EC1SAN SERIES 1W DC-DC Converters

Application Note V16

ISOLATED DC-DC Converter
EC1SAN SERIES
APPLICATION NOTE

Approved By:

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Content

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1. Introduction

The EC1SAN series offer 1 watts of output power with Industry Standard Single-In-line Package (SIP) in a 0.77 x 0.24 x 0.40inches (19.5 x 6.1 x 10.2mm), for 24Vin 0.77 x 0.28 x 0.40inches (19.5 x 7.2 x 10.2) and SMD Packages Single: 0.54 x 0.36 x 0.29inches (13.7 x 9.2 x 7.4mm), Dual: 0.64 x 0.36 x 0.29inches (16.2 x 9.2 x 7.4mm). The EC1SAN 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, 1500VDC of isolation and allow an operating ambient temperature range of –40°C to 85°C. Furthermore, 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 and SMD Packages
- Efficiency up to 83%
- 1500VDC Isolation
- Low Cost
- Unregulated Outputs
- Low Ripple and Noise
- RoHS compliance

3. Electrical Block Diagram

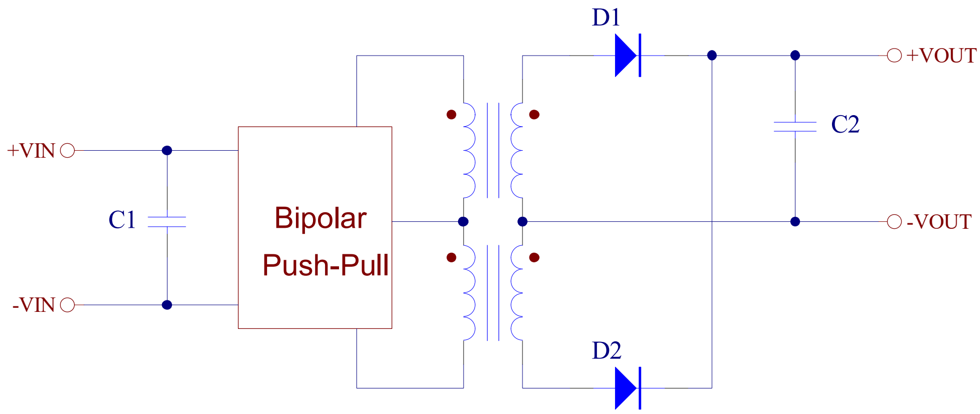


Figure1 Electrical Block Diagram for Single output

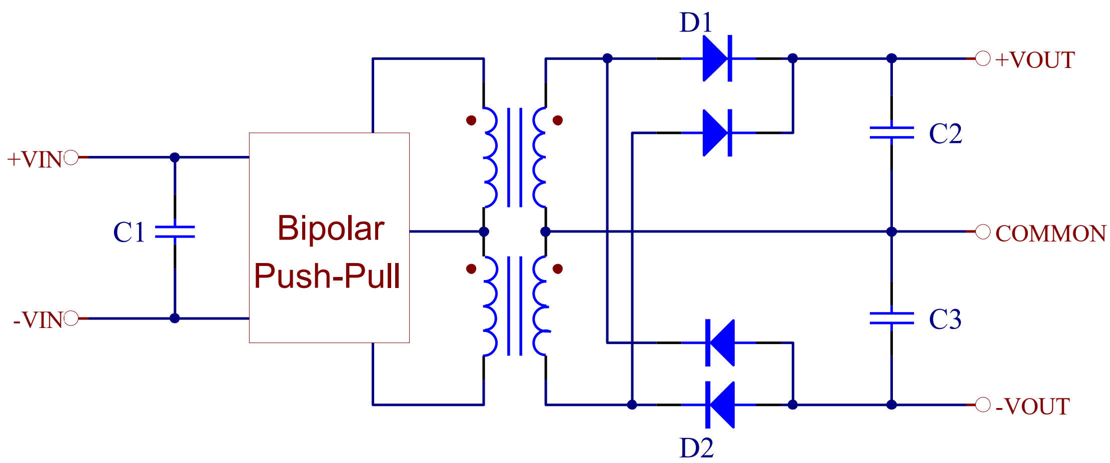


Figure2 Electrical Block Diagram for Dual output

4. Technical Specifications

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

ABSOLUTE MAXIMUM RATINGS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Input Voltage						
Continuous		EC1SA0XXX	-0.7		5.5	V_{dc}
		EC1SA1XXX	-0.7		13.2	
		EC1SA2XXX	-0.7		26.4	
Transient	100ms max.	EC1SA0XXX			9	V_{dc}
		EC1SA1XXX			18	
		EC1SA2XXX			30	
Operating Ambient Temperature		All	-40		+85	℃
Storage Temperature		All	-55		+125	℃
Operating Case Temperature		All	-40		100	℃
Isolation Voltage	1 Minute input/output	All	1500			V_{dc}

INPUT CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Operating Input Voltage		EC1SA0XXX	4.5	5	5.5	V_{dc}
		EC1SA1XXX	10.8	12	13.2	
		EC1SA2XXX	21.6	24	26.4	
Maximum Input Current	100% Load, V_{in}=4.5V for 1SA0XXX	EC1SA0XXX		250		mA
	100% Load, V_{in}=10.8V for 1SA1XXX	EC1SA1XXX		110		
	100% Load, V_{in}=21.6V for 1SA2XXX	EC1SA2XXX		50		
No-Load Input Current	V_{in}=5V	EC1SA0XXX		40		mA
	V_{in}=12V	EC1SA1XXX		15		
	V_{in}=24V	EC1SA2XXX		7		
Inrush Current (I^2t)		All			0.01	A^2s

OUTPUT CHARACTERISTIC

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Output Voltage Set Point	V_{in}=Nominal V_{in}, Io=$I_{o.max.}$, T_c=25℃	Vo=5.0Vdc	4.85	5.0	5.15	V_{dc}
		Vo=12Vdc	11.64	12	12.36	
		Vo=15Vdc	14.55	15	15.45	
		Vo=±5.0Vdc	±4.85	±5.0	±5.15	
		Vo=±12Vdc	±11.64	±12	±12.36	
		Vo=±15Vdc	±14.55	±15	±15.45	
Output Voltage Balance	V_{in}=Nominal V_{in}, Io=$I_{o.max.}$, T_c=25℃	Dual			±1.0	%
Output Voltage Regulation						
Load Regulation	I_o=20% to 100%	All			±10	%
Line Regulation	For V_{in} change of 1%	All			±1.2	%
Temperature Coefficient	T_a=-40℃ to 85℃	All			±0.05	%/℃
Output Voltage Ripple and Noise						
Peak-to-Peak	Full Load, 20MHz bandwidth Output with 0.33uF ceramic capacitor	EC1SAXXN			75	mV
		EC1SA0XNS EC1SA1XNS			120	

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Operating Output Current Range		Vo=5.0Vdc	0		200	mA
		Vo=12Vdc	0		84	
		Vo=15Vdc	0		67	
		Vo=±12Vdc	0		42	
		Vo=±15Vdc	0		33	
		Vo=±5Vdc	0		100	
Over Load	V_{in}=Nominal V_{in} Output voltage within V_o set point ±5%	All	120			%
Maximum Output Capacitance	Full load	Vo=5.0Vdc	0		220	uF
		Vo=12Vdc	0		220	
		Vo=15Vdc	0		220	
		Vo=±5.0Vdc	0		100	
		Vo=±12Vdc	0		100	
		Vo=±15Vdc	0		100	
Output Short Circuit	Momentary	All			1	sec.

