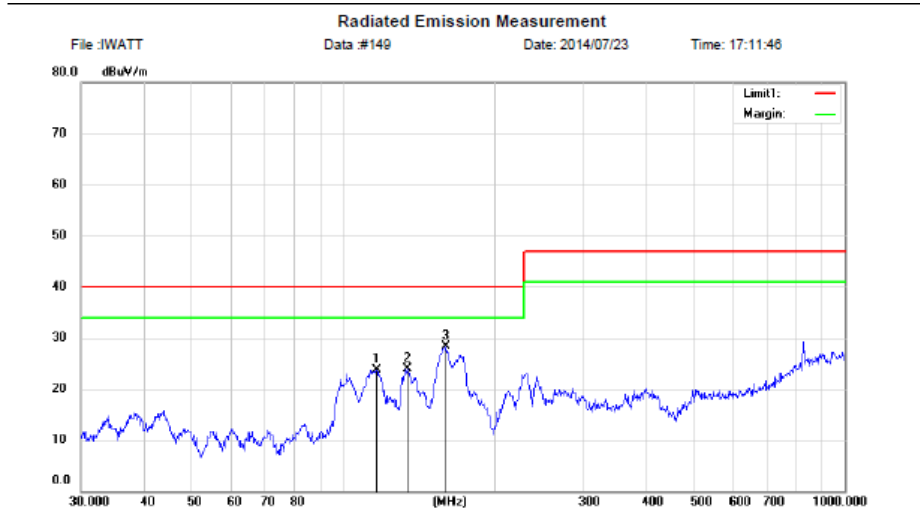
Vin=230Vac/50Hz, VERTICAL

Vin=230Vac/50Hz, HORIZONTAL



Site site #1 Polarization: **Vertical** Temperature: 24 C
 Limit: (RE)EN55022 class B Power: AC 230V/50Hz Humidity: 53 %
 EUT: Adapter
 M/N: 5V/2A
 Mode:FULL LOAD
 Note: 1#

No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree	Comment
1	*	33.0950	51.27	-22.55	28.72	40.00	-11.28			peak
2		42.0066	46.96	-20.43	26.53	40.00	-13.47			peak
3		112.9196	46.00	-21.89	24.11	40.00	-15.89			peak
4		132.6850	50.13	-24.24	25.89	40.00	-14.11			peak



Site site #1 Polarization: **Horizontal** Temperature: 24 C
 Limit: (RE)EN55022 class B Power: AC 230V/50Hz Humidity: 53 %
 EUT: Adapter
 M/N: 5V/2A
 Mode:FULL LOAD
 Note: 1#

No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over	Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree	Comment
1		116.5401	46.35	-22.62	23.73	40.00	-16.27			peak
2		134.0882	48.14	-24.29	23.85	40.00	-16.15			peak
3	*	160.3456	53.51	-25.30	28.21	40.00	-11.79			peak

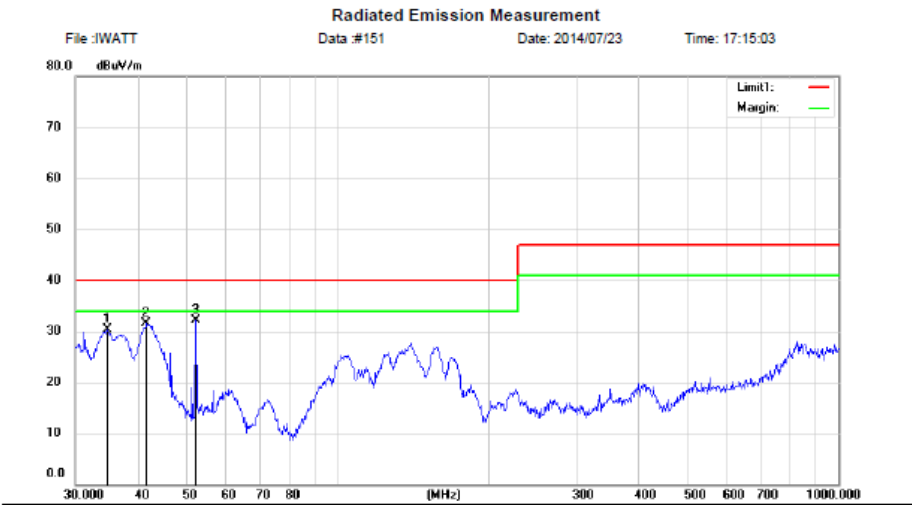
Note: Resistive & Full load; output (-) is floating.



