ISOLATED DC-DC Converter
EC2SA SERIES
APPLICATION NOTE

Approved By:

Department	Approved By	Checked By	Reported By
Research and Development Department	Enoch	Danny	Joyce
Quality Assurance Department	Jack	Benny	

EC2SA 2W Isolated DC-DC Converters

Application Note V13 July 2016

Content

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1. Introduction

The EC2SA series offer 2 watts of output power in a 0.86x0.36x0.44 inches SIL-8 plastic packages. The EC2SA series has a 2:1 wide input voltage range of 4.5-9, 9-18, 18-36 and 36-75VDC and provides a precisely regulated output. This series has features such as high efficiency, 1500VDC of isolation and allows an ambient operating temperature range of –40°C to 85°C without de-rating. 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

* 2W Isolated Output
* Compact SIP-8 Package
* Efficiency to 84%
* 2:1 Input Range
* Regulated Outputs
* Remote On/Off Control
* 1500VDC Isolation
* Continuous Short Circuit Protection

3. Electrical Block Diagram

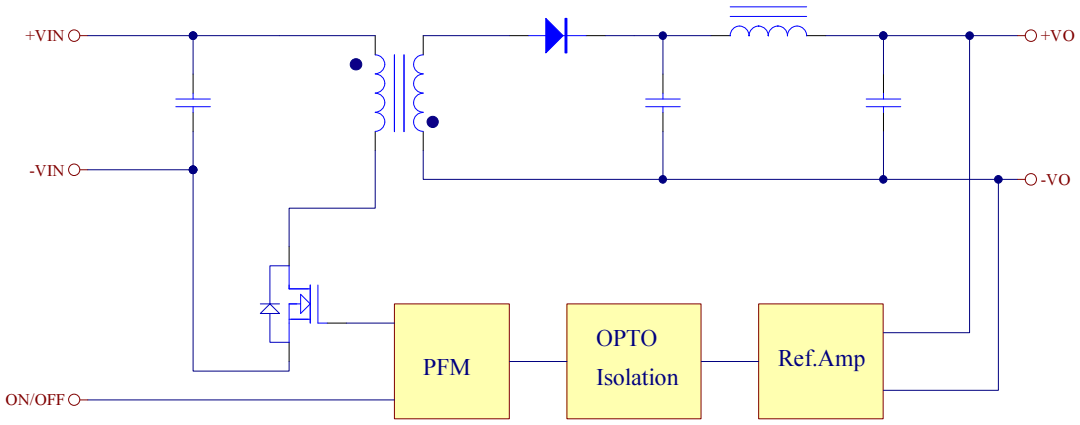


Figure1 Electrical Block Diagram of single output module

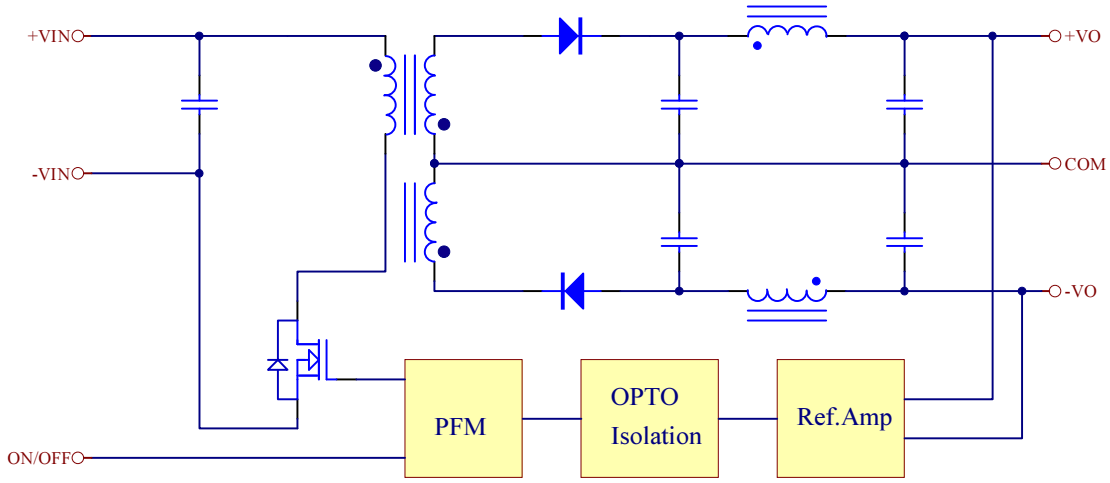


Figure2 Electrical Block Diagram of dual output module

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 0 0 0		9 18 36 75	Vdc
Transient	100ms	5Vin 12Vin 24Vin 48Vin			15 25 50 100	Vdc
Operating Ambient Temperature		All	-40		+85	℃
Case Temperature		All			100	℃
Storage Temperature		All	-55		+125	℃
Input/Output Isolation Voltage	1 minute	All	1500			Vdc

INPUT CHARACTERISTICS

Operating Input Voltage		5Vin 12Vin 24Vin 48Vin	4.5 9 18 36	5 12 24 48	9 18 36 75	Vdc
Input Under-Voltage Protection Only For Suffix “N” Model						
Turn-On Voltage Threshold		5Vin 12Vin 24Vin 48Vin	3.3 6.8 13 26		4.2 7.3 15.5 31	V_{dc}
Turn-Off Voltage Threshold		5Vin 12Vin 24Vin 48Vin	3 5.8 12 24		3.9 6.3 14.5 29	V_{dc}
Lockout Hysteresis Voltage		5Vin 12Vin 24Vin 48Vin		0.3 0.5 1 2		V_{dc}
Maximum Input Current	100% Load, Vin=4.5V 100% Load, Vin=9V 100% Load, Vin=18V 100% Load, Vin=36V	5Vin 12Vin 24Vin 48Vin		580 280 140 70		mA
No-Load Input Current	Vin=Nominal input	5Vin 12Vin 24Vin 48Vin		60 30 18 9		mA
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	Vin nominal, Io=Io_{max}, Tc=25℃	Vo=3.3V Vo=5.0V Vo=12V Vo=15V Vo=±5V Vo=±12V Vo=±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	Vdc

