

Car Charger Using ACT4533C+CHY100

FEATURES

- Wide input voltage range from 10V to 36V
- 125kHz switching frequency eases EMI design
- Stable with low-ESR ceramic capacitors
- 2% feedback voltage accuracy
- Standby input current <10mA
- Thermal shutdown protection
- Over output voltage protection
- Cord compensation
- Over current protection
- Supports Qualcomm® Quick Charge 2.0 (QC2.0) high voltage dedicated charging port (HVDCP) Class A with voltage configuration of 5V ,9V and 12V
- USB battery charging specification revision 1.2 compatible
 - Automatic USB DCP shorting D+ to D- line
 - Default 5 V mode operation
- Fast discharge from 9V/12V to 5V at USB cable unplug or from a high voltage level to a lower level

TYPICAL APPLICATIONS

- Car Charger in support QC2.0
- Battery chargers for smart phones, tablets, net-books
- Digital cameras and blue-tooth accessories
- USB power output ports

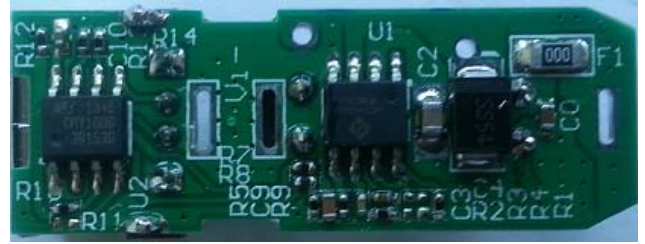
SPECIFICATION

DESCRIPTION	CONDITION	MIN	TYP	MAX	UNITS
Input Voltage		10		36	V
Switching Frequency			125		kHz
No-load Standby Input current	Vin=12V no load		5.5		mA
	Vin=24V no load		4.0		mA
Output Voltage	D+=0.6V,D-=GND	4.75	5	5.25	V
	D+=3.3V,D-=0.6V		9		
Output Current	Vout=5V	2400		2900	mA
	Vout=9V		1500		
Ripple Voltage	Vin=12V, Vo=5V,Io=2.4A		50.0		mVpp
	Vin=24V, Vo=5V,Io=2.4A		54.0		
	Vin=12V, Vo=9V,Io=1.5A		28.4		
	Vin=24V, Vo=9V,Io=1.5A		55.0		
Efficiency at full load	Vin=12V, Vo=5V,Io=2.1A		88.9		%
	Vin=24V, Vo=5V,Io=2.1A		87.6		
	Vin=12V, Vo=9V,Io=1.5A		95.0		
	Vin=24V, Vo=9V,Io=1.5A		92.8		
ENVIRONMENTAL					
ESD	Contact		4		kV
	Through air		8		kV
Ambient Temperature	Free convection	0		50	°C

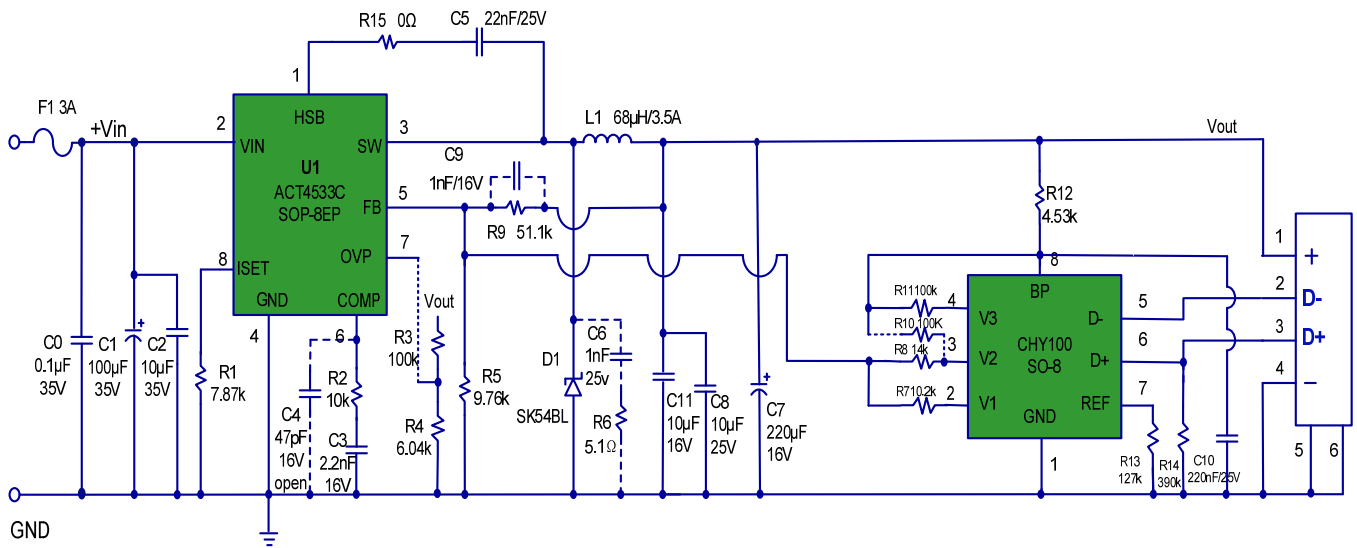
TABLE OF CONTENTS

1.	Demo Board Photo.....	4
2.	Schematic.....	4
3.	PCB Layout.....	4
4.	Bill of Materials.....	5
5.	Functional Test.....	6
5.1.	Output Regulation	6
5.2.	Efficiency (Ta=25C).....	6
5.3.	Constant Current and Constant Voltage (Ta=25C)	7
5.4.	Current Limit vs. Input Voltage	9
5.5.	Power Loss	10
5.6.	Standby Input Current	11
5.7.	Ripple and Noise	12
5.8.	Load Dynamic Response.....	13
5.9.	Turn-on Delay Time	14
5.10.	Output Voltage Transition.....	15
5.11.	Key Components Temperature Test (Ta=40C, burning for 2 hours).....	15
6.	EMI TEST (RADIATED)	16
6.1.	Input 12V Output 5V/2.1A.....	16
6.2.	Input 24V Output 5V/2.1A.....	18
6.3.	Input 12V Output 9V/1.5A.....	20
6.4.	Input 24V Output 9V/1.5A.....	22

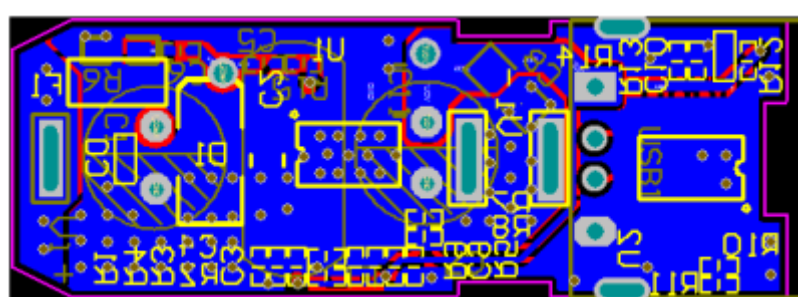
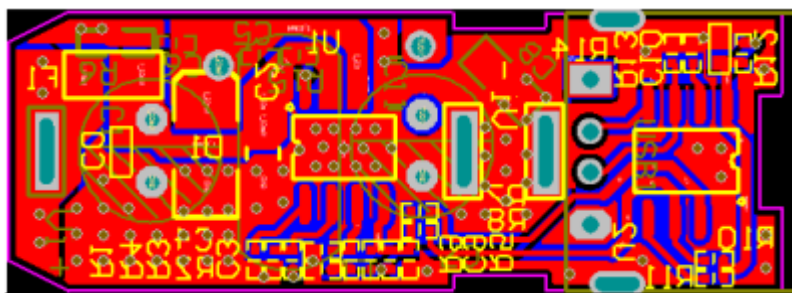
1. DEMO BOARD PHOTO



