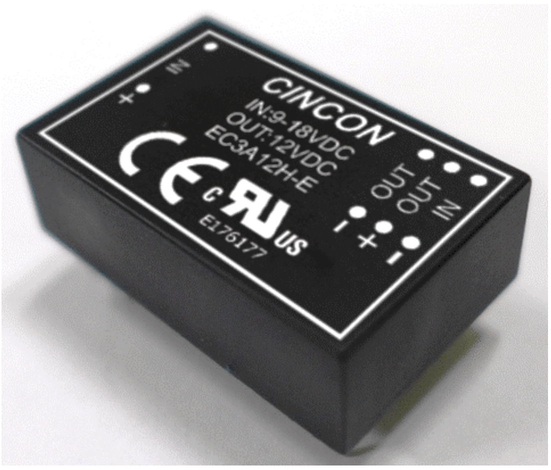
EC3A-E 2-3W Isolated DC-DC Converters

Application Note V10 June 2014

ISOLATED DC-DC Converter
EC3A-E SERIES
APPLICATION NOTE



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1. Introduction

The EC3A-E series offer 2-3 watts of output power in a 24 pin DIP and SMD package. The EC3A-E series has a 2:1 wide input voltage range of 4.5-9VDC, 9-18VDC, 18-36VDC and 36-72VDC, and provides a precisely regulated output. This series has features such as high efficiency, 500VDC, 1.5KVDC, 3KVDC of isolation and allows an ambient operating temperature range of ambient operating temperature range of –40℃ to 85° 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 87%
* 2:1 Input Range
* Regulated Outputs
* PI Input Filter
* Continuous Short Circuit Protection
* No Tantalum Capacitor Inside
* Input UVLO (Under Voltage Lockout)
* Meet EMI EN55022 class A
* Wide Operating Temperature Range
* UL60950-1 Approval

3. Electrical Block Diagram

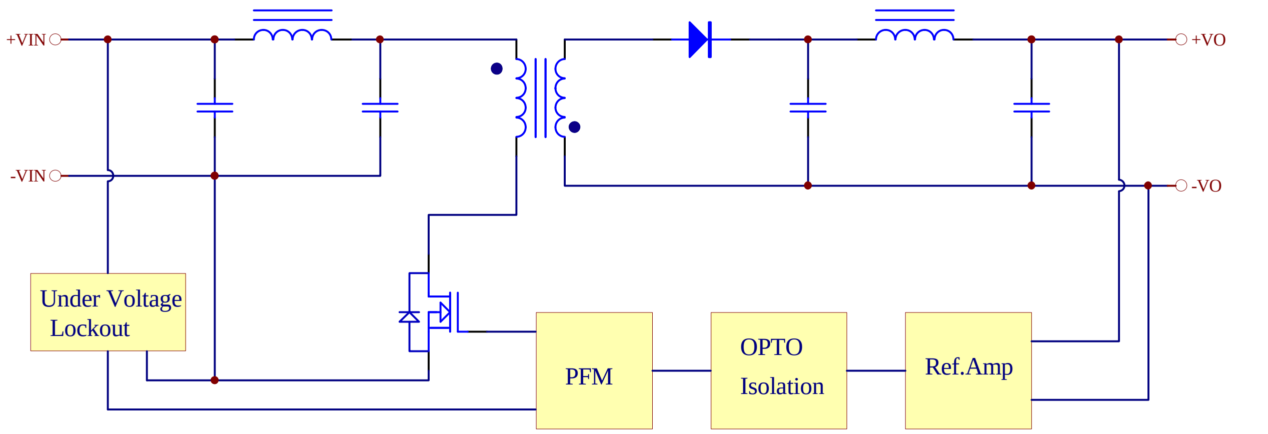

Figure 1 Electrical Block Diagram of single output module

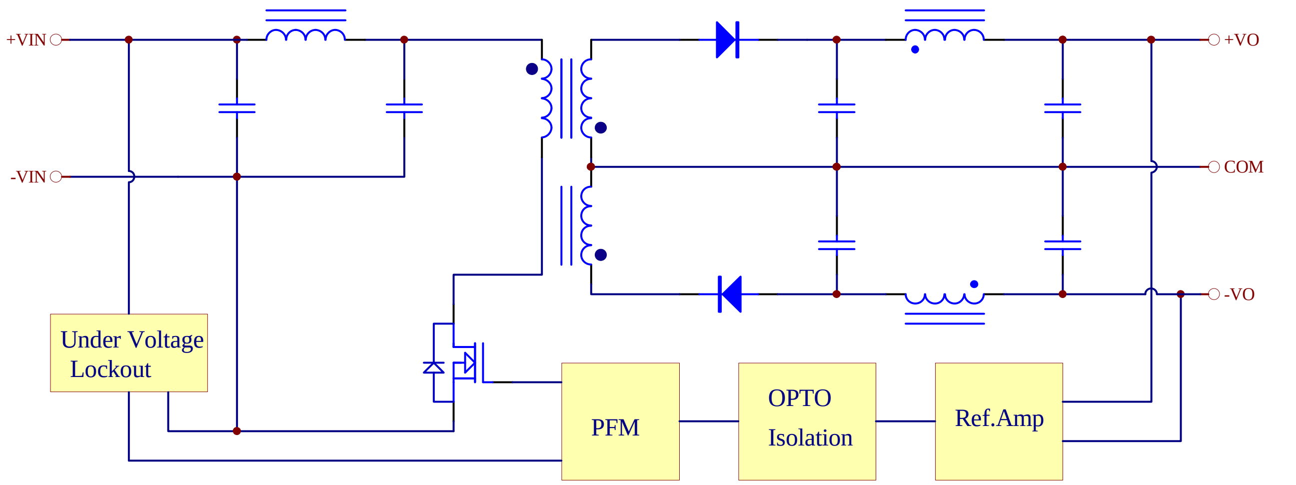

Figure 2 Electrical Block Diagram of dual output module

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		5Vin 12Vin 24Vin 48Vin	-0.3 -0.3 -0.3 -0.3		9 18 36 72	Vdc
Transient	100ms	5Vin 12Vin 24Vin 48Vin			10 25 50 100	Vdc
Operating Ambient Temperature		All	-40		+85	℃
Case Temperature		All			+100	℃
Storage Temperature		All	-40		+100	℃
Input/Output Isolation Voltage	1 minute	EC3AXX (M/MS)-E	500			Vdc
		EC3AXX (H/HS)-E	3000			
		EC3AXX (HM/HMS)-E	1500			

INPUT CHARACTERISTICS						
PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
Operating Input Voltage		5Vin 12Vin 24Vin 48Vin	4.5 9 18 36	5 12 24 48	9 18 36 72	Vdc
Turn-On Voltage Threshold		5Vin 12Vin 24Vin 48Vin	4.0 8 16 31.5	4.2 8.5 17 33	4.4 8.8 17.5 34	Vdc
Turn-Off Voltage Threshold		5Vin 12Vin 24Vin 48Vin	3.8 7.7 15 30.5	4.0 8 16 31	4.2 8.3 17 33	Vdc
Lockout Hysteresis Voltage		5Vin 12Vin 24Vin 48Vin		0.2 0.5 1.0 2.0		Vdc
Maximum Input Current	Full load, Vin=4.5V	5Vin		880		mA
	Full load, Vin= 9V	12Vin		420		
	Full load, Vin=18V	24Vin		210		
	Full load, Vin=36V	48Vin		100		
No-Load Input Current	Vin=5V	Vo=3.3Vdc Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±5Vdc Vo=±12Vdc Vo=±15Vdc		15 15 15 15 25 25 25		mA

No-Load Input Current	Vin=12V	Vo=3.3Vdc Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±5Vdc Vo=±12Vdc Vo=±15Vdc		7.5 7.5 10 10 15 12 15		mA
	Vin=24V	Vo=3.3Vdc Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±5Vdc Vo=±12Vdc Vo=±15Vdc		5 7.5 7.5 7.5 7.5 10 10		
	Vin=48V	Vo=3.3Vdc Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±5Vdc Vo=±12Vdc Vo=±15Vdc		3 3 3 5 5 5 5		mA
Inrush Current (I^2t)	As per ETS300 132-2	All			0.01	A^2s
Input Reflected-Ripple Current	P-P thru 12uH inductor, 5Hz to 20MHz	All		10		mA

