

# 5V/9V/12V Output USB Auto Detect+USB-PD Type-C Application Report

## ACT4527

## FEATURES

- Wide input voltage range from 6V to 32V
- Transparent input voltage surge up to 40V
- USB auto detect, support Apple, Samsung and BC 1.2
- Interface for USB-PD Type-C output voltage control 5V/9V/12V
- 2.4A output with Constant current regulation
- 125kHz switching frequency
- Standby input current <1mA
- Good EMC performance
- Under voltage protection at output short
- <6mA average output current at output short
- Output over voltage protection
- Output cord compensation
- Thermal shutdown protection

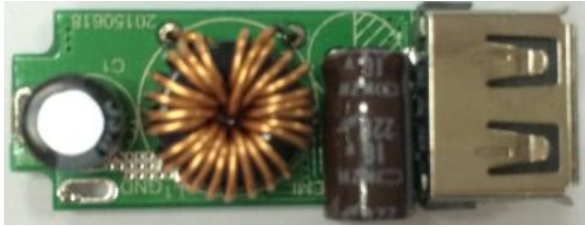
## SPECIFICATION

DESCRIPTION	CONDITION	MIN	TYP	MAX	UNITS
Output current limit range		2400	2650	2900	mA
Ripple Voltage	Vin=12V,output 5V/2.4A		46		mVpp
	Vin=12V,output 9V/2.4A		27		
	Vin=12V,output 11.6V/2.4A		19		
	Vin=24V,output 5V/2.4A		59		
	Vin=24V,output 9V/2.4A		72		
	Vin=24V,output 12V/2.4A		80		
Efficiency at full load	Vin=12V,output 5V/2.4A		89.6		%
	Vin=12V,output 9V/2.4A		94.9		
	Vin=12V,output 12V/2.4A		96.7		
	Vin=24V,output 5V/2.4A		87.7		
	Vin=24V,output 9V/2.4A		92.4		
	Vin=24V,output 12V/2.4A		93.9		
<b>ENVIRONMENTAL</b>					
ESD	Contact		8		kV
	Through air		15		kV

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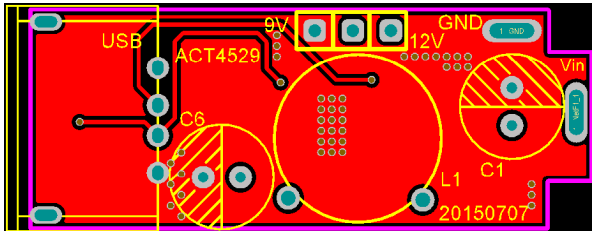
## 1. DEMO BOARD PHOTO



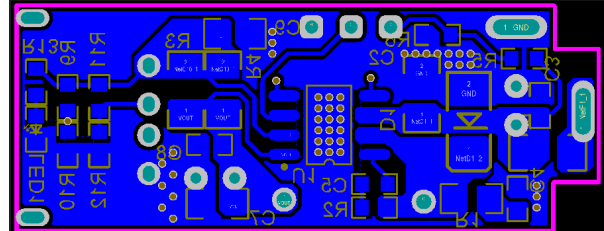
## 2. PCB LAYOUT

PCB SIZE: 39.4mm\*15.0mm

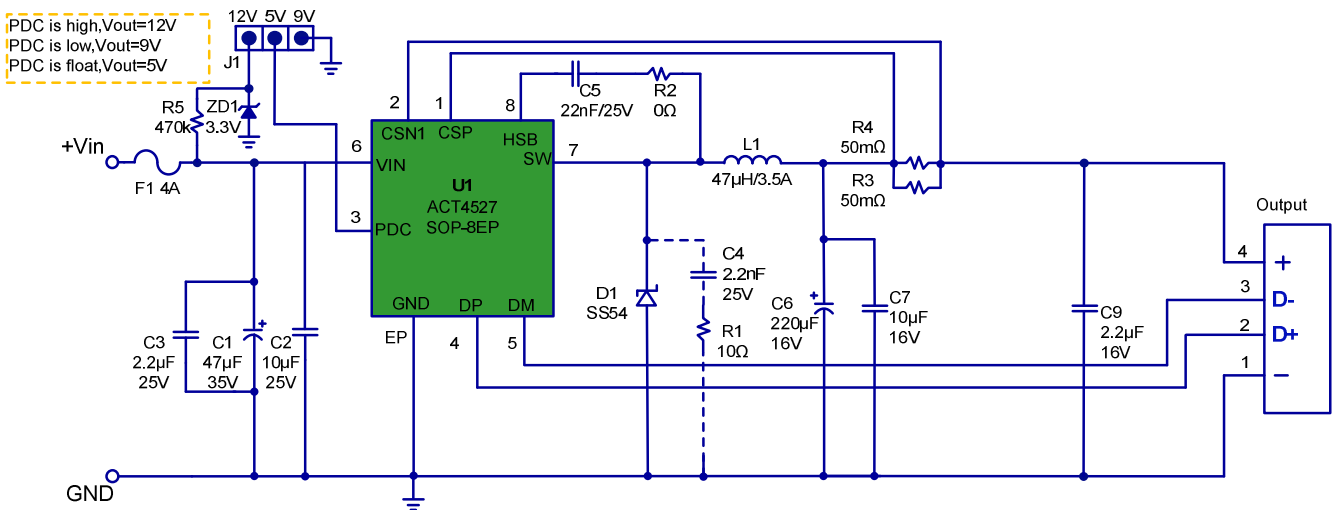
TOP LAYER



BOTTOM LAYER



## 3. SCHEMATIC



**4. BILL OF MATERIALS**

Item	Reference	Description	QTY	Manuf.
1	L1	Choke Coil, Dip, T9*5*4mm, phi=0.6mm, L=47uH	1	
2	D1	Schottky Diode, SK54BL, 40V/5A, SMB	1	Panjit
3	C1	Electrolytic capacitor, 47uF/35V, 6.3x8mm	1	Koshin
4	C2	Ceramic capacitor, 10uF/35V, X7R, 1206	1	Murata/TDK
5	C3	Ceramic capacitor, 2.2uF/35V, X7R, 0805	1	Murata/TDK
6	C4	Ceramic capacitor, 2.2nF/25V, X7R, 0603(optional)	1	Murata/TDK
7	C5	Ceramic capacitor, 22nF/25V, X7R, 0603	1	Murata/TDK
8	C6	Electrolytic capacitor, 220uF/16V, 7x11.5mm	1	Koshin
9	C7	Ceramic capacitor, 10uF/16V, X7R, 0805	1	Murata/TDK
10	C9	Ceramic capacitor, 2.2uF/16V, X7R, 0603	1	Murata/TDK
11	F1	Fuse, 3A, 1206 ( Replaced by 0Ω 0805 chip resistor )	1	Murata/TDK
12	R1	Chip Resistor, 5.1Ω, 1/8W, 5%, 0805(optional)	1	Murata/TDK
13	R2	Chip Resistor, 0Ω, 1/10W, 5%, 0603	1	Murata/TDK
14	R3/R4	Chip Resistor, 50mΩ, 1/4W, 1%, 1206	2	Murata/TDK
15	R5	Chip Resistor, 470K, 1/10W, 5%, 0603	1	Murata/TDK
16	ZD1	Zener diode, MMSZ5226BS, 3.3V, SOD-323	1	Panjit
17	U1	IC, ACT4527, SOP-8-EP	1	ACT
18	USB	USB Rev: A	1	

