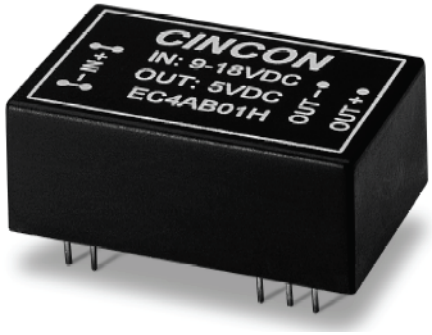
EC4AB 3.3-6W Isolated DC-DC Converters

Application Note V20 September 2015

ISOLATED DC-DC Converter
EC4AB SERIES
APPLICATION NOTE



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1. Introduction

The EC4AB series offer 3.3-6 watts of output power in a 24 pin DIP and SMD copper package. The EC4AB series has a 2:1 wide input voltage range of 9-18VDC, 18-36VDC and 36-72VDC, 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

* 3.3-6W Isolated Output
* DIP-24/SMD Package
* Efficiency Up to 84%
* 2:1 Input Range
* Regulated Outputs
* PI Input Filter
* Continuous Short Circuit Protection
* Meets EN55022 Class B Conducted
* Remote On/Off (Option)
* UL60950-1 Approval for H/HM Versions only

3. Electrical Block Diagram

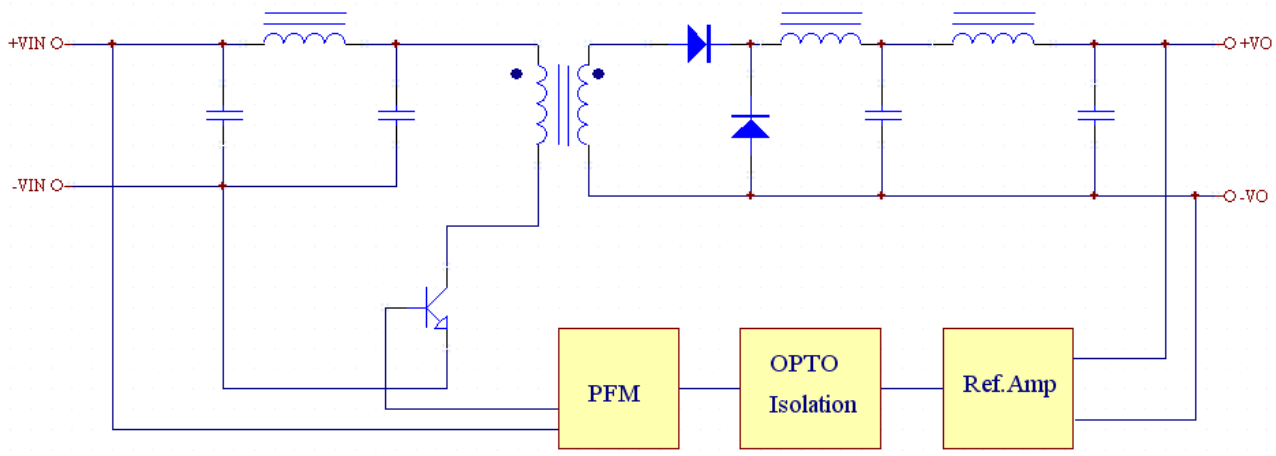


Figure 1 Electrical Block Diagram of single output module

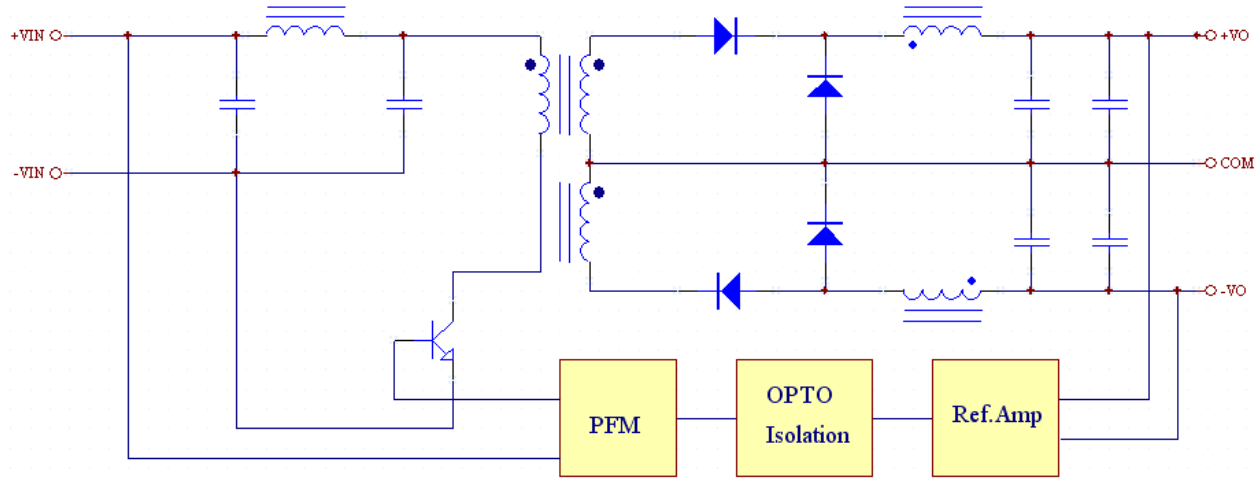


Figure 2 Electrical Block Diagram of dual output module

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		12Vin	-0.3		18	Vdc
		24Vin	-0.3		36	
		48Vin	-0.3		72	
Transient	100ms	12Vin			25	Vdc
		24Vin			50	
		48Vin			100	
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	EC4ABXX (M/MS)	500			Vdc
		EC4ABXX H	3K			
		EC4ABXX HM(HMS)	1.5K			
INPUT CHARACTERISTICS						
PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
Operating Input Voltage		12Vin	9	12	18	Vdc
		24Vin	18	24	36	
		48Vin	36	48	72	
Maximum Input Current	Full load, Vin= 9V	12Vin		800		mA
	Full load, Vin=18V	24Vin		400		
	Full load, Vin=36V	48Vin		200		
No-Load Input Current	Vin=12V	Vo=3.3Vdc		7.5		mA
		Vo=5Vdc		7.5		
		Vo=12Vdc		7.5		
		Vo=15Vdc		7.5		
		Vo=±5Vdc		12		
		Vo=±12Vdc		12		
		Vo=±15Vdc		12		
	Vin=24V	Vo=3.3Vdc		5		
		Vo=5Vdc		5		
		Vo=12Vdc		5		
		Vo=15Vdc		5		
		Vo=±5Vdc		7.5		
		Vo=±12Vdc		7.5		
		Vo=±15Vdc		7.5		

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
No-Load Input Current	Vin=48V	Vo=3.3Vdc Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±5Vdc Vo=±12Vdc Vo=±15Vdc		3 2 2 2 3 3 3		
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		TBD		mA
OUTPUT CHARACTERISTIC						
PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
