# EC6A 7.5W Isolated DC-DC Converters

## Application Note V10 December 2012

# ISOLATED DC-DC Converter
# EC6A SERIES
# APPLICATION NOTE


**Approved By:**

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# Content

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## 1. Introduction

The EC6A series offer 7.5 watts of output power in a 24 pin DIP and SMD metal package. The EC6A series has a 2:1 wide input voltage range of 9-18VDC, 18-36VDC and 36-72VDC, and provides a precisely regulated output. This series has features such as high efficiency, 1500VDC of isolation and allows an ambient operating temperature range of –40℃ to 85℃ ( de-rating abov e 71 ℃). The modules are fully protected against output short circuit. All models are very suitable for distributed power architectures, telecommunications, battery operated equipment and industrial applications.

## 2. DC-DC Converter Features

* 7.5W Isolated Output
* Efficiency to 87%
* 2:1 Input Range
* Regulated Outputs
* Pi Input Filter
* DIP-24 / SMD Metal Package
* Continuous Short Circuit Protection
* Without Tantalum Capacitors inside
* CE Mark Meets 2004/108/EC
* UL60950-1 Approval

## 3. Electrical Block Diagram

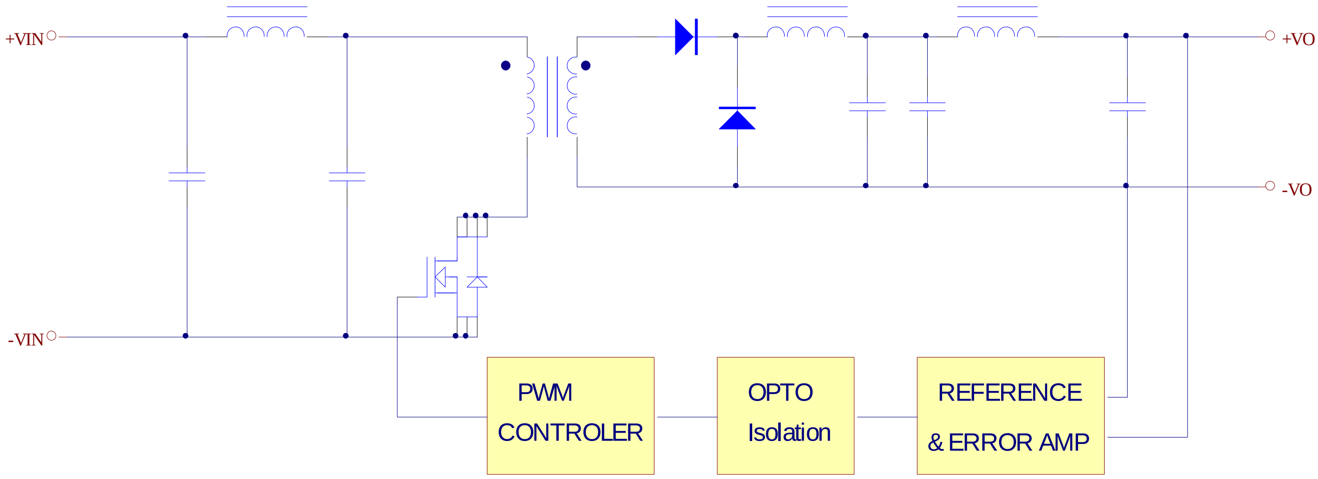



Figure1 Electrical Block Diagram of single output module

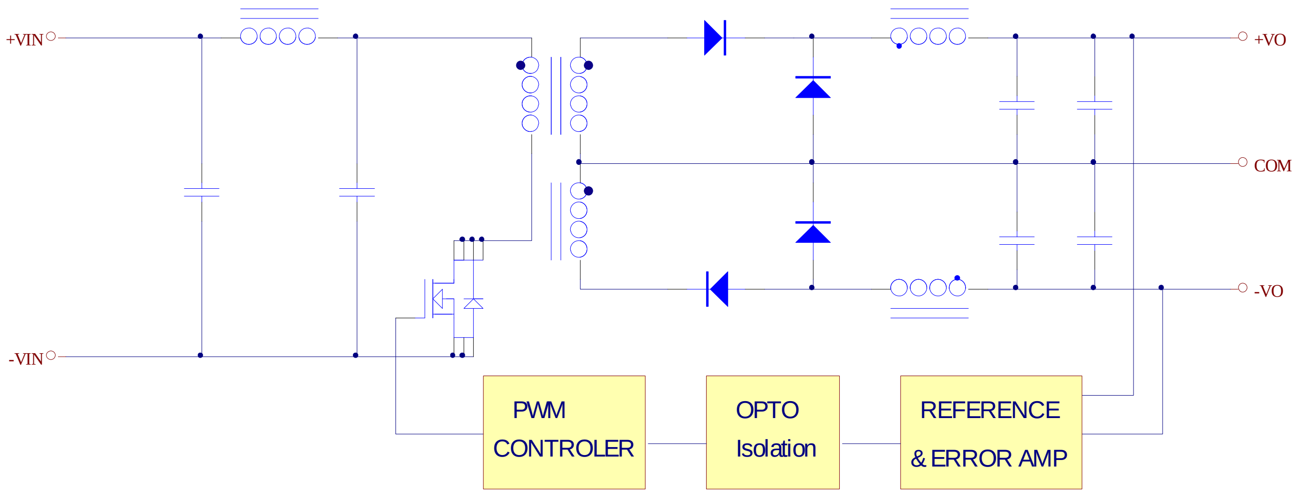



Figure2 Electrical Block Diagram of dual output module

## 4. Technical Specifications

(All specifications are typical at nominal input, full load at 25℃ unless otherwise noted.)

### *ABSOLUTE MAXIMUM RATINGS*

| PARAMETER | NOTES and CONDITIONS | Device | Min. | Typical | Max. | Units |
|---|---|---|---|---|---|---|
| Input Voltage | | | | | | |
| Continuous | | EC6A0X | 9 | 12 | 18 | Vdc |
| | | EC6A1X | 18 | 24 | 36 | |
| | | EC6A2X | 36 | 48 | 72 | |
| Transient | 100ms | EC6A0X | | | 20 | Vdc |
| | | EC6A1X | | | 50 | |
| | | EC6A2X | | | 100 | |
| Operating Ambient Temperature | With de-rating, above 71℃ | All | -40 | | +85 | ℃ |
| Case Temperature | | All | | | 100 | ℃ |
| Storage Temperature | | All | -40 | | +100 | ℃ |
| Input/Output Isolation Voltage | 1 minute | All | 1500 | | | Vdc |
| ***INPUT CHARACTERISTICS*** | | | | | | |
| Operating Input Voltage | | EC6A0X | 9 | 12 | 18 | Vdc |
| | | EC6A1X | 18 | 24 | 36 | |
| | | EC6A2X | 18 | 48 | 72 | |
| Maximum Input Current | Full Load, Vin= 9V | EC6A0X | | 1040 | | mA |
| | Full Load, Vin=18V | EC6A1X | | 500 | | |
| | Full Load, Vin=36V | EC6A2X | | 255 | | |
| No-Load Input Current | Vin=Nominal input | EC6A01 | | 25 | | mA |
| | | EC6A02 | | 25 | | |
| | | EC6A03 | | 25 | | |
| | | EC6A04 | | 30 | | |
| | | EC6A05 | | 30 | | |
| | | EC6A06 | | 30 | | |
| | | EC6A07 | | 25 | | |
| | | EC6A11 | | 20 | | |
| | | EC6A12 | | 20 | | |
| | | EC6A13 | | 20 | | |
| | | EC6A14 | | 25 | | |
| | | EC6A15 | | 25 | | |
| | | EC6A16 | | 25 | | |
| | | EC6A17 | | 20 | | |
| | | EC6A21 | | 10 | | |
| | | EC6A22 | | 10 | | |
| | | EC6A23 | | 10 | | |
| | | EC6A24 | | 15 | | |
| | | EC6A25 | | 15 | | |
| | | EC6A26 | | 15 | | |
| | | EC6A27 | | 10 | | |
| Inrush Current ($I^2t$) | | All | | | TBD | $A^2s$ |
| Input Reflected-Ripple Current | P-P thru 1uH inductor, 5Hz to 20MHz | All | | TBD | | mA |