EFFICIENCY

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
100% Load	V_{in}=Nominal V_{in}	EC1SA01N		79		%
		EC1SA02N		79		
		EC1SA03N		79		
		EC1SA04N		78		
		EC1SA05N		78		
		EC1SA06N		74		
		EC1SA11N		80		
		EC1SA12N		81		
		EC1SA13N		81		
		EC1SA14N		80		
		EC1SA15N		81		
		EC1SA16N		77		
		EC1SA21N		80		
		EC1SA22N		83		
		EC1SA23N		81		
		EC1SA24N		81		
		EC1SA25N		82		
		EC1SA26N		79		

ISOLATION CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Input to Output	1 Minutes	All	1500			V_{dc}
Isolation Resistance		All	1000			MΩ
Isolation Capacitance		All		10		pF

FEATURE CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Switching Frequency	V_{in}=Nominal V_{in}, Io=100% of $I_{o.max.}$	EC1SA2XX		75		KHz
		Others		100		

GENERAL SPECIFICATIONS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
MTBF	I_o=100% of $I_{o.max;}$, T_a=25℃ per MIL-HDBK-217F	All		1.5		M hours
Weight		EC1SA2XXX		2.7		grams
		Others		1.8		

5. Main Features and Functions

5.1 Operating Temperature Range

The EC1SAN 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 3-1~3-5.**

6.1.a. SIP Type

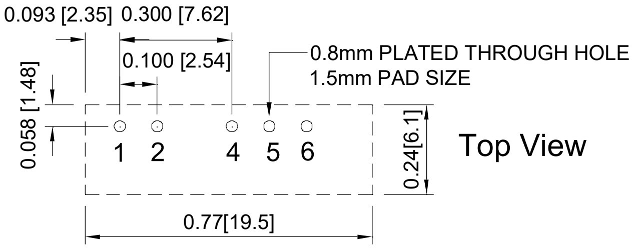


Figure3-1 Recommended PCB Footprints for SIP 5Vin and 12Vin Models

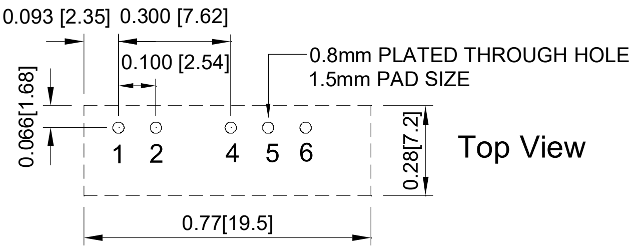


Figure3-2 Recommended PCB Footprints for SIP 24Vin Models

Note: Dimensions are in inches (millimeters)

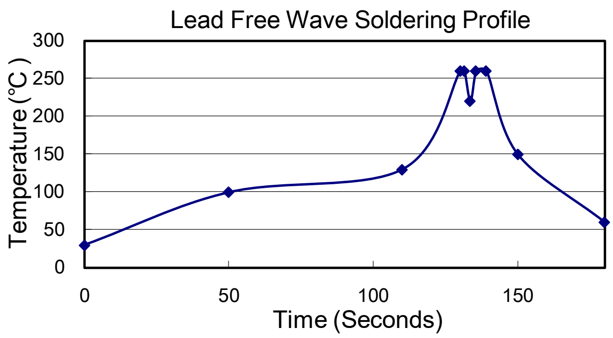


Figure3-3 Recommended Wave Soldering Profile for SIP Package Models

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℃)

6.1.b. SMD Type

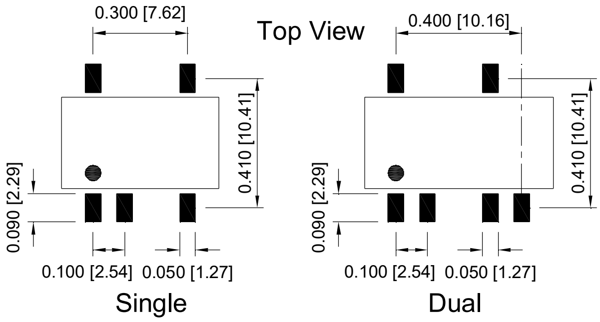


Figure3-4 Recommended PCB Footprints for SMD package Models

Note: Dimensions are in inches (millimeters)

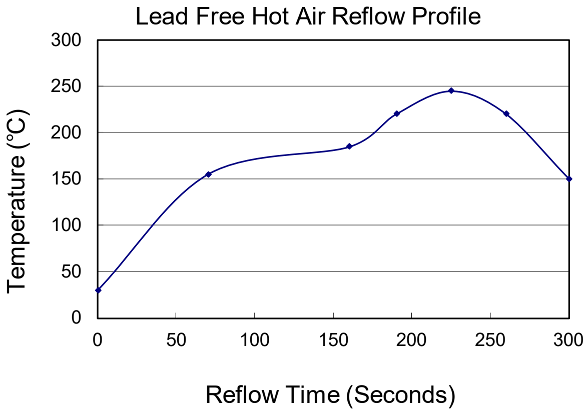


Figure3-5 Recommended Hot Air Reflow Profile for SMD package Models

Note:
1. Soldering Paste: SHENMAO PF610-P (Sn/Ag/Cu)
2. Ramp up rate during preheat: 1.79℃/Sec (from 30℃ to 155℃)
3. Soaking temperature: 0.33℃/Sec (from 155℃ to 185℃)
4. Ramp up rate during reflow: 0.71℃/Sec (from 220℃ to 245℃)
5. Peak temperature: 245℃ (10Sec max), above 220℃ 40 to 70 Seconds
6. Ramp up rate during cooling: -1.75℃/Sec (from 220℃ to 150℃)

6.2 Power De-rating curves for EC1SAN Series

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

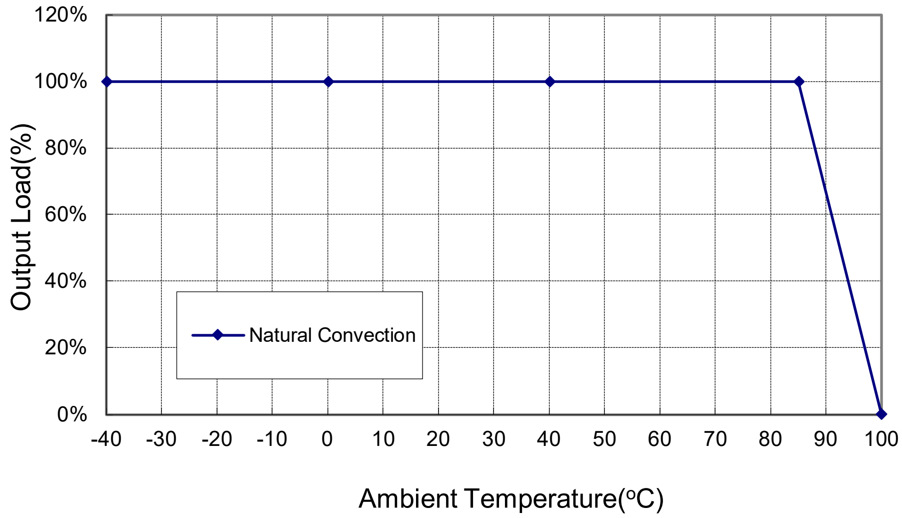
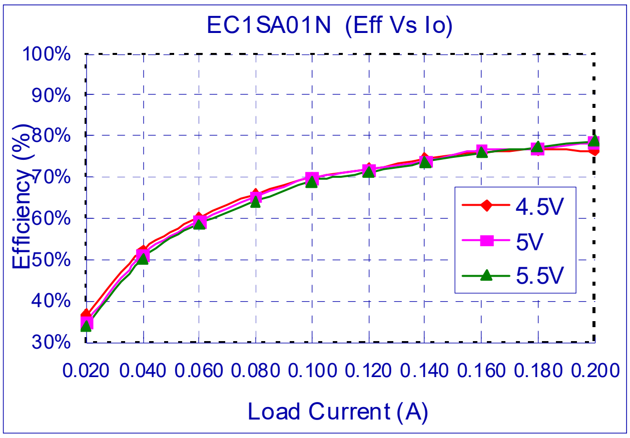
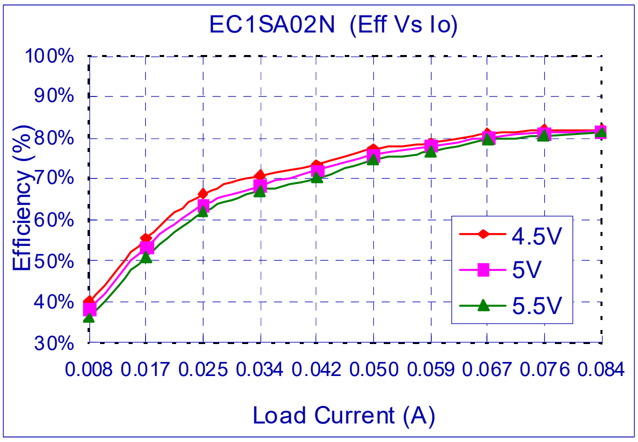
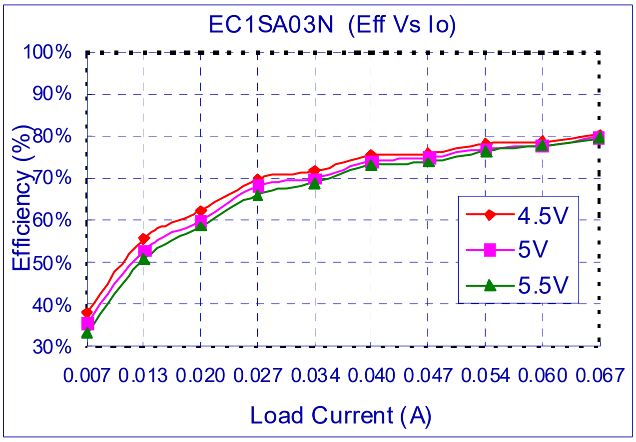