## 5. FUNCTIONAL TEST

### 5.1. Output Regulation (on PCB board)

Vout=5V (With cord compensation)

VIN	Minimum Output Voltage(V)	Maximum Output Voltage(V)	Load Regulation	Iload
10V	5.09	5.22	2.5%	0A-2.4A
12V	5.09	5.22	2.5%	
16V	5.09	5.22	2.5%	
24V	5.09	5.022	2.5%	

Vout=9V(With cord compensation)

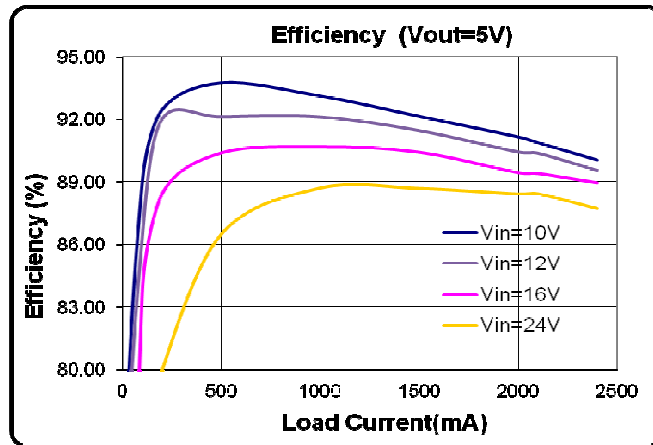
VIN	Minimum Output Voltage(V)	Maximum Output Voltage(V)	Load Regulation	Iload
10V	9.21	9.34	1.4%	0A-2.4A
12V	9.21	9.21	1.4%	
16V	9.21	9.34	1.4%	
24V	9.21	9.34	1.4%	

Vout=12V(With cord compensation)

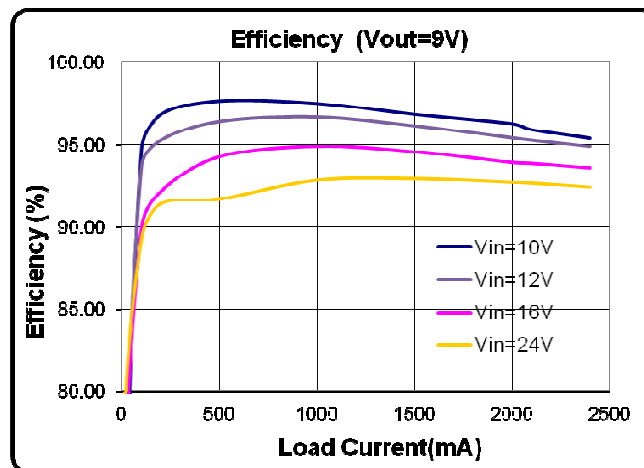
VIN	Minimum Output Voltage(V)	Maximum Output Voltage(V)	Load Regulation	Iload
10V	9.61	10.05	4.5%	0A-2.4A
12V	11.56	11.91	3.0%	
16V	12.19	12.32	1.1%	
24V	12.19	12.32	1.1%	

5.2. Efficiency (Ta=25°C)

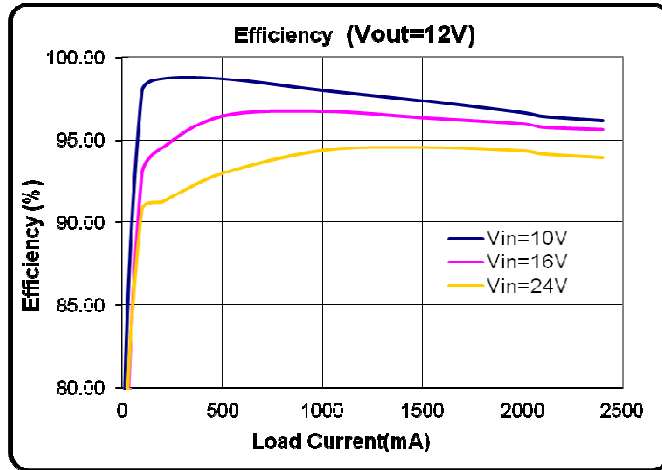
VIN	Vout=5V Efficiency (%)				
	Io=100mA	Io=1000mA	Io=1500mA	Io=2000mA	Io=2400mA
10V	88.94	93.12	92.14	91.15	90.04
12V	86.30	92.11	91.46	90.43	89.55
16V	83.16	90.69	90.43	89.44	88.96
24V	75.49	88.72	88.70	88.44	87.73



VIN	Vout=9V Efficiency (%)				
	Io=100mA	Io=1000mA	Io=1500mA	Io=2000mA	Io=2400mA
10V	94.72	97.48	96.83	96.25	95.39
12V	93.70	96.68	96.15	95.43	94.91
16V	89.93	94.88	94.55	93.89	93.56
24V	89.23	92.80	92.89	92.68	92.39

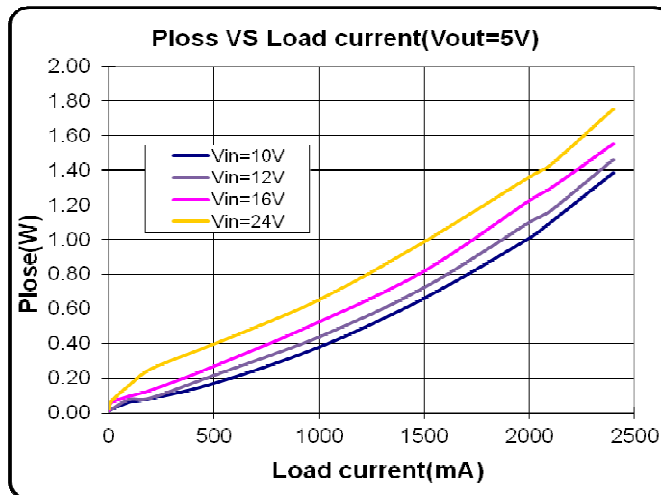


VIN	Vout=12V Efficiency (%)				
	Io=100mA	Io=1000mA	Io=1500mA	Io=2000mA	Io=2400mA
12V	97.94	98.31	97.73	97.11	96.66
16V	92.91	96.72	96.34	95.97	95.60
24V	90.74	94.33	94.52	94.30	93.90