| OUTPUT CHARACTERISTIC | | | | | | |
|---|---|---|---|---|---|---|
| Output Voltage Set Point | Vin=Nominal Vin, Io=Io max., Tc=25℃ | Vo=5Vdc | 4.9 | 5 | 5.1 | Vdc |
| | | Vo=12Vdc | 11.76 | 12 | 12.24 | |
| | | Vo=15Vdc | 14.7 | 15 | 15.3 | |
| | | Vo=±5Vdc | ±4.9 | ±5 | ±5.1 | |
| | | Vo=±12Vdc | ±11.76 | ±12 | ±12.24 | |
| | | Vo=±15Vdc | ±14.7 | ±15 | ±15.3 | |
| | | Vo=3.3Vdc | 3.234 | 3.3 | 3.366 | |
| Output Voltage Balance | Vin=nominal, Io=Iomax, Tc=25℃ | Dual | | | ±1.0 | % |
| Output Voltage Regulation | | | | | | |
| Load Regulation | Io=Full Load to 10% Load | Single | | | ±0.5 | % |
| | Io=Full Load to 25% Load | Dual | | | ±1.0 | |
| Line Regulation | Vin= high line to low line, Full Load | All | | | ±0.2 | % |
| Temperature Coefficient | Ta=-40℃ to 85℃ | All | | | ±0.05 | %/℃ |
| Output Voltage Ripple and Noise | | | | | | |
| Peak-to-Peak | Vin=nominal input, Io= full load 20MHz bandwidth | Vo=5Vdc | | | 100 | mV |
| | | Vo=12Vdc | | | | |
| | | Vo=15Vdc | | | | |
| | | Vo=±5Vdc | | | | |
| | | Vo=±12Vdc | | | | |
| | | Vo=±15Vdc | | | | |
| | | Vo=3.3Vdc | | | | |
| Operating Output Current Range | | Vo=5Vdc | 0 | | 1500 | mA |
| | | Vo=12Vdc | 0 | | 625 | |
| | | Vo=15Vdc | 0 | | 500 | |
| | | Vo=±5Vdc | 0 | | ±750 | |
| | | Vo=±12Vdc | 0 | | ±310 | |
| | | Vo=±15Vdc | 0 | | ±250 | |
| | | Vo=3.3Vdc | 0 | | 1500 | |
| Output DC Current-Limit Inception | Output Voltage =90% Nominal Output Voltage | All | 120 | | | % |
| Maximum Output Capacitance | Full load, Resistance | Vo=5Vdc | | | 4700 | uF |
| | | Vo=12Vdc | | | 4700 | |
| | | Vo=15Vdc | | | 4700 | |
| | | Vo=±5Vdc | | | 2000 | |
| | | Vo=±12Vdc | | | 2000 | |
| | | Vo=±15Vdc | | | 2000 | |
| | | Vo=3.3Vdc | | | 4700 | |

| DYNAMIC CHARACTERISTICS | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **NOTES and CONDITIONS** | Device | Min. | Typical | Max. | Units |
| Start up Time | | | | | | |
| Start up Time, From Input | Vin,min. to 90%Vo,set | EC6A0X | | 15 | | ms |
| | | Other | | 20 | | |

| EFFICIENCY | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **NOTES and CONDITIONS** | Device | Min. | Typical | Max. | Units |
| 100% Load | Vin=Nominal Vin, Io=Io.max, Tc=25℃ | EC6A01 | | 80 | | % |
| | | EC6A02 | | 83 | | |
| | | EC6A03 | | 84 | | |
| | | EC6A04 | | 81 | | |
| | | EC6A05 | | 83 | | |
| | | EC6A06 | | 83 | | |
| | | EC6A07 | | 78 | | |
| | | EC6A11 | | 83 | | |
| | | EC6A12 | | 87 | | |
| | | EC6A13 | | 87 | | |
| | | EC6A14 | | 84 | | |
| | | EC6A15 | | 87 | | |
| | | EC6A16 | | 84 | | |
| | | EC6A17 | | 78 | | |
| | | EC6A21 | | 81 | | |
| | | EC6A22 | | 85 | | |
| | | EC6A23 | | 86 | | |
| | | EC6A24 | | 82 | | |
| | | EC6A25 | | 85 | | |
| | | EC6A26 | | 85 | | |
| | | EC6A27 | | 76 | | |
| ***ISOLATION CHARACTERISTICS*** | | | | | | |
| Isolation Voltage | Input to Output 1 minutes | All | 1500 | | | Vdc |
| Isolation Resistance | Input to Output | All | | | 1000 | MΩ |
| Isolation Capacitance | Input to Output | All | | 560 | | pF |
| ***FEATURE CHARACTERISTICS*** | | | | | | |
| Switching Frequency | Vin=Nominal, Io=Io.max | All | | 300 | | KHz |
| ***GENERAL SPECIFICATIONS*** | | | | | | |
| MTBF | Io=100%of Io.max;Ta=25℃ per MIL-HDBK-217F | Single | | TBD | | Mhours |
| | | Dual | | TBD | | |
| Weight | | All | | 18.4 | | grams |

## 5. Main Features and Functions

### *5.1 Operating Temperature Range*

The EC6A series converters can be operated by a wide ambient temperature range from -40℃ to 85℃( de-rating above 71 ℃). The standard model has a Copper case and case temperature can not over 100℃ at normal operating.

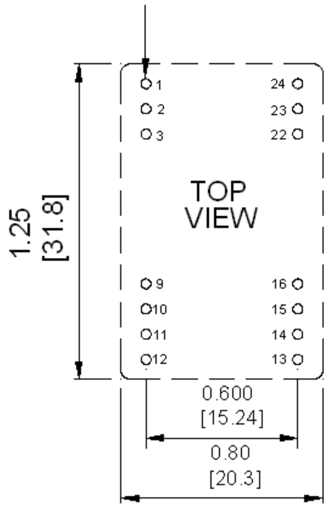
### *5.2 Over Current Protection*

All different voltage models have full continuous short-circuit protection. To provide protection in a fault condition, the unit is equipped with internal over-current protection. The unit operates normally once the fault condition is removed. At the point of current-limit inception, the converter will go into over current protection.

