

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

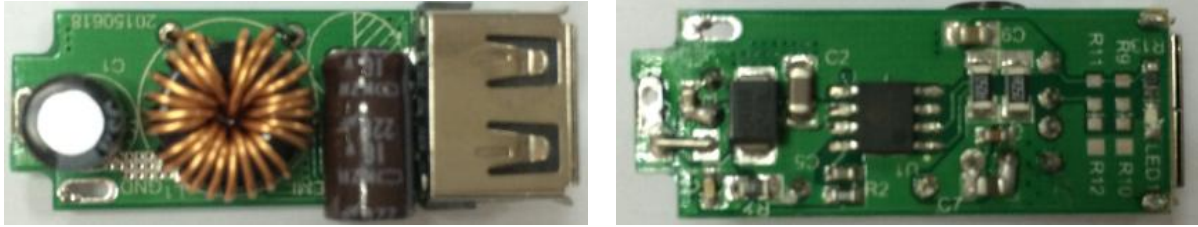
SPECIFICATION

| 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 | | |
| ENVIRONMENTAL | | | | | |
| ESD | Contact | | 8 | | kV |
| | Through air | | 15 | | kV |

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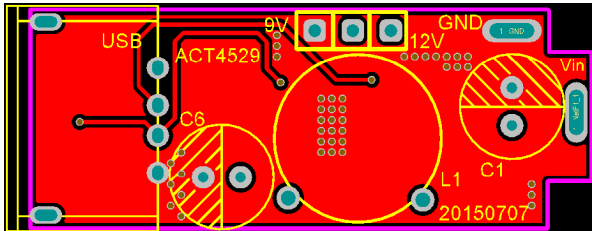
1. DEMO BOARD PHOTO



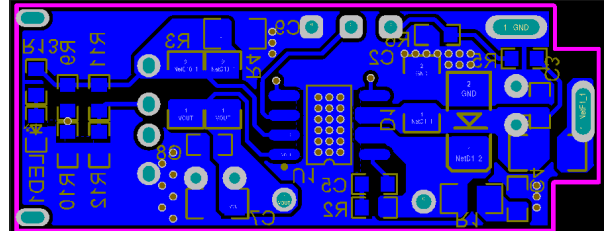
2. PCB LAYOUT

PCB SIZE: 39.4mm*15.0mm

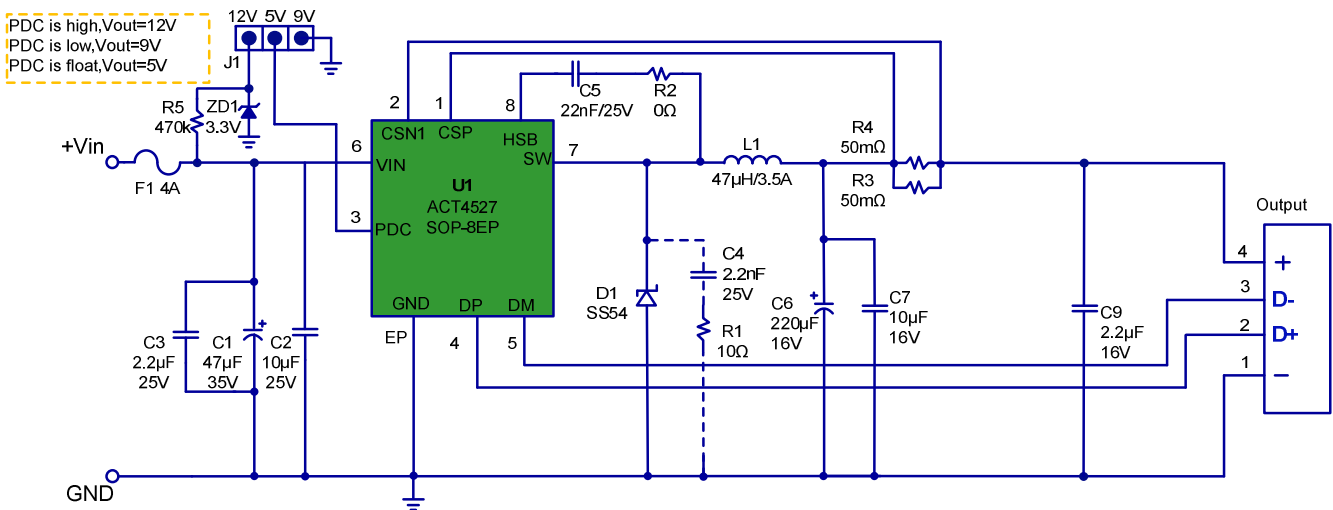
TOP LAYER



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)

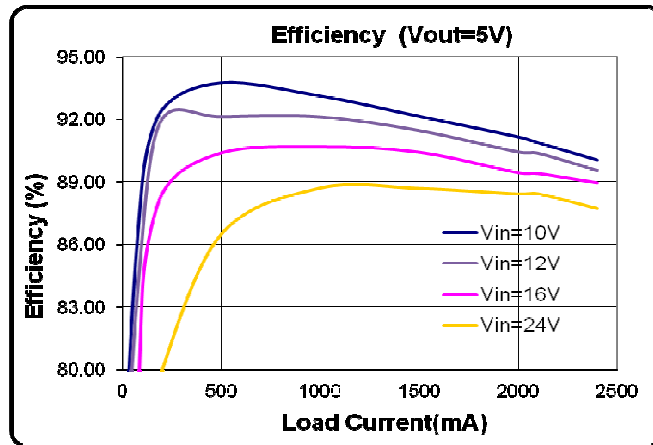
| VIN | Minimum Output Voltage(V) | Maximum Output Voltage(V) | Load Regulation | Iload |
|-----|---------------------------|---------------------------|-----------------|---------|
| 10V | 9.21 | 9.34 | 1.4% | 0A-2.4A |
| 12V | 9.21 | 9.21 | 1.4% | |
| 16V | 9.21 | 9.34 | 1.4% | |
| 24V | 9.21 | 9.34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