2. SCHEMATIC



3. PCB LAYOUT



4. BILL OF MATERIALS

Item	Reference	Description	QTY	Manuf.
1	L1	Choke Coil, 6*3*3mm, L=68uH 3.5A	1	
2	D1	Schottky Diode, SK54BL, 40V/5A, SMA	1	Diodes
3	C0	Ceramic capacitor, 0.1uF/35V, X7R, 0805	1	Murata/TDK
4	C1	Electrolytic capacitor, 100uF/35V, 5x7mm	1	Koshin
5	C2	Ceramic capacitor, 10uF/35V, X7R, 0805	1	Murata/TDK
6	C3	Ceramic capacitor, 2.2nF/16V, X7R, 0603	1	Murata/TDK
7	C4	Ceramic capacitor, 47pF/16V, X7R, 0603 (Optional)	1	Murata/TDK
8	C5	Ceramic capacitor, 22nF/25V, X7R, 0603	1	Murata/TDK
9	C6	Ceramic capacitor, 1nF/25V, X7R, 0603(Optional)	1	Murata/TDK
10	C7	Electrolytic capacitor, 220uF/16V	1	Murata/TDK
11	C8	Ceramic capacitor, 10uF/25V, X7R, 0805	1	Murata/TDK
12	C9	Ceramic capacitor, 1nF/16V, X7R, 0603	1	Murata/TDK
13	C10	Ceramic capacitor, 220nF/25V, X7R, 0603	1	Murata/TDK
14	C11	Ceramic capacitor, 10uF/16V, X7R, 0603	1	Koshin
15	F1	Fuse,3A,1206 (Replaced by 0Ω 1206 chip resistor)	1	Murata/TDK
16	R1	Chip Resistor, 7.87KΩ, 1/10W, 1%, 0603	1	Murata/TDK
17	R2	Chip Resistor, 10KΩ, 1/10W, 5%, 0603	1	Murata/TDK
18	R3	Chip Resistor, 100KΩ, 1/10W, 1%, 0603(Optional OVP)	1	Murata/TDK
19	R4	Chip Resistor, 6.04KΩ, 1/10W, 1%, 0603(Optional OVP)	1	Murata/TDK
20	R5	Chip Resistor, 9.76KΩ, 1/10W, 1%, 0603	1	Murata/TDK
21	R6	Chip Resistor, 5.1 Ω, 1/10W, 1%, 0603	1	Murata/TDK
22	R7	Chip Resistor, 10.2kΩ, 1/10W, 1%, 0603	1	Murata/TDK
23	R8	Chip Resistor, 14KΩ, 1/10W, 1%, 0603	1	Murata/TDK
24	R9	Chip Resistor, 51.1 KΩ, 1/10W, 5%, 0603	1	Murata/TDK
25	R10,R11	Chip Resistor, 100 KΩ, 1/10W, 1%, 0603 (R10, Optional)	2	Murata/TDK
26	R12	Chip Resistor, 4.53KΩ, 1/10W, 1%,0603	1	Murata/TDK
27	R13	Chip Resistor, 127KΩ, 1/10W, 5%, 0603	1	Murata/TDK
28	R14	Chip Resistor, 390KΩ, 1/10W, 1%, 0603	1	Murata/TDK
29	U1	IC, ACT4533C, SOP-8-EP	1	ACT
30	U2	IC, CHY100, SO-8	1	PI
31	USB	USB Rev:A	1	

5. FUNCTIONAL TEST

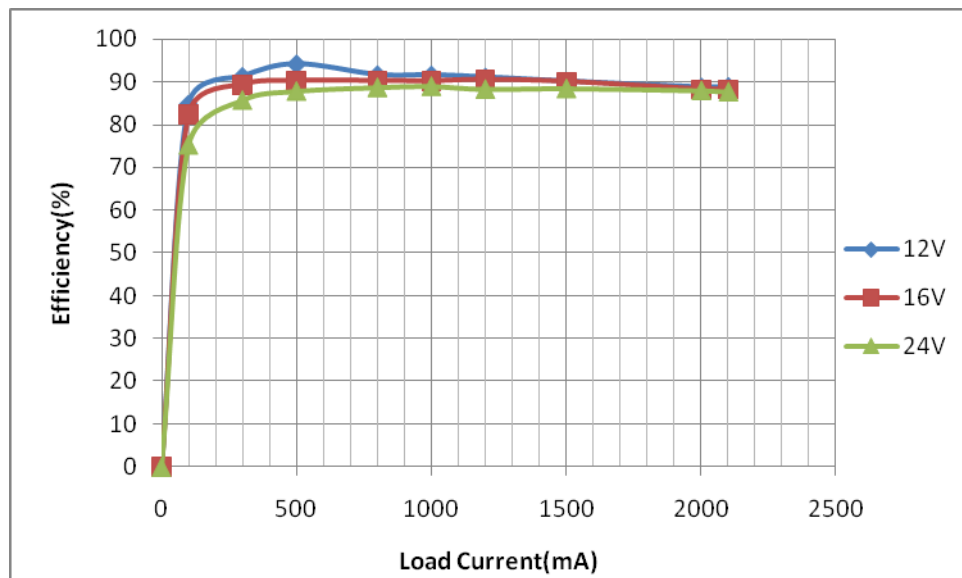
5.1. Output Regulation

VIN	Output Voltage at Max. load (V)	Output Voltage at No load (V)	Load regulation	Iload(max)
12V	5.07	5.04	0.6%	2.4A
16V	5.07	5.04	0.6%	
24V	5.07	5.04	0.6%	

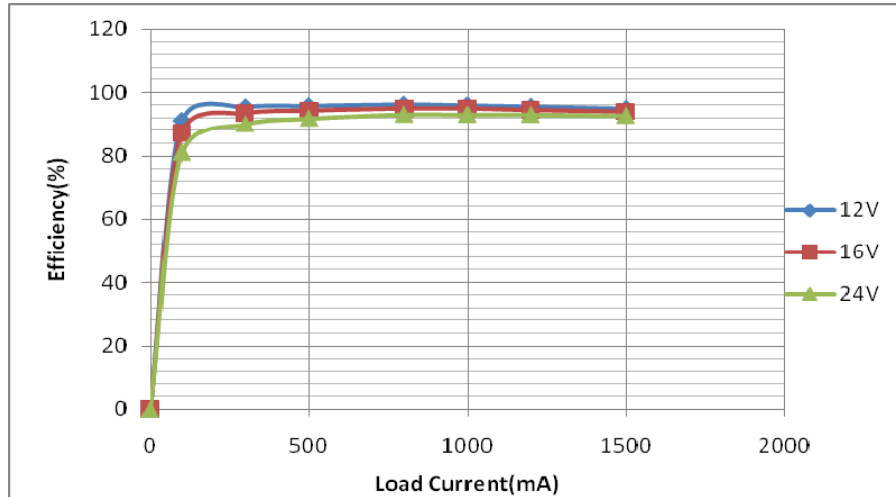
VIN	Output Voltage at Max. load (V)	Output Voltage at No load (V)	Load regulation	Iload(max)
12V	9.04	9.02	0.22%	1.5A
16V	9.04	9.02	0.22%	
24V	5.04	9.02	0.22%	

5.2. Efficiency (Ta=25C)

VIN	Efficiency (%) Vout=5V				
	Io=100mA	Io=500mA	Io=1000mA	Io=2000mA	Io=2100mA
12V	84.8	94.2	91.6	88.8	88.9
16V	82.5	90.4	90.3	88.4	88.3
24V	72.5	87.8	88.9	87.9	87.6

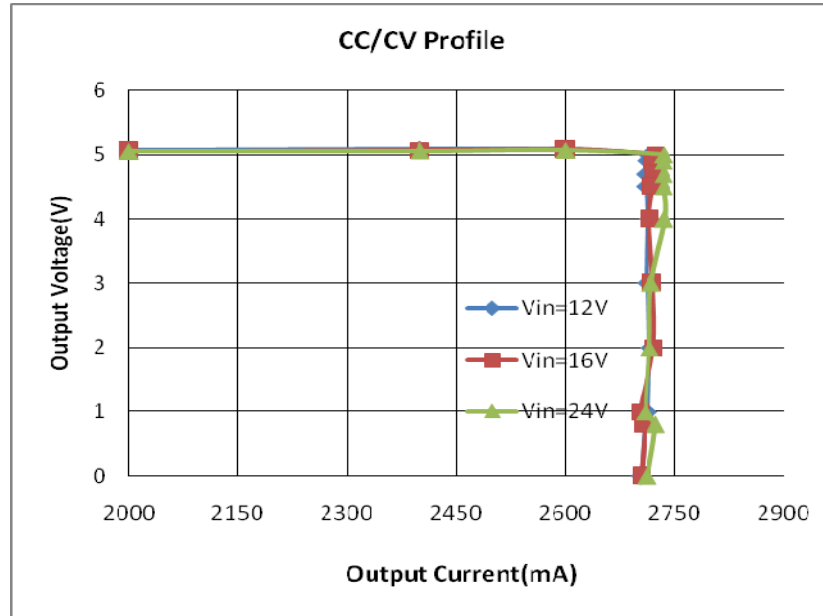


VIN	Efficiency (%) Vout=9V				
	Io=100mA	Io=300mA	Io=500mA	Io=1000mA	Io=1500mA
12V	91.1	95.5	95.9	96	95
16V	87.3	93.5	94.3	94.99	94
24V	81.7	90.1	91.92	93.1	92.8