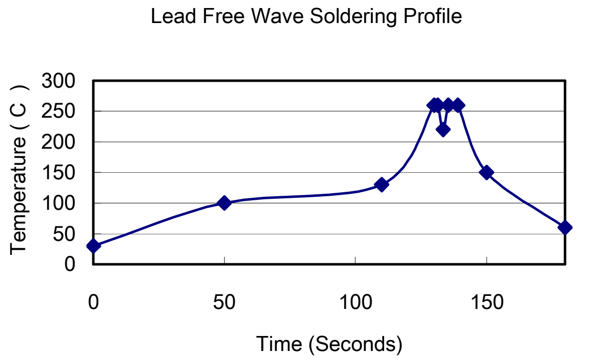
## 6. Applications

### *6.1 Recommended Layout PCB Footprints and Soldering Information*

The system designer or the end user must ensure that other components and metal in the vicinity of the converter meet the spacing requirements to which the system is approved. Low resistance and low inductance PCB layout traces are the norm and should be used where possible. Due consideration must also be given to proper low impedance tracks between power module, input and output grounds. The recommended footprints and soldering profiles are shown as Figure 3.

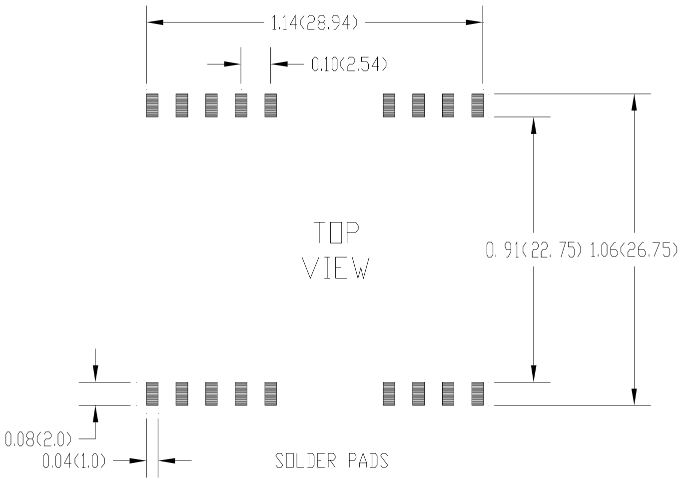


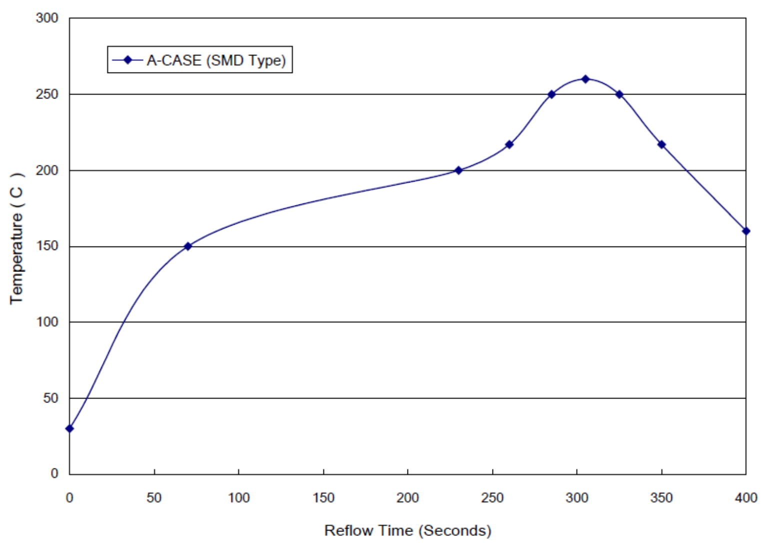

Note: Dimensions are in inches (millimeters)




Note：

1. Soldering Materials: Sn/Cu/Ni
2. Ramp up rate during preheat: 1.4 ℃/Sec (From 50℃ to 100℃)
3. Soaking temperature: 0.5 ℃/Sec (From 100℃ to 130℃), 60±20 seconds
4. Peak temperature: 260℃, above 250℃ 3~6 Seconds
5. Ramp up rate during cooling: -10.0 ℃/Sec (From 260℃ to 150℃)



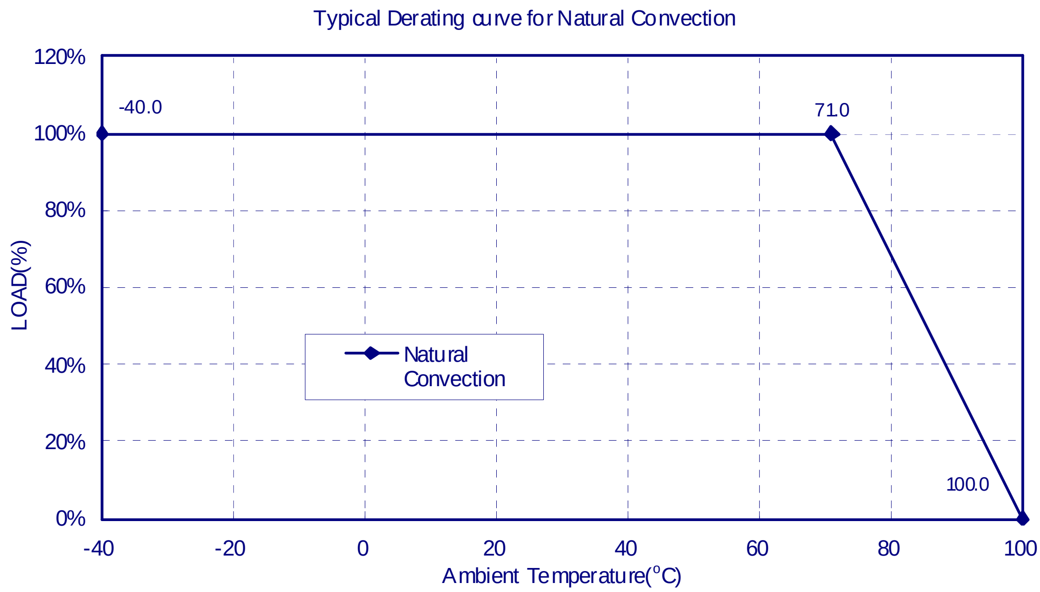

1. Soldering Paste: SHENMAO PF610-P (Sn/Ag/Cu)
2. Ramp up rate during preheat: 1.71 ℃/Sec (From 30℃ to 150℃)
3. Soaking temperature: 0.31 ℃/Sec (From 150℃ to 200℃), 160±10 seconds
4. Ramp up rate during reflow: 0.96 ℃/Sec (From 217℃ to 260℃)
5. Peak temperature: 260℃, above 217℃ 90 Seconds
6. Ramp up rate during cooling: -1.2 ℃/Sec (From 260℃ to 160℃)

Figure3 Recommended PCB Layout Footprints and Wave Soldering Profiles for DIP-24 and SMD packages

