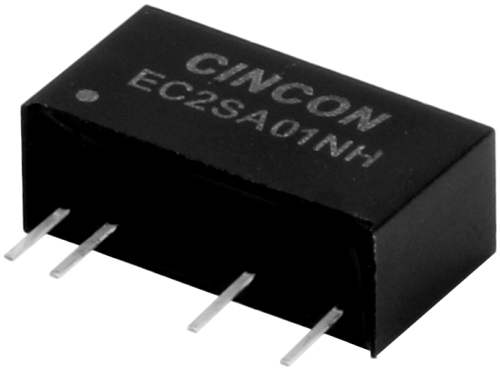
EC2SANH SERIES 2W DC-DC Converters

Application Note V10 May 2019

ISOLATED DC-DC Converter
EC2SANH SERIES
APPLICATION NOTE



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Content

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1. Introduction

The EC2SANH 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 EC2SANH 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, 3000VDC of isolation and allow an operating ambient temperature range of –40°C to 105°C with de-rating above 85℃. 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-7 Packages
- Efficiency up to 88%
- 3000VDC Isolation
- Unregulated Outputs
- Industry Standard Pinout
- No Tantalum Capacitors inside

3. Electrical Block Diagram

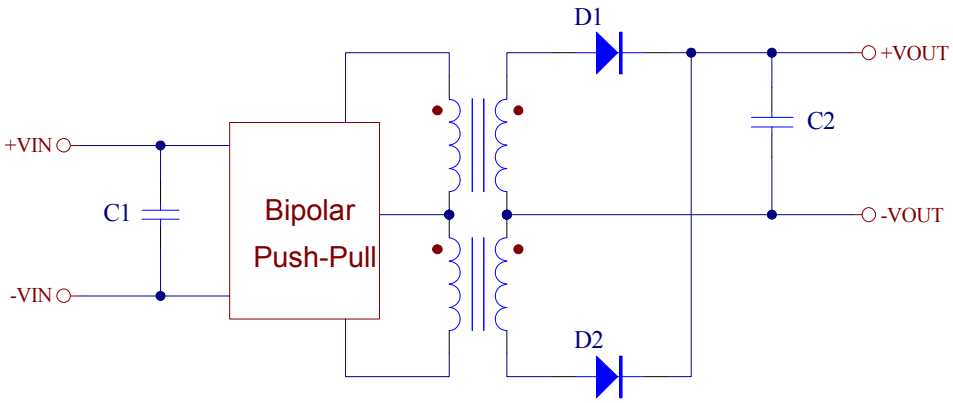


Figure1 Electrical Block Diagram for Single output

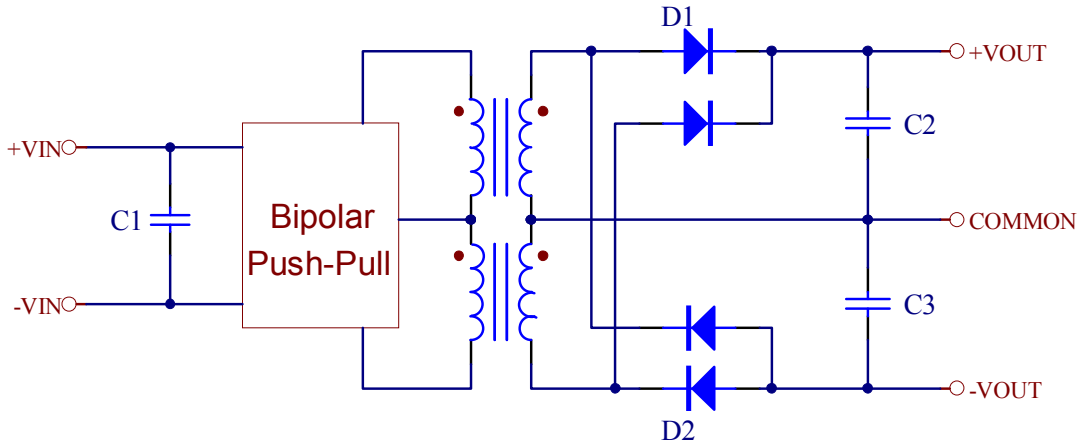


Figure2 Electrical Block Diagram for Dual output

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		$5V_{in}$ $12V_{in}$ $24V_{in}$	-0.7 -0.7 -0.7		5.5 13.2 26.4	Vdc
Transient (100ms)	100ms	$5V_{in}$ $12V_{in}$ $24V_{in}$			9 18 30	Vdc
Operating Ambient Temperature	With de-rating, above 85℃	All	-40		+105	℃
Storage Temperature		All	-55		+125	℃
Operating Case Temperature		All	-40		+120	℃
Input/Output Isolation Voltage	1 minute	All	3000			Vdc

INPUT CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Operating Input Voltage		$5V_{in}$ $12V_{in}$ $24V_{in}$	4.5 10.8 21.6	5 12 24	5.5 13.2 26.4	Vdc
Maximum Input Current	100% Load, Vin=4.5V	$5V_{in}$		500		mA
	100% Load, Vin=10.8V	$12V_{in}$		210		
	100% Load, Vin=21.6V	$24V_{in}$		110		
No-Load Input Current	V_{in}=Nominal input	$5V_{in}$ $12V_{in}$ $24V_{in}$		45 20 10		mA
Inrush Current (I^2t)		All			0.01	A^2s

OUTPUT CHARACTERISTIC

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Output Voltage Set Point	Vin=Nominal Vin , Io=Io.max, Ta=25℃	Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±5Vdc Vo=±12Vdc Vo=±15Vdc	4.85 11.64 14.55 ±4.85 ±11.64 ±14.55	5.0 12 15 ±5.0 ±12 ±15	5.15 12.36 15.45 ±5.15 ±12.36 ±15.45	Vdc
Output Voltage Regulation						
Load Regulation	Io=20% to 100%	All			±10	%
Line Regulation	For Vin Change of 1%	All			±1.2	%
Temperature Coefficient	Ta=-40℃ to 85℃	All			±0.05	%/℃

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Output Voltage Ripple and Noise						
Peak-to-Peak	Full Load, 20MHz bandwidth Output with 0.33uF Ceramic Capacitor	All			200	mV
Operating Output Current Range		Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±5Vdc Vo=±12Vdc Vo=±15Vdc	0 0 0 0 0 0		400 167 134 83 67 200	mA
Over Load	Vin=Nominal Vin Output Voltage Within Vo Set Point ±5%	All	120			%
Output Voltage Balance	Vin=nominal, Io=Iomax, Ta=25℃	Dual			±1.0	%
Maximum Output Capacitance	Full load	Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±5Vdc Vo=±12Vdc Vo=±15Vdc			220 220 220 100 100 100	uF

EFFICIENCY

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
100% Load	Vin=Nominal Vin, Io=Io.max, Ta=25℃	EC2SA01NH EC2SA02NH EC2SA03NH EC2SA04NH EC2SA05NH EC2SA06NH EC2SA11NH EC2SA12NH EC2SA13NH EC2SA14NH EC2SA15NH EC2SA16NH EC2SA21NH EC2SA22NH EC2SA23NH EC2SA24NH EC2SA25NH EC2SA26NH		82 84 85 85 87 83 82 87 87 86 87 84 82 87 88 87 88 83		%

ISOLATION CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Input to Output	1 minutes	All	3000			Vdc
Isolation Resistance		All	1000			MΩ
Isolation Capacitance		All		18		pF

FEATURE CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Switching Frequency	Vin=Nominal Vin, Io=Io.max, Ta=25℃	All		60		KHz

GENERAL SPECIFICATIONS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
MTBF	Io=100%of Io.max;Ta=25 ℃ per MIL-HDBK-217F	All		3.3		M hours
Weight		All		2.7		Grams

5. Main Features and Functions

5.1 Operating Temperature Range

The EC2SANH series converters can be operated by a wide ambient temperature range from -40℃ to 105℃. The standard model has a plastic case and case temperature can not over 120℃ at normal operating.

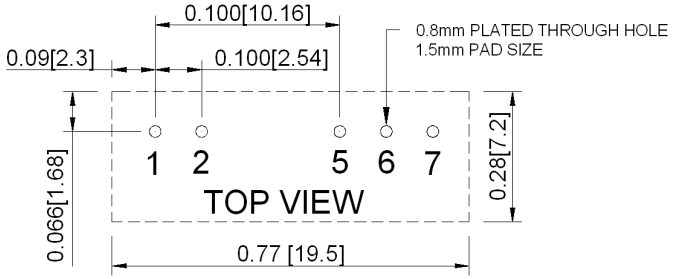
5.2 Output Short Circuit Protection

All different voltage models have a short-circuit protection (Continuous, self-recovery). Please notice this condition and avoid output short as much as possible.

