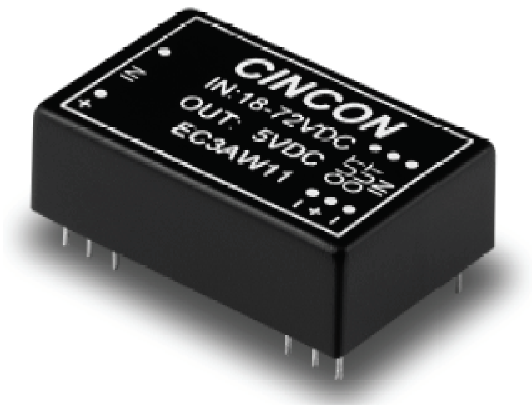
ISOLATED DC-DC Converter
EC3AW SERIES
APPLICATION NOTE



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Content

1. Introduction

The EC3AW series offer 2-3 watts of output power in a 24 pin DIP and SMD copper package. The EC3AW 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 efficiency, 500VDC,1500VDC, 3KVDC of isolation and allows an ambient operating temperature range of –25°C to 71°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

* 2-3W Isolated Output
* DIP-24 / SMD Package
* Efficiency Up to 77%
* 4:1 Input Range
* Regulated Outputs
* PI Input Filter
* Continuous Short Circuit Protection

3. Electrical Block Diagram

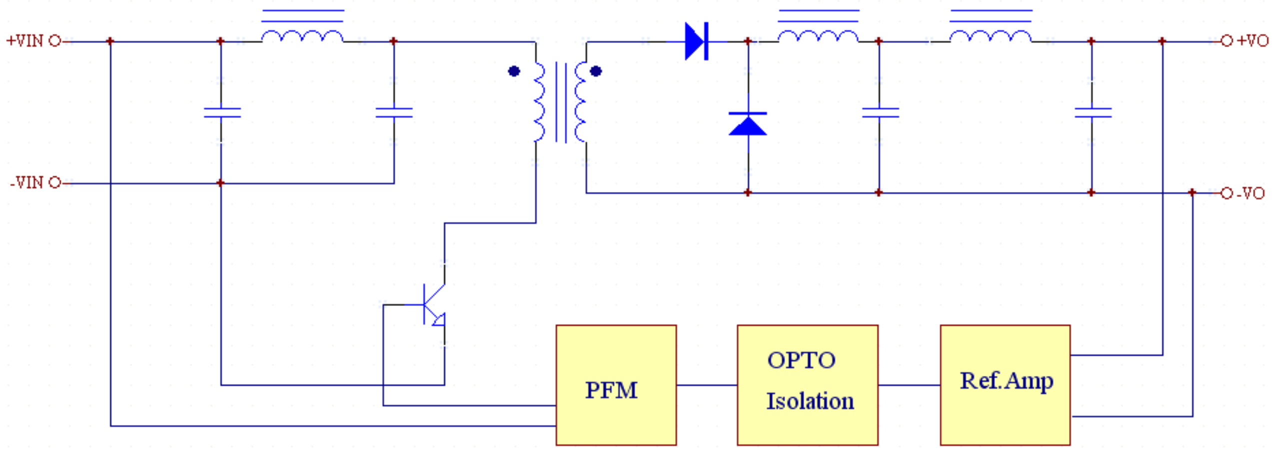


Figure 1 Electrical Block Diagram of single output module

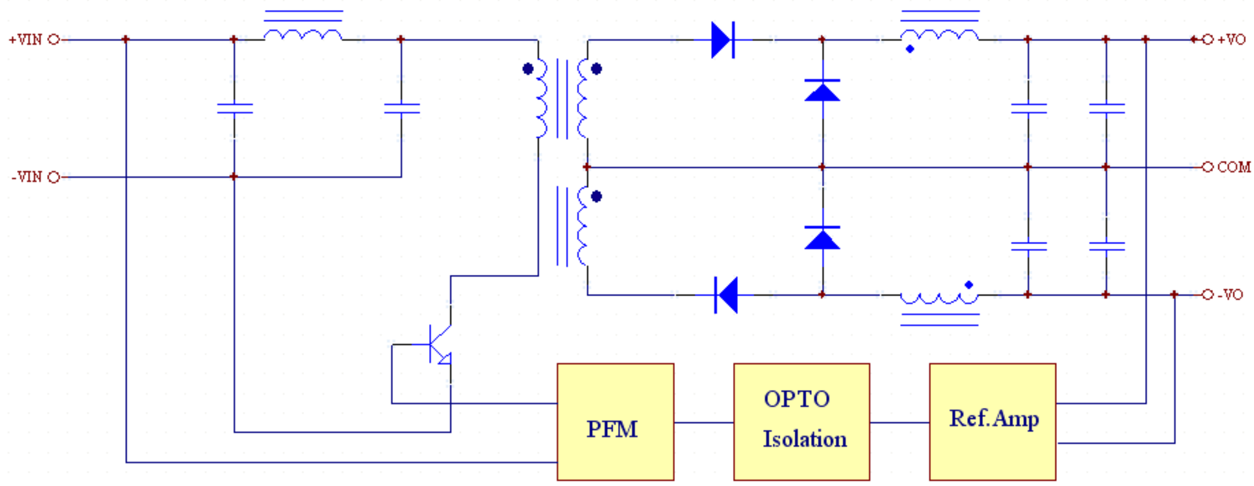


Figure 2 Electrical Block Diagram of dual output module

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 48Vin	-0.3 -0.3		36 72	Vdc
Transient	100ms	24Vin 48Vin			50 100	Vdc
Operating Ambient Temperature	With de-rating, above 71℃	All	-25		+71	℃
Case Temperature	Plastic Case	All			95	℃
	Copper Case				100	
Storage Temperature		All	-40		+100	℃
Input/Output Isolation Voltage	1 minute	EC3AWXX (M/MS) EC3AWXX (H) EC3AWXX (HM/HMS)	500 3K 1.5K			Vdc

