

# **AX2535 for 5V1A Design**

## **(Product Introduction)**

July 25, 2011  
Allright Tu

- AC Input Range: 90~264 V<sub>AC</sub>
- DC Output: 5V,1A
- Meet “300mW” No-Load standby Power Consumption Requirement
- Meet “EPA\_2.0” Efficiency Requirement
- Thermal (90V<sub>AC</sub>, 60Hz): 75°C
- V<sub>DS</sub>/V<sub>IS</sub>/Ripple Waveform

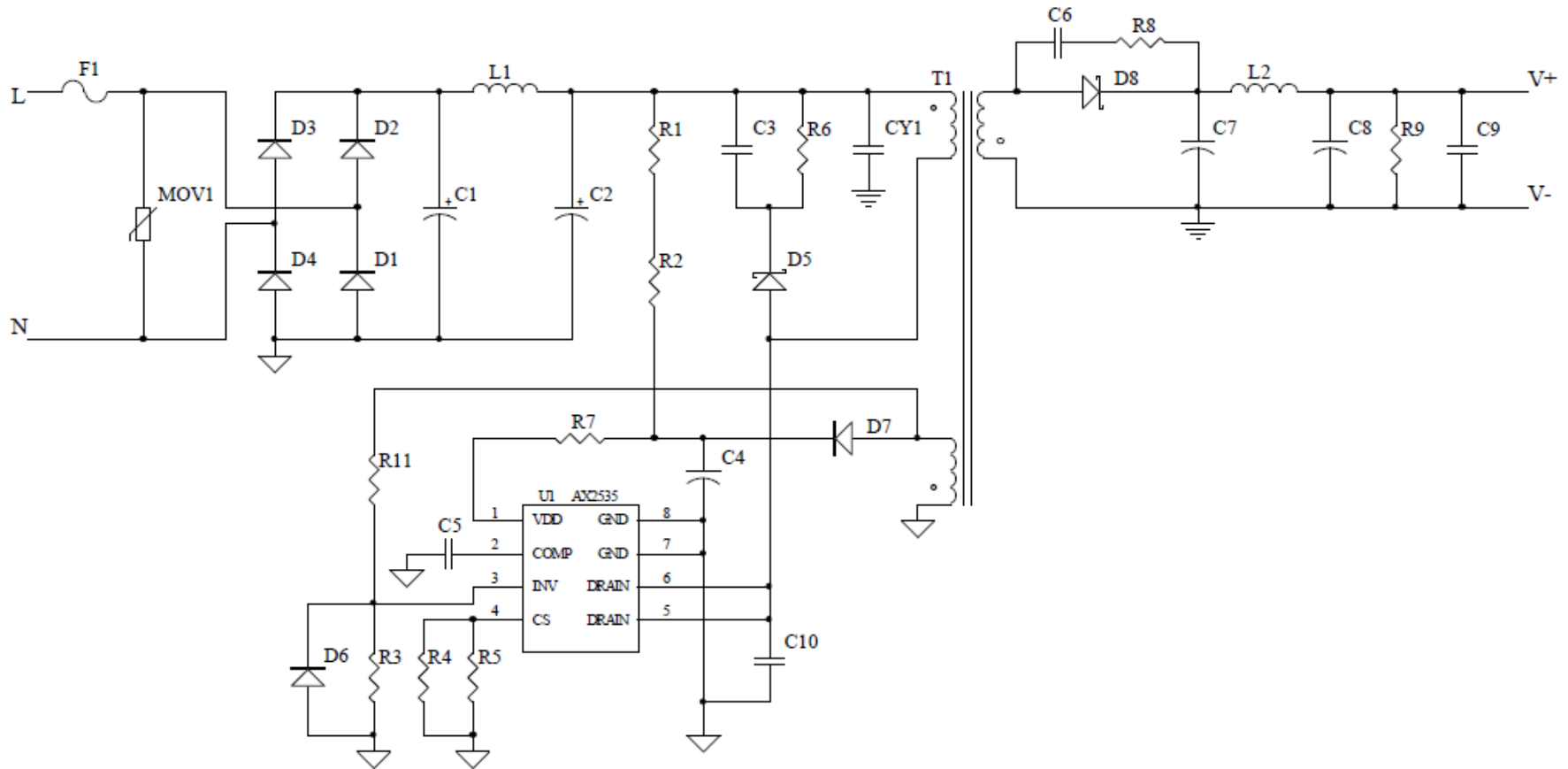
# Specification (1/2)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
<b>Supply Voltage (VDD) Section</b>						
Standby Current	$I_{DDST}$	VDD=13V		5	20	uA
Operation Current	$I_{DDOP}$	Operation supply current INV=2V, CS=0V, VDD=VDDG=20V	-	2.5	3.5	mA
VDD Under Voltage Lockout Enter	Uvlo(ON)	VDD falling	7.5	8.5	10	V
VDD Under Voltage Lockout Exit	Uvlo(OFF)	VDD rsing	13.5	14.5	16.0	V
Maximum VDD operation voltage	$V_{DD\_clamp}$	$I_{DD}=10mA$	30.5	32.5	34.5	V
Over voltage protection Threshold	OVP	Ramp VDD until gate shut down	27.5	29.5	31.5	V
<b>Current Sense Input Section</b>						
LEB time	TLEB			540		Ns
Over current threshold	Vth_oc		870	900	930	mV
OCP Propagation delay	Td_oc			150		ns
Input Impedance	$Z_{SENSE\_IN}$			50		Kohm
Soft start time	T_ss			10		ms