14.2 Radiated EMI(@9V)

Vin=230Vac/50Hz, VERTICAL

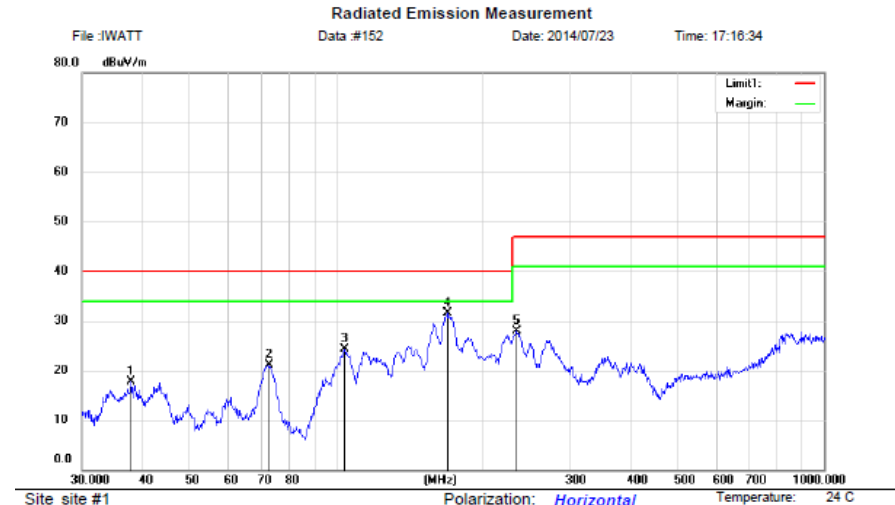
Vin=230Vac/50Hz, HORIZONTAL



File :JWATT Data :#151 Date: 2014/07/23 Time: 17:15:03

Site site #1 Polarization: *Vertical* Temperature: 24 C
 Limit: (RE)EN55022 class B Power: AC 230V/50Hz Humidity: 53 %
 EUT: Adapter
 M/N: 9V/1.2A
 Mode:FULL LOAD
 Note: 1#

No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over	Antenna Height	Table Degree
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree
1		34.7602	52.17	-21.92	30.25	40.00	-9.75	peak	
2		41.5670	51.80	-20.30	31.50	40.00	-8.50	peak	
3	*	52.2080	54.59	-22.55	32.04	40.00	-7.96	peak	



File :JWATT Data :#152 Date: 2014/07/23 Time: 17:16:34

Site site #1 Polarization: *Horizontal* Temperature: 24 C
 Limit: (RE)EN55022 class B Power: AC 230V/50Hz Humidity: 53 %
 EUT: Adapter
 M/N: 9V/1.2A
 Mode:FULL LOAD
 Note: 1#

No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over	Antenna Height	Table Degree
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	cm	degree
1		37.8121	38.39	-20.73	17.66	40.00	-22.34	peak	
2		72.8466	47.23	-26.06	21.17	40.00	-18.83	peak	
3		103.8055	45.51	-21.24	24.27	40.00	-15.73	peak	
4	*	168.4138	57.29	-25.81	31.48	40.00	-8.52	peak	

