EC8AW 15W Isolated DC-DC Converters

Application Note V13 November 2020

ISOLATED DC-DC Converter
EC8AW SERIES
APPLICATION NOTE

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Content

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1. Introduction

The EC8AW series offer 15 watts of output power in a 24 pin DIP copper package. The EC8AW series has a 4:1 wide input voltage range of 9-36VDC, 18-75VDC 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 65 °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

- 15W Isolated Output
- DIP-24 Metal Package
- Very High Efficiency up to 90%
- Low No Load Power Consumption
- 4:1 Input Range
- Regulated Outputs
- Conductive EMI Meet EN55032 Class A Without External Components
- Continuous Short Circuit Protection
- No Tantalum Capacitor Inside
- Safety Meets IEC/EN/UL 62368-1

3. Electrical Block Diagram

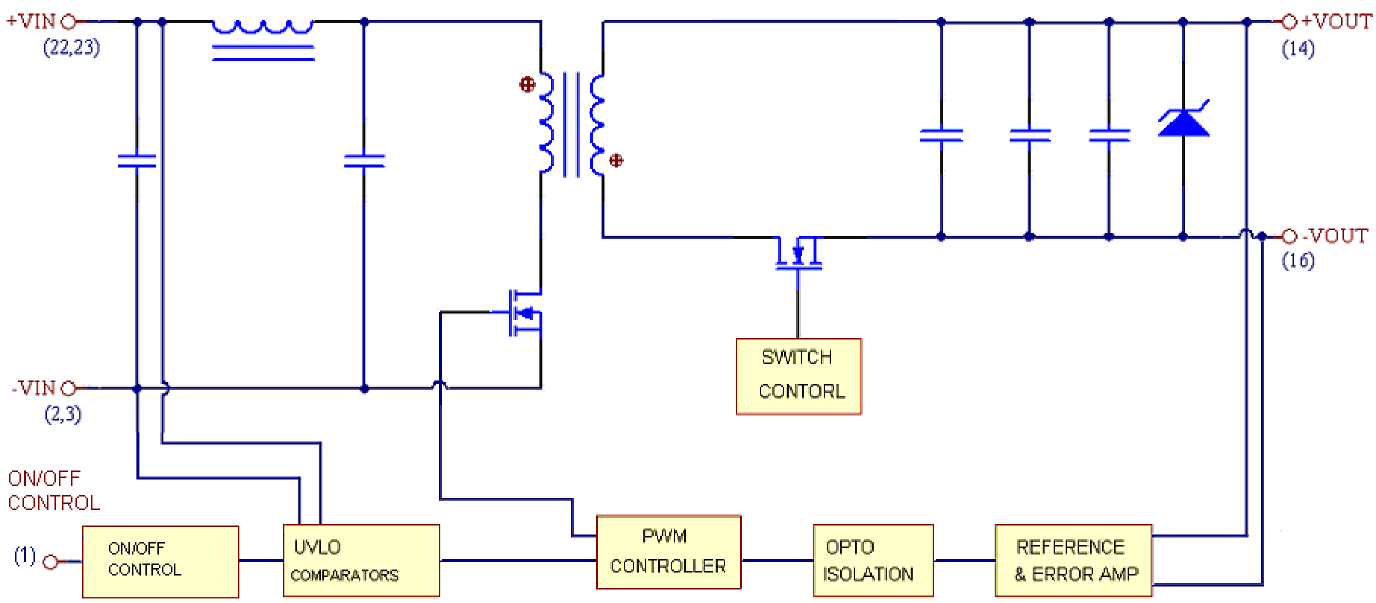


Figure1 Electrical Block Diagram of XXS33 and XXS05

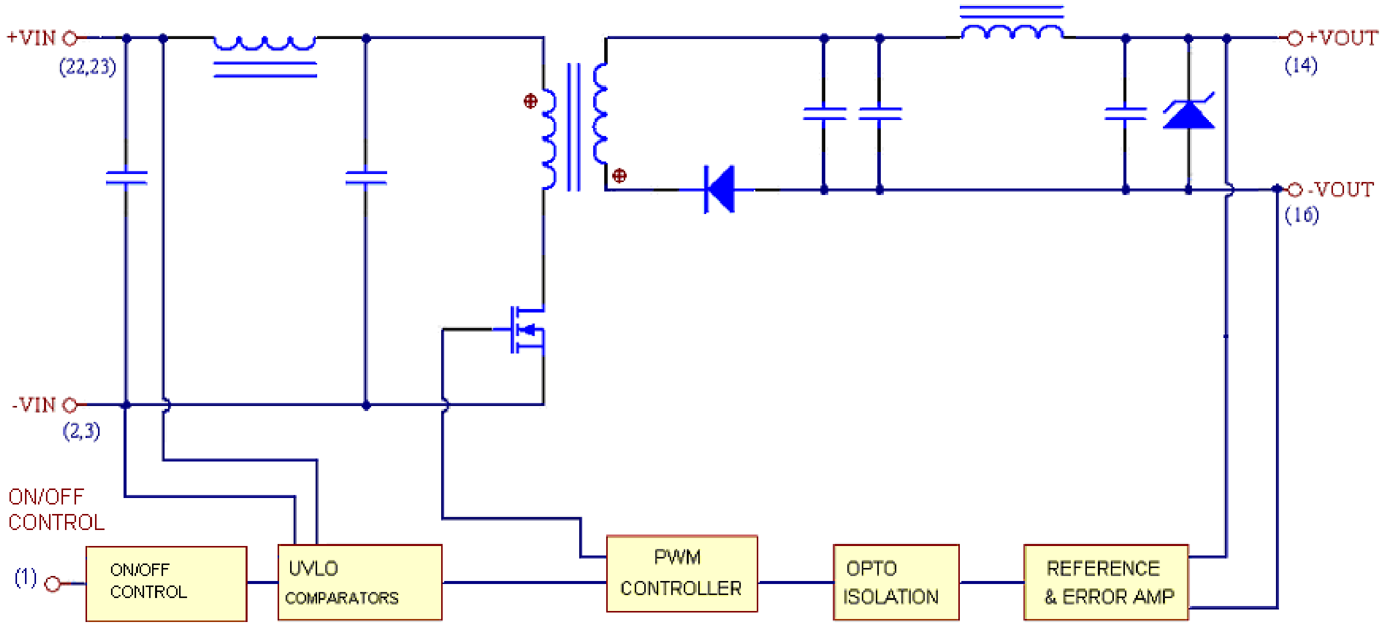


Figure2 Electrical Block Diagram of XXS12 and XXS15

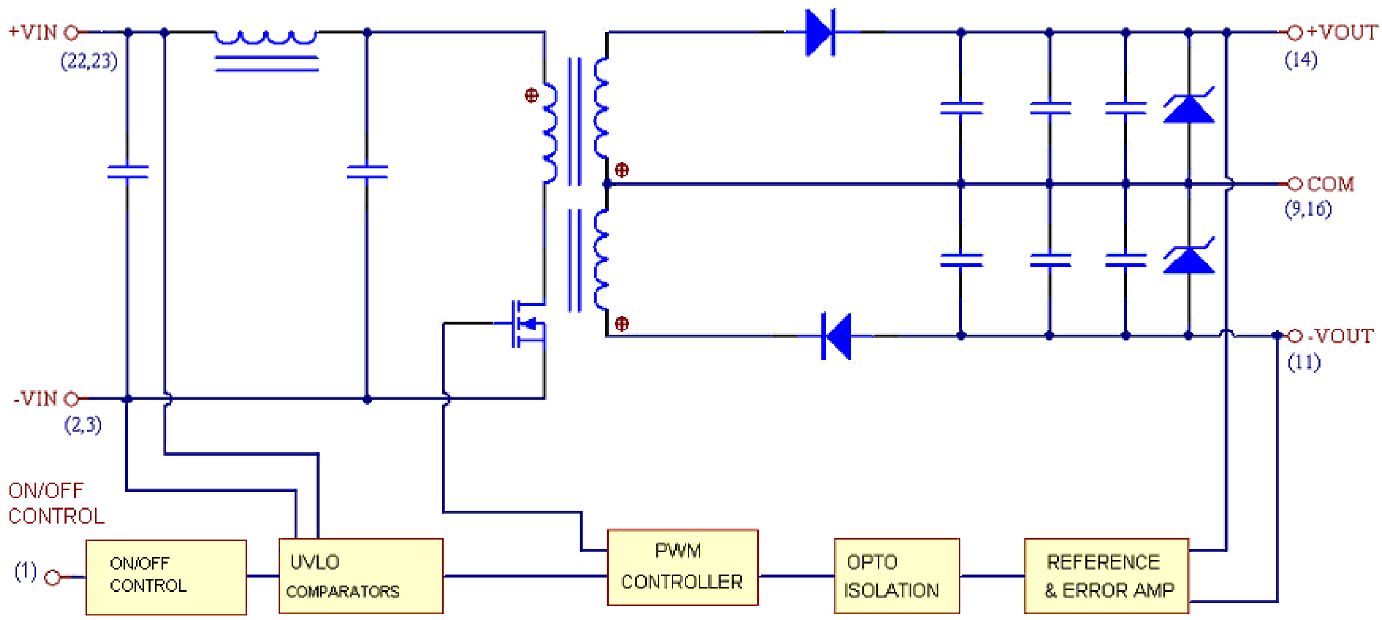


Figure3 Electrical Block Diagram of dual output module

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 48Vin	-0.3 -0.3		36 75	Vdc
Transient	100ms	24Vin 48Vin			50 100	Vdc
Operating Ambient Temperature	Derating, Above 65℃	All	-40		+85	℃
Case Temperature		All			105	℃
Storage Temperature		All	-55		+125	℃
Input/Output Isolation Voltage	1 minute	All			1500	Vdc

INPUT CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Operating Input Voltage		24Vin 48Vin	9 18	24 48	36 75	Vdc
Maximum Input Current	100% Load, Vin=9V	24Vin			1900	mA
	100% Load, Vin=18V	48Vin			1000	
No-Load Input Current	Vin=24V	24S33 24S05 24S12 24S15 24D12 24D15		8 8 8 8 8 8		mA
	Vin=48V	48S33 48S05 48S12 48S15 48D12 48D15		6 6 6 6 6 6		
Off Converter Input Current	Shutdown input idle current	All		2	4	mA
Inrush Current (I^2t)	As per ETS300 132-2	All			0.1	A^2s
Input Reflected-Ripple Current	P-P thru 12uH inductor, 5Hz to 20MHz	All			30	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=3.3V Vo=5V Vo=12V Vo=15V Vo=±12V Vo=±15V	3.2505 4.925 11.82 14.775 11.82 14.775	3.3 5 12 15 12 15	3.3495 5.075 12.18 15.225 12.18 15.225	Vdc
Output Voltage Balance	Vin=nominal, Io=Io_{max}, Tc=25℃	Dual			±1.0	%

OUTPUT CHARACTERISTIC

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Output Voltage Regulation						
Load Regulation	Io= Full Load to min. Load	Single Dual			±0.5 ±1.0	% %
Line Regulation	Vin=High line to Low line Full Load	Single Dual			±0.2 ±0.5	% %
Cross Regulation	Load cross variation 10% / 100%	Dual			±5	%
Temperature Coefficient	TC=-40℃ to 85℃	All			±0.03	%/℃
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth					
Peak-to-Peak	Full Load,20MHz bandwidth, Measure with 0.1uF Ceramic capacitor	Vo=3.3V Vo=5V Vo=12V Vo=15V Vo=±12V Vo=±15V			75	mV
Operating Output Current Range		Vo=3.3V Vo=5V Vo=12V Vo=15V Vo=±12V Vo=±15V	0 0 0 0 0 0		4000 3000 1250 1000 ±625 ±500	mA
Output DC Current-Limit Inception	Output Voltage=90% $V_{O,\ nominal}$	All	110	135	160	%
Maximum Output Capacitance	Full load, Resistance	Vo=3.3V Vo=5V Vo=12V Vo=15V Vo=±12V Vo=±15V			4000 3000 1250 1000 625 500	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			±5	%