6. Applications

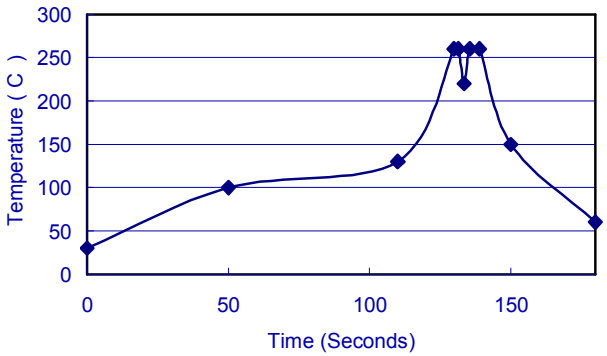
6.1 Recommended Layout PCB Footprints

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)

Lead Free Wave Soldering Profile



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 EC2SANH Series

Operating Ambient temperature Range: -40℃ ~ 105℃

Maximum case temperature under any operating condition should not be exceed 120℃.

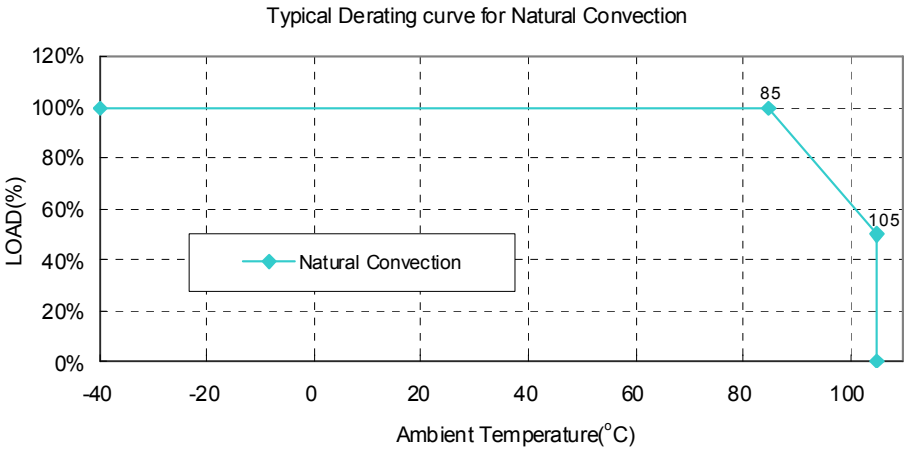
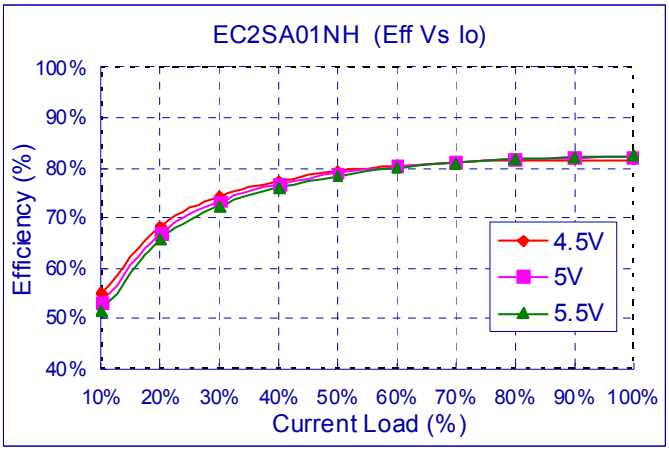
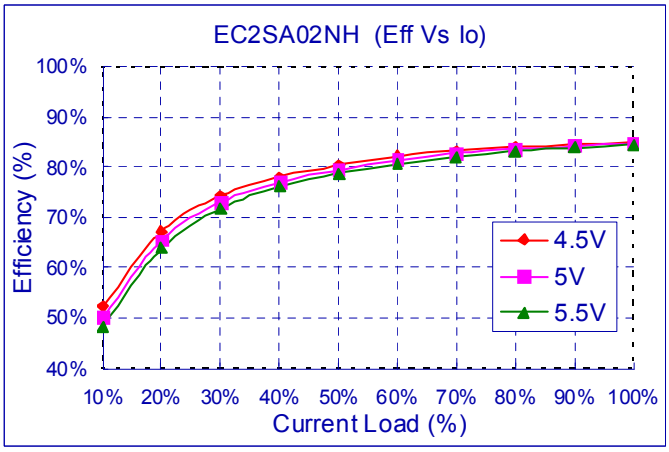
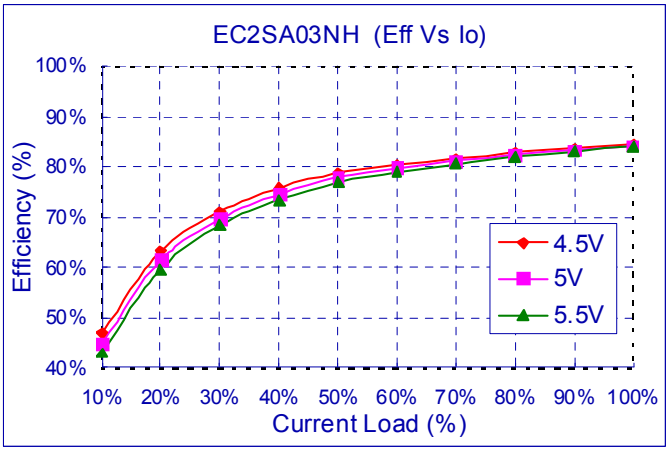


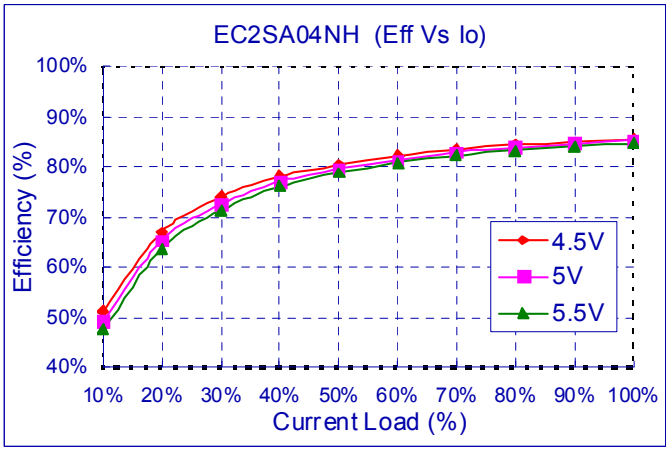
Figure4 Typical Power De-rating Curve for EC2SANH Series