INPUT CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Operating Input Voltage		24Vin 48Vin	9 18	24 48	36 72	Vdc
Maximum Input Current	Full load, Vin= 9V	24Vin		470		mA
	Full load, Vin=18V	48Vin		240		
No-Load Input Current	Vin=24V	Vo=3.3Vdc Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±5Vdc Vo=±12Vdc Vo=±15Vdc		15 15 15 25 25 25 15		mA
	Vin=48V	Vo=3.3Vdc Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±5Vdc Vo=±12Vdc Vo=±15Vdc		7.5 7.5 7.5 12 12 12 7.5		

OUTPUT CHARACTERISTIC

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Output Voltage Set Point	Vin=nominal input, Io= $Io_{max.}$	Vo=3.3Vdc	3.234	3.3	3.366	Vdc
		Vo=5Vdc	4.9	5	5.1	
		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	
Output Voltage Balance	Vin=nominal input, Io=$Io_{max.}$	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=low line to high line, full load	All			±0.5	%
Temperature Coefficient	Ta=-25℃ 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 for SMD package)	Vo=3.3Vdc			100	mV
		Vo=5Vdc			100	
		Vo=12Vdc			100	
		Vo=15Vdc			100	
		Vo=±5Vdc			100	
		Vo=±12Vdc			120	
		Vo=±15Vdc			150	
Operating Output Current Range		Vo=3.3Vdc			600	mA
		Vo=5Vdc			600	
		Vo=12Vdc			250	
		Vo=15Vdc			200	
		Vo=±5Vdc			±300	
		Vo=±12Vdc			±125	
		Vo=±15Vdc			±100	
Output DC Current-Limit Inception	Vo=90% $V_{O,\ nominal}$	All	120			%

DYNAMIC CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Turn-On Delay and Rise Time						
Turn-On Delay Time, From Input	Vin, Nominal. to 90%Vo,set	Vo=3.3&5V		0.5	1.2	ms
		Others		4	12	
Output Voltage Rise Time	10%Vo, set to 90%Vo,set	Vo=3.3&5V		0.5	1.2	ms
		Others		4	12	

EFFICIENCY

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
100% Load	Vin=24V	EC3AW01		72		%
		EC3AW02		76		
		EC3AW03		76		
		EC3AW04		70		
		EC3AW05		72		
		EC3AW06		72		
		EC3AW07		70		
	Vin=48V	EC3AW11		72		
		EC3AW12		77		
		EC3AW13		77		
		EC3AW14		71		
		EC3AW15		72		
		EC3AW16		72		
		EC3AW17		70		

ISOLATION CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Isolation Voltage	Input to Output, 1 minutes	EC3AWXX (M/MS)	500			Vdc
		EC3AWXX (H)	3K			
		EC3AWXX (HM/HMS)	1.5K			
Isolation Resistance	Input to Output	All	1000			MΩ
Isolation Capacitance	Input to Output	EC3AWXX (H)		300		pF
		Others		600		

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		2800		K hours
Weight		All		12.5		grams

5. Main Features and Functions

5.1 Operating Temperature Range

The EC3AW series converters can be operated by a wide ambient temperature range from -25℃ to 71℃ (de-rating above 71°C). The standard models case temperature should not be exceeded 100℃ at normal operating (Detail see content 6.2).

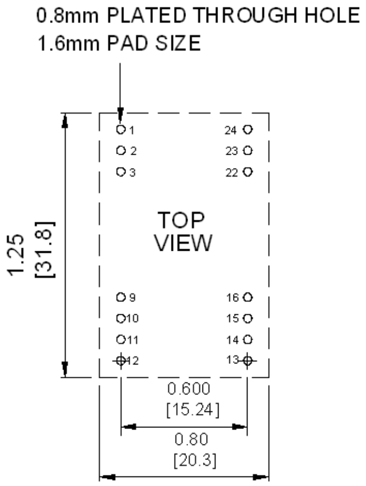
5.2 Over Current Protection

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.

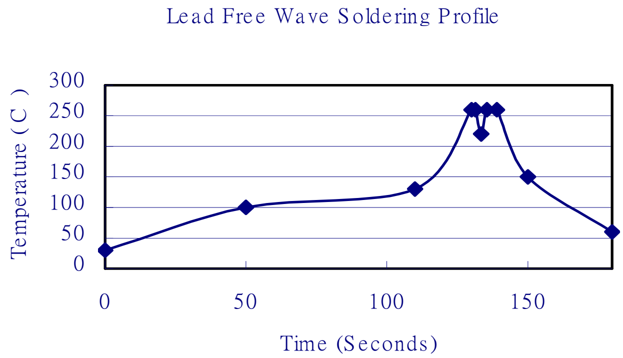
6. Applications

6.1 Recommended Layout PCB Footprints and Soldering Information

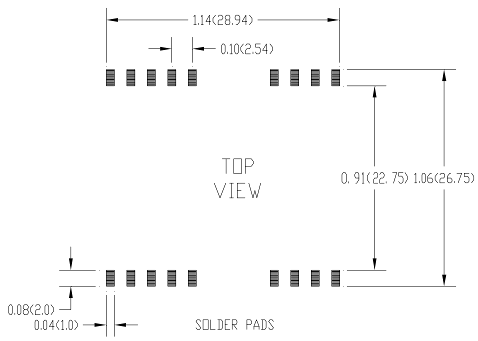
The system designer or the end user must ensure that other components and metal in the vicinity of the converter meet the spacing requirements to which the system is approved. Low resistance and low inductance PCB layout traces are the norm and should be used where possible. Due consideration must also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