Output Voltage Balance	Vin=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	Vin=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			75	mV
Operating Output Current Range		Vo=3.3V Vo=5.0V Vo=12V Vo=15V Vo=±5V Vo=±12V Vo=±15V	0 0 0 0 0 0 0		500 400 167 134 ±200 ±83 ±67	mA
Output DC Current-Limit Inception	Output Voltage =90% $Vo_{nominal}$		120			%
Maximum Output Capacitance	Full load, Resistance	Vo=3.3V Vo=5.0V Vo=12V Vo=15V Vo=±5V Vo=±12V Vo=±15V	0 0 0 0 0 0 0		500 400 167 134 200 83 67	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		ms
Turn-On Delay Time, From On/off	$V_{on/off}$ to 10% $Vo_{nominal}$	All		1		ms
Output Voltage Rise Time	10% to 90%$Vo_{nominal}$	All		2.5		ms

EFFICIENCY

100% Load	Vin=Nominal Vin, Io=Io_{max}, Tc=25℃	05S33 05S05 05S12 05S15 05D05 05D12 05D15		73 76 80 80 77 79 80		%
		12S33 12S05 12S12 12S15 12D05 12D12 12D15		76 79 82 83 79 82 83		
		24S33 24S05 24S12 24S15 24D05 24D12 24D15		76 79 82 83 79 81 84		

		48S33 48S05 48S12 48S15 48D05 48D12 48D15		74 79 82 84 78 82 84		

ISOLATION CHARACTERISTICS

Isolation Voltage	Input to Output 1 minute	All			1500	Vdc
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 or <1.2V	All	0		1.2 or Open Circuit	V
Module Off	Voltage of $V_{on/off}$ pin	All	5.5		15	V
On/Off Control Only For Suffix “N” Model						
Module On	Open ,high impedance or <0.8V	All	0		0.8 or Open Circuit	V
Module Off	Voltage of $V_{on/off}$ pin	All	4		15	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	All		2.5		M hours
Weight		All		4.8		g

5. Main Features and Functions

5.1 Operating Temperature Range

The EC2SA series converters can be operated by a wide ambient temperature range from -40℃ to 85℃ 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.

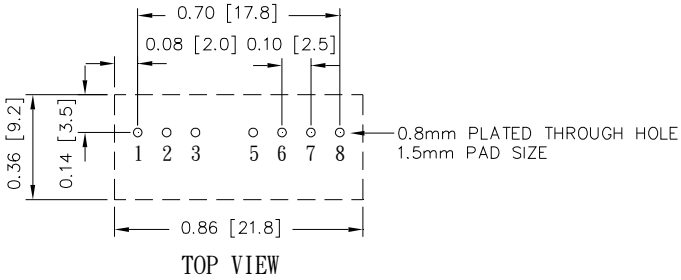
5.3 Remote On/Off

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 high impedance or open circuit. Suffix "N" to the Model Number with the remote ON/OFF pin at 4 to 15Vdc will turn the converter off, other models at 5.5 to 15Vdc. 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).

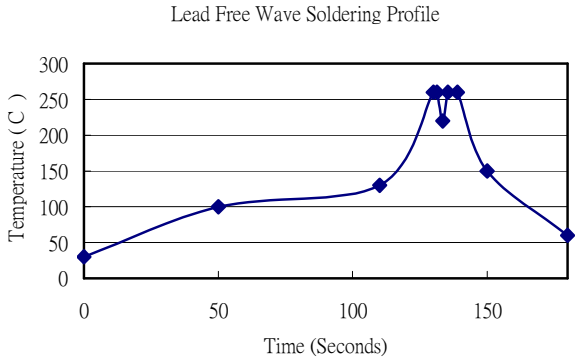
6. Applications

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：

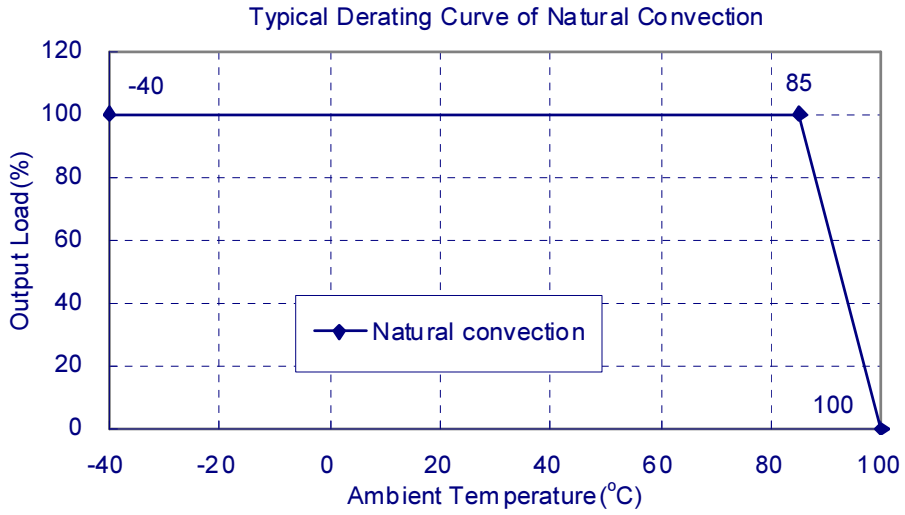
1. Soldering Materials: Sn/Cu/Ni
2. Ramp up rate during preheat: 1.4 ℃/Sec (From 50℃ to 100℃)
3. Soaking temperature: 0.5 ℃/Sec (From 100℃ to 130℃), 60±20 seconds
4. Peak temperature: 260℃, above 250℃ 3~6 Seconds
5. Ramp up rate during cooling: -10.0 ℃/Sec (From 260℃ to 150℃)