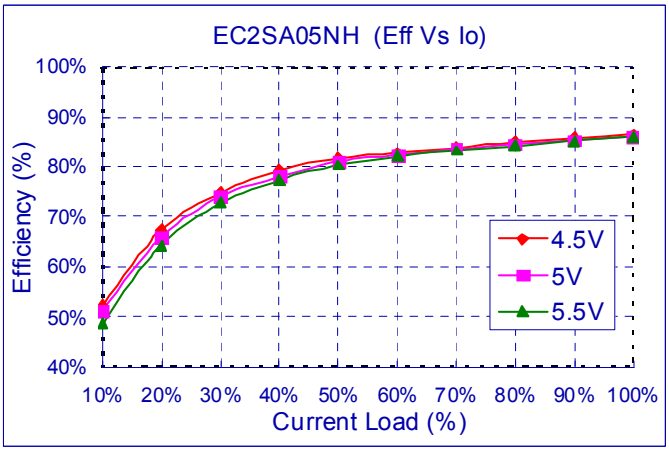
6.3 Efficiency vs. Load Curves

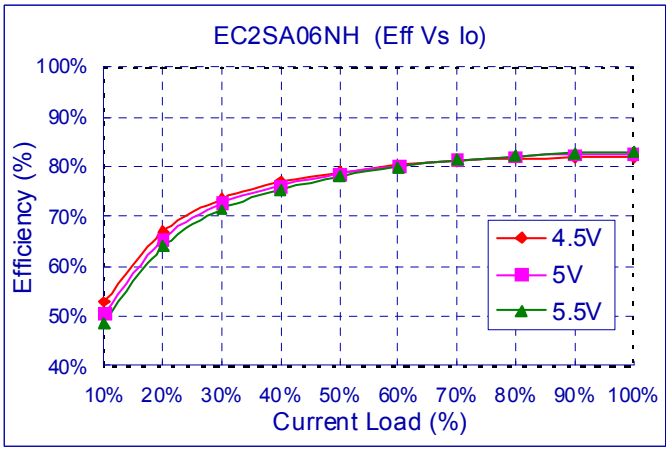


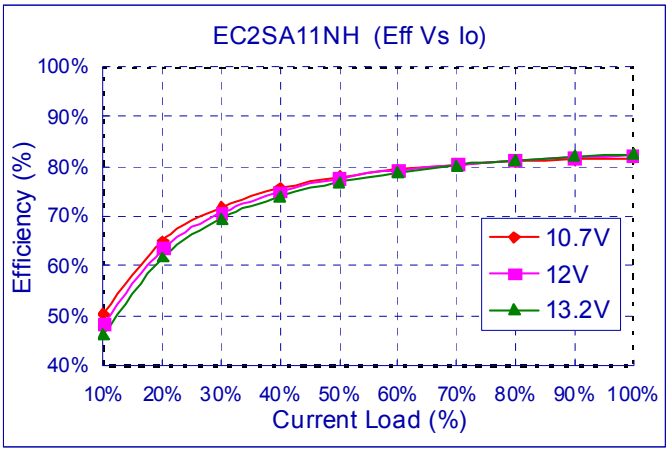


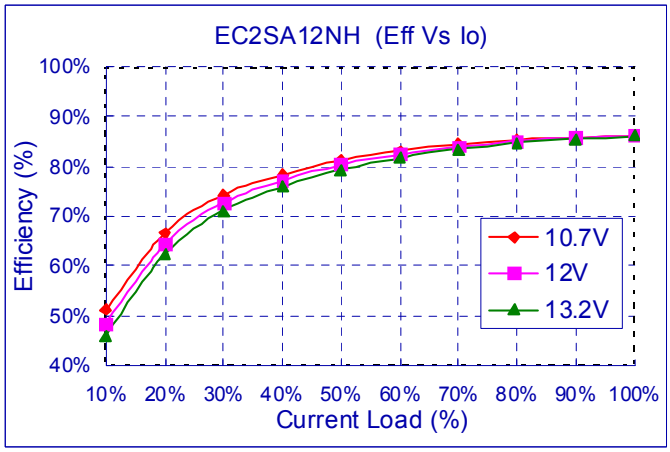


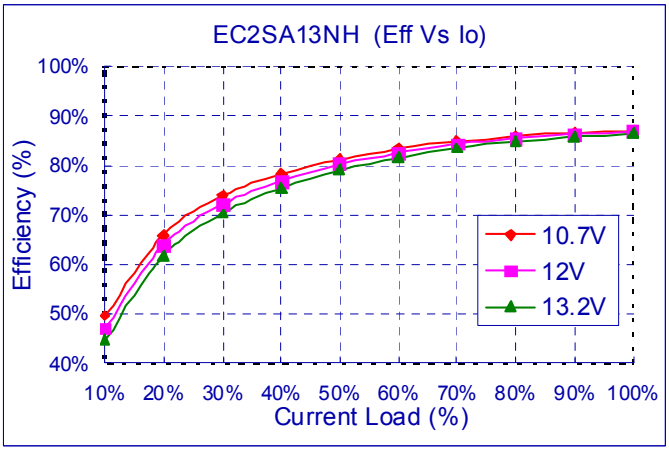


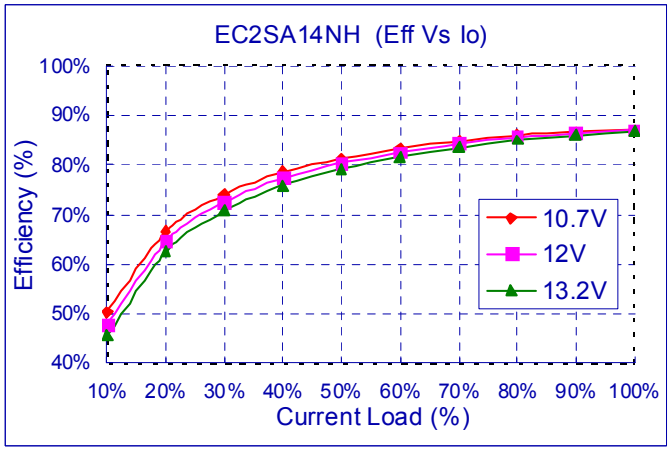


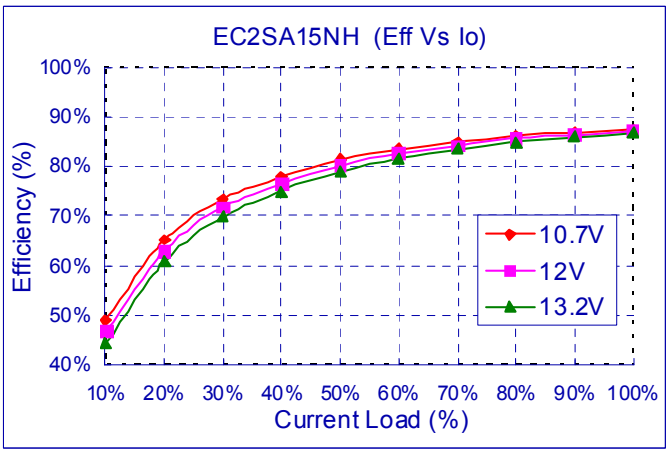


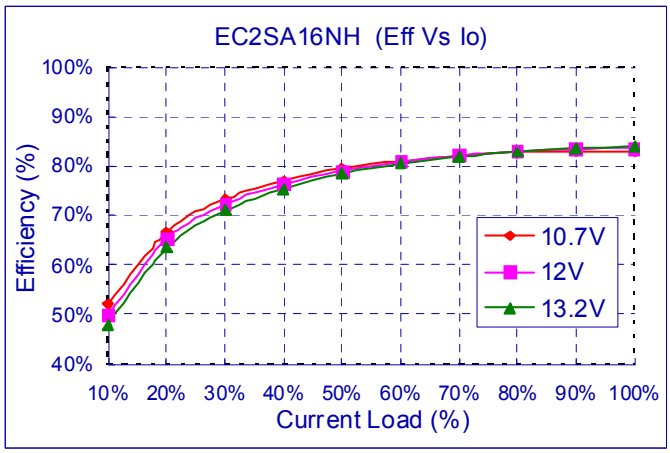

EC2SA11NH (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
10.7V
12V
13.2V

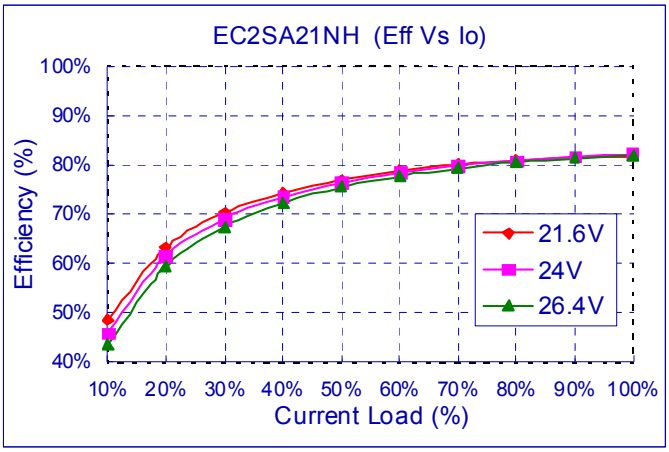

EC2SA12NH (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
10.7V
12V
13.2V

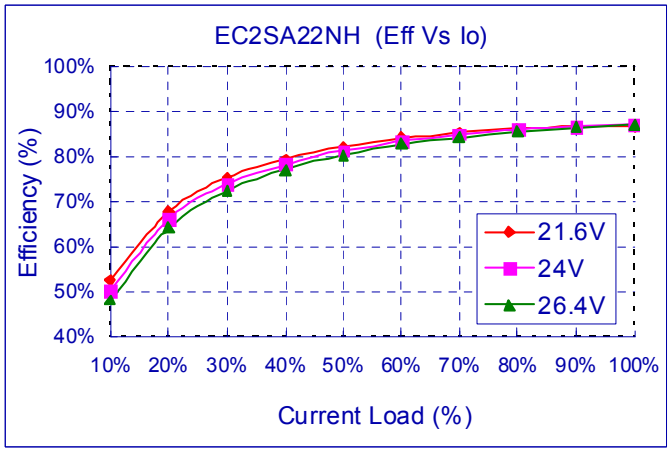

EC2SA13NH (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
10.7V
12V
13.2V

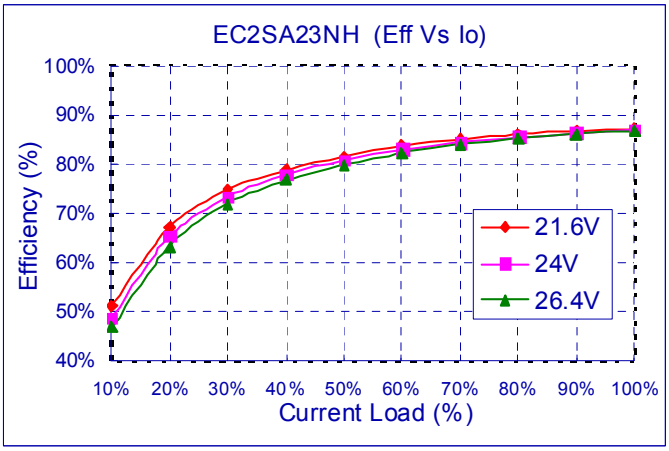

EC2SA14NH (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
10.7V
12V
13.2V

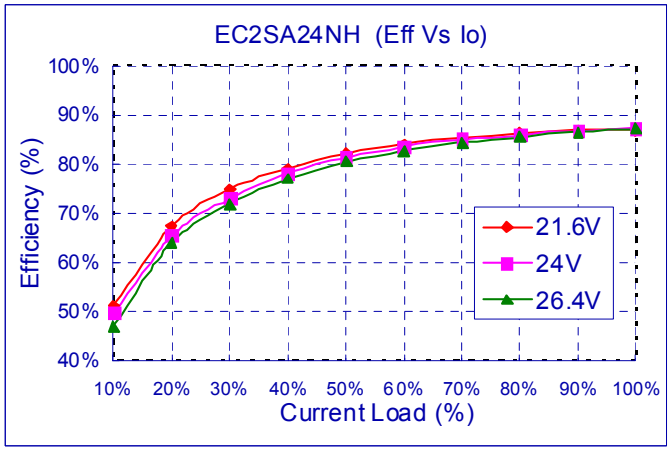

EC2SA15NH (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
10.7V
12V
13.2V

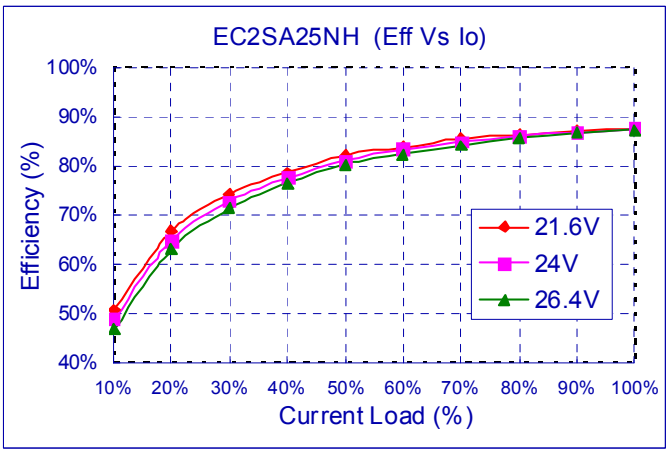

EC2SA16NH (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
10.7V
12V
13.2V

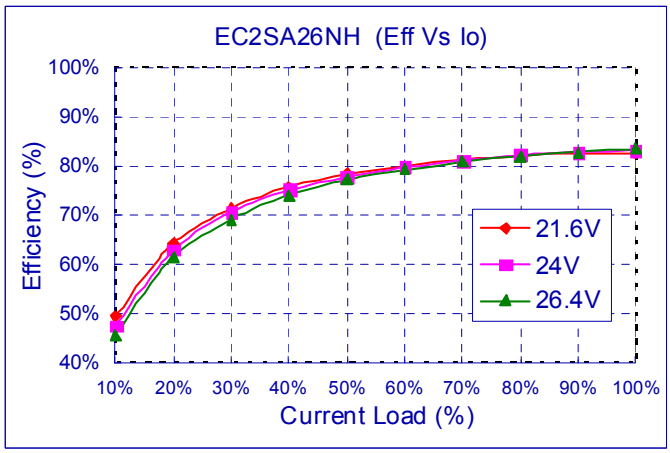

EC2SA21NH (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
21.6V
24V
26.4V


EC2SA22NH (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
21.6V
24V
26.4V


EC2SA23NH (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