Vout=12V(With cord compensation)

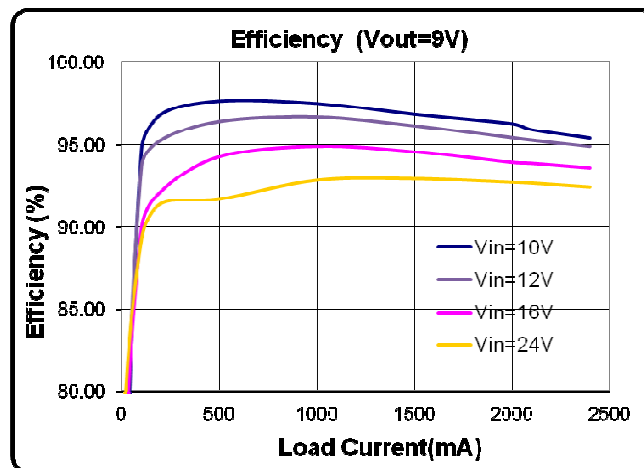
| VIN | Minimum Output Voltage(V) | Maximum Output Voltage(V) | Load Regulation | Iload |
|-----|---------------------------|---------------------------|-----------------|---------|
| 10V | 9.61 | 10.05 | 4.5% | 0A-2.4A |
| 12V | 11.56 | 11.91 | 3.0% | |
| 16V | 12.19 | 12.32 | 1.1% | |
| 24V | 12.19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

5.2. Efficiency (Ta=25°C)

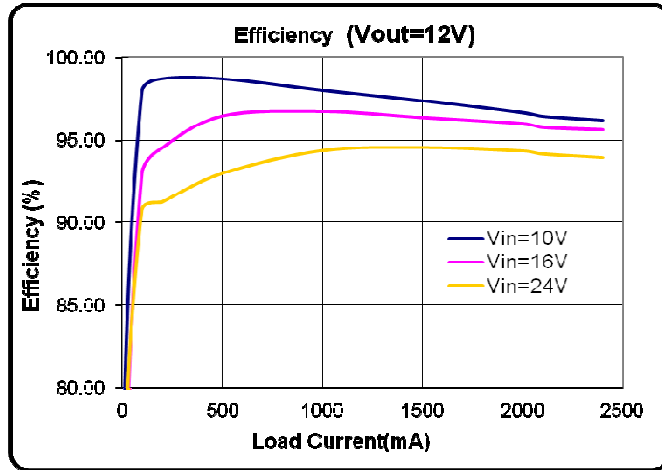
| VIN | Vout=5V Efficiency (%) | | | | |
|-----|------------------------|-----------|-----------|-----------|-----------|
| | Io=100mA | Io=1000mA | Io=1500mA | Io=2000mA | Io=2400mA |
| 10V | 88.94 | 93.12 | 92.14 | 91.15 | 90.04 |
| 12V | 86.30 | 92.11 | 91.46 | 90.43 | 89.55 |
| 16V | 83.16 | 90.69 | 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 |

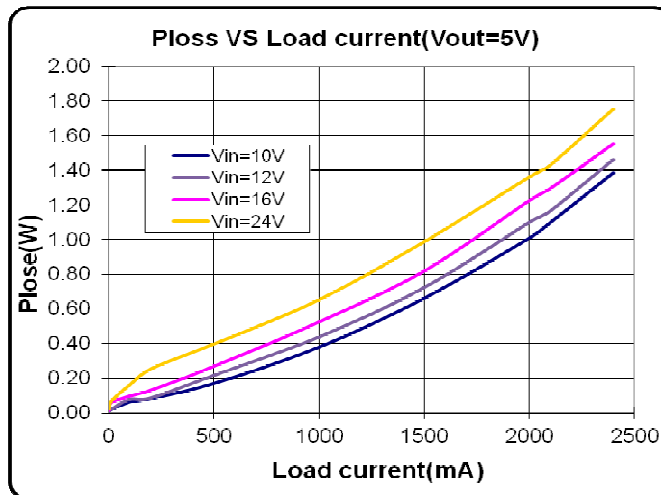


| VIN | Vout=12V Efficiency (%) | | | | |
|-----|-------------------------|-----------|-----------|-----------|-----------|
| | Io=100mA | Io=1000mA | Io=1500mA | Io=2000mA | Io=2400mA |
| 12V | 97.94 | 98.31 | 97.73 | 97.11 | 96.66 |
| 16V | 92.91 | 96.72 | 96.34 | 95.97 | 95.60 |
| 24V | 90.74 | 94.33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



