# EC2SAN SERIES 2W DC-DC Converters

## Application Note V10 November 2009

# ISOLATED DC-DC Converter
# EC2SAN SERIES
# APPLICATION NOTE


**Approved By:**

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# Content

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## 1. Introduction

The EC2SAN series offer 2 watts of output power with Industry Standard Single-In-line Package in a 0.77 x 0.28 x 0.40inches(19.6x7.2 x 10.2mm). The EC2SAN series have a ±10% input voltage range of 5Vdc、12Vdc and 24Vdc and provide a unregulated output. This series are with features as miniature size, 1000VDC of isolation and allow an operating ambient temperature range of –40℃ to 85℃. Furthermore, th is series offer a product high performance at low cost. All models are very suitable for telecommunications, distributed power systems, battery operated equipment, industrial, portable equipment applications.

## 2. DC-DC Converter Features

- Industry Standard SIP Packages
- Efficiency up to 86%
- 1000VDC Isolation
- Low Cost
- Unregulated Outputs
- Low Ripple and Noise
- RoHS compliance

## 3. Electrical Block Diagram

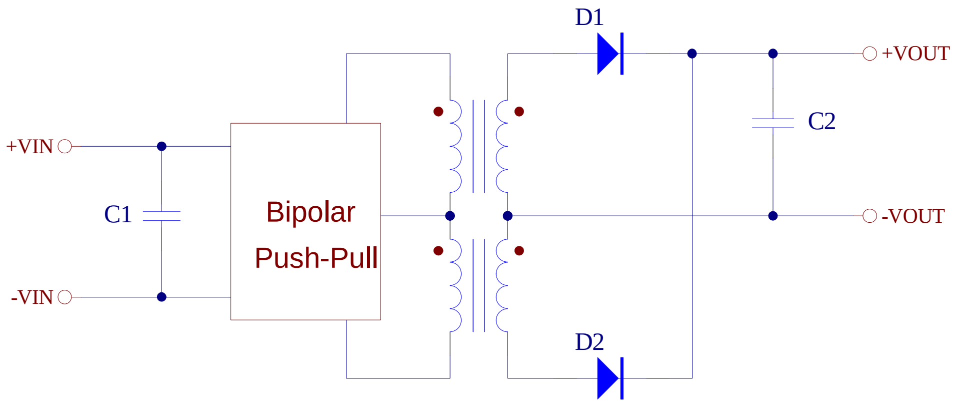


Figure1 Electrical Block Diagram for Single output

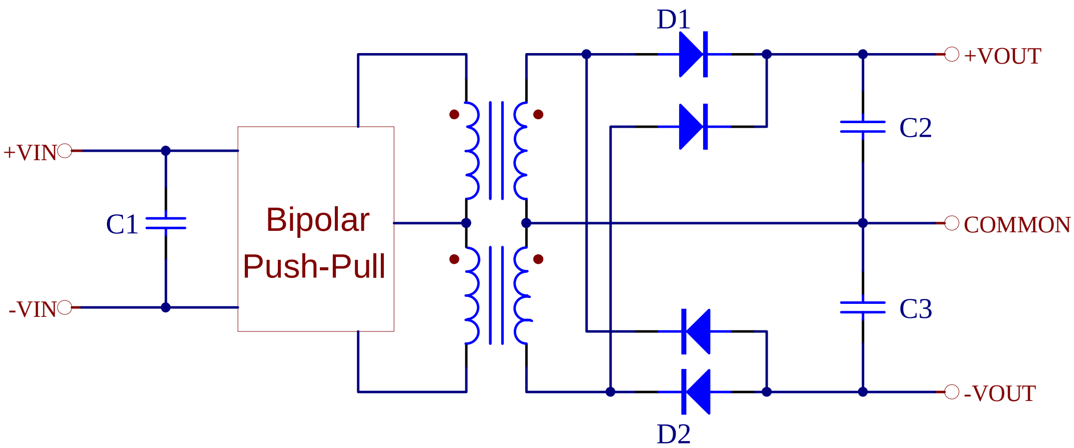


Figure2 Electrical Block Diagram for Dual output

## 4. Technical Specifications

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

| PARAMETER | NOTES and CONDITIONS | Device | Min. | Typical | Max. | Units |
|---|---|---|---|---|---|---|
| **ABSOLUTE MAXIMUM RATINGS** | | | | | | |
| Input Voltage | | | | | | |
| Continuous | | EC2SA0XN<br>EC2SA1XN<br>EC2SA2XN | -0.7<br>-0.7<br>-0.7 | | 5.5<br>13.2<br>26.4 | Vdc |
| Transient (100ms) | 100ms | EC2SA0XN<br>EC2SA1XN<br>EC2SA2XN | | | 9<br>18<br>30 | Vdc |
| Operating Ambient Temperature | With de-rating, above 75℃ | | -40 | | +85 | ℃ |
| Storage Temperature | | | -55 | | +125 | ℃ |
| Operating Case Temperature | | | -40 | | 100 | ℃ |
| Input/Output Isolation Voltage | 1 minute | | 1000 | | | Vdc |
| **INPUT CHARACTERISTICS** | | | | | | |
| Operating Input Voltage | | EC2SA0XN<br>EC2SA1XN<br>EC2SA2XN | 4.5<br>10.8<br>21.6 | 5<br>12<br>24 | 5.5<br>13.2<br>26.4 | Vdc |
| Maximum Input Current | 100% Load, Vin=4.5V for 2SA0XN<br>100% Load, Vin=10.8V for 2SA1XN<br>100% Load, Vin=21.6V for 2SA2xN | EC2SA0XN<br>EC2SA1XN<br>EC2SA2XN | | 500<br>210<br>110 | | mA |
| No-Load Input Current | Vin=5V<br>Vin=12V<br>Vin=24V | EC2SA0XN<br>EC2SA1XN<br>EC2SA2XN | | 60<br>40<br>20 | | mA |
| Inrush Current ($I^2t$) | | | | | 0.01 | $A^2s$ |
| **OUTPUT CHARACTERISTIC** | | | | | | |
| Output Voltage Set Point | Vin=Nominal Vin , Io=Io.max, Tc=25℃ | Vo=5.0Vdc<br>Vo=12Vdc<br>Vo=15Vdc<br>Vo=±5.0Vdc<br>Vo=±12Vdc<br>Vo=±15Vdc | 4.85<br>11.64<br>14.55<br>±4.85<br>±11.64<br>±14.55 | 5.0<br>12<br>15<br>±5.0<br>±12<br>±15 | 5.15<br>12.36<br>15.45<br>±5.15<br>±12.36<br>±15.45 | Vdc |
| Output Voltage Regulation | | | | | | |
| Load Regulation | Io=20% to 100% | | | | ±10 | % |
| Line Regulation | For Vin Change of 1% | | | | ±1.2 | % |
| Temperature Coefficient | Ta=-40℃ to 85℃ | | | | ±0.05 | %/℃ |
| Output Voltage Ripple and Noise | | | | | | |
| Peak-to-Peak | Full Load, 20MHz bandwidth<br>Output with 0.33uF Ceramic Capacitor | EC2SAX1N<br>EC2SAXXN | | | 100<br>150 | mV |
| Operating Output Current Range | | Vo=5.0Vdc<br>Vo=12Vdc<br>Vo=15Vdc<br>Vo=±12Vdc<br>Vo=±15Vdc<br>Vo=±5Vdc | 0<br>0<br>0<br>0<br>0<br>0 | | 400<br>167<br>134<br>83<br>67<br>200 | mA |
| Over Load | Vin=Nominal Vin<br>Output Voltage Within Vo Set Point ±5% | All | 120 | | | % |
| Output Voltage Balance | Vin=nominal, Io=Iomax, Tc=25℃ | Dual | | | ±1.0 | % |
| Maximum Output Capacitance | Full load | Vo=5.0Vdc<br>Vo=12Vdc<br>Vo=15Vdc<br>Vo=±5.0Vdc<br>Vo=±12Vdc<br>Vo=±15Vdc | | | 470<br>470<br>470<br>470<br>470<br>470 | uF |
| Output Short Circuit | Momentary | | | | 1 | Sec. |

