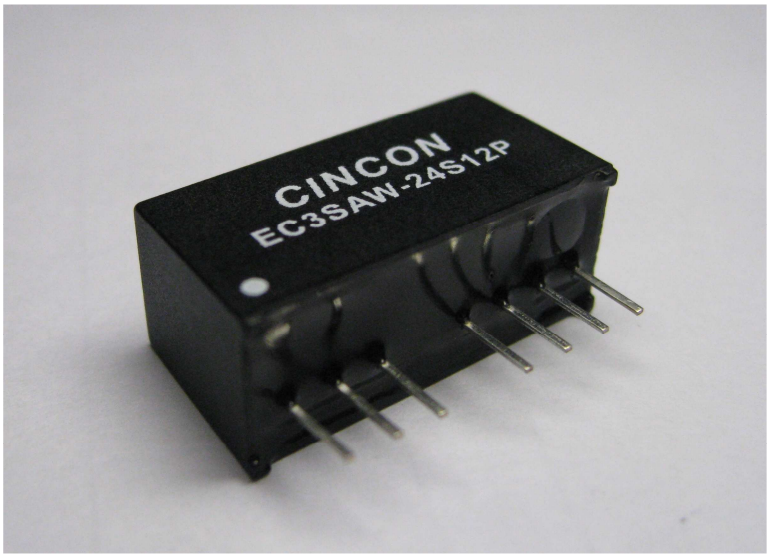
ISOLATED DC-DC Converter
EC3SAW SERIES
APPLICATION NOTE



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Content

EC3SAW 3W Isolated DC-DC Converters

Application Note V11 August 2011

1. Introduction

The EC3SAW series offer 3 watts of output power in a 0.86x0.36x0.44 inches SIP-8 plastic packages. The EC3SAW series has a 4:1 wide input voltage range of 9-36 and 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℃ to 71℃ without de-ratin g. The features include short circuit protection and remote on/off control. All models are very suitable for distributed power architectures, telecommunications, battery operated equipment and industrial applications.

2. DC-DC Converter Features

* 3W Isolated Output
* Compact SIP-8 Package
* Efficiency to 85%
* 4:1 Input Range
* Regulated Outputs
* Remote On/Off Control
* 1500VDC Isolation
* Continuous Short Circuit Protection
* Under Voltage Protection
* Without Tantalum Capacitors inside

3. Electrical Block Diagram

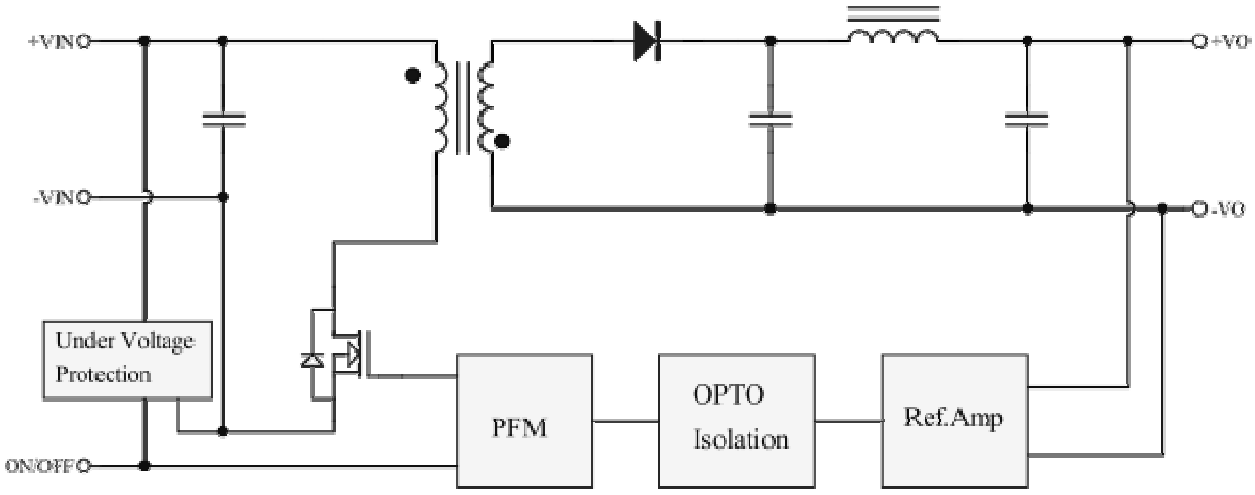


Figure 1 Electrical Block Diagram of single output module

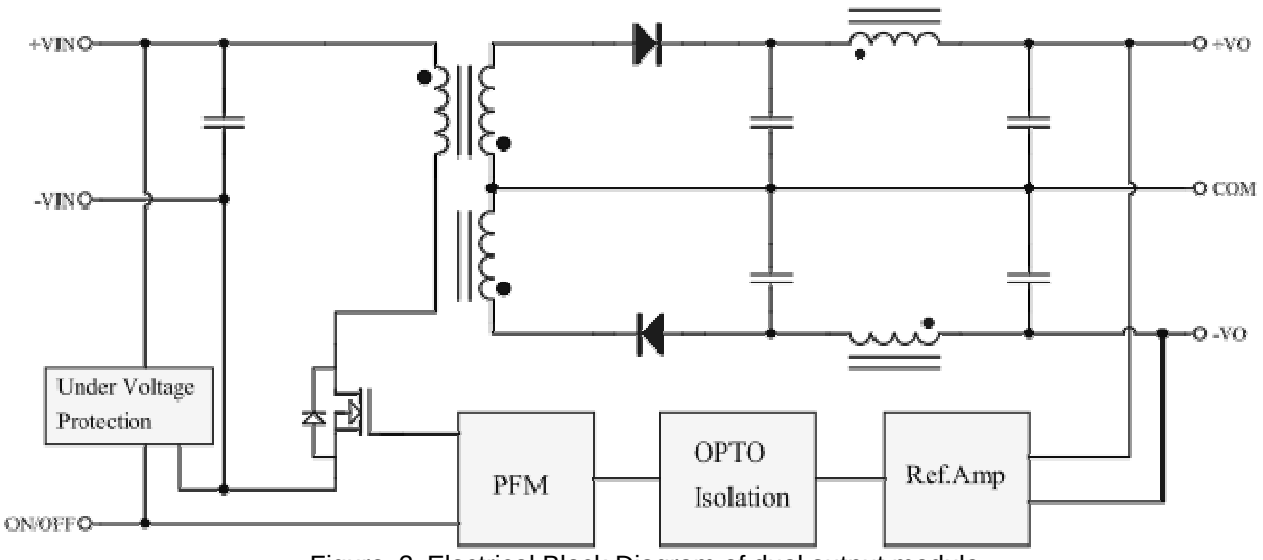


Figure 2 Electrical Block Diagram of dual output module

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		24V_{in} 48V_{in}	9 18	24 48	36 75	V_{dc}
Transient	100ms	24V_{in} 48V_{in}			50 100	V_{dc}
Operating Ambient Temperature	With de-rating, above 71℃	All	-40		+85	℃
Case Temperature		All			100	℃
Storage Temperature		All	-55		+125	℃
Input/Output Isolation Voltage	1 minute	All	1500			V_{dc}

INPUT CHARACTERISTICS

Operating Input Voltage		24V_{in} 48V_{in}	9 18	24 48	36 75	V_{dc}
Input Under-Voltage Protection						
Turn-On Voltage Threshold		24Vin 48Vin	6.5 13	7 14	7.5 15.5	V_{dc}
Turn-Off Voltage Threshold		24Vin 48Vin	6 12	6.5 13.5	7 14.5	V_{dc}
Lockout Hysteresis Voltage		24Vin 48Vin		0.5 0.5		V_{dc}
Maximum Input Current	100% Load, V_{in}=9V 100% Load, V_{in}=18V	24Vin 48Vin		427 213		mA
No-Load Input Current	V_{in}=Nominal input	24S33P 24S05P		4		mA
		24S12P 24D05P		8		
		24S15P 24D12P 24D15P		12		
		48S33P 48S05P		3		
		48S12P 48S15P		5		
		48D05P 48D12P 48D15P		10		
Off Converter Input Current	Shutdown input idle current	All			1	mA
Inrush Current (I^2t)		All			0.01	A^2s
Input Reflected-Ripple Current	P-P thru 12uH inductor, 5Hz to 20MHz	All		30		mA

