ISOLATED DC-DC Converter
EC4AW SERIES
APPLICATION NOTE

Approved By:

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EC4AW 3.3-6W Isolated DC-DC Converters

Application Note V10 August 2014

Content

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1. Introduction

The EC4AW series offer 3.3-6watts of output power in a 24 pin DIP and SMD metal package. The EC4AW series has a 4:1 wide input voltage range of 9-36VDC, 18-72VDC, 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°C to 85°C (de-rating above 71 °C). 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

* 3.3-6W Isolated Output
* Efficiency to 83%
* 4:1 Input Range
* Regulated Outputs
* Pi Input Filter
* DIP-24 / SMD Metal Package
* Continuous Short Circuit Protection
* No Tantalum Capacitor Inside

3. Electrical Block Diagram

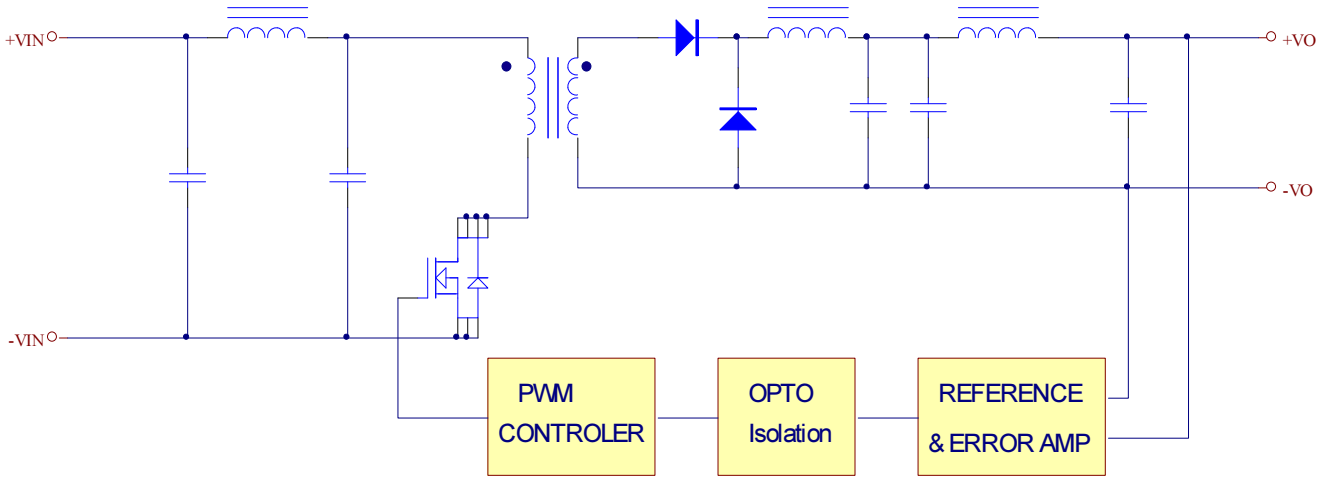


Figure1 Electrical Block Diagram of single output module

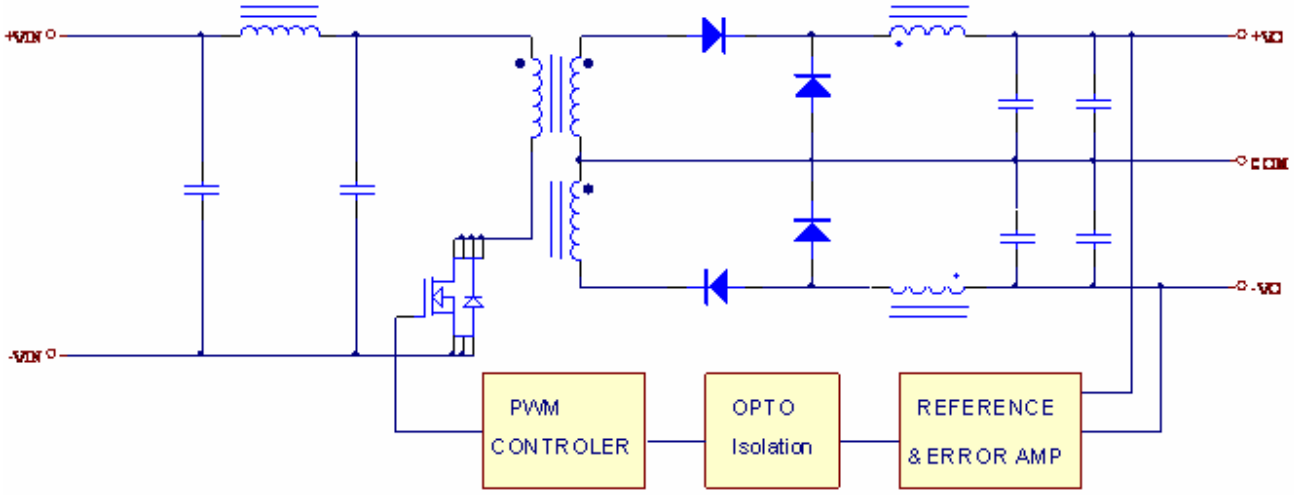


Figure2 Electrical Block Diagram of dual output module

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		EC4AW0X	-0.7		36	Vdc
		EC4AW1X	-0.7		72	
Transient	100ms	EC4AW0X			50	Vdc
		EC4AW1X			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	EC4AWXX (HM/HMS)	1500			Vdc
		EC4AWXXH	3000			Vdc

INPUT CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Operating Input Voltage		EC4AW0X	9	24	36	Vdc
		EC4AW1X	18	48	72	
Maximum Input Current	Full Load, Vin= 9V	EC4AW0X		825		mA
	Full Load, Vin=18V	EC4AW1X		420		
No-Load Input Current	Vin=Nominal input	EC4AW01		5		mA
		EC4AW02		5		
		EC4AW03		5		
		EC4AW04		7.5		
		EC4AW05		7.5		
		EC4AW06		5		
		EC4AW07		5		
		EC4AW11		5		
		EC4AW12		5		
		EC4AW13		5		
		EC4AW14		7.5		
		EC4AW15		7.5		
		EC4AW16		5		
		EC4AW17		5		
Inrush Current (I^2t)	As per ETS300 132-2	All			0.0003	A^2s
Input Reflected-Ripple Current	P-P thru 12uH inductor, 5Hz to20MHz	All		10		mA

OUTPUT CHARACTERISTIC

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
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			±0.5	%
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 Vo=12Vdc Vo=15Vdc Vo=±5Vdc Vo=±12Vdc Vo=±15Vdc Vo=3.3Vdc			100	mV
Operating Output Current Range		Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±5Vdc Vo=±12Vdc Vo=±15Vdc Vo=3.3Vdc	0 0 0 0 0 0 0		1000 470 400 ±500 ±230 ±190 1000	mA
Output DC Current-Limit Inception	Output Voltage =90% Nominal Output Voltage	All	120			%
Maximum Output Capacitance	Full load, Resistance	Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±5Vdc Vo=±12Vdc Vo=±15Vdc Vo=3.3Vdc	0 0 0 0 0 0 0		1000 470 400 500 230 190 1000	uF

DYNAMIC CHARACTERISTICS

PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
Start up Time						
Turn-On Delay Time, From Input	Vin, min. to 10%Vo,set	All		15		ms
Output Voltage Rise Time	10%Vo,set to 90%Vo,set	All		15		ms