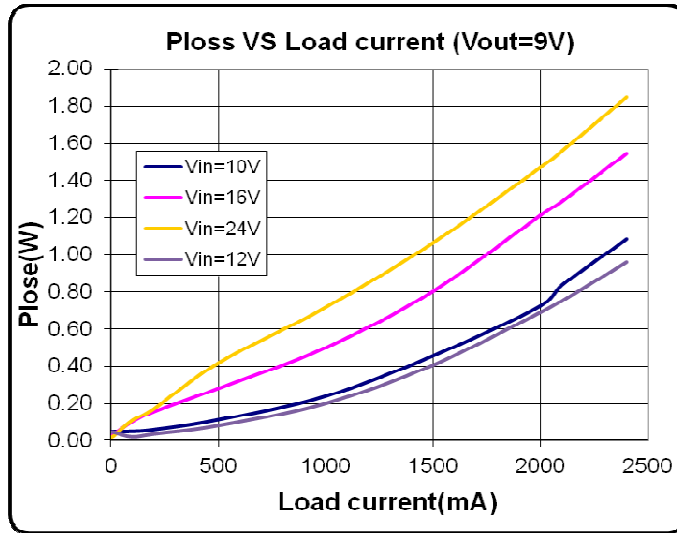
5.3. Power Loss

Vin	Vout=5V Power loss (W)					
	Io=0mA	Io=100mA	Io=1000mA	Io=1500mA	Io=2000mA	Io=2400mA
Vin=10V	0.01	0.06	0.38	0.66	1.01	1.39
Vin=12V	0.01	0.08	0.44	0.72	1.1	1.46
Vin=16V	0.02	0.10	0.53	0.82	1.23	1.56
Vin=24V	0.02	0.17	0.65	0.99	1.36	1.75

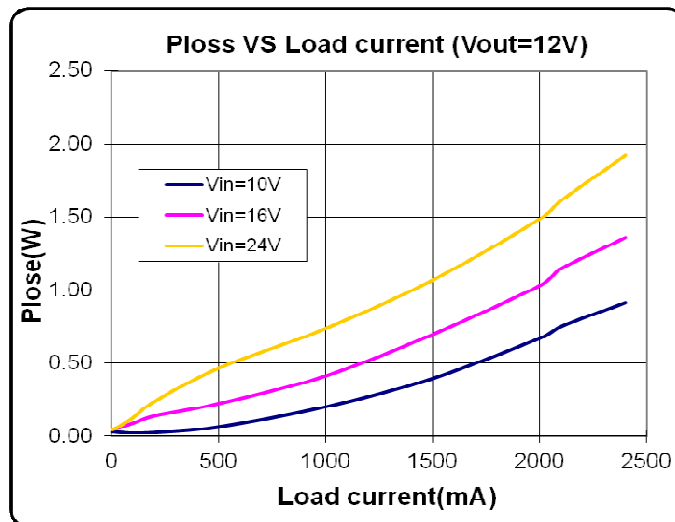


Vin	Vout=9V Power loss (W)
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	Io=0mA	Io=100mA	Io=1000mA	Io=1500mA	Io=2000mA	Io=2400mA
Vin=10V	0.05	0.05	0.24	0.46	0.73	1.08
Vin=12V	0.02	0.06	0.32	0.56	0.89	1.2
Vin=16V	0.03	0.10	0.50	0.80	1.21	1.54
Vin=24V	0.02	0.11	0.72	1.07	1.47	1.85



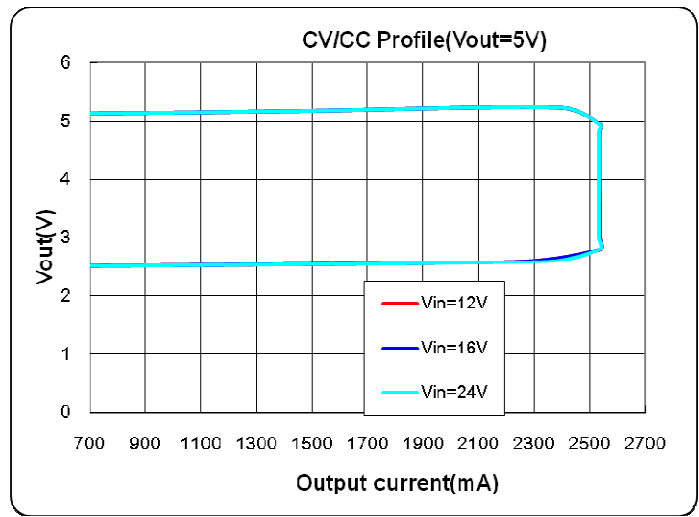
Vin	Vout=12V Power loss (W)					
	Io=0mA	Io=100mA	Io=1000mA	Io=1500mA	Io=2000mA	Io=2400mA
Vin=12V	0.04	0.03	0.20	0.41	0.69	0.96
Vin=16V	0.05	0.09	0.42	0.70	1.03	1.36
Vin=24V	0.05	0.12	0.74	1.07	1.49	1.92