OUTPUT CHARACTERISTIC

Output Voltage Set Point	V_{in} nominal, Io=Io_{max}, Tc=25℃	V_o=3.3V V_o=5.0V V_o=12V V_o=15V V_o=±5V V_o=±12V V_o=±15V	3.250 4.925 11.82 14.77 ±4.92 ±11.82 ±14.77	3.3 5.0 12 15 ±5.0 ±12 ±15	3.349 5.075 12.18 15.23 ±5.08 ±12.18 ±15.23	V_{dc}
Output Voltage Balance	V_{in}=nominal, Io=Io_{max}, Tc=25℃	Dual			±1.0	%
Output Voltage Regulation						

Load Regulation	Io=Full Load to 10% Load Io=Full Load to 10% Load	Single Dual			±0.5 ±1.0	% %
Line Regulation	V_{in}=High line to Low line Full Load	All			±0.5	%
Cross Regulation	Asymmetrical Load 25%/100%	Dual			±5	%
Temperature Coefficient	Ta=-40℃ to 85℃	All			±0.03	%/℃
Output Voltage Ripple and Noise						
Peak-to-Peak	Full Load, 20MHz bandwidth	All			50	mV
Operating Output Current Range		V_o=3.3V V_o=5.0V V_o=12V V_o=15V V_o=±5V V_o=±12V V_o=±15V	0 0 0 0 0 0 0		700 600 250 200 ±300 ±125 ±100	mA
Output DC Current-Limit Inception	Output Voltage =90% $Vo_{nominal}$	All	120			%
Maximum Output Capacitance	Full load, Resistance	V_o=3.3V V_o=5.0V V_o=12V V_o=15V V_o=±5V V_o=±12V V_o=±15V	0 0 0 0 0 0 0		1800 1000 220 120 ±470 ±100 ±47	uF

DYNAMIC CHARACTERISTICS

PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
Output Voltage Current Transient						
Step Change in Output Current	75% to 100% Io_max , di/dt=0.1A/us	All			±6	%
Setting Time (within 1% $Vo_{nominal}$)	di/dt=0.1A/us	All			500	us
Turn-On Delay and Rise Time						
Turn-On Delay Time, From Input	Vin_{min} to 10% $Vo_{nominal}$	All		1	2	ms
Turn-On Delay Time, From On/off	$V_{on/off}$ to 10% $Vo_{nominal}$	All		1	2	ms
Output Voltage Rise Time	10% to 90%$Vo_{nominal}$	All		1.5	3	ms

EFFICIENCY

100% Load	V_{in}=Nominal V_{in}, Io=Io_{max}, Tc=25℃	24S33P 24S05P 24S12P 24S15P 24D05P 24D12P 24D15P 48S33P 48S05P 48S12P 48S15P 48D05P 48D12P 48D15P		79 81 84 84 81 84 83 79 82 85 84 82 84 83		%

ISOLATION CHARACTERISTICS

Isolation Voltage	Input to Output 1 minute	All			1500	V_{dc}
Isolation Resistance	Input to Output	All			1000	MΩ
Isolation Capacitance	Input to Output	All		500		pF

FEATURE CHARACTERISTICS

Switching Frequency		All	100			KHz
ON/OFF Control						
Module On	Open ,high impedance	All			Open	V

					Circuit	
Module Off	Voltage of $V_{on/off}$ pin	All	0		1.2	V
Off Converter Input Current	Shutdown input idle current	All			1	mA

GENERAL SPECIFICATIONS

MTBF	Io=100%of $Io_{max,}$Ta=25℃ per MIL-HDBK-217F	Single		2.8		M hours
		Dual		2.1		
Weight		All		4.8		g

5. Main Features and Functions

5.1 Operating Temperature Range

The EC3SAW series converters can be operated by a wide ambient temperature range from -40℃ to 71℃ without de-rating. The standard model has a plastic 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 mode.

5.3 Remote ON/OFF

The remote ON/OFF input feature of the converter allows external circuitry to turn the converter ON or OFF. Active-high remote ON/OFF is available as standard. The converter is turned on if the remote ON/OFF pin is open circuit. Supplying the on/off pin at 0 to 1.2Vdc will turn the converter off. The signal level of the on/off pin is defined with respect to ground. If not using the on/off pin, leave the pin open (module will be on).

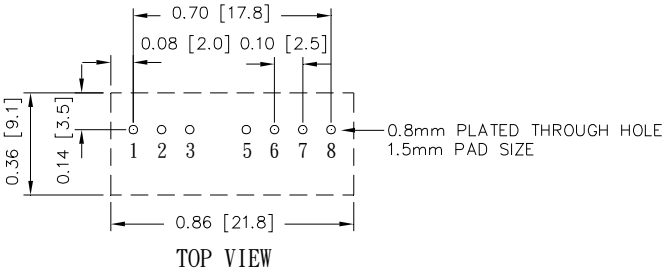
5.4 UVP (Undervoltage Protection)

Input under voltage protection is standard on the EC3SAW 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.

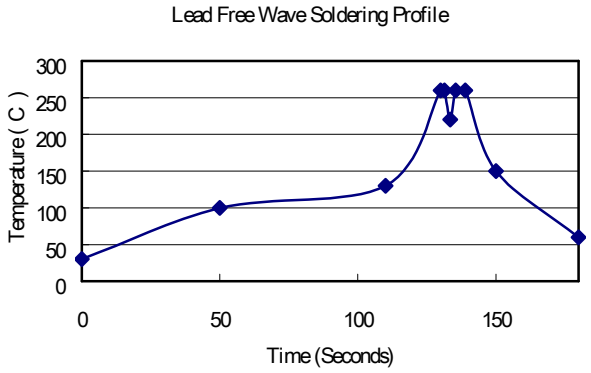
6. Applications

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.



Note: Dimensions are in inches(millimeters)



Note：

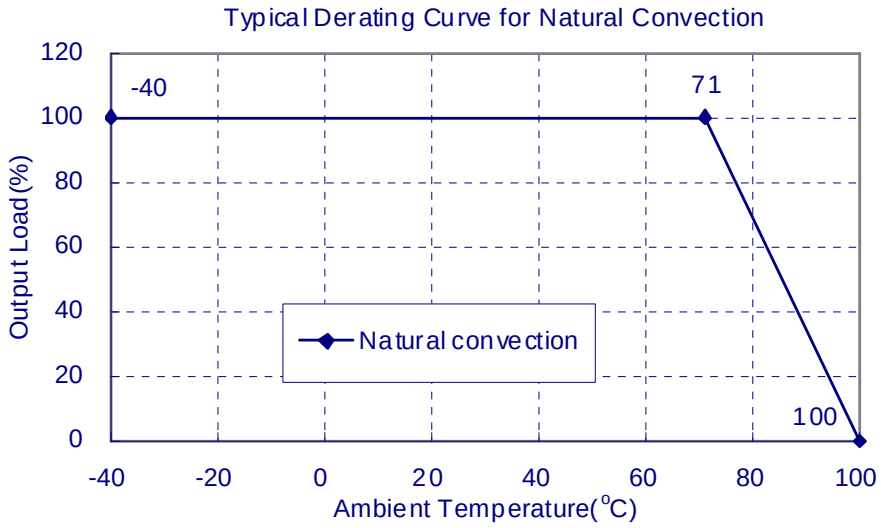
1. Soldering Materials : Sn/Cu/Ni
2. Ramp up rate during preheat : 1.4 ℃/Sec (From 50℃ to 100℃)
3. Soaking temperature : 0.5 ℃/Sec (From 100℃ to 130℃), 60±20 seconds
4. Peak temperature : 260℃, above 250℃ 3~6 Seconds
5. Ramp up rate during cooling : -10.0 ℃/Sec (From 260℃ to 150℃)

Figure3 Recommended PCB Layout Footprints and Wave Soldering Profiles for SIL packages