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

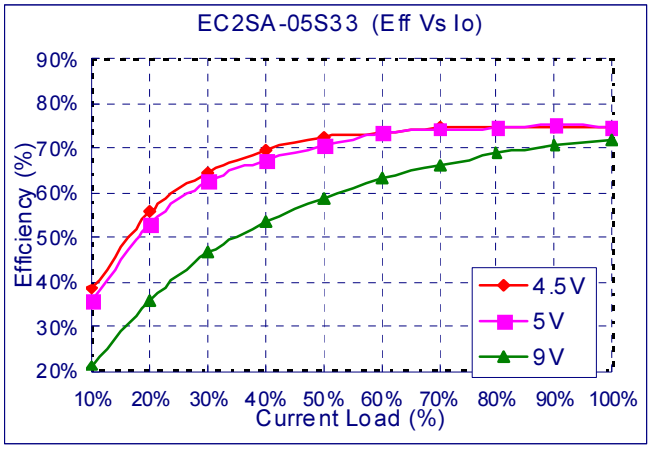
6.2 Power De-Rating Curves for EC2SA Series

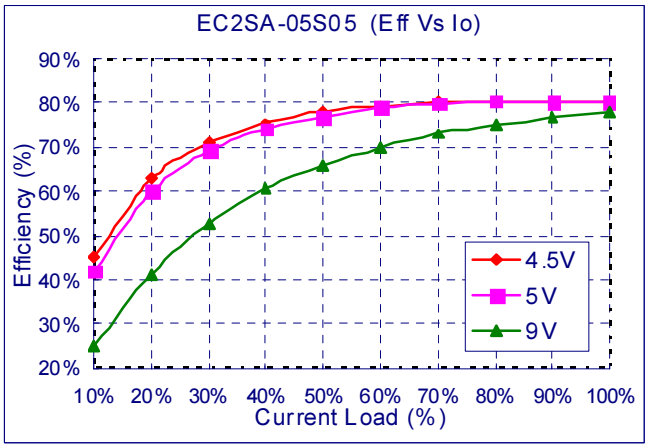
Operating Ambient temperature Range: -40℃ ~ 85℃ without de-rating.

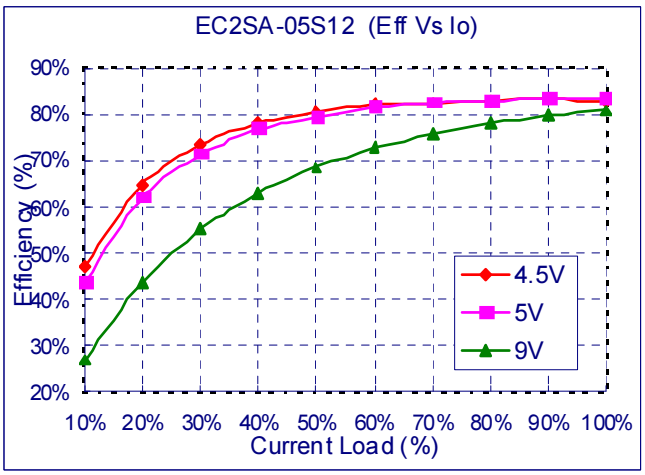
Maximum case temperature under any operating condition should not exceed 100℃.