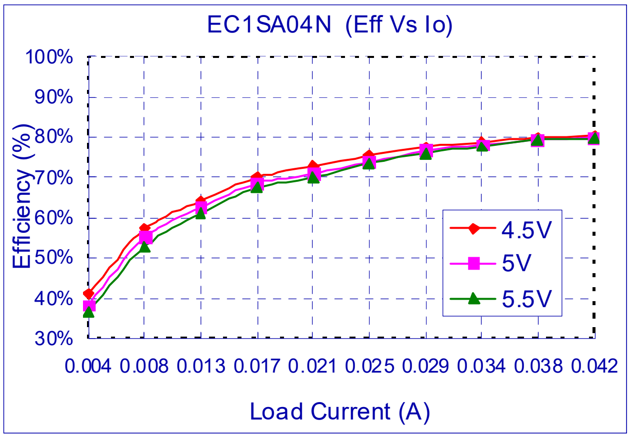
Figure3 Typical Power De-rating Curve for EC1SAN Series

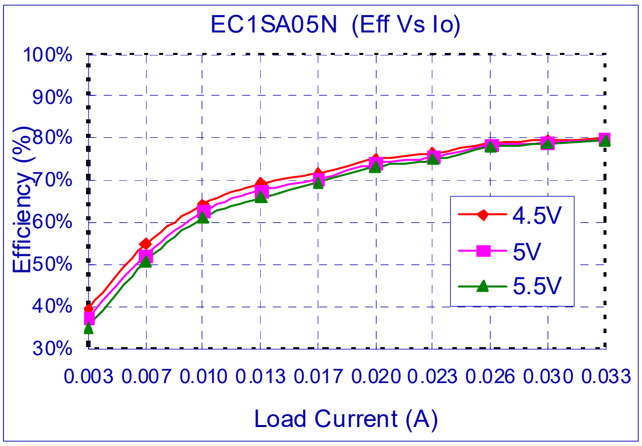
6.3 Efficiency vs. Load Curves

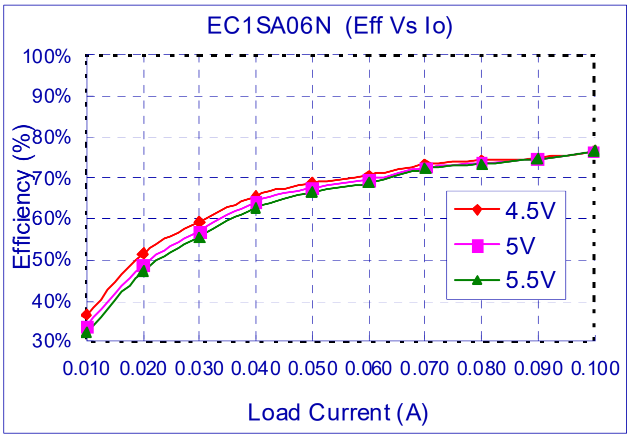


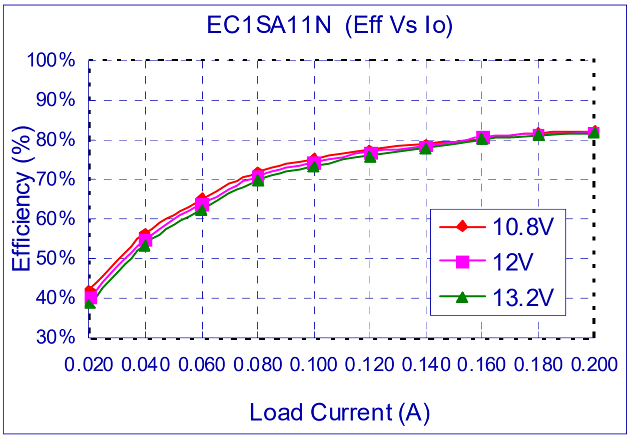




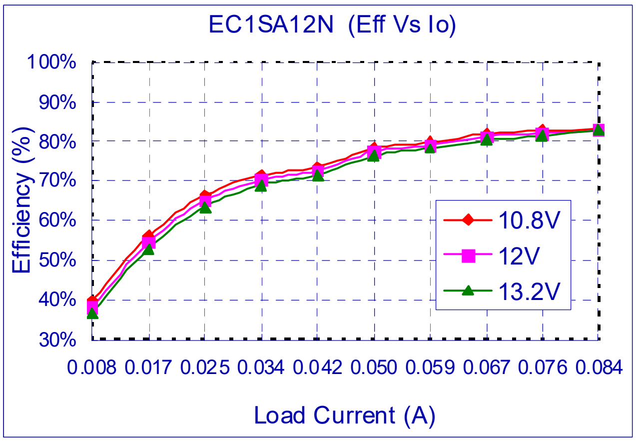




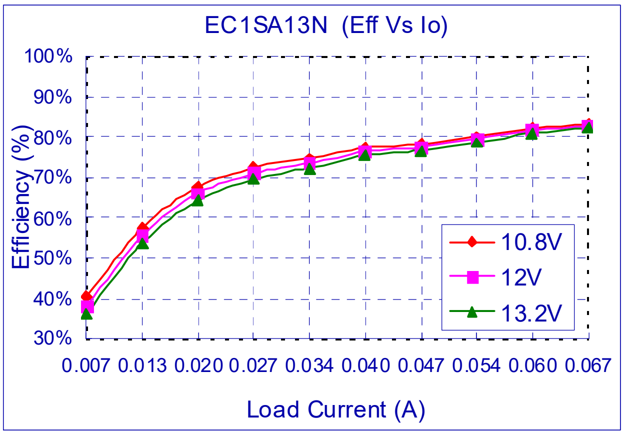




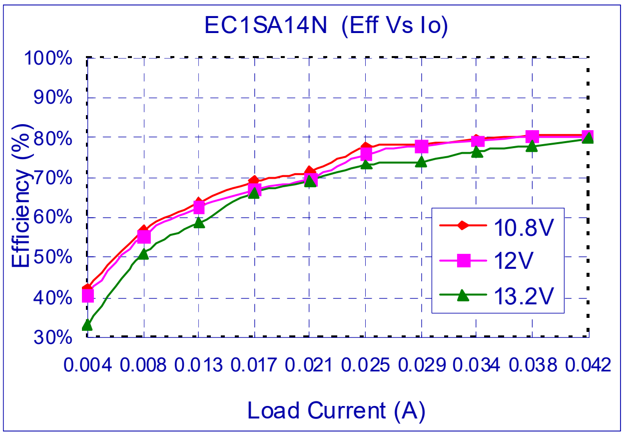
EC1SA11N (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
0.020 0.040 0.060 0.080 0.100 0.120 0.140 0.160 0.180 0.200
Load Current (A)
10.8V
12V
13.2V