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| PARAMETER | NOTES and CONDITIONS | Device | Min. | Typical | Max. | Units |
|---|---|---|---|---|---|---|
| **EFFICIENCY** | | | | | | |
| 100% Load | Vin=Nominal Vin, Io=Io.max, Tc=25℃ | EC2SA01N | | 82 | | % |
| | | EC2SA02N | | 86 | | |
| | | EC2SA03N | | 85 | | |
| | | EC2SA04N | | 86 | | |
| | | EC2SA05N | | 86 | | |
| | | EC2SA06N | | 83 | | |
| | | EC2SA11N | | 82 | | |
| | | EC2SA12N | | 83 | | |
| | | EC2SA13N | | 84 | | |
| | | EC2SA14N | | 82 | | |
| | | EC2SA15N | | 84 | | |
| | | EC2SA16N | | 82 | | |
| | | EC2SA21N | | 79 | | |
| | | EC2SA22N | | 81 | | |
| | | EC2SA23N | | 82 | | |
| | | EC2SA24N | | 81 | | |
| | | EC2SA25N | | 82 | | |
| | | EC2SA26N | | 79 | | |
| **ISOLATION CHARACTERISTICS** | | | | | | |
| Input to Output | 1 minutes | All | 1000 | | | Vdc |
| Isolation Resistance | | All | 1000 | | | MΩ |
| Isolation Capacitance | | All | | 15 | | pF |
| **FEATURE CHARACTERISTICS** | | | | | | |
| Switching Frequency | Vin=Nominal Vin, Io=Io.max, Tc=25℃ | All | | 80 | | KHz |
| | | | | | | |
| **GENERAL SPECIFICATIONS** | | | | | | |
| MTBF | Io=100%of Io.max;Ta=25℃ per MIL-HDBK-217F | All | | 3.3 | | M hours |
| Weight | | All | | 2.7 | | Grams |
| | | | | | | |

# EC2SAN SERIES 2W DC-DC Converters

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## 5. Main Features and Functions

### *5.1 Operating Temperature Range*

The EC2SAN series converters can be operated by a wide ambient temperature range from -40℃ to 85℃. The standard model has a plastic case and case temperature can not over 100℃ at normal operating.

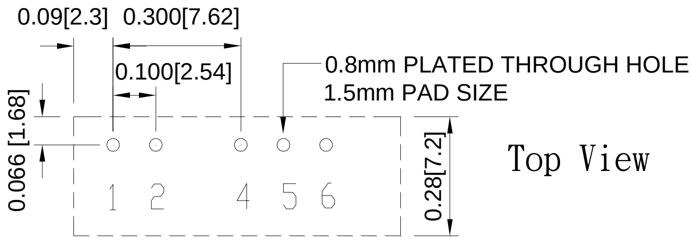
### *5.2 Output Short Circuit Protection*

All different voltage models have a momentary short-circuit protection (1 Second maximum). Please notice this condition and avoid output short as much as possible.

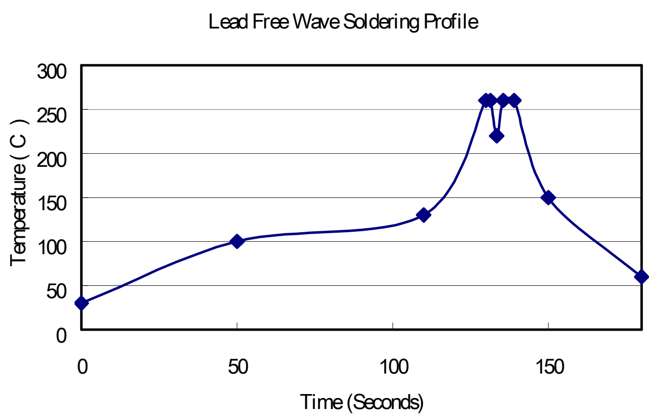
## 6. Applications

### *6.1 Recommended Layout PCB Footprints*

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℃)

Figure3 Recommended PCB Layout Footprints and Soldering Profile

## *6.2 Power De-rating curves for EC2SAN Series*

Operating Ambient temperature Range: -40℃ ~ 85℃
Maximum case temperature under any operating condition should not be exceed 100℃.