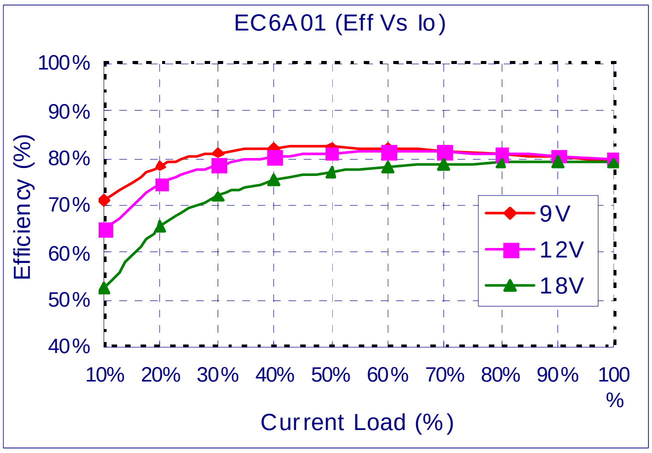
### *6.2 Power De-Rating Curves for EC6A Series*

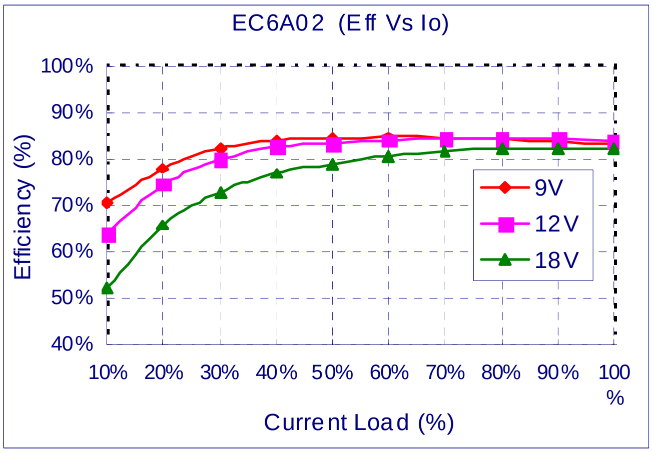
Operating Ambient temperature Range: -40℃ ~ 85℃ with de-rating above 71℃.

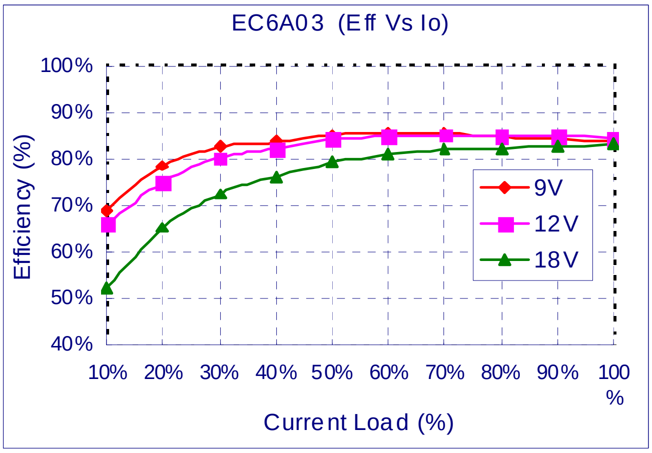
Maximum case temperature under any operating condition should not exceed 100℃.