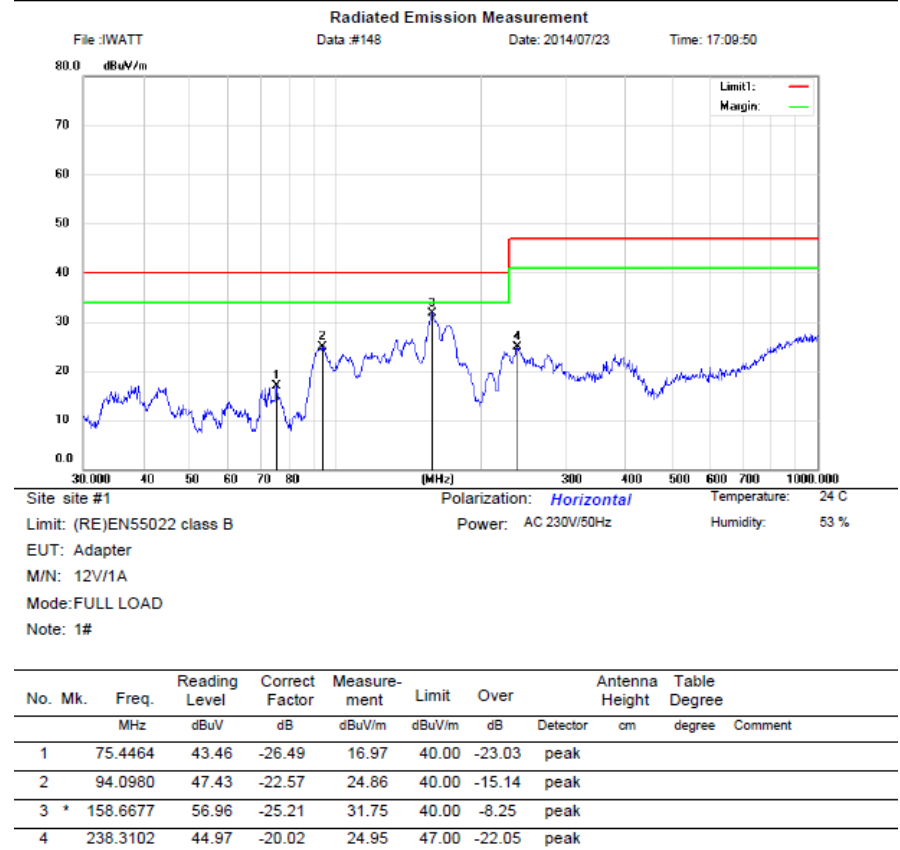
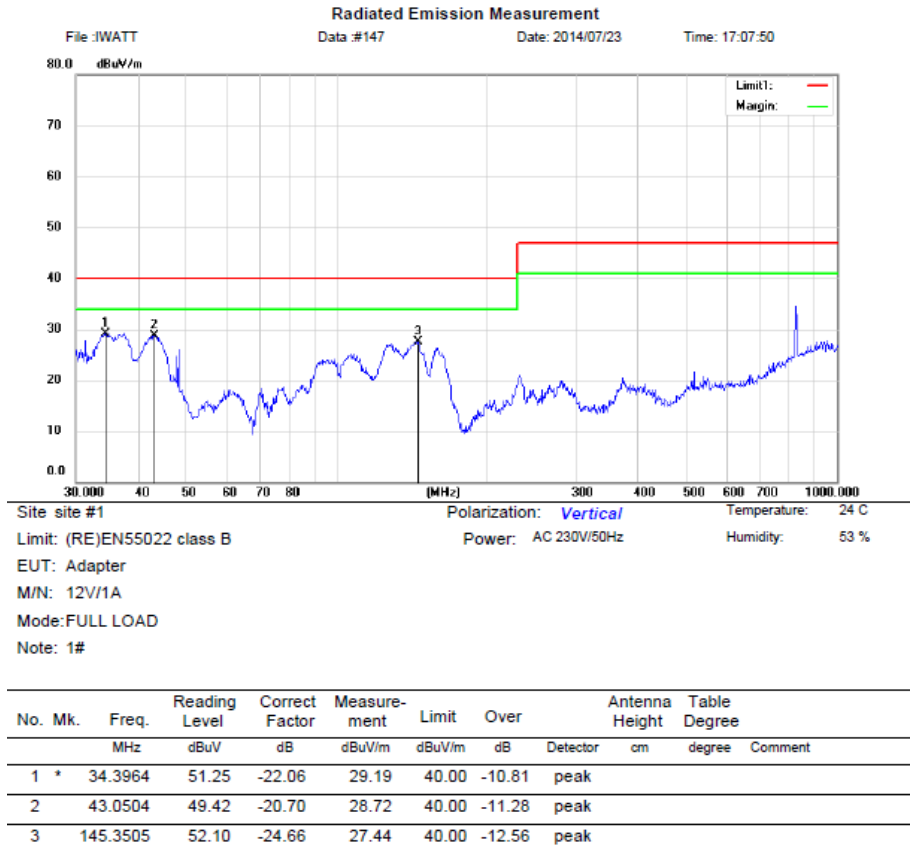
Note: Resistive & Full load; output (-) is floating.



14.3 Radiated EMI(@12V)

Vin=230Vac/50Hz, VERTICAL

Vin=230Vac/50Hz, HORIZONTAL



Note: Resistive & Full load; output (-) is floating.



The power to be...

- ...personal
- ...portable
- ...connected