OUTPUT CHARACTERISTIC

PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
Output Voltage Set Point	Vin=nominal input, Io= $Io_{max.}$	Vo=3.3Vdc Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±5Vdc Vo=±12Vdc Vo=±15Vdc	3.2505 4.925 11.82 14.775 ±4.925 ±11.82 ±14.775	3.3 5 12 15 ±5 ±12 ±15	3.3495 5.075 12.18 15.225 ±5.075 ±12.18 ±15.225	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=-40℃ to 85℃	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			600 600 250 200 ±300 ±125 ±100	mA
Output DC Current-Limit Inception	Vo=90% $V_{O,\ nominal}$	All	120			%
Maximum Output Capacitance	Full load (resistive)	Vo=3.3Vdc Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±5Vdc Vo=±12Vdc Vo=±15Vdc	0 0 0 0 0 0 0		2200 2200 2200 2200 1000 1000 1000	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	All		±6		%
Setting Time (within 1% Vout 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, set	All			2	ms
Output Voltage Rise Time	10%Vo, set to 90%Vo, set	All			2	ms
EFFICIENCY						
PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
100% Load	Vin=5V	EC3A01-E EC3A02-E EC3A03-E EC3A04-E EC3A05-E EC3A06-E EC3A07-E		77 80 80 77 80 80 72		%
	Vin=12V	EC3A11-E EC3A12-E EC3A13-E EC3A14-E EC3A15-E EC3A16-E EC3A17-E		81 84 85 82 84 85 78		
	Vin=24V	EC3A21-E EC3A22-E EC3A23-E EC3A24-E EC3A25-E EC3A26-E EC3A27-E		82 86 86 82 85 86 78		

100% Load	Vin=48V	EC3A31-E		84		%
		EC3A32-E		86		
		EC3A33-E		86		
		EC3A34-E		85		
		EC3A35-E		87		
		EC3A36-E		87		
		EC3A37-E		79		
ISOLATION CHARACTERISTICS						
PARAMETER	**NOTES and CONDITIONS**	Device	Min.	Typical	Max.	Units
Isolation Voltage	Input to Output, 1 minutes	EC3AXX (S/M/MS)-E			500	Vdc
		EC3AXX (H/HS)-E			3000	
		EC3AXX (HM/HMS)-E			1500	
Isolation Resistance	Input to Output	All	1000			MΩ
Isolation Capacitance	Input to Output	All		250		pF
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		2.5		M hours
Weight		All		12.5		grams

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5. Main Features and Functions

5.1 Operating Temperature Range

The EC3A-E series converters can be operated by a wide ambient temperature range from -40℃ to 85℃. The standard models case temperature should not be exceeded 100℃ at normal operating (Detail see content 6.2).

5.2 UVLO (Under Voltage Lockout)

Input under voltage lockout is standard on the EC3A-E models. The unit will shut down when the input voltage drops below a threshold, and the unit will operate when the input voltage goes above the upper threshold.

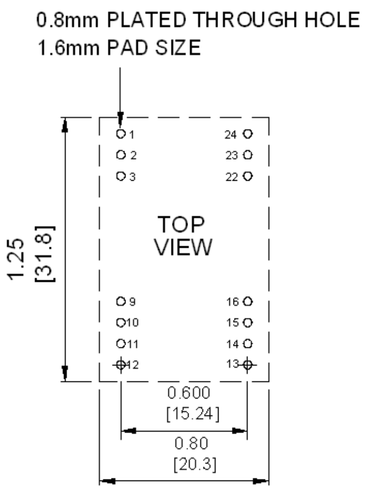
5.3 Over Current Protection

All models have internal over current and continuous short circuit protection. The unit operates normally once the fault condition is removed. At the point of current limit inception, the converter will go into over current protection.

6. Applications

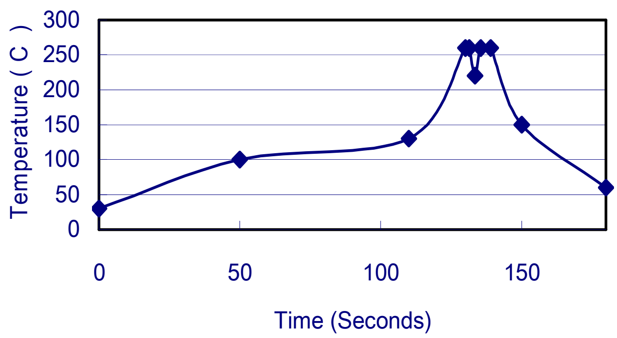
6.1 Recommended Layout PCB Footprints and Soldering Information

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

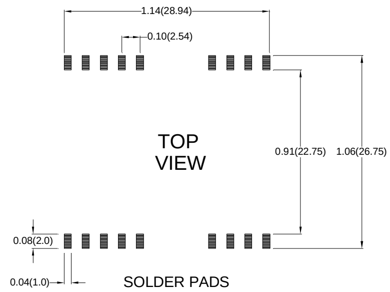


Note: Dimensions are in inches (millimeters)

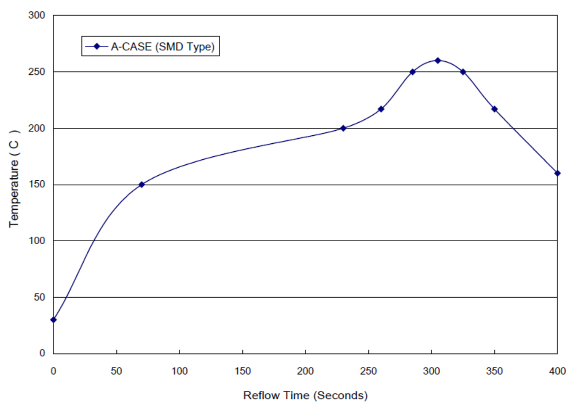
Lead Free Wave Soldering Profile



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

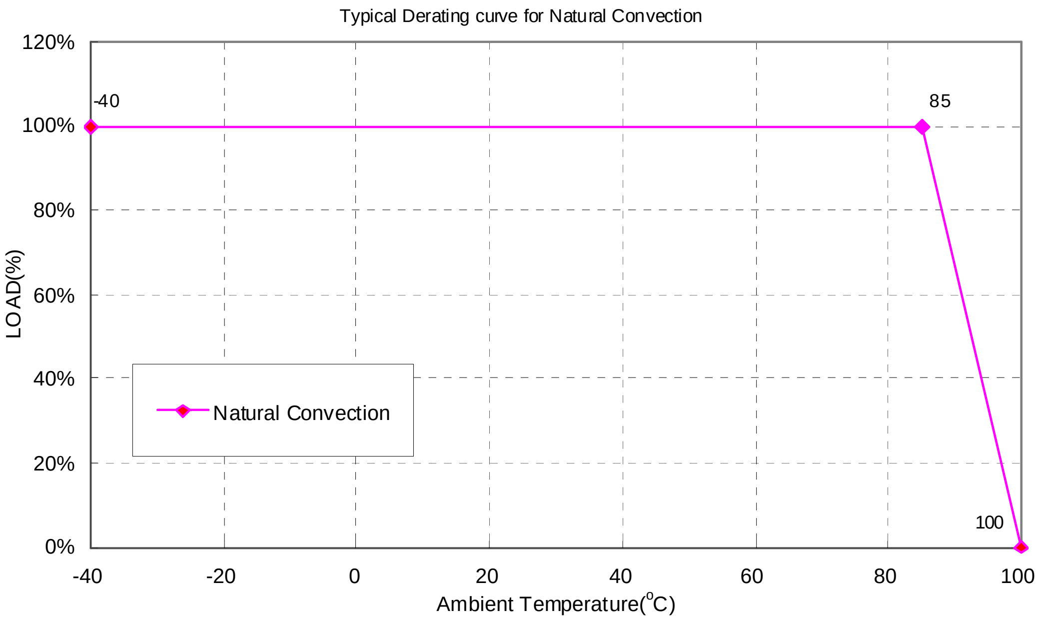


Note：
1. Soldering Paste: SHENMAO PF610-P (Sn/Ag/Cu)
2. Ramp up rate during preheat: 1.71 ℃/Sec (From 30℃ to 150℃)
3. Soaking temperature: 0.31 ℃/Sec (From 150℃ to 200℃), 160±10 seconds
4. Ramp up rate during reflow: 0.96 ℃/Sec (From 217℃ to 260℃)
5. Peak temperature: 260℃, above 217℃ 90 Seconds
6. Ramp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

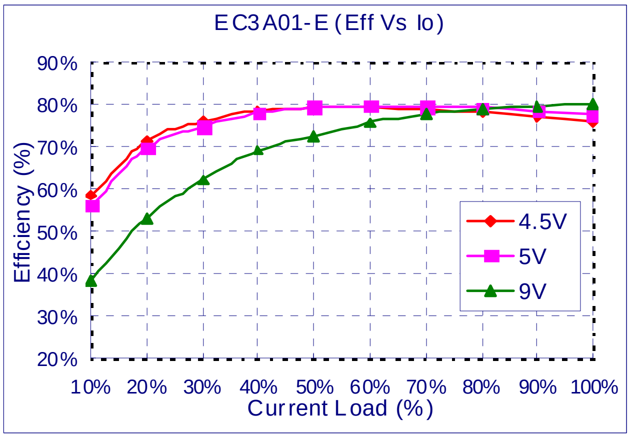
Figure 3 Recommended PCB Layout Footprints and Wave Soldering Profiles for DIP-24 and SMD packages