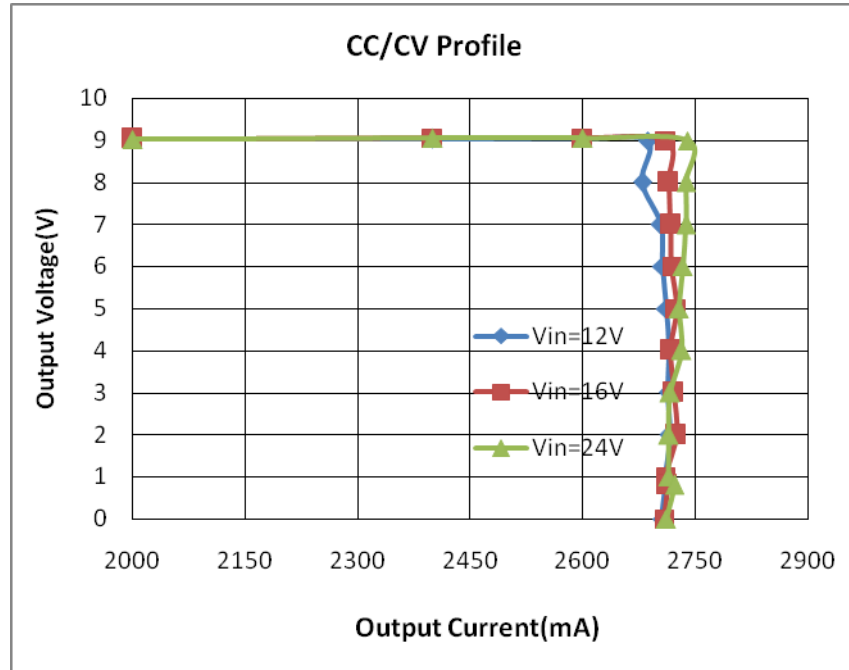


5.3. Constant Current and Constant Voltage (Ta=25C)

	Vin=12V		Vin=16V		Vin=24V	
	Vout (V)	Iout (mA)	Vout (V)	Iout (mA)	Vout (V)	Iout (mA)
CC Load	5.04	0	5.04	0	5.04	0
	5.04	200	5.04	200	5.04	200
	5.05	1000	5.05	1000	5.04	1000
	5.07	2000	5.06	2000	5.05	2000
	5.08	2400	5.07	2400	5.06	2400
	5.08	2600	5.08	2600	5.07	2600
CV Load	5	2714	5	2723	5	2736
	4.9	2712	4.9	2721	4.9	2735
	4.7	2711	4.7	2720	4.7	2735
	4.5	2711	4.5	2719	4.5	2735
	4	2713	4	2715	4	2736
	3	2712	3	2719	3	2717
	2	2715	2	2720	2	2715
	1	2713	1	2703	1	2711
	0.8	2710	0.8	2709	0.8	2723
	0	2704	0	2705	0	2712



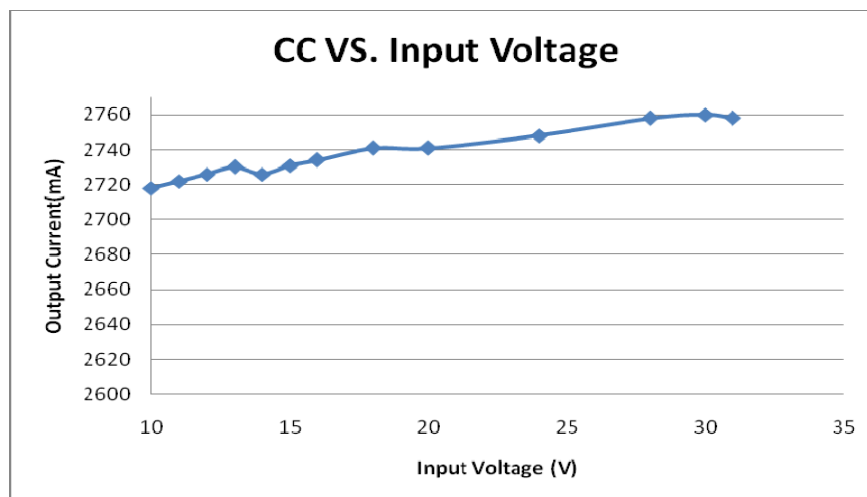
	Vin=12V		Vin=16V		Vin=24V	
	Vout (V)	Iout (mA)	Vout (V)	Iout (mA)	Vout (V)	Iout (mA)
CC Load	9.02	0	9.02	0		0
	9.03	200	9.03	200	9.03	200
	9.03	1000	9.03	1000	9.03	1000
	9.04	2000	9.04	2000	9.03	2000
	9.04	2400	9.05	2400	9.05	2400
	9.05	2600	9.06	2600	9.05	2600
CV Load	9	2686	9	2711	9	2739
	8	2679	8	2714	8	2737
	7	2704	7	2717	7	2737
	6	2706	6	2718	6	2733
	5	2711	5	2724	5	2728
	4	2715	4	2717	4	2731
	3	2713	3	2721	3	2716
	2	2716	2	2724	2	2714
	1	2710	1	2710	1	2714
	0.8	2710	0.8	2712	0.8	2722
	0	2705	0	2708	0	2711



5.4. Current Limit vs. Input Voltage

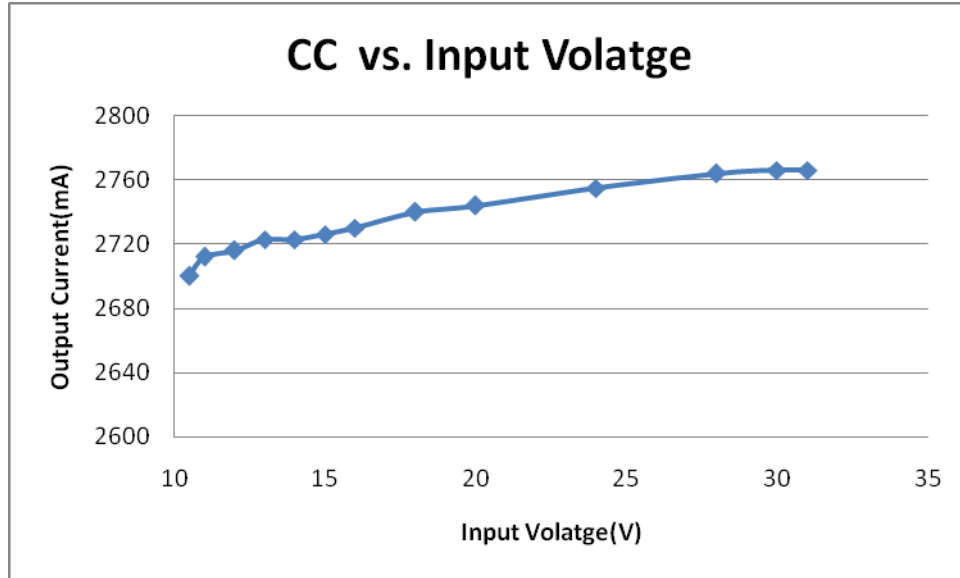
No Wind (Test Condition : CV load 4.7V, Ta=25C)

Vin (V)	10	11	12	13	14	15	16	18	20	24	28	30	31
Iout (mA)	2718	2722	2726	2730	2726	2731	2734	2741	2741	2748	2758	2760	2758



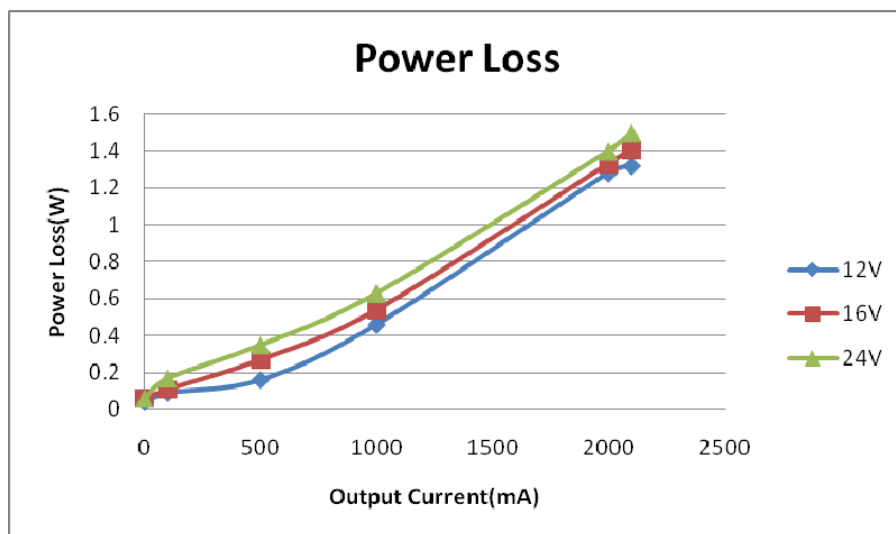
No Wind (Test Condition : CV load 7V, Ta=25C)

