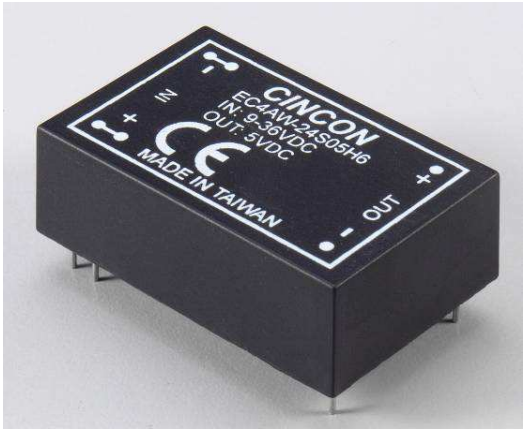
ISOLATED DC-DC Converter
EC4AW-H6 SERIES
APPLICATION NOTE



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Content

EC4AW-H6 5-6W Isolated DC-DC Converters

Application Note V10 September 2014

1. Introduction

The EC4AW-H6 series offer 5-6 watts of output power in a 24 pin DIP package. The EC4AW-H6 series has a 4:1 wide input voltage range of 9-36VDC and 18-72VDC, and provides a precisely regulated output. This series has features such as high isolation voltage and allows an ambient operating temperature range of –40°C to 71°C(de-rating above 71°C). The modules are fully protected against input UVLO (under voltage lock out), output short circuit and output overvoltage conditions. All models are very suitable for distributed power architectures, telecommunications, battery operated equipment and industrial applications.

2. DC-DC Converter Features

* 5-6W Isolated Output
* DIP-24 Package
* Regulated Outputs
* Efficiency to 85%
* Continuous Short Circuit Protection
* I/O Isolation Voltage 6000VDC
* Reinforced Insulation Rate for Working Voltage 300VAC
* 5uA Leakage Current
* EMI Meets EN55022 Class A
* Safety Meets UL60950-1 and UL60601-1
* CE Mark Meets 2004/108/EC