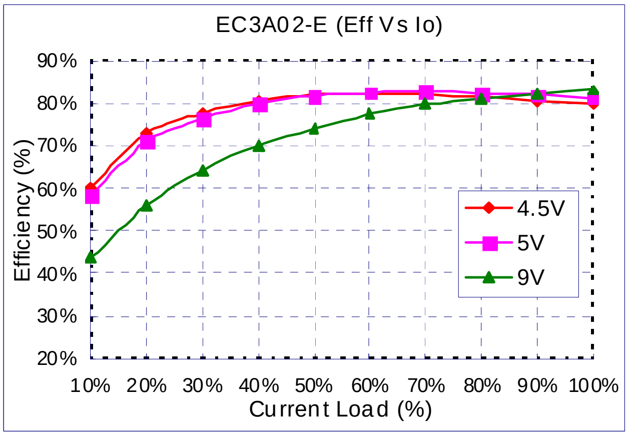
6.2 Power De-Rating Curves for EC3A-E Series

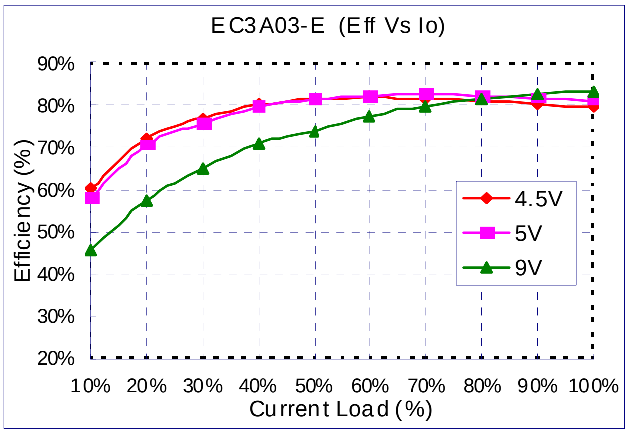
Operating Ambient temperature Range: -40℃ ~ 85℃

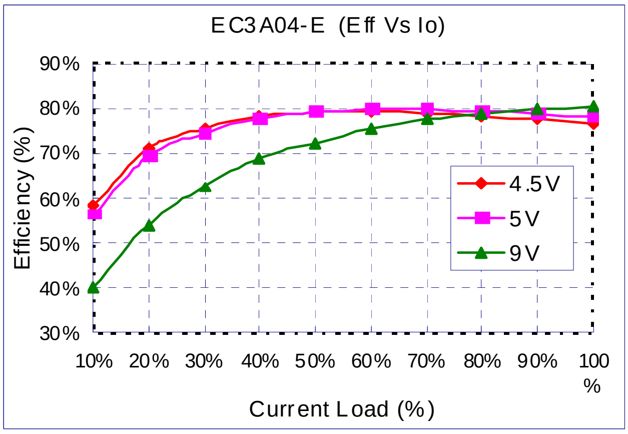


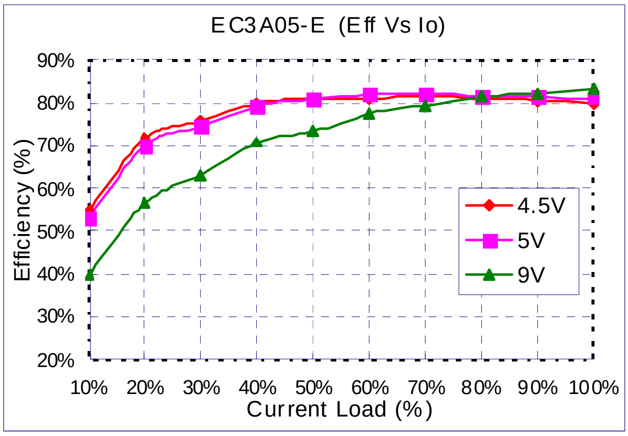
6.3 Efficiency vs. Load Curves

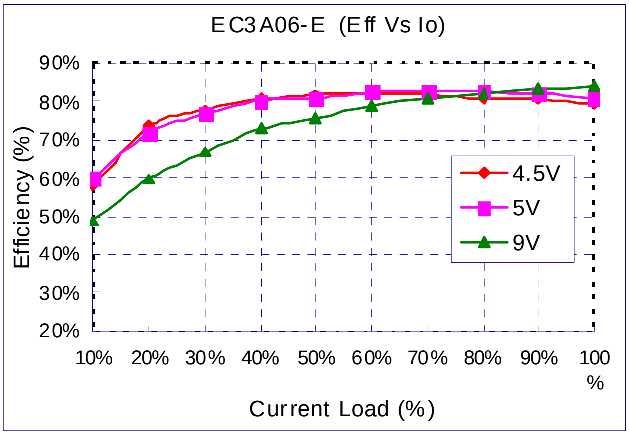












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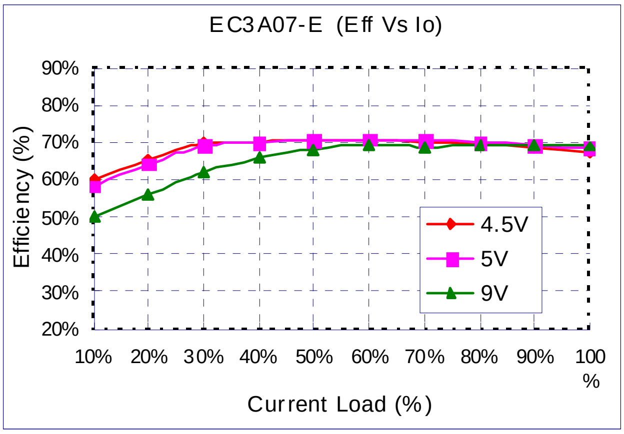