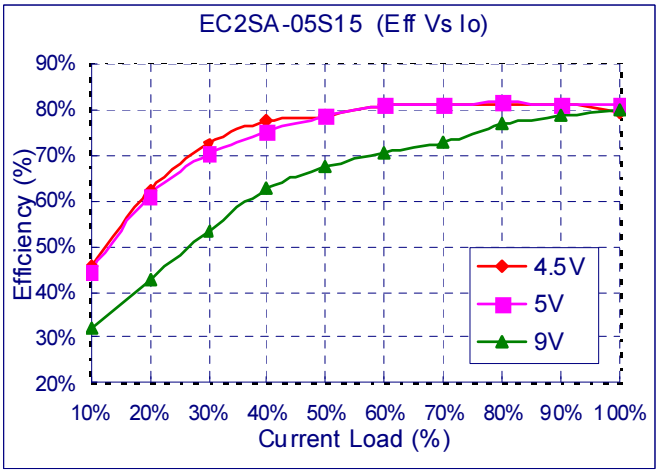


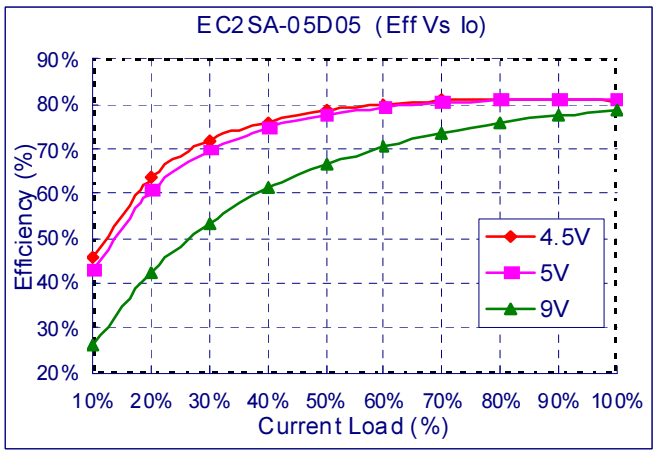
6.3 Efficiency vs. Load Curves

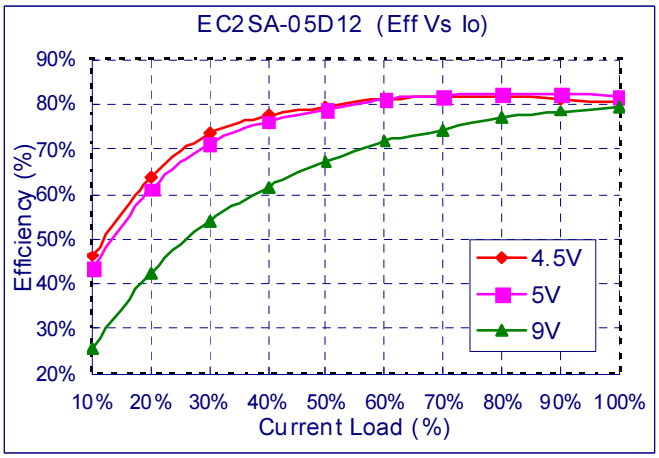


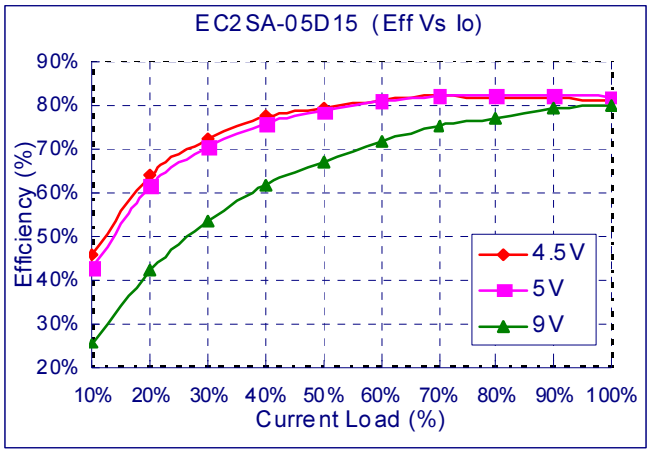


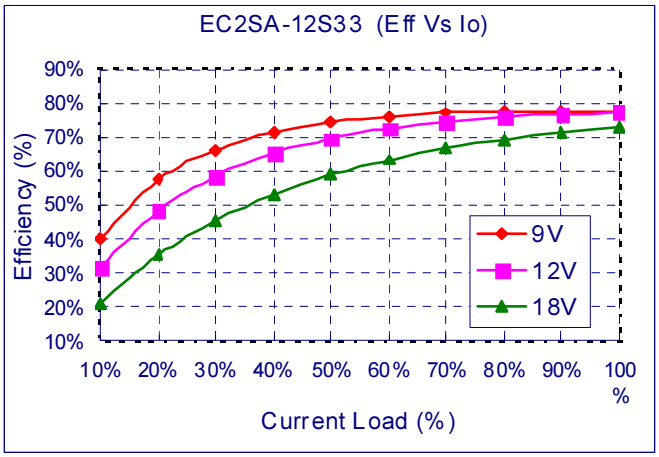


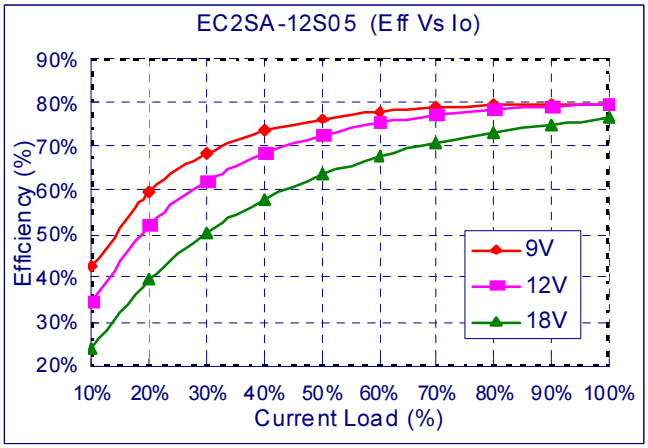


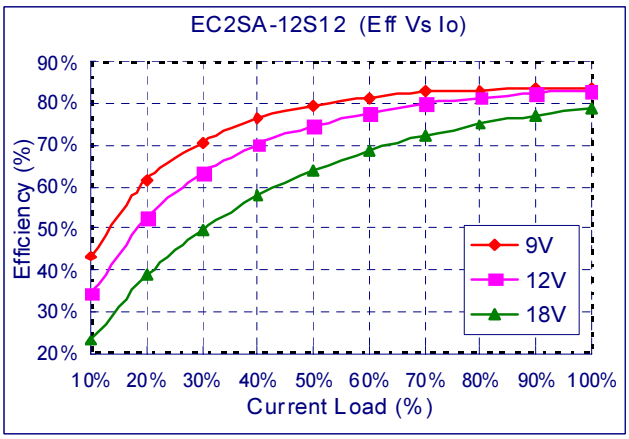


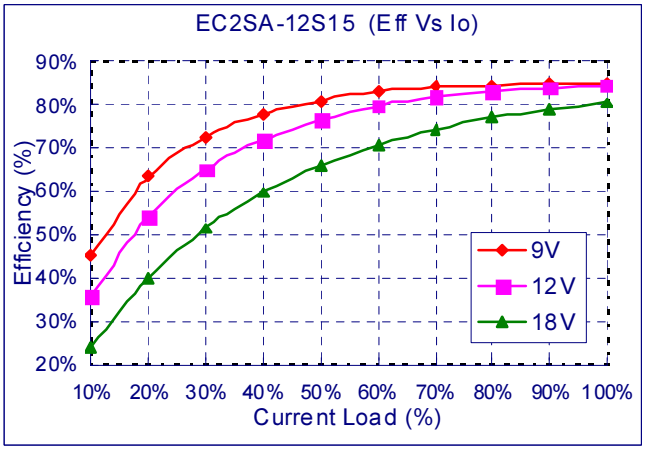


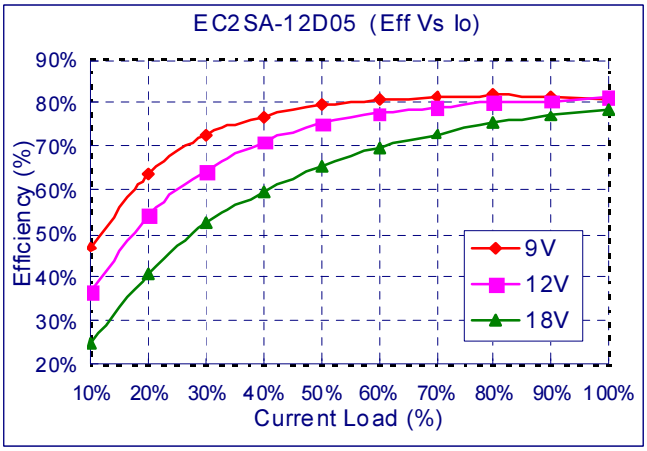

EC2SA-05D15 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
4.5V
5V
9V

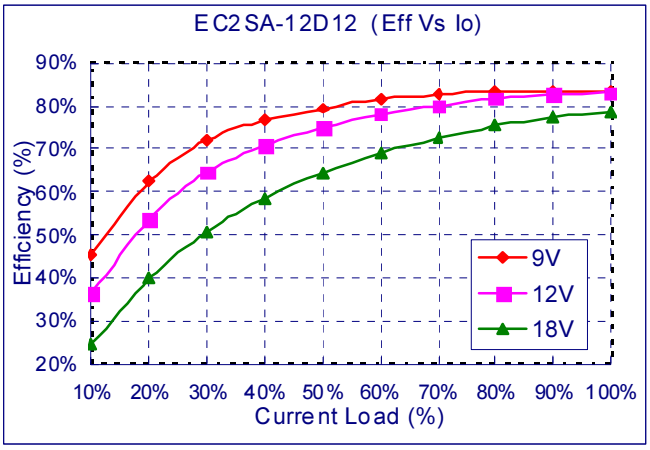

EC2SA-12S33 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
9V
12V
18V

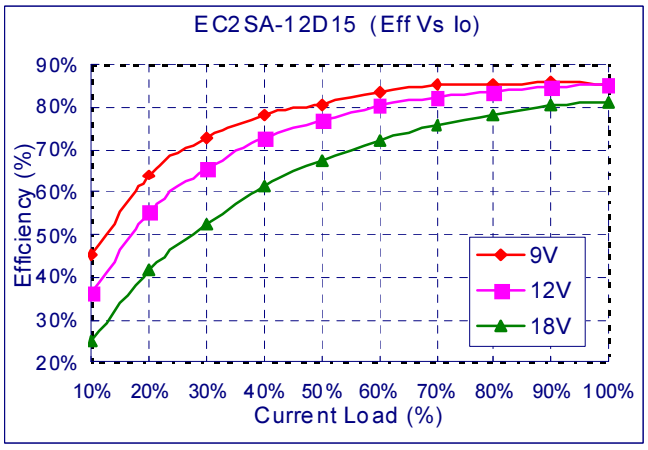

EC2SA-12S05 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
9V
12V
18V