3. Electrical Block Diagram

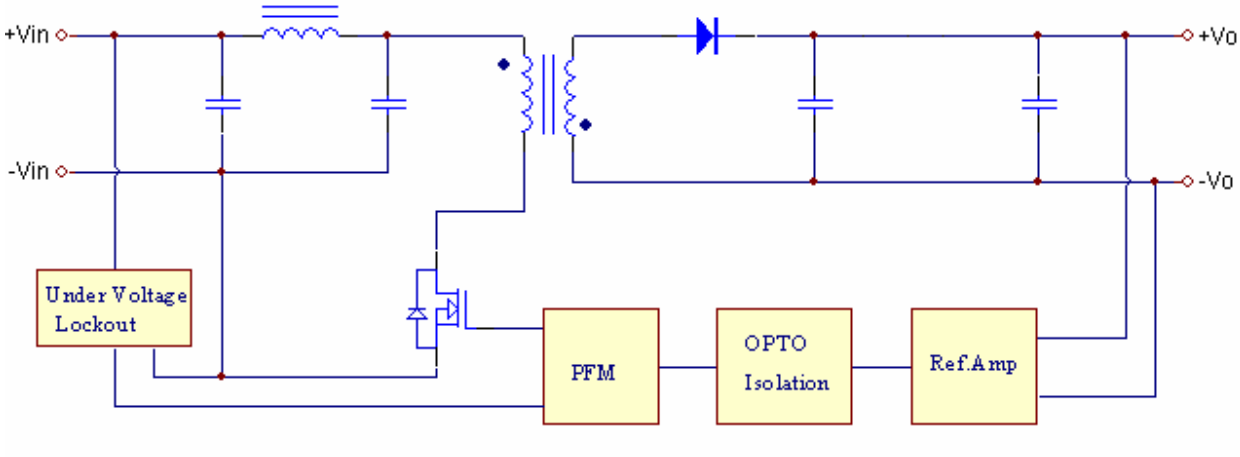


Figure 1 Electrical Block Diagram of single output module

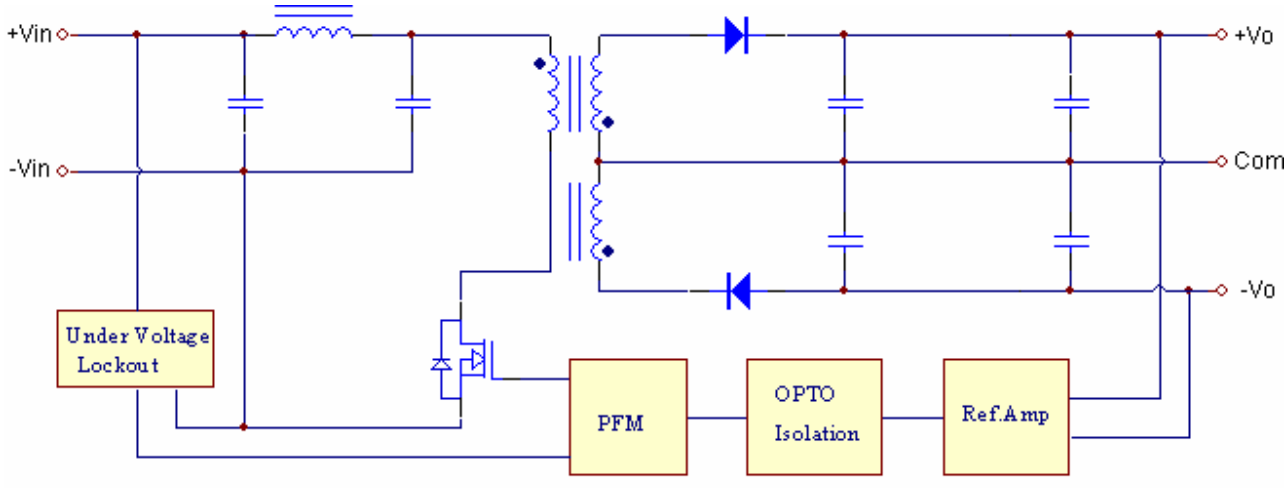


Figure 2 Electrical Block Diagram of dual output module

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		24Vin	-0.7		36	Vdc
		48Vin	-0.7		72	
Transient	100ms	24Vin			50	Vdc
		48Vin			100	
Operating Ambient Temperature	With de-rating, above 71℃	All	-40		+71	℃
Case Temperature		All			+100	℃
Storage Temperature		All	-40		+100	℃
Input/Output Isolation Voltage	1 minute	All			6000	Vdc

INPUT CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Operating Input Voltage		24Vin	9	24	36	Vdc
		48Vin	18	48	72	
Turn-On Voltage Threshold		24Vin	8.2	8.5	8.8	Vdc
		48Vin	16.5	17	17.5	
Turn-Off Voltage Threshold		24Vin	7.7	8	8.3	Vdc
		48Vin	15.3	16	16.8	
Lockout Hysteresis Voltage		24Vin		0.5		Vdc
		48Vin		1.0		
Maximum Input Current	Full load, Vin= 9V	24Vin		800		mA
	Full load, Vin=36V	48Vin		400		
No-Load Input Current	Vin=24V	24S05H6		10		mA
		24S12H6		10		
		24D12H6		15		
		24D15H6		15		
	Vin=48V	48S05H6		5		
		48S12H6		5		
		48D12H6		8		
		48D15H6		8		
Inrush Current (I^2t)	As per ETS300 132-2	All			0.01	A^2s
Input Reflected-Ripple Current	P-P thru 12uH inductor, 5Hz to 20MHz	All		10		mA

OUTPUT CHARACTERISTIC

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Output Voltage Set Point	Vin=nominal input, Io= $Io_{max.}$	Vo=5Vdc	4.925	5	5.075	Vdc
		Vo=12Vdc	11.82	12	12.18	
		Vo=±12Vdc	±11.82	±12	±12.18	
		Vo=±15Vdc	±14.775	±15	±15.225	
Output Voltage Balance	Vin=nominal input, Io=$Io_{max.}$	Dual			±2.0	%
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=low line to high line, full load	All			±0.5	%
Temperature Coefficient	Ta=-40℃ to 71℃	All			±0.05	%/℃
Output Voltage Ripple and Noise (5Hz to 20MHz bandwidth)						
Peak-to-Peak	Vin=Nominal Input, Io= Full Load (with 0.1uF MLCC)	24S05H6 48S05H6			100	mV
		24S12H6 24D12H6 48S12H6 48D12H6			120	
		24D15H6 48D15H6			150	
Operating Output Current Range		24S05H6 24S12H6 24D12H6 24D15H6 48S05H6 48S12H6 48D12H6 48D15H6	100 50 25 20 100 50 25 20		1000 500 ±250 ±200 1000 500 ±250 ±200	mA
Output DC Current-Limit Inception	Vo=90% $V_{O, nominal}$	All	120			%
Maximum Output Capacitance	Full load (resistive)	24S05H6 24S12H6 24D12H6 24D15H6 48S05H6 48S12H6 48D12H6 48D15H6	0 0 0 0 0 0 0 0 0		1000 500 250 200 1000 500 250 200	uF
DYNAMIC CHARACTERISTICS						
PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
Output Voltage Current Transient						
Step Change in Output Current	75% to 100% of Io.max di/dt=0.1A/us	All			±6	%
Setting Time (within 1% Vout nominal)		All			500	us
Turn-On Delay and Rise Time						
Turn-On Delay Time, From Input	Vin, min. to 10%Vo,set	All		0.5		ms
Output Voltage Rise Time	10%Vo, set to 90%Vo,set	All		1.0		ms

EFFICIENCY						
PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
100% Load	Vin=24V	24S05H6		80		%
		24S12H6		85		
		24D12H6		84		
		24D15H6		84		
	Vin=48V	48S05H6		80		
		48S12H6		84		
		48D12H6		83		
		48D15H6		84		
ISOLATION CHARACTERISTICS						
PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
Isolation Voltage	Input to Output, 1 minutes	All	6000			Vdc
Isolation Resistance	Input to Output	All	1000			MΩ
Isolation Capacitance	Input to Output (No Capacitor Between Input to Output)	All		40		pF
Reinforced Insulation	Creepage Distances	All	8			mm
	Air Clearances	All	8			
FEATURE CHARACTERISTICS						
PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
Switching Frequency		All	100			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		TBD		M hours
Weight		All		13.1		grams

5. Main Features and Functions

5.1 Operating Temperature Range

The EC4AW-H6 series converters can be operated by a wide ambient temperature range from -40℃ to 71℃ (de-rating above 71°C). The standard model has a plastic case and case temperature can not over 100℃ at normal operating.

5.2 UVLO (Under Voltage Lock Out)

Input under voltage lockout is standard on the EC4AW-H6 unit. The unit will shut down when the input voltage drops below a threshold, and the unit will operate when the input voltage goes above the upper threshold.