Setting Time (within 1% $Vo_{nominal}$)		All			250	us
Turn-On Delay and Rise Time						
Turn-On Delay Time, From On/Off Control	Von/off to 10%Vo, set	All		7.5		ms
Turn-On Delay Time, From Input	Vin,min. to 10%Vo, set	All		7.5		ms
Output Voltage Rise Time	10%Vo, set to 90%Vo, set	All		7.5		ms

EFFICIENCY

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
100% Load	Vin=12V, Io=Io$_{max}$, Tc=25℃	24S33		88		%
		24S05		90		
		24S12		90		
		24S15		90		
		24D12		89		
		24D15		90		
	Vin=24V, Io=Io$_{max}$, Tc=25℃	48S33		89		
		48S05		90		
		48S12		90		
		48S15		90		
		48D12		89.5		
		48D15		90		
100% Load	Vin=24V, Io=Io$_{max}$, Tc=25℃	24S33		88		%
		24S05		90		
		24S12		90		
		24S15		90		
		24D12		89		
		24D15		90		
	Vin=48V, Io=Io$_{max}$, Tc=25℃	48S33		89		
		48S05		90		
		48S12		90		
		48S15		90		
		48D12		89.5		
		48D15		90		

ISOLATION CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Input to Output	1 minutes	All			1500	Vdc
Isolation Resistance		All	1000			MΩ
Isolation Capacitance		All		1000		pF

FEATURE CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Switching Frequency		All		300		KHz
On/Off Control, Positive Remote On/Off logic						
Logic Low (Module Off)	Von/off at Ion/off=1.0mA	All	0		1.2	V
Logic High (Module On)	Von/off at Ion/off=0.1uA	All	3.5 or Open Circuit		75	V
On/Off Current (for both remote on/off logic)	Ion/off at Von/off=0.0V	All		0.3	1	mA
Leakage Current (for both remote on/off logic)	Logic High, Von/off=15V	All			30	uA
Off Converter Input Current	Shutdown input idle current	All		2	4	mA
Output Voltage Trim Range	Pout=max rated power	Single	-10		+10	%

FEATURE CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Output Over Voltage Protection	Zener or TVS Clamp	Vo=3.3V Vo=5.0V Vo=12V Vo=15V Vo=±12V Vo=±15V		3.9 6.2 15 18 ±15 ±18		Vdc

GENERAL SPECIFICATIONS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
MTBF	Io=100%of Io max.; Ta=25℃ per MIL-HDBK-217F	Vo=3.3&5V Others		960 1250		K hours
Weight		All		18		grams

5. Main Features and Functions

5.1 Operating Temperature Range

The EC8AW series converters can be operated by a wide ambient temperature range from -40℃ to 85℃ (de-rating above 65℃). The standard model has a Copper case and case temperature can not over 105℃ at normal operating.

5.2 Remote On/Off

The EC8AW series allows the user to switch the module on and off electronically with the remote on/off feature. All models are available in "positive logic" versions. The converter turns on if the remote on/off pin is high (>3.5Vdc or open circuit). Setting the pin low (0 to <1.2Vdc) will turn the converter off. The signal level of the remote on/off input is defined with respect to ground. If not using the remote on/off pin, leave the pin open (converter will be on).

5.3 UVLO (Under Voltage Lock Out)

Input under voltage lockout is standard on the EC8AW 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.

5.4 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 hiccup mode protection.

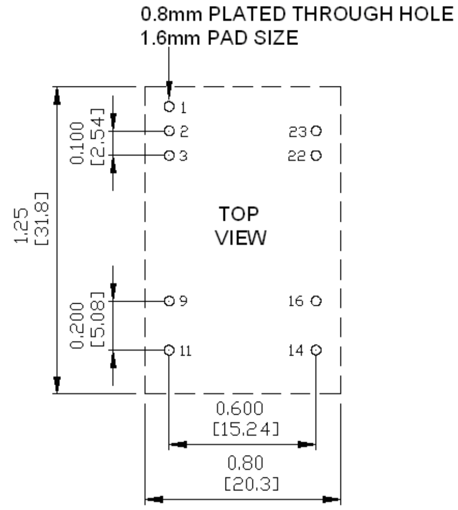
5.5 Over Voltage Protection

The over-voltage protection consists of a zener diode to limiting the out voltage.