# Specification (2/2)

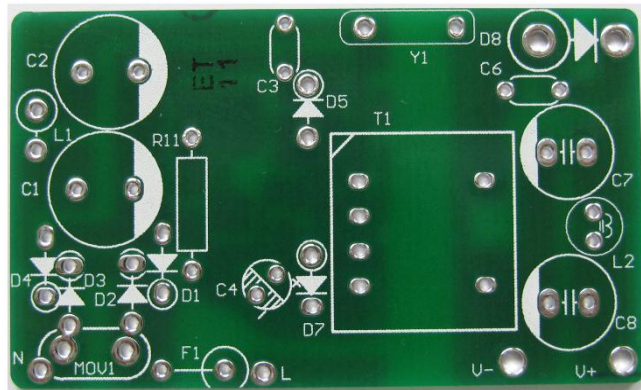
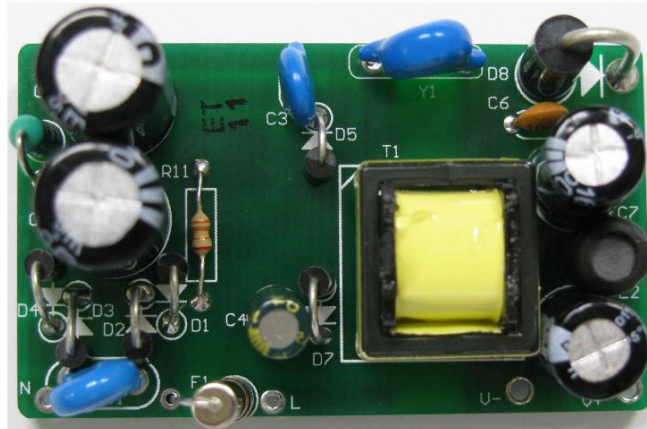
Parameter	Symbol	Conditions	Min	Typ	Max	Units
<b>Frequency Section</b>						
IC Maximum frequency	Freq_Max <sup>Note1</sup>		66	72	78	KHz
System Nominal switch frequency	Freq_Nom			60		KHz
	Freq_startup	INV=0V, Comp=5V		14		KHz
Frequency shuffling range	$\Delta f/\text{Freq}$			+/-4		%
<b>Error Amplifier Section</b>						
Reference voltage for EA	Vref_EA		1.97	2	2.03	V
DC gain of EA	Gain			60		dB
Max. Cable compensation current	I_COMP_MAX	INV=2V, Comp=0V		42		uA
<b>Power MOSFET Section</b>						
MOSFET Drain-Source Breakdown Voltage	BVdss		600			V
On Resistance	Rdson	Static, Id=0.4A		12	15	$\Omega$

# Schematic Circuit

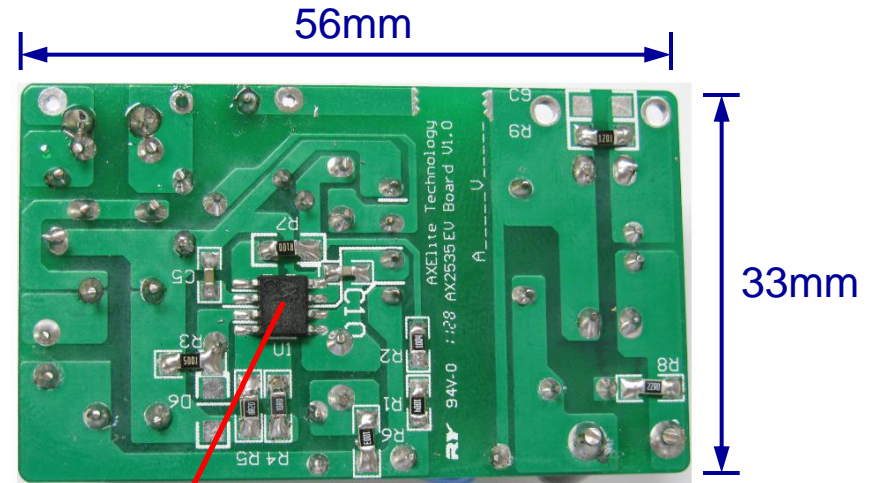


# Circuit Board Photograph

**(Top Side)**



**(Bottom Side)**



**AX2535 High Precision CC/CV  
PSR Converter**

# Bill of Material (1/2)

序號	位置	封裝規格	數量 (PCS)
1	MOV1	壓敏電阻 7D471K	1
2	F1	保險絲 T1A/250V Φ3.6*10mm (玻璃封裝)	1
3	C1	電解電容 4.7uF/400V 10x16mm	1
4	C2	電解電容 6.8uF/400V 10x16mm	1
5	C3, C6	陶瓷電容 102pF/1KV Y5P 腳距4.5mm	2
6	C4	電解電容 10uF/25V 5x11mm	1
7	C5	SMD電容 0.1uF 0805 X7R	1
8	C7, C8	電解電容 1000uF/16V 8x16mm	2
9	C10	SMD電容 68pF/50V 0805 X7R	1
10	R1, R2	SMD電阻 750K 1206 5%	2
11	R3	SMD電阻 5.1K 1206 5%	1
12	R4	SMD電阻 5.1R 1206 5%	1
13	R5	SMD電阻 3.9R 1206 5%	1
14	R6	SMD電阻 270K 1206 5%	1
15	R7	SMD電阻 0R 1206 5%	1