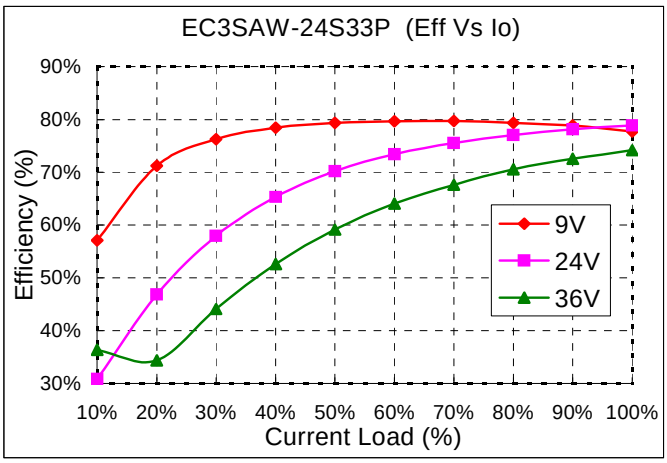
6.2 Power Derating Curves for EC3SAW Series

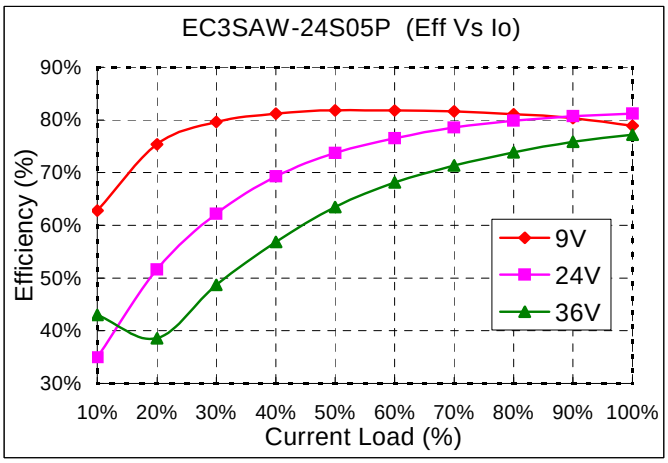
Operating Ambient temperature Range : -40℃ ~ 71℃ without derating.

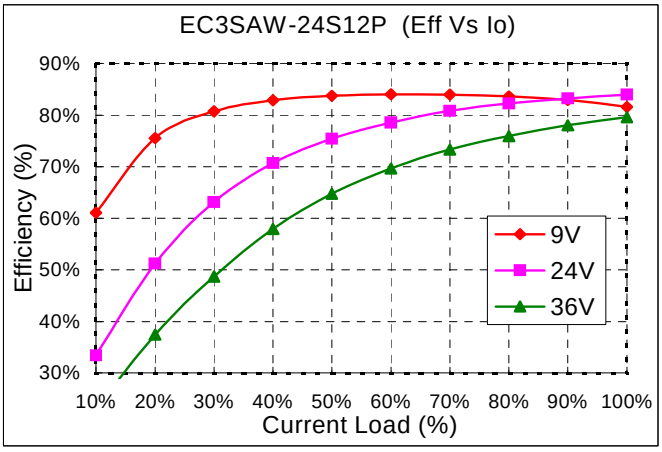
Maximum case temperature under any operating condition should not exceed 100℃.