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 Figure4.



Note: Dimensions are in inches (millimeters)

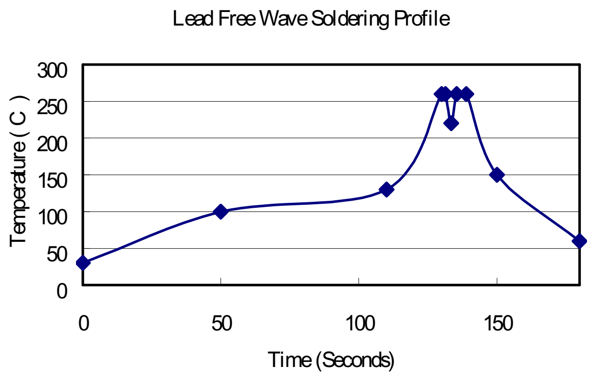


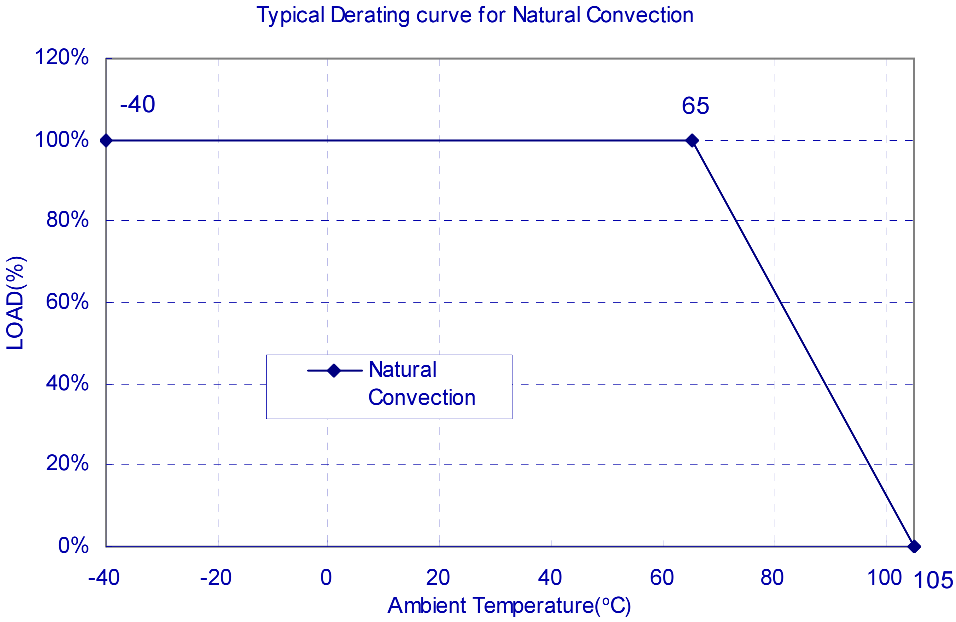
Figure4 Recommended PCB Layout Footprints and Wave Soldering Profiles

Note：

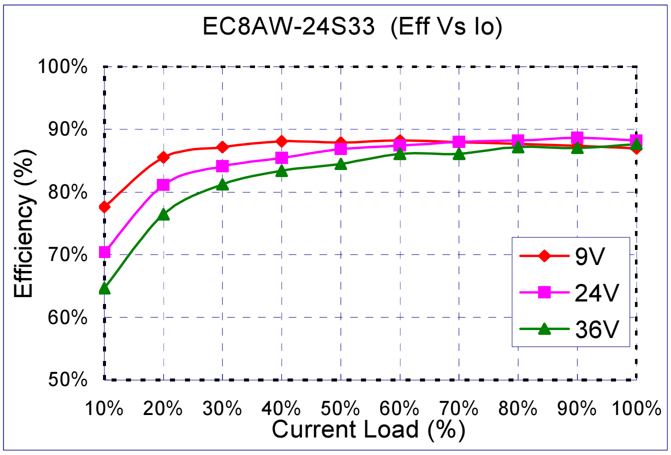
1. Soldering Materials: Sn/Cu/Ni
2. Ramp up rate during preheat: 1.4 ℃/Sec (From 50℃ to 100℃)
3. Soaking temperature: 0.5 ℃/Sec (From 100℃ to 130℃), 60±20 seconds
4. Peak temperature: 260℃, above 250℃ 3~6 Seconds
5. Ramp up rate during cooling: -10.0 ℃/Sec (From 260℃ to 150℃)

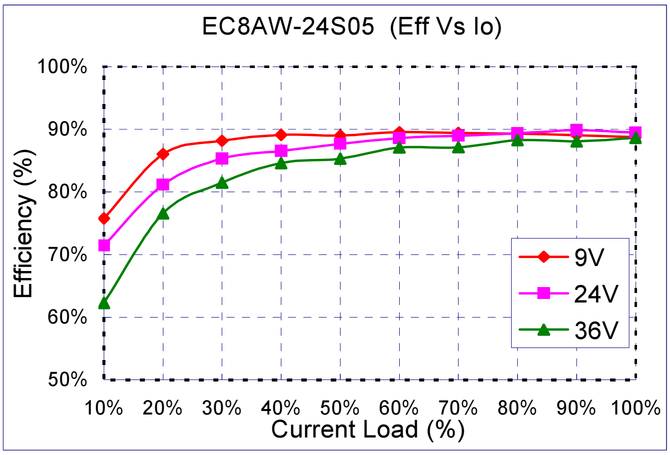
6.2 Power De-Rating Curves for EC8AW Series

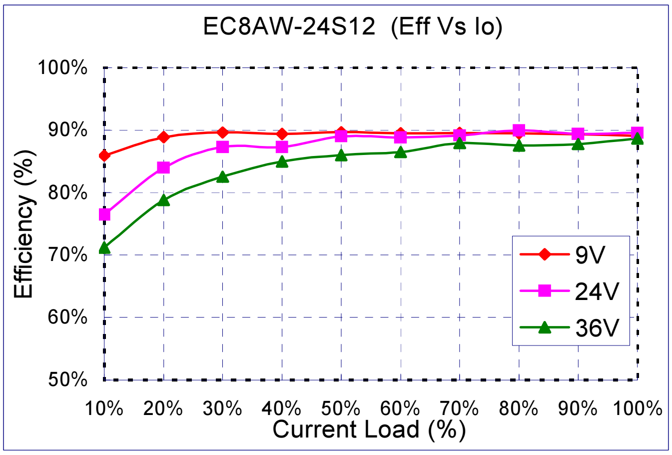
Operating Ambient temperature Range: -40℃ ~ 85℃ (derating above 65℃).
Maximum case temperature under any operating condition should not exceed 105℃.