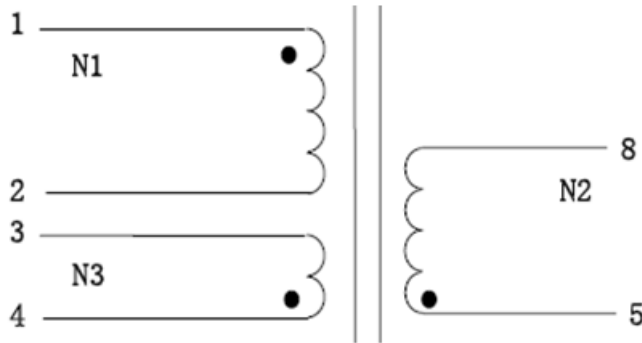
# Bill of Material (2/2)

序號	位置	封裝規格	數量 (PCS)
16	R8	SMD電阻 20R 1206 5%	1
17	R9	SMD電阻 1.2K 1206 5%	1
18	R11	金屬薄膜電阻 33K 1/4W	1
19	CY1	Y電容 222pF/250V Y1 腳距10mm	1
20	U1	AX2535 SOP-8L	1
21	D1~D4, D7	二極體 1N4007 DO-41	5
22	D5	快速恢復二極體 FR107 DO-41	1
23	D8	蕭特基二極體 SR360 DO-201AD	1
24	T1	變壓器 EE16 臥式	1
25	L1	色碼電感 1mH	1
27	PCB	PCB 56x33x1.6mm FR-4	1
28	FOR F1	熱縮套管 $\Phi$ 4.5x15mm	1
29	ROR F1	熱縮套管 $\Phi$ 1x15mm,	1
30	FOR PCB	線材 1.5M 2468 24AWG	1
31	FOR PCB	CASE	1

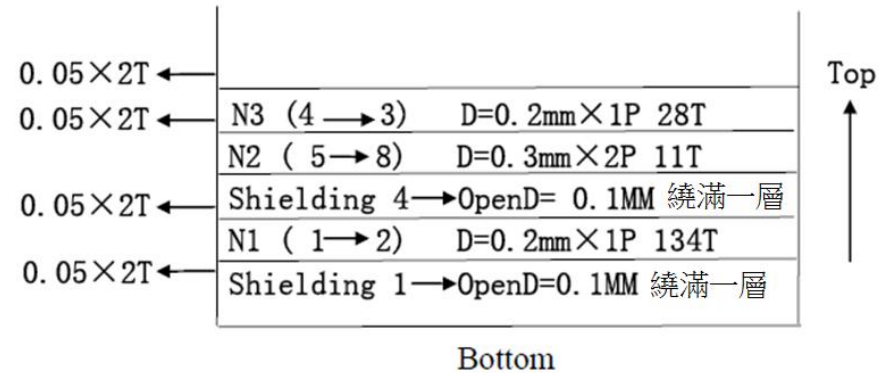


# Transformer Drawing

## Schematic



## Winding Configuration



Bobbin: 臥式      CORE:EE16 TDK PC40  
 Total: 8Pin4+4      排距: 10.5mm

### 說明:

1. LP(1 2)= 2.2mH +/-10% @1KHz/0.25V 漏感≤300uH.
2. 耐壓測試: 初次 AC3750V/2MA/6S; 初磁芯, 次磁芯 AC1500V/2MA/6S.
3. 絕緣電阻: 初次, 次磁芯 DC500V R≥100MΩ.
4. 各繞阻出入線加鐵氟龍套管.
5. N2 選用三層絕緣線, 頂部出線.
6. N1,N2,N3 請均勻緊密繞製.
7. 請一定保證材質.

# EPA\_2.0 Requirement

Nameplate Output Power (Pno)	Minimum Efficiency in Active Mode (decimal equivalent of percentage)	
	Standard Models	Low Voltage Models (Vo<6V and Io≥0.55A)
0 to 1 W	$\geq 0.48 * P_{no} + 0.140$	$\geq 0.497 * P_{no} + 0.067$
1 to 49 W	$\geq 0.0626 * \ln(P_{no}) + 0.622$	$\geq 0.0750 * \ln(P_{no}) + 0.561$
> 49 W	$\geq 0.87$	$\geq 0.86$
	Maximum Energy Consumption in No-Load Mode	
	AC/AC External Power Supply	AC/DC External Power Supply
0 to 50 W	0.5 W	0.3 W
50 to 250 W	0.5 W	0.5 W