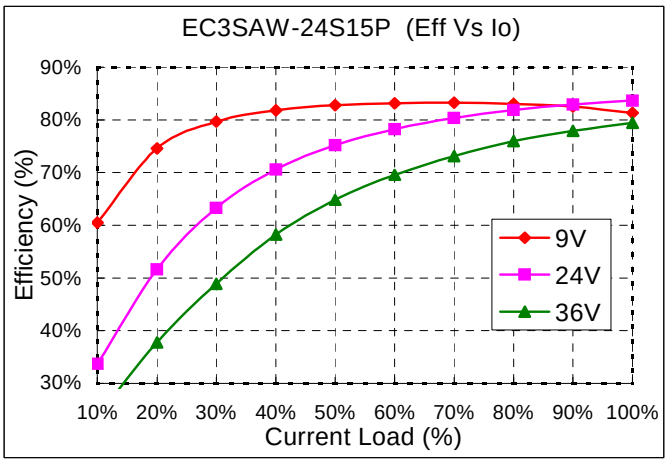


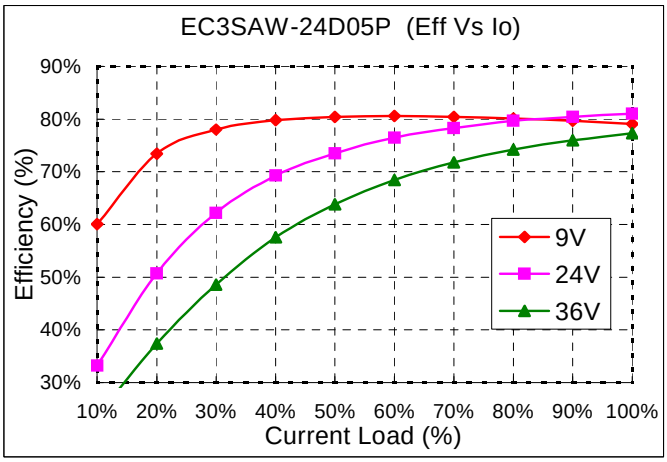
6.3 Efficiency vs. Load Curves

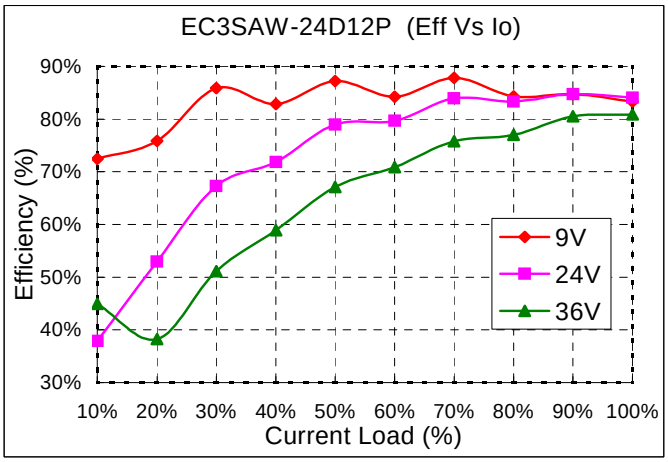


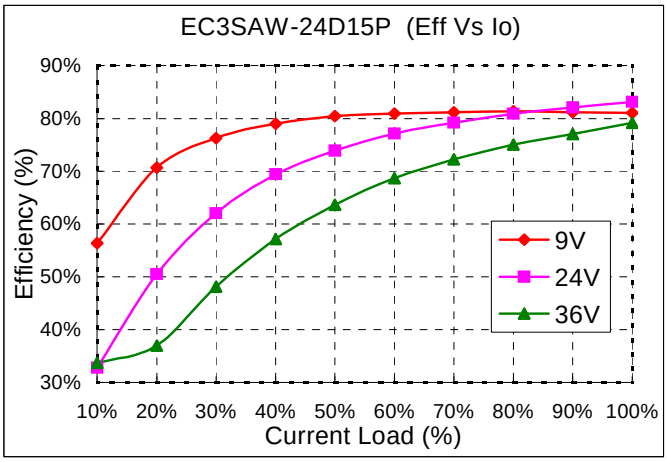


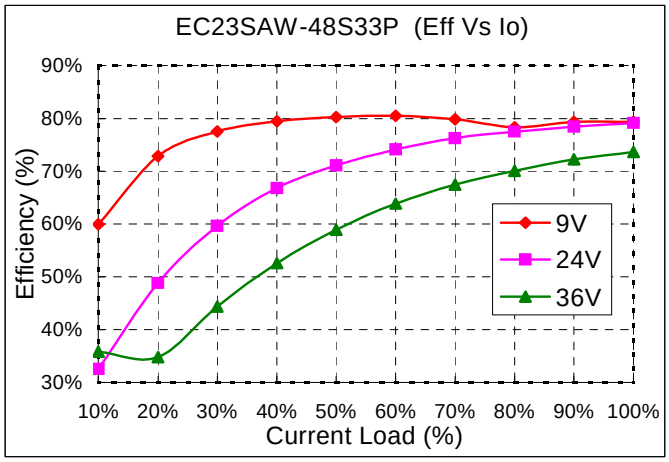


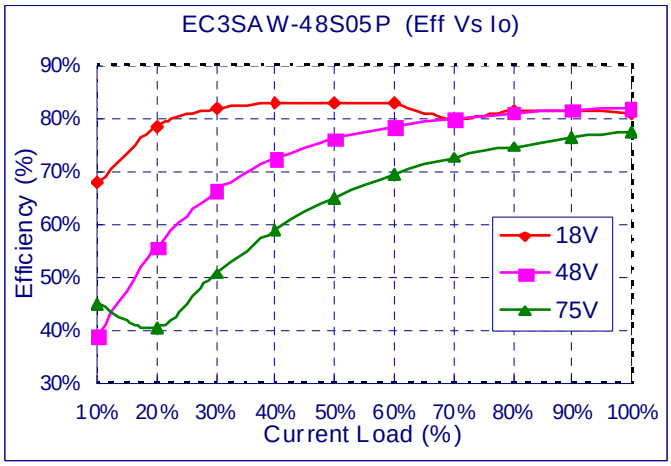


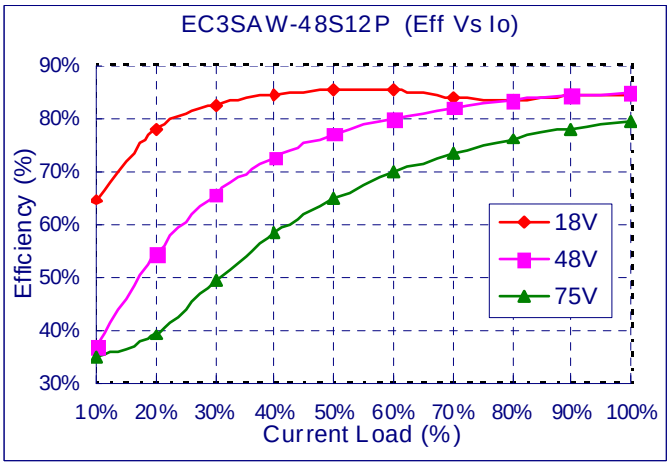


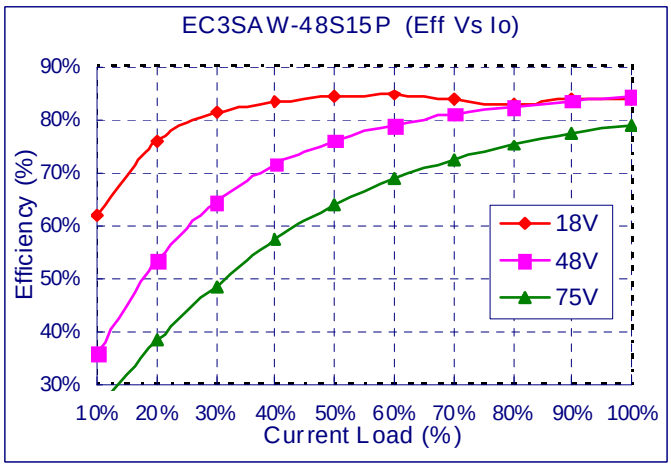


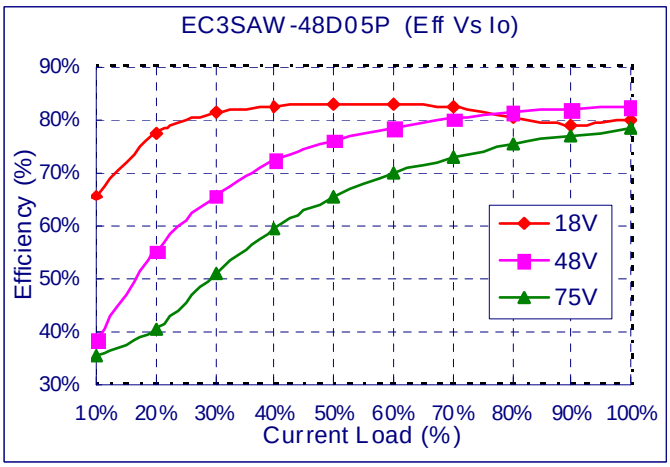

EC3SAW-24D15P (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
9V
24V
36V

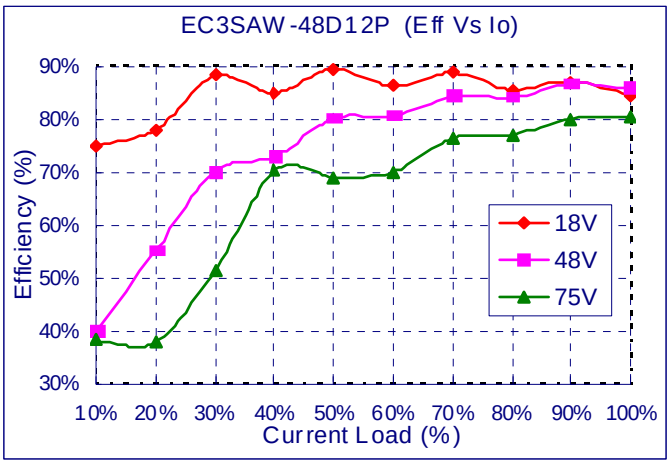

EC23SAW-48S33P (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
9V
24V
36V

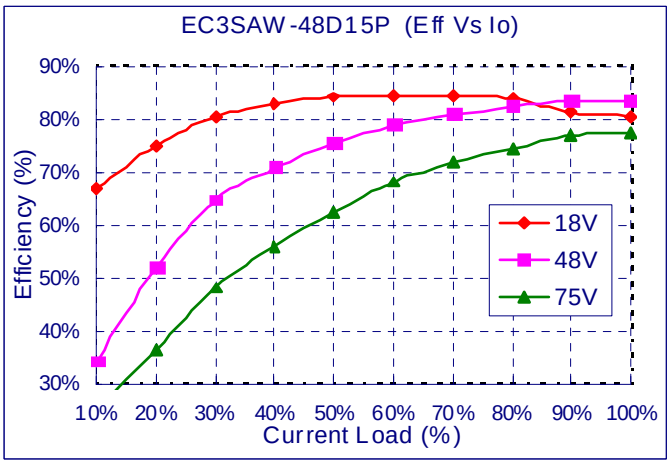

EC3SAW-48S05P (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
48V
75V


EC3SAW-48S12P (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
48V
75V


EC3SAW-48S15P (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
48V
75V

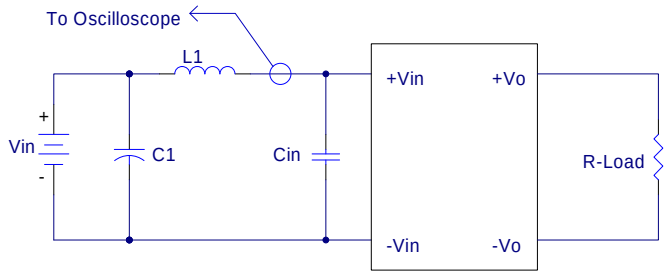

EC3SAW-48D05P (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
48V
75V


EC3SAW-48D12P (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
48V
75V


EC3SAW-48D15P (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
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 Figure4 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 : 12uF
C1: None
Cin: 33uF ESR<0.7ohm @100KHz

Figure4 Input Reflected-Ripple Test Setup

6.5 Test Set-Up

The basic test set-up to measure parameters such as efficiency and load regulation is shown in Figure5. 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.