EFFICIENCY

PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
100% Load	Vin=Nominal Vin, Io=Io.max, Tc=25℃	EC4AW01 EC4AW02 EC4AW03 EC4AW04 EC4AW05 EC4AW06 EC4AW07		82 83 83 82 81 83 78		%

EFFICIENCY						
PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
100% Load	Vin=Nominal Vin, Io=Io.max, Tc=25℃	EC4AW11		79		%
		EC4AW12		82		
		EC4AW13		81		
		EC4AW14		80		
		EC4AW15		80		
		EC4AW16		80		
		EC4AW17		74		
	Vin=1/2Nominal Vin, Io=Io.max, Tc=25℃	EC4AW01		84		
		EC4AW02		85		
		EC4AW03		85		
		EC4AW04		85		
		EC4AW05		85		
		EC4AW06		85		
		EC4AW07		80		
		EC4AW11		83		
		EC4AW12		86		
		EC4AW13		86		
		EC4AW14		85		
		EC4AW15		85		
		EC4AW16		84		
		EC4AW17		79		
ISOLATION CHARACTERISTICS						
PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
Isolation Voltage	Input to Output 1 minutes	EC4AWXX (HM/HMS)			1500	Vdc
		EC4AWXXH			3000	Vdc
Isolation Resistance	Input to Output	All			1000	MΩ
Isolation Capacitance	Input to Output	EC4AWXX (HM/HMS)		560		pF
		EC4AWXXH		280		pF
FEATURE CHARACTERISTICS						
PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
Switching Frequency	Vin=Nominal, Io=Io.max	Single		300		KHz
		Dual		230		KHz
GENERAL SPECIFICATIONS						
PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
MTBF	Io=100%of Io.max;Ta=25℃ per MIL-HDBK-217F	Single		TBD		Mhours
		Dual		TBD		
Weight		All		12.5		grams

5. Main Features and Functions

5.1 Operating Temperature Range

The EC4AW series converters can be operated by a wide ambient temperature range from -40℃ to 85℃(de-rating above 71 °C). The standard model has a Copper case and case temperature can not over 100℃ at normal operating.

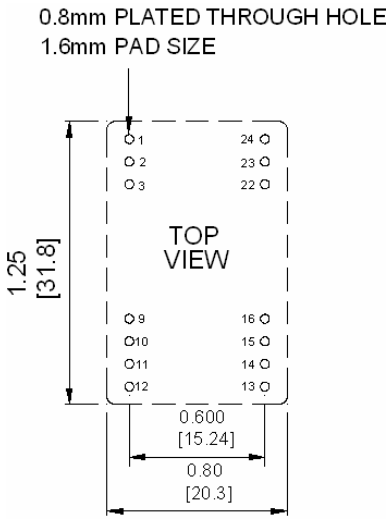
5.2 Over Current Protection

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

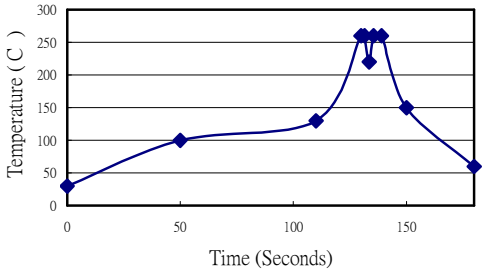
The system designer or the end user must ensure that other components and metal in the vicinity of the converter meet the spacing requirements to which the system is approved. Low resistance and low inductance PCB layout traces are the norm and should be used where possible. Due consideration must also be given to proper low impedance tracks between power module, input and output grounds. The recommended footprints and soldering profiles are shown as Figure 3~6.



Note: Dimensions are in inches (millimeters)

Figure3 Recommended PCB Layout Footprints for DIP-24 packages

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℃)

Figure4 Recommended Wave Soldering Profiles for DIP-24 packages

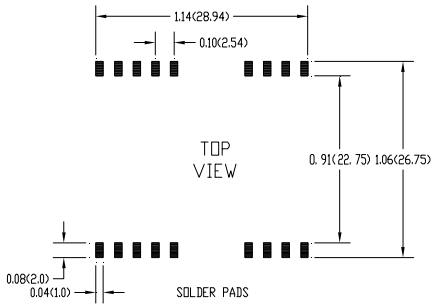
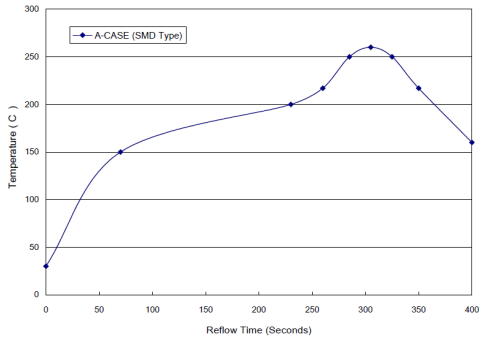


Figure5 Recommended PCB Layout Footprints for SMD packages

Lead Free Hot Air Reflow Profile



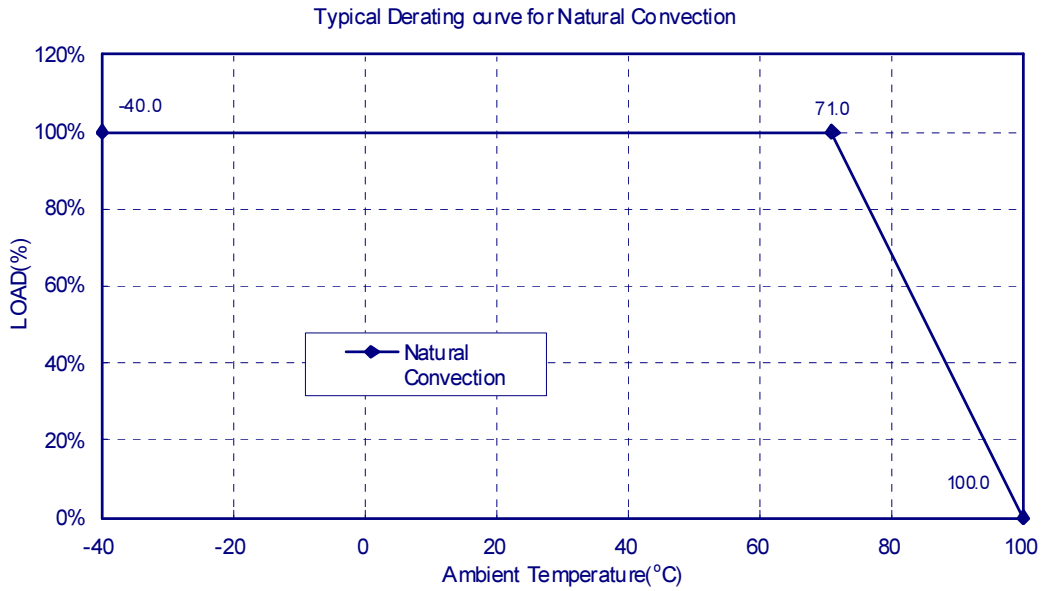
1. Soldering Paste: SHENMAO PF610-P (Sn/Ag/Cu)
2. Ramp up rate during preheat: 1.71 ℃/Sec (From 30℃ to 150℃)
3. Soaking temperature: 0.31 ℃/Sec (From 150℃ to 200℃), 160±10 seconds
4. Ramp up rate during reflow: 0.96 ℃/Sec (From 217℃ to 260℃)
5. Peak temperature: 260℃, above 217℃ 90 Seconds
6. Ramp up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