21.6V
24V
26.4V

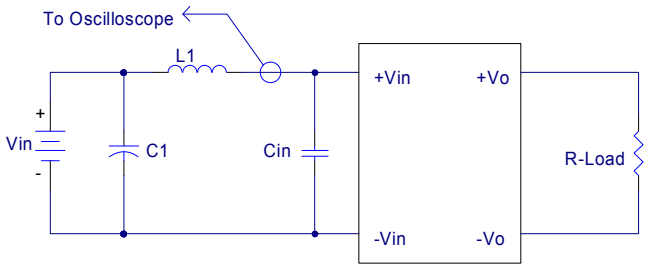

EC2SA24NH (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
21.6V
24V
26.4V


EC2SA25NH (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
21.6V
24V
26.4V


EC2SA26NH (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
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 1uF 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 1uF Tantalum 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.

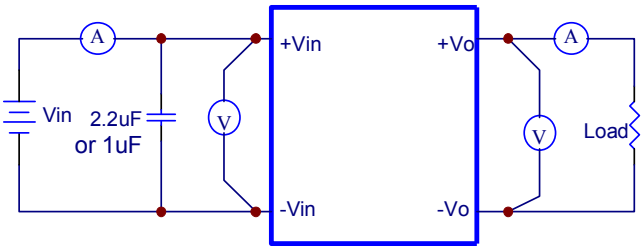


Figure6 EC2SANH Series Single output Test Setup

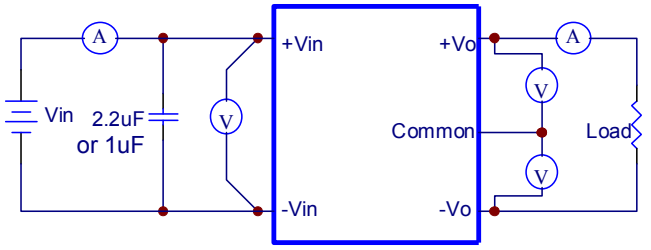


Figure7 EC2SANH Series Dual output Test Setup

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.

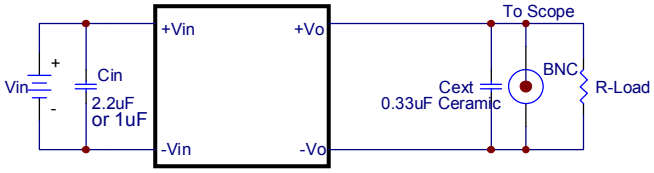


Figure8 Output Voltage Ripple and Noise Measurement Set-up for Single Output

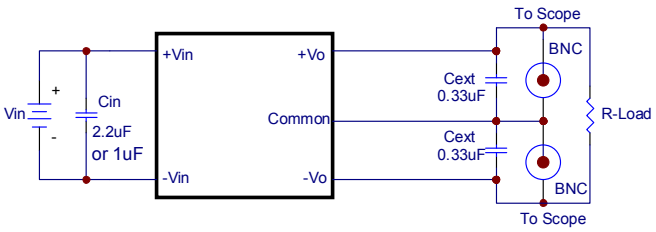


Figure9 Output Voltage Ripple and Noise Measurement Set-up for Dual output

6.7 Output Capacitance

The EC2SANH 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 EC2SANH 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.

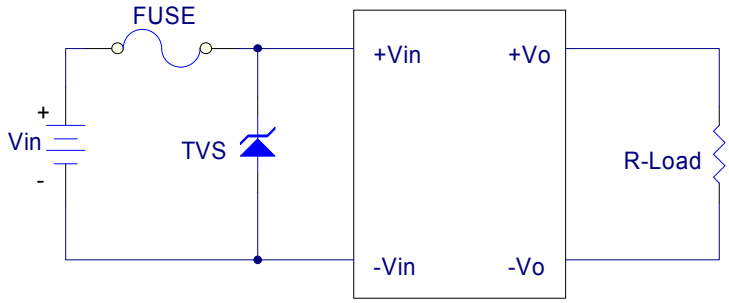


Figure10 Input Protection

7.2 EMC Considerations

EMI Test standard: EN55032 Class A and Class B Conducted Emission
Test Condition: Input Voltage: Nominal, Output Load: Full Load