Vin (V)	10.5	11	12	13	14	15	16	18	20	24	28	30	31
Iout (mA)	2700	2712	2716	2723	2723	2726	2730	2740	2744	2755	2764	2766	2766

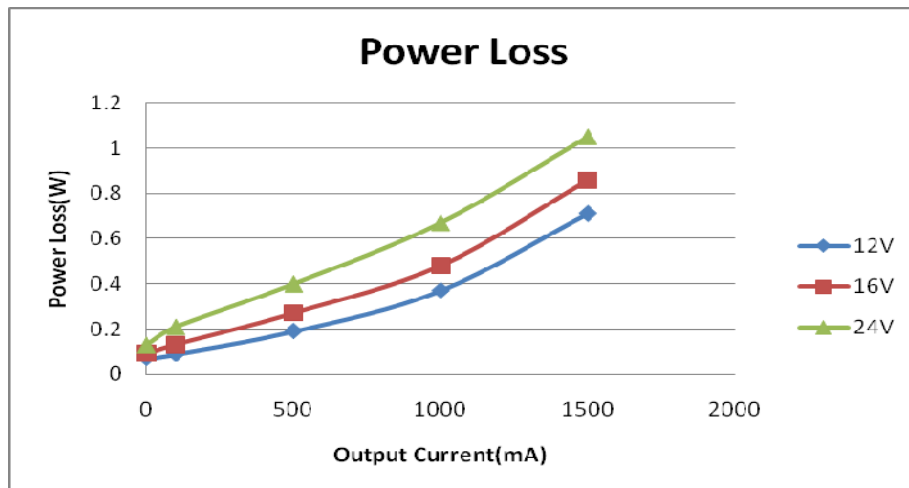


5.5. Power Loss

Vin	Power loss (W) Vout=5V					
	Io=0mA	Io=100mA	Io=500mA	Io=1000mA	Io=2000mA	Io=2100mA
Vin=12V	0.04	0.09	0.16	0.46	1.28	1.32
Vin=16V	0.06	0.11	0.27	0.54	1.33	1.41
Vin=24V	0.06	0.17	0.35	0.63	1.40	1.50



Vin	Power loss (W) Vout=9V				
	Io=0mA	Io=100mA	Io=500mA	Io=1000mA	Io=1500mA
Vin=12V	0.07	0.09	0.19	0.37	0.71
Vin=16V	0.09	0.13	0.27	0.48	0.86
Vin=24V	0.13	0.21	0.40	0.67	1.05



5.6. Standby Input Current

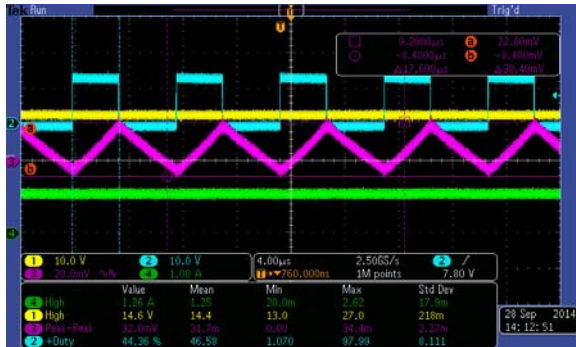
Test Conditions(Vout=5V)	Input Current (mA)	Power Loss at No Load (W)
Vin=12V	3.65	0.04
Vin=16V	3.53	0.06
Vin=24V	2.41	0.06

Test Conditions(Vout=9V)	Input Current (mA)	Power Loss at No Load (W)
Vin=12V	5.89	0.07
Vin=16V	5.42	0.09
Vin=24V	5.55	0.13

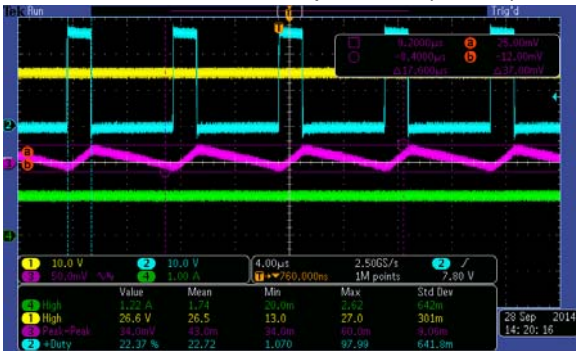
5.7. Ripple and Noise

(Note: CH1: Input Voltage CH2:SW
Vin=12V 5V/1A output load (30.4mV)

CH3:Output voltage CH4:Output Current)
Vin=12V 5V/2.4A output load (50mV)



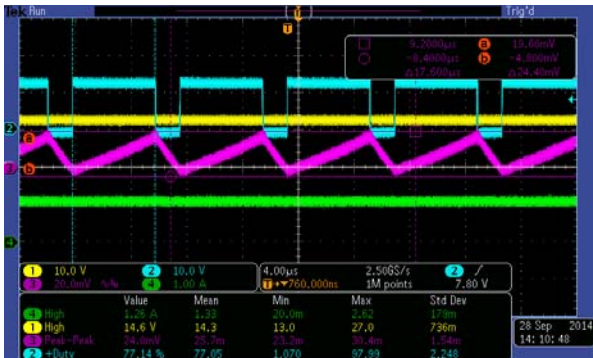
Vin=24V 5V/1A output load (37mV)



Vin=24V 5V/2.4A output load(54mV)



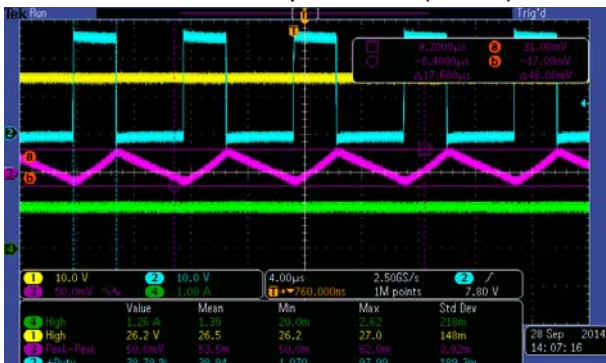
Vin=12V 9V/1A output load (24.4mV)



Vin=12V 9V/1.5A output load(28.4mV)



Vin=24V 9V/1A output load (48mV)



Vin=24V 9V/1.5A output load(55mV)



Ripple & noise are measured by using 20MHz bandwidth limited oscilloscope.

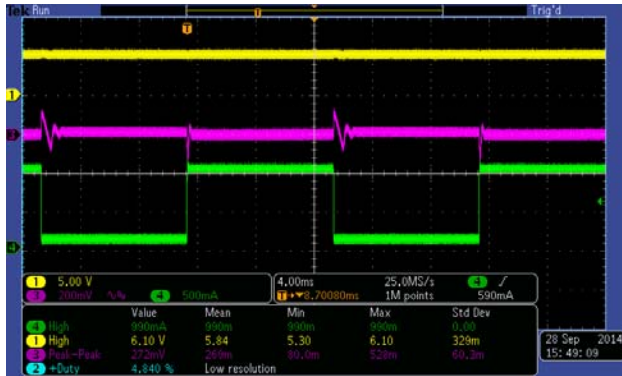
Test Conditions	Output Ripple at 5V/1A Load (mV)	Output Ripple at 5V/2.4A Load (mV)
Vin=12V	30.4	50.0
Vin=24V	37.0	54.0

Test Conditions	Output Ripple at 9V/1A Load (mV)	Output Ripple at 9V/1.5A Load (mV)
Vin=12V	24.4	28.4
Vin=24V	48.0	55.0