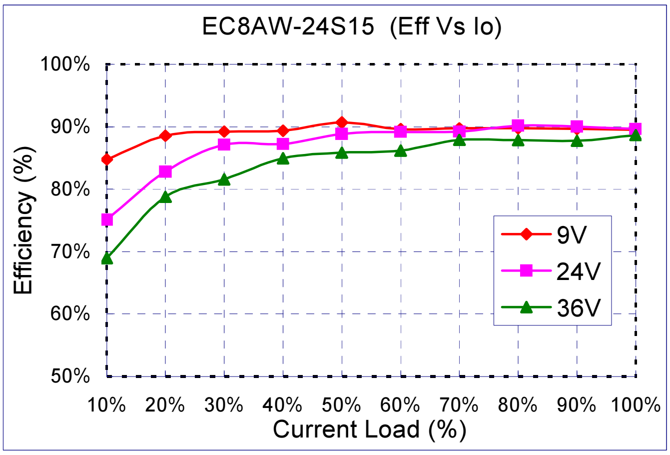


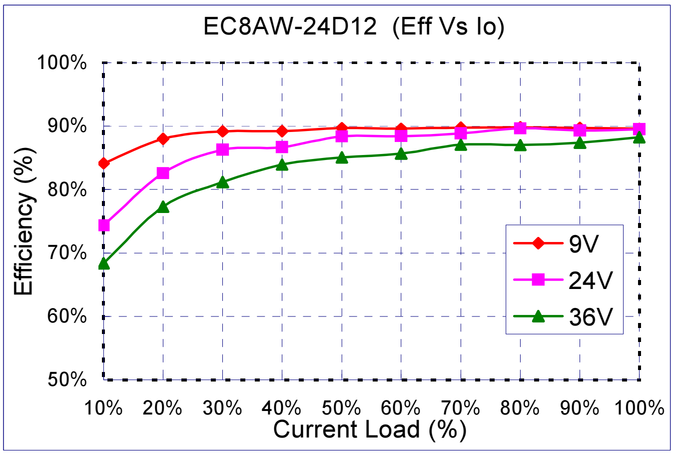
6.3 Efficiency vs. Load Curves

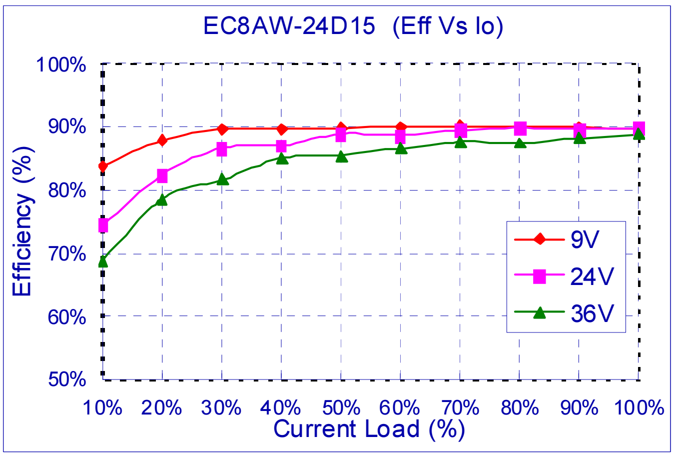


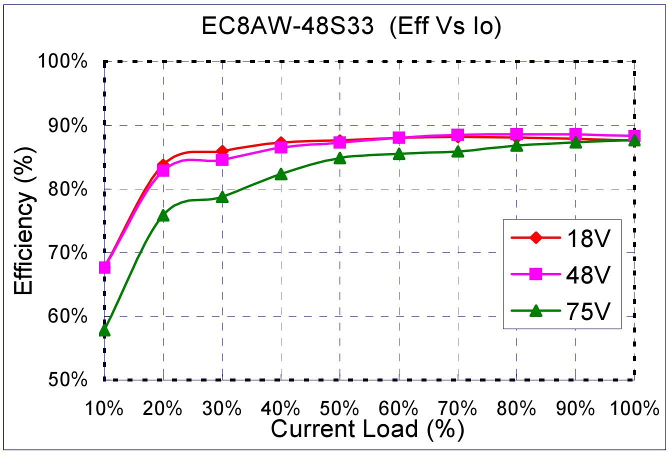


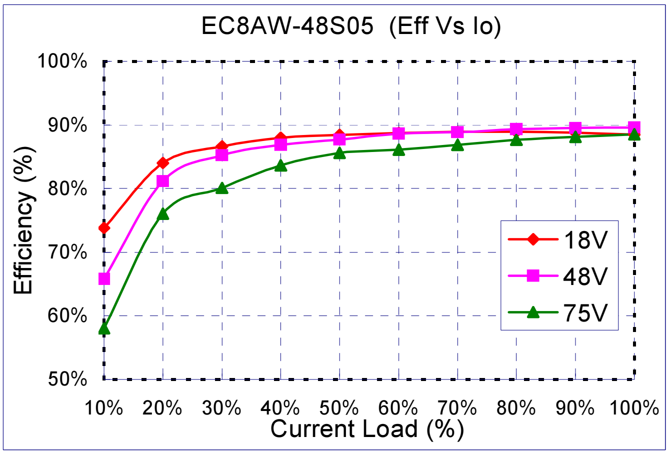


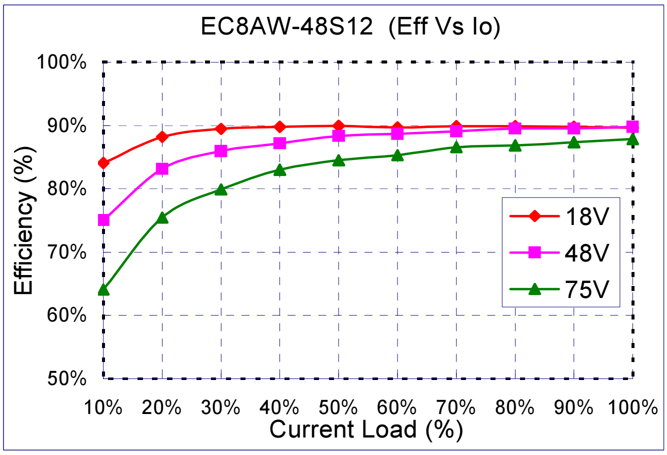


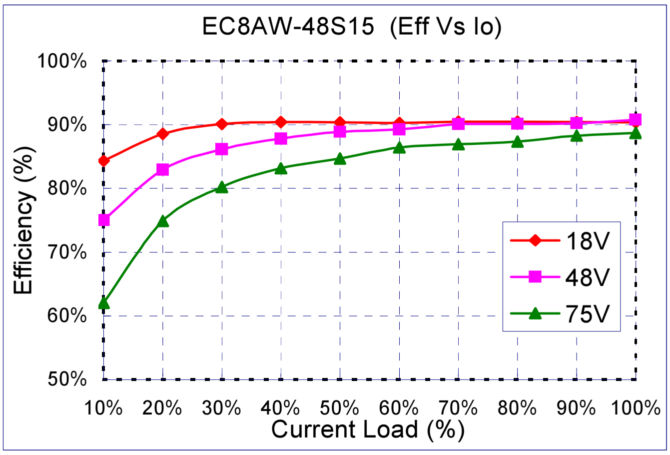


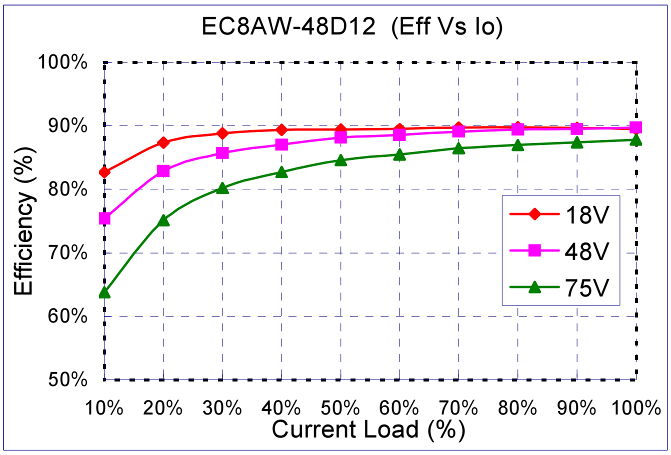


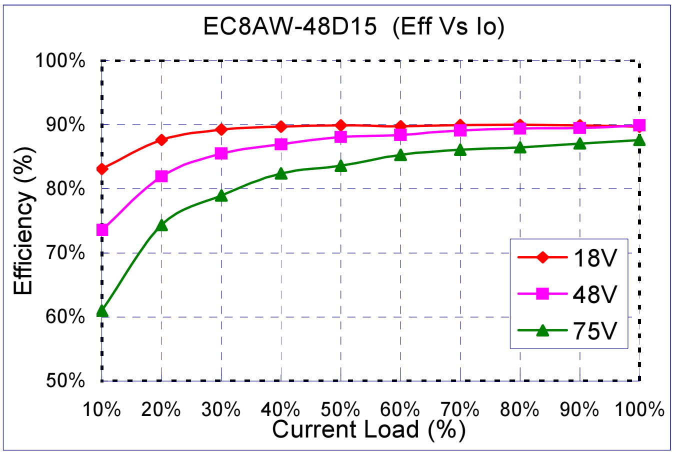

EC8AW-48S33 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
48V
75V


EC8AW-48S05 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
48V
75V


EC8AW-48S12 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
48V
75V

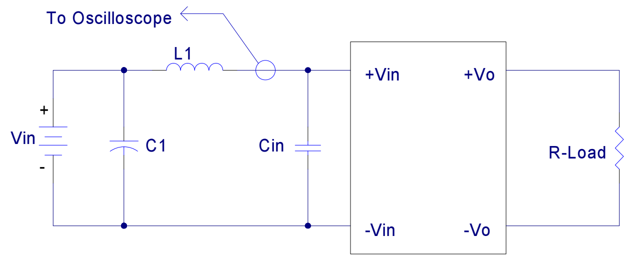

EC8AW-48S15 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
48V
75V


EC8AW-48D12 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
48V
75V


EC8AW-48D15 (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
48V
75V

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 Figure5 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: 1uH
C1: None
Cin: 22uF ESR<0.7ohm @100KHz

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. 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:

$$\eta = \frac{V_O \times I_O}{V_{IN} \times I_{IN}} \times 100\%$$

Where
V_O is output voltage,
I_O is output current,
V_{IN} is input voltage,
I_{IN} 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.