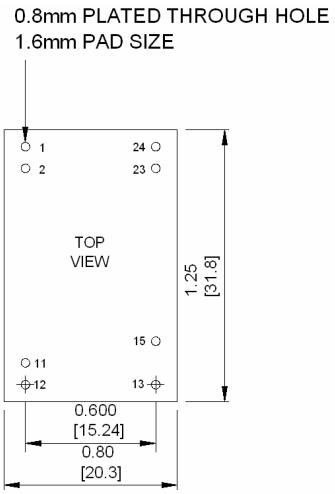
5.3 Over Current Protection

All models have internal over current and continuous short circuit 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.

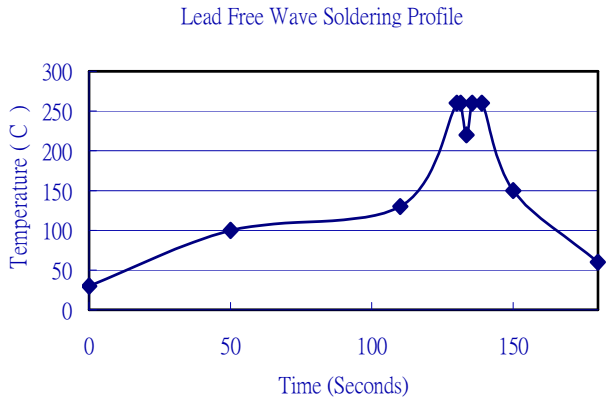
6. Applications

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 below.



Note: Dimensions are in inches (millimeters)



Note：

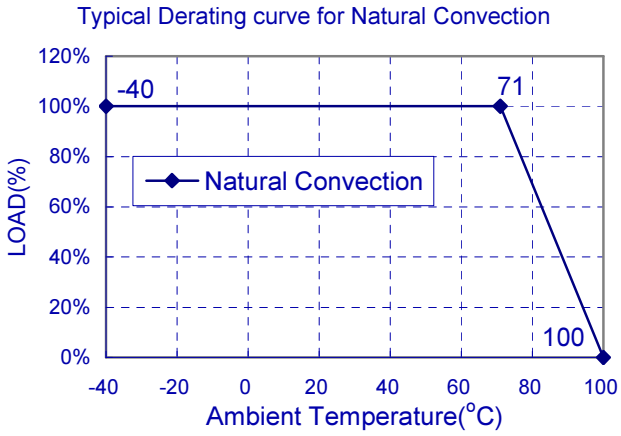
1. Soldering Materials: Sn/Cu/Ni
2. Ramp up rate during preheat: 1.4 ℃/Sec (From 50℃ to 100℃)
3. Soaking temperature: 0.5 ℃/Sec (From 100℃ to 130℃), 60±20 seconds
4. Peak temperature: 260℃, above 250℃ 3~6 Seconds
5. Ramp up rate during cooling: -10.0 ℃/Sec (From 260℃ to 150℃)

Figure 3 Recommended PCB Layout Footprints and Wave Soldering Profiles for DIP-24 packages

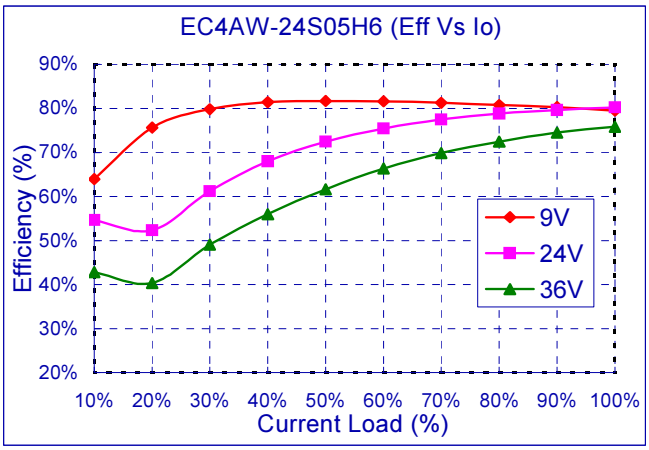
6.2 Power De-Rating Curves for EC4AW-H6 Series

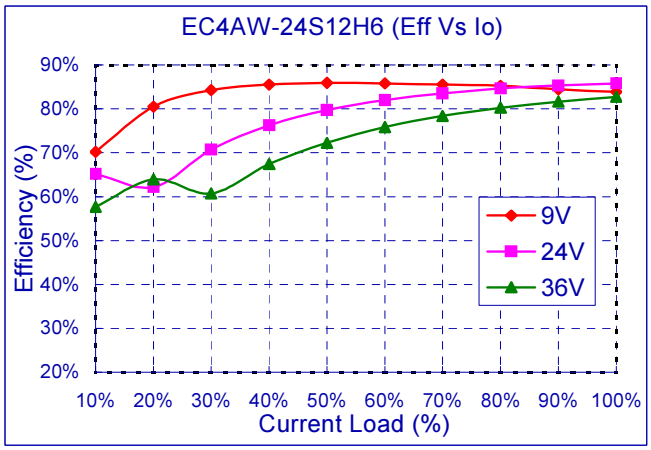
Operating Ambient temperature Range: -40℃ ~71℃ with de-rating above 71℃.