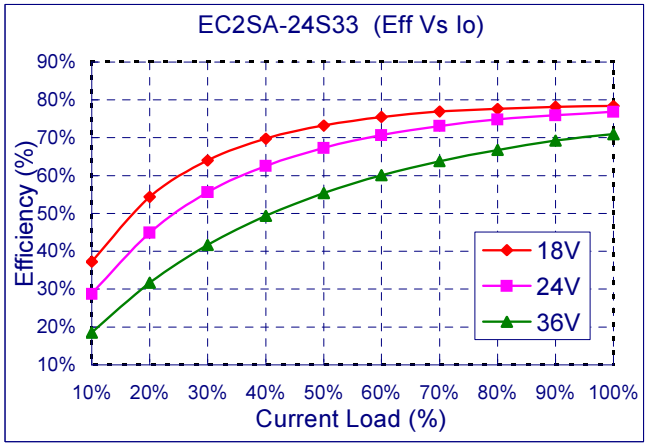

EC2SA-12S12 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
9V
12V
18V

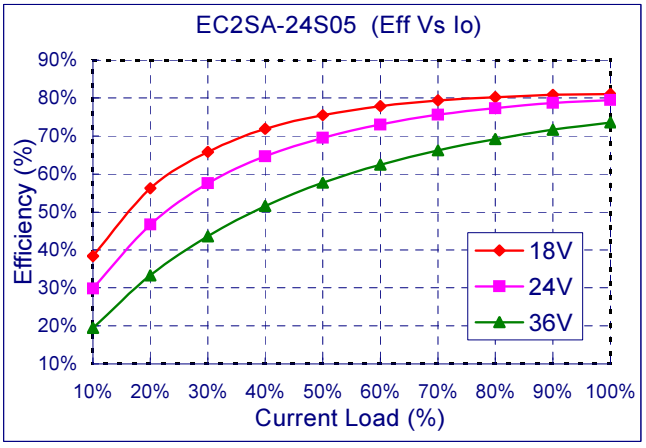

EC2SA-12S15 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
9V
12V
18V

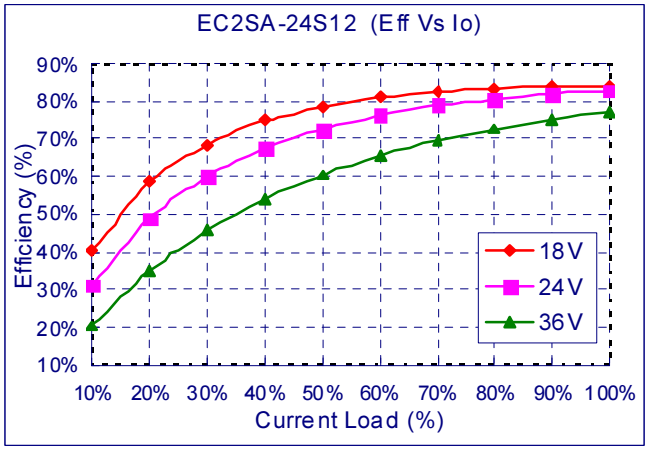

EC2SA-12D05 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
9V
12V
18V

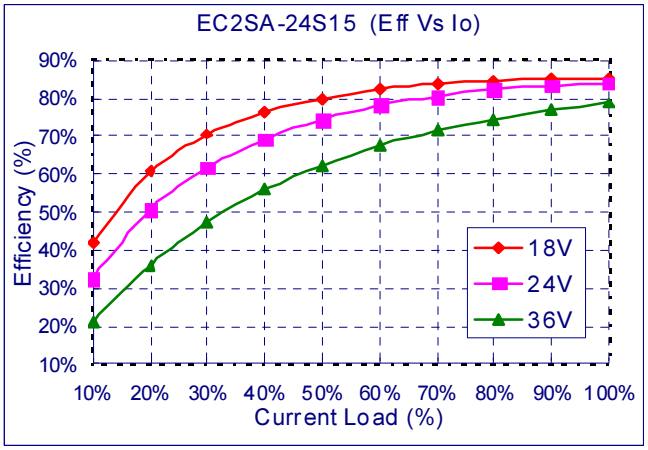

EC2SA-12D12 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
9V
12V
18V

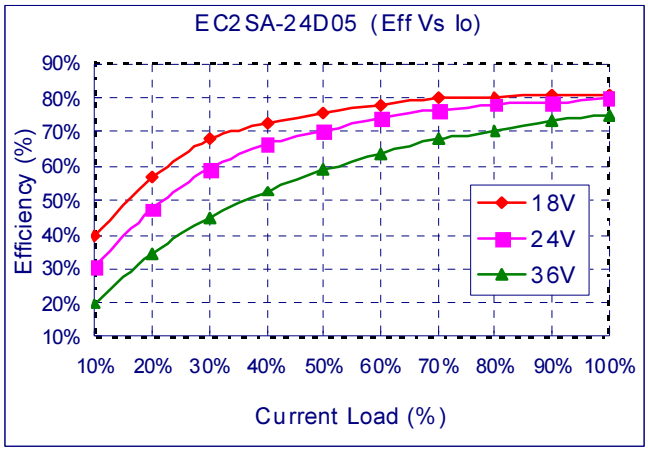

EC2SA-12D15 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
9V
12V
18V

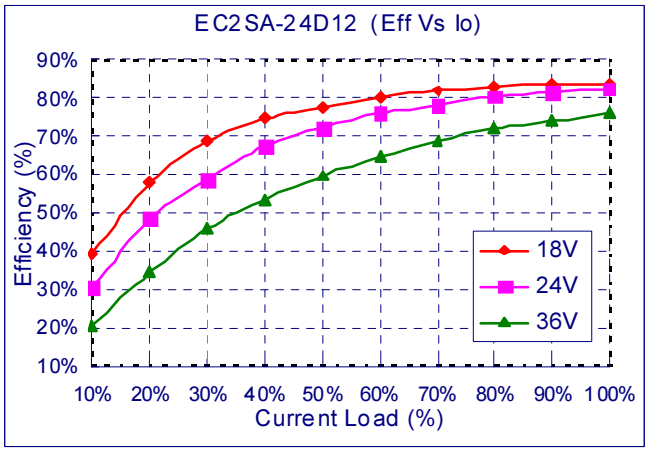

EC2SA-24S33 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
24V
36V

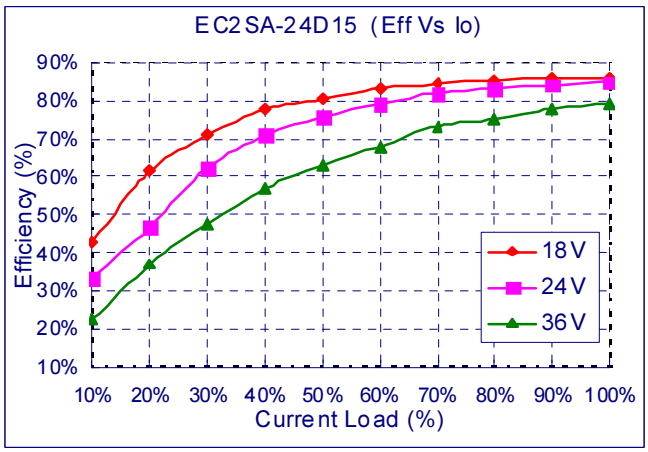