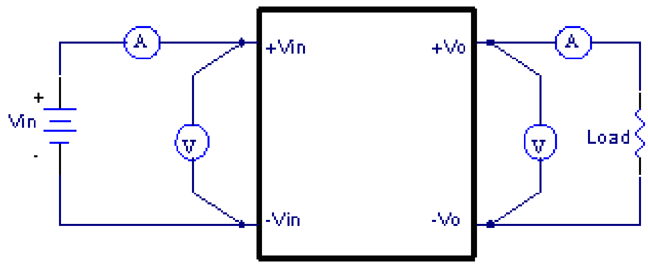
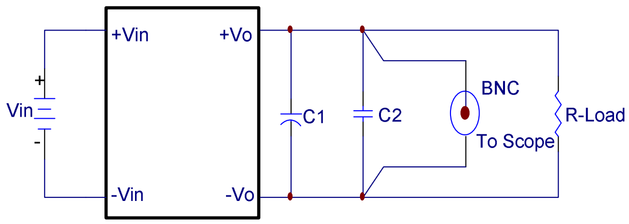


Figure6 EC8AW Series Test Setup

6.6 Output Ripple and Noise Measurement

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



Note: C1: None
C2: 0.1uF Ceramic capacitor

Figure9 Output Voltage Ripple and Noise Measurement Set-Up

6.7 Output Capacitance

The EC8AW 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 EC8AW series converters have not an internal fuse. However, to achieve maximum safety and system protection, always use an input line fuse. We recommended a fast acting fuse 3.15A for 24Vin models and 1.6A for 48Vin 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.

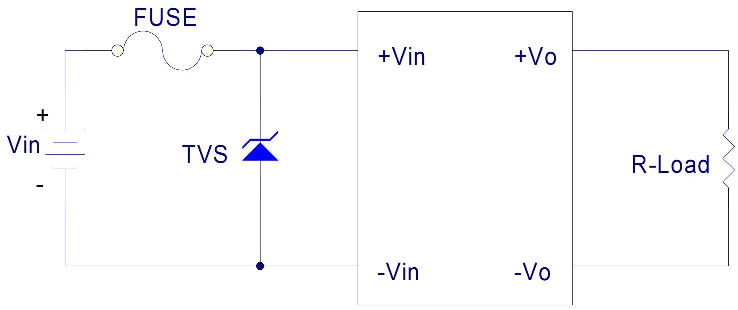
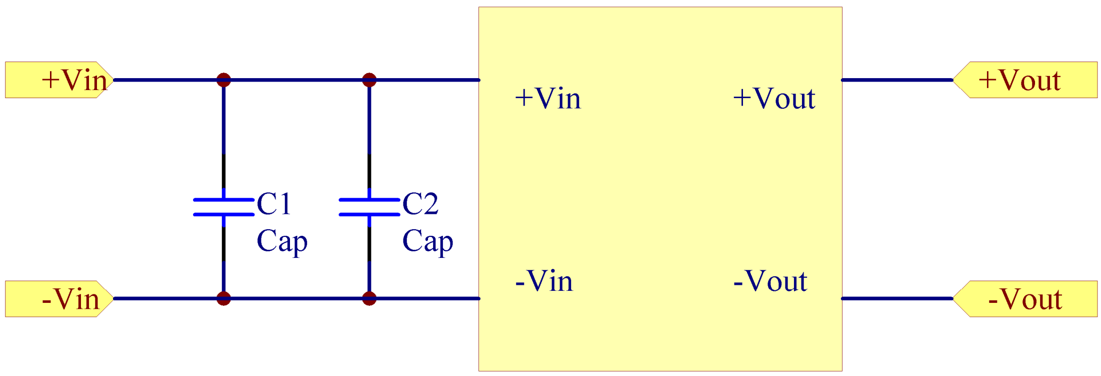


Figure10 Input Protection

7.2 EMC Considerations

(1) EMI Test standard: EN55032 Class A Conducted Emission
Test Condition: Input Voltage: Nominal, Output Load: Full Load



Figur11 Connection circuit for conducted EMI testing

EN55032 class A					
Model No.	C1	C2	Model No.	C1	C2
EC8AW-24S33	None	None	EC8AW -48S33	None	None
EC8AW -24S05	None	None	EC8AW -48S05	None	None
EC8AW -24S12	None	None	EC8AW -48S12	None	None
EC8AW -24S15	None	None	EC8AW -48S15	None	None
EC8AW -24D12	None	None	EC8AW -48D12	None	None
EC8AW -24D15	None	None	EC8AW -48D15	None	None

Note: All of capacitors are ceramic capacitors and 1812 size.