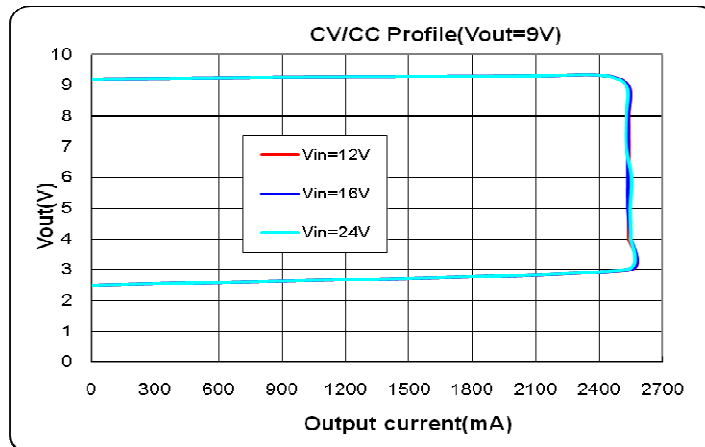


5.4. Constant Current and Constant Voltage (Ta=25°C)

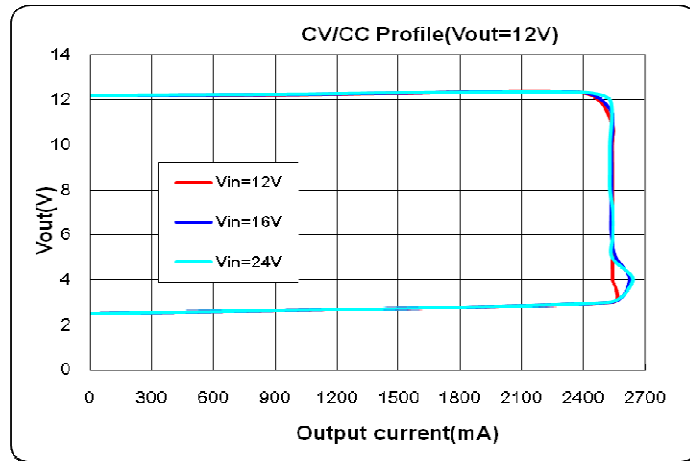
Vout=5V	Vin=12V		Vin=16V		Vin=24V	
	Vout (V)	Iout(mA)	Vout (V)	Iout (mA)	Vout (V)	Iout (mA)
<b>CC Load</b>	5.09	0	5.09	0	5.09	0
	5.12	500	5.12	100	5.12	100
	5.14	1000	5.14	1000	5.14	1000
	5.17	2000	5.17	2000	5.17	2000
	5.22	2400	5.22	2400	5.22	2400
<b>CV Load</b>	4.95	2537	4.85	2536	4.85	2533
	4.8	2537	4.75	2536	4.75	2533
	4.5	2537	4.5	2536	4.5	2533
	4	2537	4	2536	4	2533
	3.5	2537	3.5	2537	3.5	2533
	3	2538	3	2537	3	2533
	2.8	2538	2.5	2537	2.5	2533
	2.6	2212	2.4	2240	2.4	2340
	2.5	0	2.5	0	2.5	0



Vout=9V	Vin=12V		Vin=16V		Vin=24V	
	Vout (V)	Iout(mA)	Vout (V)	Iout (mA)	Vout (V)	Iout (mA)
<b>CC Load</b>	9.21	0	9.21	0	9.21	0
	9.24	500	9.24	500	9.24	500
	9.27	1000	9.27	1000	9.27	1000
	9.3	2000	9.3	2000	9.3	2000
	9.34	2400	9.34	2400	9.34	2400
<b>CV Load</b>	9	2542	9	2535	9	2529
	8	2543	8	2535	8	2529
	7	2543	7	2535	7	2529
	6	2544	6	2535	6	2555
	5	2544	5	2535	5	2548
	4	2544	4	2547	4	2610
	3	2543	3	2535	3	2525
	2.5	0	2.5	0	2.5	0



Vout=12V	Vin=12V		Vin=16V		Vin=24V	
	Vout (V)	Iout(mA)	Vout (V)	Iout (mA)	Vout (V)	Iout (mA)
<b>CC Load</b>	12.19	0	12.19	0	12.19	0
	12.22	500	12.22	500	12.22	500
	12.24	1000	12.24	1000	12.24	1000
	12.3	1500	12.3	1500	12.3	1500
	12.32	2400	12.32	2400	12.32	2400
<b>CV Load</b>	11	2538	11.5	2533	12	2530
	10	2538	10	2533	10	2530
	9	2539	9	2534	9	2530
	8	2539	8	2534	8	2530
	7	2540	7	2534	7	2545
	6	2541	6	2535	6	2545
	5	2540	5	2557	5	2540
	4	2541	4	2625	4	2642
	3	2540	3	2530	3	2521
	2.5	0	2.5	0	2.5	0



## 5.5. Standby Input Current

Vout=5V

Test Conditions	Input Current (mA)	Power Loss at No Load (mW)
Vin=10V	0.75	7.5
Vin=12V	0.7	8.4
Vin=16V	0.84	13.4
Vin=24V	0.69	16.6

Vout=9V

Test Conditions	Input Current (mA)	Power Loss at No Load (mW)
Vin=10V	3.94	39.4
Vin=12V	1.69	20.3
Vin=16V	1.35	21.6
Vin=24V	1.06	25.4

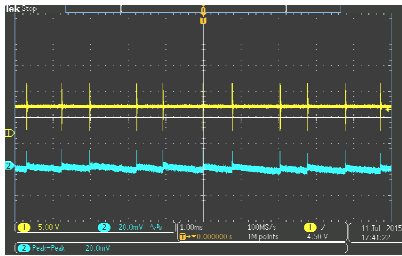
Vout=12V

Test Conditions	Input Current (mA)	Power Loss at No Load (mW)
Vin=12V	2.13	25.6
Vin=16V	2.13	34.1
Vin=24V	1.56	37.4