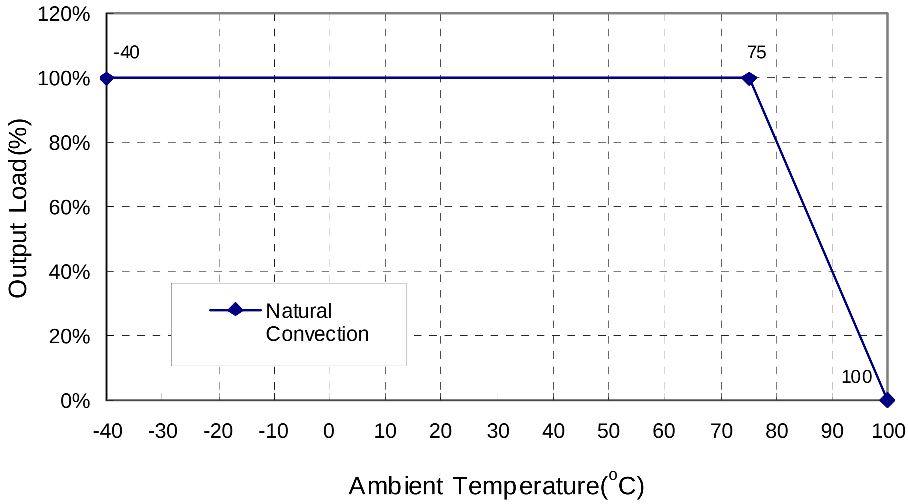
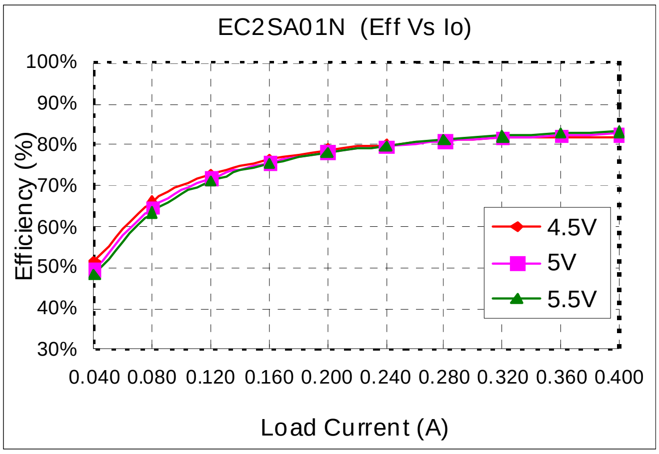
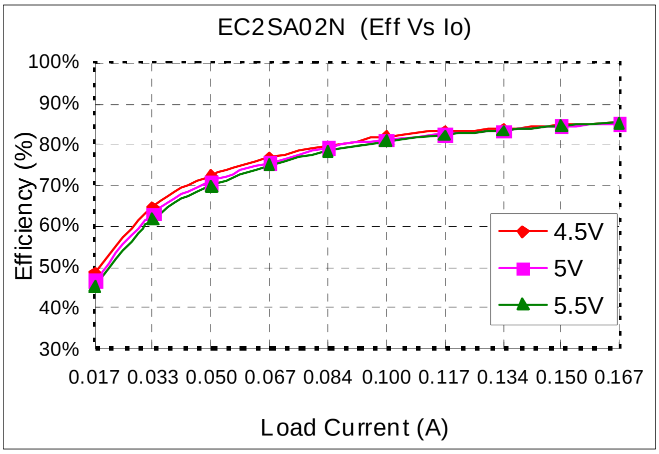
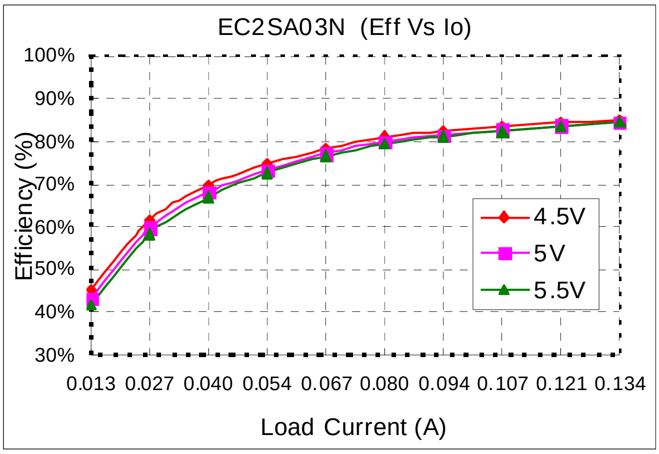