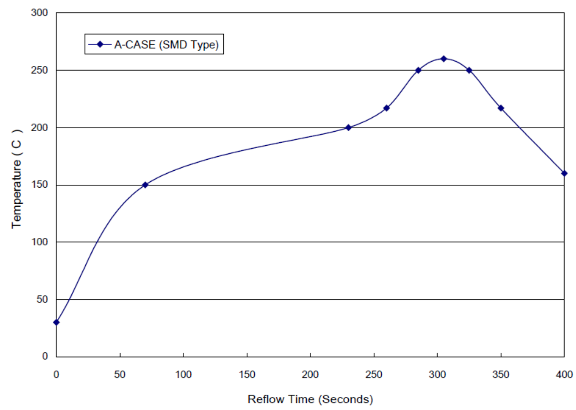
Note: Dimensions are in inches (millimeters)



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℃)



Lead Free Hot Air Reflow Profile



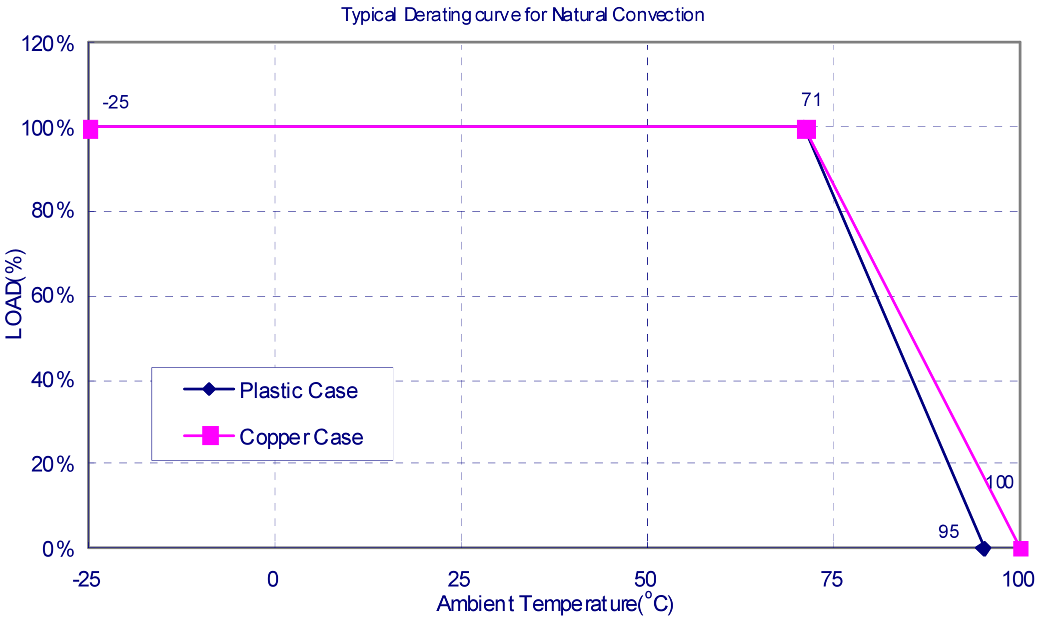
Note：
1. Soldering Paste: SHENMAO PF610-P (Sn/Ag/Cu)
2. Ramp up rate during preheat: 1.71 ℃/Sec (From 30℃ to 150℃)
3. Soaking temperature: 0.31 ℃/Sec (From 150℃ to 200℃), 160±10 seconds
4. Ramp up rate during reflow: 0.96 ℃/Sec (From 217℃ to 260℃)
5. Peak temperature: 260℃, above 217℃ 90 Seconds
6. Ramp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

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

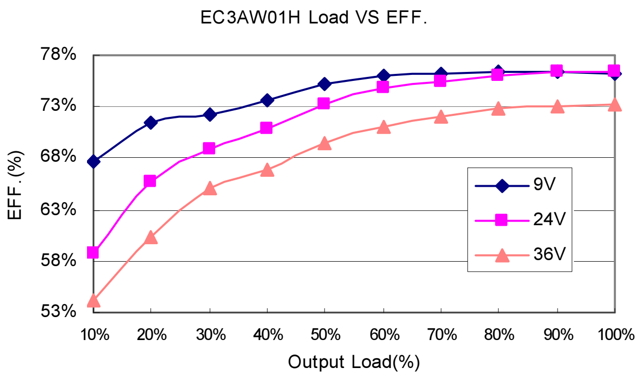
6.2 Power De-Rating Curves for EC3AW Series

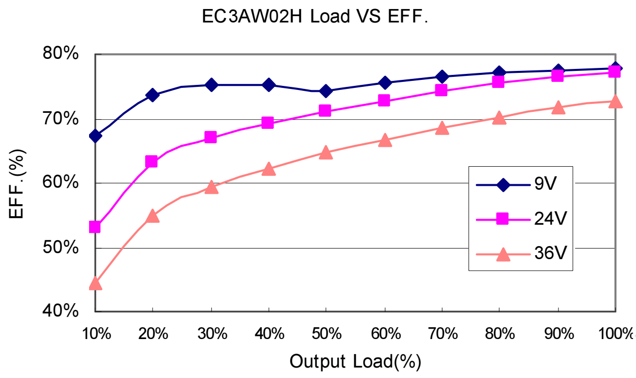
Operating Ambient temperature Range: -25℃ ~ 71℃ with de-rating above 71℃.