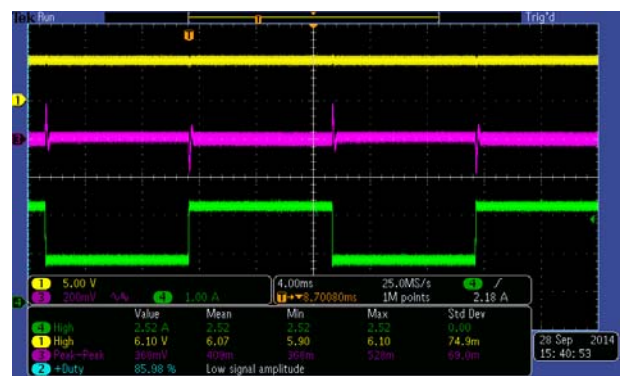
5.8. Load Dynamic Response

(Note: CH1:Output Voltage(DC) CH2: Output Voltage(AC) CH3: Output Current)

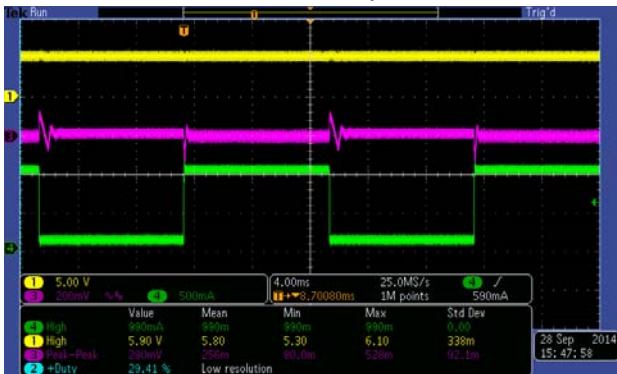
Vin=12V Vout=5V load step 80mA-1A -80mA



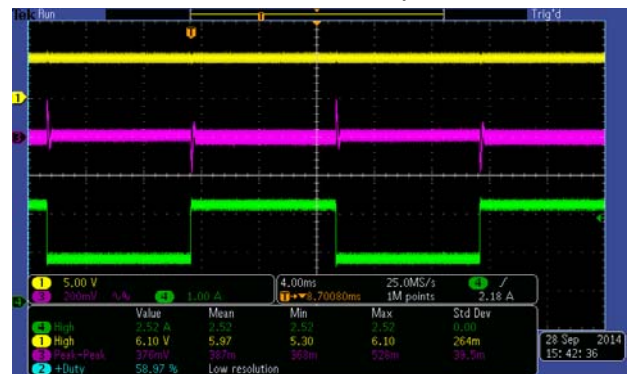
Vin=12V Vout=5V load step 1A-2.4A-1A



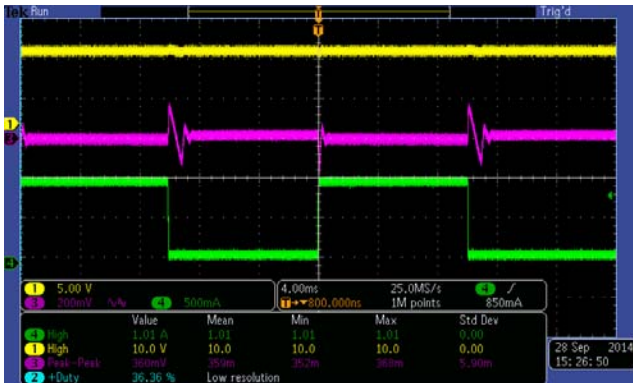
Vin=24V Vout=5V load step 80mA-1A -80mA



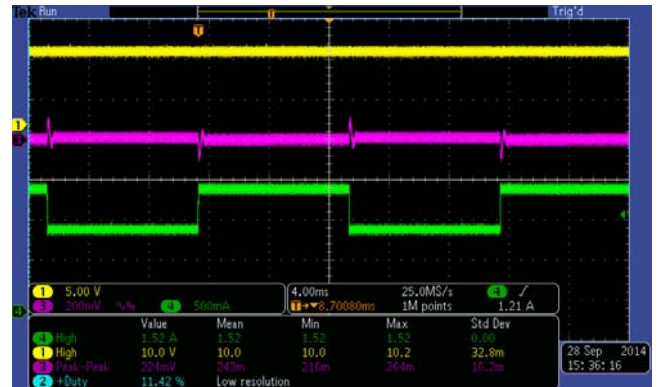
Vin=24V Vout=5V load step 1A-2.4A-1A



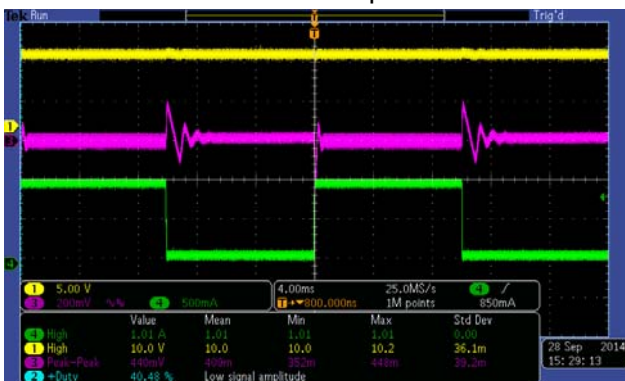
Vin=12V Vout=9V load step 80mA-1A -80mA



Vin=12V Vout=9V load step 1A-1.5A-1A



Vin=24V Vout=9V load step 80mA-1A -80mA



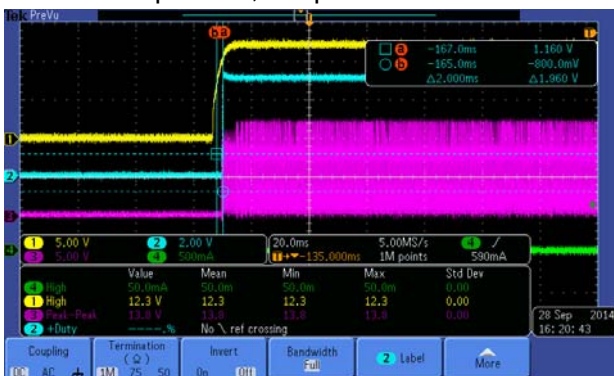
Vin=24V Vout=9V load step 1A-1.5A -1A



5.9. Turn-on Delay Time

(Note:CH1:Input Voltage CH2:Output Voltage CH3: SW)

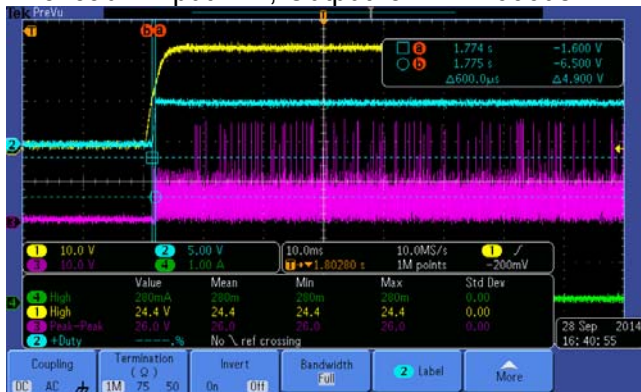
No load Input:12V, Output: 5V T= 2ms



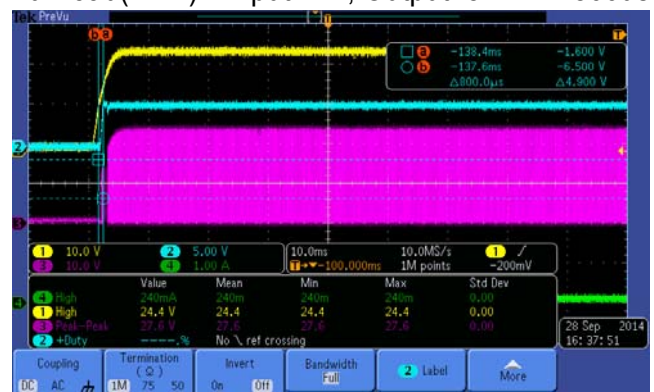
Full load(2.4A) Input:12V, Output: 5V T= 2ms



No load Input:24V, Output: 5V T= 600us



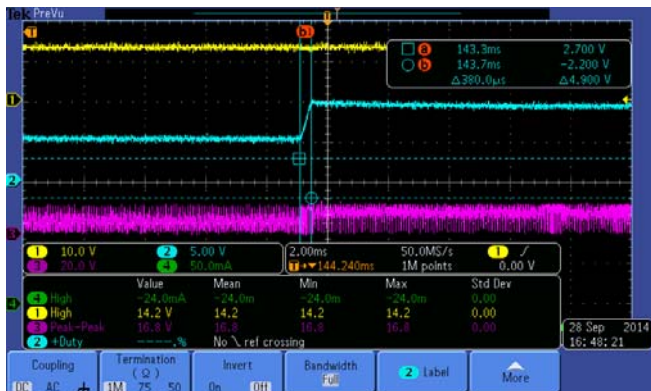
Full load(2.4A) Input:24V, Output: 5V T= 800us