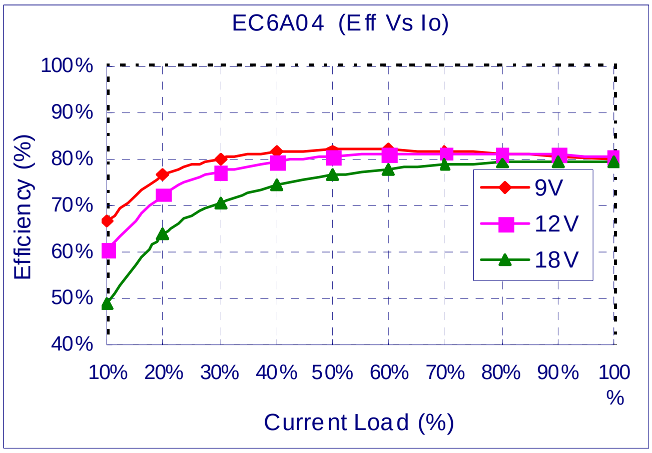


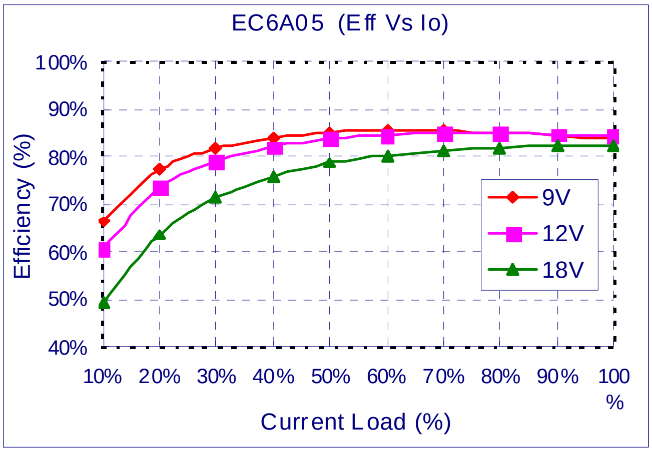
### *6.3 Efficiency vs. Load Curves*

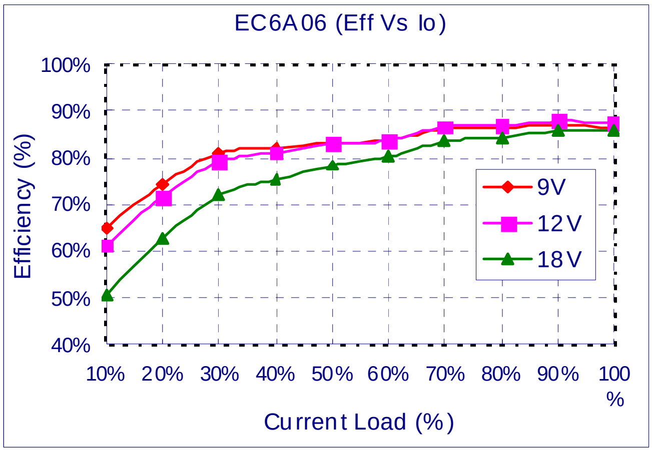


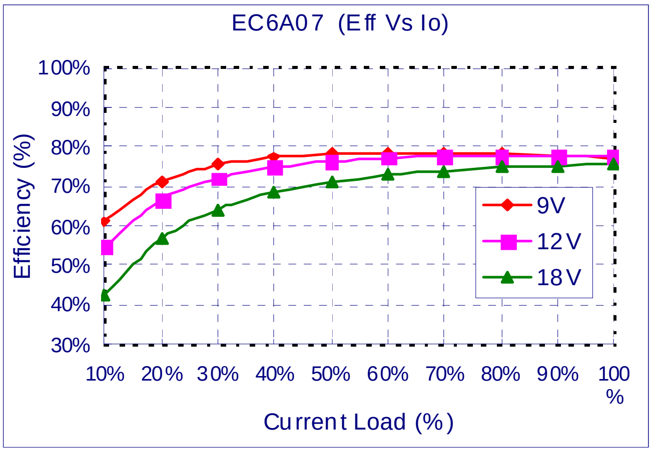



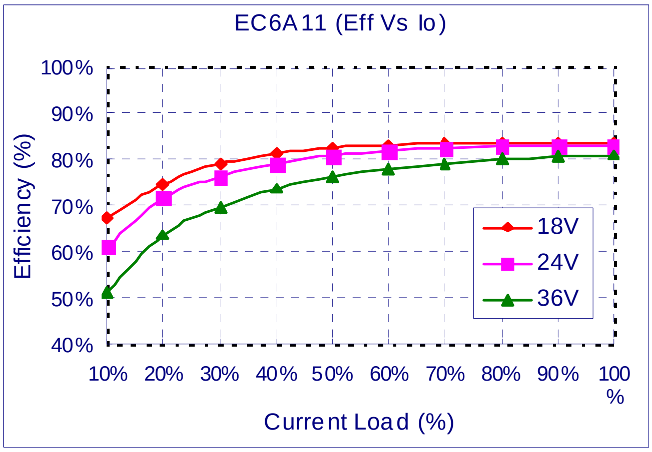



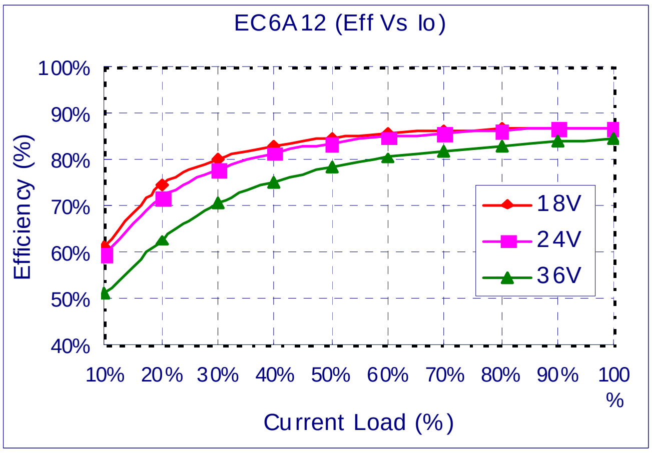



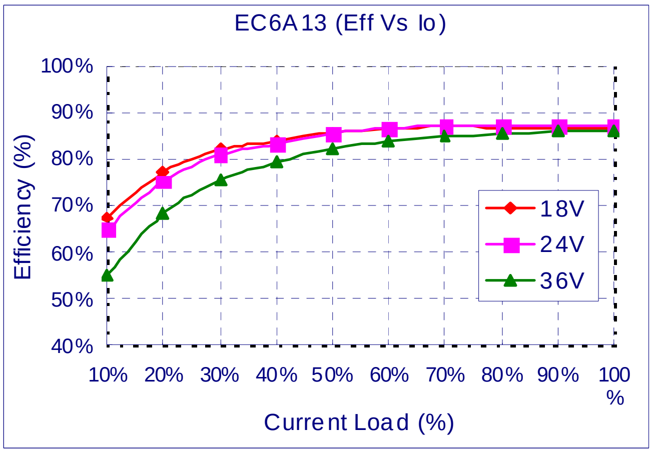



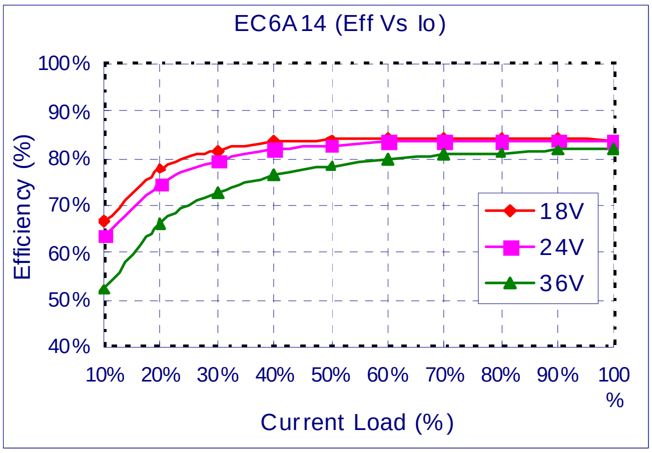



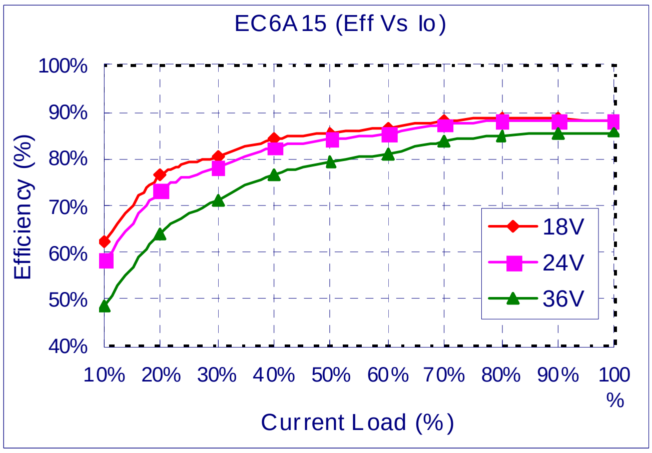

EC6A07 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
9V
12V
18V

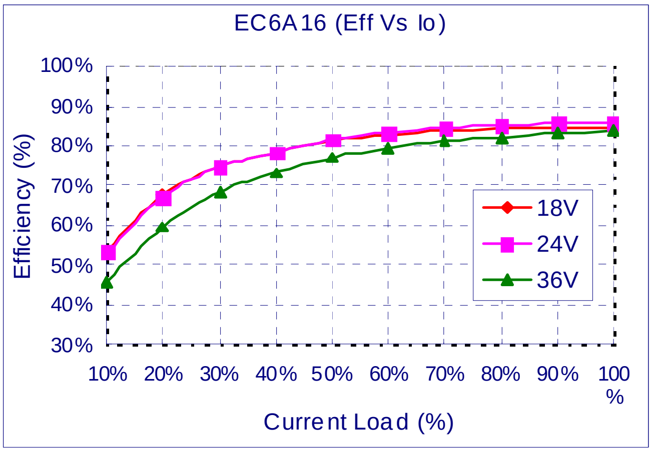

EC6A11 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
24V
36V

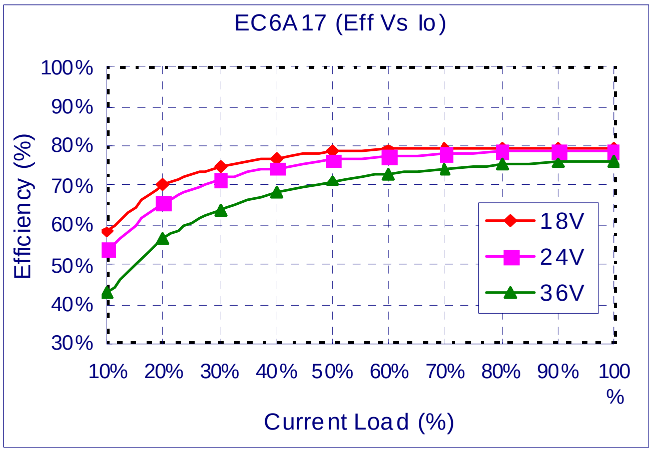

EC6A12 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
24V
36V

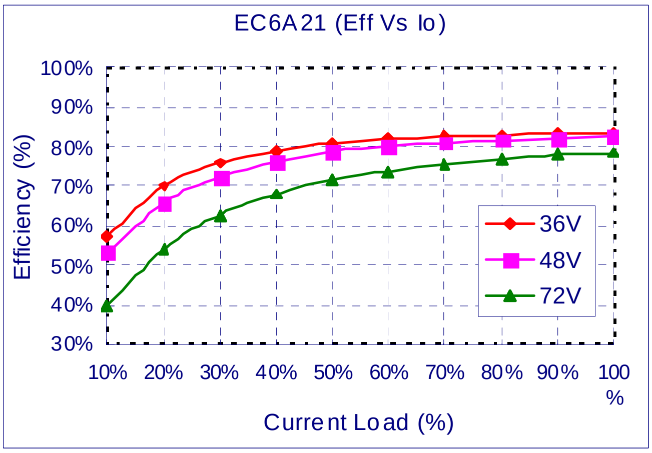

EC6A13 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
24V
36V

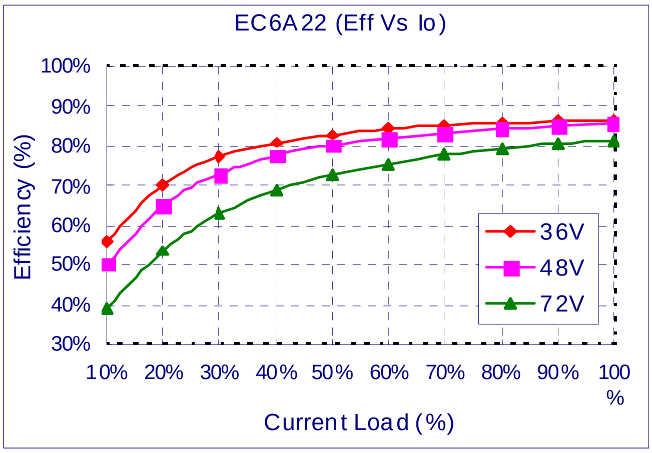