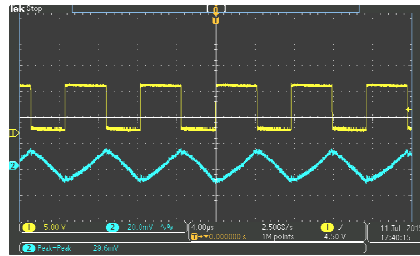
## 5.6. Ripple and Noise

CH1:Vsw, CH2:Vout2

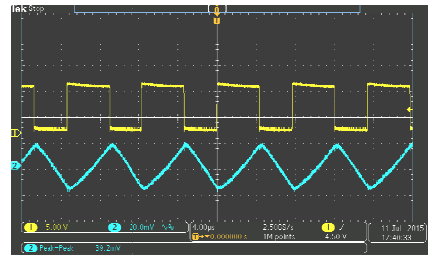
Vin=10V Vout=5V Iout=0A



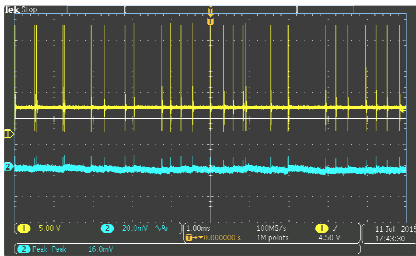
Vin=10V Vout=5V Iout=1A



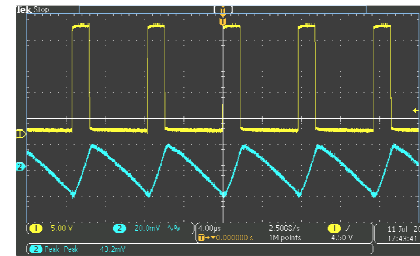
Vin=10V Vout=5V Iout=2.4A



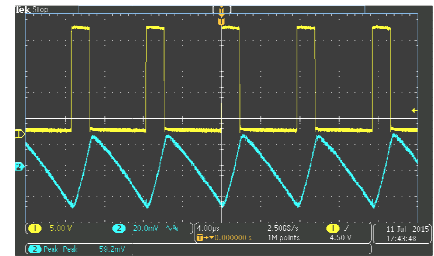
Vin=24V Vout=5V Iout=0A



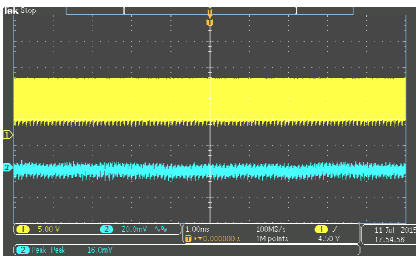
Vin=24V Vout=5V Iout=1A



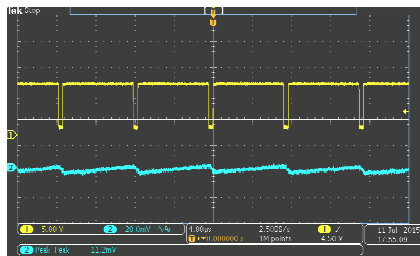
Vin=24V Vout=5V Iout=2.4A



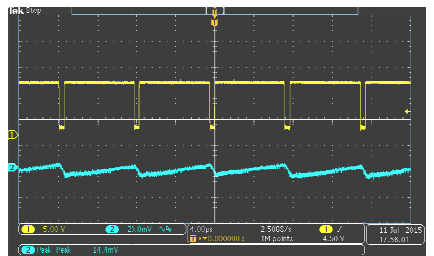
Vin=10V Vout=9V Iout=0A



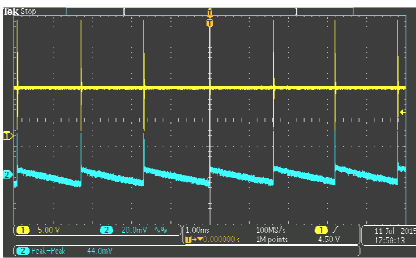
Vin=10V Vout=9V Iout=1A



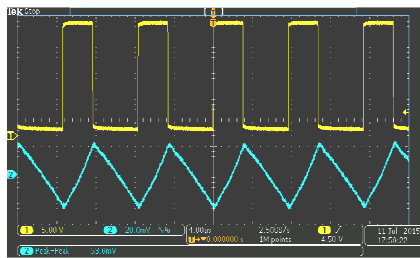
Vin=10V Vout=9V Iout=2.4A



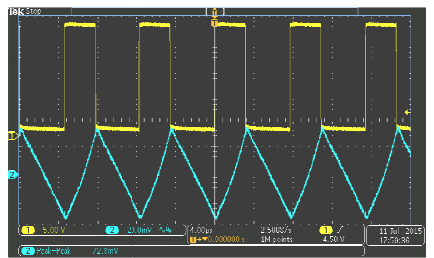
Vin=24V Vout=9V Iout=0A



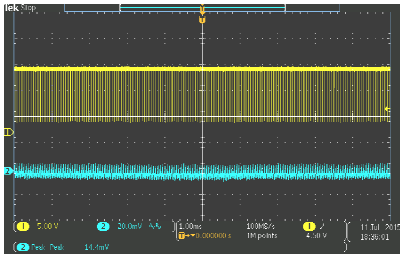
Vin=24V Vout=9V Iout=1A



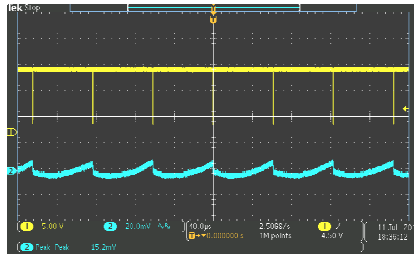
Vin=24V Vout=9V Iout=2.4A



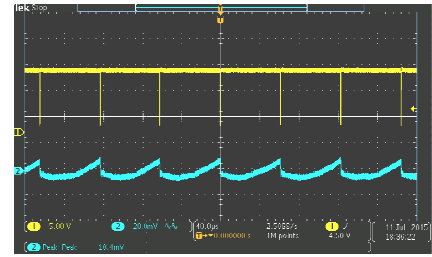
Vin=12V Vout=12V Iout=0A



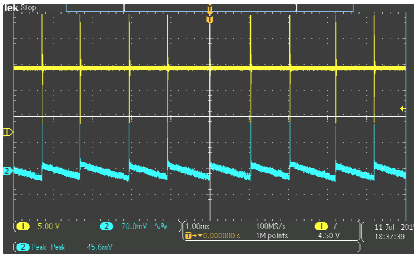
Vin=12V Vout=12V Iout=1A



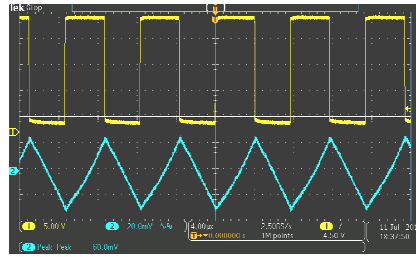
Vin=12V Vout=12V Iout=2.4A



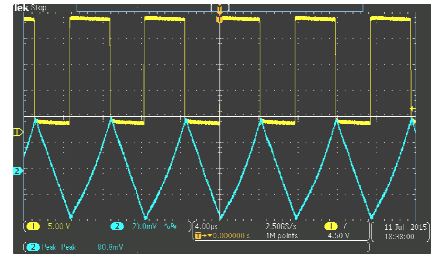
Vin=24V Vout=12V Iout=0A



Vin=24V Vout=12V Iout=1A



Vin=24V Vout=12V Iout=2.4A



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

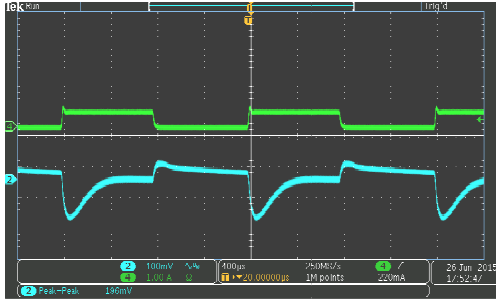
Test Conditions	Vout=5V			Vout=9V			Vout=12V		
	Iout=0A	Iout=1A	Iout=2.4A	Iout=0A	Iout=1A	Iout=2.4A	Iout=0A	Iout=1A	Iout=2.4A
Vin=10V	20	30	39	16	11	14	13	14	17
Vin=12V	25	34	46	15	21	27	11	15	18
Vin=16V	34	38	52	22	38	51	21	30	38
Vin=24V	36	43	59	44	54	73	46	60	80