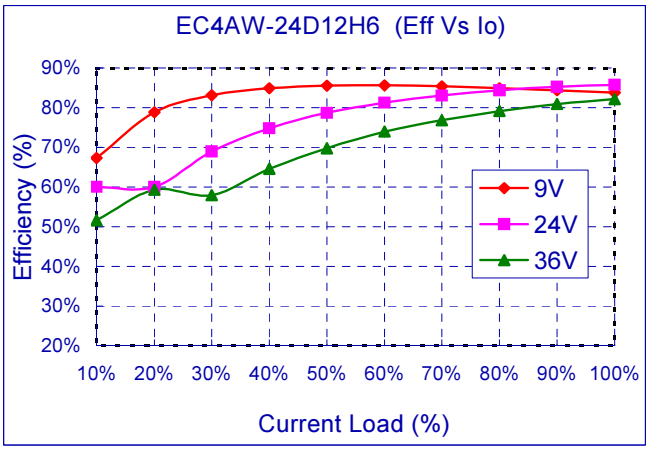
Maximum case temperature under any operating condition should not exceed 100℃.

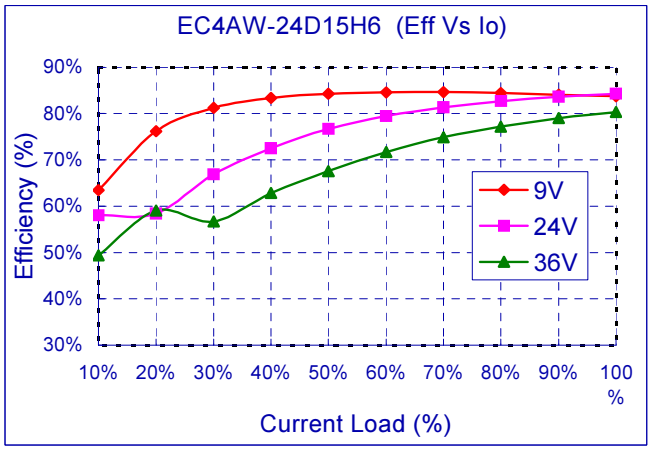


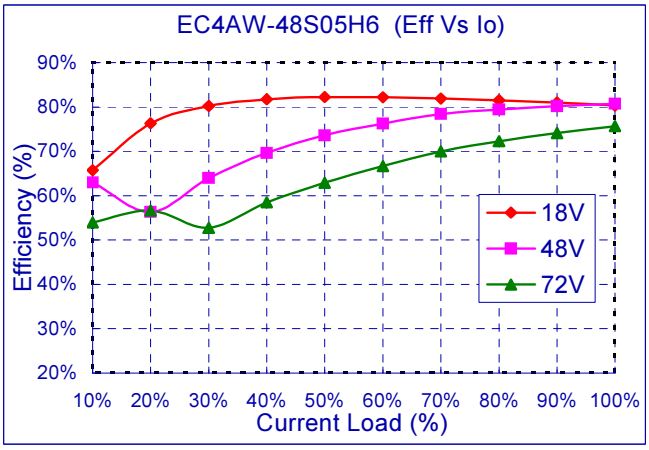
6.3 Efficiency vs. Load Curves

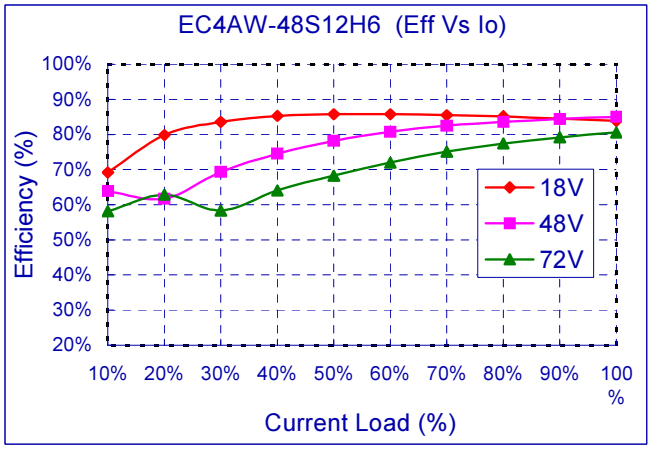


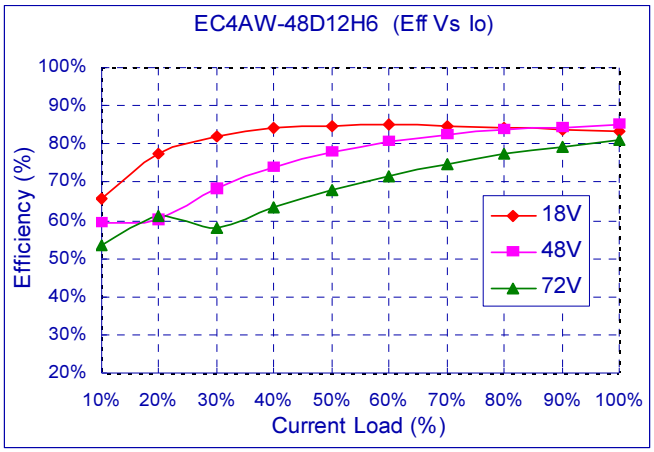


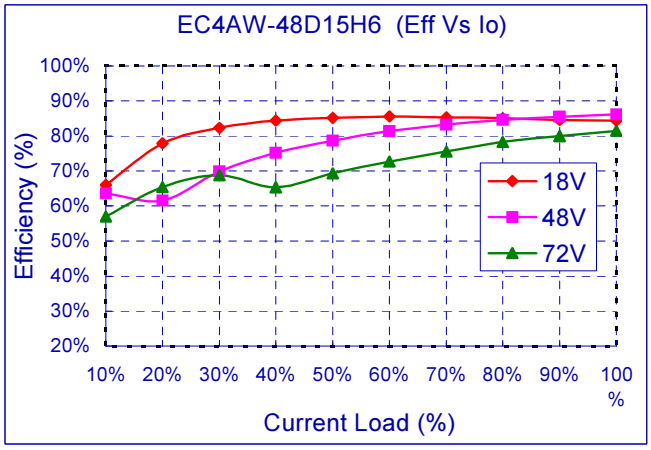






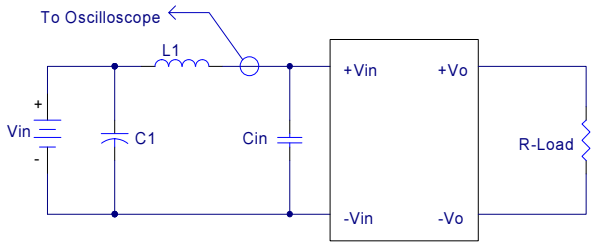



EC4AW-48D12H6 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
48V
72V


EC4AW-48D15H6 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100 %
Current Load (%)
18V
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 Figure 4 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: 33uF, ESR < 0.7Ω @ 20℃, 100KHz.
Cin: None

Figure 4 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 Figure 5. 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