EC2SA-24S05 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
24V
36V

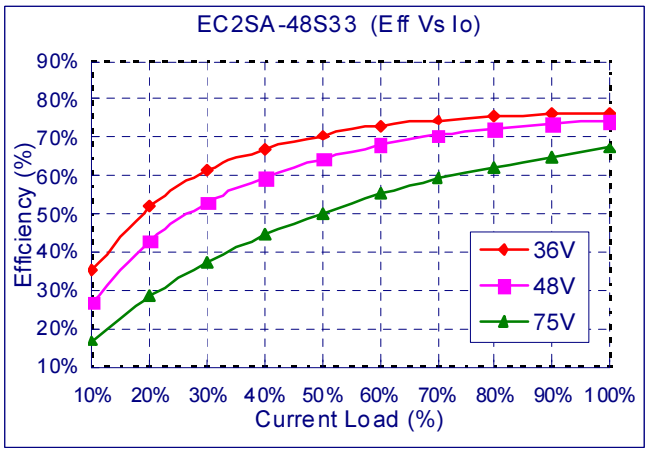

EC2SA-24S12 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
24V
36V

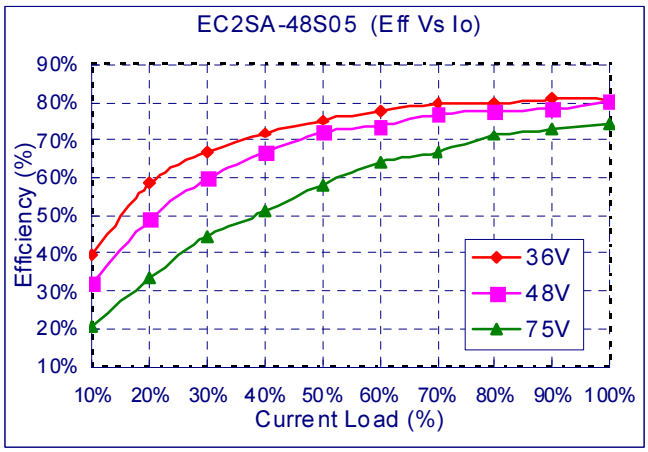

EC2SA-24S15 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
24V
36V

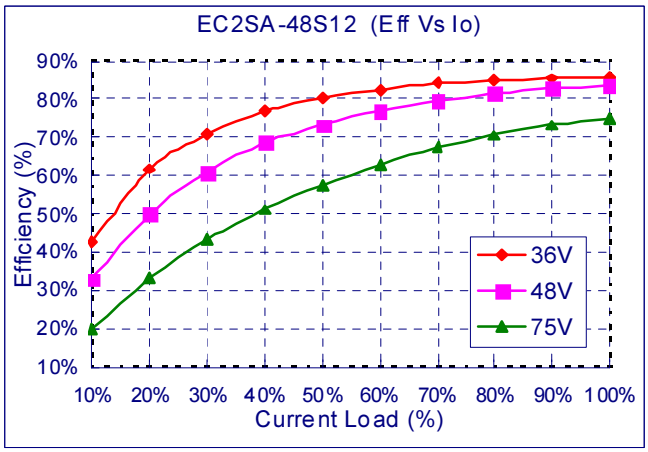

EC2SA-24D05 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
24V
36V

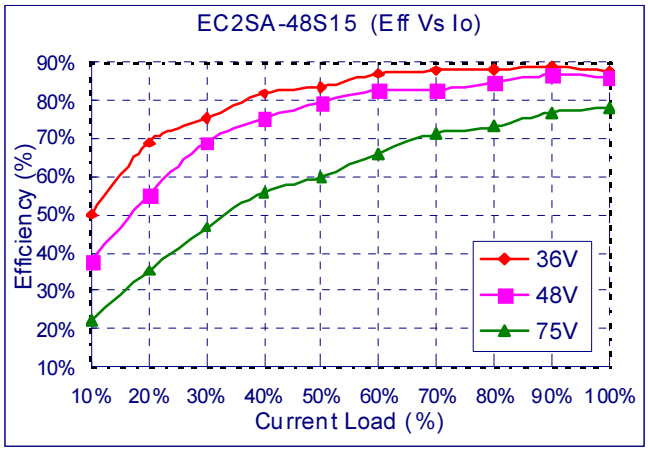

EC2SA-24D12 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
24V
36V

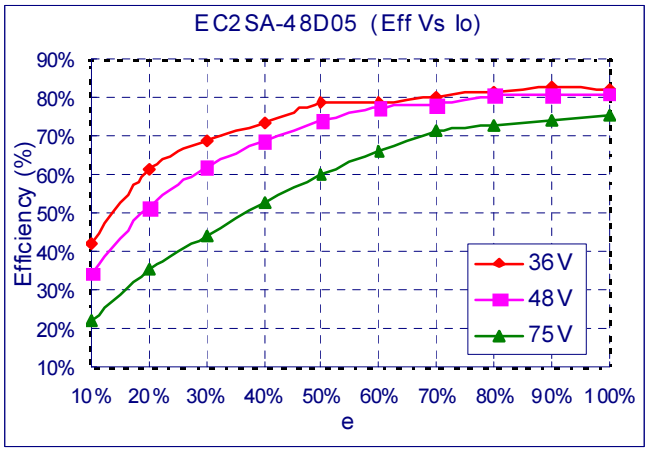

EC2SA-24D15 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
18V
24V
36V

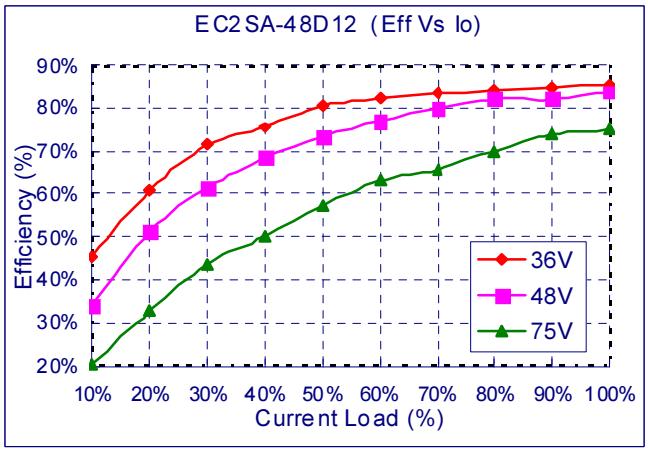

EC2SA-48S33 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