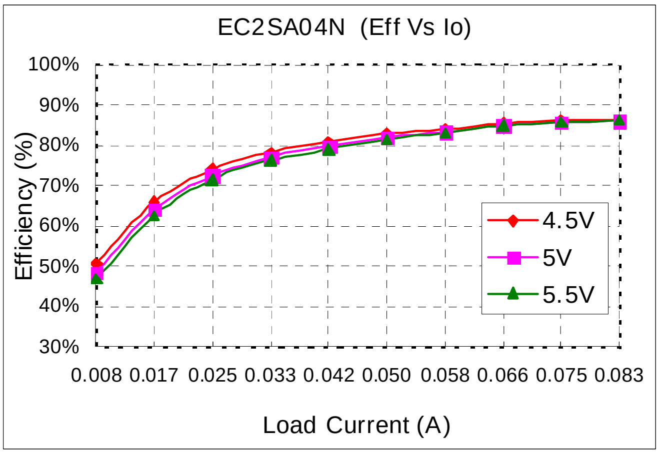

Figure4 Typical Power De-rating Curve for EC2SAN Series

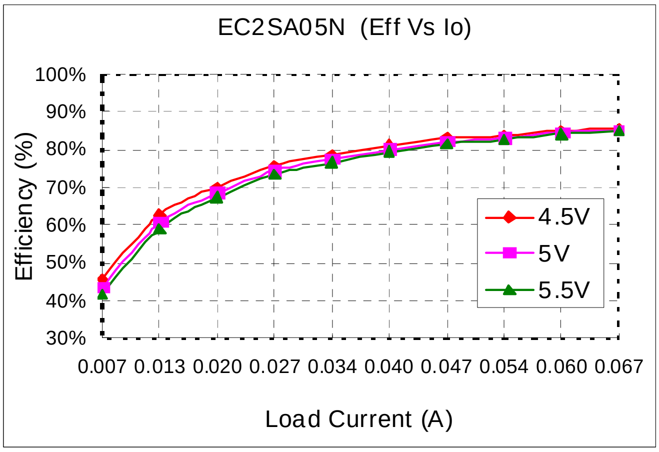
### *6.3 Efficiency vs. Load Curves*

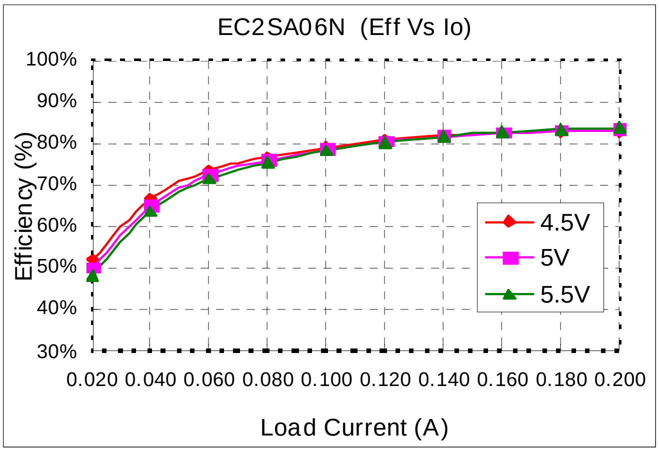


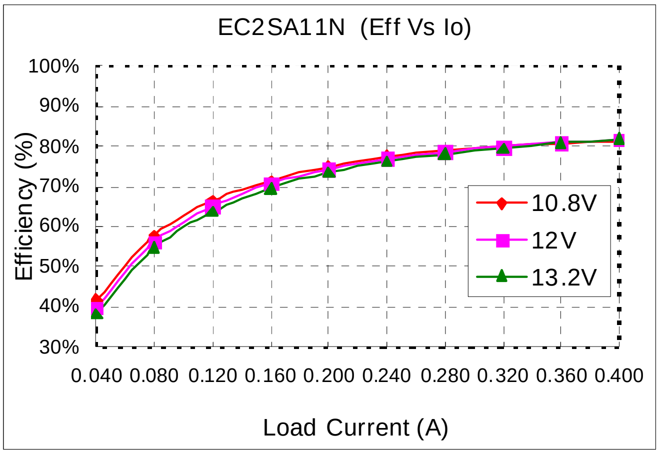



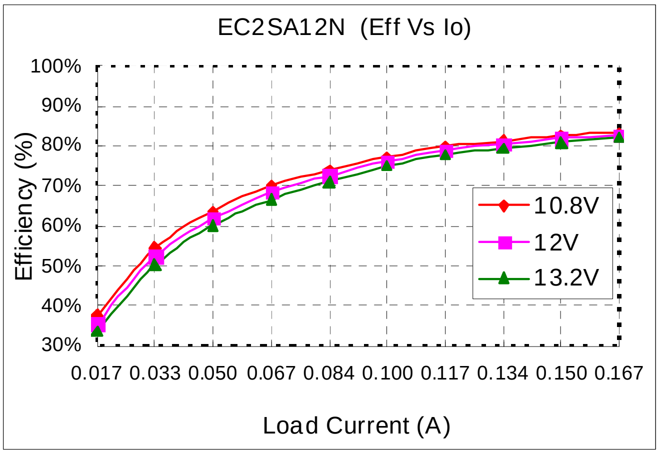



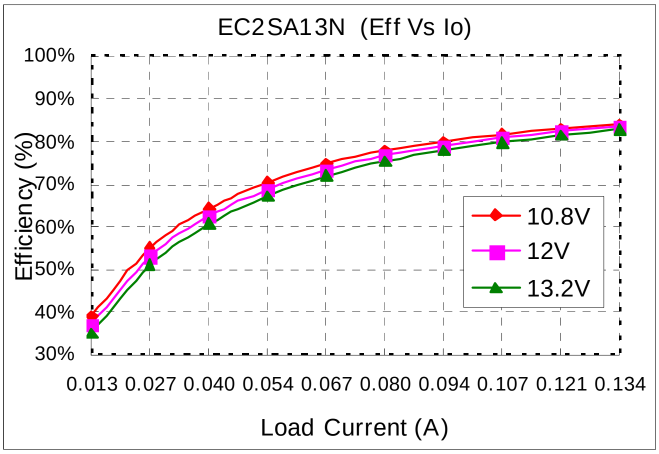





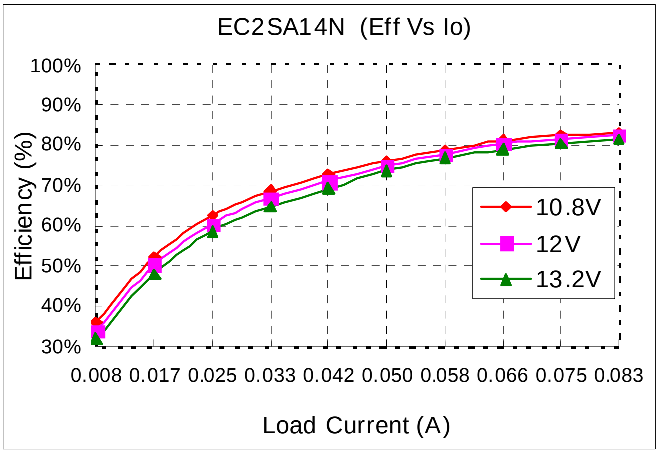
EC2SA11N (Eff Vs Io)
100%
90%
80%
70%
60%
50%
40%
30%
Efficiency (%)
10.8V
12V
13.2V
0.040 0.080 0.120 0.160 0.200 0.240 0.280 0.320 0.360 0.400
Load Current (A)

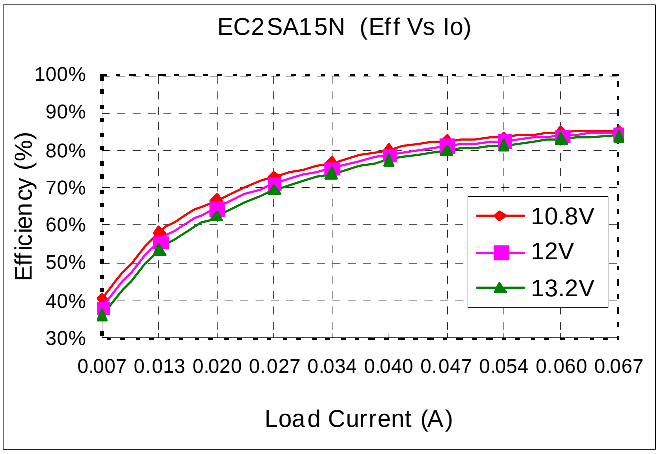
EC2SA12N (Eff Vs Io)
100%
90%
80%
70%
60%
50%
40%
30%
Efficiency (%)
10.8V
12V
13.2V
0.017 0.033 0.050 0.067 0.084 0.100 0.117 0.134 0.150 0.167
Load Current (A)