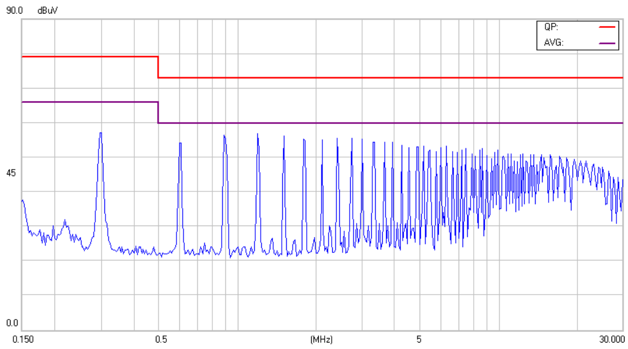


Figure12 Conducted Class A of EC8AW-24S33

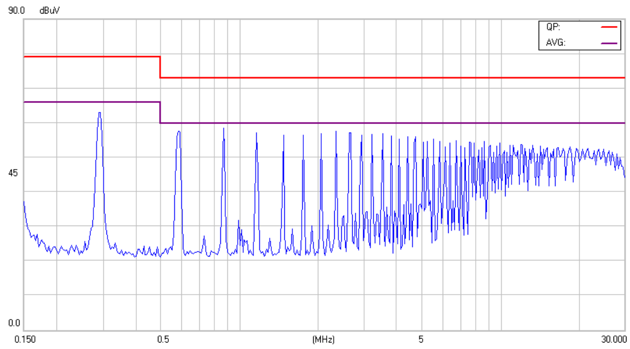


Figure13 Conducted Class A of EC8AW-24S05

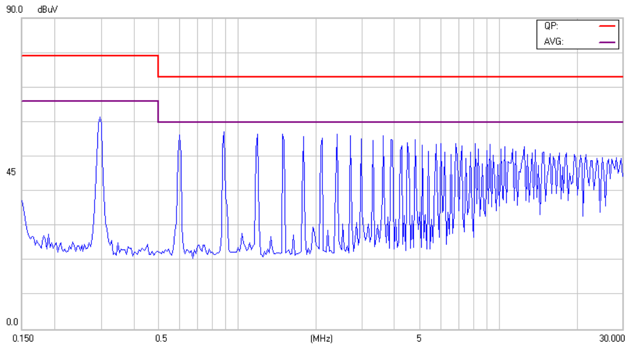


Figure14 Conducted Class A of EC8AW-24S12

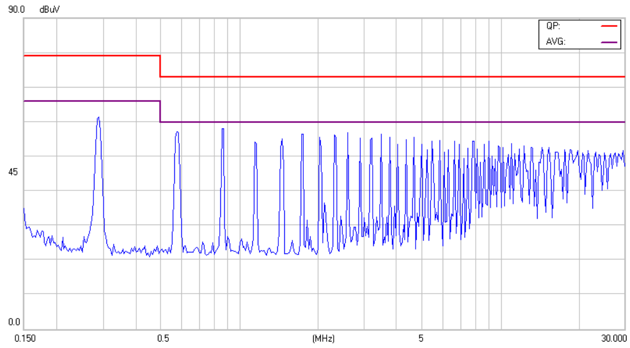


Figure15 Conducted Class A EC8AW-24S15

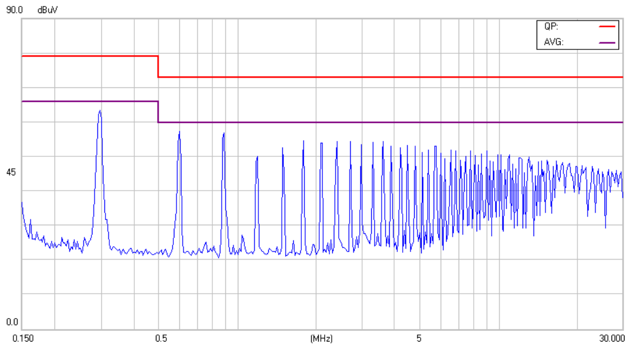


Figure16 Conducted Class A of EC8AW-24D12

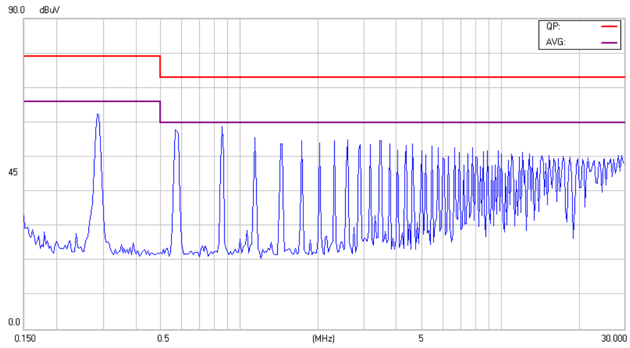


Figure17 Conducted Class A of EC8AW-24D15

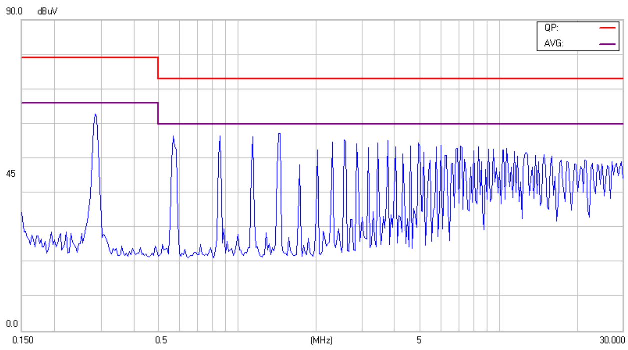


Figure18 Conducted Class A of EC8AW-48S33

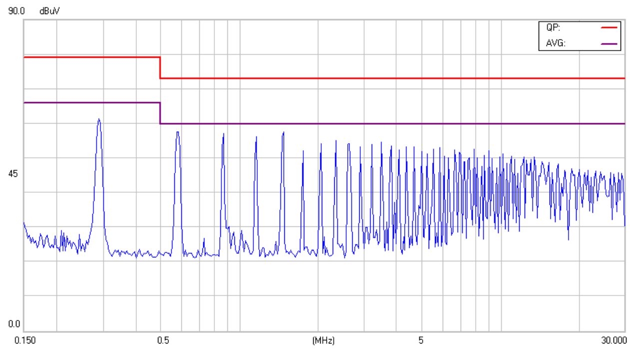


Figure19 Conducted Class A of EC8AW-48S05

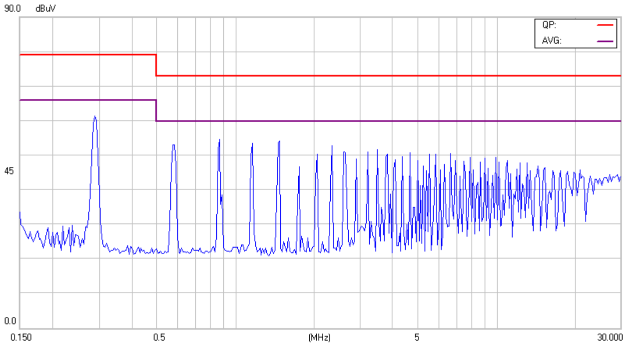


Figure20 Conducted Class A of EC8AW-48S12

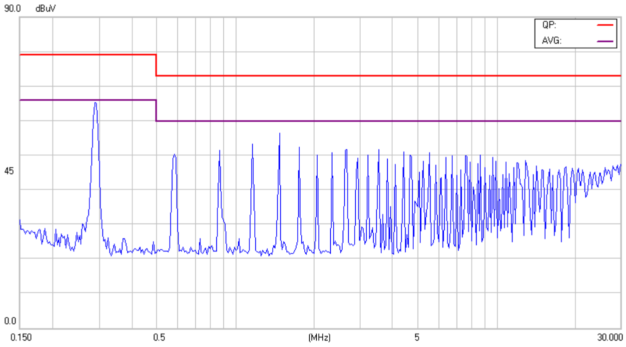


Figure21 Conducted Class A of EC8AW-48S15

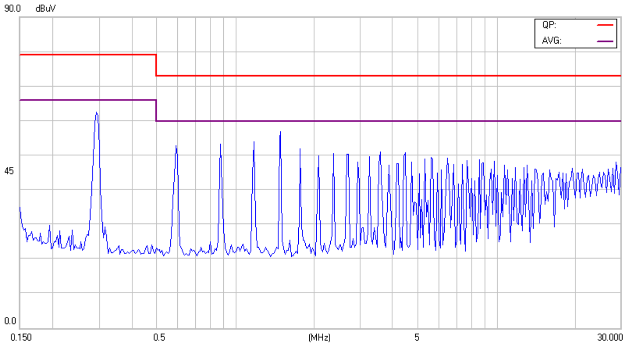


Figure22 Conducted Class A of EC8AW-48D12

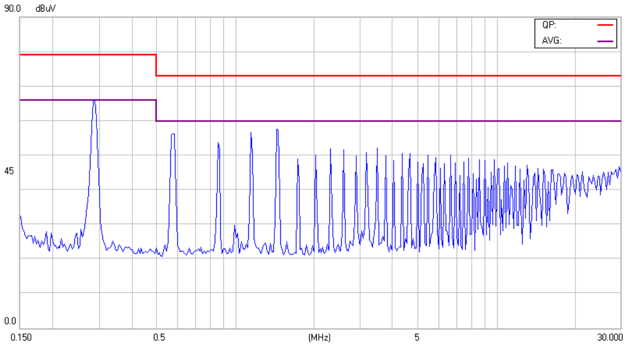
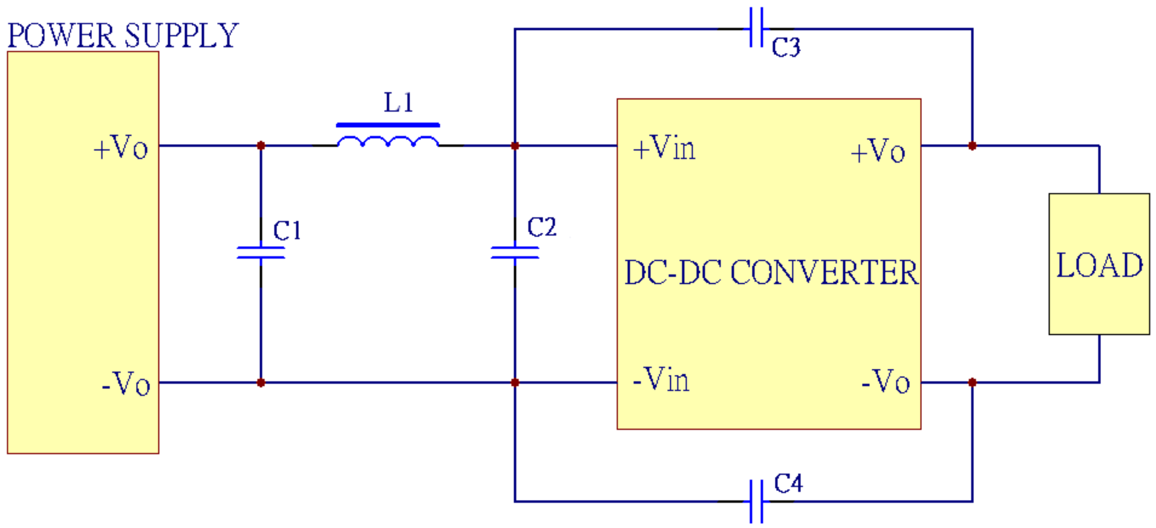