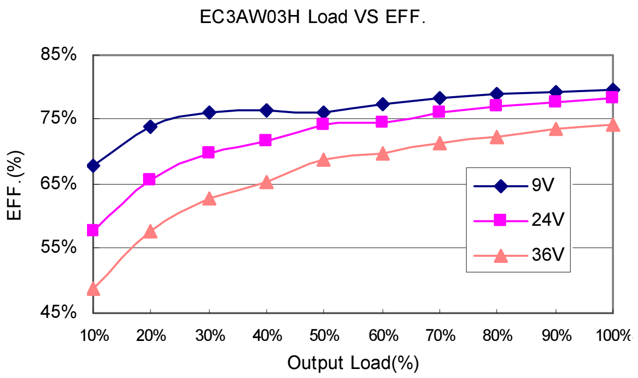
Maximum case temperature under any operating condition should not exceed 95℃(Plastic Case), 100℃(Copper Case).

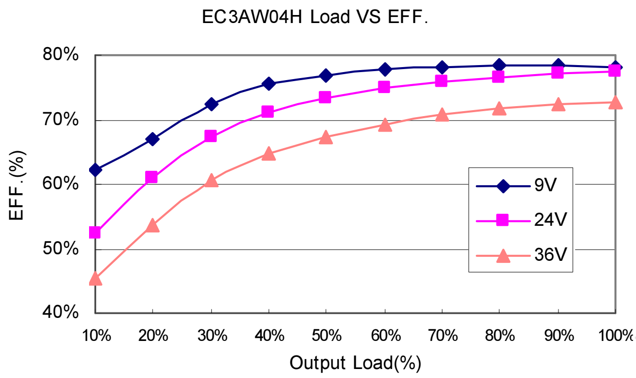


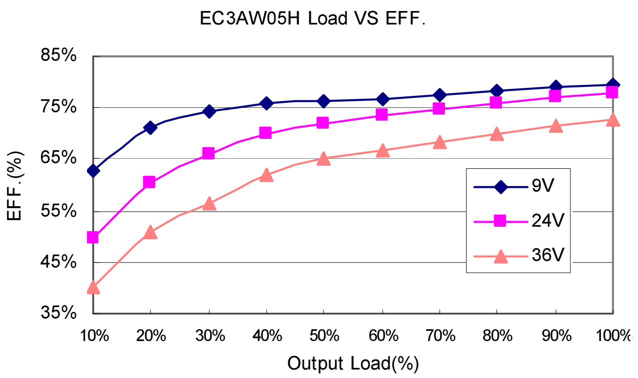
6.3 Efficiency vs. Load Curves

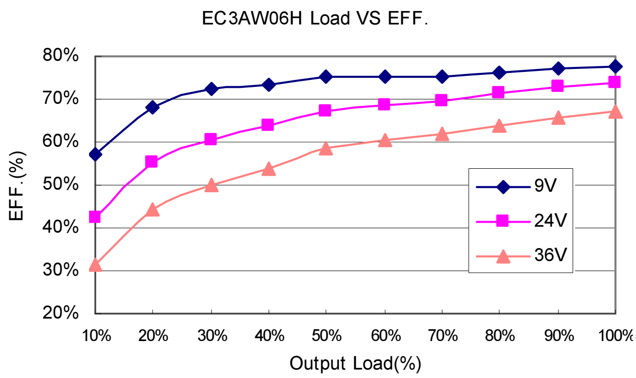


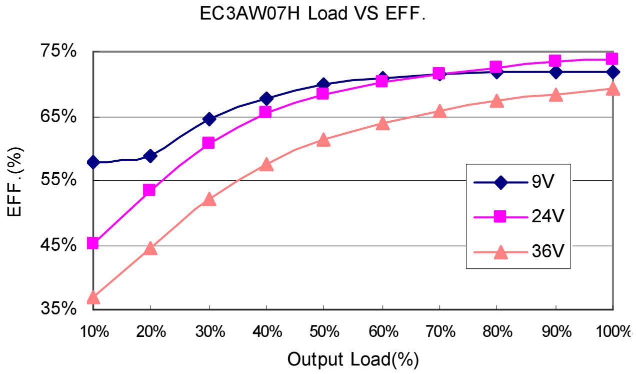


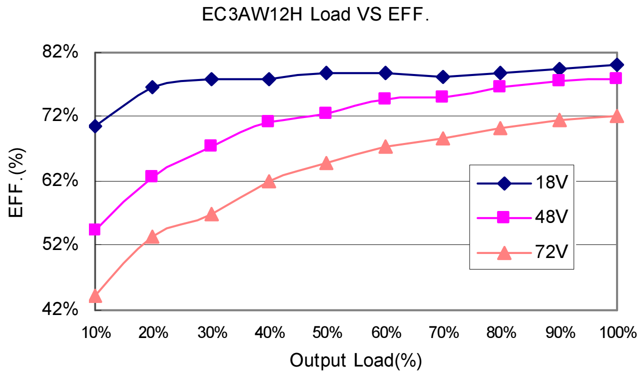


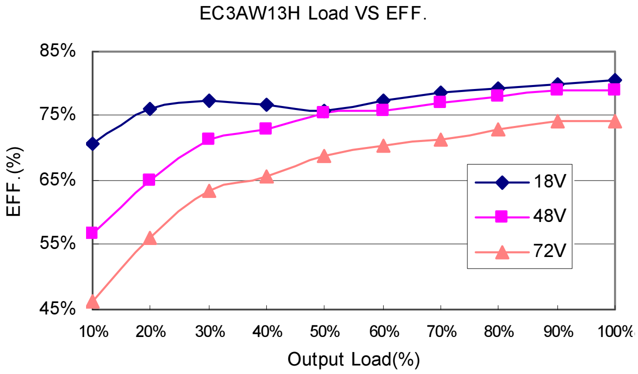


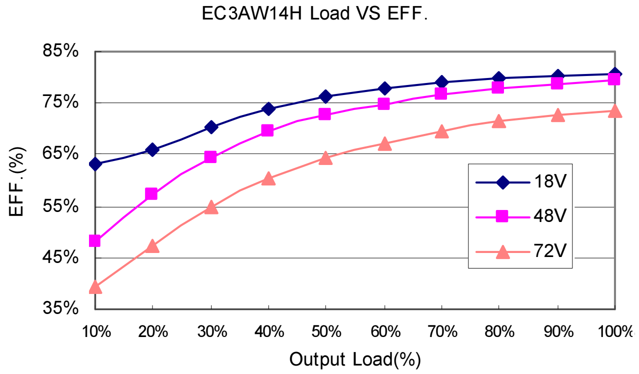


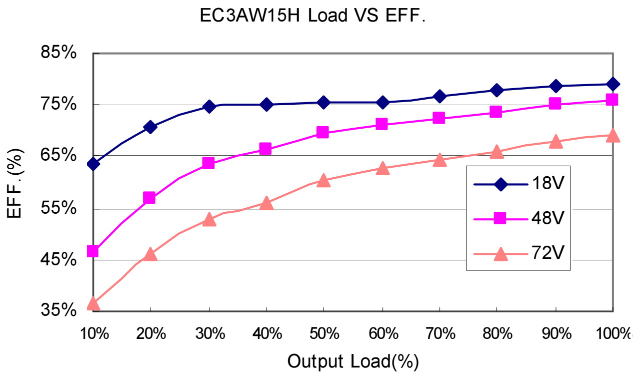


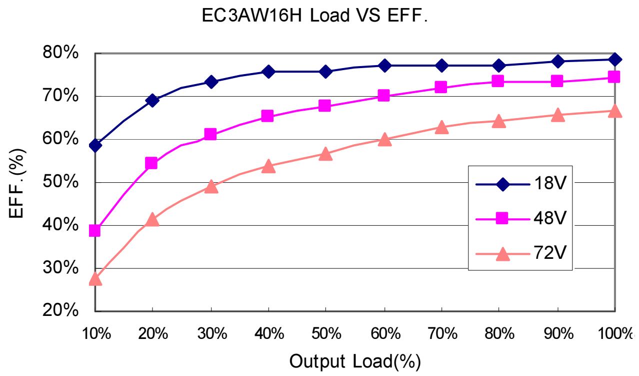

EC3AW07H Load VS EFF.
75%
65%
55%
45%
35%
EFF.(%)
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Output Load(%)
9V
24V
36V

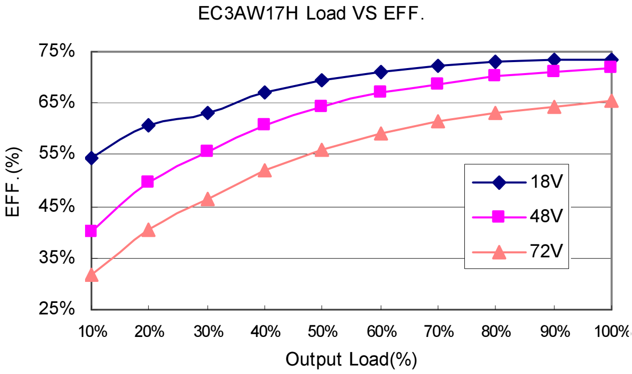

EC3AW12H Load VS EFF.
82%
72%
62%
52%
42%
EFF.(%)
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Output Load(%)
18V
48V
72V


EC3AW13H Load VS EFF.
85%
75%
65%
55%
45%
EFF.(%)