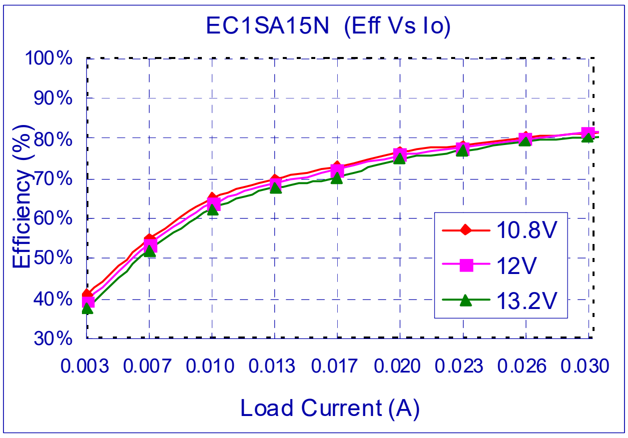
EC1SA12N (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
0.008 0.017 0.025 0.034 0.042 0.050 0.059 0.067 0.076 0.084
Load Current (A)
10.8V
12V
13.2V



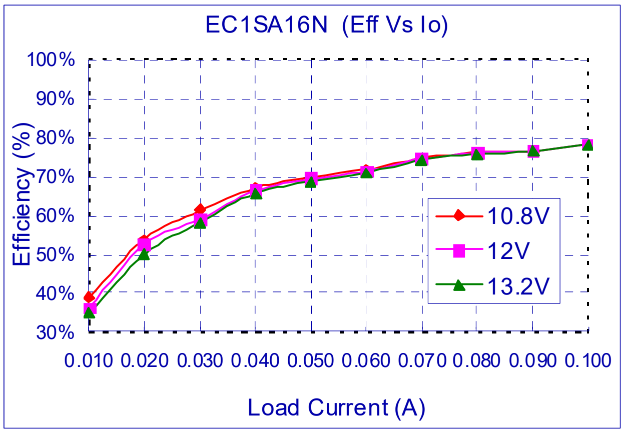
EC1SA13N (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
0.007 0.013 0.020 0.027 0.034 0.040 0.047 0.054 0.060 0.067
Load Current (A)
10.8V
12V
13.2V



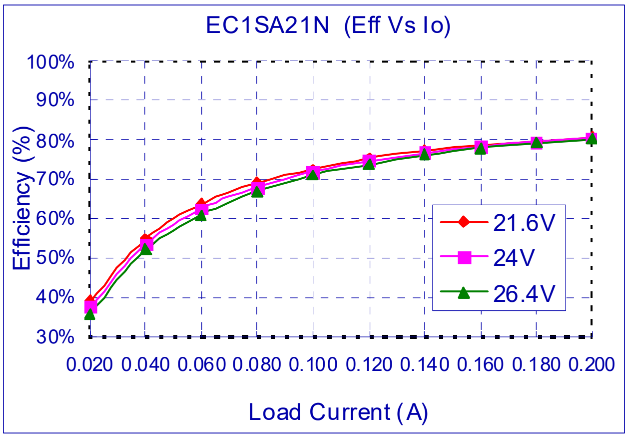
EC1SA14N (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
0.004 0.008 0.013 0.017 0.021 0.025 0.029 0.034 0.038 0.042
Load Current (A)
10.8V
12V
13.2V

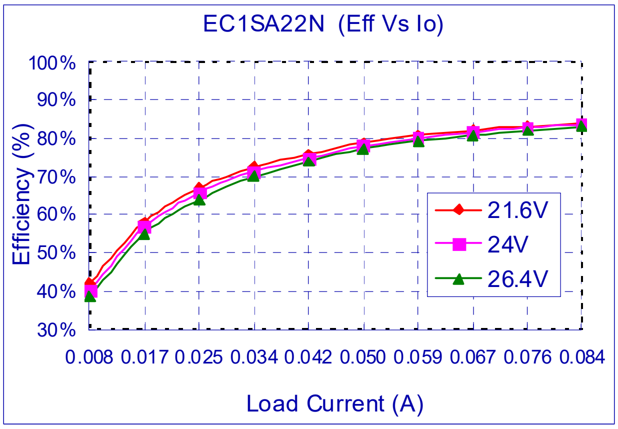


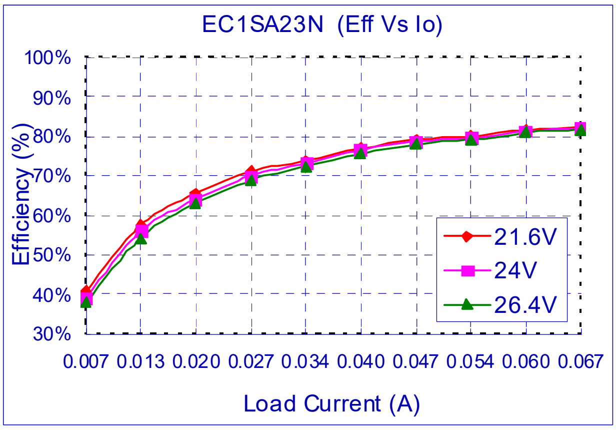
EC1SA15N (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
0.003 0.007 0.010 0.013 0.017 0.020 0.023 0.026 0.030
Load Current (A)
10.8V
12V
13.2V

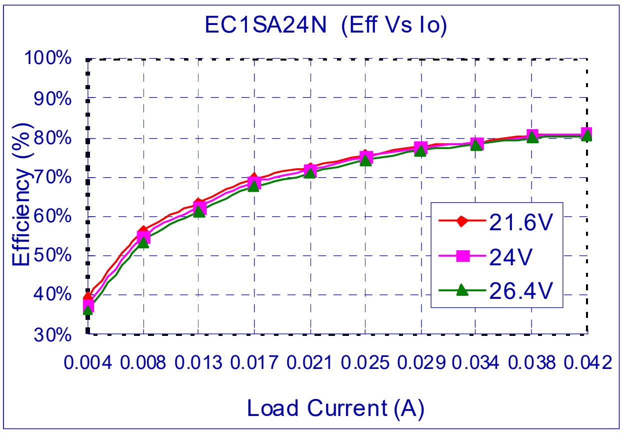


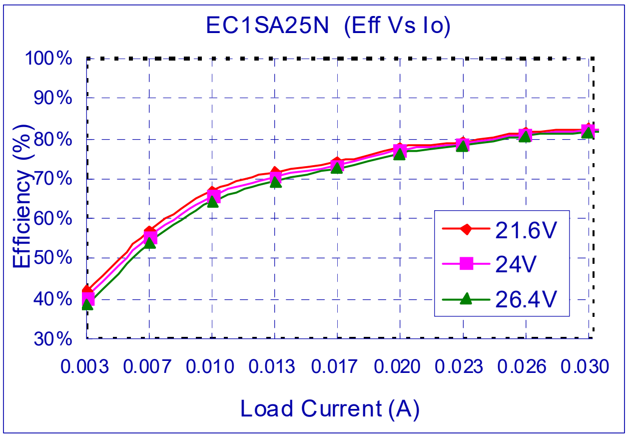
EC1SA16N (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
0.010 0.020 0.030 0.040 0.050 0.060 0.070 0.080 0.090 0.100
Load Current (A)
10.8V
12V
13.2V