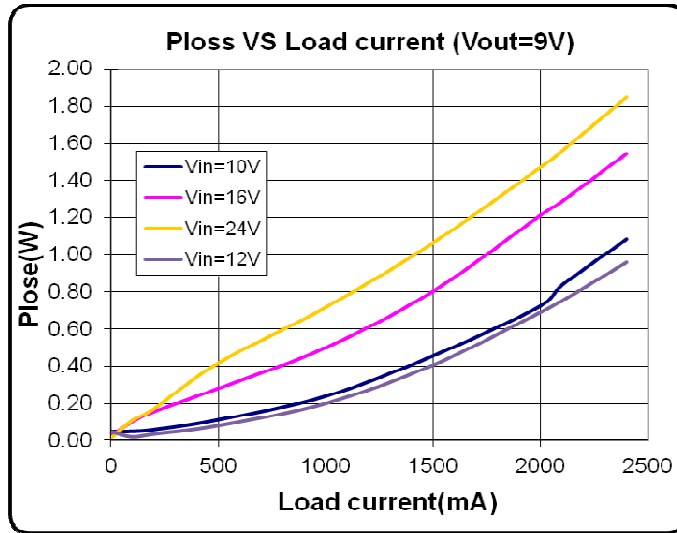
5.3. Power Loss

| 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 |

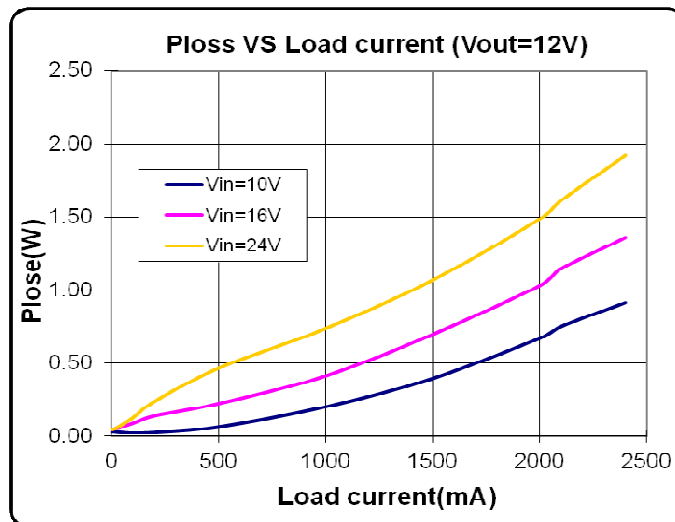


| Vin | Vout=9V Power loss (W) |
|-----|------------------------|
|-----|------------------------|

| | 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 |

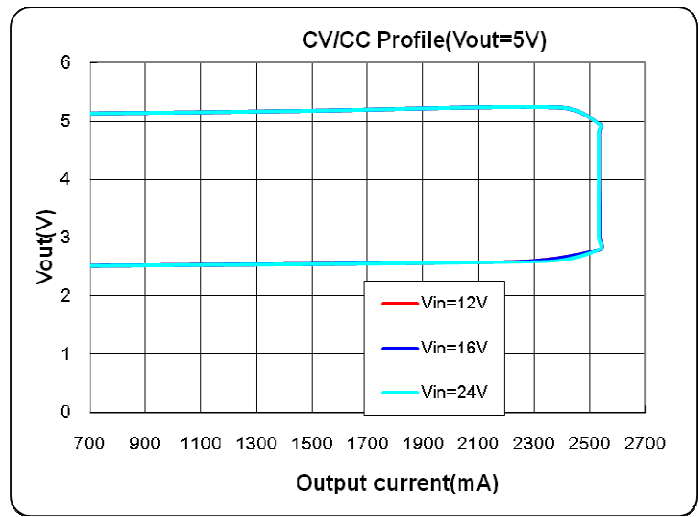


| Vin | Vout=12V Power loss (W) | | | | | |
|---------|-------------------------|----------|-----------|-----------|-----------|-----------|
| | Io=0mA | Io=100mA | Io=1000mA | Io=1500mA | Io=2000mA | Io=2400mA |
| Vin=12V | 0.04 | 0.03 | 0.20 | 0.41 | 0.69 | 0.96 |
| Vin=16V | 0.05 | 0.09 | 0.42 | 0.70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