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.

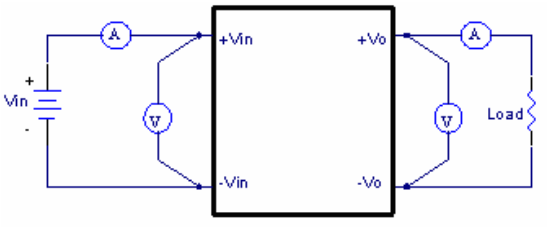
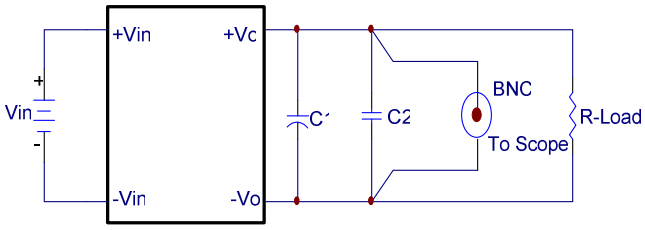


Figure 5 EC4AW-H6 Series Test Setup

6.6 Output Ripple and Noise Measurement

The test set-up for noise and ripple measurements is shown in Figure 6. 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 5Hz to 20MHz Band Width.



Note: C1: None
C2: 0.1uF Ceramic capacitor

Figure 6 Output Voltage Ripple and Noise Measurement Set-Up

6.7 Output Capacitance

The EC4AW-H6 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-H6 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. Figure 7 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.

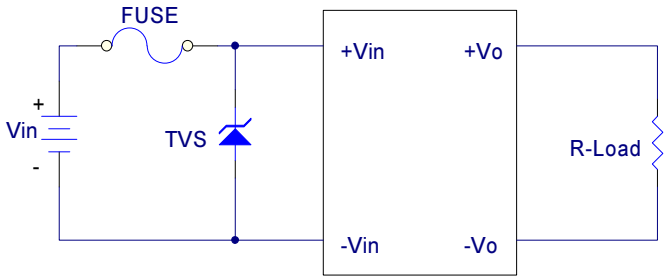


Figure 7 Input Protection

7.2 EMC Considerations

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

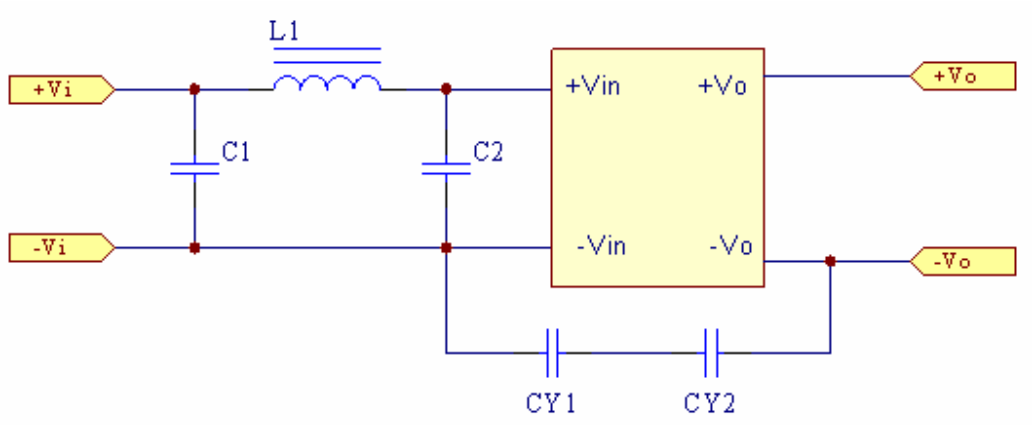
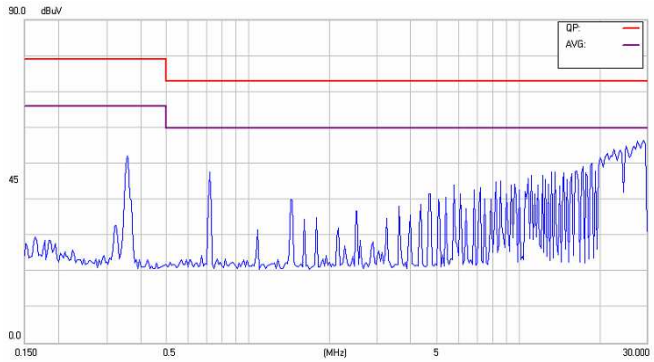