5.10. Output Voltage Transition

(Note: CH1: Input Voltage CH2: Output Voltage CH3: SW)

5V-9V No Load Tr=380us



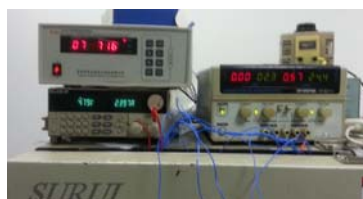
9V-5V No Load Tr=248ms



5.11. Key Components Temperature Test (Ta=40°C, burning for 2 hours)

Vout=5V	Vin/Iout	IC	Diode	Inductor
	12V/2.4A	80.3 °C	83.6 °C	72.3 °C
	16V/2.4A	80.7 °C	84.2 °C	72.6 °C
	24V/2.4A	88.8 °C	93.7 °C	77.1 °C

Vout=9V	Vin/Iout	IC	Diode	Inductor
	12V/1.5A	63.3 °C	61.9 °C	58.2 °C
	16V/1.5A	65.3 °C	65.9 °C	59.8 °C
	24V/1.5A	67.5 °C	71.1 °C	61.5 °C



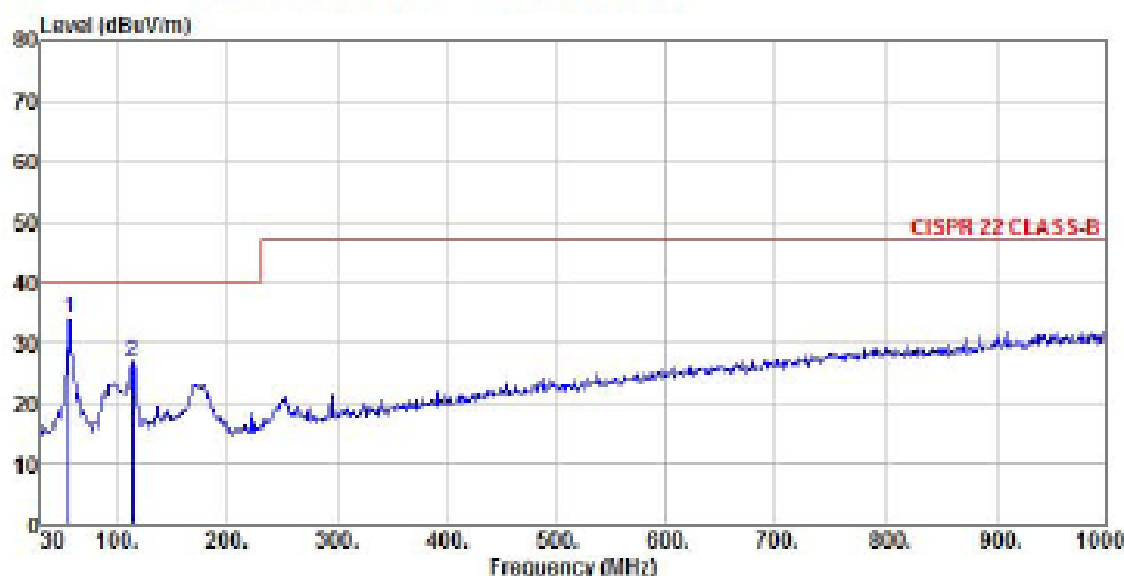
6. EMI TEST (RADIATED)

6.1. Input 12V Output 5V/2.1A



No. 1350, Lianxi Rd, Pudong New District, Shanghai, P.R.China
Tel: 021-50275125
Fax: 021-50275126
Mail: wangrong@unilab.cn

Data: 1 File: D:\customer\2014\机箱\20141009.EMI5 (16)



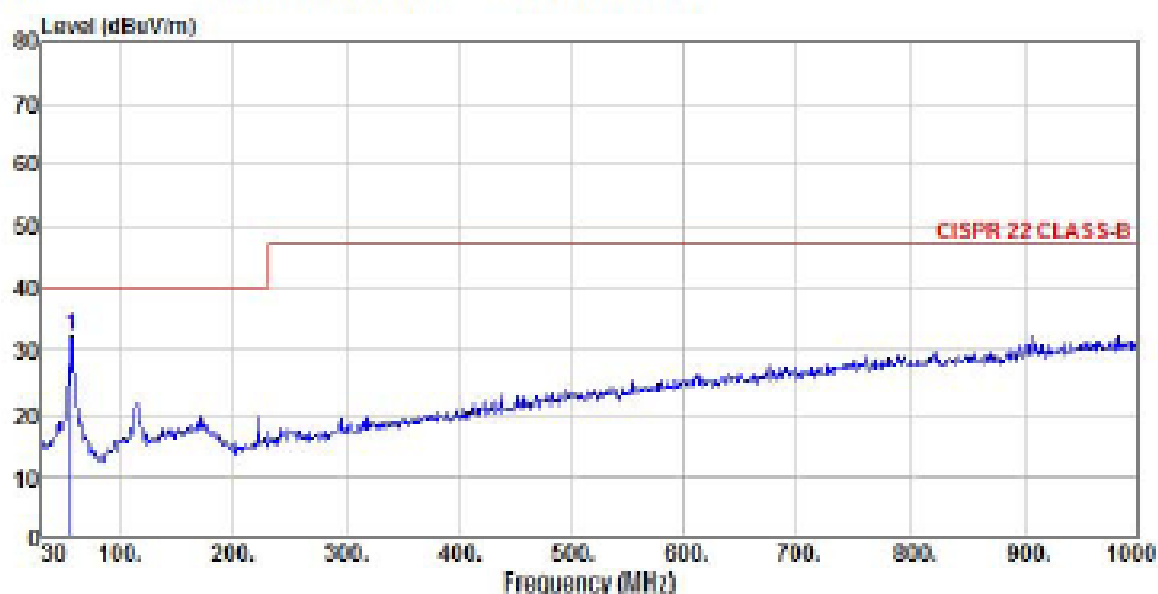
Site : chamber
Condition : CISPR 22 CLASS-B 3m VULB9160 HORIZONTAL
EUT : ACT4533C
Model Name : #1
Temp/Humi : 23℃ / 54 %
Power Rating: DC 12V
Mode : 5V/2.1A
Memo : SNUBBER=1nF+5.1ohm

		Freq	Read Level	Antenna Factor	Cable Loss	Preamp Factor	Limit Level	Over Limit	Remark
		MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB
1	pp	55.22	20.67	12.48	1.00	0.00	34.07	40.00	-5.93 Peak
2		113.42	13.97	11.45	1.42	0.00	26.84	40.00	-13.16 Peak



No. 1350, Lianxi Rd, Pudong New District, Shanghai, P.R.China
Tel: 021-50275125
Fax: 021-50275126
Mail: wangrong@unilab.cn

Data: 2 File: D:\customer\2014\技术\20141009.EMS (16)



Site : chamber
Condition : CISPR 22 CLASS-B 3m VULB9160 VERTICAL
CUT : ACT4533C
Model Name : #1
Temp/Humi : 23°C / 54 %
Power Rating: DC 12V
Mode : 5V/2.1A
Memo : SNUBBER=1nF+5.1ohm