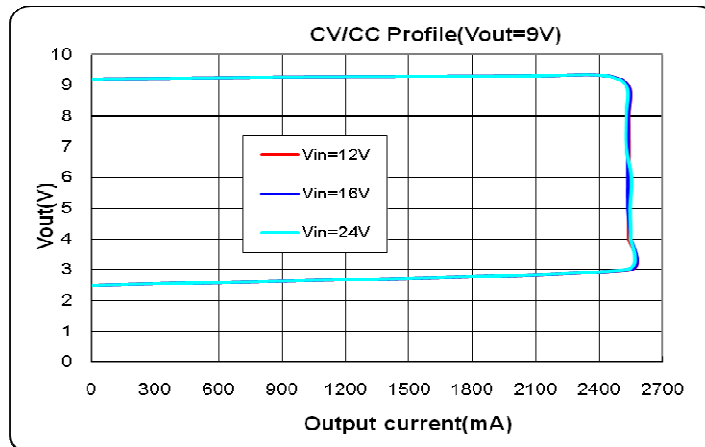


5.4. Constant Current and Constant Voltage (Ta=25°C)

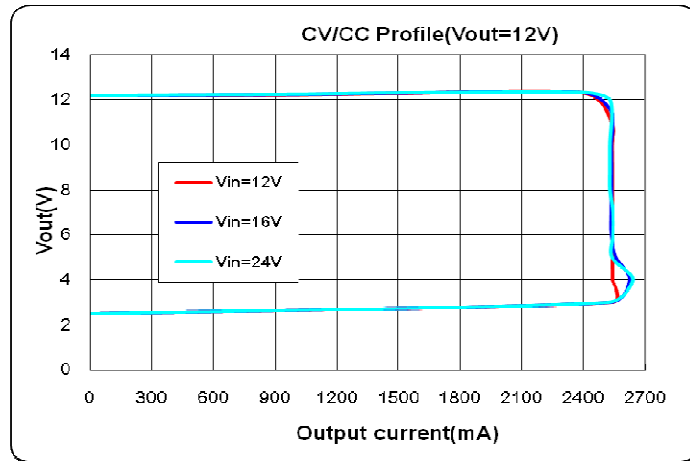
| Vout=5V | Vin=12V | | Vin=16V | | Vin=24V | |
|----------------|----------|----------|----------|-----------|----------|-----------|
| | Vout (V) | Iout(mA) | Vout (V) | Iout (mA) | Vout (V) | Iout (mA) |
| CC Load | 5.09 | 0 | 5.09 | 0 | 5.09 | 0 |
| | 5.12 | 500 | 5.12 | 100 | 5.12 | 100 |
| | 5.14 | 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 |
| CV Load | 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) |
| CC Load | 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 |
| CV Load | 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) |
| CC Load | 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 |
| CV Load | 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 |