Output Voltage Set Point	Vin=nominal input, Io= $Io_{max.}$	Vo=3.3Vdc Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±5Vdc Vo=±12Vdc Vo=±15Vdc	3.234 4.9 11.76 14.7 ±4.9 ±11.76 ±14.7	3.3 5 12 15 ±5 ±12 ±15	3.366 5.1 12.24 15.3 ±5.1 ±12.24 ±15.3	Vdc
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	Single Dual			±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 Vo=5Vdc Vo=±5Vdc			100	mV
		Vo=12Vdc Vo=±12Vdc			120	
		Vo=15Vdc Vo=±15Vdc			150	
Operating Output Current Range		Vo=3.3Vdc Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±5Vdc Vo=±12Vdc Vo=±15Vdc			1000 1000 470 400 ±500 ±230 ±190	mA
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	All		6	10	ms
Output Voltage Rise Time	10%Vo, set to 90%Vo,set	All		3		ms
EFFICIENCY						
PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
100% Load	Vin=12V	EC4AB01		76		%
		EC4AB02		80		
		EC4AB03		81		
		EC4AB04		81		
		EC4AB05		81		
		EC4AB06		76		
		EC4AB07		72		
	Vin=24V	EC4AB11		79		
		EC4AB12		83		
		EC4AB13		84		
		EC4AB14		81		
		EC4AB15		82		
		EC4AB16		79		
		EC4AB17		73		
	Vin=48V	EC4AB21		79		
		EC4AB22		82		
		EC4AB23		81		
		EC4AB24		81		
		EC4AB25		80		
		EC4AB26		79		
		EC4AB27		73		
ISOLATION CHARACTERISTICS						
PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
Isolation Voltage	Input to Output, 1 minutes	EC4ABXX (M/MS)	500			Vdc
		EC4ABXX H	3K			
		EC4ABXX HM(HMS)	1.5K			
Isolation Resistance	Input to Output	All	1000			MΩ

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Isolation Capacitance	Input to Output	EC4ABXXH		300		pF
		Others		500		
FEATURE CHARACTERISTICS						
PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
Switching Frequency		All	100			KHz
On/Off Control Positive Remote On/Off Logic						
Logic Low (Module Off)	Von/off at Ion/off=1.0mA	All	0		1.8	V
Logic High (Module On)	Von/off at Ion/off=0.1uA	All	5.5 or Open Circuit		10	V
Off Converter Input Current	Shutdown input idle current	All			10	mA
GENERAL SPECIFICATIONS						
PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
MTBF	Io=100% of Io.max; Ta=25℃ per MIL-HDBK-217F	All		2100		K hours
Weight		All		15		grams

5. Main Features and Functions

5.1 Operating Temperature Range

The EC4AB 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 95℃(Plastic Case), 100℃ (Copper Case) at normal operating (Detail see content 6.2).