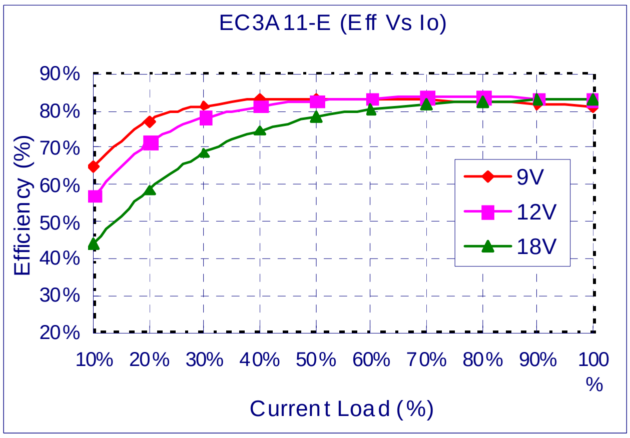

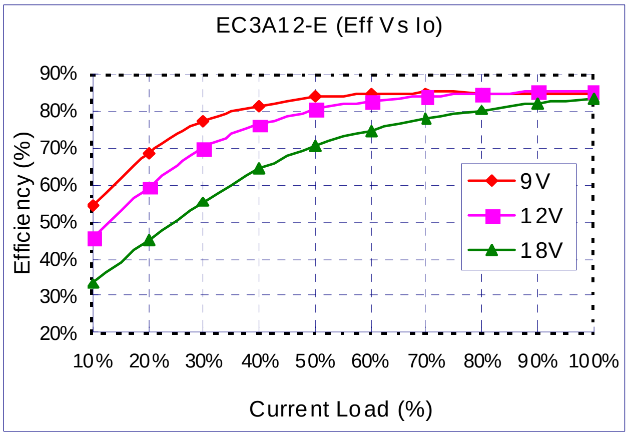

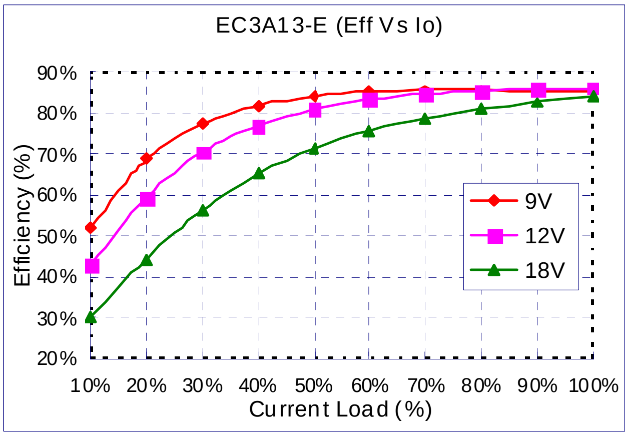

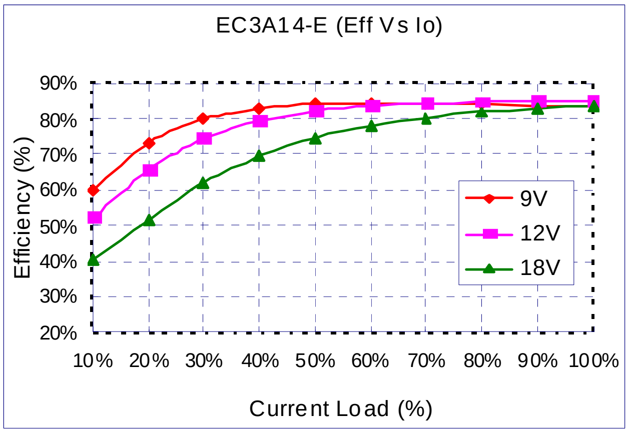

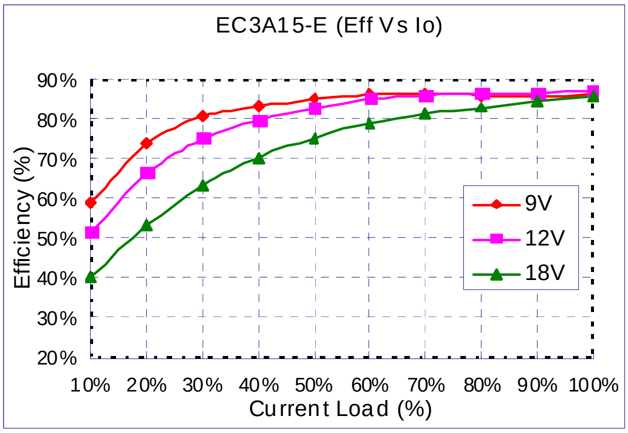

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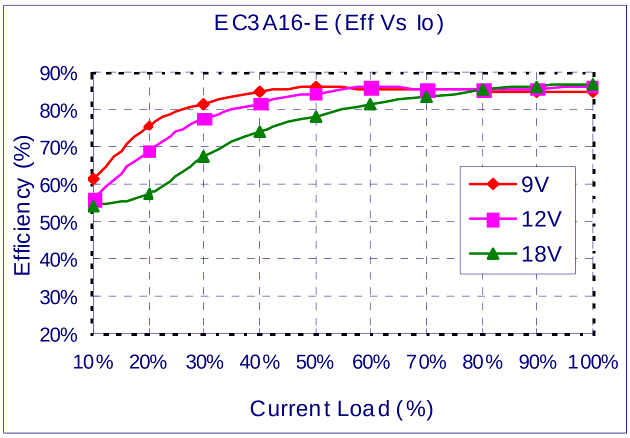
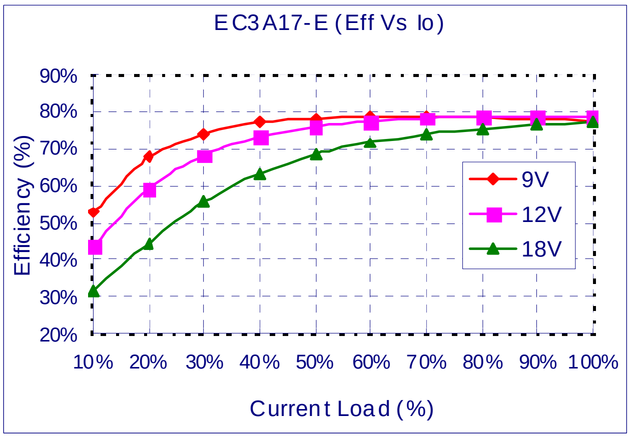
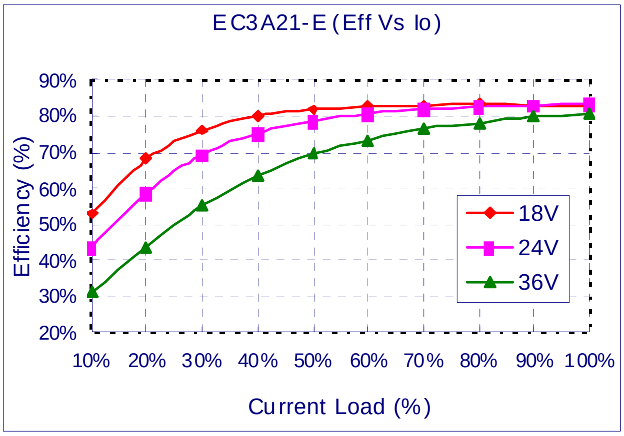
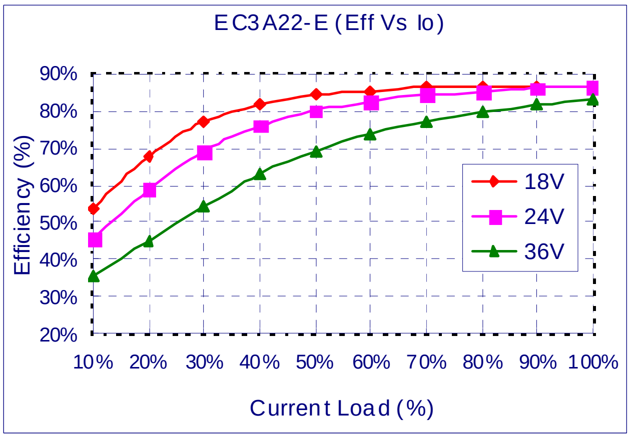
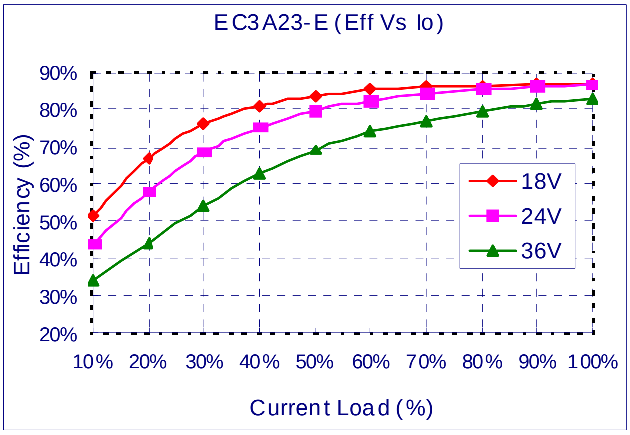
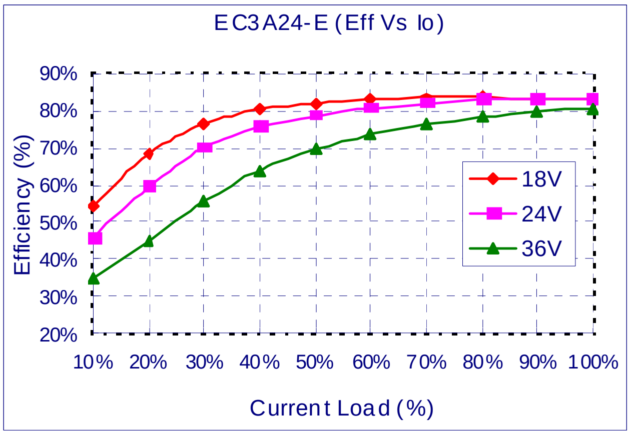


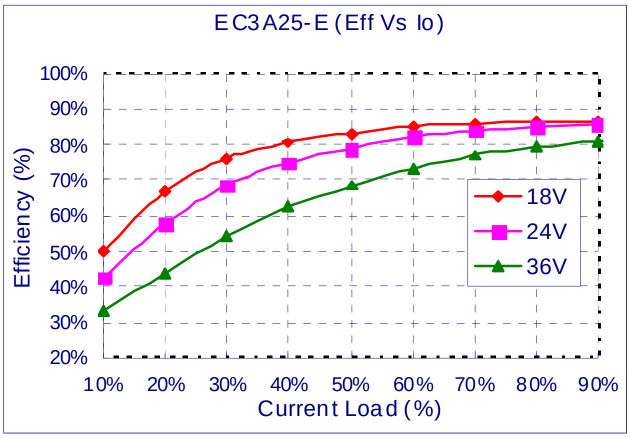




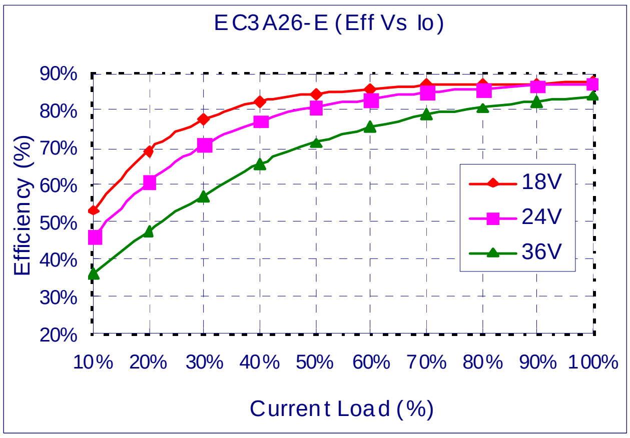




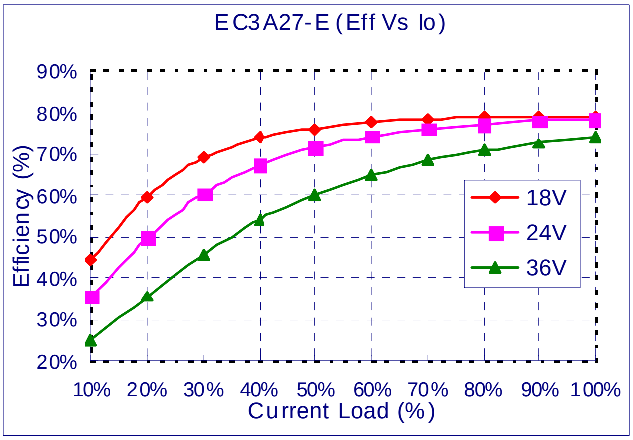




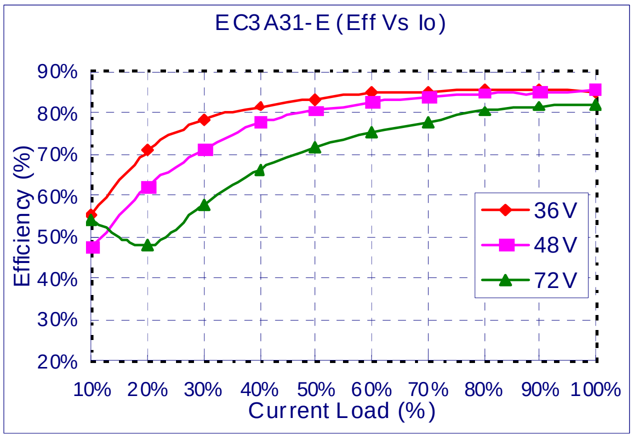
EC3A25-E (Eff Vs Io)
Efficiency (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10% 20% 30% 40% 50% 60% 70% 80% 90%
Current Load (%)
18V
24V
36V