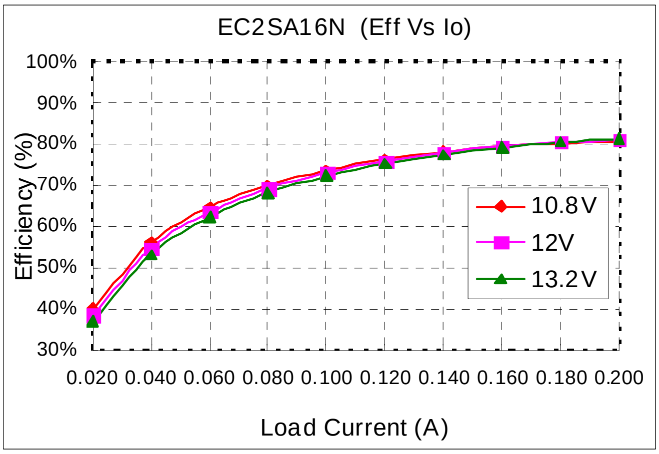
EC2SA13N (Eff Vs Io)
100%
90%
80%
70%
60%
50%
40%
30%
Efficiency (%)
10.8V
12V
13.2V
0.013 0.027 0.040 0.054 0.067 0.080 0.094 0.107 0.121 0.134
Load Current (A)

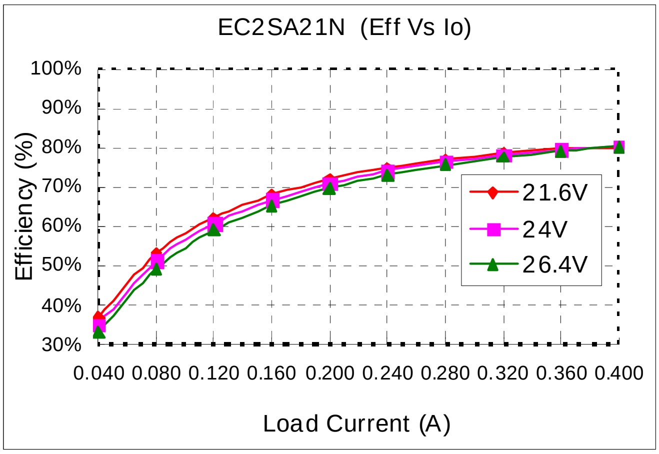
EC2SA14N (Eff Vs Io)
100%
90%
80%
70%
60%
50%
40%
30%
Efficiency (%)
10.8V
12V
13.2V
0.008 0.017 0.025 0.033 0.042 0.050 0.058 0.066 0.075 0.083
Load Current (A)

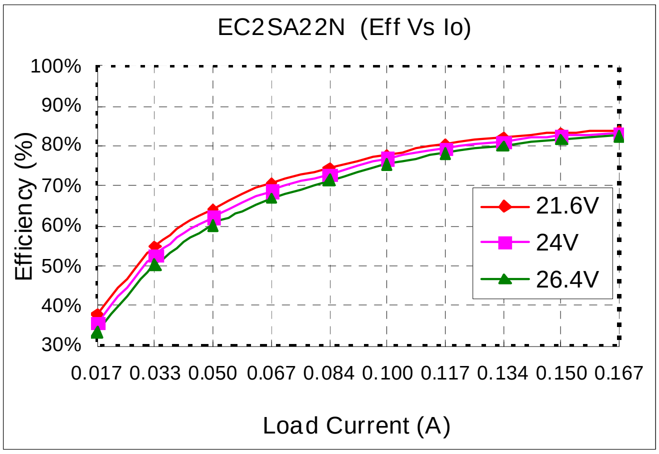



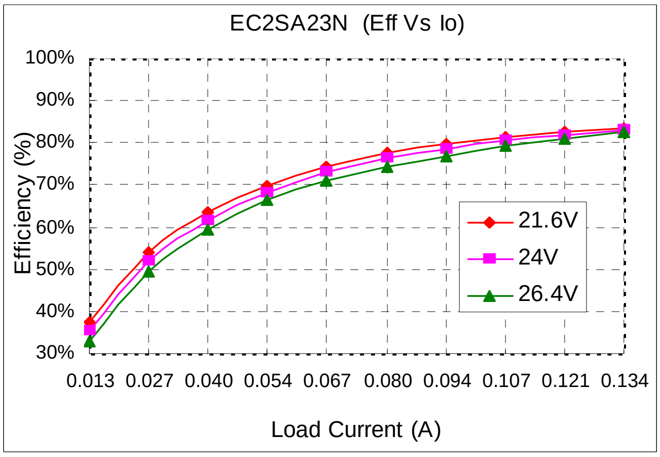
EC2SA15N (Eff Vs Io)
100%
90%
80%
70%
60%
50%
40%
30%
Efficiency (%)
10.8V
12V
13.2V
0.007 0.013 0.020 0.027 0.034 0.040 0.047 0.054 0.060 0.067
Load Current (A)

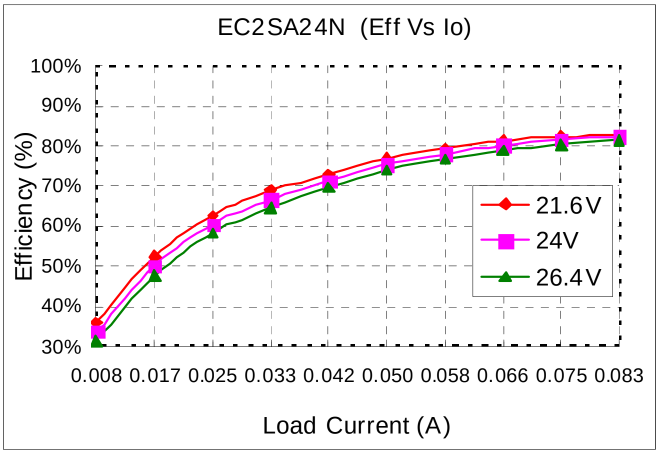



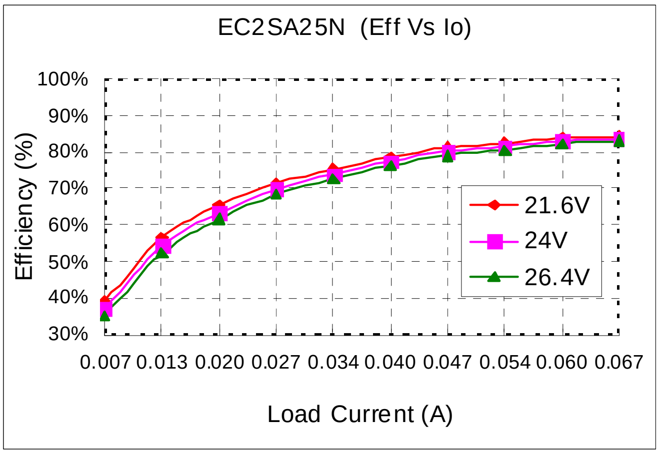
EC2SA16N (Eff Vs Io)
100%
90%
80%
70%
60%
50%
40%
30%
Efficiency (%)
10.8V
12V
13.2V
0.020 0.040 0.060 0.080 0.100 0.120 0.140 0.160 0.180 0.200
Load Current (A)