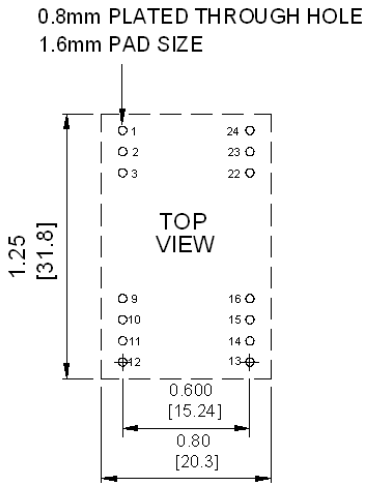
5.2 Over Current Protection

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.

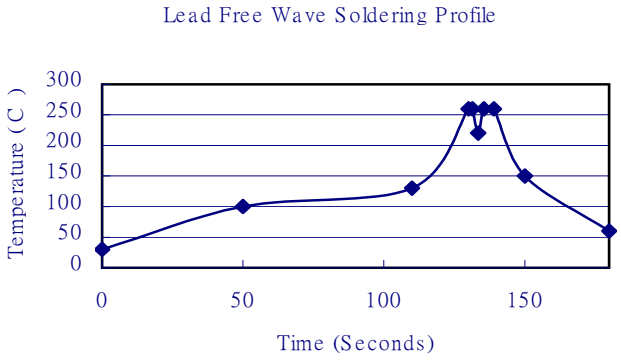
6. Applications

6.1 Recommended Layout PCB Footprints and Soldering Information

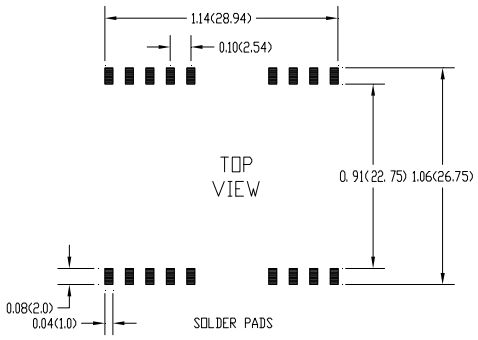
The system designer or the end user must ensure that other components and metal in the vicinity of the converter meet the spacing requirements to which the system is approved. Low resistance and low inductance PCB layout traces are the norm and should be used where possible. Due consideration must also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



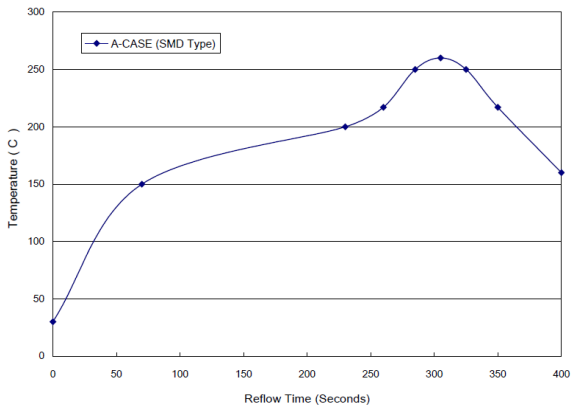
Note: Dimensions are in inches (millimeters)



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



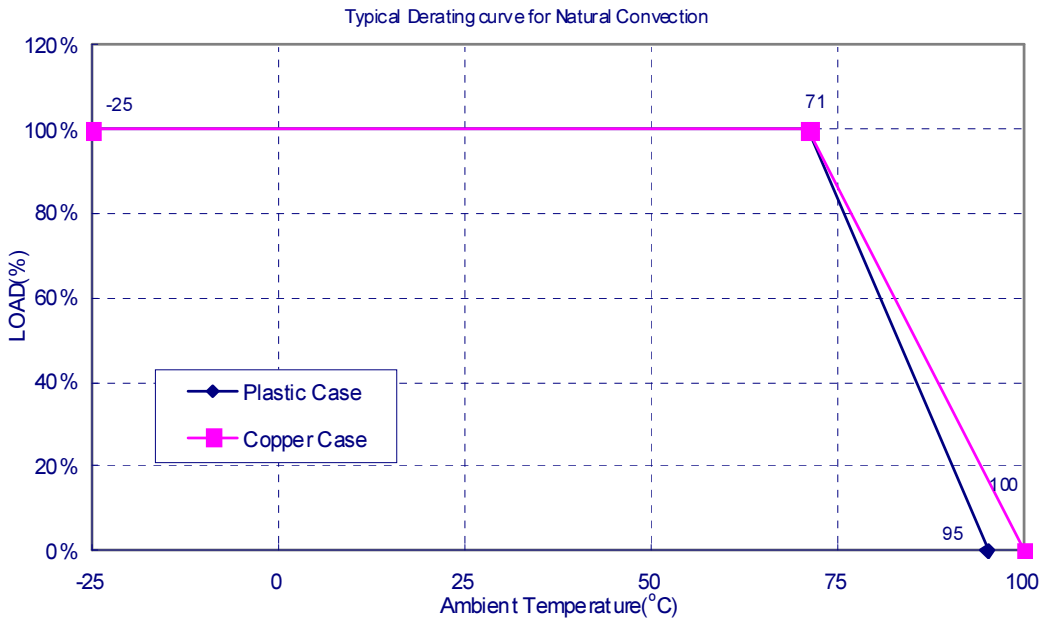
Note：
1. Soldering Paste: SHENMAO PF610-P (Sn/Ag/Cu)
2. Ramp up rate during preheat: 1.71 ℃/Sec (From 30℃ to 150℃)
3. Soaking temperature: 0.31 ℃/Sec (From 150℃ to 200℃), 160±10 seconds
4. Ramp up rate during reflow: 0.96 ℃/Sec (From 217℃ to 260℃)
5. Peak temperature: 260℃, above 217℃ 90 Seconds
6. Ramp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