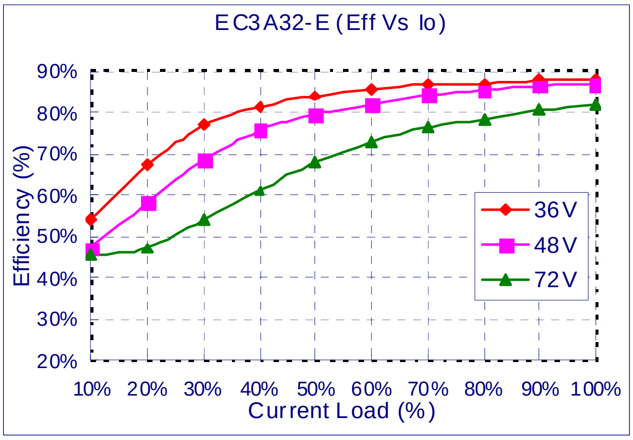
EC3A26-E (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
24V
36V



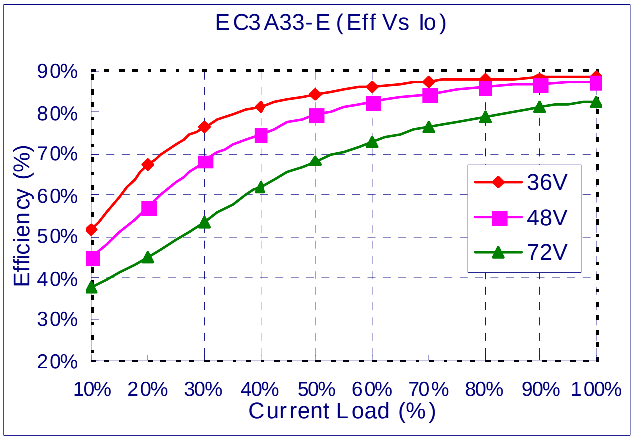
EC3A27-E (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
24V
36V



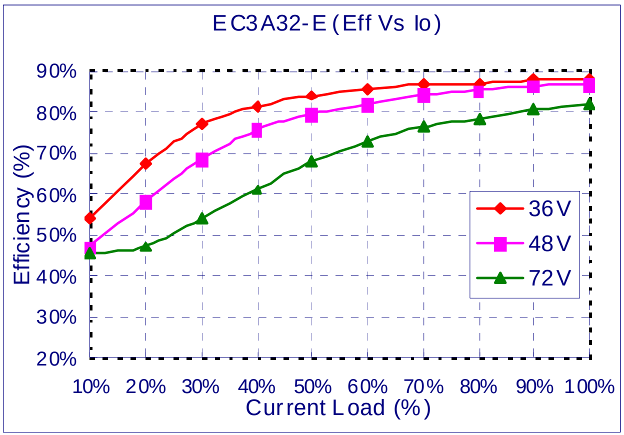
EC3A31-E (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
36V
48V
72V

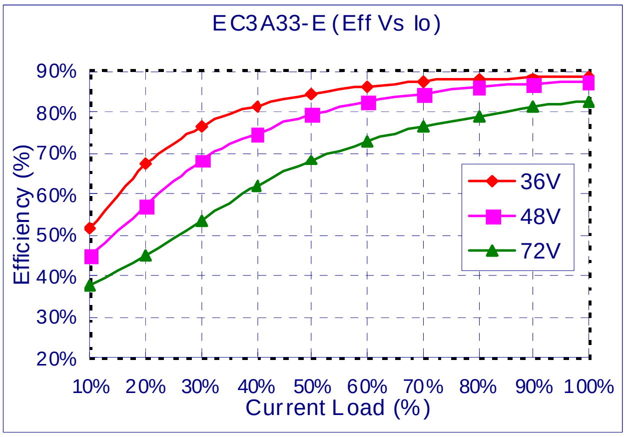


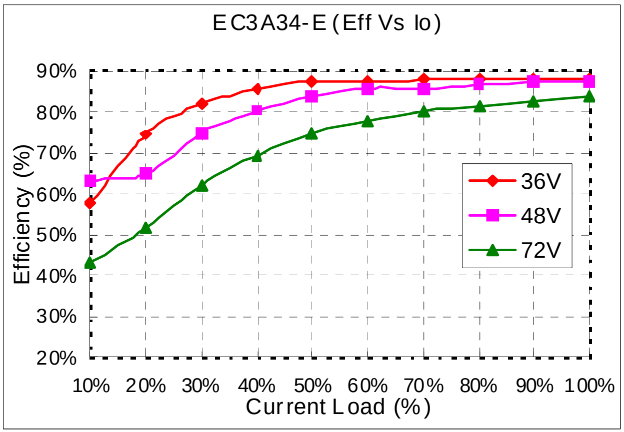
EC3A32-E (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
36V
48V
72V

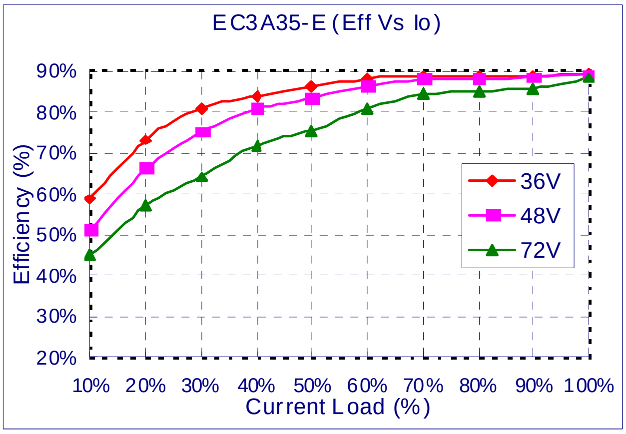


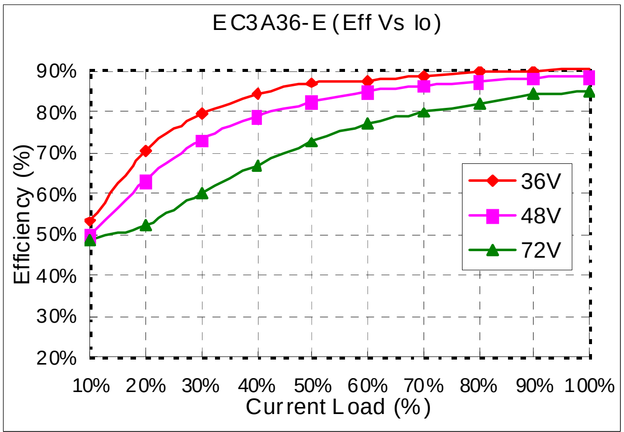
EC3A33-E (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
36V
48V
72V

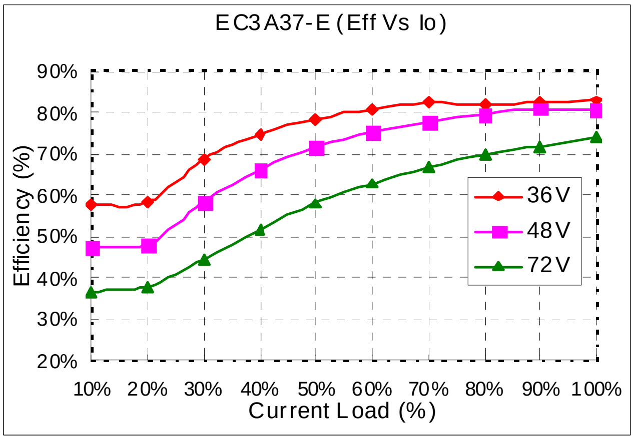

EC3A32-E (Eff Vs Io)
Efficiency (%)
Current Load (%)
36V
48V
72V


EC3A33-E (Eff Vs Io)
Efficiency (%)
Current Load (%)
36V
48V
72V


EC3A34-E (Eff Vs Io)
Efficiency (%)
Current Load (%)
36V
48V
72V

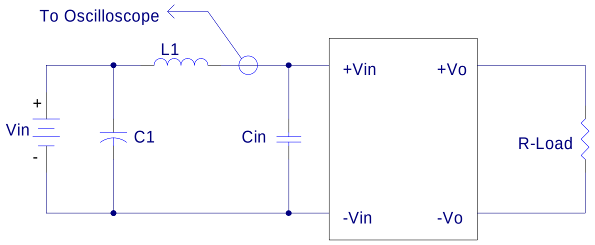

EC3A35-E (Eff Vs Io)
Efficiency (%)
Current Load (%)
36V
48V
72V


EC3A36-E (Eff Vs Io)
Efficiency (%)
Current Load (%)
36V
48V
72V


EC3A37-E (Eff Vs Io)
Efficiency (%)
Current Load (%)
36V
48V
72V

6.4 Input Capacitance at the Power Module

The converters must be connected to low AC source impedance. To avoid problems with loop stability source inductance should be low. Also, the input capacitors (Cin) should be placed close to the converter input pins to de-couple distribution inductance. However, the external input capacitors are chosen for suitable ripple handling capability. Low ESR capacitors are good choice. Circuit as shown in Figure 4 represents typical measurement methods for reflected ripple current. C1 and L1 simulate a typical DC source impedance. The input reflected-ripple current is measured by current probe tooscilloscope with a simulated source Inductance (L1).