Figure6 Recommended Air Reflow Profiles for SMD packages

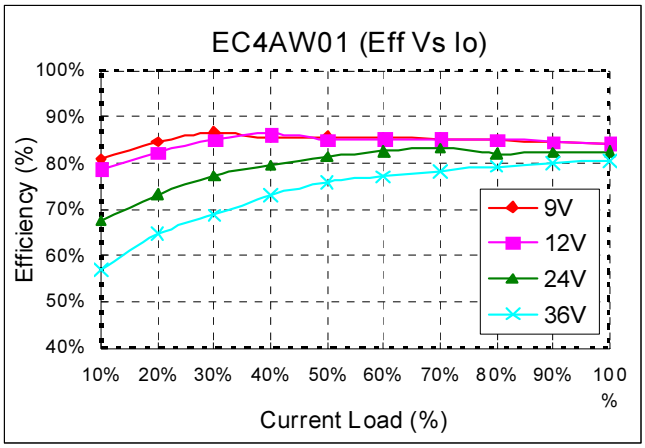
6.2 Power De-Rating Curves for EC4AW Series

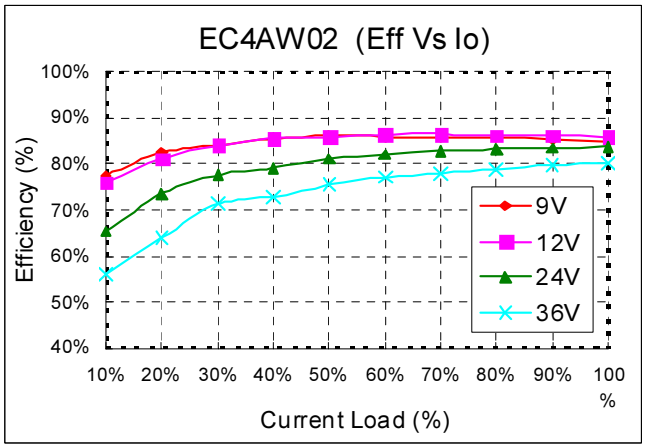
Operating Ambient temperature Range: -40℃ ~ 85℃ with de-rating above 71℃.

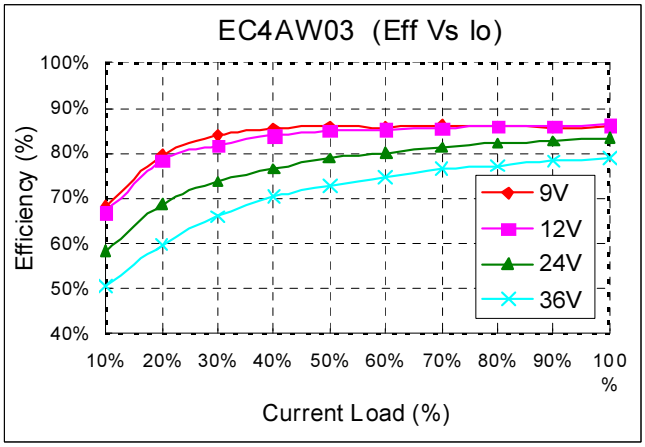
Maximum case temperature under any operating condition should not exceed 100℃.