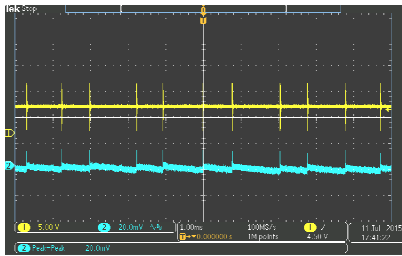
Vout=12V

| 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 |

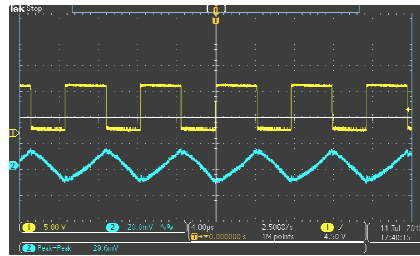
5.6. Ripple and Noise

CH1:Vsw, CH2:Vout2

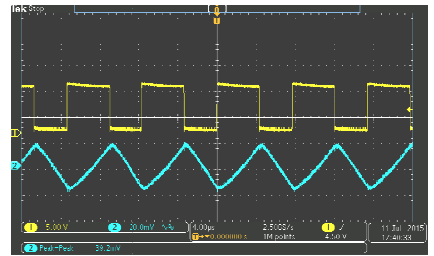
Vin=10V Vout=5V Iout=0A



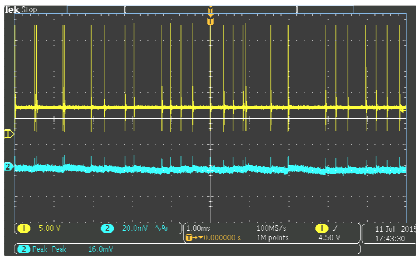
Vin=10V Vout=5V Iout=1A



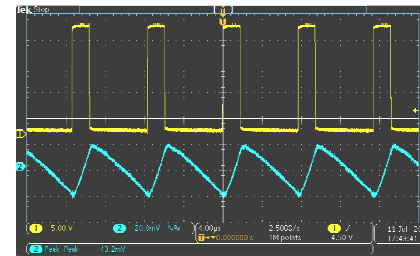
Vin=10V Vout=5V Iout=2.4A



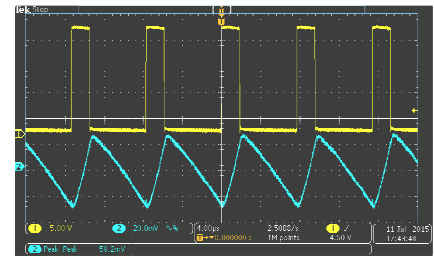
Vin=24V Vout=5V Iout=0A



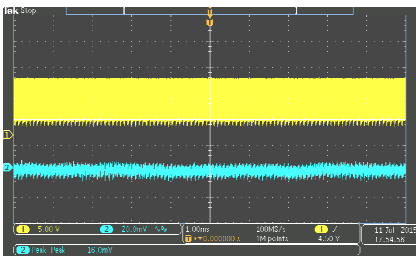
Vin=24V Vout=5V Iout=1A



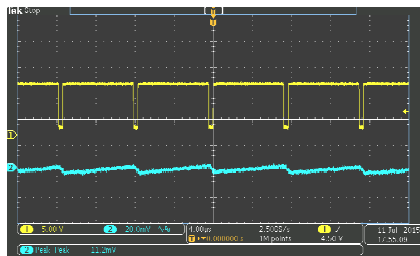
Vin=24V Vout=5V Iout=2.4A



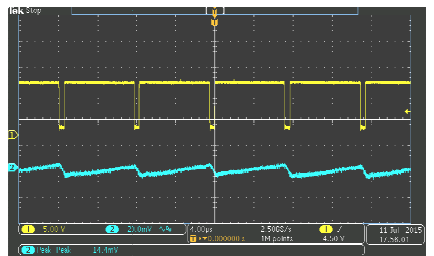
Vin=10V Vout=9V Iout=0A



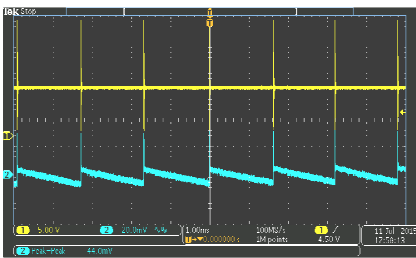
Vin=10V Vout=9V Iout=1A



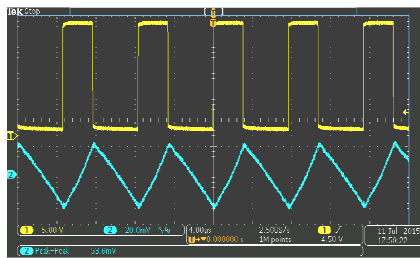
Vin=10V Vout=9V Iout=2.4A



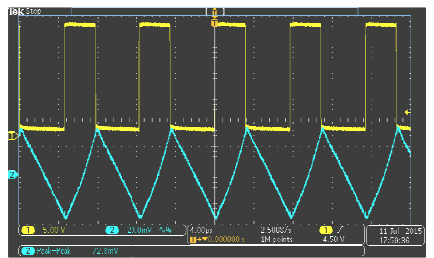
Vin=24V Vout=9V Iout=0A



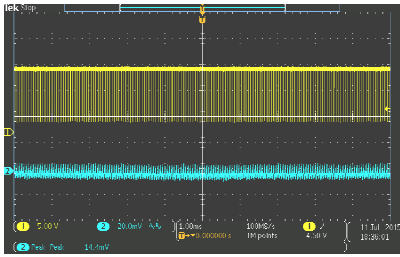
Vin=24V Vout=9V Iout=1A



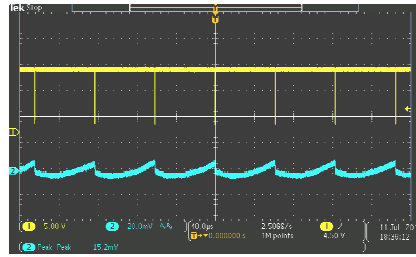
Vin=24V Vout=9V Iout=2.4A



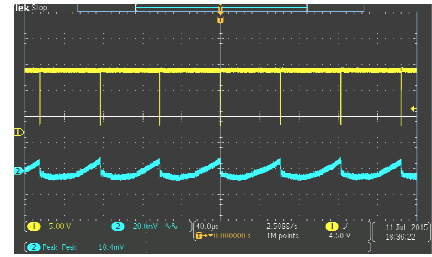
Vin=12V Vout=12V Iout=0A



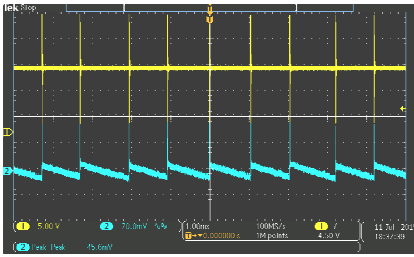
Vin=12V Vout=12V Iout=1A



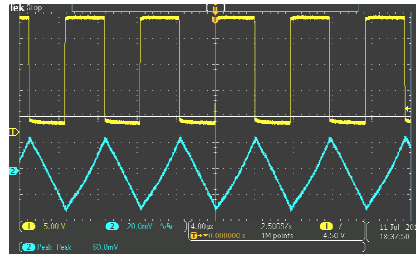
Vin=12V Vout=12V Iout=2.4A



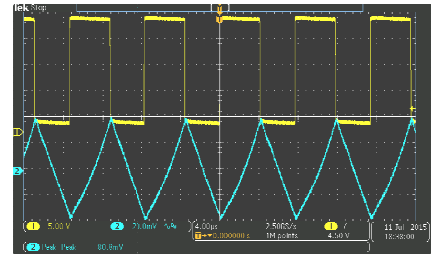
Vin=24V Vout=12V Iout=0A



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



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



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

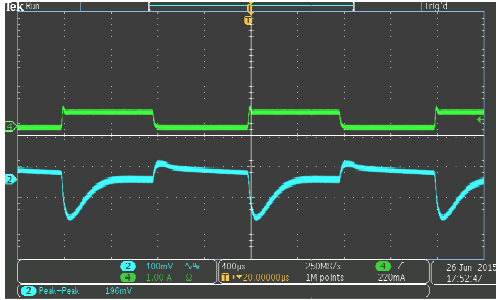
| Test Conditions | Vout=5V | | | Vout=9V | | | Vout=12V | | |
|-----------------|---------|---------|-----------|---------|---------|-----------|----------|---------|-----------|
| | Iout=0A | Iout=1A | Iout=2.4A | Iout=0A | Iout=1A | Iout=2.4A | Iout=0A | Iout=1A | Iout=2.4A |
| Vin=10V | 20 | 30 | 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