EPA\_2.0 (Final) for Low Voltage Model (Pno=5.0W)

$$0.075 \times \ln(5.0) + 0.561 = 68.17\%$$

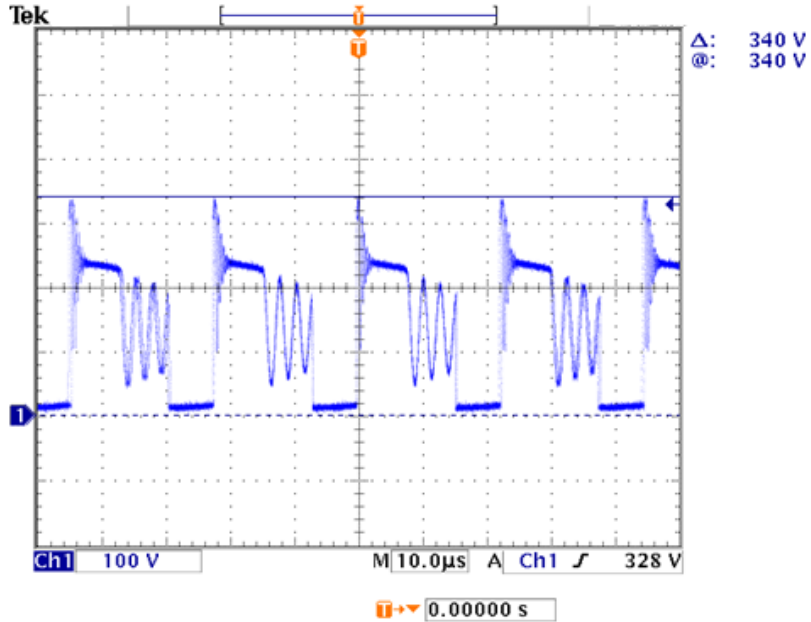
# Efficiency Measurement

V <sub>IN</sub> (AC)	P <sub>IN</sub> (W)	V <sub>OUT</sub> (V)	I <sub>OUT</sub> (A)	OCP (A)	Short Protection (Pass/Fail)	Short (W)	P <sub>OUT</sub> (W)	η	AVG(η)	V <sub>DS</sub> (V)	Diode (V)
90V60Hz	0.07	5.46	0.00	1.09	Pass	0.64	0.00	--	--	--	--
	--	--	--				--				
	--	--	--				--				
	--	--	--				--				
	7.67	5.52	1.00				5.52	71.97 %			
115V60Hz	0.08	5.44	0.00	1.08	Pass	0.67	/		73.13%	--	--
	1.91	5.52	0.25				1.38	72.25 %			
	3.77	5.56	0.50				2.78	73.74 %			
	5.64	5.55	0.75				4.16	73.80 %			
	7.59	5.52	1.00				5.52	72.73 %			
230V50Hz	0.15	5.41	0.00	1.16	Pass	0.77	/		69.99%	--	--
	2.05	5.48	0.25				1.37	66.83 %			
	3.97	5.53	0.50				2.76	69.65 %			
	5.76	5.53	0.75				4.14	72.01 %			
	7.71	5.51	1.00				5.51	71.47 %			
264V50Hz	0.18	5.41	0.00	1.18	Pass	0.86	0.00	--	--	566	37
	--	--	--				--	--			
	--	--	--				--	--			
	--	--	--				--	--			
	7.72	5.52	1.00				5.52	71.50 %			

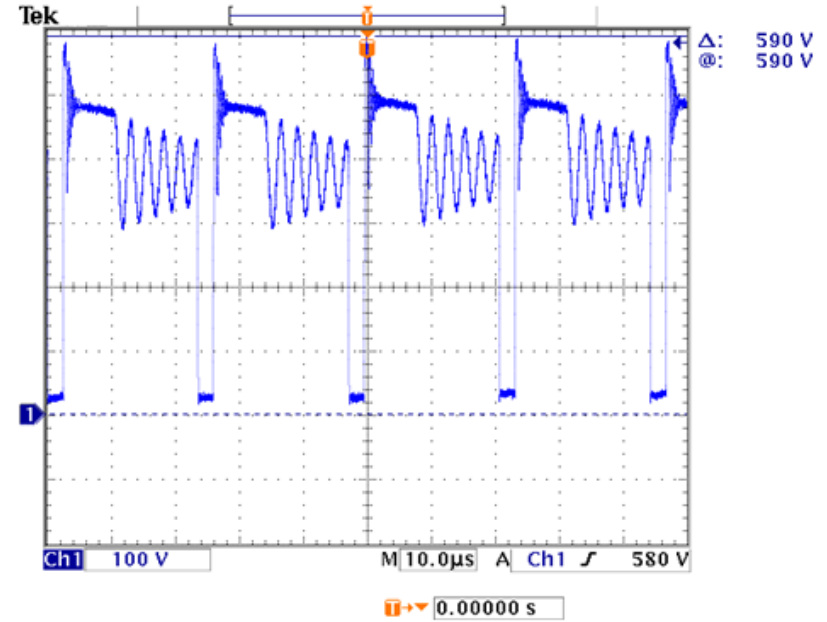
# Thermal Test

Item	90V <sub>AC</sub> , 60Hz, I <sub>OUT</sub> =1A		264V <sub>AC</sub> , 50Hz, I <sub>OUT</sub> =1A	
	Temperature	Rising	Temperature	Rising
AX2535	72°C	50°C	71°C	49°C
Ambient	22°C		22°C	