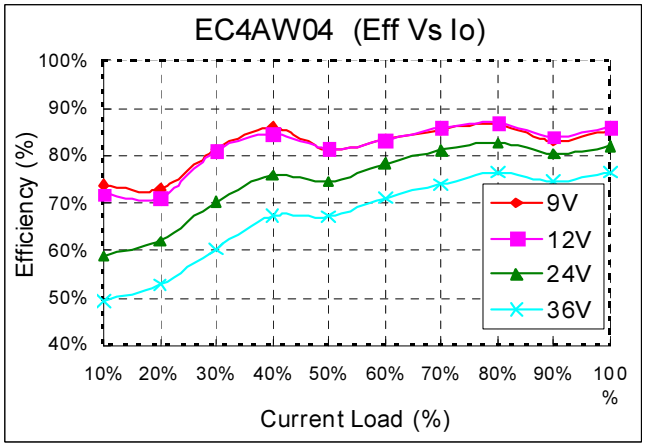


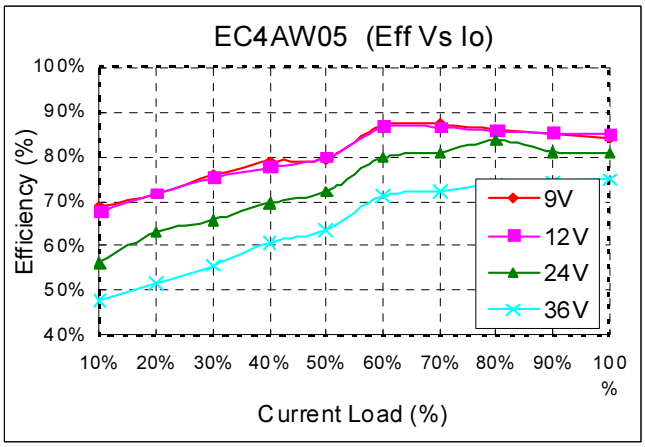
6.3 Efficiency vs. Load Curves

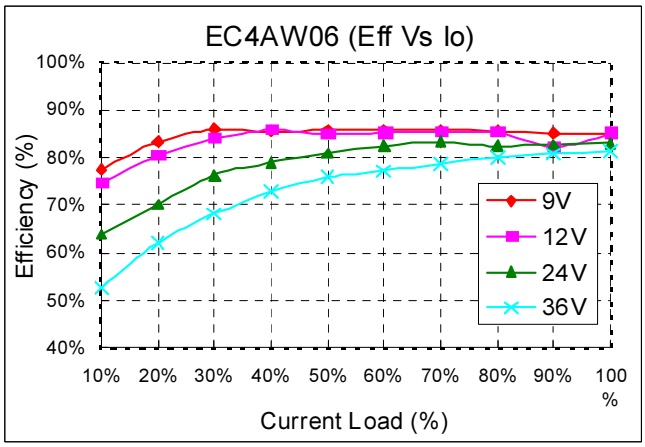


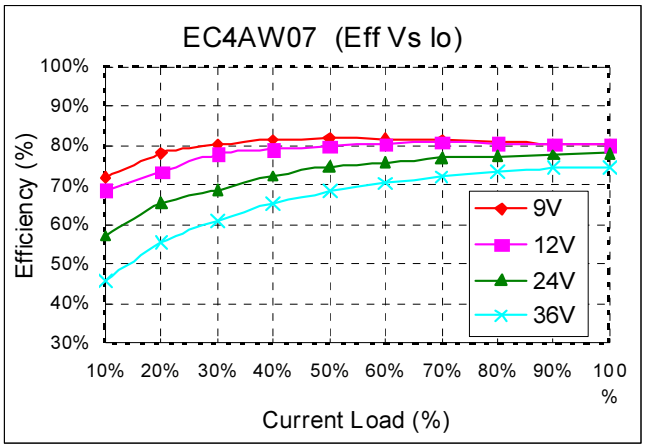


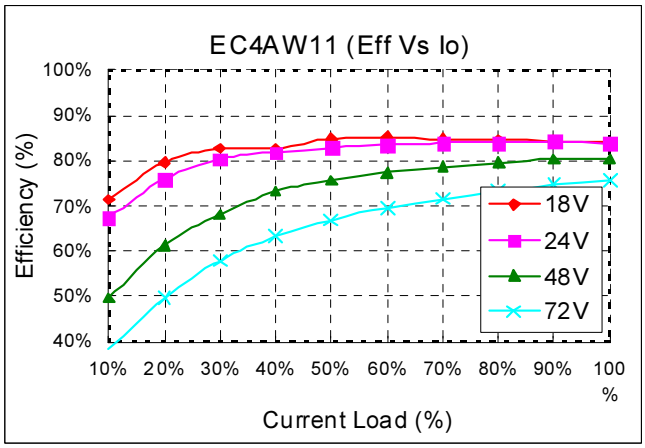


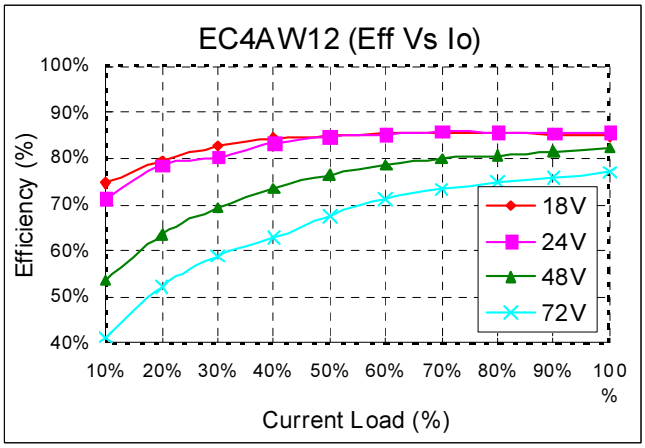


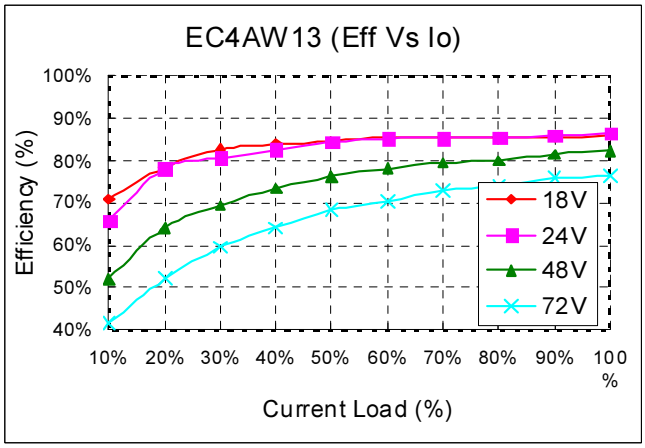


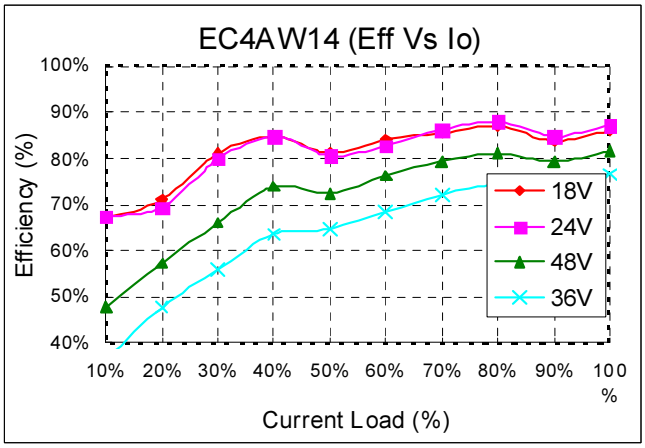


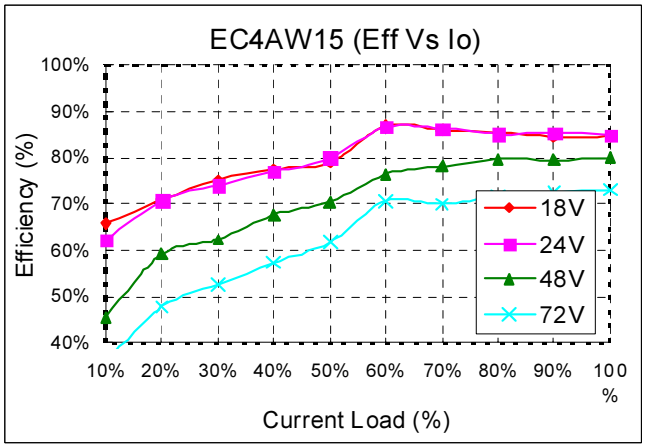

EC4AW07 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100 %
Current Load (%)
9V
12V
24V
36V

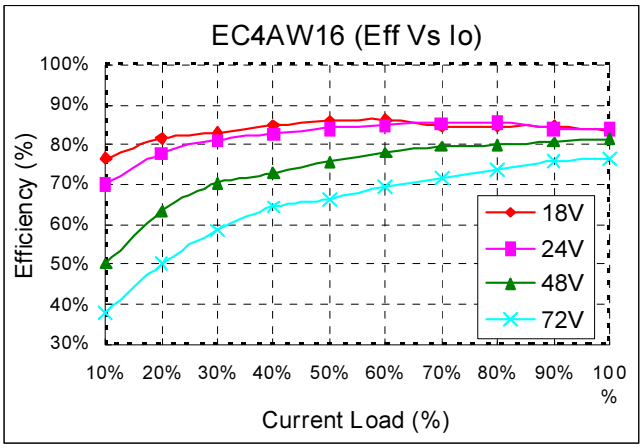

EC4AW11 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100 %
Current Load (%)
18V
24V
48V
72V

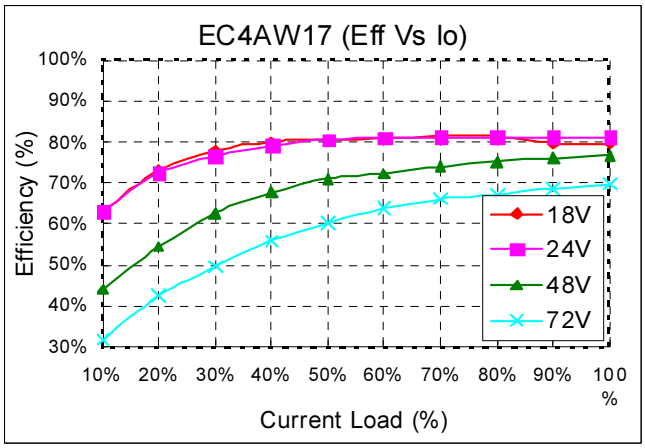

EC4AW12 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100 %
Current Load (%)
18V
24V
48V
72V


EC4AW13 (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
48V
72V


EC4AW14 (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
48V
36V

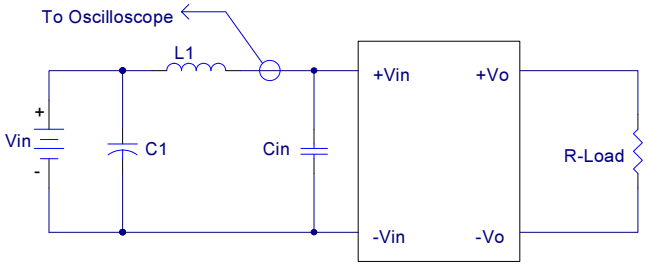

EC4AW15 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100 %
Current Load (%)
18V
24V
48V
72V


EC4AW16 (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
48V
72V


EC4AW17 (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
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 Figure7 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: 47uF ESR <0.17Ω @ 20℃, 100KHz.
Cin: None

Figure7 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 Figure8. 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

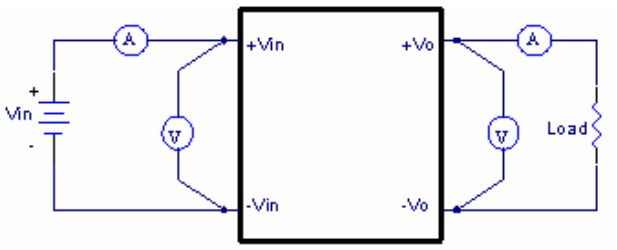


Figure8 EC4AW Series Test Setup

6.6 Output Ripple and Noise Measurement

The test set-up for noise and ripple measurements is shown in Figure9 and Figure10. 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.