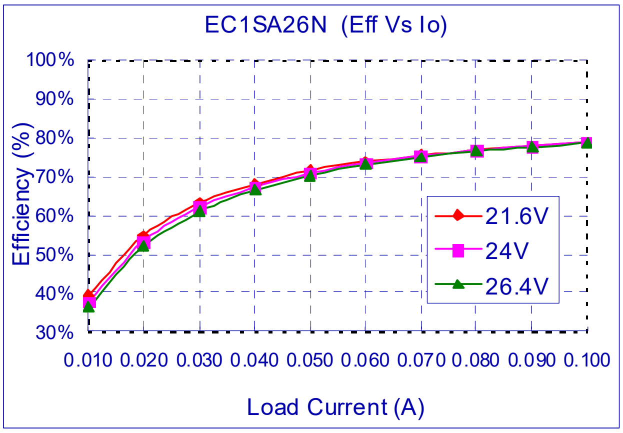

EC1SA21N (Eff Vs Io)
100%
90%
80%
70%
60%
50%
40%
30%
Efficiency (%)
0.020 0.040 0.060 0.080 0.100 0.120 0.140 0.160 0.180 0.200
Load Current (A)
21.6V
24V
26.4V


EC1SA22N (Eff Vs Io)
100%
90%
80%
70%
60%
50%
40%
30%
Efficiency (%)
0.008 0.017 0.025 0.034 0.042 0.050 0.059 0.067 0.076 0.084
Load Current (A)
21.6V
24V
26.4V


EC1SA23N (Eff Vs Io)
100%
90%
80%
70%
60%
50%
40%
30%
Efficiency (%)
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

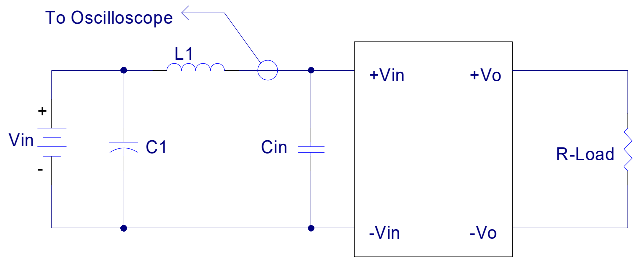

EC1SA24N (Eff Vs Io)
100%
90%
80%
70%
60%
50%
40%
30%
Efficiency (%)
0.004 0.008 0.013 0.017 0.021 0.025 0.029 0.034 0.038 0.042
Load Current (A)
21.6V
24V
26.4V


EC1SA25N (Eff Vs Io)
100%
90%
80%
70%
60%
50%
40%
30%
Efficiency (%)
0.003 0.007 0.010 0.013 0.017 0.020 0.023 0.026 0.030
Load Current (A)
21.6V
24V
26.4V


EC1SA26N (Eff Vs Io)
100%
90%
80%
70%
60%
50%
40%
30%
Efficiency (%)
0.010 0.020 0.030 0.040 0.050 0.060 0.070 0.080 0.090 0.100
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) is recommended by low ESR capacitors for 5Vin, 12Vin models of 2.2uF, for 24Vin.Model of 4.7uF. 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 or 4.7uF Tantalum capacitor
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 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.

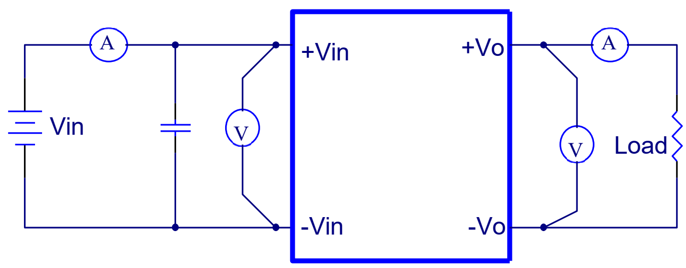


Figure5 EC1SAN Series Single output Test Setup

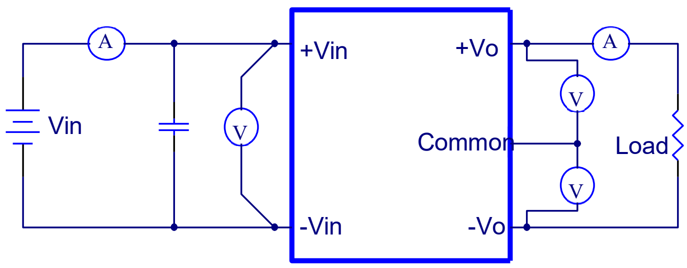


Figure6 EC1SAN Series Dual output Test Setup

Note:
* For 5Vin, 12Vin models input terminal need to parallel with 2.2uF ceramic capacitor.
* For 24Vin models input terminal need to parallel with 4.7uF ceramic capacitor.

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.

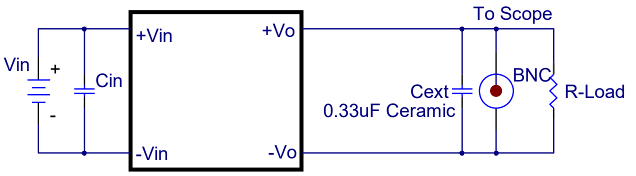


Figure7 Output Voltage Ripple and Noise Measurement Set-up for Single Output

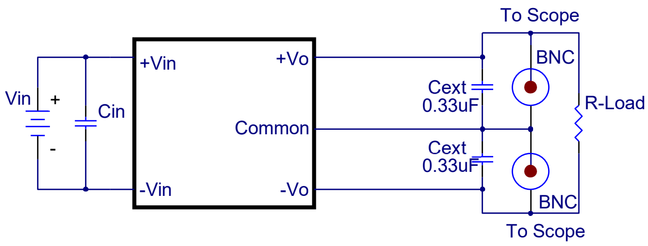


Figure8 Output Voltage Ripple and Noise Measurement Set-up for Dual output

Note:
* For 5Vin, 12Vin models Cin with 2.2uF ceramic capacitor.
* For 24Vin models Cin with 4.7uF ceramic capacitor.

6.7 Output Capacitance

The EC1SAN 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 EC1SAN 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 0.5A for all 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.