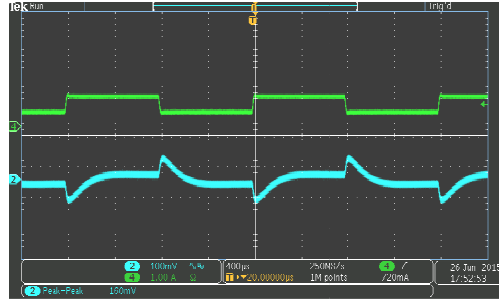
CH2:Vout ripple, CH4:Iout

Vout=5V

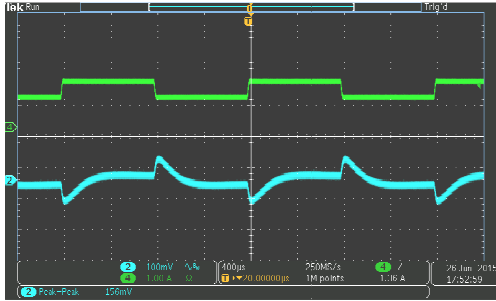
Vin=24V, load step 0A-0.5A-0A



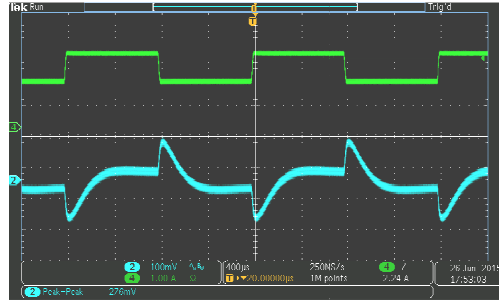
Vin=24V, load step 0.5A-1A-0.5A



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

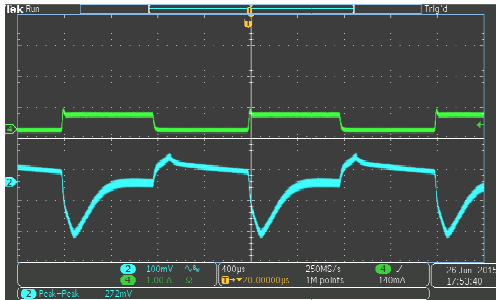


Vin=24V, load step 1.5A-2.4A-1.5A

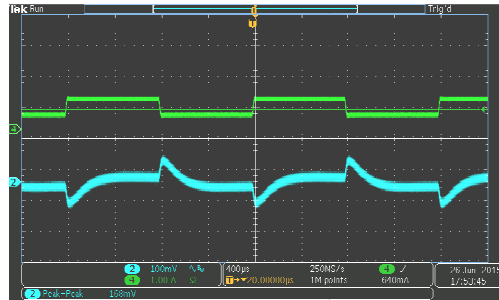


Vout=9V

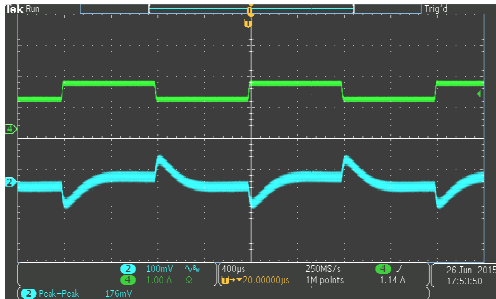
Vin=24V, load step 0A-0.5A-0A



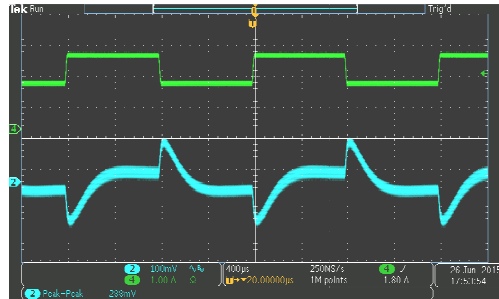
Vin=24V, load step 0.5A-1A-0.5A



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

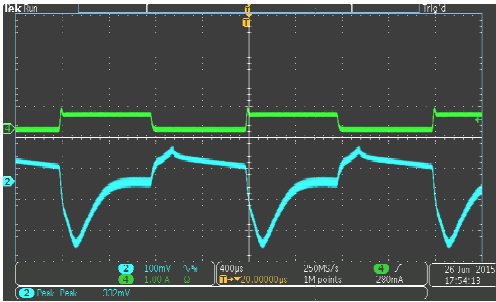


Vin=24V, load step 1.5A-2.4A-1.5A

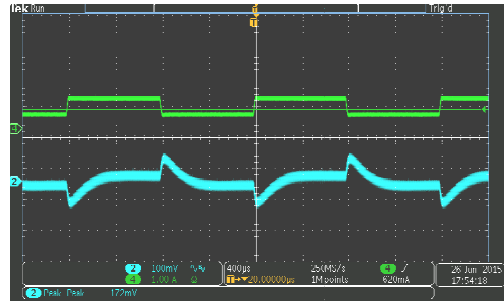


Vout=12V

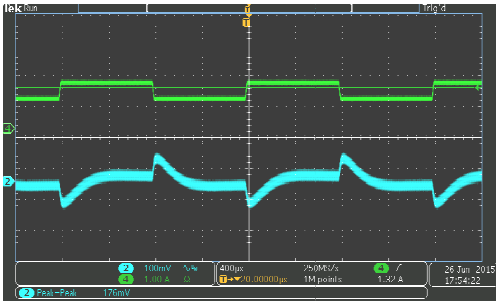
Vin=24V, load step 0A-0.5A -0A



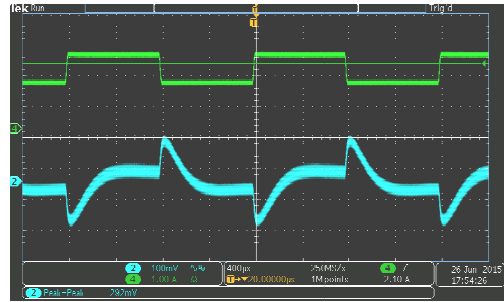
Vin=24V, load step 0.5A-1A-0.5A



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



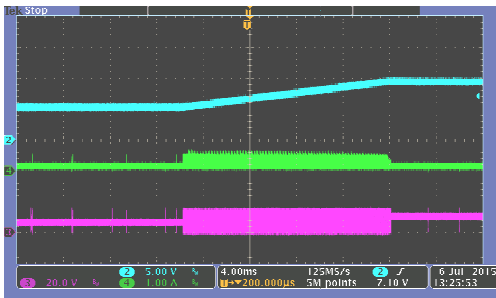