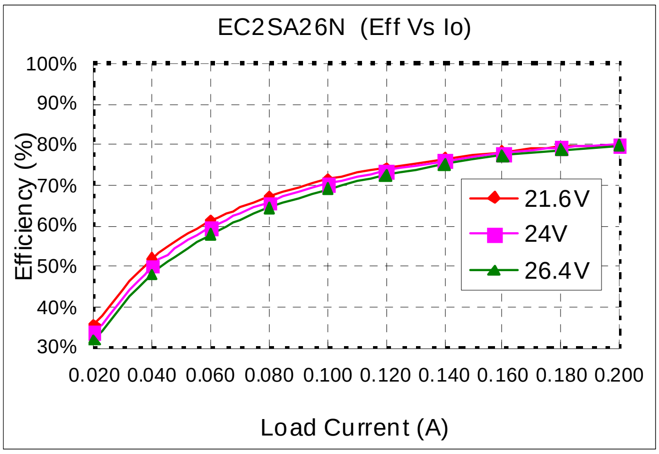

EC2SA21N (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
0.040 0.080 0.120 0.160 0.200 0.240 0.280 0.320 0.360 0.400
Load Current (A)
21.6V
24V
26.4V


EC2SA22N (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
0.017 0.033 0.050 0.067 0.084 0.100 0.117 0.134 0.150 0.167
Load Current (A)
21.6V
24V
26.4V


EC2SA23N (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
0.013 0.027 0.040 0.054 0.067 0.080 0.094 0.107 0.121 0.134
Load Current (A)
21.6V
24V
26.4V

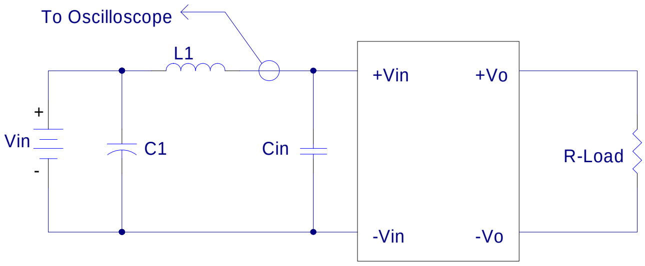

EC2SA24N (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
0.008 0.017 0.025 0.033 0.042 0.050 0.058 0.066 0.075 0.083
Load Current (A)
21.6V
24V
26.4V


EC2SA25N (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
0.007 0.013 0.020 0.027 0.034 0.040 0.047 0.054 0.060 0.067
Load Current (A)
21.6V
24V
26.4V


EC2SA26N (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
0.020 0.040 0.060 0.080 0.100 0.120 0.140 0.160 0.180 0.200
Load Current (A)
21.6V
24V
26.4V

### *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. The input capacitors (Cin) are recommended by low ESR capacitors of 2.2uF for 5Vin and 12Vin models or 10uF for 24Vin models. Testing Circuit for reflected ripple current as shown in Figure5 represents typical measurement methods. 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: 2.2uF Tantalum capacitor for 5Vin and 12Vin models or
10uFCeramic capacitor for 24Vin models
Cin: None

Figure5 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 Figure6 and 7. 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:

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

Where: $V_{FL}$ is the output voltage at full load
$V_{ML}$ is the output voltage at 20%full load

Line regulation is per 1.0% change in input voltage.
The value of line regulation is defined as:

$$Line.reg = \frac{\frac{V_{HL} - V_{LL}}{V_{NOM}} \times 100\%}{20}$$

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.
$V_{NOM}$ is the output voltage of nominal input voltage at full load.

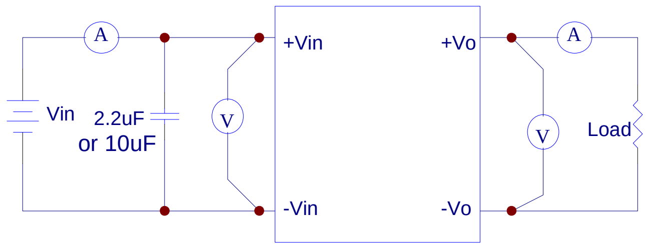



Figure6 EC2SAN Series Single output Test Setup

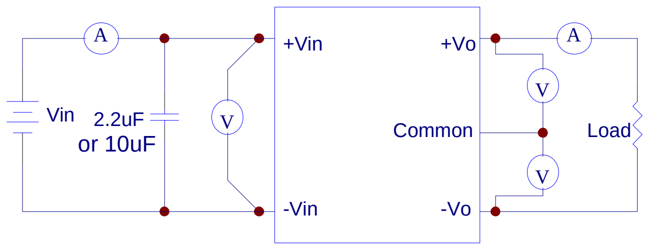



Figure7 EC2SAN Series Dual output Test Setup

### *6.6 Output Ripple and Noise Measurement*

The test set-up for noise and ripple measurements is shown in Figure8 and 9. 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. The output ripple/noise is measured with 0.33uF ceramic capacitor across output. The ripple and noise is measured by BNC at 50mm to 75mm (2" to 3") from the module.