36V
48V
75V

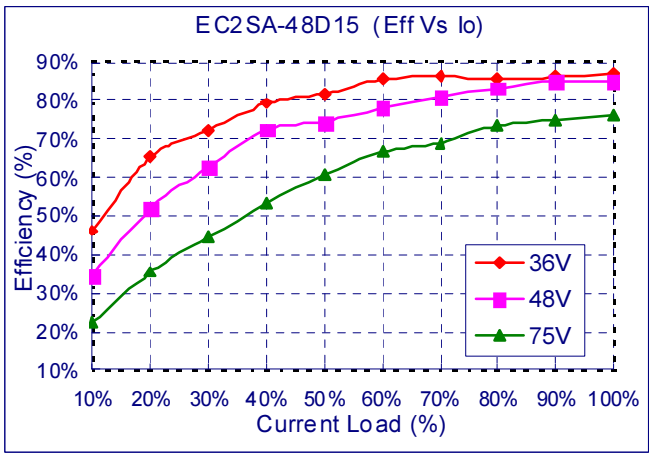

EC2SA-48S05 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
36V
48V
75V


EC2SA-48S12 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
36V
48V
75V


EC2SA-48S15 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
36V
48V
75V

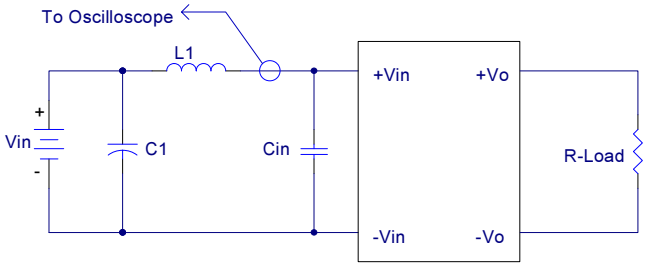

EC2SA-48D05 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
e
36V
48V
75V


EC2SA-48D12 (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
75V


EC2SA-48D15 (Eff Vs Io)
Efficiency (%)
90%
80%
70%
60%
50%
40%
30%
20%
10%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Current Load (%)
36V
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: 12uH
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.