Vin=24V, load step 1.5A-2.4A-1.5A



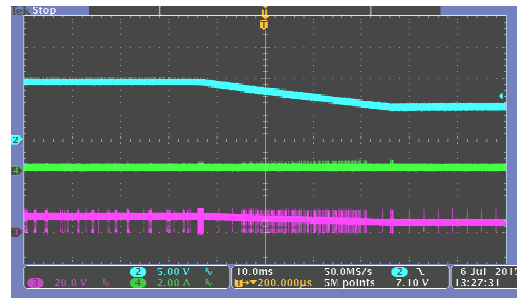
5.8. Output Voltage Transient

CH2:Vout,CH3:Vsw,CH4:IL

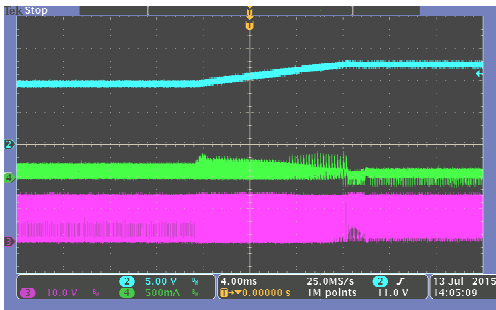
Vin=12V,Iout=0A,Vout 5V—>9V



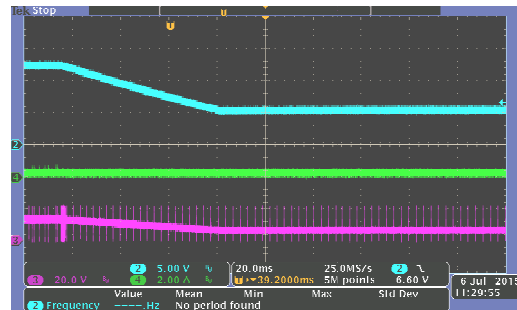
Vin=12V,Iout=0A,Vout 9V—>5V

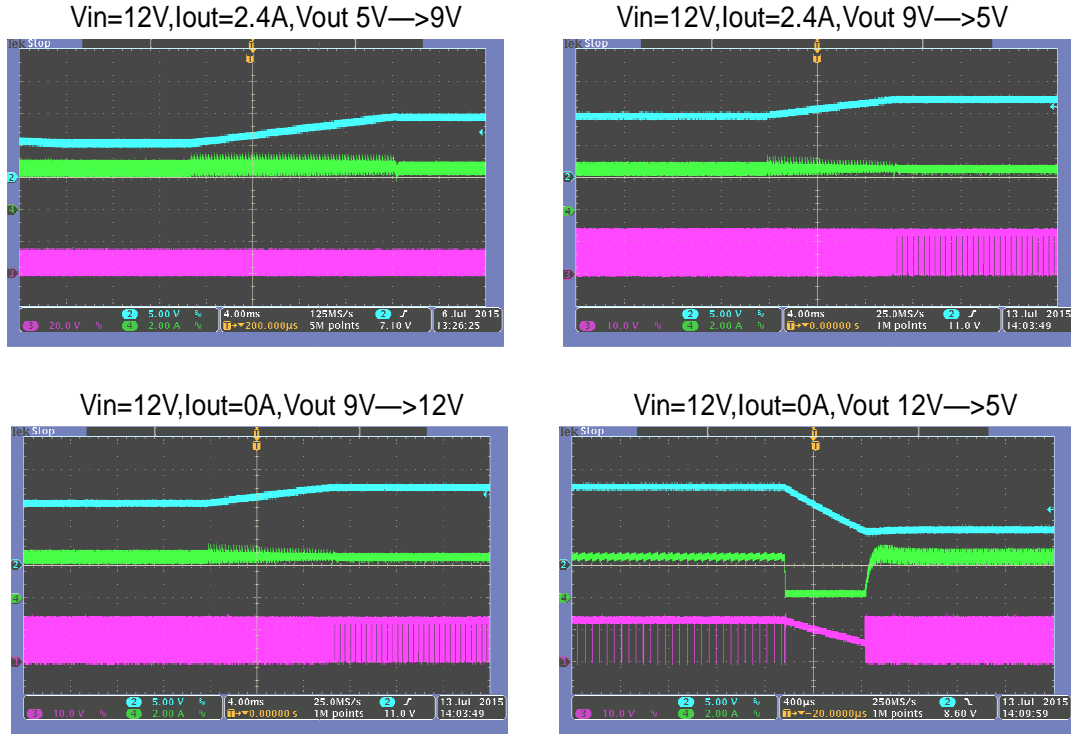


Vin=12V,Iout=0A,Vout 9V—>12V



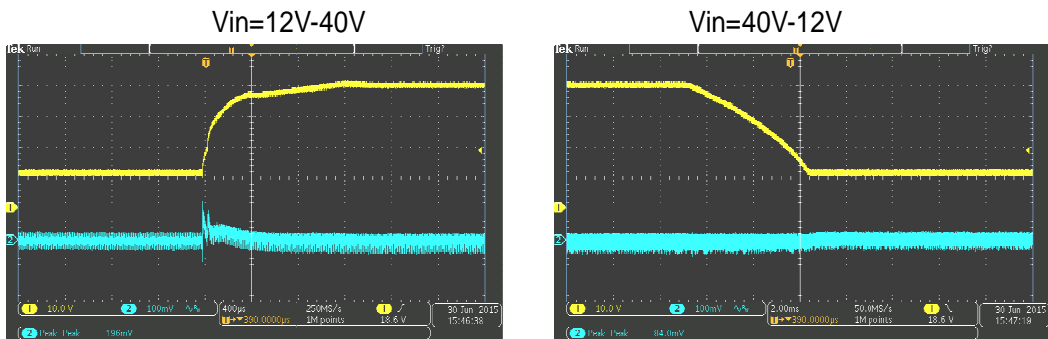
Vin=12V,Iout=0A,Vout 12V—>5V





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

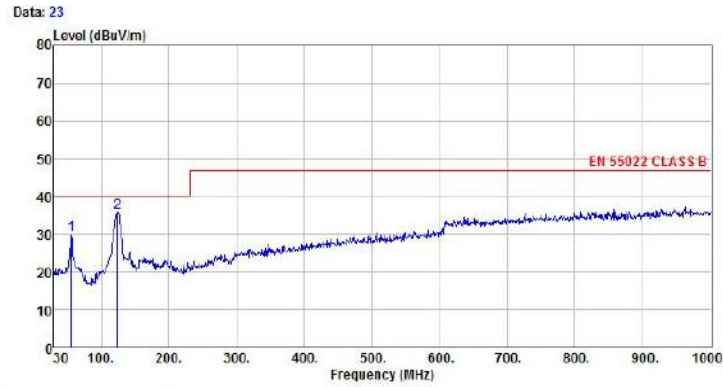
| Vin/lout | Ambient (°C) | PCB (°C) | IC (°C) | Schottky (°C) | Inductor (°C) |
|----------|--------------|----------|---------|---------------|---------------|
| 12V/2A | 37 | 72 | 75 | 66 | 72 |
| 16V/2A | 38 | 81 | 85 | 78 | 83 |
| 24V/2A | 39 | 92 | 96 | 90 | 95 |



6. EMI TEST

6.1. Output 5V

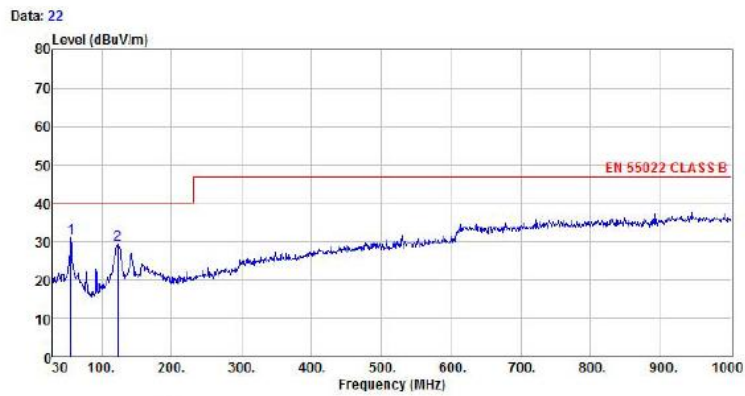
Vin=12V Output 5V2.4A Horizontal



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 | ReadAntenna | | Cable Preamp | | Limit | | Over | Remark | Factor |