# V<sub>DS</sub> Waveform

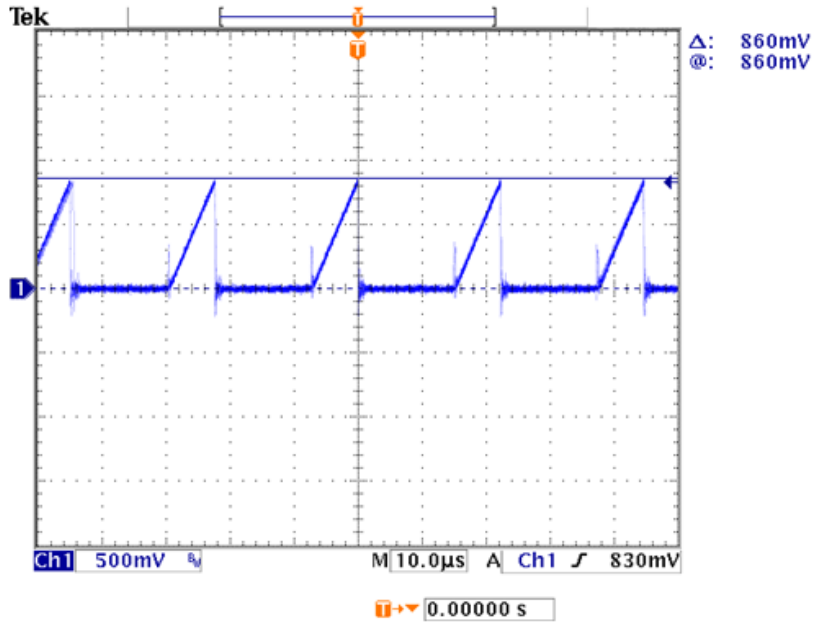


90VAC, 60Hz, Full Load

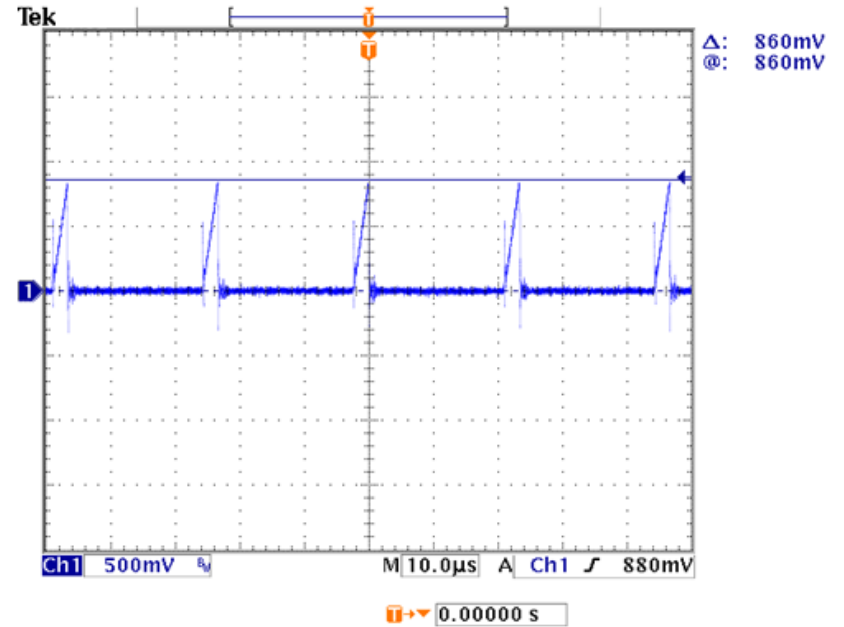


264VAC, 50Hz, Full Load

# V<sub>IS</sub> Waveform

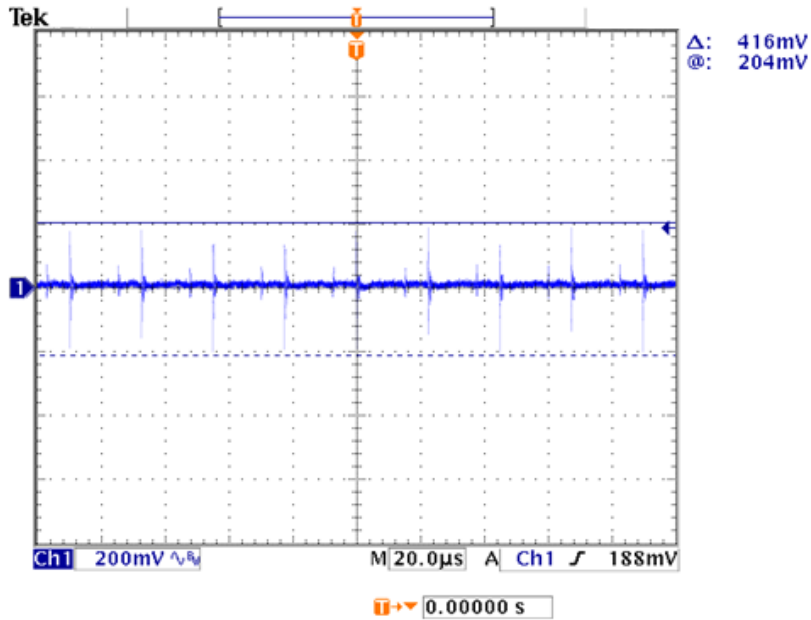


90VAC, 60Hz, Full Load

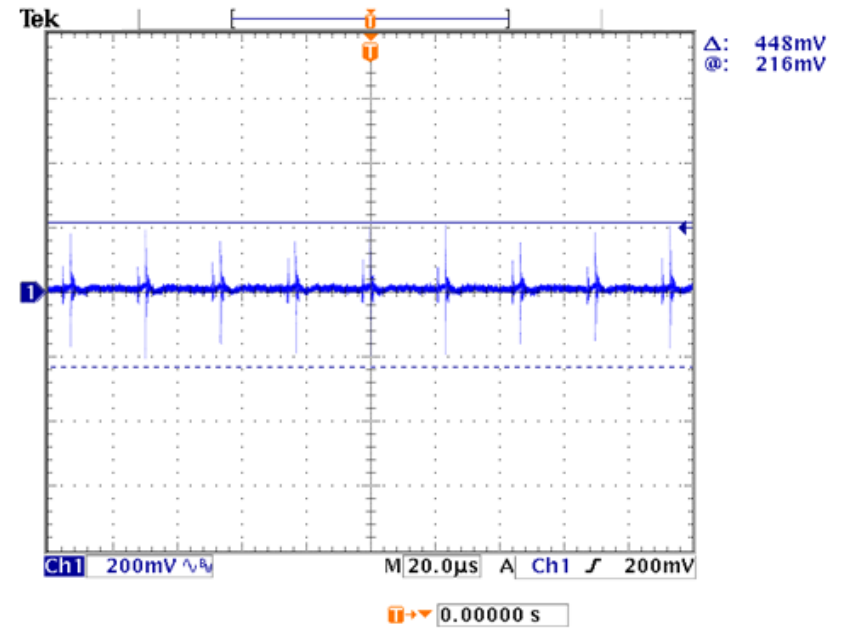


264VAC, 50Hz, Full Load