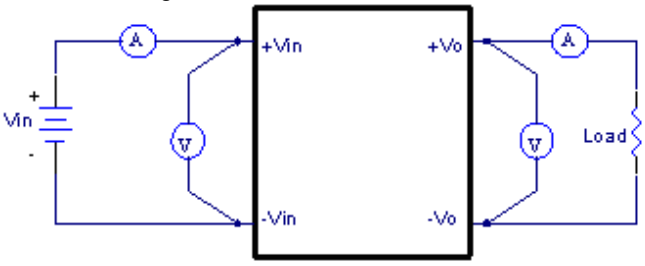
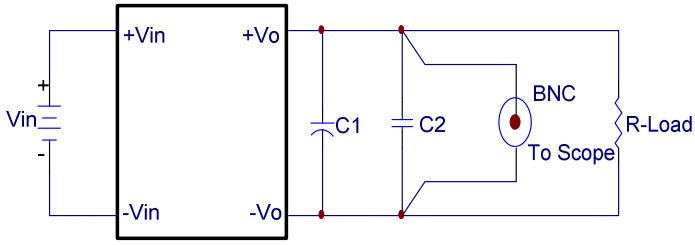


Figure5 EC3SAW Series Test Setup

6.6 Output Ripple and Noise Measurement

The test set-up for noise and ripple measurements is shown in Figure6. 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: None

Figure 6. Output Voltage Ripple and Noise Measurement Set-Up

6.7 Output Capacitance

The EC3SAW 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 EC3SAW 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 500mA for 48Vin modules. Figure7 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.

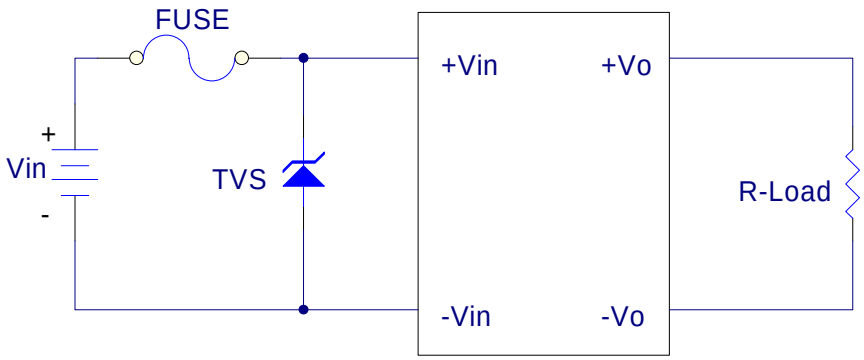


Figure7 Input Protection

7.2 EMC Considerations

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

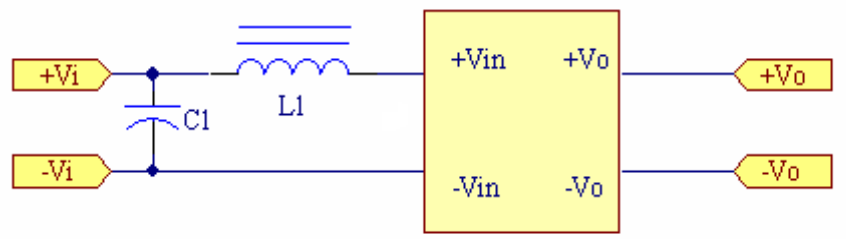
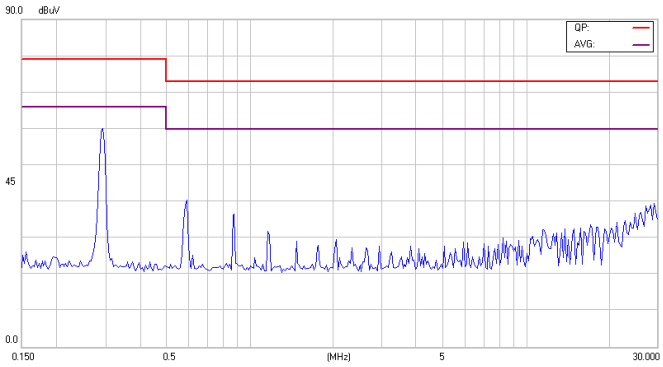


Figure8 Connection circuit for conducted EMI testing

	EN55022 class A		EN55022 class B	
Model No.	C1	L1	C1	L1
EC3SAW-24S33P	2.2uF/50V	10uH	6.8uF/50V	18uH
EC3SAW-24S05P	2.2uF/50V	10uH	6.8uF/50V	18uH
EC3SAW-24S12P	2.2uF/50V	10uH	6.8uF/50V	18uH
EC3SAW-24S15P	2.2uF/50V	10uH	6.8uF/50V	18uH
EC3SAW-24D05P	2.2uF/50V	10uH	6.8uF/50V	18uH
EC3SAW-24D12P	2.2uF/50V	10uH	6.8uF/50V	18uH
EC3SAW-24D15P	2.2uF/50V	10uH	6.8uF/50V	18uH
EC3SAW-48S33P	2.2uF/100V	15uH	2.2uF/100V	56uH
EC3SAW-48S05P	2.2uF/100V	15uH	2.2uF/100V	56uH
EC3SAW-48S12P	2.2uF/100V	15uH	2.2uF/100V	56uH
EC3SAW-48S15P	2.2uF/100V	15uH	2.2uF/100V	56uH
EC3SAW-48D05P	2.2uF/100V	15uH	2.2uF/100V	56uH
EC3SAW-48D12P	2.2uF/100V	15uH	2.2uF/100V	56uH
EC3SAW-48D15P	2.2uF/100V	15uH	2.2uF/100V	56uH

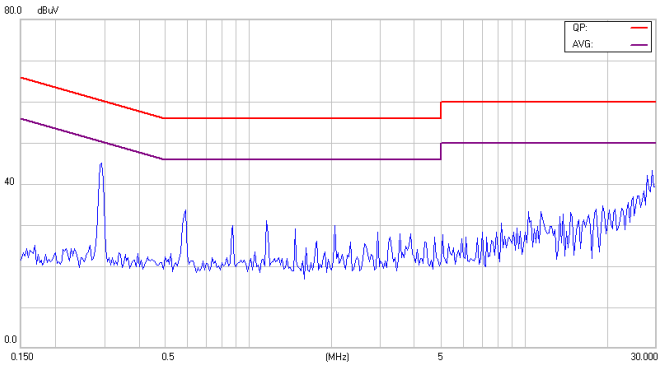
Note : All of capacitors are ceramic capacitors and 1210 size for EN55022 class A、1812 size for EN55022 class B