|------|--------|-------------|--------|--------------|--------|--------|--------|--------|--------|--------|
| | | Level | Factor | Loss | Factor | Level | Line | | | |
| | MHz | dBuV | dB/m | dB | dB | dBuV/m | dBuV/m | dB | | dB/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

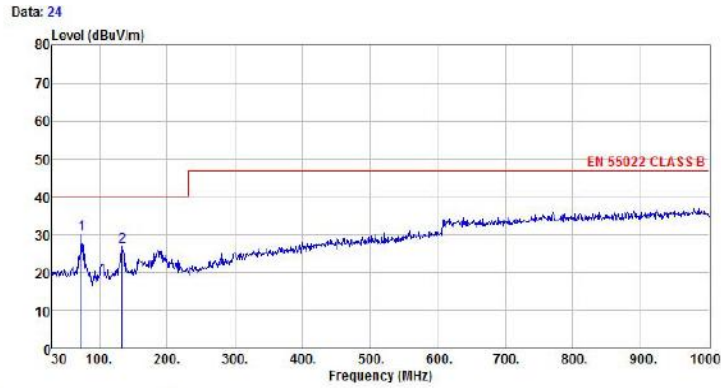


Site : chamber
Condition : EN 55022 CLASS B 3m VULB9160 VERTICAL
EUT :
Model Name : 5
Temp/Humi : 25°C / 53 %
Power Rating: AC 230V/50Hz
Mode :
Memo :

| | Freq | ReadAntenna | | Cable Preamp | | Limit | | Over | Remark | Factor |
|------|--------|-------------|--------|--------------|--------|--------|--------|--------|--------|--------|
| | | Level | Factor | Loss | Factor | Level | Line | | | |
| | MHz | dBuV | dB/m | dB | dB | dBuV/m | dBuV/m | dB | | dB/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

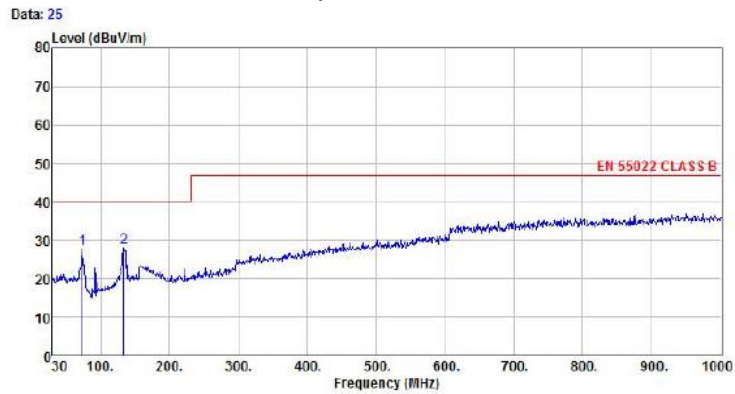
Vin=12V Output 9V2.4A Horizontal



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 |