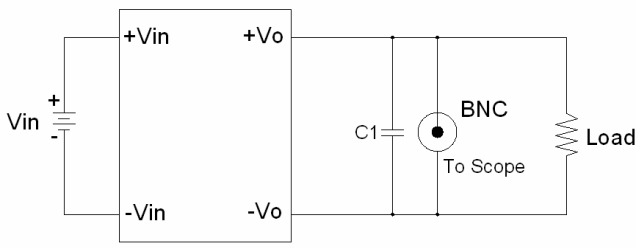


Figure9 Using BNC to Measure Output Ripple and Noise

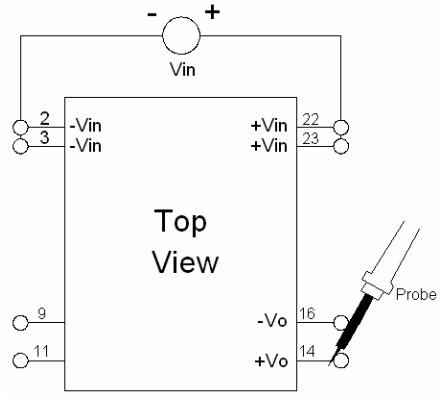


Figure 10 Using Probe to Measure Output Ripple and Noise

6.7 Output Capacitance

The EC4AW 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 EC4AW 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 24Vin models and 0.5A for 48Vin modules. Figure11 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.

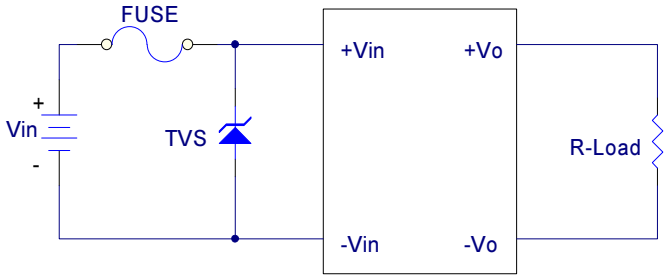


Figure11 Input Protection

7.2 EMC Considerations

EMI Test standard: EN55022
Test Condition: Input Voltage: Nominal, Output Load: Full Load

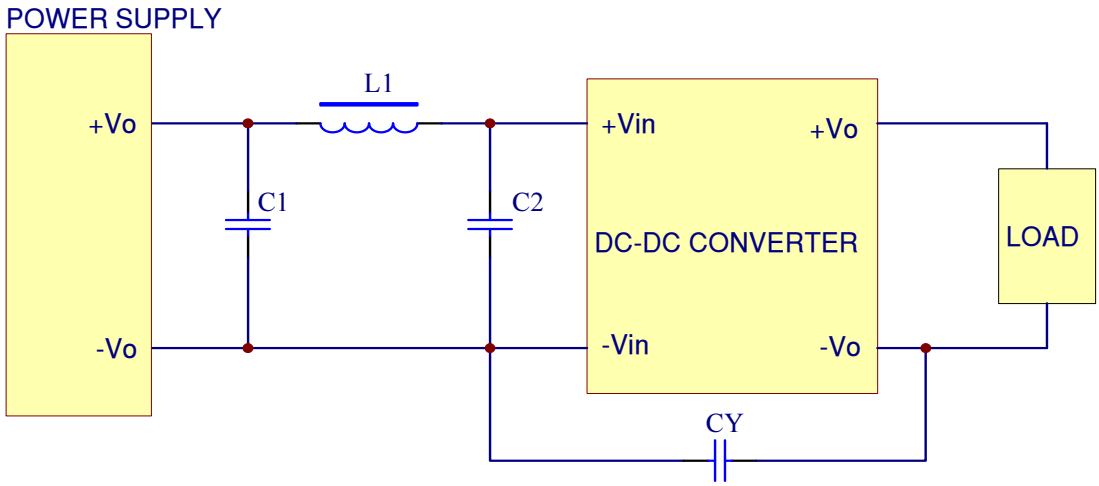


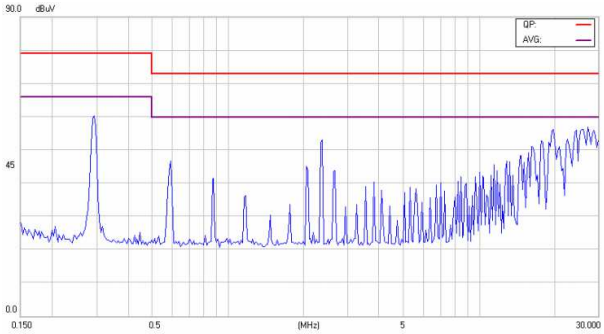
Figure12 Connection circuit for conducted EMI testing

	EN55022 Class A			
Model No.	C1	C2	CY	L1
EC4AW01	NC	120uF/100V	NC	SHORT
EC4AW02	NC	120uF/100V	NC	SHORT
EC4AW03	NC	120uF/100V	NC	SHORT
EC4AW04	NC	120uF/100V	NC	SHORT
EC4AW05	NC	120uF/100V	NC	1uH
EC4AW06	NC	120uF/100V	NC	SHORT
EC4AW07	NC	120uF/100V	NC	SHORT
EC4AW11	NC	120uF/100V	NC	SHORT
EC4AW12	NC	120uF/100V	NC	SHORT
EC4AW13	NC	120uF/100V	NC	SHORT
EC4A1W4	NC	120uF/100V	NC	SHORT
EC4AW15	NC	120uF/100V	NC	1uH
EC4AW16	NC	120uF/100V	NC	SHORT
EC4AW17	NC	120uF/100V	NC	SHORT

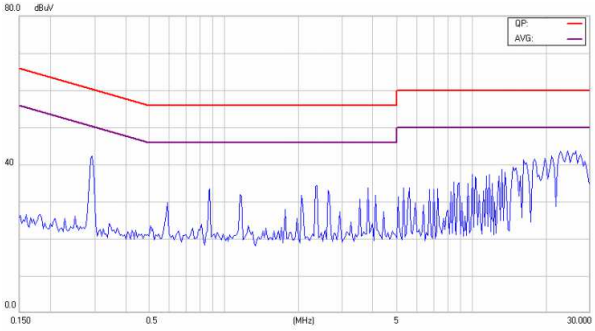
Note: C2 of capacitors are CHEMI-CON KY Series aluminum capacitors.