L1: 12uH.
C1: 220uF ESR <0.1Ω @ 20℃, 100KHz.
Cin: None

Figure 4 Input Reflected-Ripple Test Setup

6.5 Test Set-Up

The basic test set-up to measure parameters such as efficiency and load regulation is shown in Figure 5. When testing the modules under any transient conditions please ensure that the transient response of the source is sufficient to power the equipment under test. We can calculate the

- Efficiency
- Load regulation and line regulation.

The value of efficiency is defined as:

$$\eta = \frac{Vo \times Io}{Vin \times Iin} \times 100\%$$

Where

Vo is output voltage,
Io is output current,
Vin is input voltage,
Iin is input current.

The value of load regulation is defined as:

$$Load.reg = \frac{V_{FL} - V_{NL}}{V_{NL}} \times 100\%$$

Where

V_{FL} is the output voltage at full load
V_{NL} is the output voltage at 10% load (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.

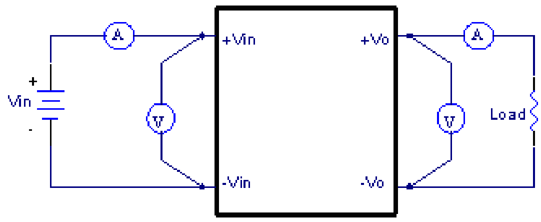
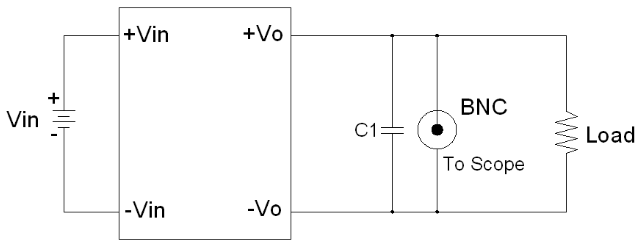


Figure 5 EC3A Series Test Setup

6.6 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

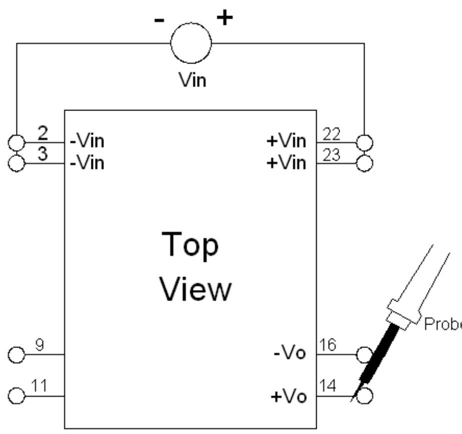


Figure 7 Using Probe to Measure Output Ripple and Noise

6.7 Output Capacitance

The EC3A-E 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 EC3A-E 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 1.5A for 5Vin models, 0.8A for 12Vin models, 0.5A for 24Vin models and 0.25A for 48Vin modules. Figure 8 circuits are recommended by a Transient Voltage Suppressor diode across the input terminal to protect the unit against surge or spike voltage and input reverse voltage.

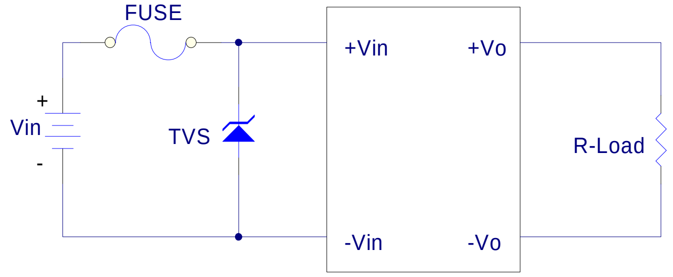


Figure 8 Input Protection

7.2 EMC Considerations

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

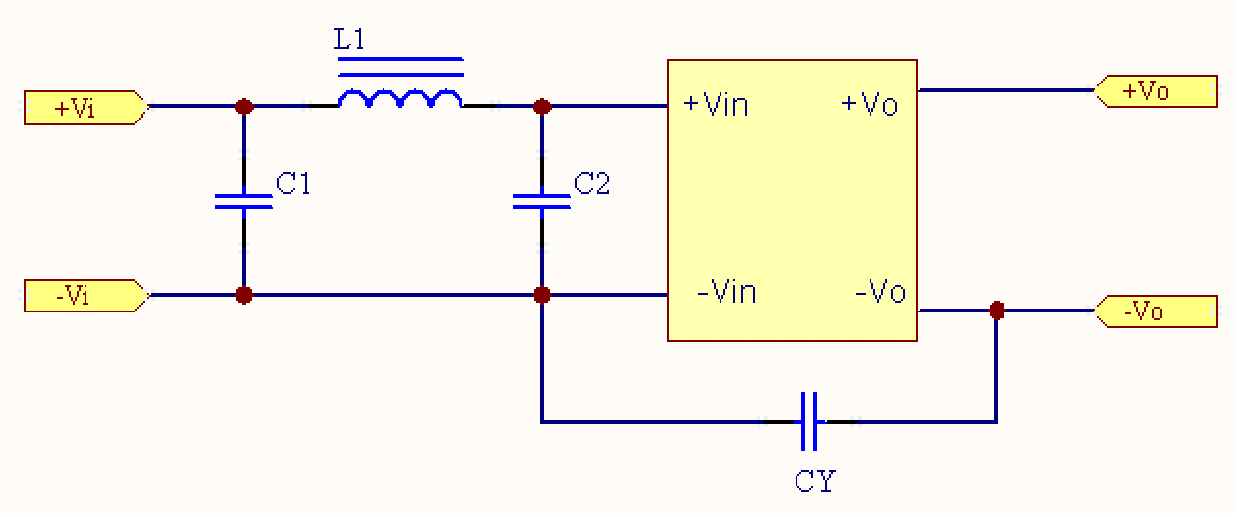
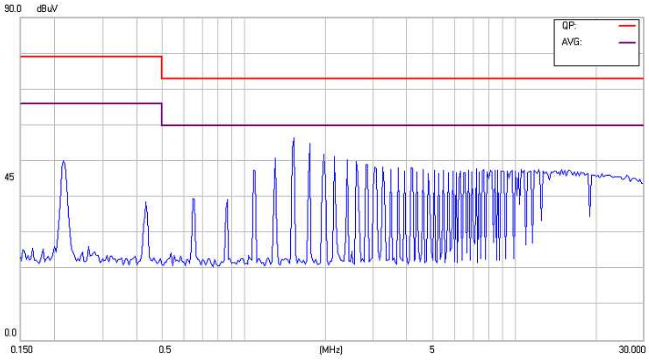


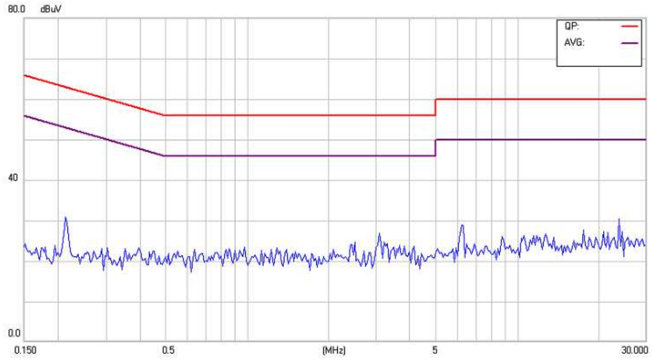
Figure 9 Connection circuit for conducted EMI testing