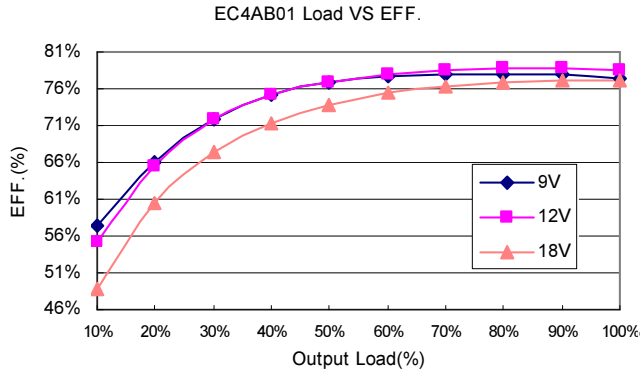
6.2 Power De-Rating Curves for EC4AB Series

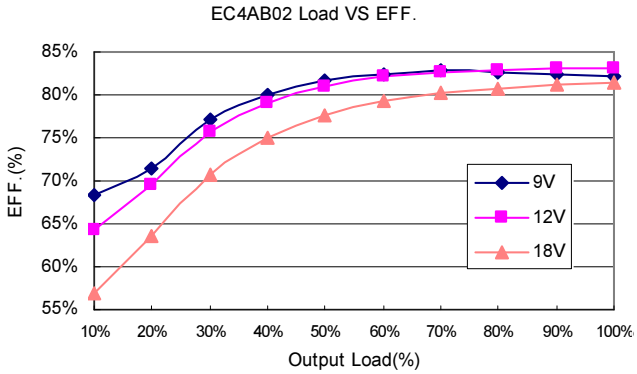
Operating Ambient temperature Range: -25℃ ~ 71℃ with de-rating above 71℃.

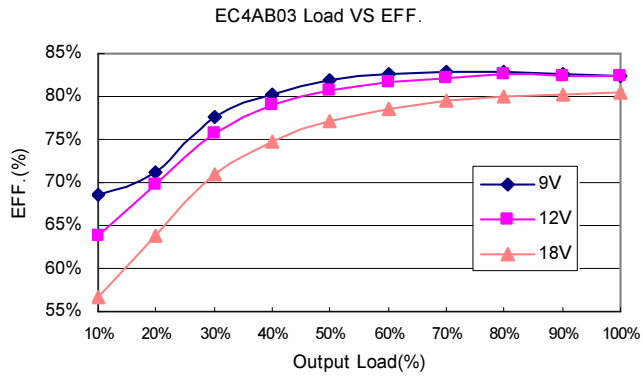
Maximum case temperature under any operating condition should not exceed 95℃(Plastic Case), 100℃(Copper Case).