	EN55022 Class B			
Model No.	C1	C2	CY	L1
EC4AW01	47uF/100V	47uF/100V	NC	1uH
EC4AW02	47uF/100V	47uF/100V	NC	1uH
EC4AW03	NC	10uF/50V*5	NC	68uH
EC4AW04	47uF/100V	47uF/100V	NC	1uH
EC4AW05	47uF/100V	47uF/100V	NC	1uH
EC4AW06	47uF/100V	47uF/100V	NC	1uH
EC4AW07	47uF/100V	47uF/100V	NC	1uH
EC4AW11	47uF/100V	47uF/100V	NC	1uH
EC4AW12	47uF/100V	47uF/100V	NC	1uH
EC4AW13	47uF/100V	47uF/100V	NC	1uH
EC4A1W4	47uF/100V	47uF/100V	NC	1uH
EC4AW15	47uF/100V	47uF/100V	NC	1uH
EC4AW16	47uF/100V	47uF/100V	NC	1uH
EC4AW17	47uF/100V KY	47uF/100V KY	NC	1uH

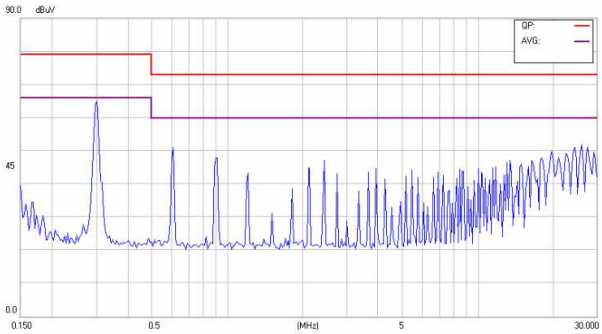
Note: C1, C2 of capacitors are CHEMI-CON KY Series aluminum capacitors, EC4AW03 C2 ceramic capacitor.