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Output Load(%)
18V
48V
72V


EC3AW14H Load VS EFF.
85%
75%
65%
55%
45%
35%
EFF.(%)
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Output Load(%)
18V
48V
72V


EC3AW15H Load VS EFF.
85%
75%
65%
55%
45%
35%
EFF.(%)
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Output Load(%)
18V
48V
72V

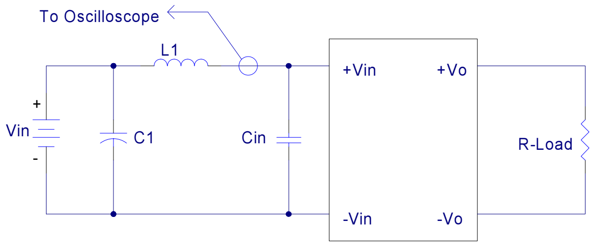

EC3AW16H Load VS EFF.
80%
70%
60%
50%
40%
30%
20%
EFF.(%)
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Output Load(%)
18V
48V
72V



EC3AW17H Load VS EFF.
75%
65%
55%
45%
35%
25%
EFF.(%)
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Output Load(%)
18V
48V
72V

6.5 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: 220uF ESR <0.1Ω @ 20℃, 100KHz.
Cin: None

Figure 4 Input Reflected-Ripple Test Setup

6.6 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

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 (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.