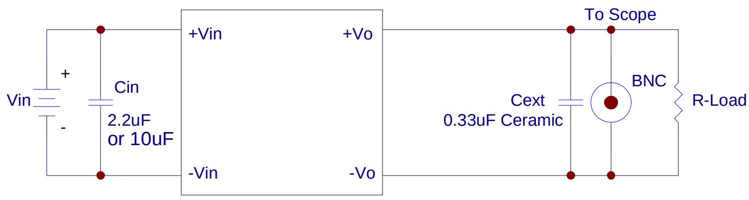



Figure8 Output Voltage Ripple and Noise Measurement Set-up for Single Output

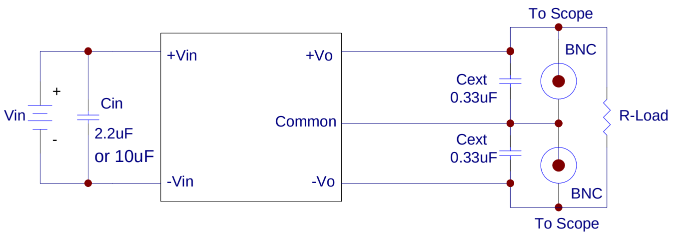



Figure9 Output Voltage Ripple and Noise Measurement Set-up for Dual output

### *6.7 Output Capacitance*

The EC2SAN 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 EC2SAN 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 1A for 5Vin models, 500mA for 12Vin models and 250mA for 24Vin models. Figure10 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.

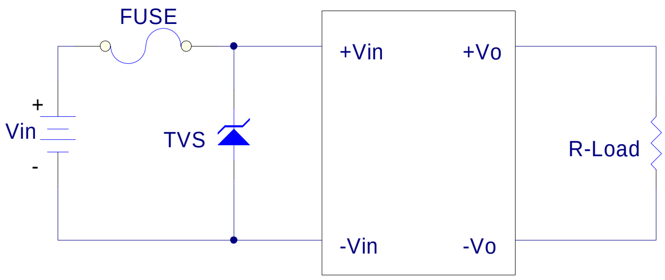



Figure10 Input Protection

### *7.2 EMC Considerations*

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

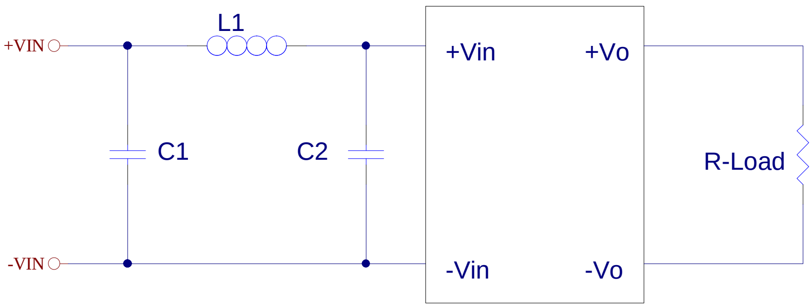



Figure11 Connection circuit for conducted EMI testing

| | EN55022 class A | | | EN55022 class B | | |
|---|---|---|---|---|---|---|
| Model No. | C1 | C2 | L1 | C1 | C2 | L1 |
| EC2SA01N | 4.7uF/50V 1812 | NC | 2.2uH | 10uF/25V 1812 | NC | 5.6uH |
| EC2SA02N | 4.7uF/50V 1812 | NC | 2.2uH | 10uF/25V 1812 | NC | 5.6uH |
| EC2SA03N | 10uF/25V 1812 | NC | 5.6uH | 10uF/25V 1812 | 10uF/25V 1812 | 5.6uH |
| EC2SA04N | 4.7uF/50V 1812 | NC | 2.2uH | 10uF/25V 1812 | NC | 5.6uH |
| EC2SA05N | 10uF/25V 1812 | NC | 5.6uH | 10uF/25V 1812 | 10uF/25V 1812 | 5.6uH |
| EC2SA06N | 4.7uF/50V 1812 | NC | 2.2uH | 10uF/25V 1812 | NC | 5.6uH |
| EC2SA11N | 10uF/25V 1812 | NC | 5.6uH | 10uF/25V 1812 | 10uF/25V 1812 | 5.6uH |
| EC2SA12N | 4.7uF/50V 1812 | NC | 5.6uH | 10uF/25V 1812 | 10uF/25V 1812 | 5.6uH |
| EC2SA13N | 4.7uF/50V 1812 | NC | 5.6uH | 10uF/25V 1812 | 10uF/25V 1812 | 5.6uH |
| EC2SA14N | 4.7uF/50V 1812 | NC | 5.6uH | 10uF/25V 1812 | 10uF/25V 1812 | 5.6uH |
| EC2SA15N | 4.7uF/50V 1812 | NC | 5.6uH | 10uF/25V 1812 | 10uF/25V 1812 | 5.6uH |
| EC2SA16N | 10uF/25V 1812 | NC | 5.6uH | 10uF/25V 1812 | 10uF/25V 1812 | 5.6uH |
| EC2SA21N | 4.7uF/50V 1812 | 4.7uF/50V 1812 | 5.6uH | 10uF/50V 2220 | 10uF/50V 2220 | 5.6uH |
| EC2SA22N | 4.7uF/50V 1812 | 4.7uF/50V 1812 | 5.6uH | 10uF/50V 2220 | 10uF/50V 2220 | 5.6uH |
| EC2SA23N | 4.7uF/50V 1812 | 4.7uF/50V 1812 | 5.6uH | 10uF/50V 2220 | 10uF/50V 2220 | 5.6uH |
| EC2SA24N | 4.7uF/50V 1812 | 4.7uF/50V 1812 | 5.6uH | 10uF/50V 2220 | 10uF/50V 2220 | 5.6uH |
| EC2SA25N | 4.7uF/50V 1812 | 4.7uF/50V 1812 | 5.6uH | 10uF/50V 2220 | 10uF/50V 2220 | 5.6uH |
| EC2SA26N | 4.7uF/50V 1812 | 4.7uF/50V 1812 | 5.6uH | 10uF/50V 2220 | 10uF/50V 2220 | 5.6uH |

Note: All of capacitors are ceramic capacitors.