## 5.7. Load Dynamic Response

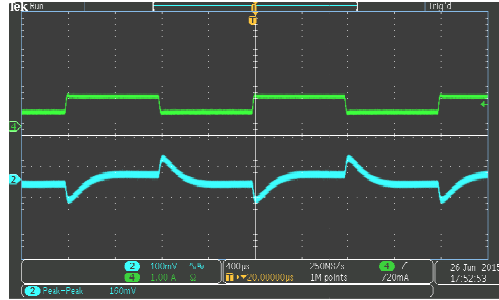
CH2:Vout ripple, CH4:Iout

Vout=5V

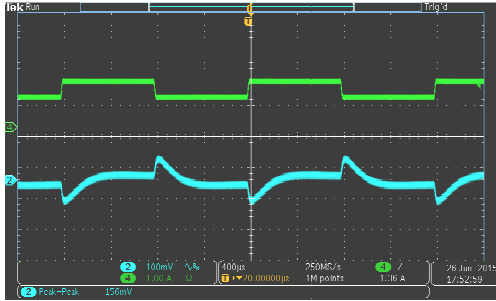
Vin=24V, load step 0A-0.5A-0A



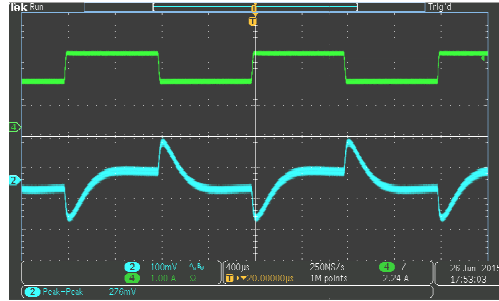
Vin=24V, load step 0.5A-1A-0.5A



Vin=24V, load step 1A-1.5A-1A

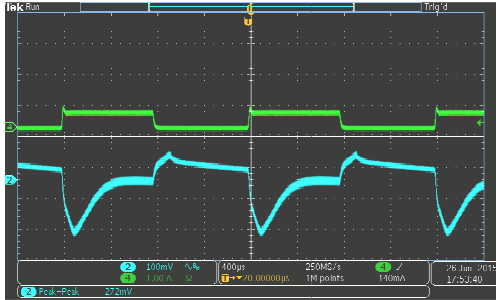


Vin=24V, load step 1.5A-2.4A-1.5A

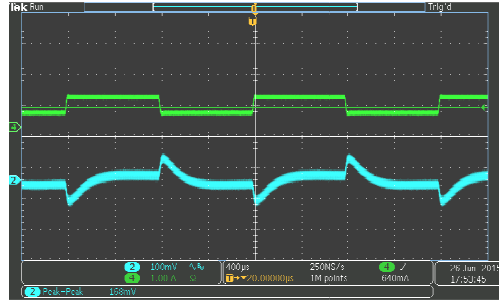


Vout=9V

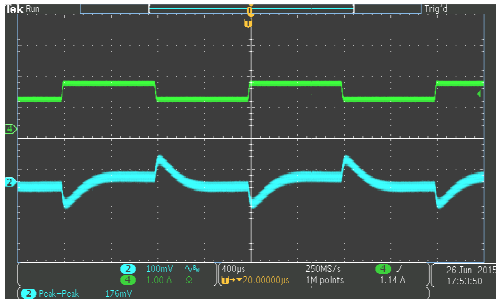
Vin=24V, load step 0A-0.5A-0A



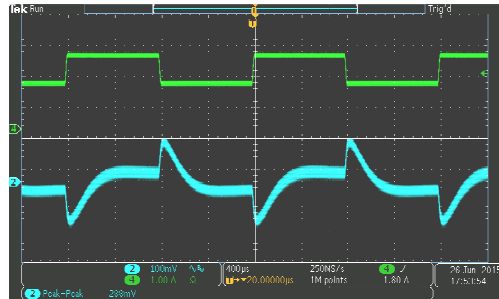
Vin=24V, load step 0.5A-1A-0.5A



Vin=24V, load step 1A-1.5A-1A

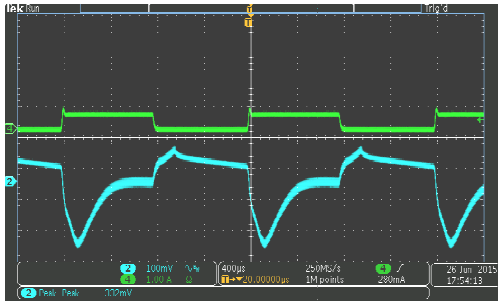


Vin=24V, load step 1.5A-2.4A-1.5A

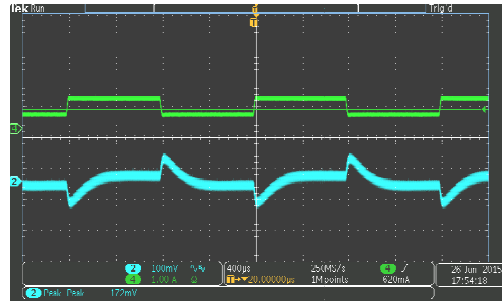


Vout=12V

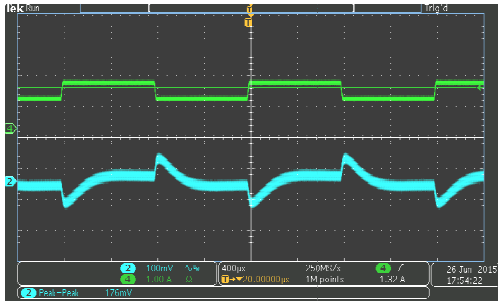
Vin=24V, load step 0A-0.5A -0A



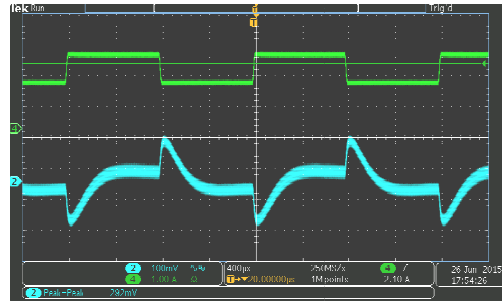
Vin=24V, load step 0.5A-1A-0.5A



Vin=24V, load step 1A-1.5A-1A