Model No.	EN55022 Class A				EN55022 Class B			
	C1	C2	L1	CY	C1	C2	L1	CY
EC3A01-E	NC	NC	NC	NC	3.3uF/50V	NC	3.3uH	NC
EC3A02-E	NC	NC	NC	NC	3.3uF/50V	NC	3.3uH	NC
EC3A03-E	NC	NC	NC	NC	3.3uF/50V	NC	3.3uH	NC
EC3A04-E	NC	NC	NC	NC	3.3uF/50V	NC	3.3uH	NC
EC3A05-E	NC	NC	NC	NC	3.3uF/50V	NC	3.3uH	NC
EC3A06-E	NC	NC	NC	NC	3.3uF/50V	NC	3.3uH	NC
EC3A07-E	NC	NC	NC	NC	3.3uF/50V	NC	3.3uH	NC
EC3A11-E	NC	NC	NC	NC	1.0uF/50V	NC	5.6uH	NC
EC3A12-E	NC	NC	NC	NC	1.0uF/50V	NC	5.6uH	NC
EC3A13-E	NC	NC	NC	NC	1.0uF/50V	NC	5.6uH	NC
EC3A14-E	NC	NC	NC	NC	1.0uF/50V	NC	5.6uH	NC
EC3A15-E	NC	NC	NC	NC	1.0uF/50V	NC	5.6uH	NC
EC3A16-E	NC	NC	NC	NC	1.0uF/50V	NC	5.6uH	NC
EC3A17-E	NC	NC	NC	NC	1.0uF/50V	NC	5.6uH	NC
EC3A21-E	NC	NC	NC	NC	3.3uF/50V	NC	5.6uH	470pF/3KV
EC3A22-E	NC	NC	NC	NC	3.3uF/50V	NC	5.6uH	470pF/3KV
EC3A23-E	NC	NC	NC	NC	3.3uF/50V	NC	5.6uH	470pF/3KV
EC3A24-E	NC	NC	NC	NC	3.3uF/50V	NC	5.6uH	470pF/3KV
EC3A25-E	NC	NC	NC	NC	3.3uF/50V	NC	5.6uH	470pF/3KV
EC3A26-E	NC	NC	NC	NC	3.3uF/50V	NC	5.6uH	470pF/3KV
EC3A27-E	NC	NC	NC	NC	3.3uF/50V	NC	5.6uH	470pF/3KV
EC3A31-E	NC	NC	NC	NC	2.2uF/100V	NC	10uH	470pF/3KV
EC3A32-E	NC	NC	NC	NC	2.2uF/100V	NC	10uH	470pF/3KV
EC3A33-E	NC	NC	NC	NC	2.2uF/100V	NC	10uH	470pF/3KV
EC3A34-E	NC	NC	NC	NC	2.2uF/100V	NC	10uH	470pF/3KV
EC3A35-E	NC	NC	NC	NC	2.2uF/100V	NC	10uH	470pF/3KV
EC3A36-E	NC	NC	NC	NC	2.2uF/100V	NC	10uH	470pF/3KV
EC3A37-E	NC	NC	NC	NC	2.2uF/100V	NC	10uH	470pF/3KV

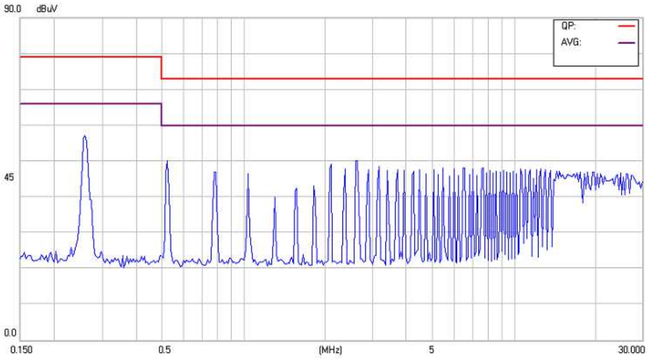
Note: All of capacitors are ceramic capacitors.