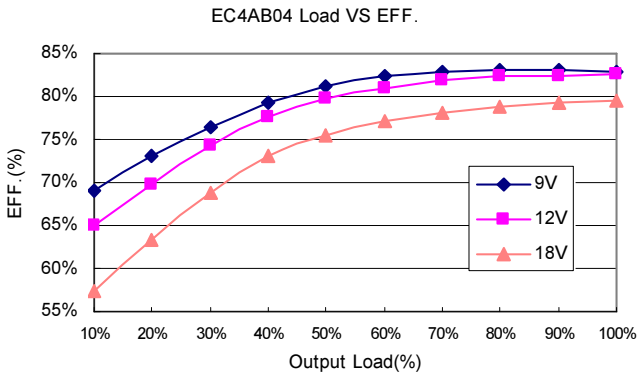


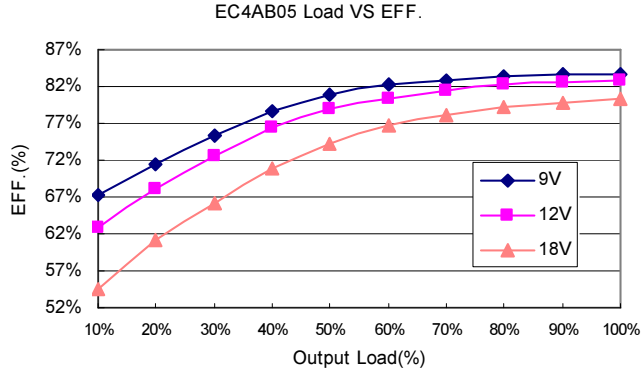
6.3 Efficiency vs. Load Curves

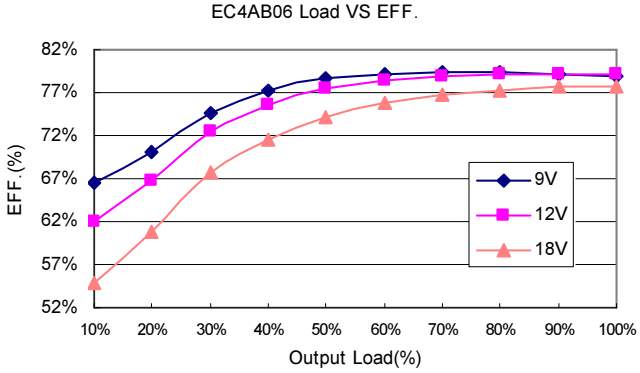




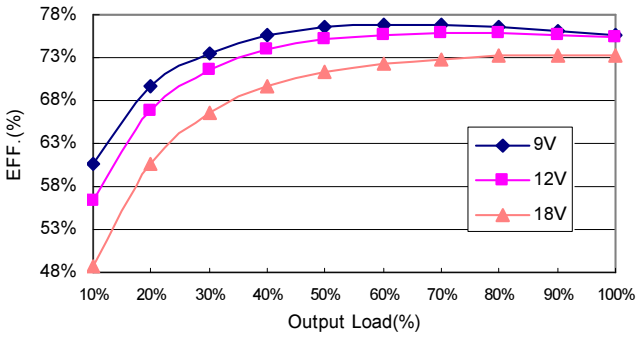




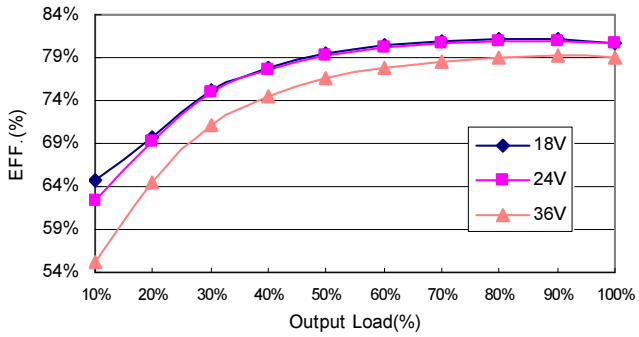




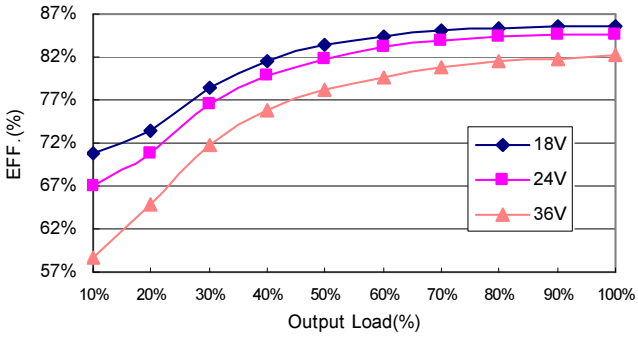
EC4AB07 Load VS EFF.



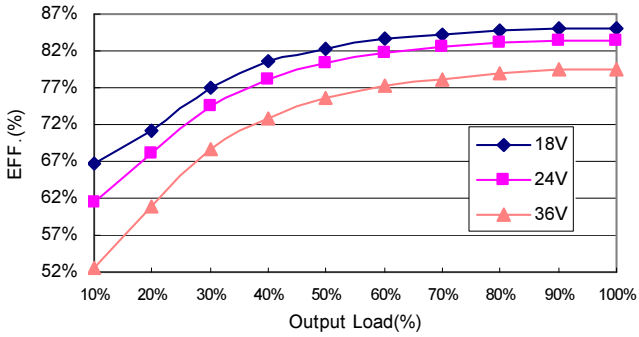
EC4AB11 Load VS EFF.



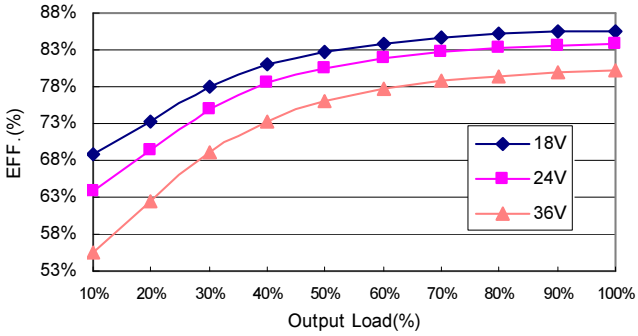
EC4AB12 Load VS EFF.