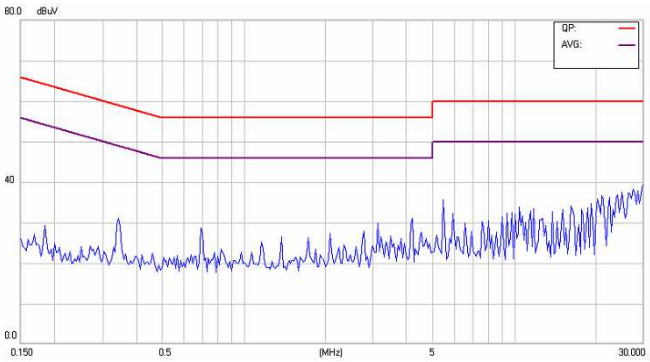
Figure 8 Connection circuit for conducted EMI testing

Model No.	EN55022 Class A					EN55022 Class B				
	C1	C2	CY1	CY2	L1	C1	C2	CY1	CY2	L1
EC4AW-24S05H6	NC	NC	NC	NC	Short	3.3uF/50V	NC	470pF/3KVAC	470pF/3KVAC	3.3uH
EC4AW-24S12H6	NC	NC	NC	NC	Short	3.3uF/50V	NC	470pF/3KVAC	470pF/3KVAC	3.3uH
EC4AW-24D12H6	NC	NC	NC	NC	Short	3.3uF/50V	NC	470pF/3KVAC	470pF/3KVAC	3.3uH
EC4AW-24D15H6	NC	NC	NC	NC	Short	3.3uF/50V	NC	470pF/3KVAC	470pF/3KVAC	3.3uH
EC4AW-48S05H6	NC	NC	NC	NC	Short	2.2uF/100V	NC	680pF/3KVAC	680pF/3KVAC	6.8uH
EC4AW-48S12H6	NC	NC	NC	NC	Short	2.2uF/100V	NC	680pF/3KVAC	680pF/3KVAC	6.8uH
EC4AW-48D12H6	NC	NC	NC	NC	Short	2.2uF/100V	NC	680pF/3KVAC	680pF/3KVAC	6.8uH
EC4AW-48D15H6	NC	NC	NC	NC	Short	2.2uF/100V	NC	680pF/3KVAC	680pF/3KVAC	6.8uH

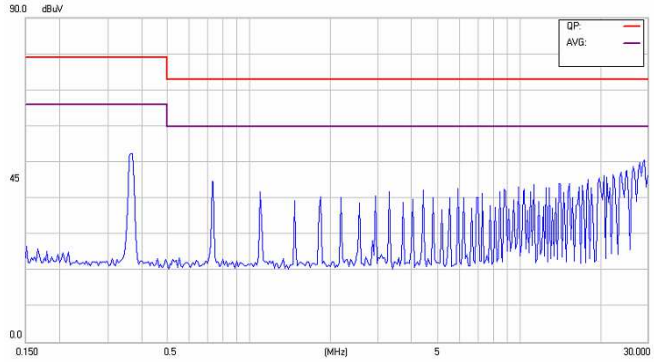
Note: C1 are ceramic capacitors, CY1 and CY2 are Y1 capacitors