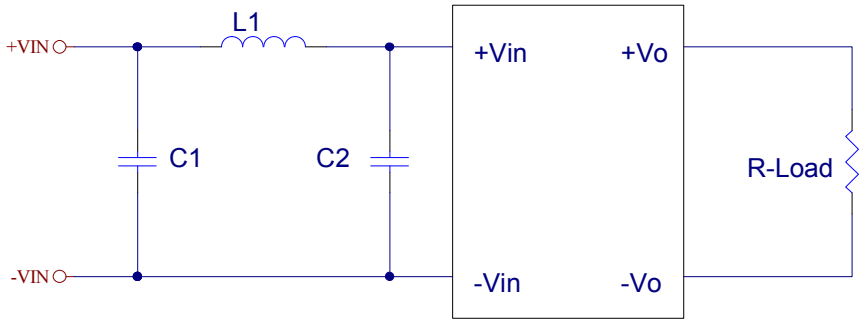


Figure11 Connection circuit for conducted EMI testing

	EN55032 class A			EN55032 class B		
Model No.	C1	C2	L1	C1	C2	L1
EC2SA01NH	4.7uF/50V 1812	NC	2.2uH	10uF/25V 1812	NC	4.7uH
EC2SA02NH	4.7uF/50V 1812	NC	2.2uH	10uF/25V 1812	NC	4.7uH
EC2SA03NH	4.7uF/50V 1812	NC	2.2uH	10uF/25V 1812	NC	4.7uH
EC2SA04NH	4.7uF/50V 1812	NC	2.2uH	10uF/25V 1812	NC	4.7uH
EC2SA05NH	4.7uF/50V 1812	NC	2.2uH	10uF/25V 1812	NC	4.7uH
EC2SA06NH	4.7uF/50V 1812	NC	2.2uH	10uF/25V 1812	NC	4.7uH
EC2SA11NH	4.7uF/50V 1812	NC	2.2uH	10uF/25V 1812	NC	4.7uH
EC2SA12NH	4.7uF/50V 1812	NC	2.2uH	10uF/25V 1812	NC	4.7uH
EC2SA13NH	4.7uF/50V 1812	NC	2.2uH	10uF/25V 1812	NC	4.7uH
EC2SA14NH	4.7uF/50V 1812	NC	2.2uH	10uF/25V 1812	NC	4.7uH
EC2SA15NH	4.7uF/50V 1812	NC	2.2uH	10uF/25V 1812	NC	4.7uH
EC2SA16NH	4.7uF/50V 1812	NC	2.2uH	10uF/25V 1812	NC	4.7uH
EC2SA21NH	4.7uF/50V 1812	4.7uF/50V 1812	2.2uH	6.8uF/50V 1812	6.8uF/50V 1812	4.7uH
EC2SA22NH	4.7uF/50V 1812	4.7uF/50V 1812	2.2uH	6.8uF/50V 1812	6.8uF/50V 1812	4.7uH
EC2SA23NH	4.7uF/50V 1812	4.7uF/50V 1812	2.2uH	6.8uF/50V 1812	6.8uF/50V 1812	4.7uH
EC2SA24NH	4.7uF/50V 1812	4.7uF/50V 1812	2.2uH	6.8uF/50V 1812	6.8uF/50V 1812	4.7uH
EC2SA25NH	4.7uF/50V 1812	4.7uF/50V 1812	2.2uH	6.8uF/50V 1812	6.8uF/50V 1812	4.7uH
EC2SA26NH	4.7uF/50V 1812	4.7uF/50V 1812	2.2uH	6.8uF/50V 1812	6.8uF/50V 1812	4.7uH

Note: All of capacitors are ceramic capacitors.

2.2uH (P/N: SCD0403T-2R2M-N, CHILISIN), 4.7uH (P/N: SCD0403T-4R7M-N, CHILISIN)