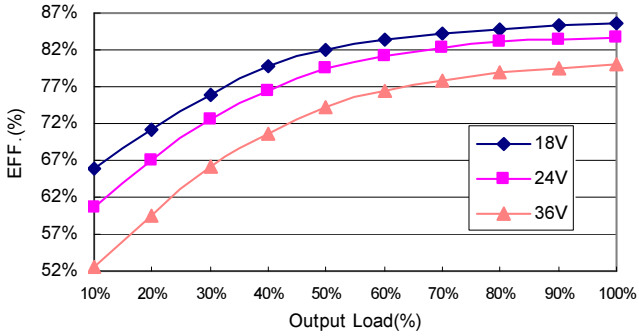
EC4AB13 Load VS EFF.



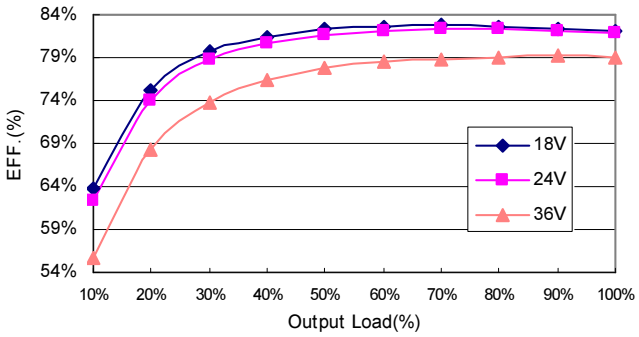
EC4AB14 Load VS EFF.



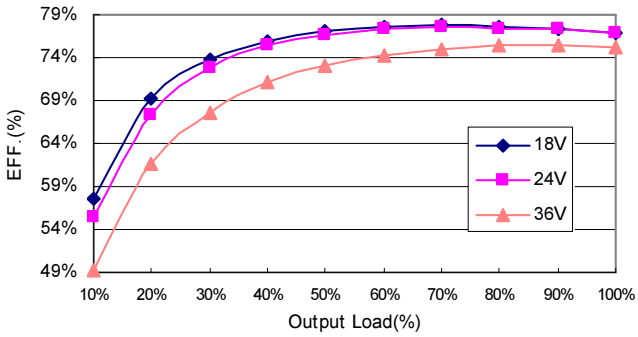
EC4AB15 Load VS EFF.



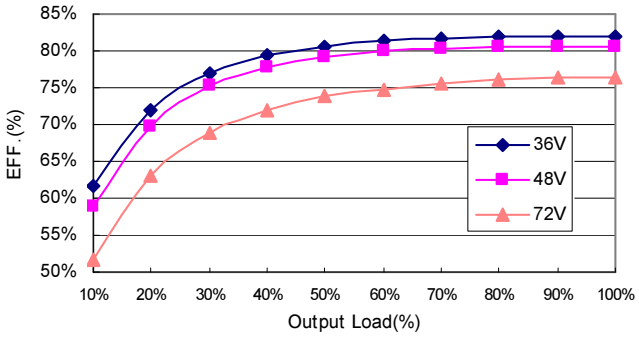
EC4AB16 Load VS EFF.



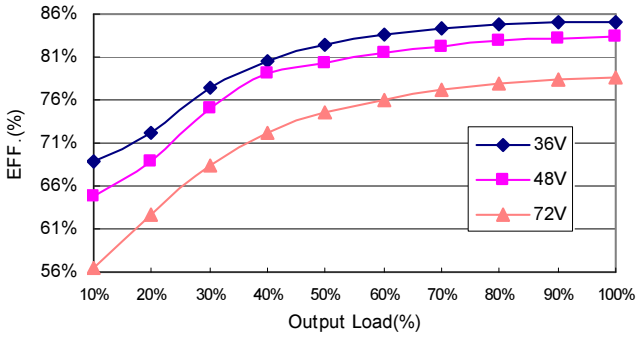
EC4AB17 Load VS EFF.



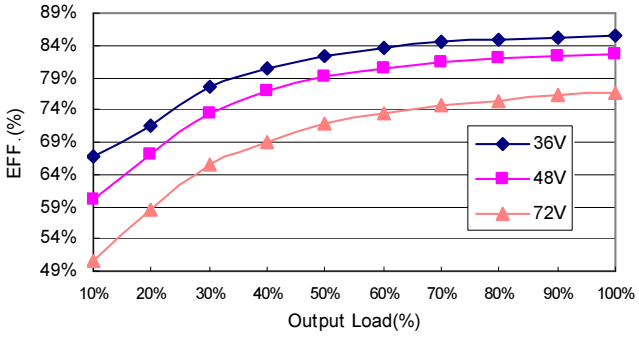
EC4AB21 Load VS EFF.