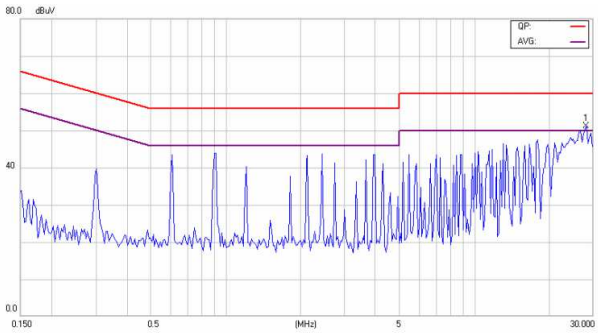
Conducted Class A of EC4AW01



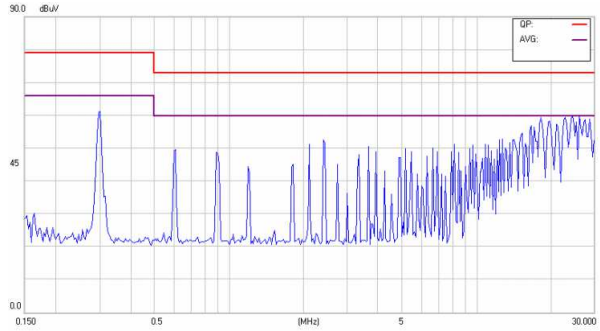
Conducted Class B of EC4AW01



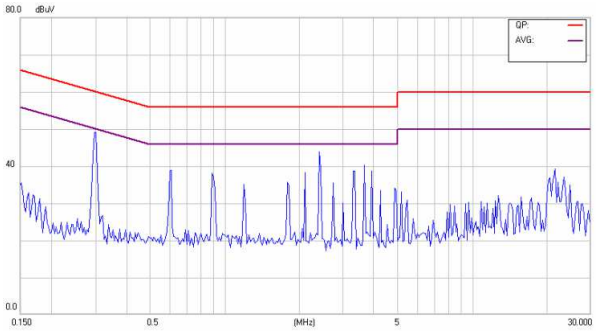
Conducted Class A of EC4AW02



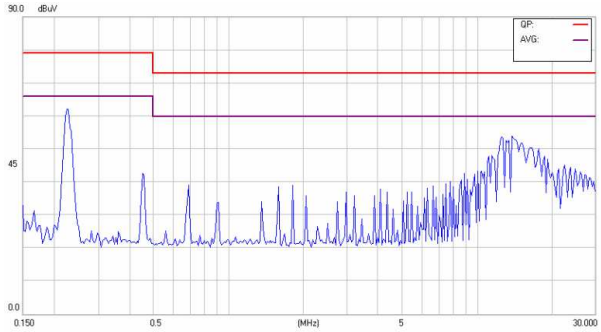
Conducted Class B of EC4AW02



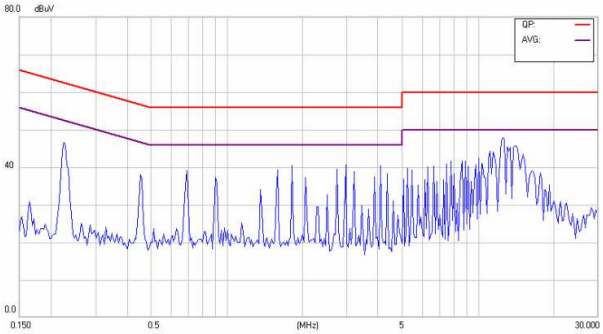
Conducted Class A of EC4AW03



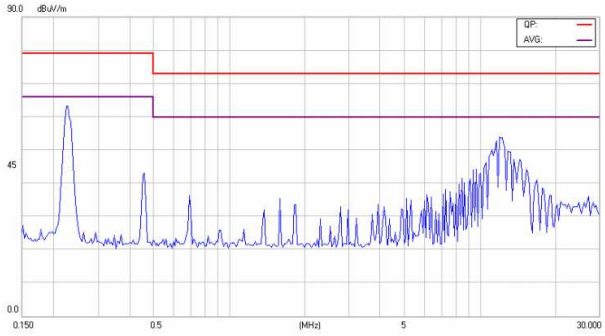
Conducted Class B of EC4AW03



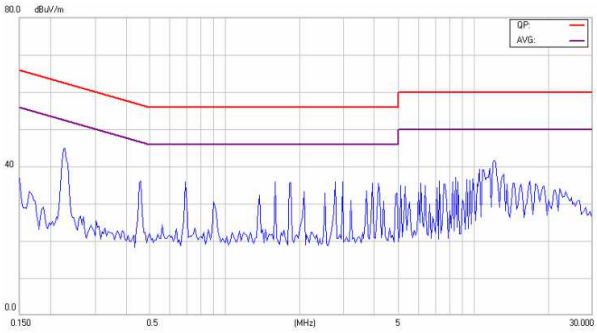
Conducted Class A of EC4AW04



Conducted Class B of EC4AW04



Conducted Class A of EC4AW05



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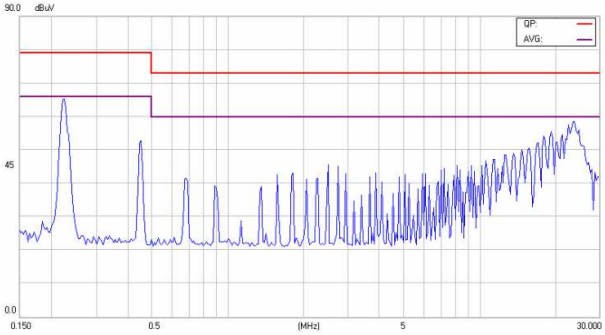
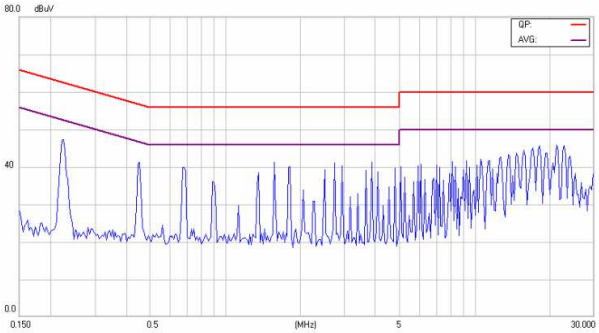
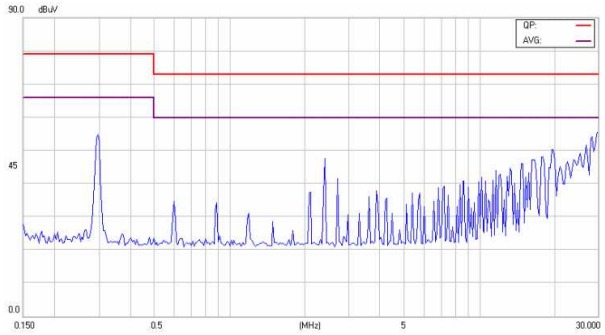