Vin = 24Vdc



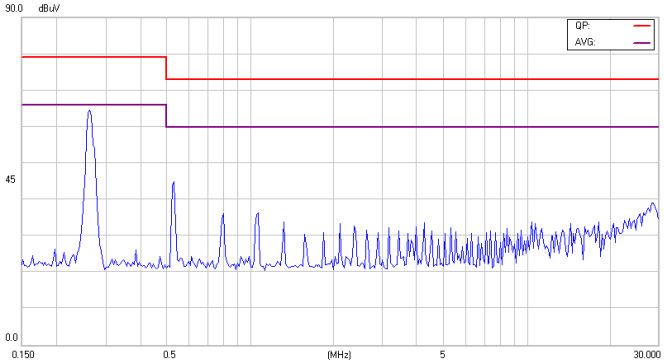
Conducted Class A of EC3SAW-24S33P

Vin = 24Vdc



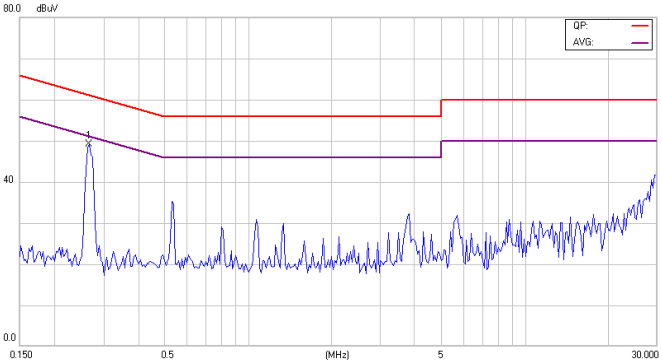
Conducted Class B of EC3SAW-24S33P

Vin = 24Vdc



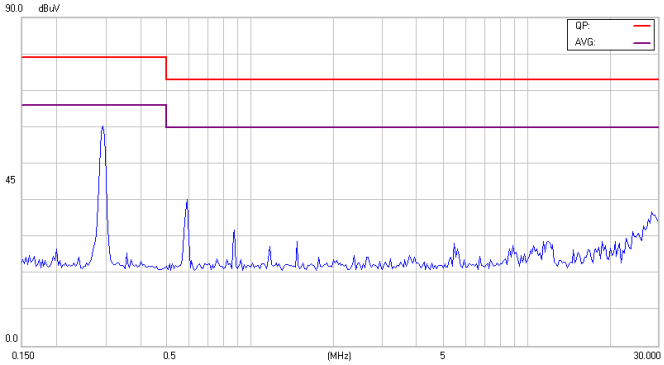
Conducted Class A of EC3SAW-24S05P

Vin = 24Vdc



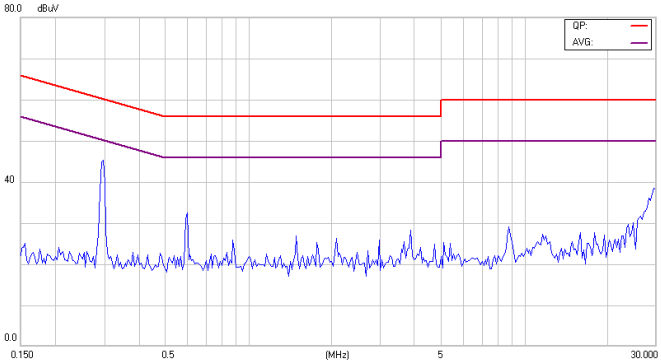
Conducted Class B of EC3SAW-24S05P

Vin = 24Vdc



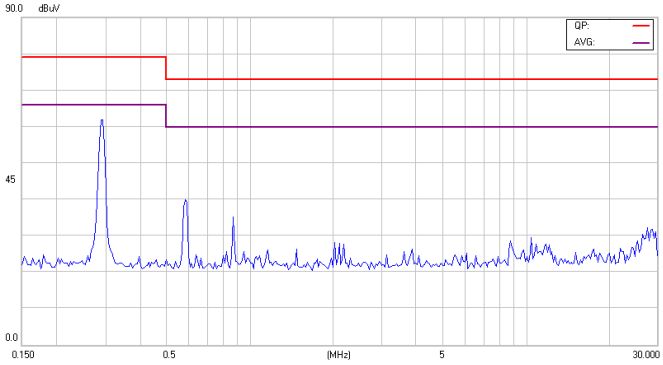
Conducted Class A of EC3SAW-24S12P

Vin = 24Vdc



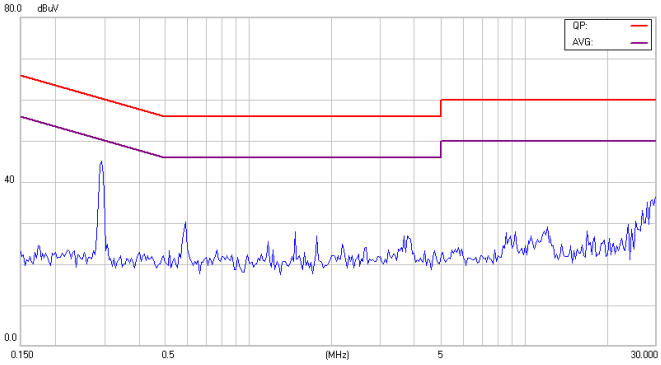
Conducted Class B of EC3SAW-24S12P

Vin = 24Vdc



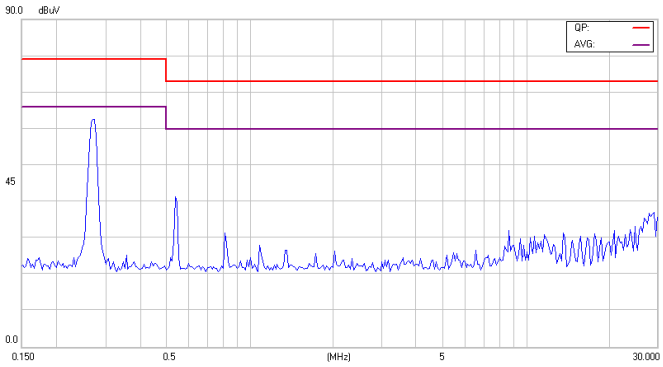
Conducted Class A of EC3SAW-24S15P

Vin = 24Vdc



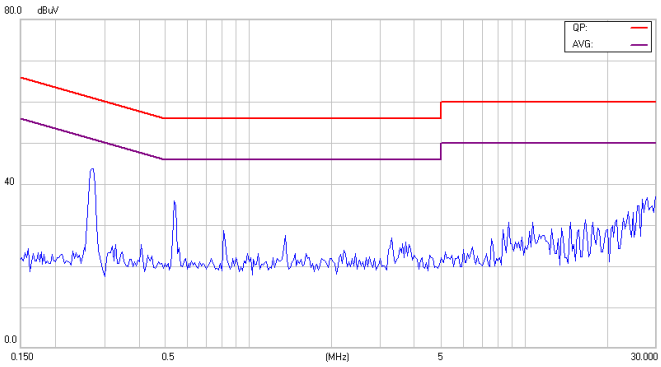
Conducted Class B of EC3SAW-24S15P

Vin = 24Vdc



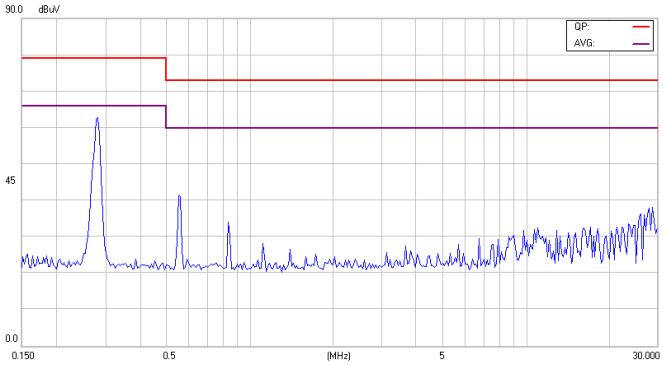
Conducted Class A of EC3SAW-24D05

Vin = 24Vdc



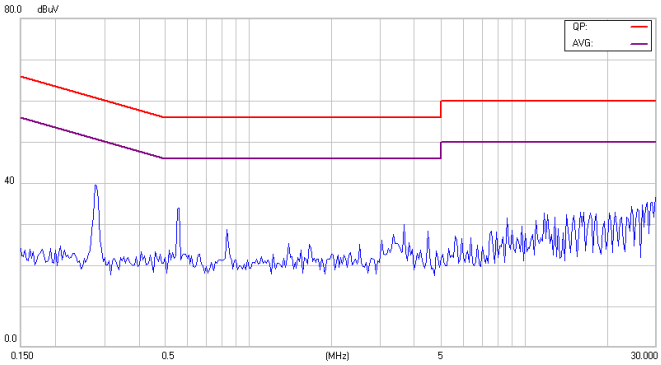
Conducted Class B of EC3SAW-24D05

Vin = 24Vdc



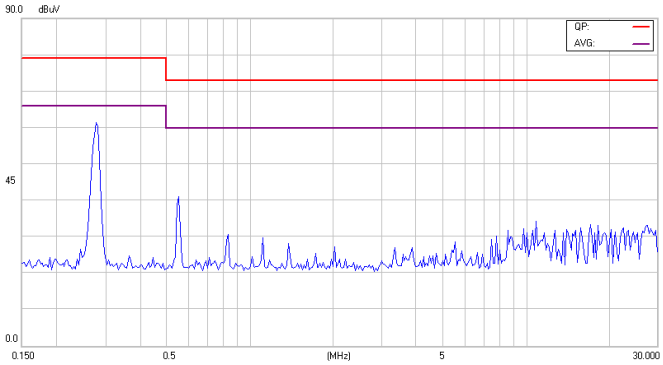