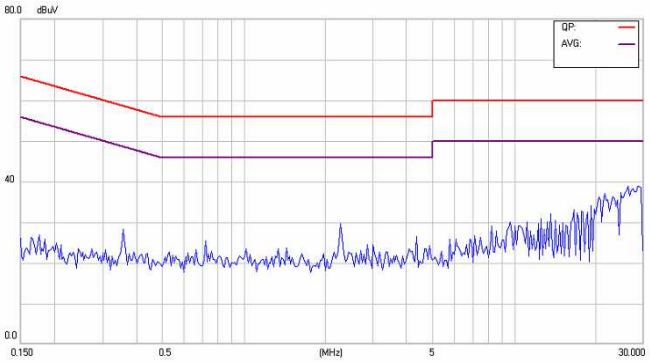
Conducted Class A of EC4AW-24S05H6



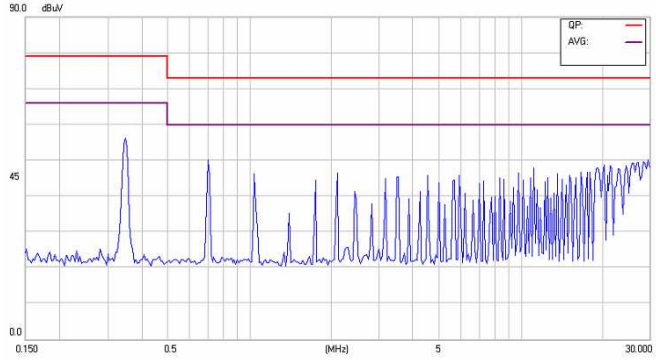
Conducted Class B EC4AW-24S05H6



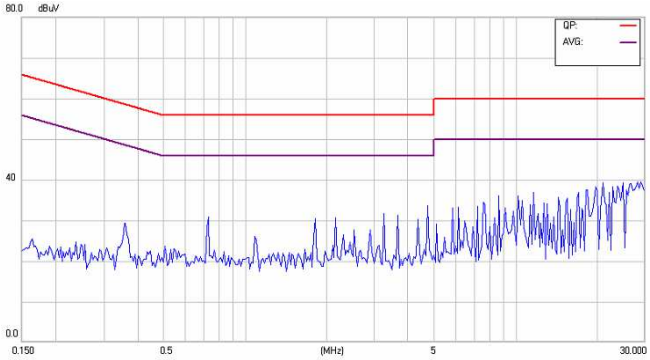
Conducted Class A EC4AW-24S12H6



Conducted Class B EC4AW-24S12H6



Conducted Class A of EC4AW-24D12H6



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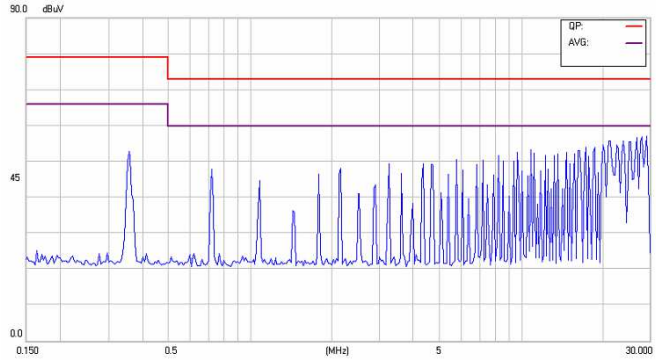
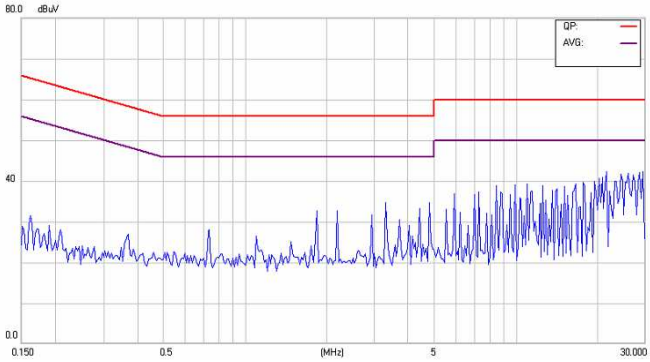
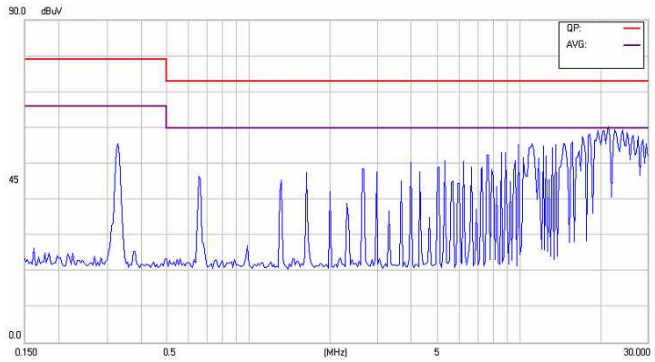


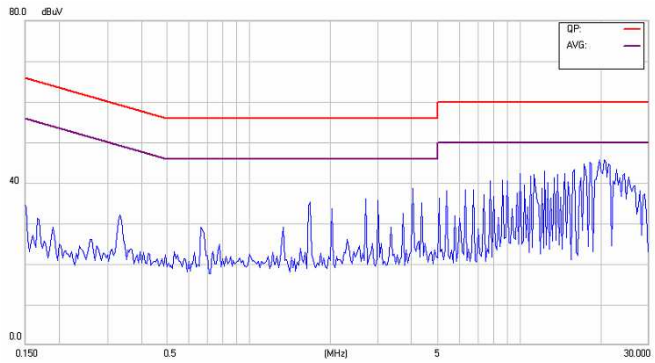
Conducted Class A EC4AW-24D15H6



Conducted Class B EC4AW-24D15H6



Conducted Class A EC4AW-48S05H6



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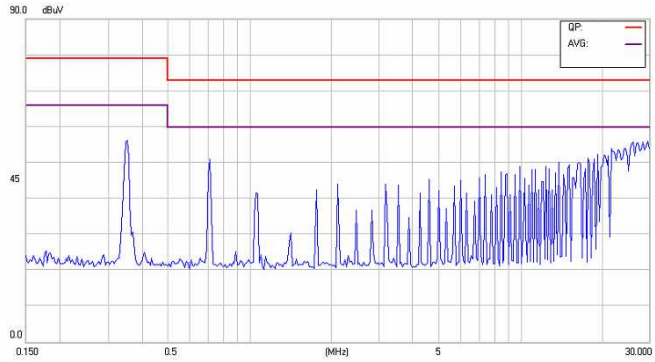
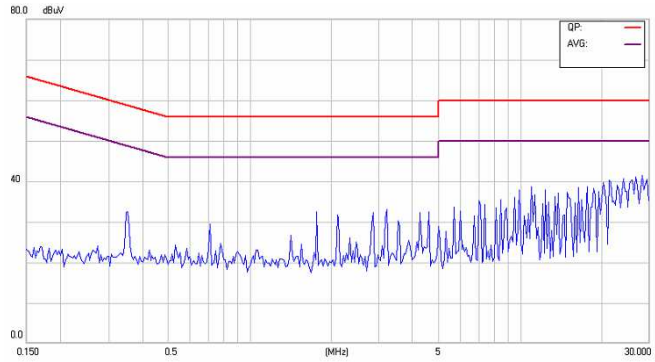


Conducted Class A of EC4AW-48S12H6



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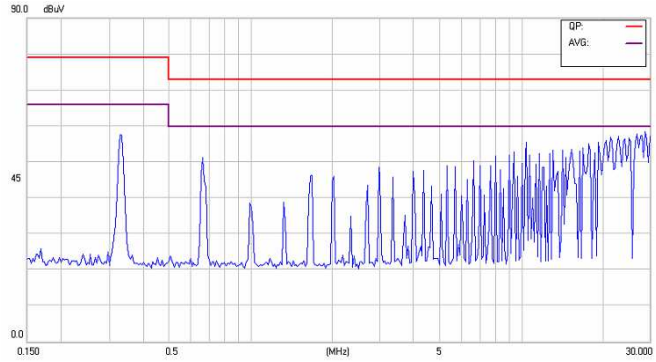