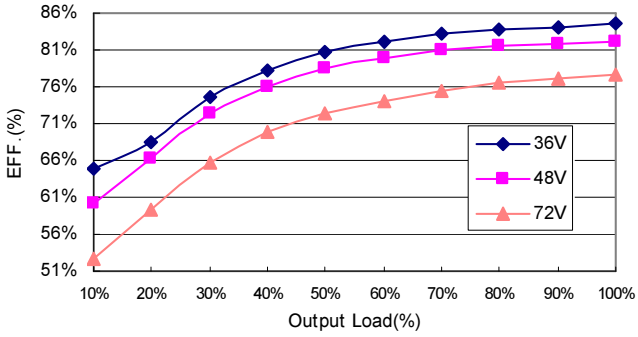
EC4AB22 Load VS EFF.



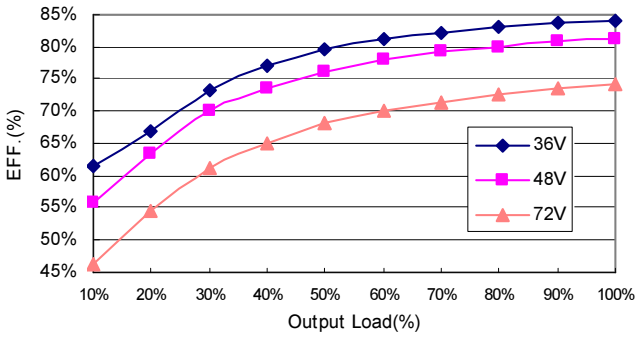
EC4AB23 Load VS EFF.



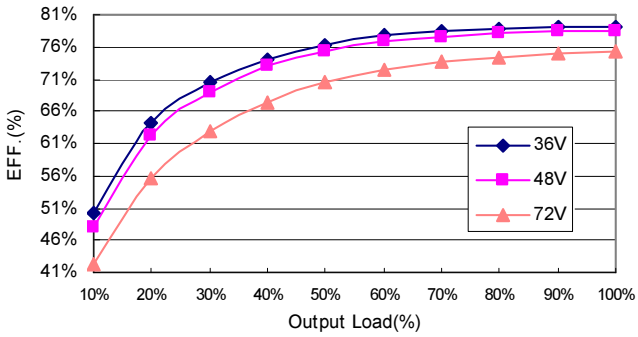
EC4AB24 Load VS EFF.



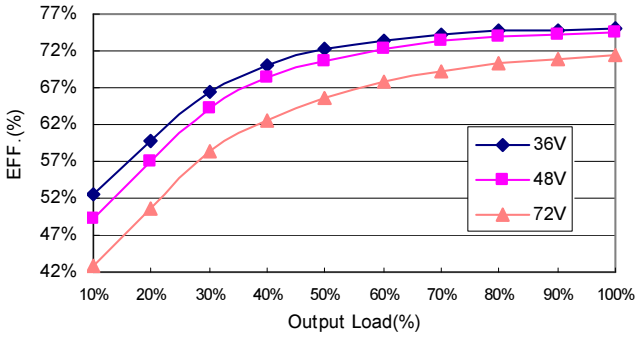
EC4AB25 Load VS EFF.



EC4AB26 Load VS EFF.

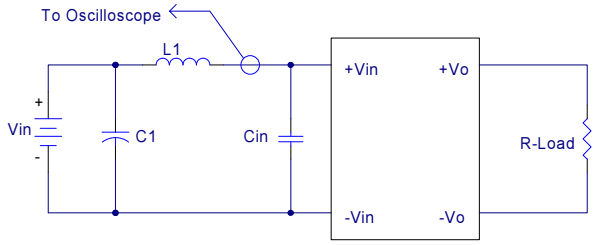


EC4AB27 Load VS EFF.



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.

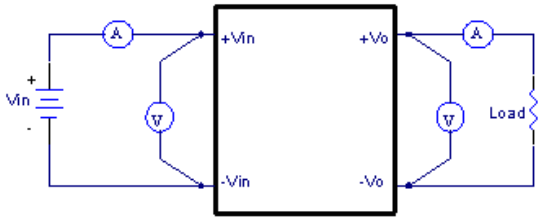
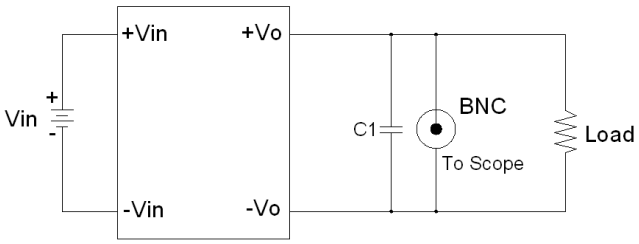


Figure 5 EC4AB Series Test Setup

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

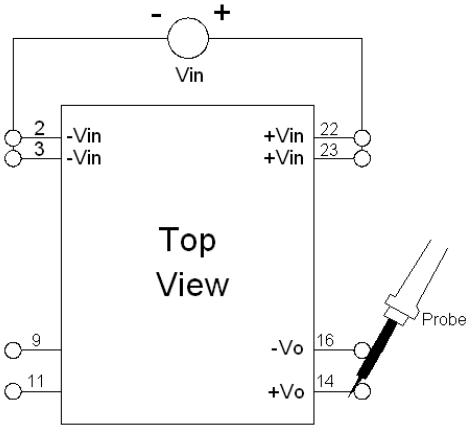


Figure 7 Using Probe to Measure Output Ripple and Noise

6.8 Output Capacitance

The EC4AB 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 EC4AB 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 1.25A for 12Vin models, 0.63A for 24Vin models and 0.3A for 48Vin modules. 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.