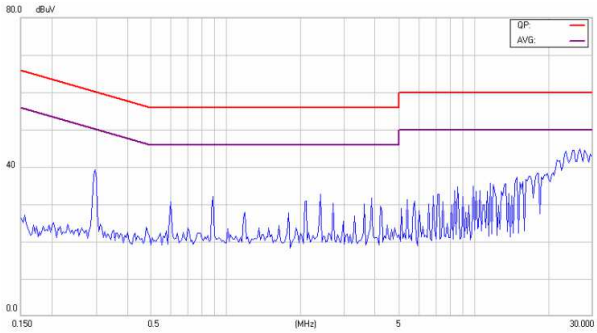
Conducted Class A of EC4AW06



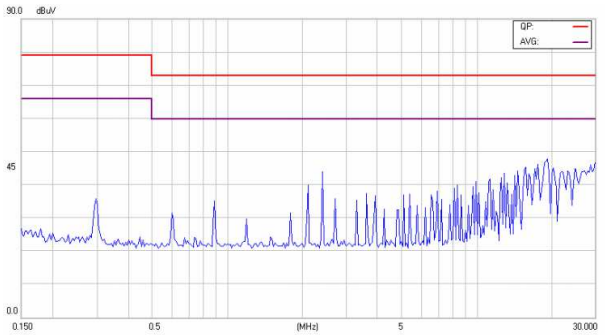
Conducted Class B of EC4AW06



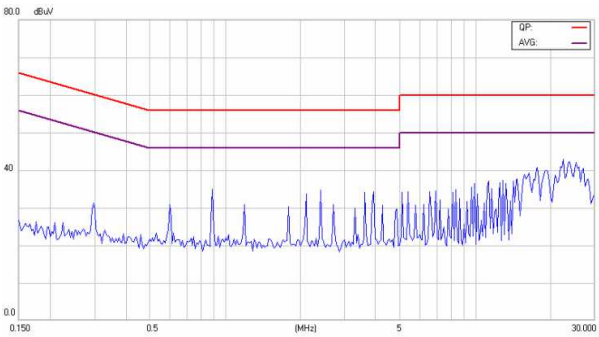
Conducted Class A of EC4AW07



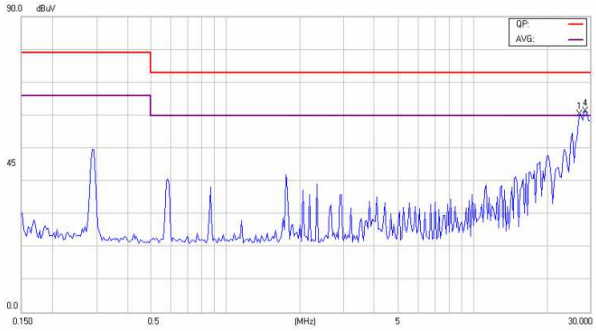
Conducted Class B of EC4AW07



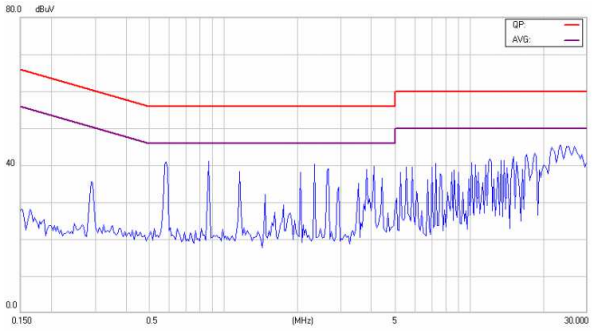
Conducted Class A of EC4AW11



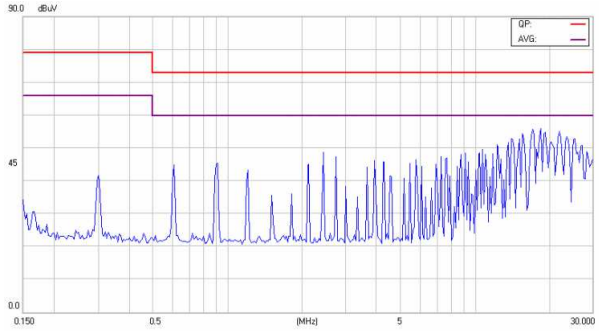
Conducted Class B of EC4AW11



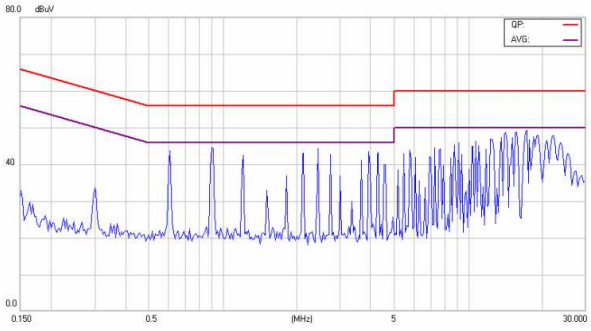
Conducted Class A of EC4AW12



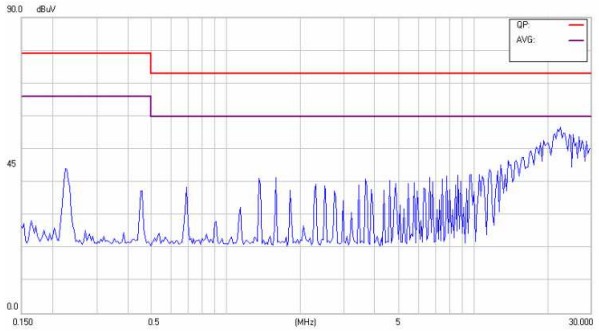
Conducted Class B of EC4AW12



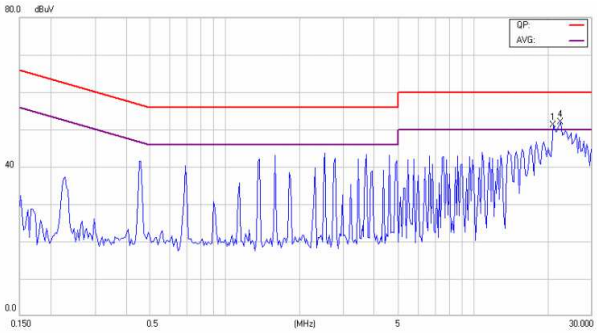
Conducted Class A of EC4AW13



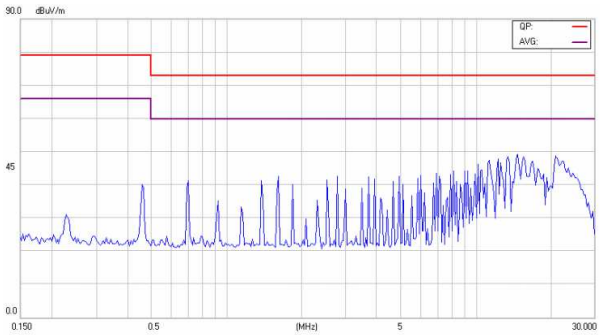
Conducted Class B of EC4AW13



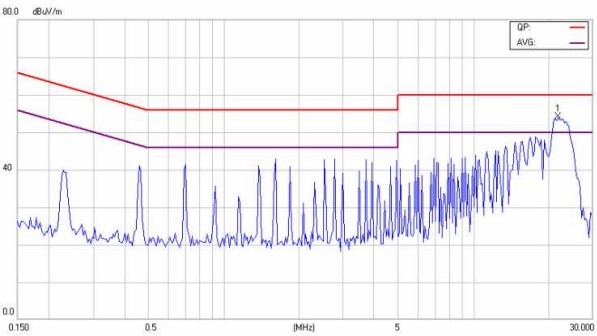
Conducted Class A of EC4AW14



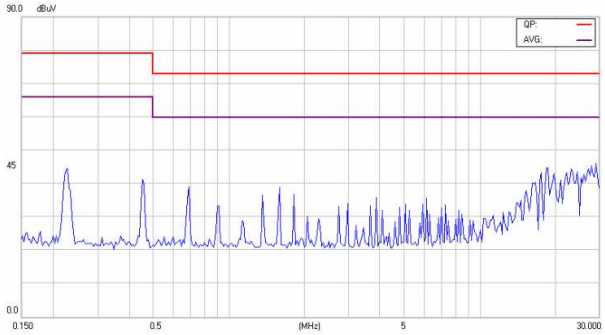
Conducted Class B of EC4AW14



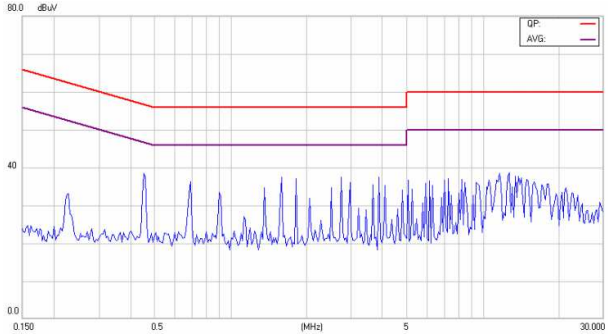
Conducted Class A of EC4AW15



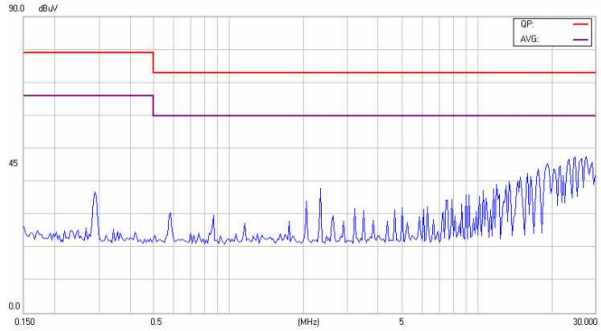
Conducted Class B of EC4AW15



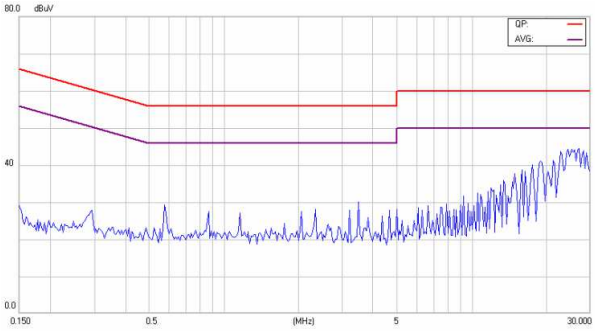
Conducted Class A of EC4AW16



Conducted Class B of EC4AW16



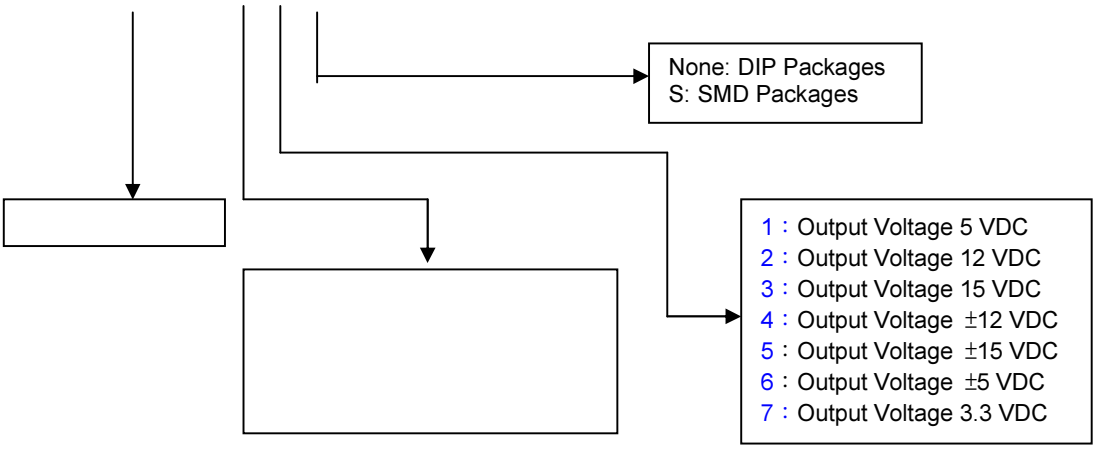
Conducted Class A of EC4AW17



Conducted Class B of EC4AW17

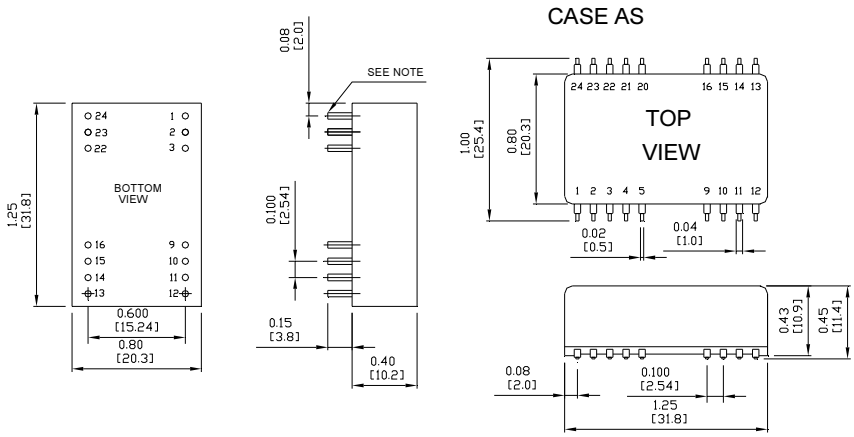
8. Part Number

EC4AW X X X



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



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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