# Ripple Noise



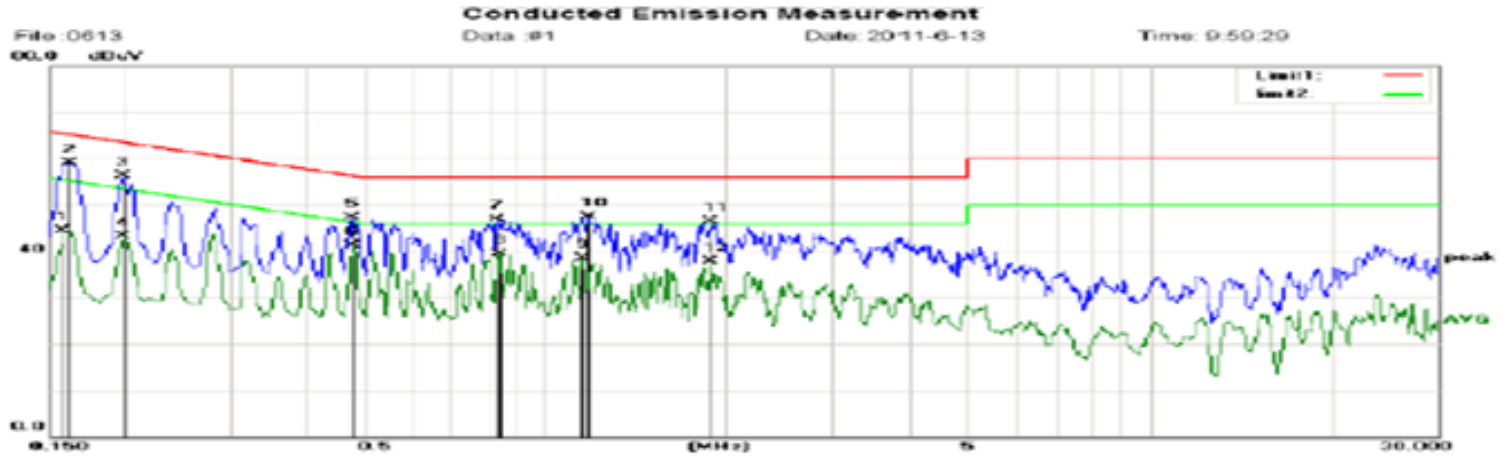
90VAC, 60Hz, Full Load



264VAC, 50Hz, Full Load



# Conducted N Wire



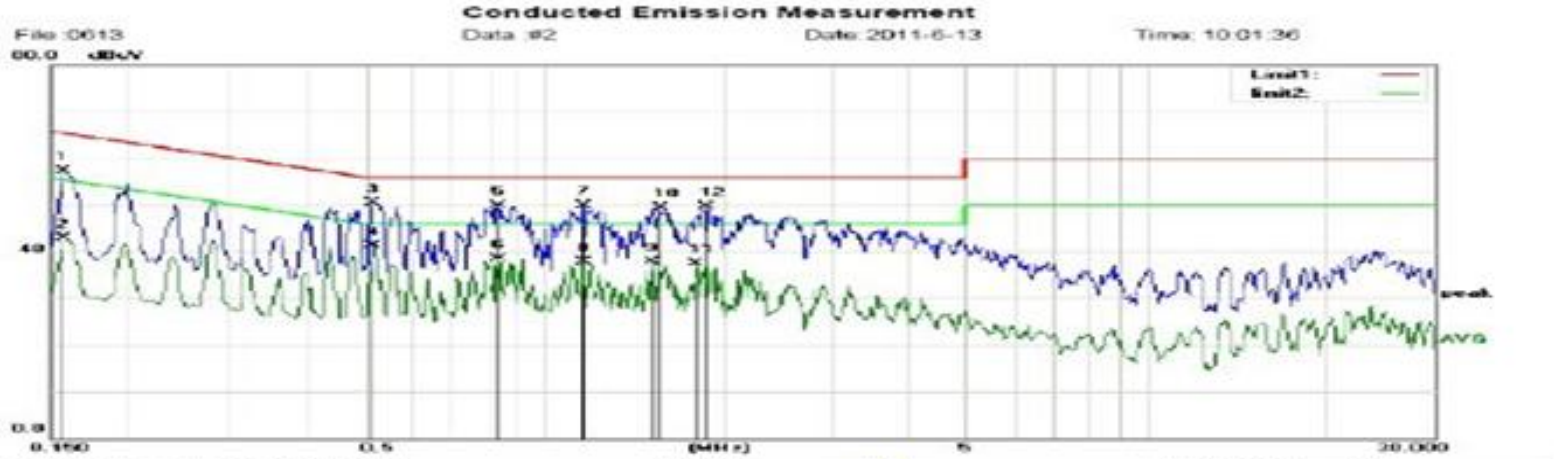
Site : Conducted Emission Test Site  
 Limit: (CE)CISPR22 class B\_QP  
 EUT: 5V 1A  
 M/N:  
 Mode:  
 Note: FULL LOAD NO.1