EC6A14 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
24V
36V

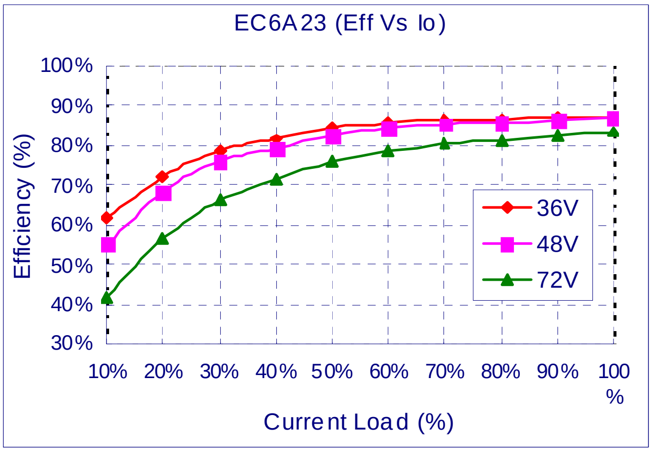

EC6A15 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
24V
36V

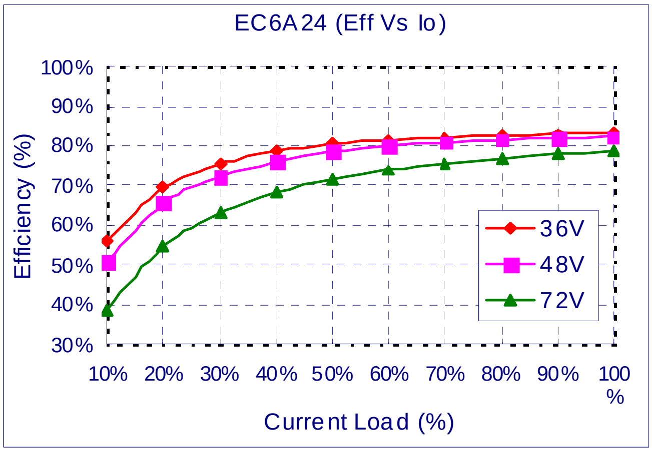

EC6A16 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Current Load (%)
18V
24V
36V

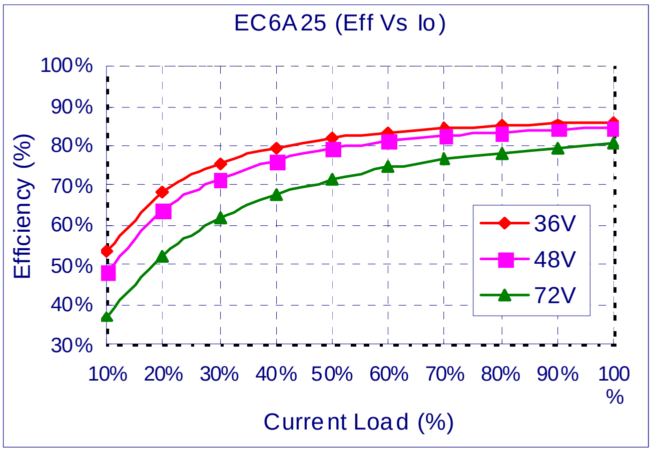

EC6A17 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Current Load (%)
18V
24V
36V


EC6A21 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Current Load (%)
36V
48V
72V

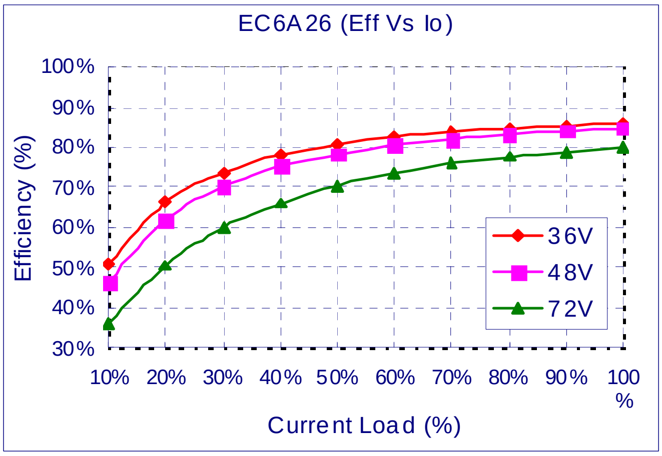

EC6A22 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Current Load (%)
36V
48V
72V


EC6A23 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Current Load (%)
36V
48V
72V

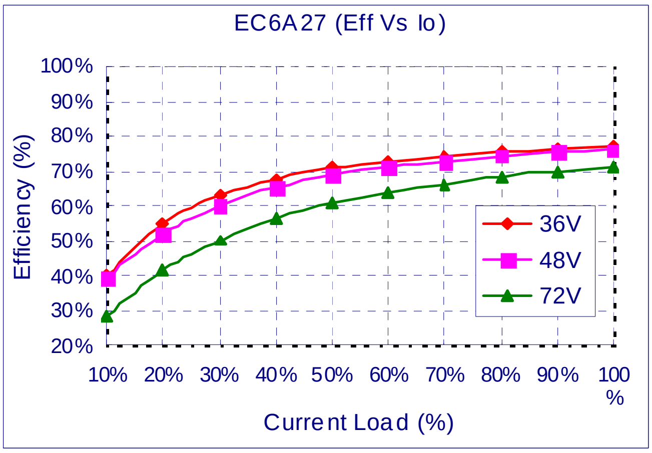

EC6A24 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Current Load (%)
36V
48V
72V