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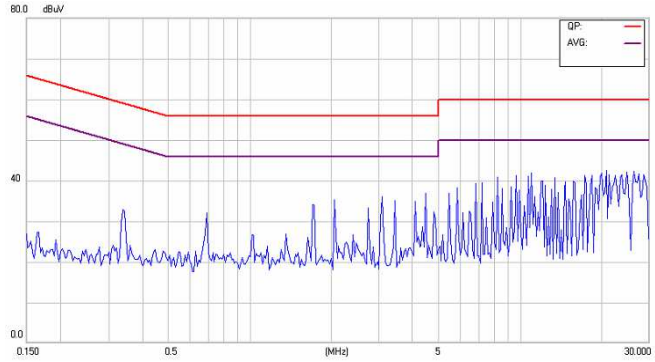

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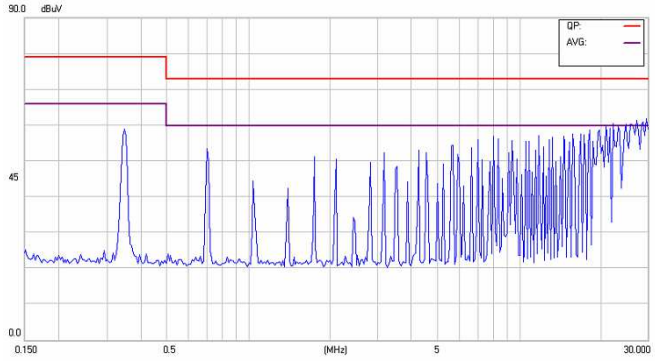

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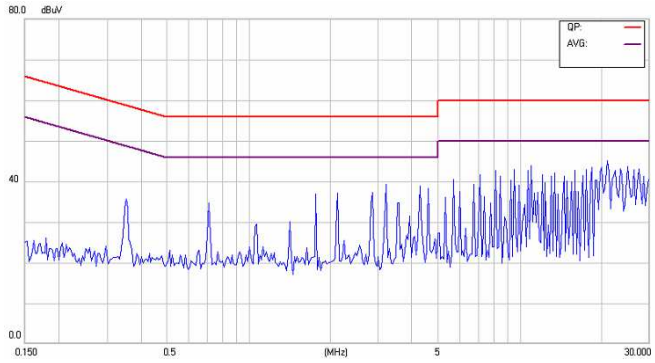
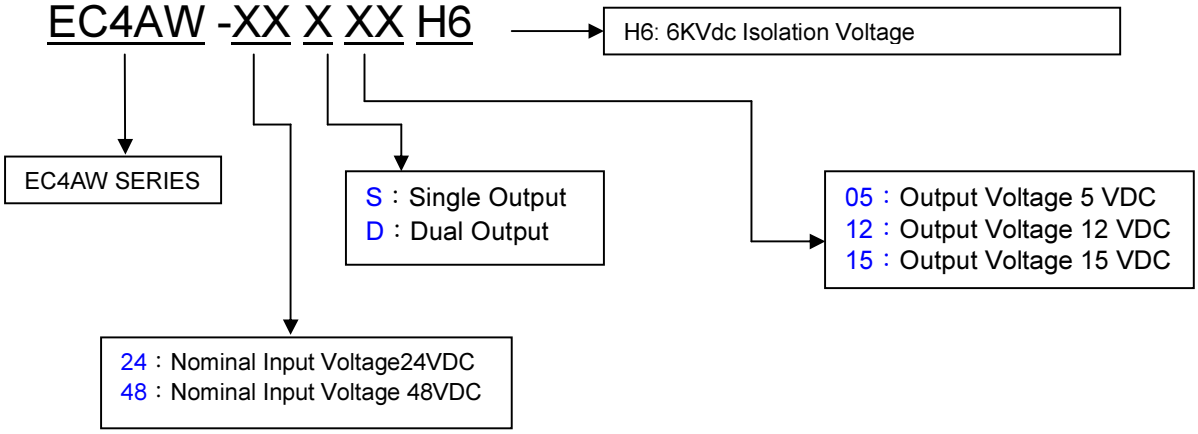


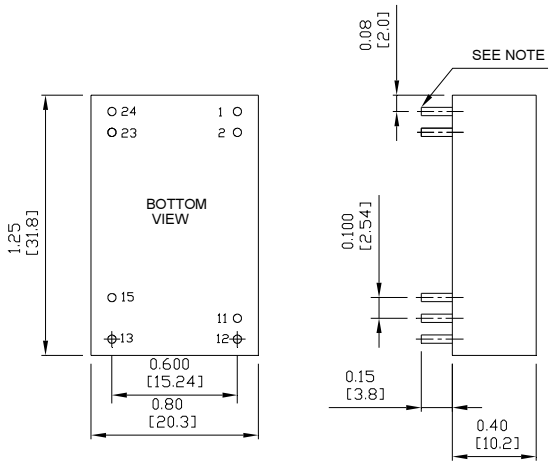
Conducted Class B EC4AW-48D15H6

8. Part Number



9. Mechanical Specifications

NOTE:Pin Size is 0.02±0.002 Inch (0.5±0.05 mm)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
1	+V Input	+V Input
2	+V Input	+V Input
11	NP	Common
12	-V Ouput	NP
13	+V Output	-V Output
15	NP	+V Output
23	-V Input	-V Input
24	-V Input	-V Input

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

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