Conducted Class A of EC3SAW-24D12P

Vin = 24Vdc



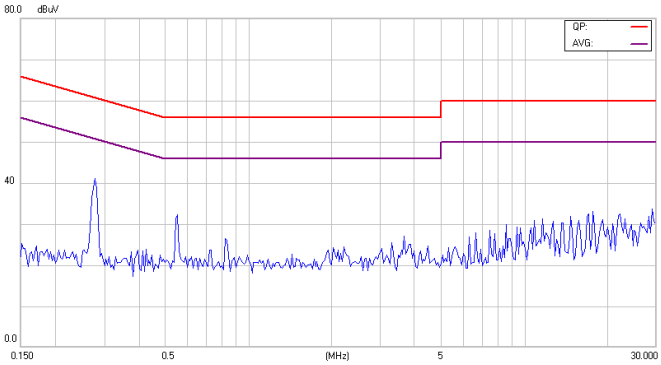
Conducted Class B of EC3SAW-24D12P

Vin = 24Vdc



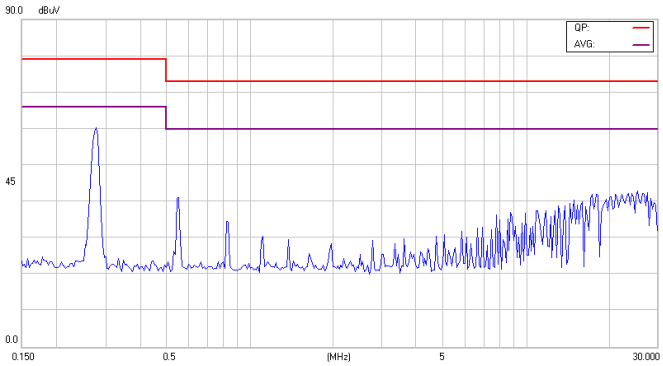
Conducted Class A of EC3SAW-24D15P

Vin = 24Vdc



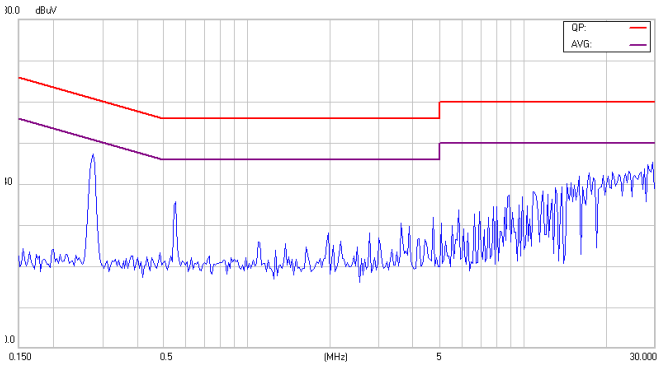
Conducted Class B of EC3SAW-24D15P

Vin =48Vdc



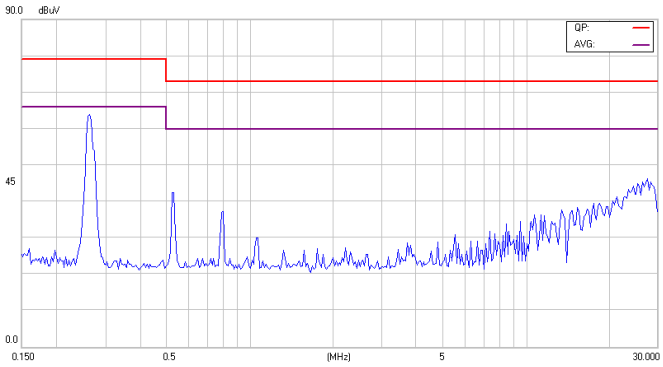
Conducted Class A of EC3SAW-48S33P

Vin = 48Vdc



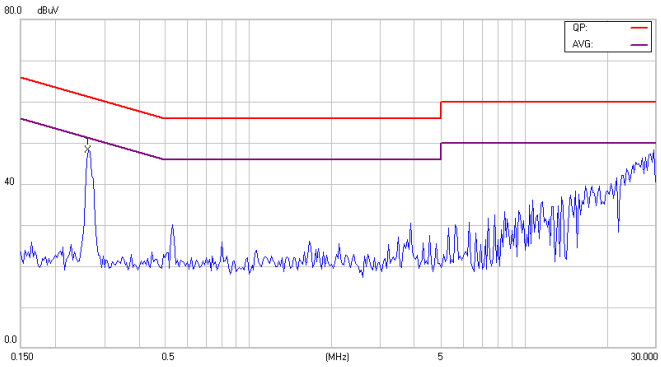
Conducted Class B of EC3SAW-48S33P

Vin = 48Vdc



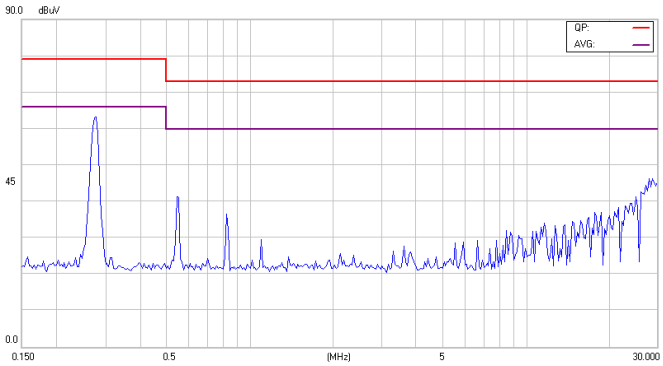
Conducted Class A of EC3SAW-48S05P

Vin = 48Vdc



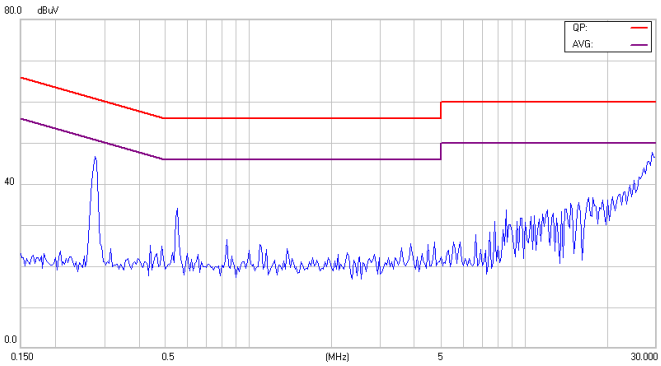
Conducted Class B of EC3SAW48S05P

Vin = 48Vdc



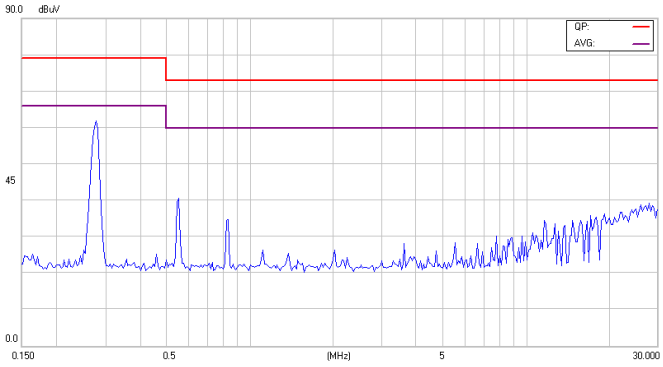
Conducted Class A of EC3SAW-48S12P

Vin =48Vdc



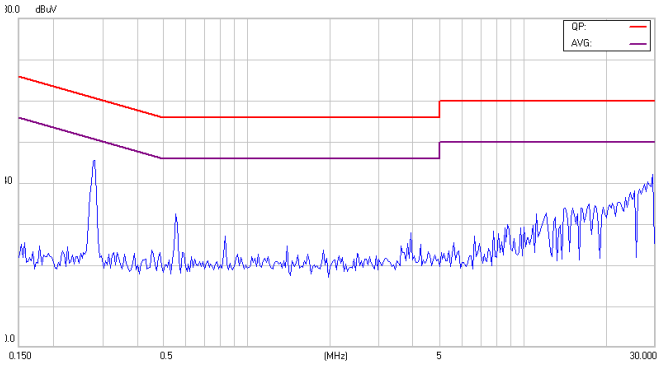
Conducted Class B of EC3SAW-48S12P

Vin =48Vdc



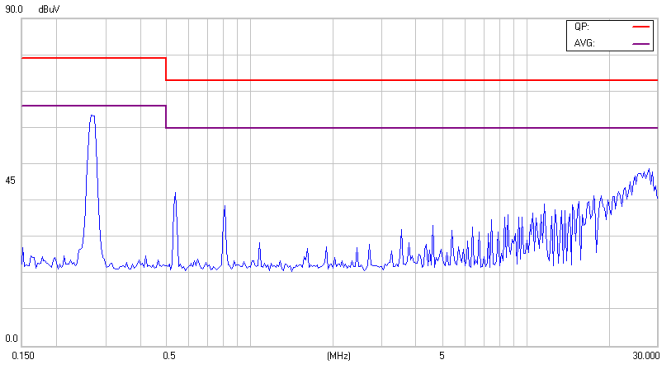
Conducted Class A of EC3SAW-48S15P