EC6A25 (Eff Vs Io)
100%
90%
80%
70%
60%
50%
40%
30%
Efficiency (%)
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Current Load (%)
36V
48V
72V

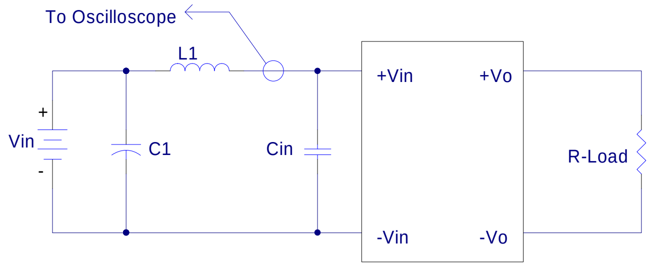
EC6A26 (Eff Vs Io)
100%
90%
80%
70%
60%
50%
40%
30%
Efficiency (%)
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Current Load (%)
36V
48V
72V

EC6A27 (Eff Vs Io)
100%
90%
80%
70%
60%
50%
40%
30%
20%
Efficiency (%)
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Current Load (%)
36V
48V
72V

### *6.4 Input Capacitance at the Power Module*

The converters must be connected to low AC source impedance. To avoid problems with loop stability source inductance should be low. Also, the input capacitors (Cin) should be placed close to the converter input pins to de-couple distribution inductance. However, the external input capacitors are chosen for suitable ripple handling capability. Low ESR capacitors are good choice. Circuit as shown in Figure4 represents typical measurement methods for reflected ripple current. C1 and L1 simulate a typical DC source impedance. The input reflected-ripple current is measured by current probe to oscilloscope with a simulated source Inductance (L1).




L1: 12uH.

C1: 220uF ESR <0.1Ω @ 20℃, 100KHz.

Cin: None

Figure4 Input Reflected-Ripple Test Setup

### *6.5 Test Set-Up*

The basic test set-up to measure parameters such as efficiency and load regulation is shown in Figure5. When testing the modules under any transient conditions please ensure that the transient response of the source is sufficient to power the equipment under test. We can calculate the

- Efficiency
- Load regulation and line regulation.

The value of efficiency is defined as:

$$\eta = \frac{Vo \times Io}{Vin \times Iin} \times 100\%$$

Where

Vo is output voltage,

Io is output current,

Vin is input voltage,

Iin is input current.

The value of load regulation is defined as:

$$Load.reg = \frac{V_{FL} - V_{NL}}{V_{NL}} \times 100\%$$

Where

$V_{FL}$ is the output voltage at full load

$V_{NL}$ is the output voltage at 10% load (Single output)

$V_{NL}$ is the output voltage at 25% load (Dual output)

The value of line regulation is defined as:

$$Line.reg = \frac{V_{HL} - V_{LL}}{V_{LL}} \times 100\%$$

Where

$V_{HL}$ is the output voltage of maximum input voltage at full load.

$V_{LL}$ is the output voltage of minimum input voltage at full load

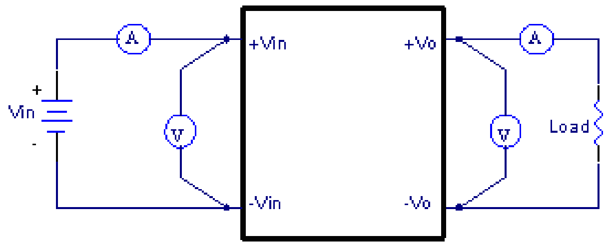



Figure5 EC6A Series Test Setup

### *6.6 Output Ripple and Noise Measurement*

The test set-up for noise and ripple measurements is shown in Figure6 and Figure7. A coaxial cable was used to prevent impedance mismatch reflections disturbing the noise readings at higher frequencies. Measurements are taken with output appropriately loaded and all ripple/noise specifications are from D.C. to 20MHz Band Width.

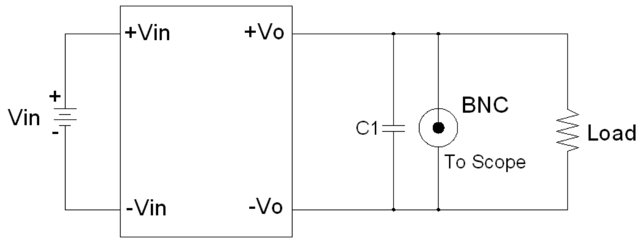



Figure6 Using BNC to Measure Output Ripple and Noise

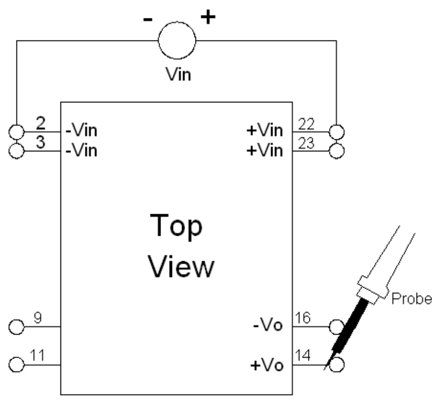



Figure 7 Using Probe to Measure Output Ripple and Noise

### *6.7 Output Capacitance*

The EC6A series converters provide unconditional stability with or without external capacitors. For good transient response low ESR output capacitors should be located close to the point of load. These series converters are designed to work with load capacitance to see technical specifications.

# 7. Safety & EMC

## *7.1 Input Fusing and Safety Considerations.*

The EC6A series converters have not an internal fuse. However, to achieve maximum safety and system protection, always use an input line fuse. We recommended a time delay fuse 1.5A for 12Vin, 1A for 24Vin models and 0.5A for 48Vin modules. Figure8 circuit is recommended by a Transient Voltage Suppressor diode across the input terminal to protect the unit against surge or spike voltage and input reverse voltage.

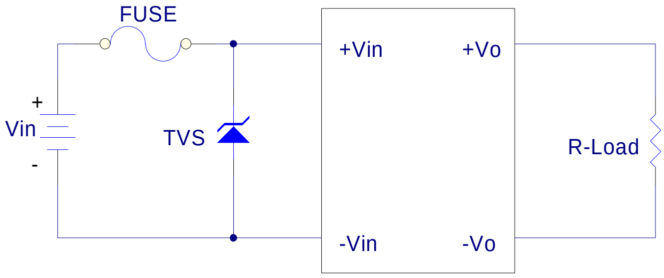



Figure8 Input Protection

## *7.2 EMC Considerations*

EMI Test standard: EN55022 Class B Conducted Emission
Test Condition: Input Voltage: Nominal, Output Load: Full Load