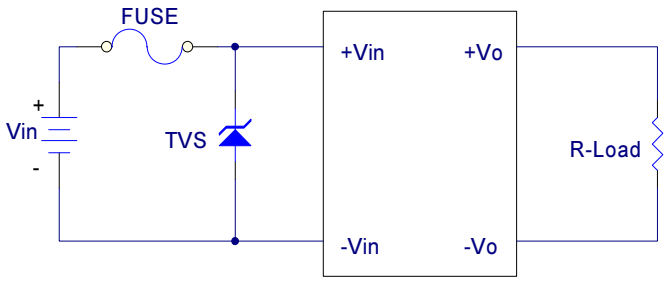


Figure 8 Input Protection

7.2 EMC Considerations

EMI Test standard: EN55022 Class B
Test Condition: Input Voltage: Nominal, Output Load: Full Load without External Input Filter

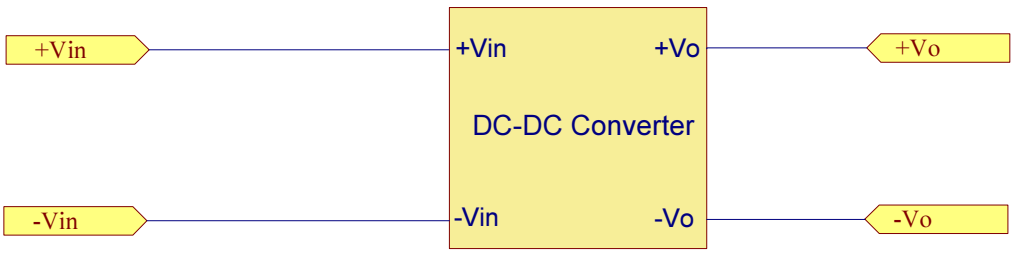


Figure 9 Connection circuit for conducted EMI testing

8. Part Number

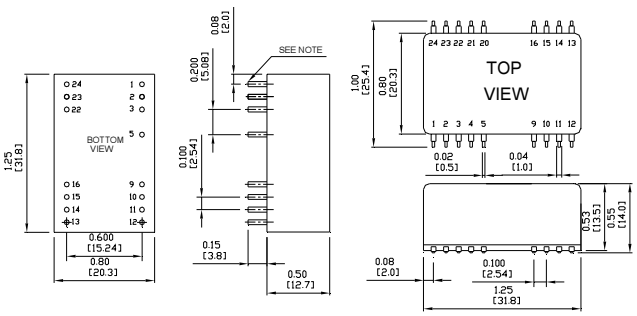
EC4AB X X XX X

- EC4AB SERIES
- 0 : Nominal Input Voltage12VDC
  1 : Nominal Input Voltage 24VDC
  2 : Nominal Input Voltage 48VDC
- 1 : Output Voltage 5 VDC
  2 : Output Voltage 12 VDC
  3 : Output Voltage 15 VDC
  4 : Output Voltage ±12 VDC
  5 : Output Voltage ±15 VDC
  6 : Output Voltage ±5 VDC
  7 : Output Voltage 3.3 VDC
- 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
  HT: 3KVdc Isolation Voltage, Plastic Case with Remote On/Off
  HMT: 1.5KVdc Isolation Voltage, Copper Case with Remote On/Off
- None: DIP Packages
  S: SMD Packages

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

CASE AS



PIN CONNECTION

Pin	500 VDC Single Output DIP	500 VDC Single Output SMD	500 VDC Dual Output DIP	500 VDC Dual Output SMD	Pin	1.5K & 3K VDC Single Output DIP	1.5K & 3K VDC Single Output SMD	1.5K & 3K VDC Dual Output DIP	1.5K & 3K VDC Dual Output 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	NP	NC	NP	NC
4	NP	NC	NP	NC	5	NP/ Remote On/Off	NC/ Remote On/Off	NP/ Remote On/Off	NC/ Remote On/Off
5	NP	NC	NP	NC	9	NC		Common	
9	NP	NC	NP	NC	10,15	NC		NC	
10,15	-V Output		Common		11	NC		-V Output	
11,14	+V Output		+V Output		12,13	NP	NC	NP	NC
12,13	-V Input		-V Input		14	+V Output		+V Output	
16	NP	NC	NP	NC	16	-V Output		Common	
20	NP	NC	NP	NC	20,21	NP	NC	NP	NC
21	NP	NC	NP	NC	22,23	+V Input		+V Input	

* NC-NO CONNECTION WITH PIN
* NP-NO PIN
* Remote On/Off (Option)

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