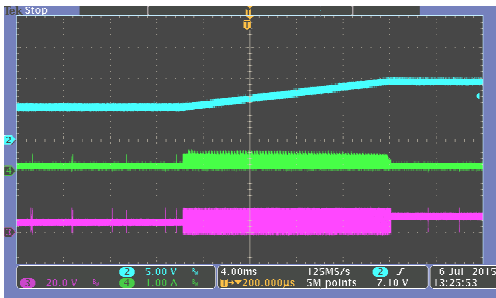
Vin=24V, load step 1.5A-2.4A-1.5A



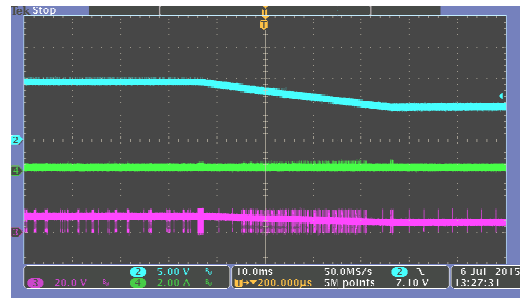
## 5.8. Output Voltage Transient

CH2:Vout,CH3:Vsw,CH4:IL

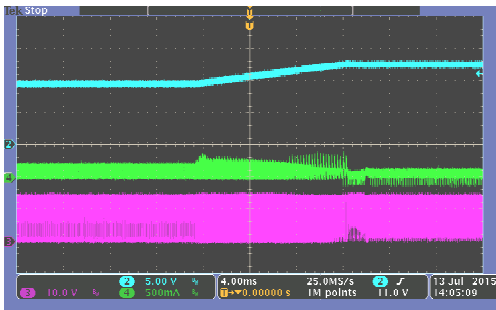
Vin=12V,Iout=0A,Vout 5V—>9V



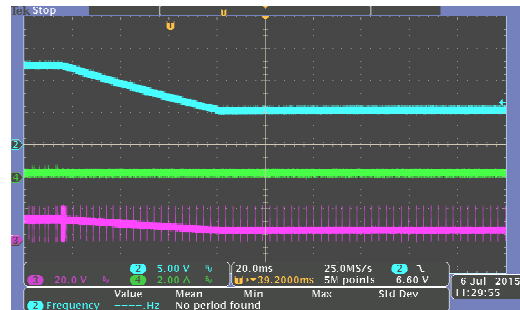
Vin=12V,Iout=0A,Vout 9V—>5V



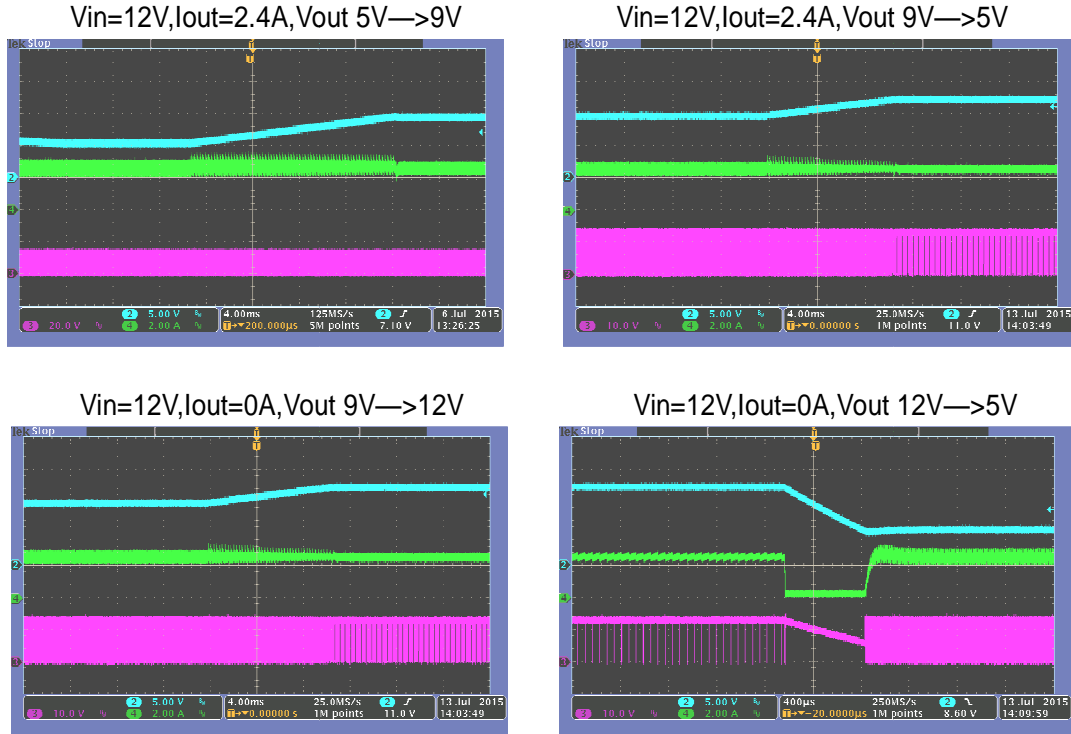
Vin=12V,Iout=0A,Vout 9V—>12V



Vin=12V,Iout=0A,Vout 12V—>5V

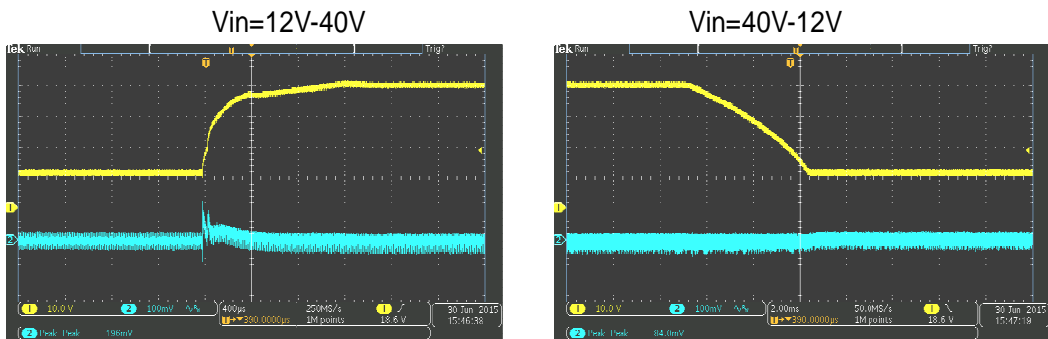






## 5.9. Line Dynamic Response (Vin change from 12V to 40V, 0.1V/us)

CH1: Vin, CH2: Vout ripple, output 5V/2.4A



5.10.Key Components Temperature Test ( burning for 2 hours)

Vout=5V

Vin/lout	Ambient (°C)	PCB (°C)	IC (°C)	Schottky (°C)	Inductor (°C)
12V/2.4A	33	92	95	97	95
16V/2.4A	33	97	99	104	101
24V/2.4A	33	101	104	109	106

Vout=9V

Vin/lout	Ambient (°C)	PCB (°C)	IC (°C)	Schottky (°C)	Inductor (°C)
12V/2A	33	74	75	73	72
16V/2A	33	84	85	88	83
24V/2A	33	92	93	96	91