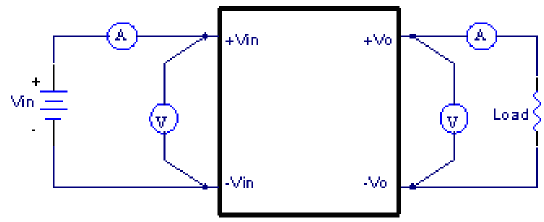
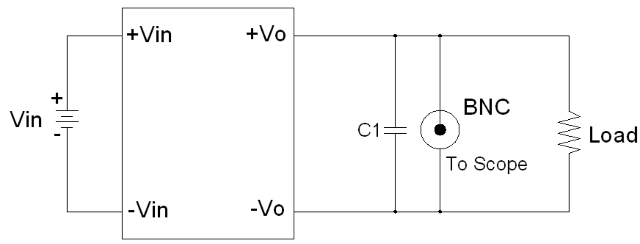


Figure 5 EC3AW Series Test Setup

6.7 Output Ripple and Noise Measurement

The test set-up for noise and ripple measurements is shown in Figure 6 and 7. 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: 0.1uF Ceramic capacitor for SMD Models Only

Figure 6 Using BNC to Measure Output Ripple and Noise

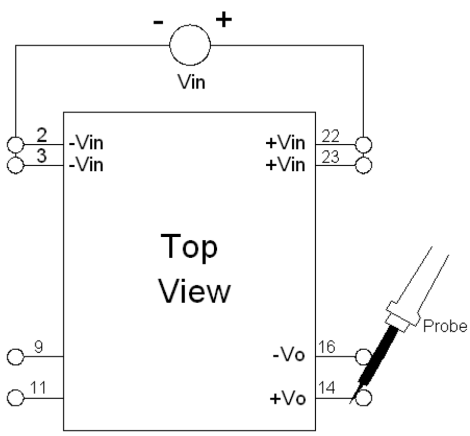


Figure 7 Using Probe to Measure Output Ripple and Noise

6.8 Output Capacitance

The EC3AW 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 EC3AW series converters have not an internal fuse. However, to achieve maximum safety and system protection, always use an input line fuse. We recommended a active fast fuse 0.63A for 24Vin models and 0.3A for 48Vin models. Figure 8 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.

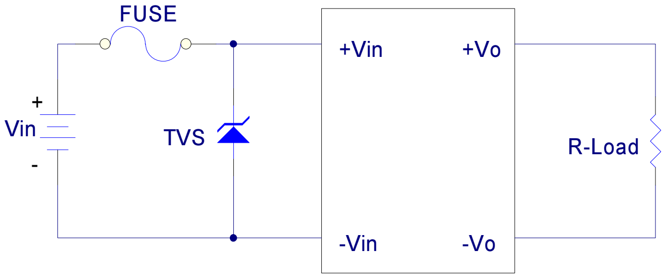


Figure 8 Input Protection

7.2 EMC Considerations

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

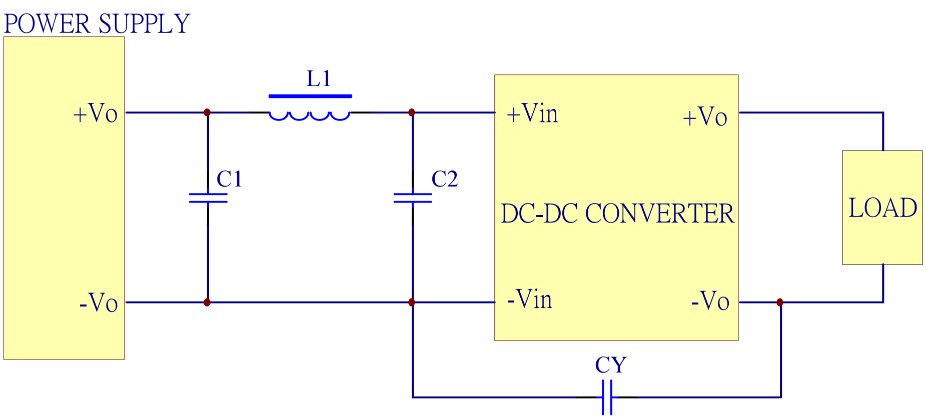
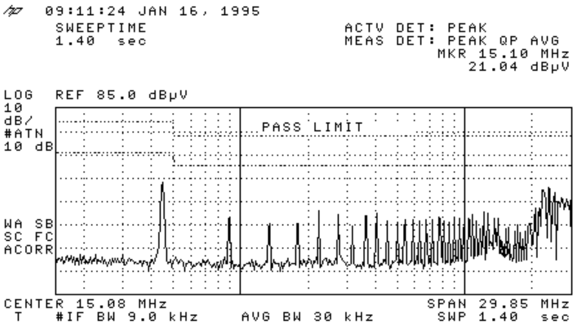


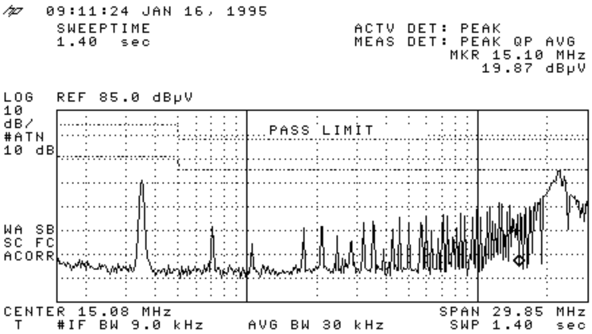
Figure 9 Connection circuit for conducted EMI testing

Model No.	EN55022 Class A			
	C1	C2	L1	CY
EC3AW01	NC	47uF/50V ESR<0.17Ω	Short	NC
EC3AW02	NC	47uF/50V ESR<0.17Ω	Short	NC
EC3AW03	NC	47uF/50V ESR<0.17Ω	Short	NC
EC3AW04	NC	47uF/50V ESR<0.17Ω	Short	NC
EC3AW05	NC	47uF/50V ESR<0.17Ω	Short	NC
EC3AW06	NC	47uF/50V ESR<0.17Ω	Short	NC
EC3AW07	NC	47uF/50V ESR<0.17Ω	Short	NC
EC3AW11	NC	47uF/100V ESR<0.17Ω	Short	NC
EC3AW12	NC	47uF/100V ESR<0.17Ω	Short	NC
EC3AW13	NC	47uF/100V ESR<0.17Ω	Short	NC
EC3AW14	NC	47uF/100V ESR<0.17Ω	Short	NC
EC3AW15	NC	47uF/100V ESR<0.17Ω	Short	NC
EC3AW16	NC	47uF/100V ESR<0.17Ω	Short	NC
EC3AW17	NC	47uF/100V ESR<0.17Ω	Short	NC