Figure23 Conducted Class A of EC8AW-48D15

(2) EMI Test standard: EN55032 Class B Conducted Emission
Test Condition: Input Voltage: Nominal, Output Load: Full Load



EN55032 class B					
Model No.	C1	C2	C3	C4	L1
EC8AW-24S33	6.8uF/50V	6.8uF/50V	1000pF/2KV	1000pF/2KV	3.3uH
EC8AW -24S05	6.8uF/50V	6.8uF/50V	1000pF/2KV	1000pF/2KV	3.3uH
EC8AW -24S12	6.8uF/50V	6.8uF/50V	1000pF/2KV	1000pF/2KV	3.3uH
EC8AW -24S15	6.8uF/50V	6.8uF/50V	1000pF/2KV	1000pF/2KV	3.3uH
EC8AW -24D12	6.8uF/50V	6.8uF/50V	1000pF/2KV	1000pF/2KV	3.3uH
EC8AW -24D15	6.8uF/50V	6.8uF/50V	1000pF/2KV	1000pF/2KV	3.3uH
EC8AW -48S33	2.2uF/100V	2.2uF/100V	1500pF/2KV	1500pF/2KV	3.3uH
EC8AW -48S05	2.2uF/100V	2.2uF/100V	1500pF/2KV	1500pF/2KV	3.3uH
EC8AW -48S12	2.2uF/100V	2.2uF/100V	1500pF/2KV	1500pF/2KV	3.3uH
EC8AW -48S15	2.2uF/100V	2.2uF/100V	1500pF/2KV	1500pF/2KV	3.3uH
EC8AW -48D12	2.2uF/100V	2.2uF/100V	1500pF/2KV	1500pF/2KV	3.3uH
EC8AW -48D15	2.2uF/100V	2.2uF/100V	1500pF/2KV	1500pF/2KV	3.3uH

Note: C1, C2 are ceramic capacitors 1812 size and C3, C4 are ceramic capacitors 1206 size