Vout=12V

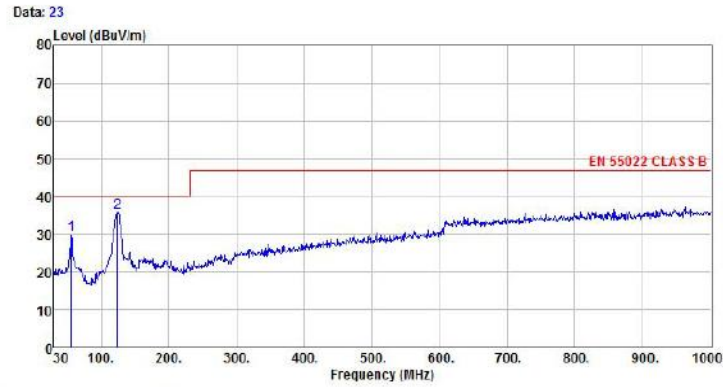
Vin/lout	Ambient (°C)	PCB (°C)	IC (°C)	Schottky (°C)	Inductor (°C)
12V/2A	37	72	75	66	72
16V/2A	38	81	85	78	83
24V/2A	39	92	96	90	95



## 6. EMI TEST

### 6.1. Output 5V

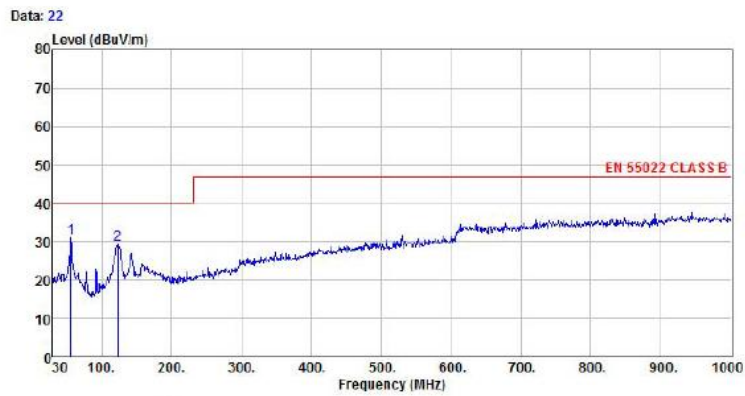
Vin=12V Output 5V2.4A Horizontal



Site : chamber  
Condition : EN 55022 CLASS B 3m VULB9160 HORIZONTAL  
EUT :  
Model Name : 5  
Temp/Humi : 25°C / 53 %  
Power Rating: AC 230V/50Hz  
Mode :  
Memo :

	Freq MHz	ReadAntenna		Cable Preamp		Limit		Over Limit	Remark	Factor
		Level dBuV	Factor dB/m	Loss dB	Factor dB	Level dBuV/m	Line dBuV/m			
1	55.22	16.32	12.40	1.00	0.00	29.72	40.00	-10.28	Peak	13.40
2 pp	124.09	21.86	12.27	1.51	0.00	35.64	40.00	-4.36	Peak	13.78

Vin=12V Output 5V2.4A Vertical

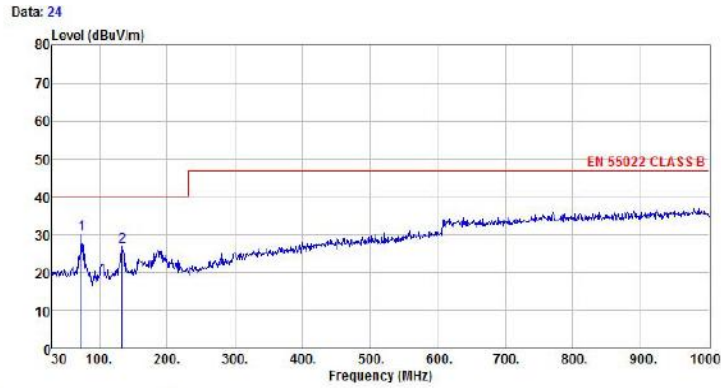


Site : chamber  
Condition : EN 55022 CLASS B 3m VULB9160 VERTICAL  
EUT :  
Model Name : 5  
Temp/Humi : 25°C / 53 %  
Power Rating: AC 230V/50Hz  
Mode :  
Memo :

	Freq MHz	ReadAntenna		Cable Preamp		Limit		Over Limit	Remark	Factor
		Level dBuV	Factor dB/m	Loss dB	Factor dB	Level dBuV/m	Line dBuV/m			
1 pp	55.22	17.71	12.40	1.00	0.00	31.11	40.00	-8.89	Peak	13.40
2	123.12	15.33	12.27	1.50	0.00	29.10	40.00	-10.90	Peak	13.77

## 6.2. Output=9V

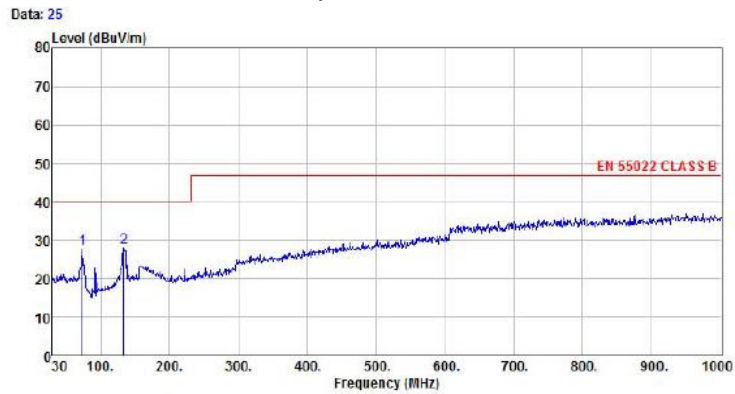
Vin=12V Output 9V2.4A Horizontal



Site : chamber  
 Condition : EN 55022 CLASS B 3m VULB9160 HORIZONTAL  
 EUT :  
 Model Name : 7  
 Temp/Humi : 25°C / 53 %  
 Power Rating: AC 230V/50Hz  
 Mode :  
 Memo :

	Freq	ReadAntenna Level	Antenna Factor	Cable Loss	Preamp	Level	Limit	Over Limit	Remark	Factor
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB		dB/m
1	pp	73.65	19.13	9.87	1.12	0.00	30.12	40.00	-9.88 Peak	10.99
2		133.79	12.29	12.92	1.61	0.00	26.82	40.00	-13.18 Peak	14.53

Vin=12V Output 9V2.4A Vertical



Site : chamber  
 Condition : EN 55022 CLASS B 3m VULB9160 VERTICAL  
 EUT :  
 Model Name : 7  
 Temp/Humi : 25°C / 53 %  
 Power Rating: AC 230V/50Hz  
 Mode :  
 Memo :

	Freq	ReadAntenna Level	Antenna Factor	Cable Loss	Preamp	Level	Limit	Over Limit	Remark	Factor
	MHz	dBuV	dB/m	dB	dB	dBuV/m	dBuV/m	dB		dB/m
1		73.65	16.69	9.87	1.12	0.00	27.68	40.00	-12.32 Peak	10.99
2	pp	133.79	13.50	12.92	1.61	0.00	28.03	40.00	-11.97 Peak	14.53

Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

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«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели, кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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