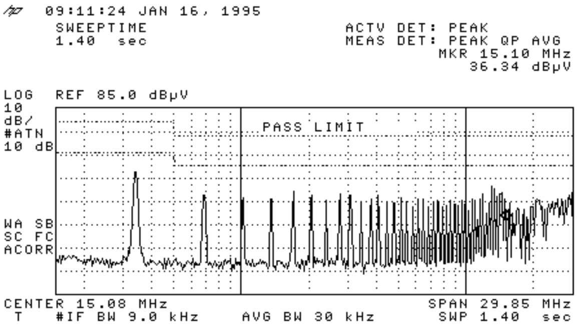
Note: The C2 is KY series aluminum capacitors.



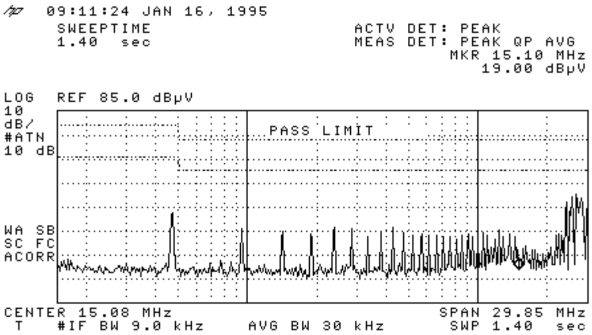
Conducted Class A of EC3AW01



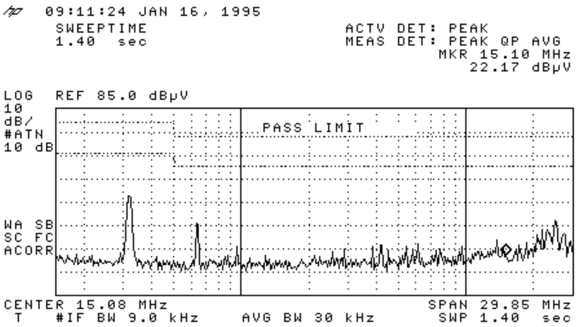
Conducted Class A EC3AW02



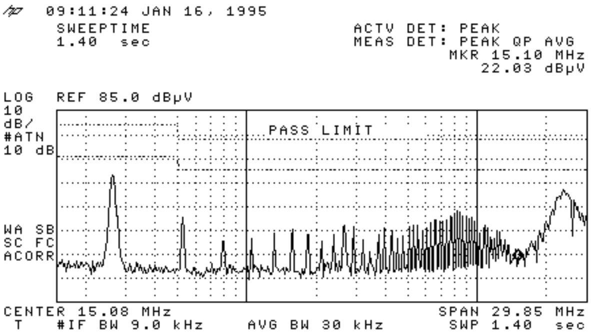
Conducted Class A EC3AW03



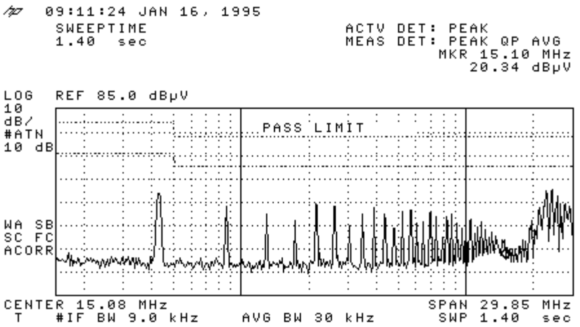
Conducted Class A EC3AW04



Conducted Class A EC3AW05



Conducted Class B EC3AW06



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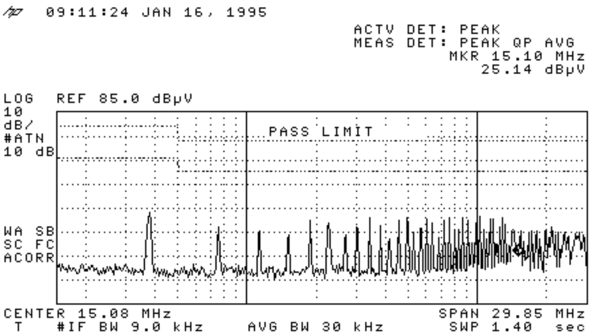

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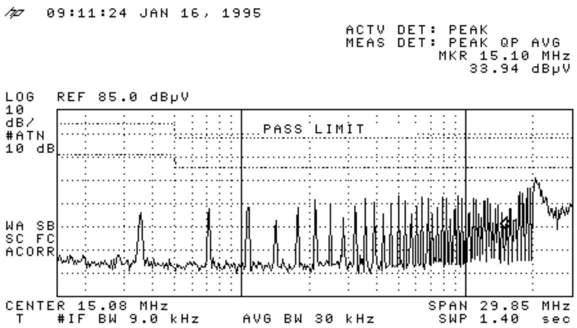
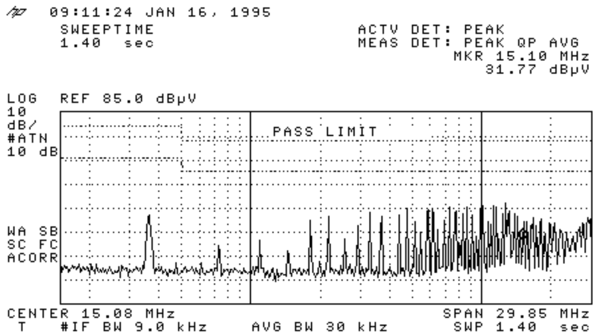