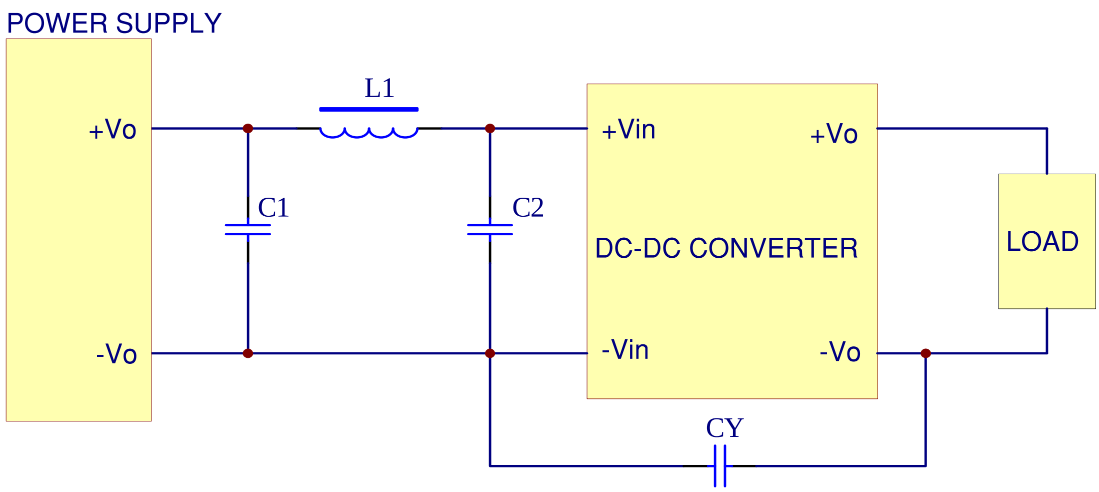



Figure9 Connection circuit for conducted EMI testing

| | EN55022 Class B | | | |
|---|---|---|---|---|
| Model No. | C1 | C2 | CY | L1 |
| EC6A01 | 47uF/50V ESR<0.6Ω | 47uF/50V ESR<0.6Ω | NC | 3.5uH |
| EC6A02 | 47uF/50V ESR<0.6Ω | 47uF/50V ESR<0.6Ω | NC | 3.5uH |
| EC6A03 | 47uF/50V ESR<0.6Ω | 47uF/50V ESR<0.6Ω | NC | 3.5uH |
| EC6A04 | 47uF/50V ESR<0.6Ω | 47uF/50V ESR<0.6Ω | NC | 3.5uH |
| EC6A05 | 47uF/50V ESR<0.6Ω | 47uF/50V ESR<0.6Ω | NC | 3.5uH |
| EC6A06 | 47uF/50V ESR<0.6Ω | 47uF/50V ESR<0.6Ω | NC | 3.5uH |
| EC6A07 | 47uF/50V ESR<0.6Ω | 47uF/50V ESR<0.6Ω | NC | 3.5uH |
| EC6A11 | 47uF/50V ESR<0.6Ω | 47uF/50V ESR<0.6Ω | NC | 3.5uH |
| EC6A12 | 47uF/50V ESR<0.6Ω | 47uF/50V ESR<0.6Ω | NC | 3.5uH |
| EC6A13 | 47uF/50V ESR<0.6Ω | 47uF/50V ESR<0.6Ω | NC | 3.5uH |
| EC6A14 | 47uF/50V ESR<0.6Ω | 47uF/50V ESR<0.6Ω | NC | 3.5uH |
| EC6A15 | 47uF/50V ESR<0.6Ω | 47uF/50V ESR<0.6Ω | NC | 3.5uH |
| EC6A16 | 47uF/50V ESR<0.6Ω | 47uF/50V ESR<0.6Ω | NC | 3.5uH |
| EC6A17 | 47uF/50V ESR<0.6Ω | 47uF/50V ESR<0.6Ω | NC | 3.5uH |
| EC6A21 | 22uF/100V ESR<0.66Ω | 22uF/100V ESR<0.66Ω | NC | 3.5uH |
| EC6A22 | 22uF/100V ESR<0.66Ω | 22uF/100V ESR<0.66Ω | NC | 3.5uH |
| EC6A23 | 22uF/100V ESR<0.66Ω | 22uF/100V ESR<0.66Ω | NC | 3.5uH |
| EC6A24 | 22uF/100V ESR<0.66Ω | 22uF/100V ESR<0.66Ω | NC | 3.5uH |
| EC6A25 | 22uF/100V ESR<0.66Ω | 22uF/100V ESR<0.66Ω | NC | 3.5uH |
| EC6A26 | 22uF/100V ESR<0.66Ω | 22uF/100V ESR<0.66Ω | NC | 3.5uH |
| EC6A27 | 22uF/100V ESR<0.66Ω | 22uF/100V ESR<0.66Ω | NC | 3.5uH |

Note: C1, C2 of capacitors are aluminum capacitors.

## 8. Part Number

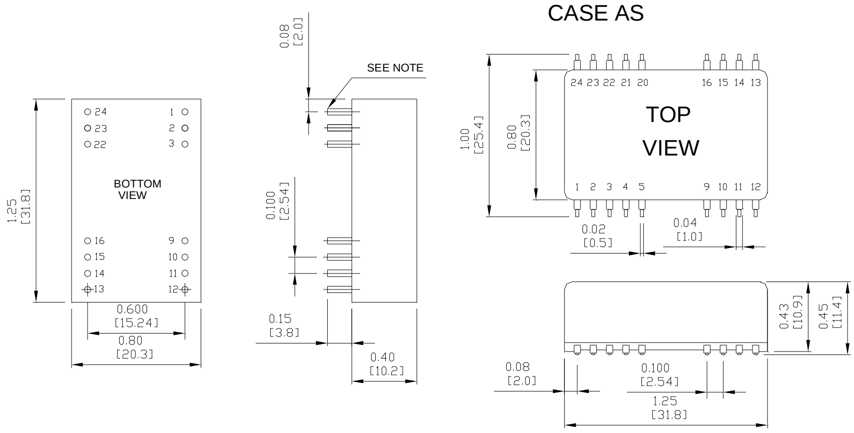
EC6A X X X

- EC6A → EC6A SERIES
- First X:
  - 0 : Nominal Input Voltage12VDC
  - 1 : Nominal Input Voltage 24VDC
  - 2 : Nominal Input Voltage 48VDC
- Second X:
  - 1：Output Voltage 5 VDC
  - 2：Output Voltage 12 VDC
  - 3：Output Voltage 15 VDC
  - 4：Output Voltage ±5 VDC
  - 5：Output Voltage ±12 VDC
  - 6：Output Voltage ±15 VDC
  - 7：Output Voltage 3.3 VDC
- Third X:
  - None: DIP Packages
  - S: SMD Packages

## 9. Mechanical Specifications

NOTE:Pin Size is 0.02"Inch (0.5mm)DIA
All Dimensions In Inches (mm)
Tolerances Inches: X.XX= ±0.02 , X.XXX= ±0.010
Millimeters: X.X= ±0.5 , X.XX=±0.25

CASE AS




| PIN CONNECTION | | | | |
|---|---|---|---|---|
| Pin | Single Output | | Dual Output | |
| | DIP | SMD | DIP | SMD |
| 1,24 | NP | NC | NP | NC |
| 2,3 | -V Input | | -V Input | |
| 4,5 | NP | NC | NP | NC |
| 9 | NC | | Common | |
| 10,15 | NC | | NC | |
| 11 | NC | | -V Output | |
| 12,13 | NP | NC | NP | NC |
| 14 | +V Output | | +V Output | |
| 16 | -V Output | | Common | |
| 20,21 | NP | NC | NP | NC |
| 22,23 | +V Input | | +V Input | |

* NC-NO CONNECTION WITH PIN
* NP-NO PIN

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