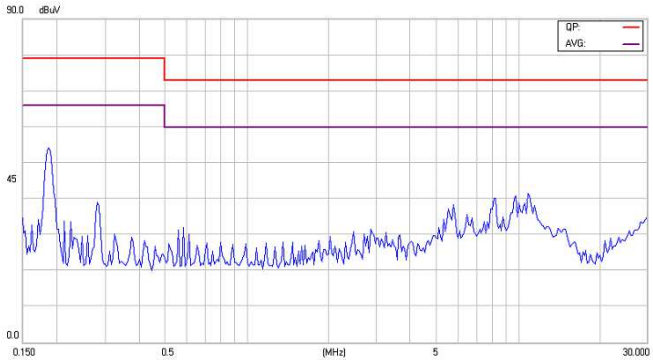


Figure12-1 EMI Conducted Class A for EC2SA01NH

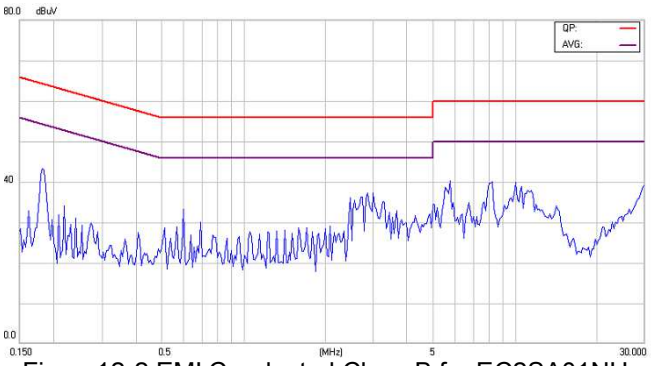


Figure12-2 EMI Conducted Class B for EC2SA01NH

Figure13-1 EMI Conducted Class A for EC2SA02NH

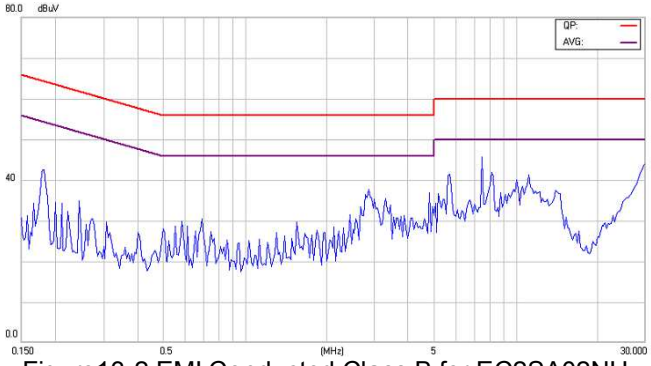


Figure13-2 EMI Conducted Class B for EC2SA02NH

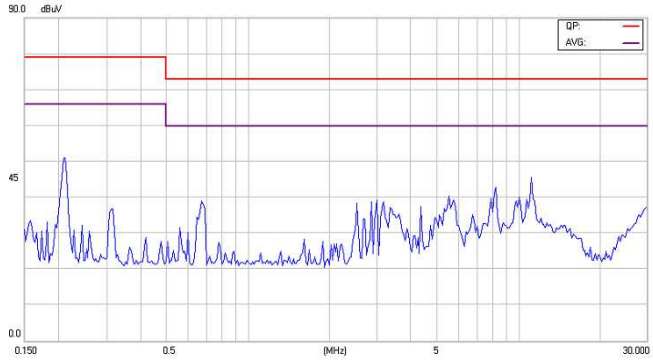


Figure14-1 EMI Conducted Class A for EC2SA03NH

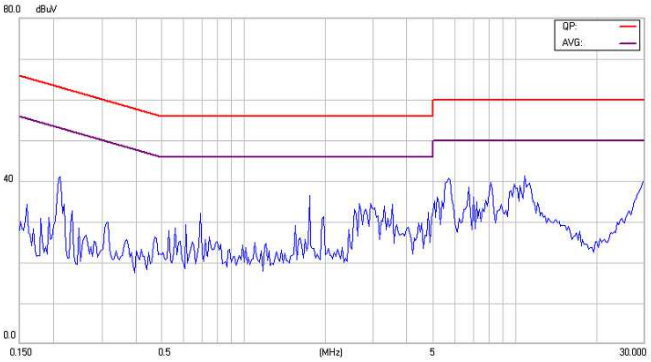


Figure14-2 EMI Conducted Class B for EC2SA03NH

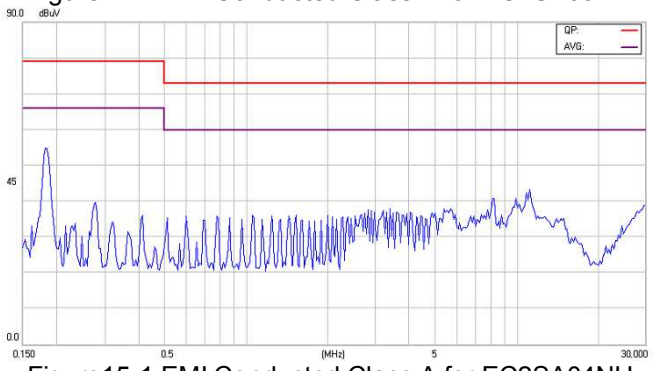


Figure15-1 EMI Conducted Class A for EC2SA04NH

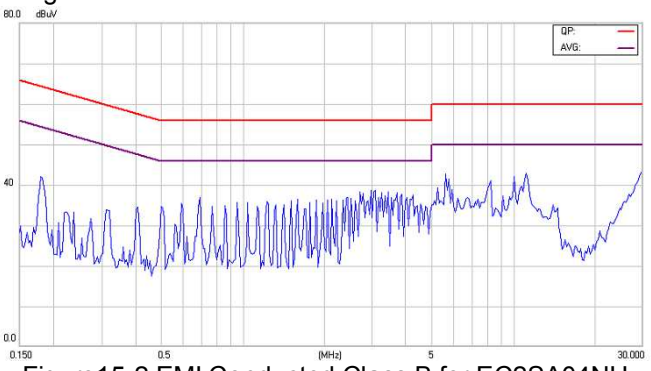


Figure15-2 EMI Conducted Class B for EC2SA04NH

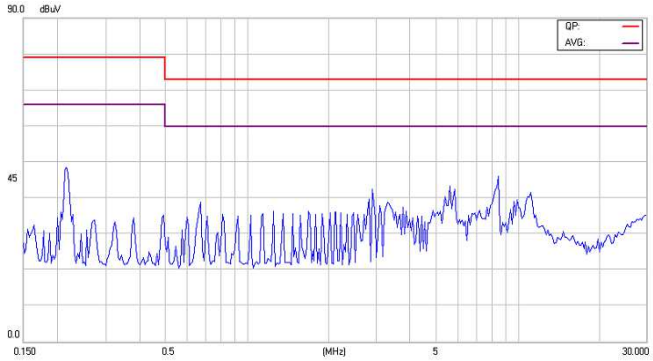


Figure16-1 EMI Conducted Class A for EC2SA05NH

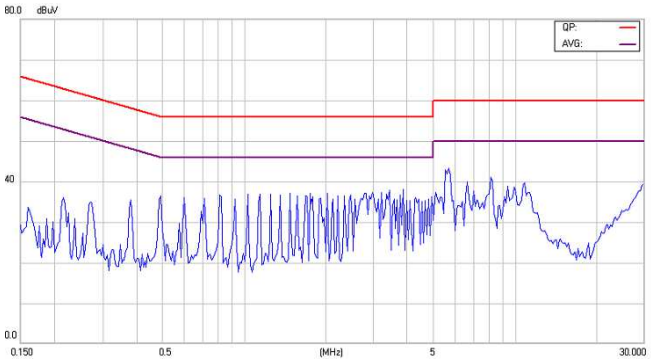


Figure16-2 EMI Conducted Class B for EC2SA05NH

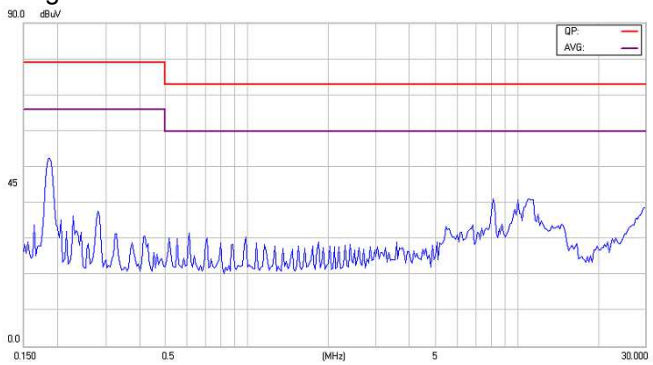


Figure17-1 EMI Conducted Class A for EC2SA06NH

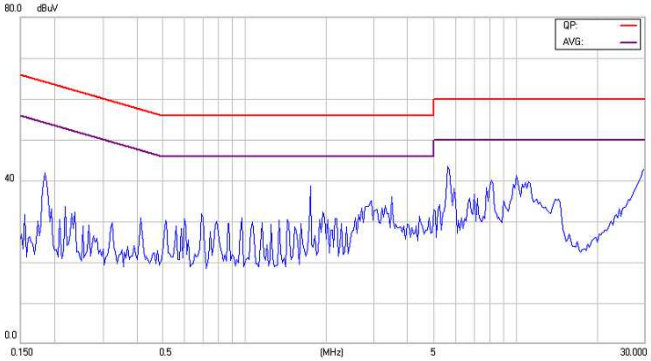


Figure17-2 EMI Conducted Class B for EC2SA06NH

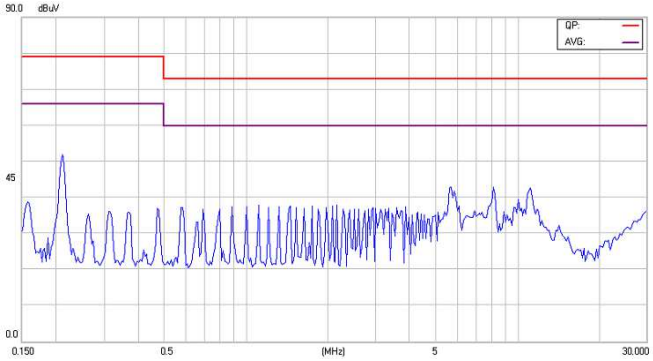


Figure18-1 EMI Conducted Class A for EC2SA11NH

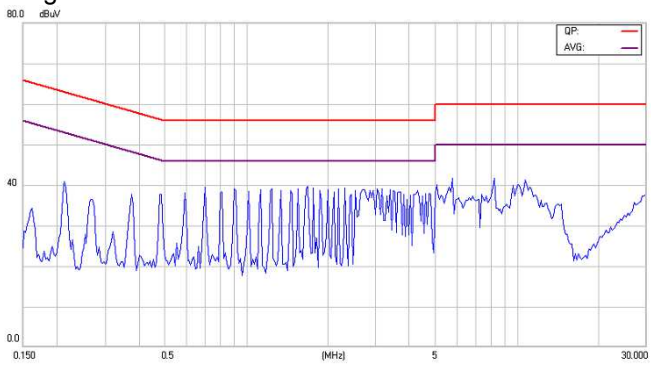


Figure18-2 EMI Conducted Class B for EC2SA11NH

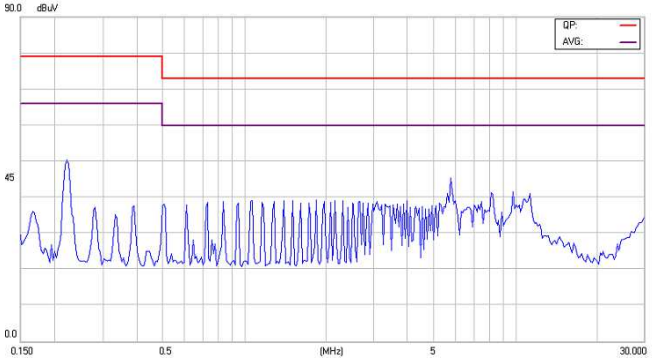


Figure19-1 EMI Conducted Class A for EC2SA12NH