Phase: N  
 Power: AC 230V/50Hz

Temperature: 25  
 Humidity: 60 %

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dB	Over dB	Detector	Comment
1		0.1580	33.10	11.41	44.51	55.56	-11.05	AVG	
2		0.1620	47.73	11.39	59.12	65.36	-6.24	peak	
3		0.1980	45.15	11.14	56.29	63.69	-7.40	peak	
4		0.1980	32.26	11.14	43.40	53.69	-10.29	AVG	
5		0.4780	37.17	10.21	47.38	56.37	-8.99	peak	
6	*	0.4780	31.18	10.21	41.39	46.37	-4.98	AVG	
7		0.8300	36.84	10.09	46.93	56.00	-9.07	peak	
8		0.8380	29.38	10.10	39.48	56.00	-16.52	QP	
9		1.1500	28.39	10.10	38.49	46.00	-7.51	AVG	
10		1.1780	37.38	10.10	47.48	56.00	-8.52	peak	
11		1.8740	36.37	10.11	46.48	56.00	-9.52	peak	
12		1.8740	27.86	10.11	37.97	46.00	-8.03	AVG	

# Conducted L Wire



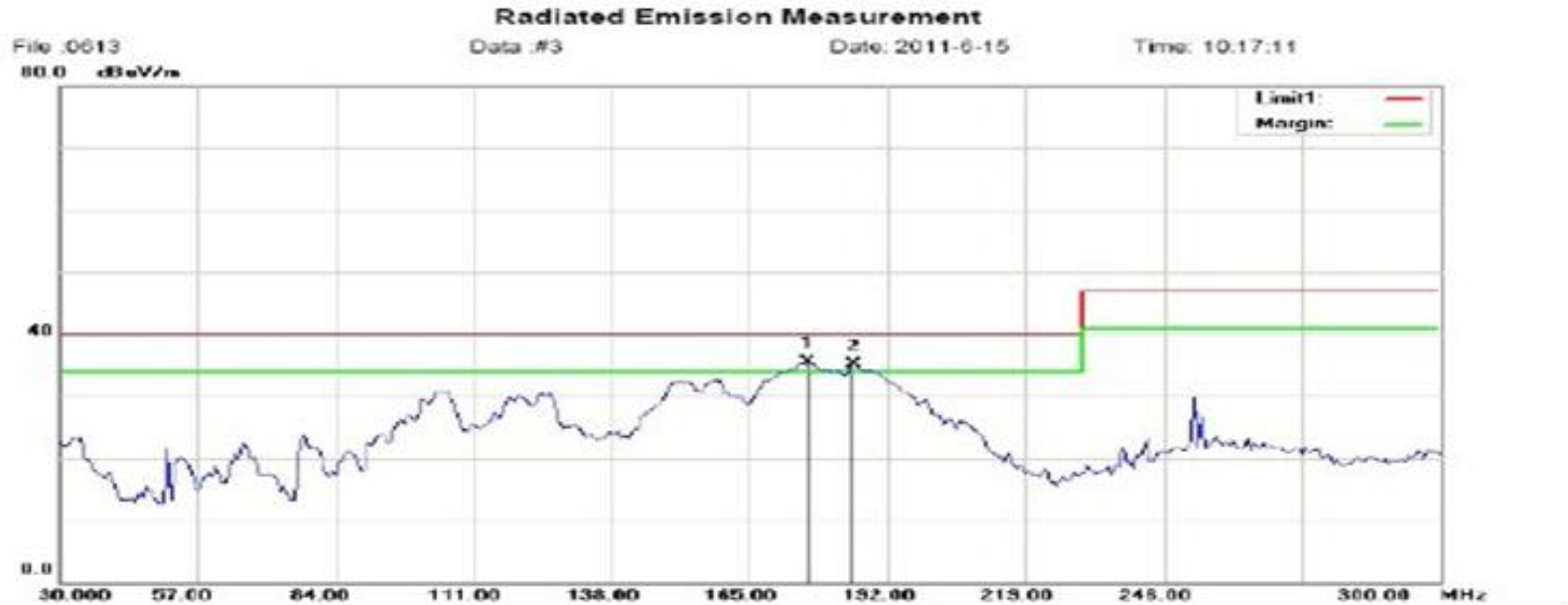
Site : Conducted Emission Test Site  
Limit: (CE)CISPR22 class B\_OP  
EUT: 5V 1A  
M/N:  
Mode:  
Note: FULL LOAD NO.1