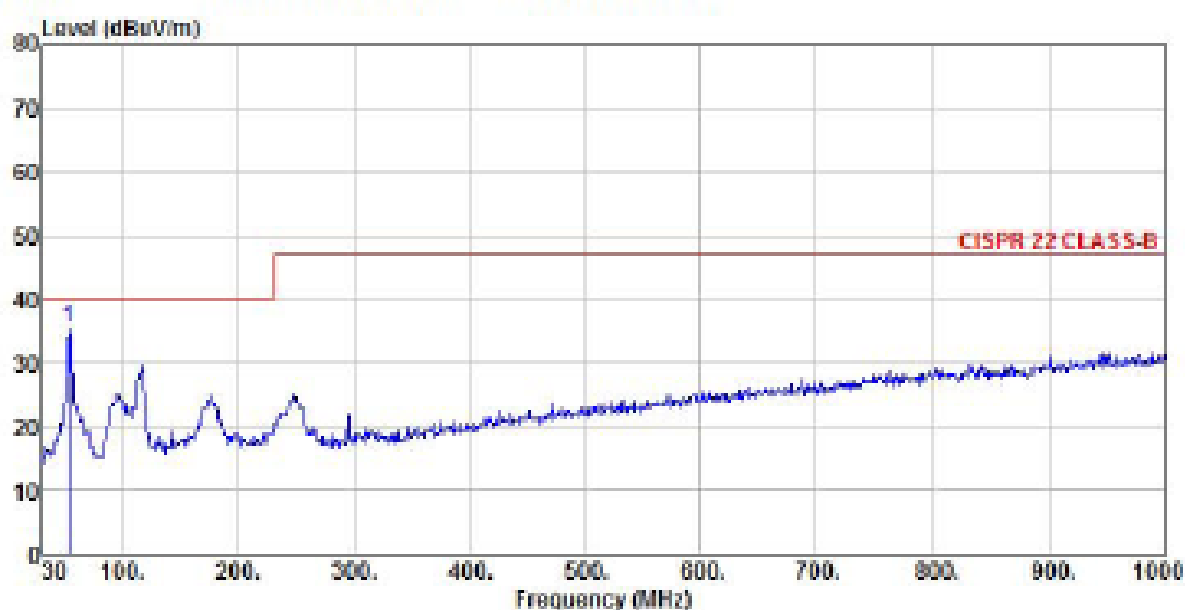
		ReadAntenna	Cable	Preamp		Limit	Over	
	Freq	Level	Factor	Loss	Factor	Level	Line	Limit Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB
1 pp	55.22	18.82	12.40	1.00	0.00	32.22	40.00	-7.78 Peak

6.2. Input 24V Output 5V/2.1A



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Data: 12 File: D:\customer\2014\技特\20141009.EMI5 (16)



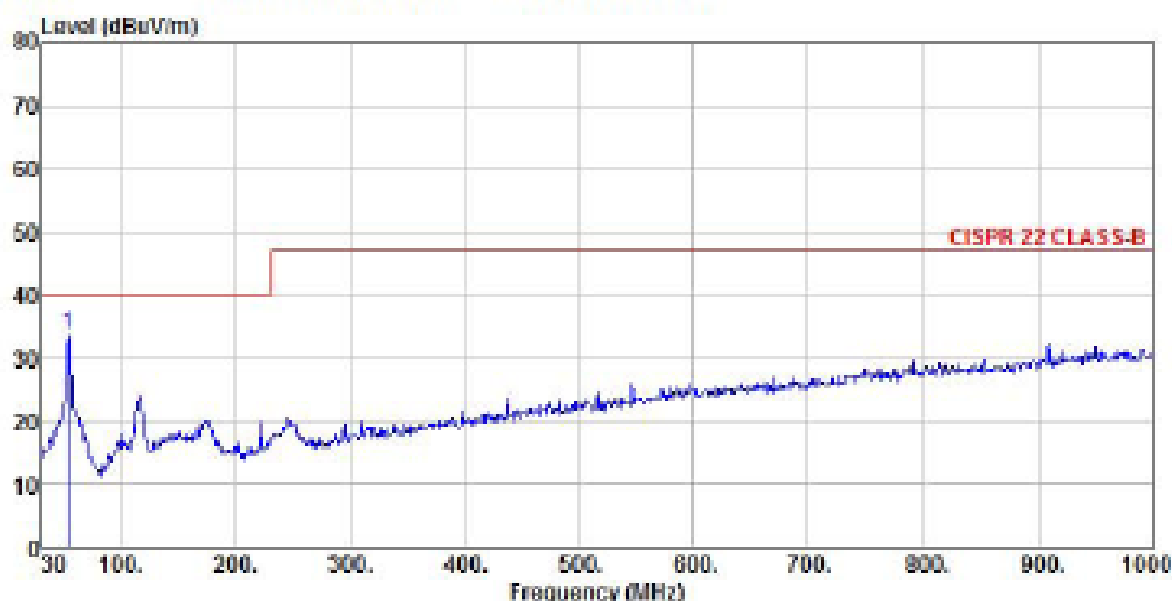
Site : chamber
Condition : CISPR 22 CLASS-B 3m VULB9160 HORIZONTAL
EUT : ACT4533C
Model Name : #1
Temp/Humi : 23°C / 54 %
Power Rating: DC 24V
Mode : 5 V / 2.1 A
Memo :

		ReadAntenna	Cable Preamp		Limit	Over	
	Freq	Level	Factor	Loss Factor	Level	Line	Limit Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m
1 pp	53.28	21.91	12.48	0.98	0.00	35.37	40.00 -4.63 Peak



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Data: 11 File: D:\customer\2014\捷程\20141009.EIMS (16)



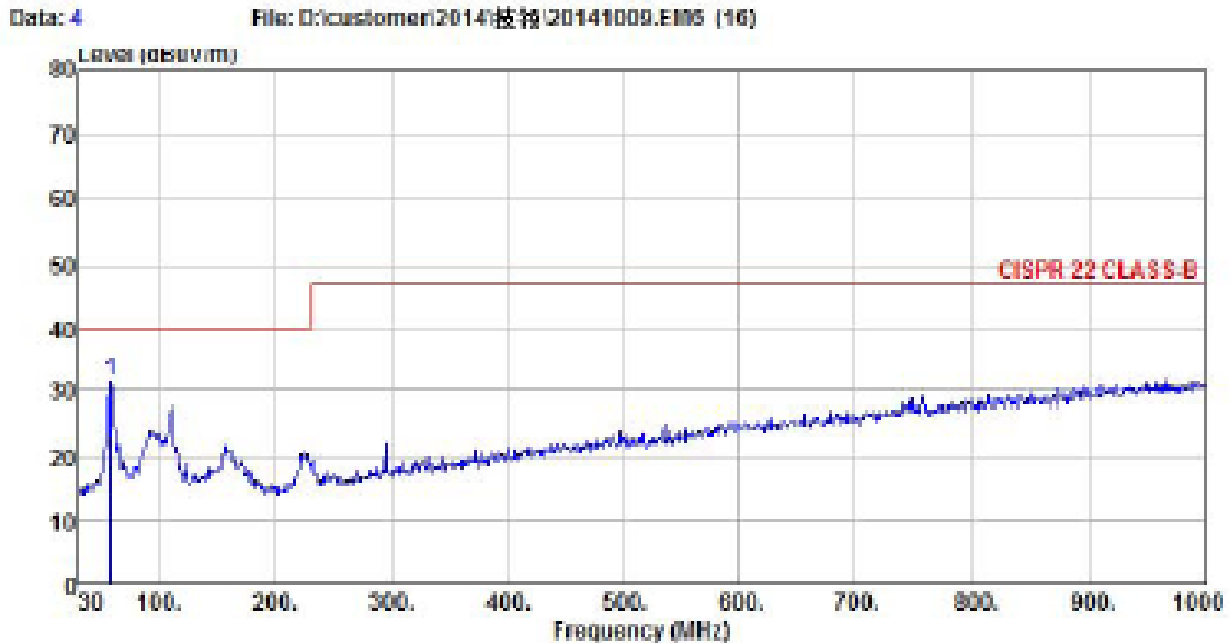
Site : chamber
Condition : CISPR 22 CLASS-B 3m VULB9160 VERTICAL
EUT : ACT4533C
Model Name : #1
Temp/Humi : 23°C / 54 %
Power Rating: DC 24V
Node : 5 V / 2.1 A
Memo :

	Freq	Read Level	Antenna Factor	Cable Loss	Preamplifier Factor	Limit Level	Over Limit	Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB
1 pp	53.28	20.22	12.48	0.98	0.00	33.68	40.00	-6.32 Peak