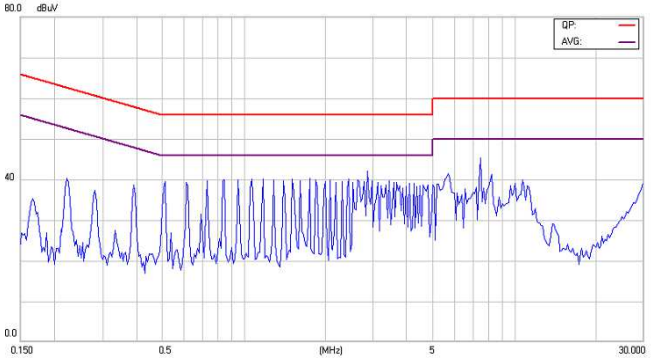


Figure19-2 EMI Conducted Class B for EC2SA12NH

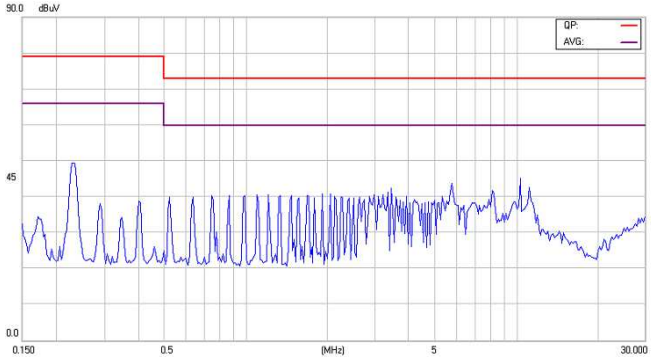


Figure20-1 EMI Conducted Class A for EC2SA13NH

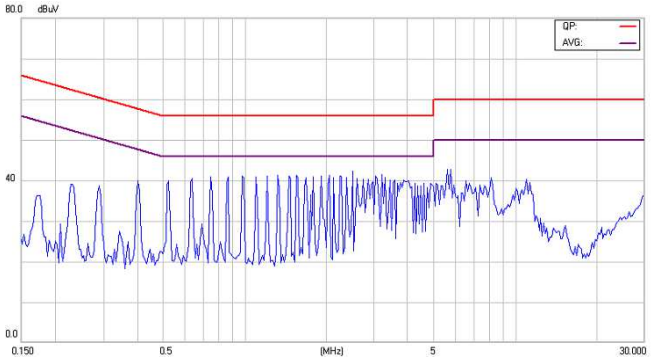


Figure20-2 EMI Conducted Class B for EC2SA13NH

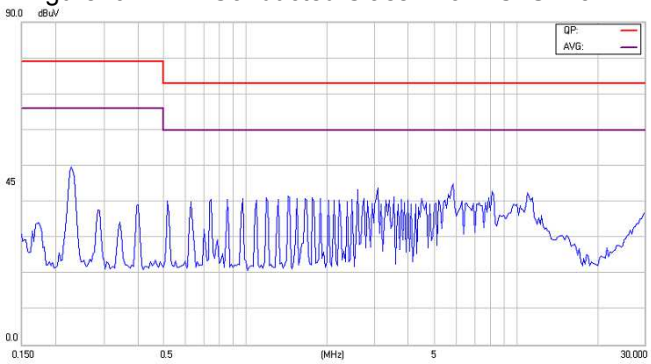


Figure21-1 EMI Conducted Class A for EC2SA14NH

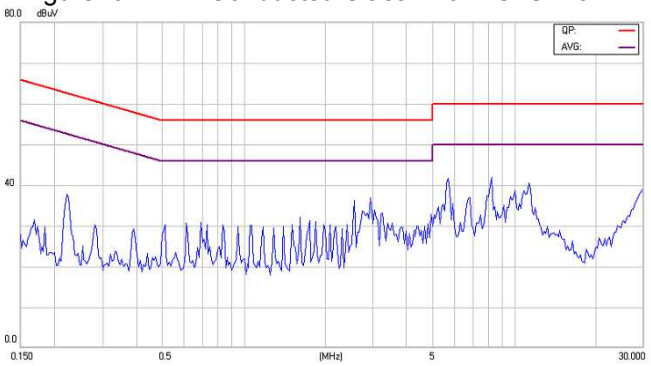


Figure21-2 EMI Conducted Class B for EC2SA14NH

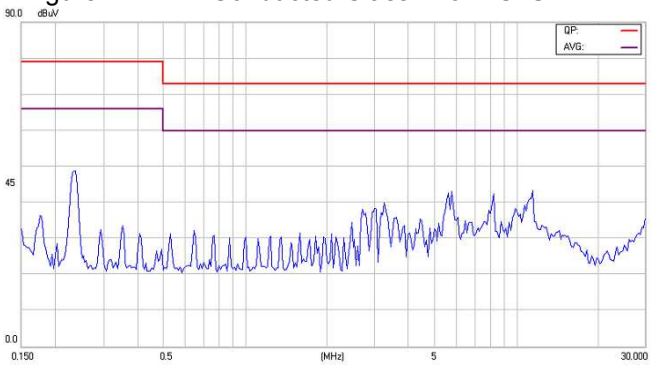


Figure22-1 EMI Conducted Class A for EC2SA15NH

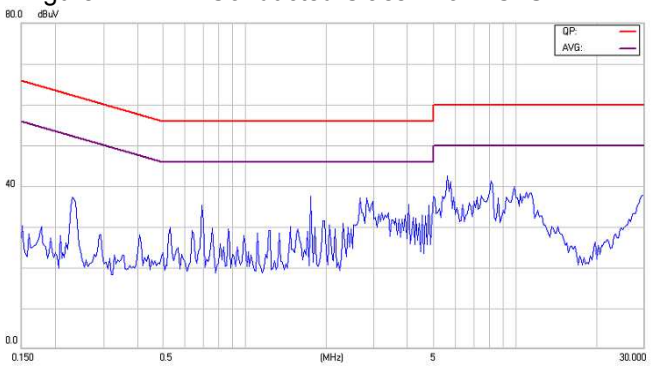


Figure22-2 EMI Conducted Class B for EC2SA15NH

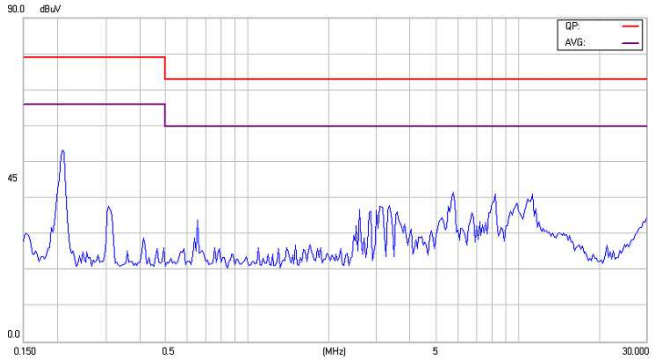


Figure23-1 EMI Conducted Class A for EC2SA16NH

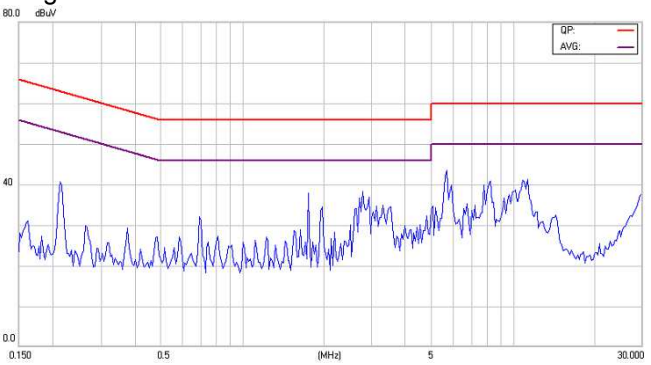


Figure23-2 EMI Conducted Class B for EC2SA16NH

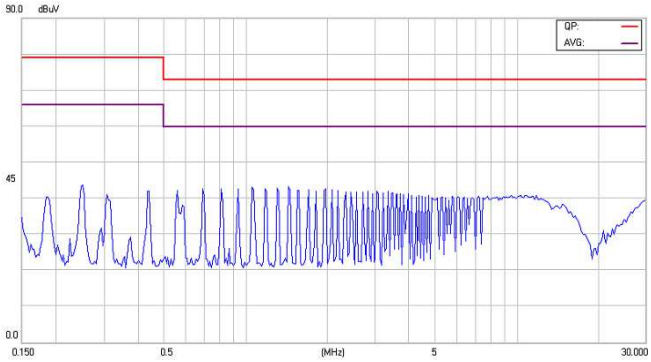


Figure24-1 EMI Conducted Class A for EC2SA21NH

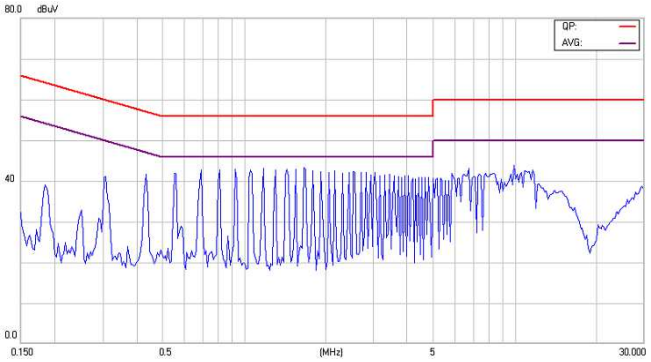


Figure24-2 EMI Conducted Class B for EC2SA21NH

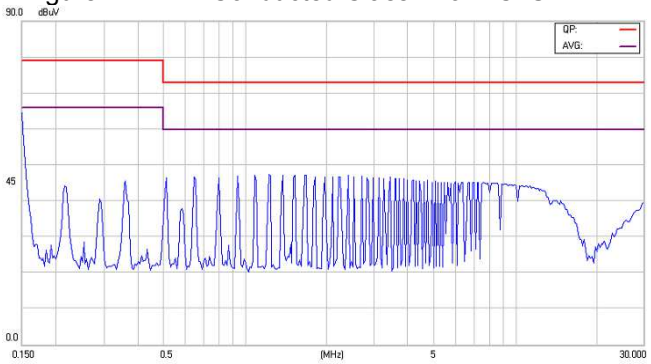


Figure25-1 EMI Conducted Class A for EC2SA22NH

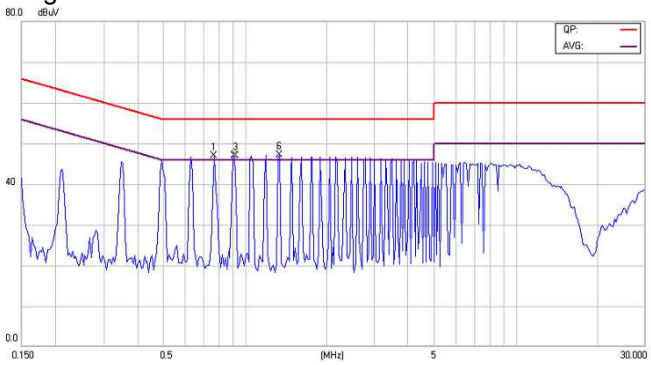


Figure25-2 EMI Conducted Class B for EC2SA22NH

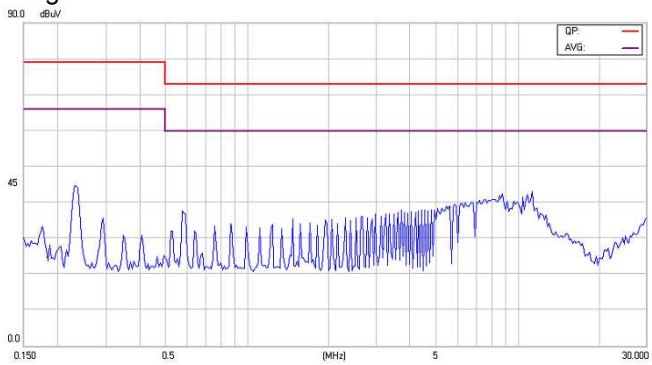


Figure26-1 EMI Conducted Class A for EC2SA23NH

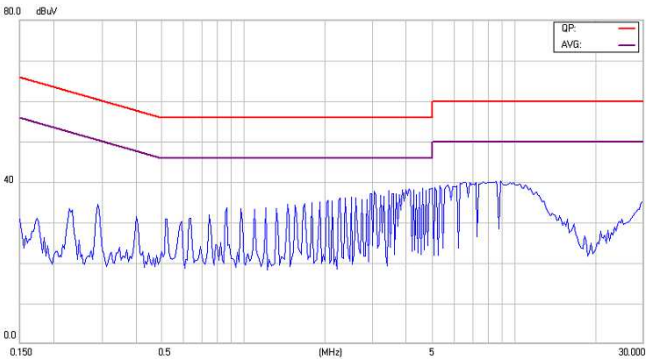