Conducted Class A of EC3AW12



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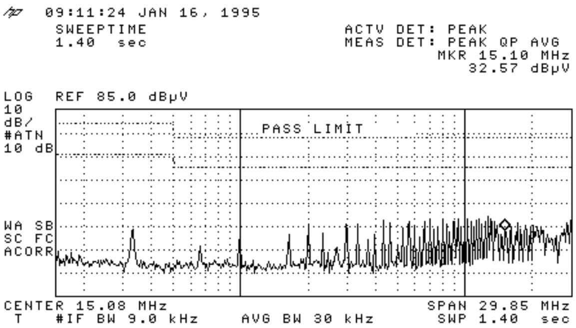

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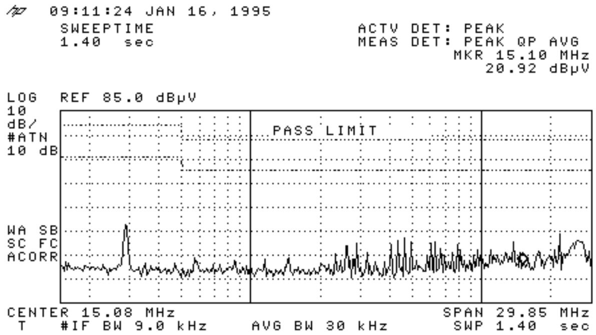
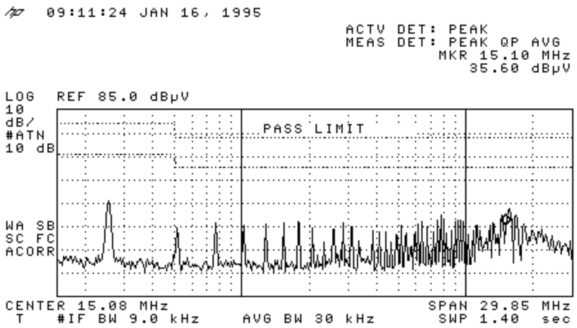
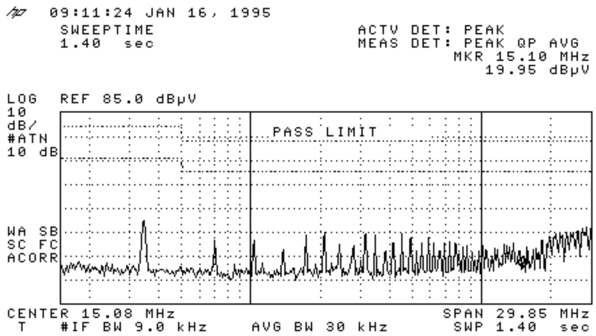


Conducted Class A of EC3AW15



Conducted Class A of EC3AW16



Conducted Class A of EC3AW17

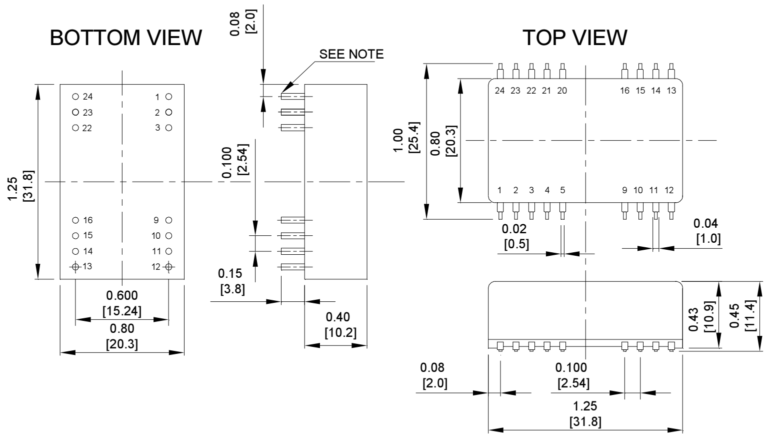
8. Part Number

EC3AW X X XX X

- EC3AW
- X: 0 : Nominal Input Voltage24VDC; 1 : Nominal Input Voltage 48VDC
- XX: 1 : Output Voltage 5 VDC; 2 : Output Voltage 12 VDC; 3 : Output Voltage 15 VDC; 4 : Output Voltage ±5 VDC; 5 : Output Voltage ±12 VDC; 6 : Output Voltage ±15 VDC; 7 : Output Voltage 3.3 VDC
- X: None: 500Vdc Isolation Voltage, Plastic Case; M: 500Vdc Isolation Voltage, Copper Case; H: 3KVdc Isolation Voltage, Plastic Case; HM: 1.5KVdc Isolation Voltage, Copper Case
- X: None: DIP Packages; S: SMD Packages

9. Mechanical Specifications

CASE AS



PIN CONNECTION									
500 VDC					1.5K & 3K VDC				
Pin	Single Output		Dual Output		Pin	Single Output		Dual Output	
	DIP	SMD	DIP	SMD		DIP	SMD	DIP	SMD
1,24	+V Input		+V Input		1,24	NP	NC	NP	NC
2,23	NC		-V Output		2,3	-V Input		-V Input	
3,22	NC		Common		4,5	NP	NC	NP	NC
4	NP	NC	NP	NC	9	NC		Common	
5	NP	NC	NP	NC	10,15	NC		NC	
9	NP	NC	NP	NC	11	NC		-V Output	
10,15	-V Output		Common		12,13	NP	NC	NP	NC
11,14	+V Output		+V Output		14	+V Output		+V Output	
12,13	-V Input		-V Input		16	-V Output		Common	
16	NP	NC	NP	NC	20,21	NP	NC	NP	NC
20,21	NP	NC	NP	NC	22,23	+V Input		+V Input	

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

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

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