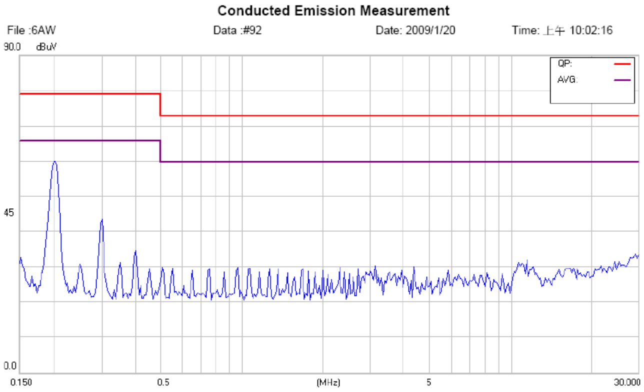



Figure12-1 EMI Conducted Class A for EC2SAN01N

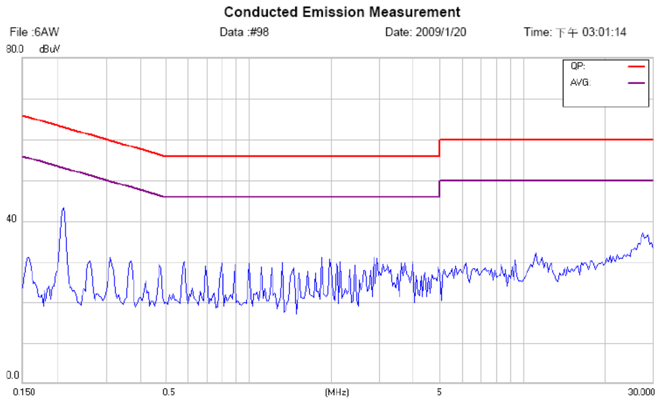



Figure12-2 EMI Conducted Class B for EC2SAN01N

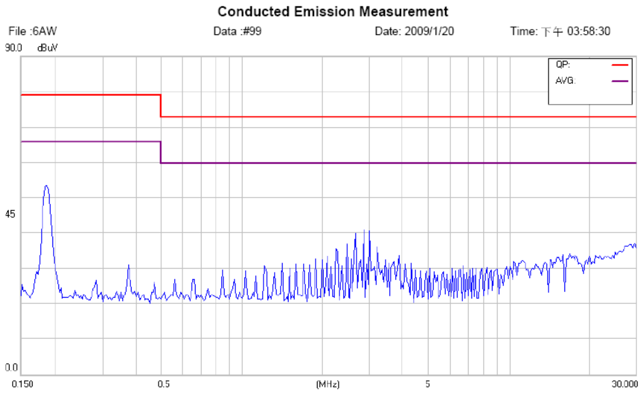



Figure13-1 EMI Conducted Class A for EC2SAN24N

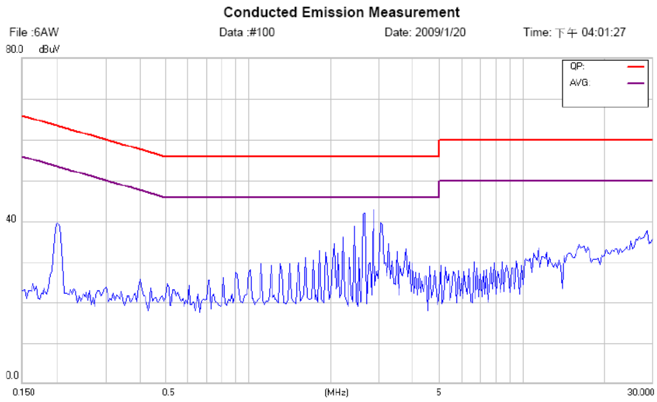



Figure13-2 EMI Conducted Class B for EC2SAN24N

## 8. Part Number

EC2SA X X N

EC2SAN

0 : Nominal Input Voltage 5VDC
1 : Nominal Input Voltage 12VDC
2 : Nominal Input Voltage 24VDC

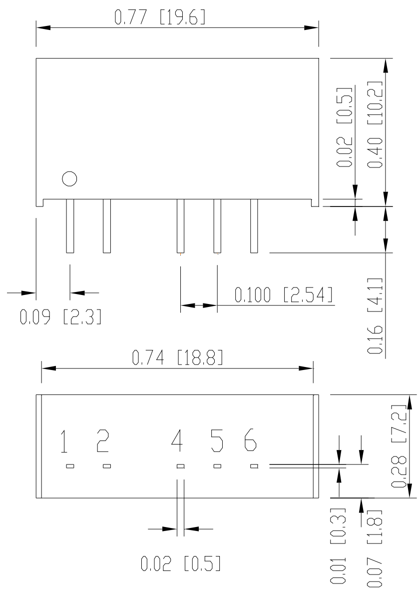
1 : Output Voltage 5 VDC
2 : Output Voltage 12 VDC
3 : Output Voltage 15 VDC
4 : Output Voltage ±12 VDC
5 : Output Voltage ±15 VDC
6 : Output Voltage ±5 VDC

N: Unregulated Output SIL packages

## 9. Mechanical Outline Diagrams

### *9.1 Mechanical Outline Diagrams*

SIP PACKAGES




All Dimensions In Inches(mm)

| Tolerance | Inches | Millimeters |
|---|---|---|
| | X.XX±0.01 | X.X±0.25 |
| | X.XXX±0.005 | X.XX±0.13 |
| Pin | ±0.002 | ±0.05 |

PIN CONNECTION

| Pin | Single Output | Dual Output |
|---|---|---|
| 1 | +Vin | +Vin |
| 2 | -Vin | -Vin |
| 4 | -Vout | -Vout |
| 5 | No Pin | Common |
| 6 | +Vout | +Vout |

Figure14 EC2SAN Mechanical Outline Diagram

### *9.2 Packaging Details*

The EC2SAN series SIL version are supplied in Tube(11x20x330mm). Modules are shipped in quantities of 14 modules per Tube. Details of tube dimensions are shown below.

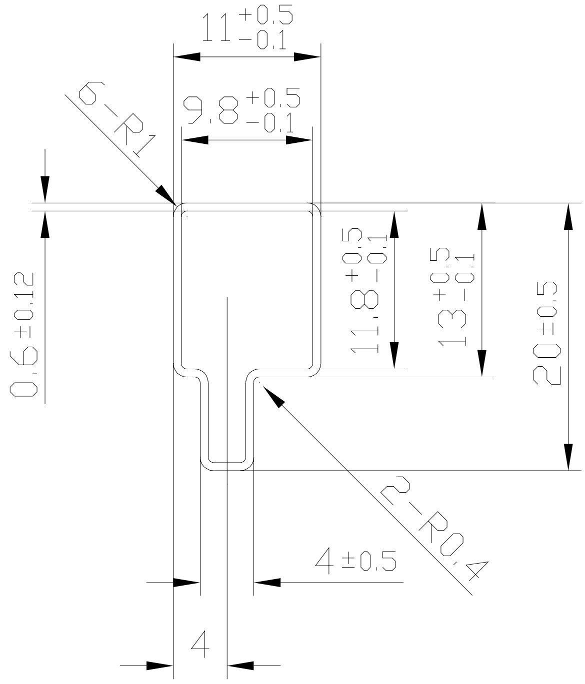



Figure15  SIL Packages Tube for EC2SAN

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