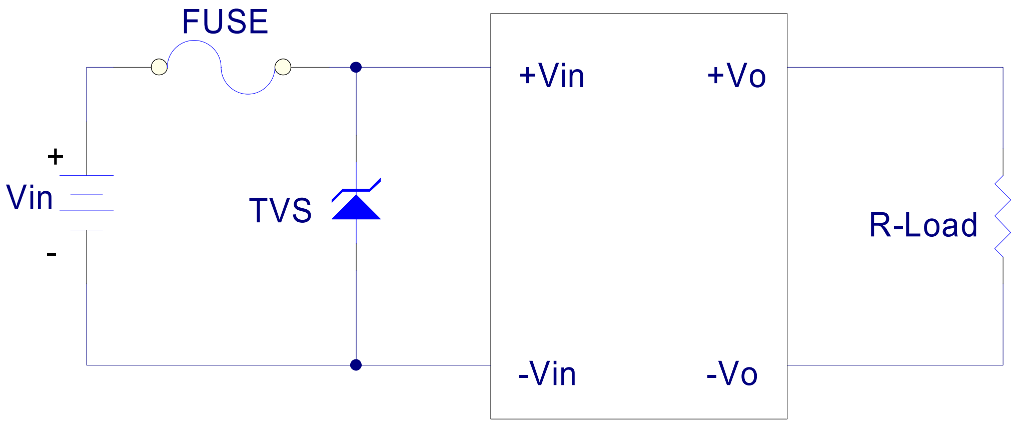


Figure9 Input Protection

7.2 EMC Considerations

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

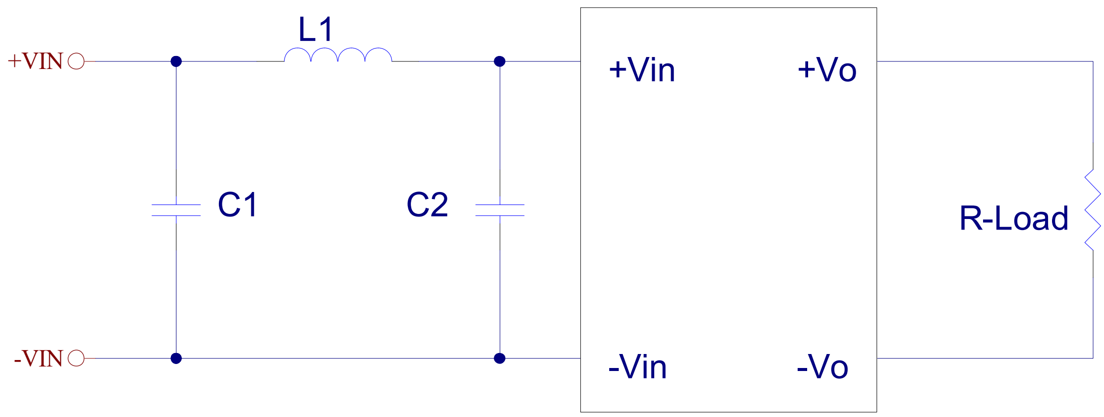


Figure10 Suggested Configuration for EN55022 Class B Conducted Emission

MODEL NO.	C1	C2	L1
EC1SA01N	4.7uF/25V	4.7uF/25V	10uH
EC1SA02N	4.7uF/25V	4.7uF/25V	10uH
EC1SA03N	4.7uF/25V	4.7uF/25V	10uH
EC1SA04N	4.7uF/25V	4.7uF/25V	10uH
EC1SA05N	4.7uF/25V	4.7uF/25V	10uH
EC1SA06N	4.7uF/25V	4.7uF/25V	10uH
EC1SA11N	4.7uF/25V	4.7uF/25V	10uH
EC1SA12N	4.7uF/25V	4.7uF/25V	10uH
EC1SA13N	4.7uF/25V	4.7uF/25V	10uH
EC1SA14N	4.7uF/25V	4.7uF/25V	10uH
EC1SA15N	4.7uF/25V	4.7uF/25V	10uH
EC1SA16N	4.7uF/25V	4.7uF/25V	10uH
EC1SA21N	10uF/50V	10uF/50V	7.5uH
EC1SA22N	10uF/50V	10uF/50V	7.5uH
EC1SA23N	10uF/50V	10uF/50V	7.5uH
EC1SA24N	10uF/50V	10uF/50V	7.5uH
EC1SA25N	10uF/50V	10uF/50V	7.5uH
EC1SA26N	10uF/50V	10uF/50V	7.5uH

Note: C1, C2 is ceramic capacitors.