6.3. Input 12V Output 9V/1.5A



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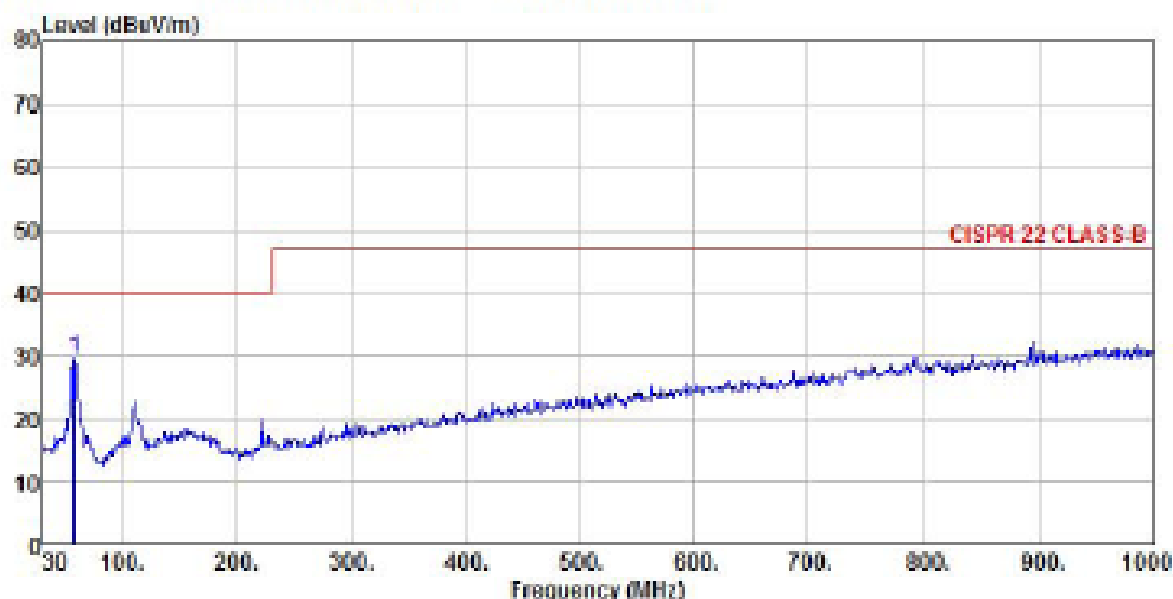
Site : chamber
Condition : CISPR 22 CLASS-B 3m VULB9160 HORIZONTAL
EUT : ACT4533C
Model Name : #1
Temp/Humi : 23℃ / 54 %
Power Rating: DC 12V
Mode : 9 V / 1.5A
Memo : SNUBBER=1nF+5.1ohm

		ReadAntenna	Cable	Preamp		Limit	Over	
	Freq	Level	Factor	Loss	Factor	Level	Line	Limit Remark
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB
1 pp	57.16	17.75	12.49	1.02	0.00	31.26	40.00	-8.74 Peak



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Data: 3 File: D:\customer\2014\技特\20141009.EIMS (16)



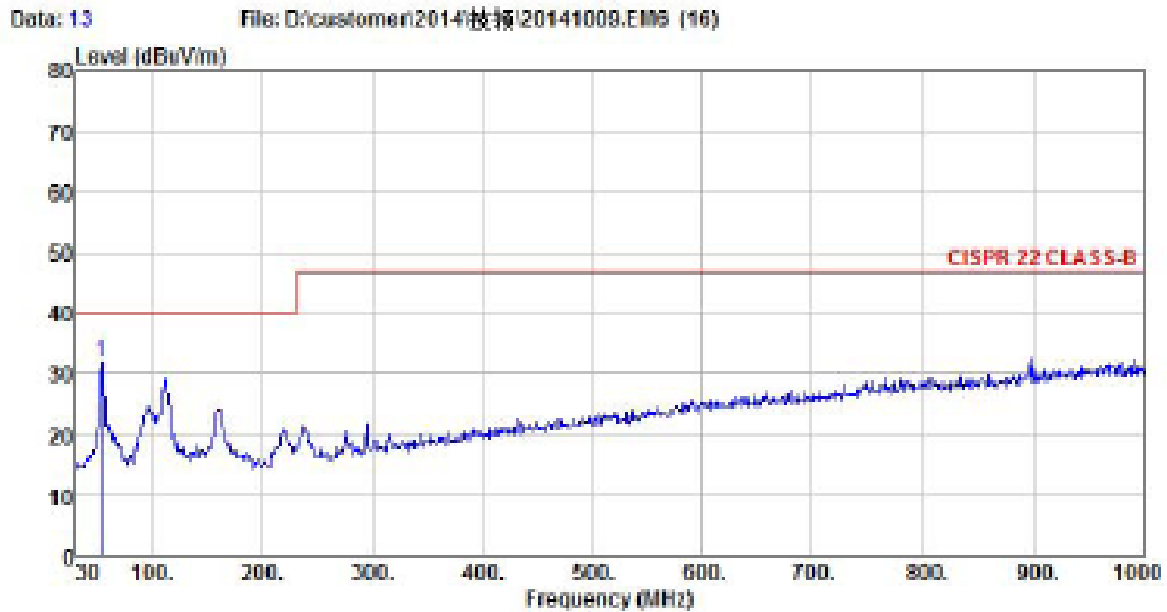
Site : chamber
Condition : CISPR 22 CLASS-B 3m VULB9160 VERTICAL
EUT : ACT4533C
Model Name : #1
Temp/Humi : 23°C / 54 %
Power Rating: DC 12V
Mode : 9 V / 1.5A
Memo : SNUBBER=1nF+5.1ohm

		ReadAntenna	Cable	Preamp		Limit	Over	
Freq	Level	Factor	Loss	Factor	Level	Line	Limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1 pp	57.16	16.15	12.49	1.02	0.00	29.66	40.00	-10.34 Peak

6.4. Input 24V Output 9V/1.5A



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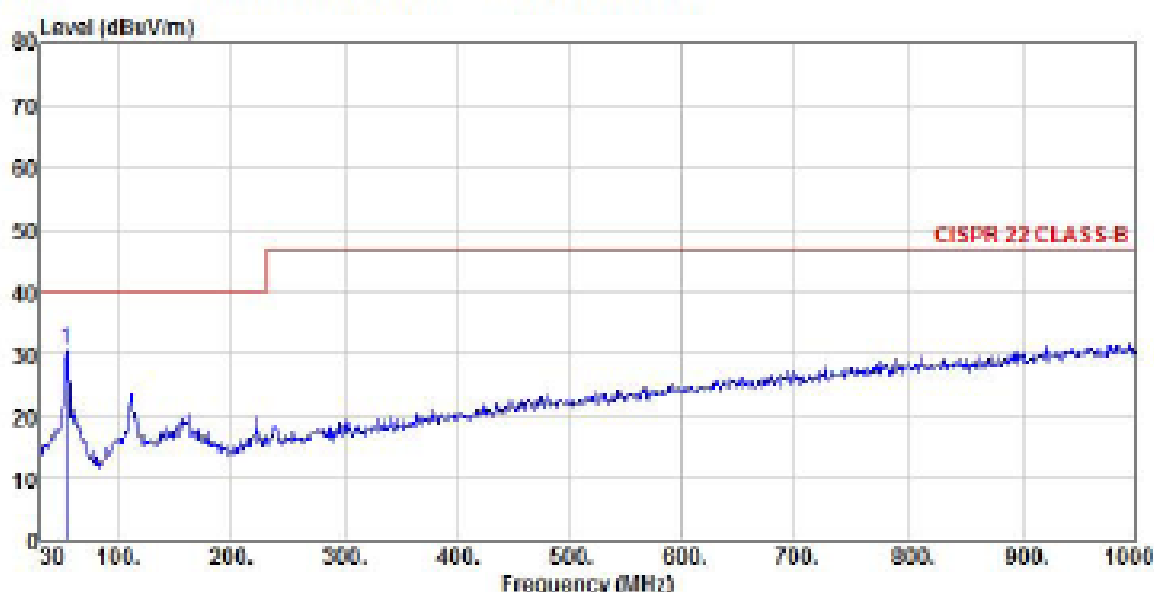
Site : chamber
Condition : CISPR 22 CLASS-B 3m VULB9160 HORIZONTAL
EUT : ACT4533C
Model Name : #1
Temp/Humi : 23°C / 54 %
Power Rating: DC 24V
Mode : 9 V /1.5 A
Memo :

		ReadAntenna	Cable Preamp		Limit	Over	
Freq	Level	Factor	Loss Factor	Level	Line	Limit	Remark
MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB
1 pp	53.28	18.42	12.48	0.98	0.00	31.88	40.00 -8.12 Peak



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Data: 14 File: D:\customer\2014\技格\20141009.E106 (16)



Site : chamber
Condition : CISPR 22 CLASS-B 3m VULB9160 VERTICAL
EUT : ACT4533C
Model Name : #1
Temp/Humi : 23℃ / 54 %
Power Rating: DC 24V
Mode : 5 V /1.5 A
Memo :

	Freq	ReadAntenna		Cable Preamp		Limit		Over	Remark
		Level	Factor	Loss	Factor	Level	Line		
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB	
1 pp	53.28	17.11	12.48	0.98	0.00	30.57	40.00	-9.43	Peak