Figure26-2 EMI Conducted Class B for EC2SA23NH

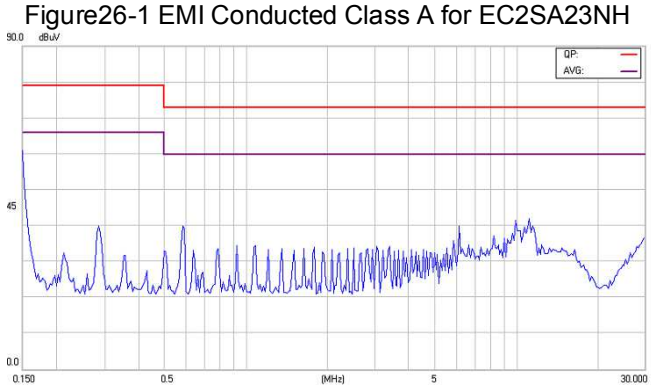


Figure27-1 EMI Conducted Class A for EC2SA24NH

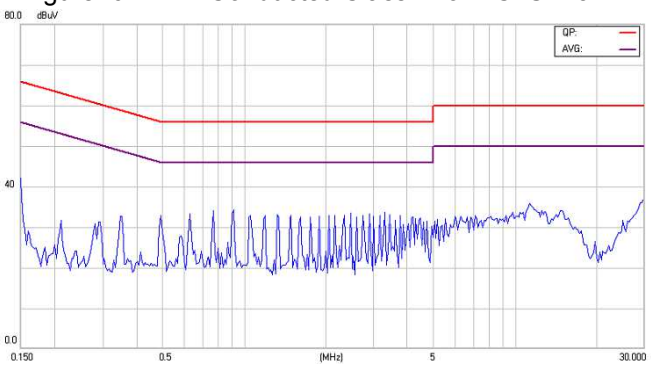


Figure27-2 EMI Conducted Class B for EC2SA24NH

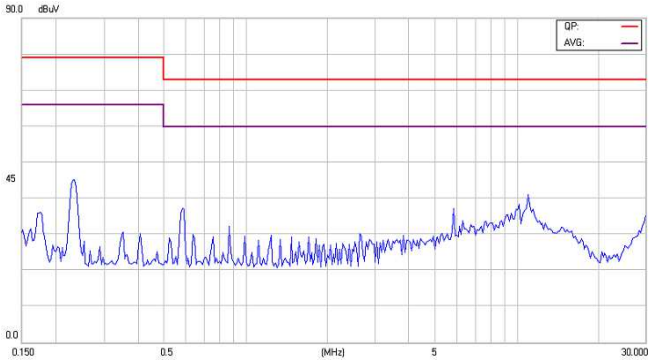


Figure28-1 EMI Conducted Class A for EC2SA25NH

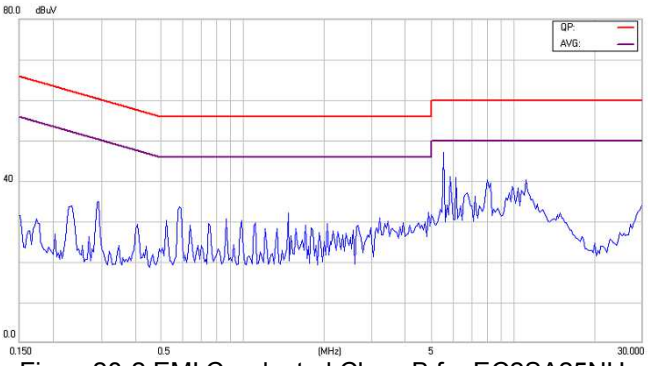


Figure28-2 EMI Conducted Class B for EC2SA25NH

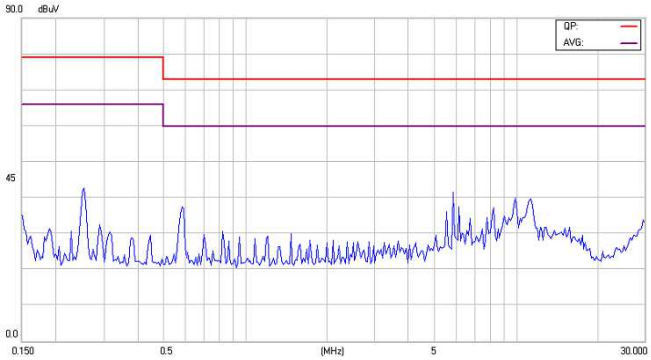


Figure29-1 EMI Conducted Class A for EC2SA26NH

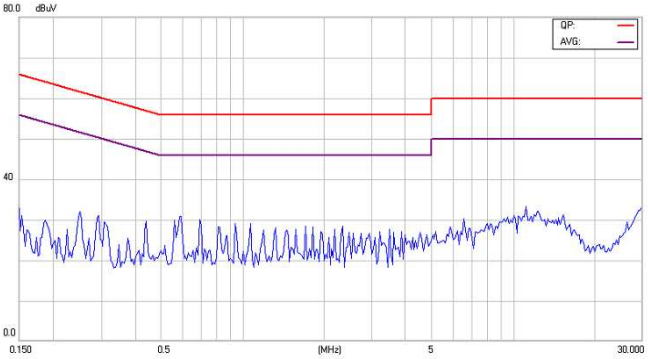


Figure29-2 EMI Conducted Class B for EC2SA26NH

8. Part Number

EC2SA X X N H

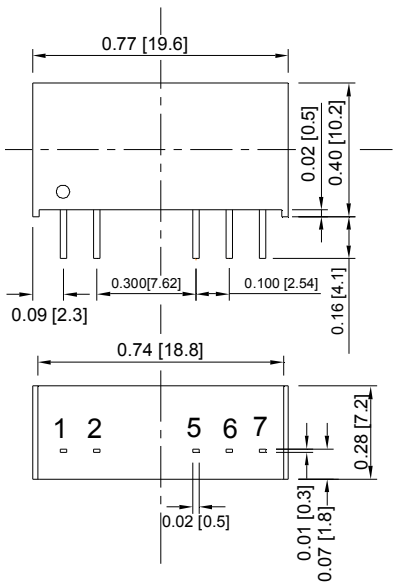
- EC2SAN
- H: Isolation Voltage 3000Vdc
- N: Unregulated Output SIL packages
- 0 : Nominal Input Voltage 5VDC
  1 : Nominal Input Voltage 12VDC
  2 : Nominal Input Voltage 24VDC
- 1 : Output Voltage 5 VDC
  2 : Output Voltage 12 VDC
  3 : Output Voltage 15 VDC
  4 : Output Voltage ±12 VDC
  5 : Output Voltage ±15 VDC
  6 : Output Voltage ±5 VDC

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



PIN CONNECTION		
Pin	Single Output	Dual Output
1	+V Input	+V Input
2	-V Input	-V Input
5	-V Output	-V Output
6	No Pin	Common
7	+V Output	+V Output

Figure30 EC2SANH Mechanical Outline Diagram

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