EC1SAN SERIES 1W DC-DC Converters

Application Note V16

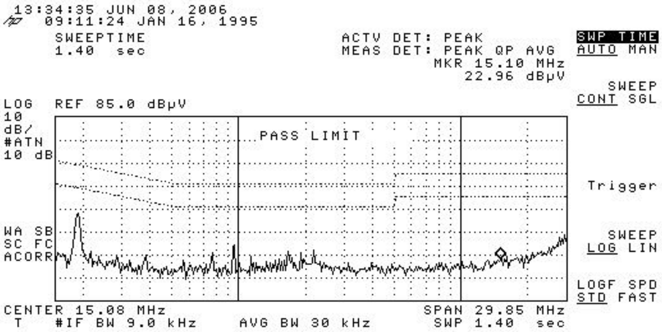


Figure11-1 EMI Conducted Class B for EC1SA01N

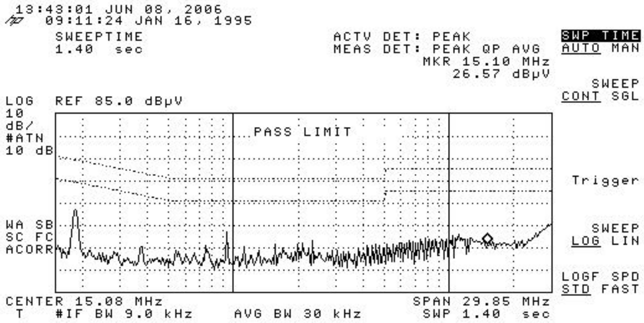


Figure11-2 EMI Conducted Class B for EC1SA02N

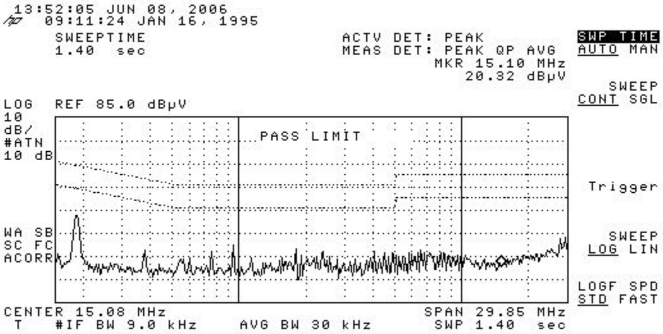


Figure12-1 EMI Conducted Class B for EC1SA03N

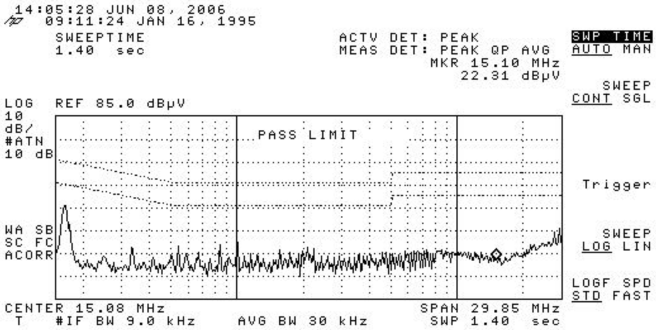


Figure12-2 EMI Conducted Class B for EC1SA04N

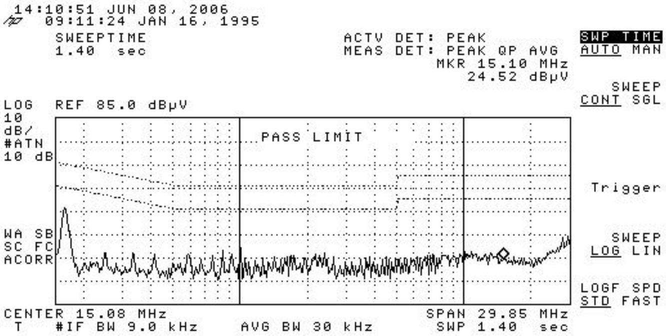


Figure13-1 EMI Conducted Class B for EC1SA05N

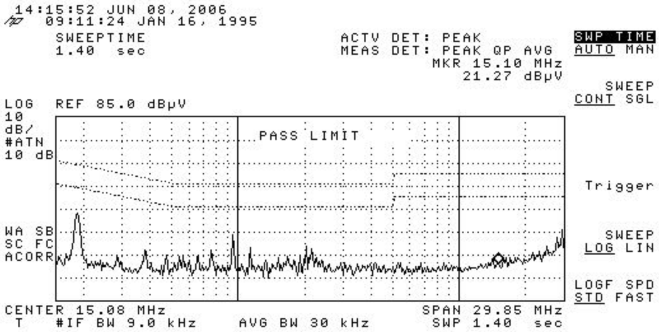


Figure13-2 EMI Conducted Class B for EC1SA06N

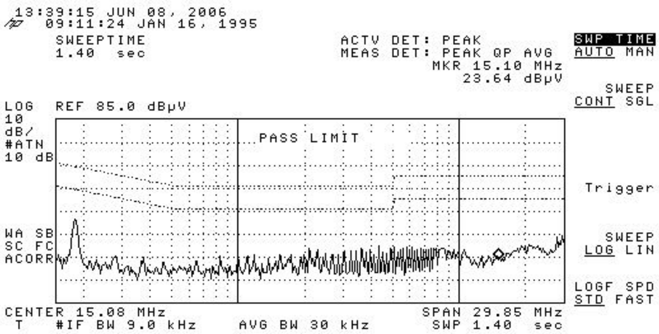


Figure14-1 EMI Conducted Class B for EC1SA11N

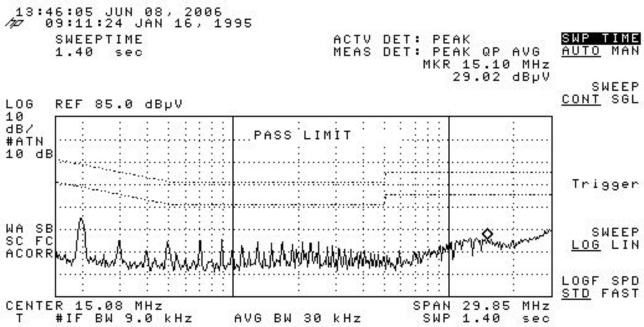


Figure14-2 EMI Conducted Class B for EC1SA12N

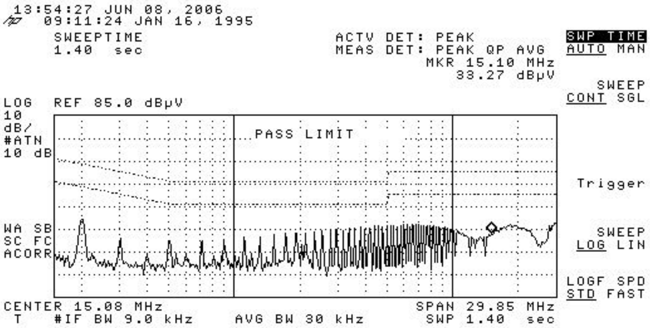


Figure15-1 EMI Conducted Class B for EC1SA13N

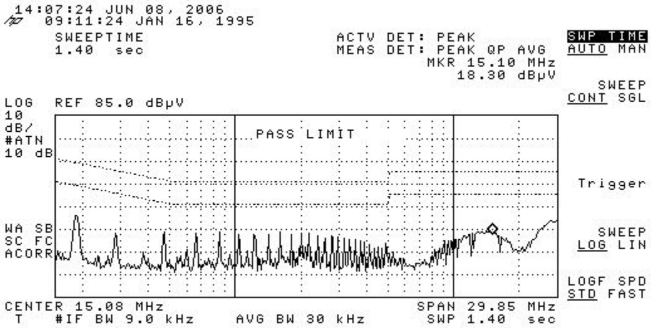


Figure15-2 EMI Conducted Class B for EC1SA14N

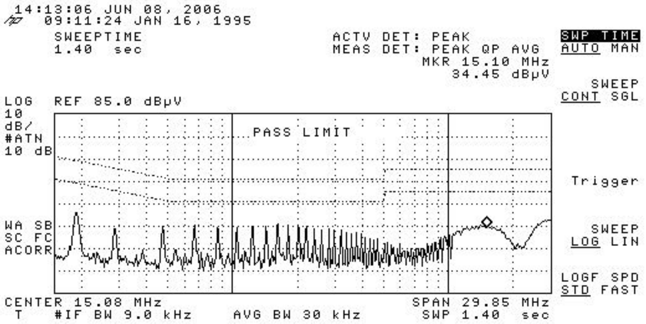


Figure16-1 EMI Conducted Class B for EC1SA15N

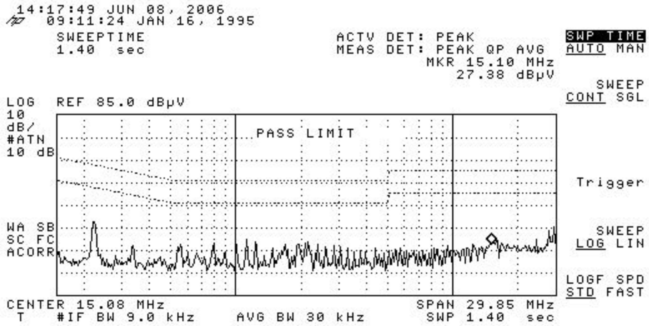


Figure16-2 EMI Conducted Class B for EC1SA16N

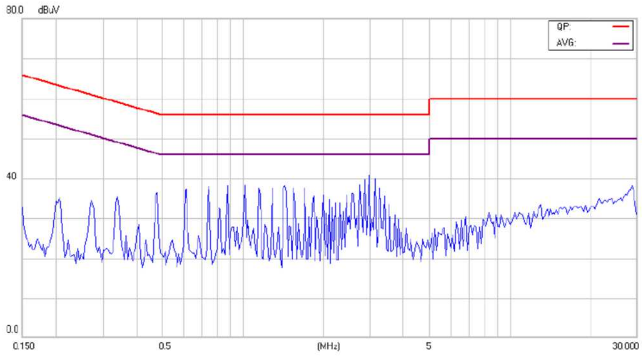


Figure17-1 EMI Conducted Class B for EC1SA21N

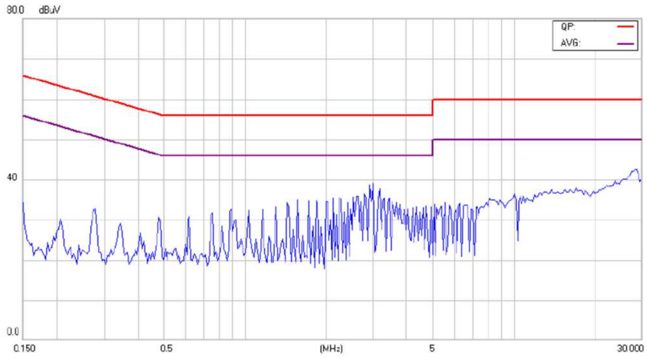


Figure17-2 EMI Conducted Class B for EC1SA22N

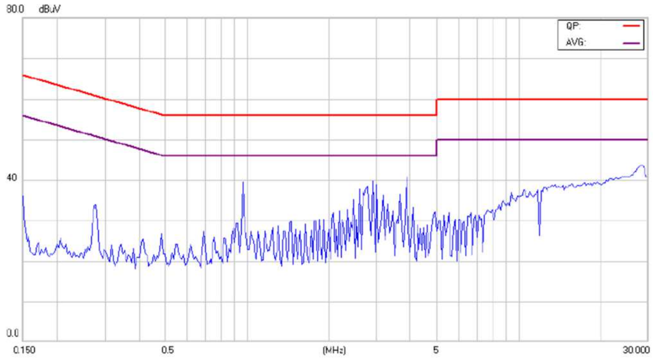


Figure18-1 EMI Conducted Class B for EC1SA23N

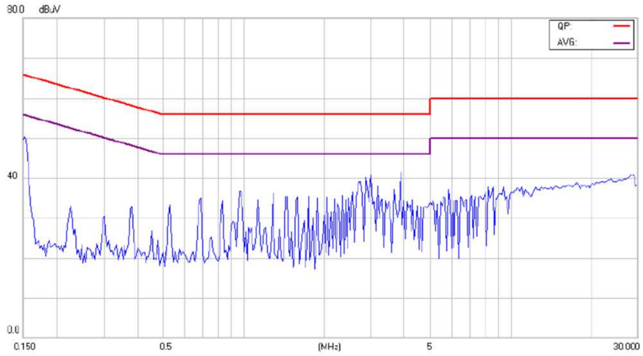


Figure18-1 EMI Conducted Class B for EC1SA24N

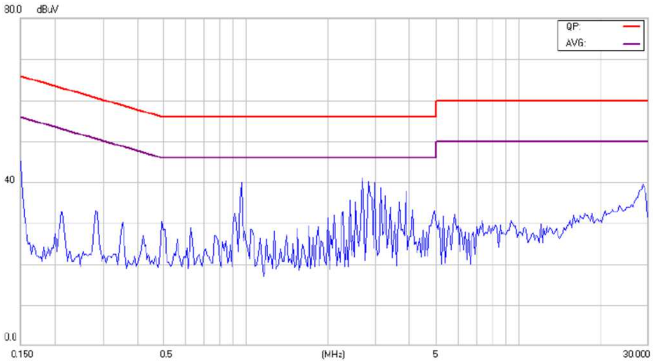


Figure19-1 EMI Conducted Class B for EC1SA25N

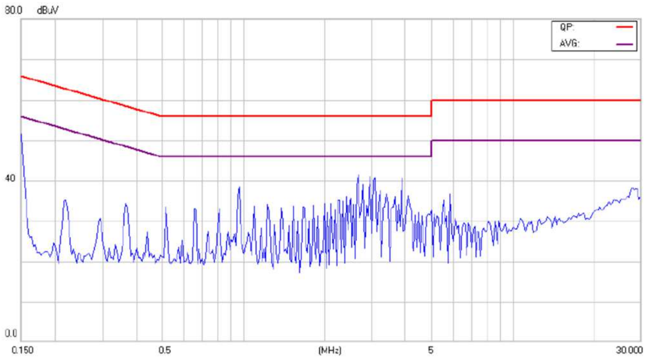