Vin = 48Vdc



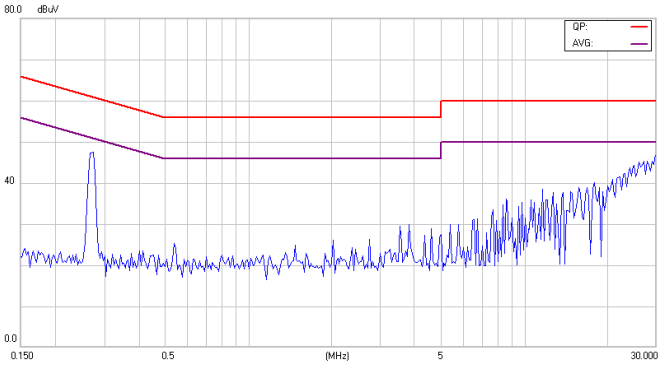
Conducted Class B of EC3SAW-48S15P

Vin = 48Vdc



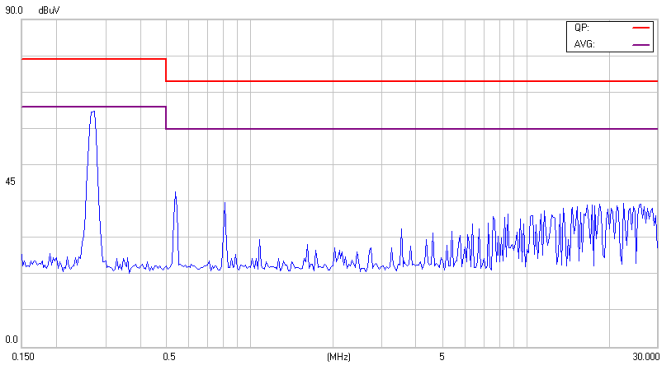
Conducted Class A of EC3SAW-48D05P

Vin = 48Vdc



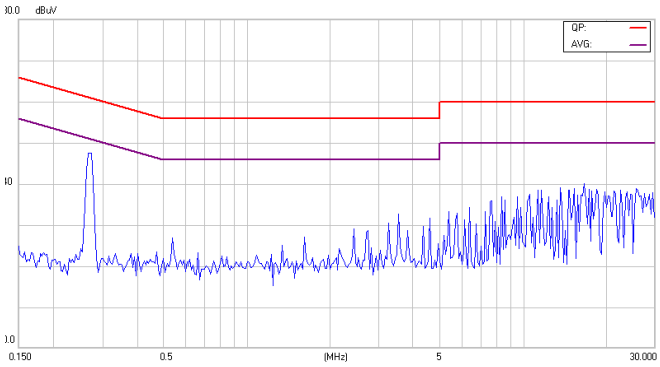
Conducted Class B of EC3SAW48D05P

Vin = 48Vdc



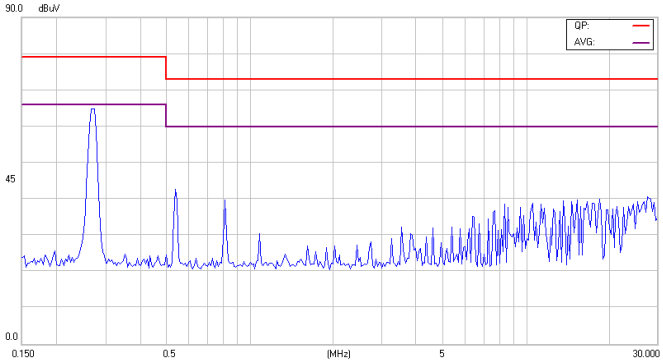
Conducted Class A of EC3SAW-48D12P

Vin =48Vdc



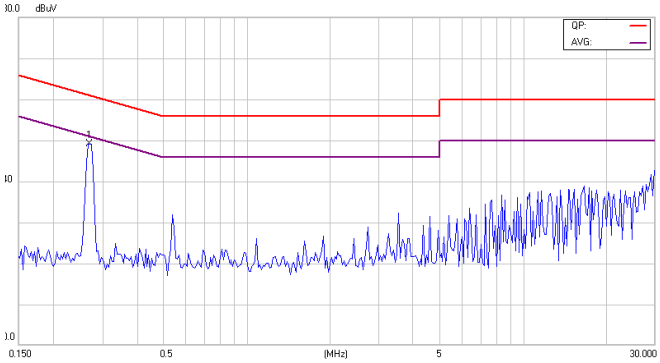
Conducted Class B of EC3SAW-48D12P

Vin =48Vdc



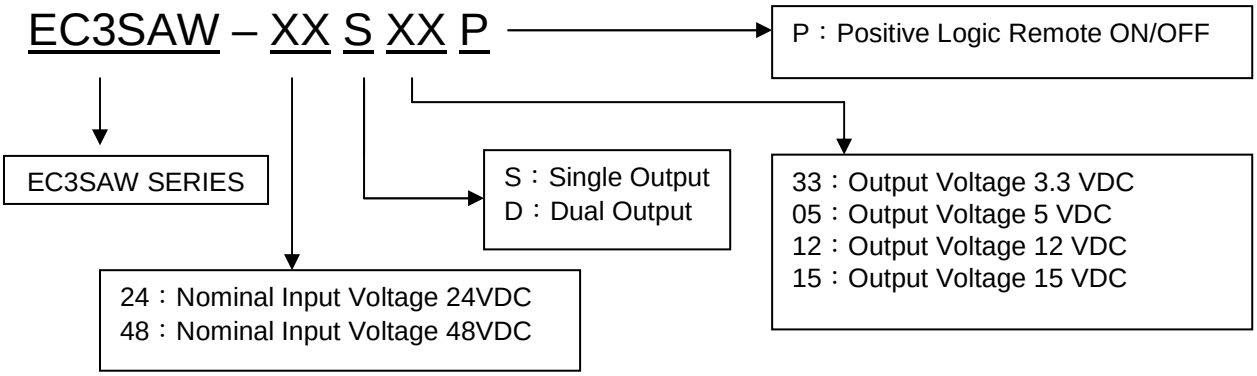
Conducted Class A of EC3SAW-48D15P

Vin = 48Vdc



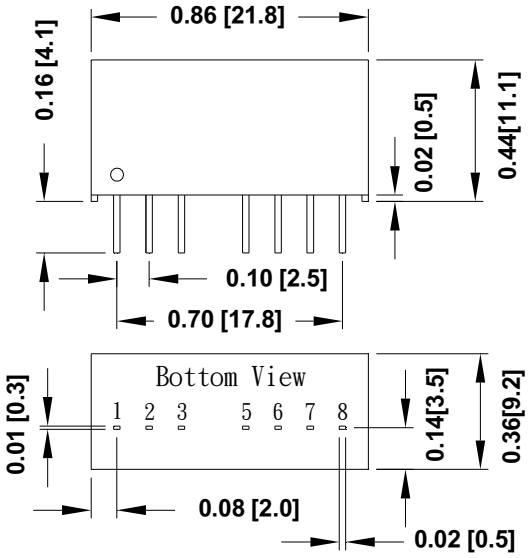
Conducted Class B of EC3SAW-48D15P

8. Part Number



9. Mechanical Specifications

All Dimensions In Inches(mm)
Tolerances : Inches millimeters
X.XX±0.02 X.X±0.5
Pin ±0.002 ±0.05



PIN CONNECTION		
Pin	Single	Dual
1	-Vin	-Vin
2	+Vin	+Vin
3	ON/OFF	ON/OFF
5	NC	NC
6	+Vo	+Vo
7	-Vo	Common
8	NC	-Vo

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