Phase: L7  
Power: AG 230V/50Hz

Temperature: 26  
Humidity: 60 %

No.	Mk.	Freq MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dB	Over dB	Detector	Comment
1		0.1580	45.96	11.41	57.37	65.56	-8.19	peak	
2		0.1580	31.52	11.41	42.93	55.56	-12.63	AVG	
3		0.5180	40.42	10.17	50.59	56.00	-5.41	peak	
4	*	0.5180	31.20	10.17	41.37	46.00	-4.63	AVG	
5		0.8340	39.84	10.10	49.94	56.00	-6.06	peak	
6		0.8340	28.46	10.10	38.56	46.00	-7.44	AVG	
7		1.1580	39.79	10.10	49.89	56.00	-6.11	peak	
8		1.1580	27.81	10.10	37.91	46.00	-8.09	AVG	
9		1.4980	27.84	10.10	37.94	46.00	-8.06	AVG	
10		1.5460	39.39	10.11	49.50	56.00	-6.50	peak	
11		1.7740	27.30	10.11	37.41	46.00	-8.59	AVG	
12		1.8580	39.52	10.11	49.63	56.00	-6.37	peak	

# Radiation Horizontal

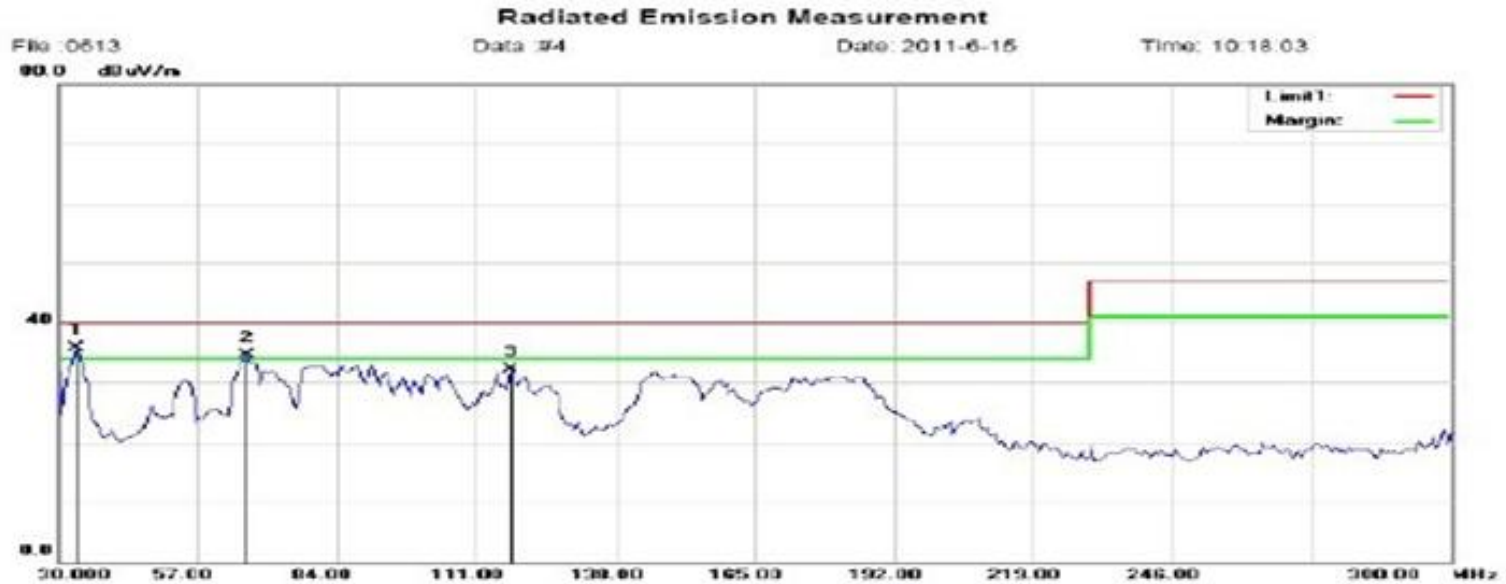


Site : Radiated Emission Test Site  
 Limit: (RE)CISPR22 class B 3m  
 EUT: 5V 1A  
 M/N:  
 Mode:  
 Note: FULL LOAD

Polarization: **Horizontal**  
 Power: AC 230V/50Hz  
 Distance: 3m  
 Temperature: 26  
 Humidity: 60%

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dB/m	Over dB	Detector	Antenna Height cm	Table Degree degree	Comment
1	^	176.4749	46.75	-11.24	35.51	40.00	-4.49	peak			
2	I	186.2500	45.78	-10.75	35.01	40.00	-4.99	peak			

# Radiation Vertical



Site : Radiated Emission Test Site  
 Limit: (RE)CISPR22 class B 3m  
 EUT: 5V 1A  
 M/N:  
 Mode:  
 Note: FULL LOAD

Polarization: **Vertical**  
 Power: AC 230V/50Hz  
 Distance: 3m

Temperature: 26  
 Humidity: 60 %

No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dB/m	Over dB	Detector	Antenna Height cm	Table Degree degree	Comment
1	*	33.3750	49.89	-14.26	35.63	40.00	-4.37	peak			
2	!	66.4500	40.39	-5.96	34.43	40.00	-5.57	peak			
3		117.7500	39.83	-7.69	32.14	40.00	-7.86	peak			

# Thank You !!