Figure19-2 EMI Conducted Class B for EC1SA26N

8. Part Number

EC1SA X X XX

- EC1SAN
- 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
- NS: Unregulated Output SMD packages 5&12Vin models only

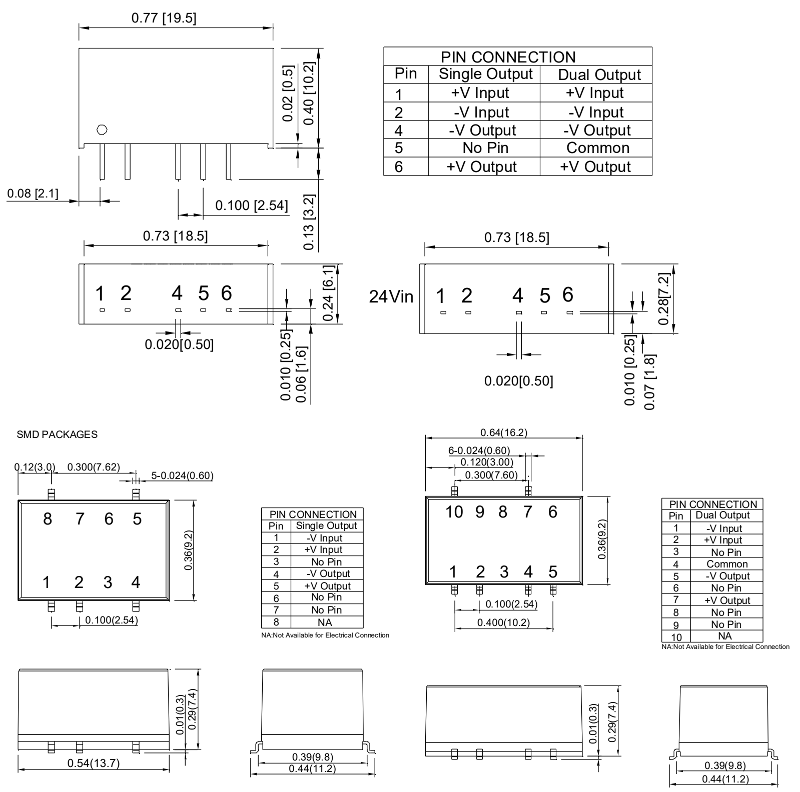
9. Mechanical Outline Diagrams

9.1 Mechanical Outline Diagrams

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

SIP PACKAGES



PIN CONNECTION (SIP)

Pin	Single Output	Dual Output
1	+V Input	+V Input
2	-V Input	-V Input
4	-V Output	-V Output
5	No Pin	Common
6	+V Output	+V Output

PIN CONNECTION (SMD)

Pin	Single Output
1	-V Input
2	+V Input
3	No Pin
4	-V Output
5	+V Output
6	No Pin
7	No Pin
8	NA

NA:Not Available for Electrical Connection

PIN CONNECTION (SMD)

Pin	Dual Output
1	-V Input
2	+V Input
3	No Pin
4	Common
5	-V Output
6	No Pin
7	+V Output
8	No Pin
9	No Pin
10	NA

NA:Not Available for Electrical Connection

Figure20 EC1SAN Mechanical Outline Diagram

9.2 Packaging Details

The EC1SAN series SIL version are supplied in Tube, and SMD version are supplied in tape&reel as standard. Modules are shipped in quantities for EC1SA0XN, EC1SA1XN of 16 modules (17.2*9*340mm) for EC1SA2XN of 14 modules (11*20*330mm) per Tube and 430 modules per reel. Details of tube and tape&reel dimensions are shown below.

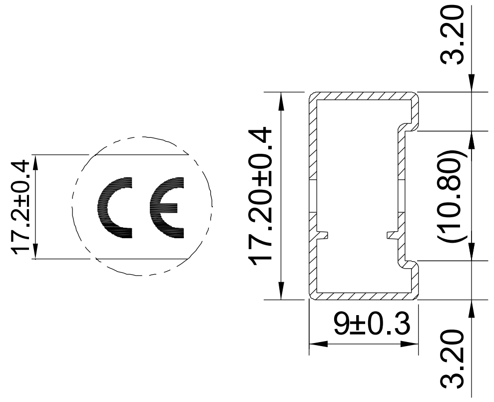


Figure21 SIL Packages Tube for EC1SA0xN and EC1SA1xN

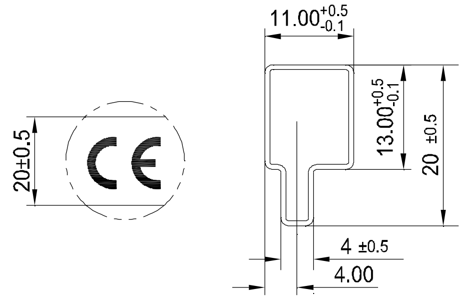


Figure23 SIL Packages Tube for EC1SA2xN

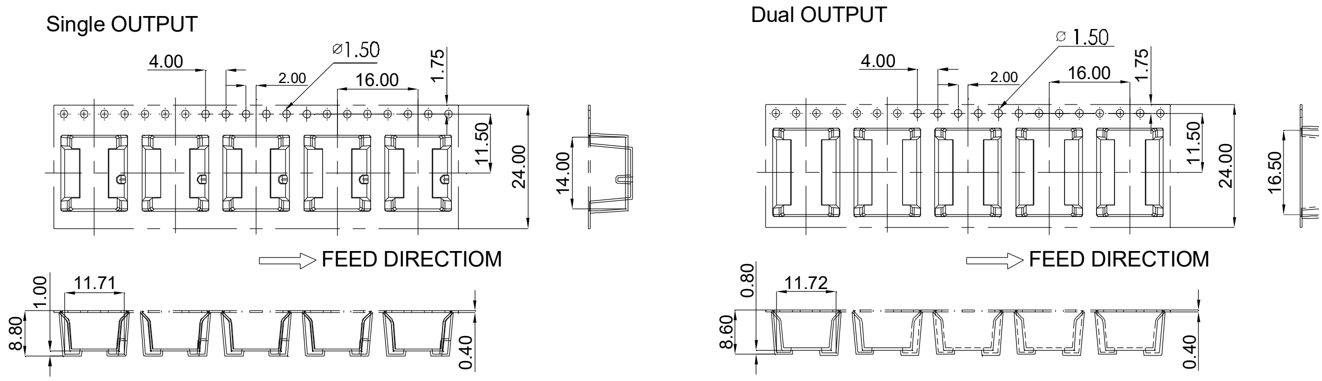


Figure22 SMD packages Tape and Reel for EC1SA0xNS and EC1SA1xNS

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