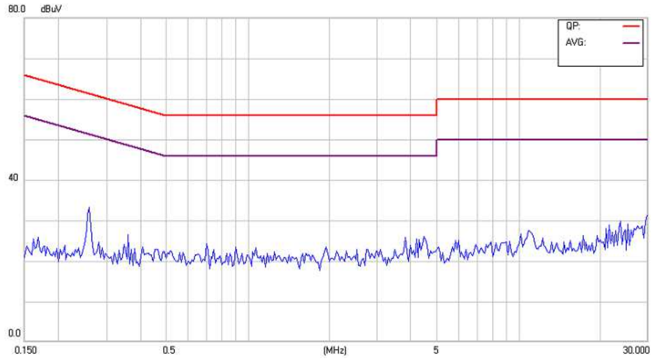
Conducted Class A of EC3A01-E



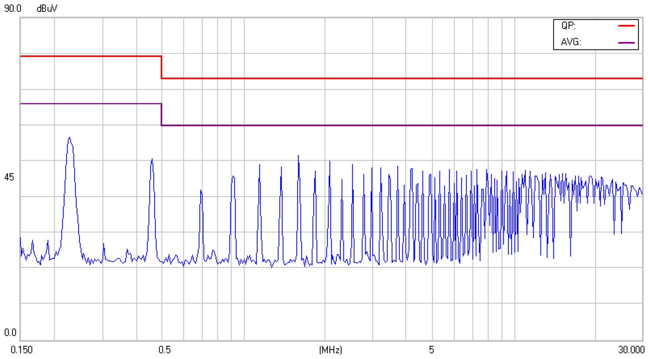
Conducted Class B EC3A01-E



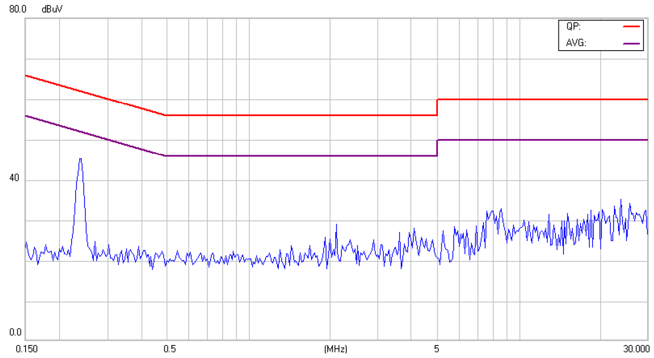
Conducted Class A EC3A05-E



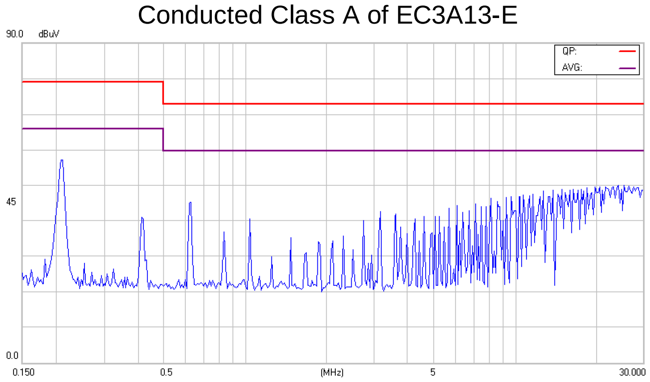
Conducted Class B EC3A05-E



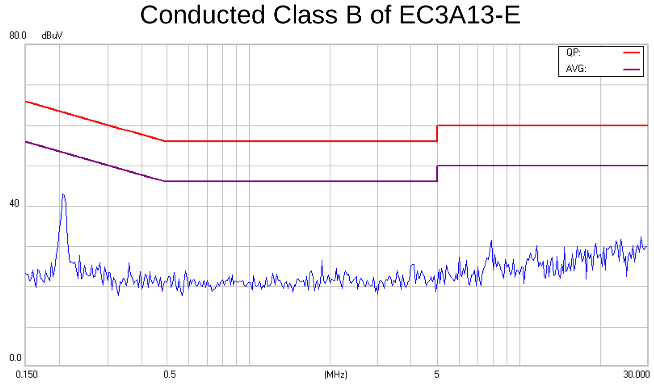
Conducted Class A of EC3A13-E



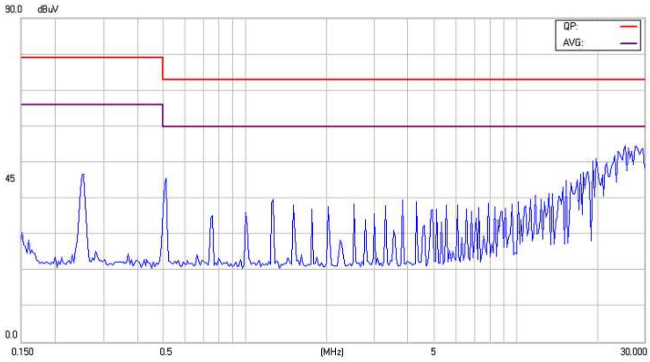
Conducted Class B of EC3A13-E



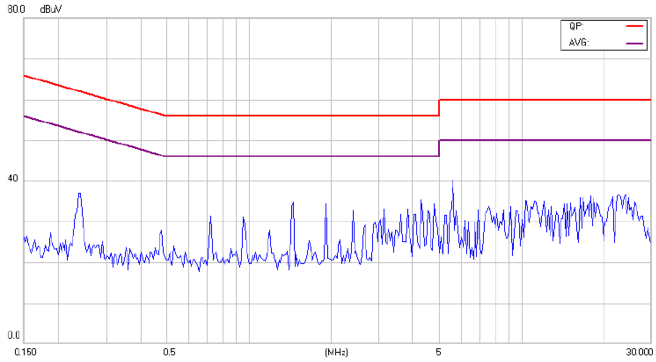
Conducted Class A EC3A14-E



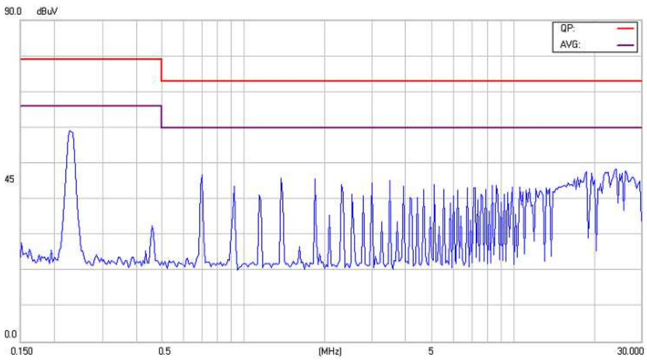
Conducted Class B EC3A14-E



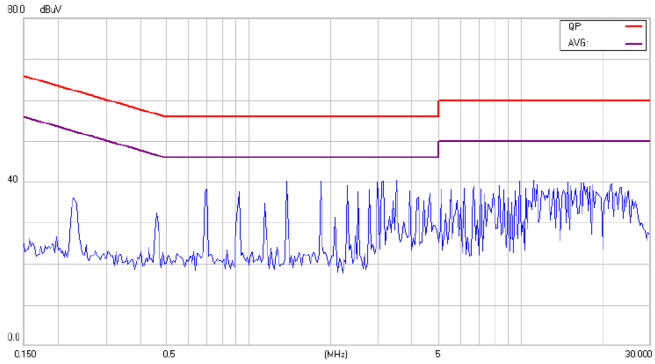
Conducted Class A EC3A22-E



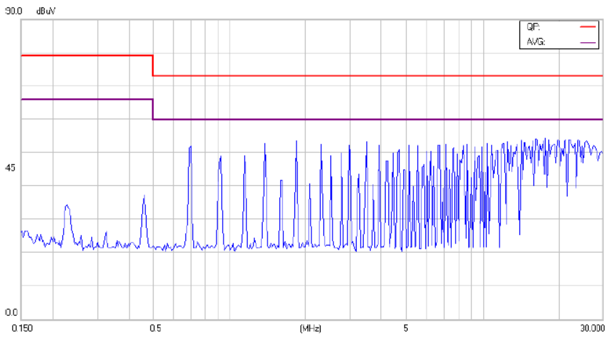
Conducted Class B EC3A22-E



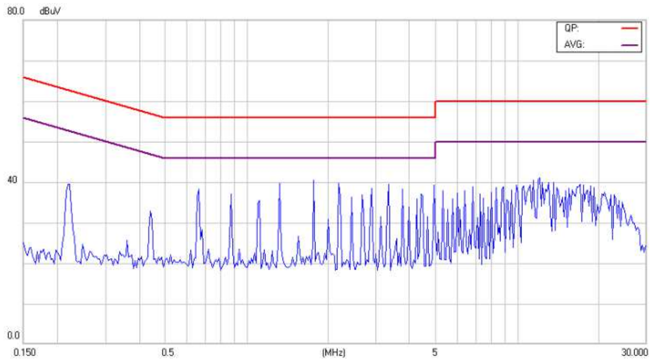
Conducted Class A of EC3A26-E



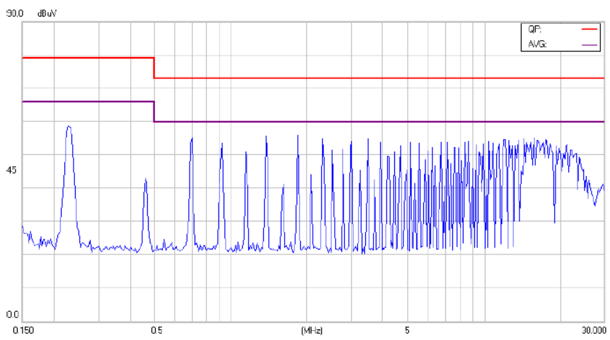
Conducted Class B of EC3A26-E



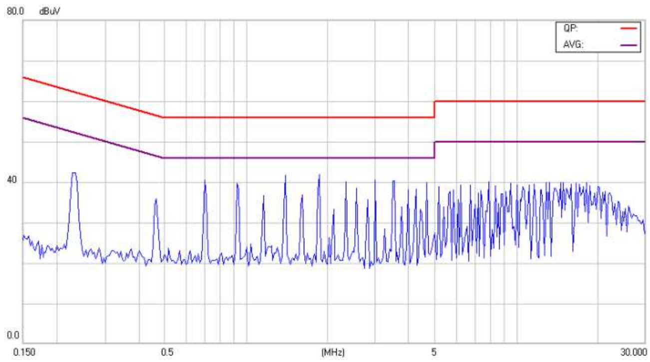
Conducted Class A EC3A33-E



Conducted Class B EC3A33-E



Conducted Class A of EC3A36-E

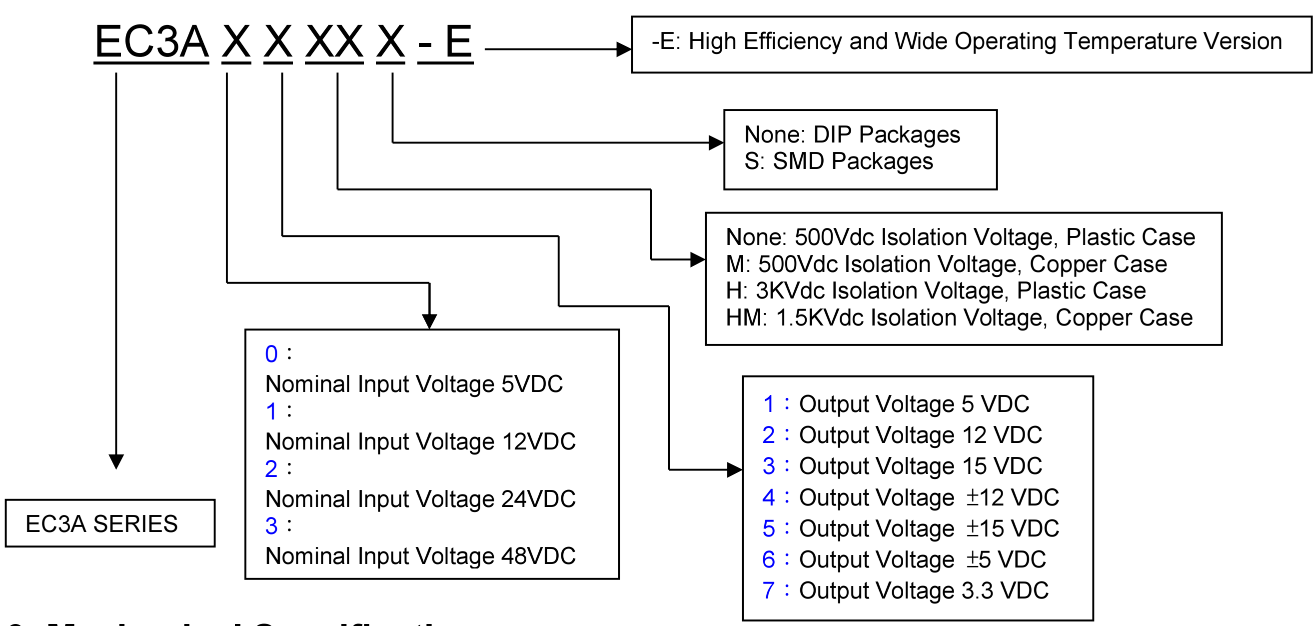


Conducted Class B of EC3A35-E

EC3A-E 2-3W Isolated DC-DC Converters

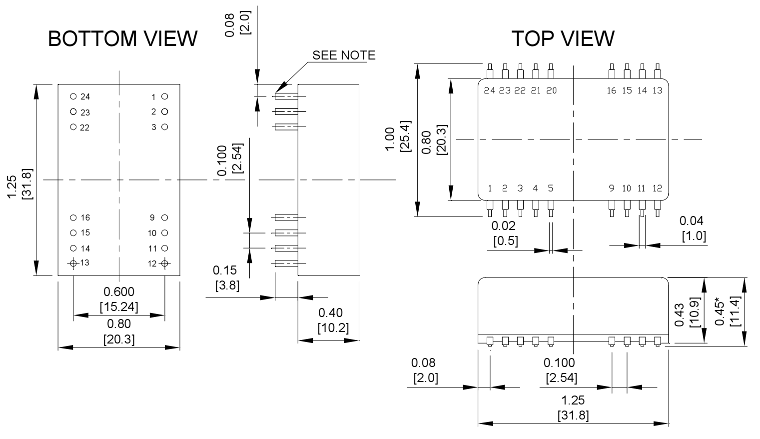
Application Note V10 June 2014

8. Part Number



9. Mechanical Specifications

CASE AS



*0.41(10.4) for S/HS Models

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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