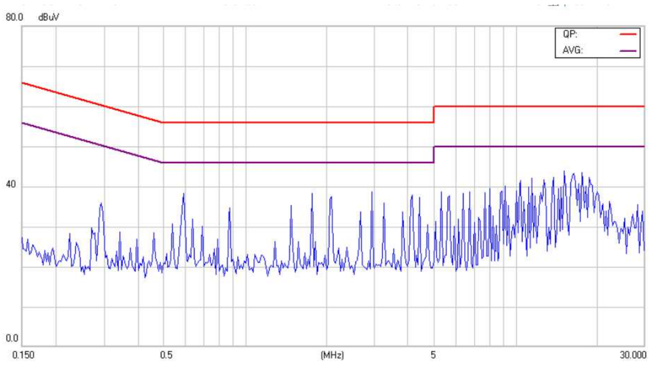


Figure24 Conducted Class A of EC8AW-24S33

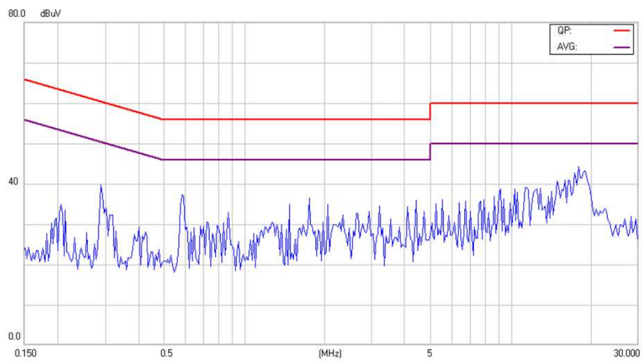


Figure25 Conducted Class B of EC8AW-24S05

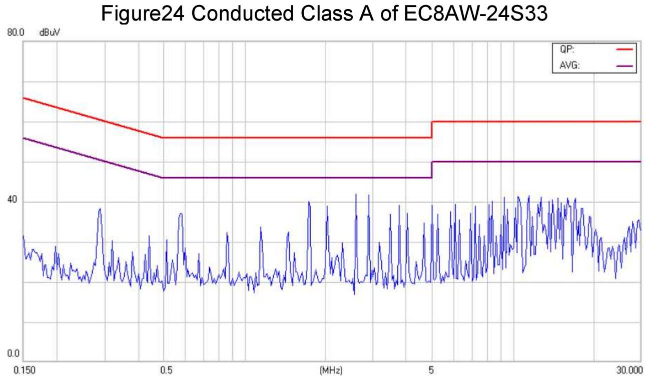


Figure26 Conducted Class B of EC8AW-24S12

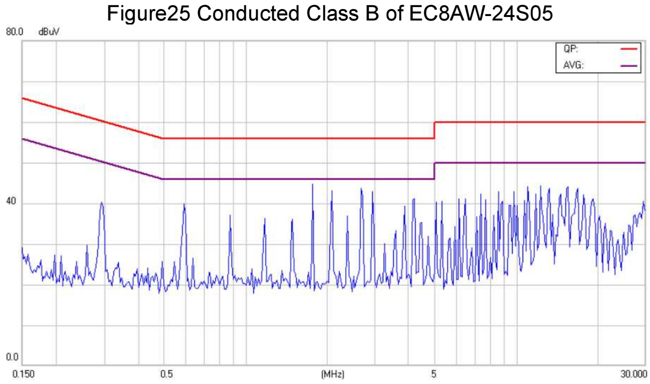


Figure27 Conducted Class B EC8AW-24S15

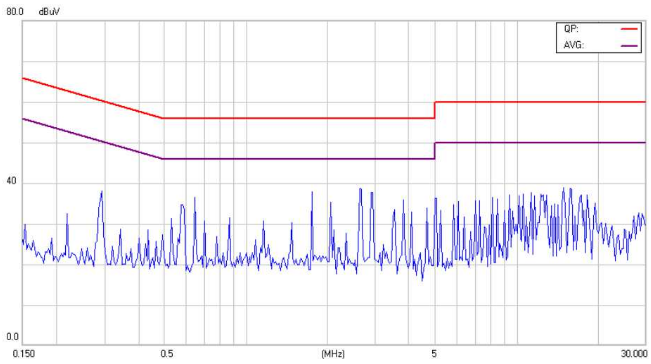


Figure28 Conducted Class B of EC8AW-24D12

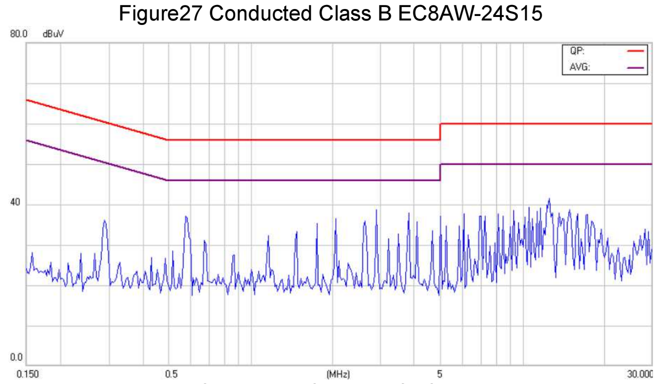


Figure29 Conducted Class B of EC8AW-24D15

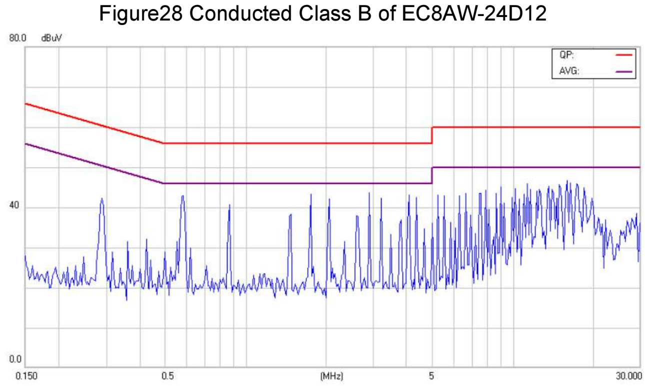


Figure30 Conducted Class B of EC8AW-48S33

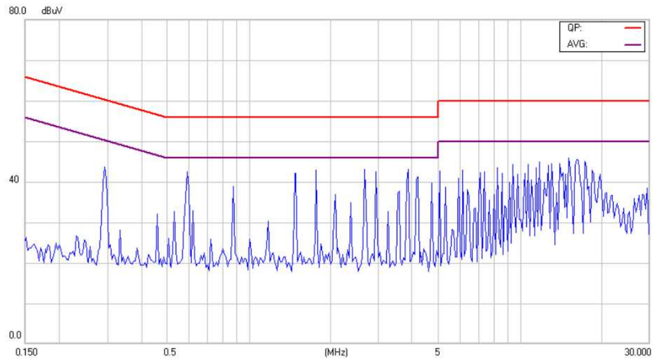


Figure31 Conducted Class B of EC8AW-48S05

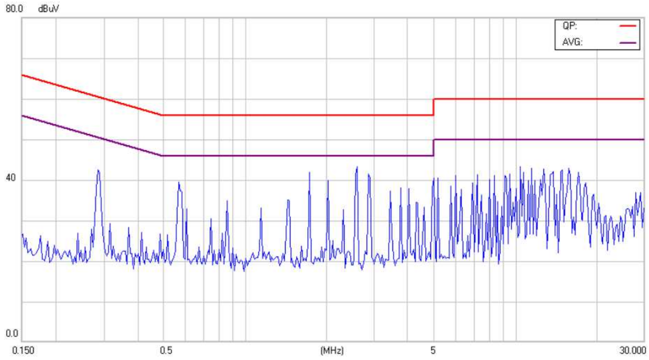


Figure32 Conducted Class B of EC8AW-48S12

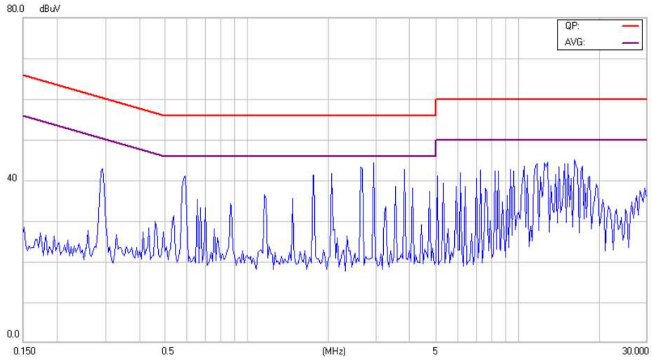


Figure33 Conducted Class B of EC8AW-48S15

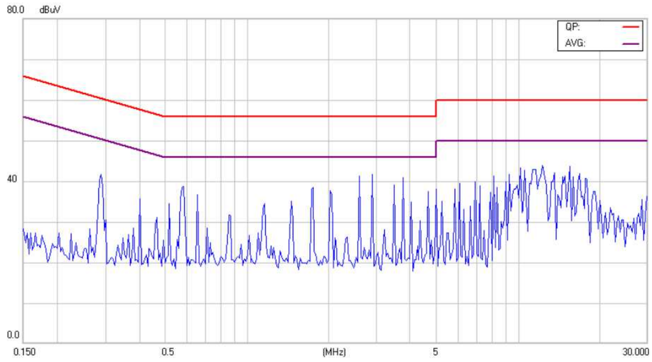


Figure34 Conducted Class B of EC8AW-48D12

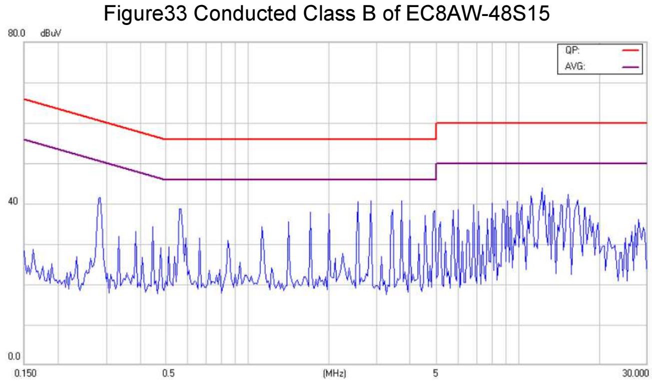


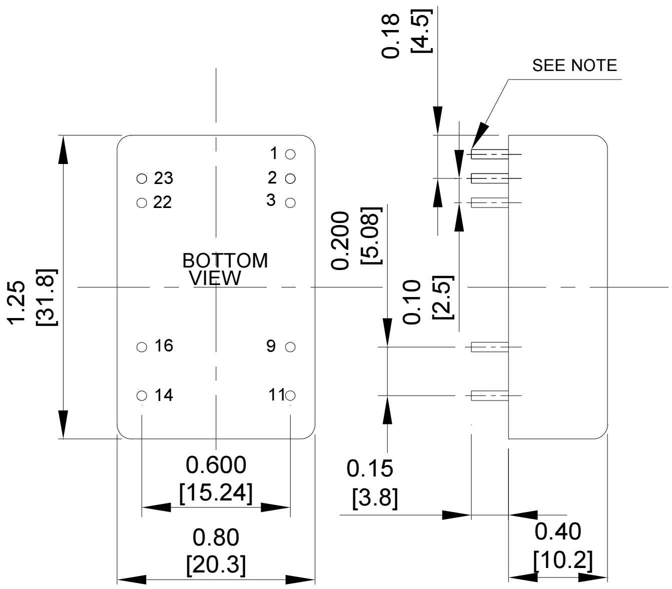
Figure35 Conducted Class B of EC8AW-48D15

8. Part Number

EC8AW – XX X XX

- EC8AW: EC8AW Series
- XX (input): 24 : Nominal Input Voltage 24VDC; 48 : Nominal Input Voltage 48VDC
- X: S : Single Output; D : Dual Output
- XX (output): 33 : Output Voltage 3.3 VDC; 05 : Output Voltage 5 VDC; 12 : Output Voltage 12 VDC; 15 : Output Voltage 15 VDC

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	Remote on/off	Remote on/off
2,3	-V Input	-V Input
4,5	NP	NP
9	NP	Common
10	NP	NP
11	NC	-V Output
12	NP	NP
13	NP	NP
14	+V Output	+V Output
15	NP	NP
16	-V Output	Common
20,21,24	NP	NP
22,23	+V Input	+V Input

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

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