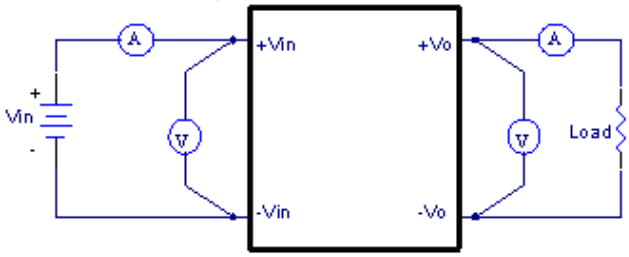
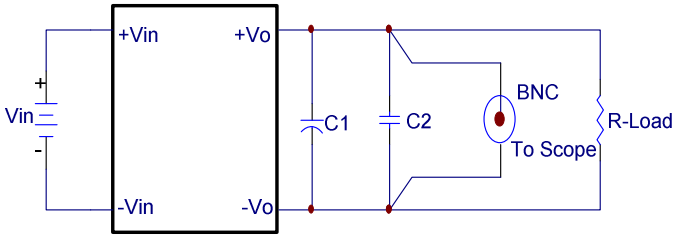


Figure5 EC2SA Series Test Setup

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

Figure6 Output Voltage Ripple and Noise Measurement Set-Up

6.7 Output Capacitance

The EC2SA 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 EC2SA 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 5Vin models, 500mA for 12Vin models and 250mA for 24Vin and 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.

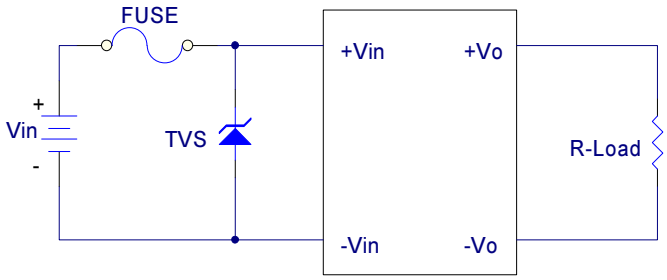


Figure7 Input Protection

7.2 EMC Considerations

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

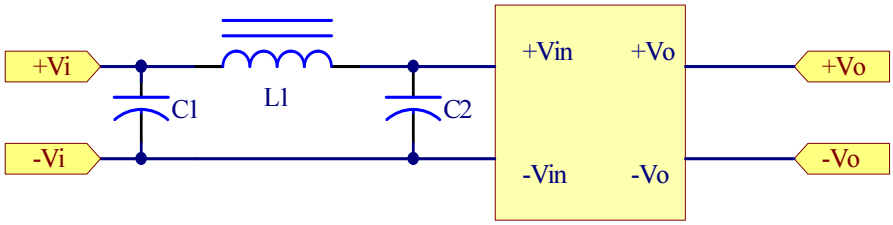


Figure8 Connection circuit for conducted EMI testing

	EN55022 class A			EN55022 class B		
Model No.	C1	C2	L1	C1	C2	L1
EC2SA-05S33	10uF/16V 1206	NC	2.2uH	10uF/25V 1210	NC	10uH
EC2SA-05S05	10uF/16V 1206	NC	2.2uH	10uF/25V 1210	NC	10uH
EC2SA-05S12	10uF/16V 1206	NC	2.2uH	10uF/25V 1210	NC	10uH
EC2SA-05S15	10uF/16V 1206	NC	2.2uH	10uF/25V 1210	NC	10uH
EC2SA-05D05	10uF/16V 1206	NC	2.2uH	10uF/25V 1210	NC	10uH
EC2SA-05D12	10uF/16V 1206	NC	2.2uH	10uF/25V 1210	NC	10uH
EC2SA-05D15	10uF/16V 1206	NC	2.2uH	10uF/25V 1210	NC	10uH
EC2SA-12S33	2.2uF/25V 1206	NC	12uH	2.2uF/25V 1210	NC	33uH
EC2SA-12S05	2.2uF/25V 1206	NC	12uH	2.2uF/25V 1210	NC	33uH
EC2SA-12S12	2.2uF/25V 1206	NC	12uH	2.2uF/25V 1210	NC	33uH
EC2SA-12S15	2.2uF/25V 1206	NC	12uH	2.2uF/25V 1210	NC	33uH
EC2SA-12D05	2.2uF/25V 1206	NC	12uH	2.2uF/25V 1210	NC	33uH
EC2SA-12D12	2.2uF/25V 1206	NC	12uH	2.2uF/25V 1210	NC	33uH
EC2SA-12D15	2.2uF/25V 1206	NC	12uH	2.2uF/25V 1210	NC	33uH
EC2SA-24S33	4.7uF/50V 1812	NC	12uH	6.8uF/50V 1812	NC	33uH
EC2SA-24S05	4.7uF/50V 1812	NC	12uH	6.8uF/50V 1812	NC	33uH
EC2SA-24S12	4.7uF/50V 1812	NC	12uH	6.8uF/50V 1812	NC	33uH
EC2SA-24S15	4.7uF/50V 1812	NC	12uH	6.8uF/50V 1812	NC	33uH
EC2SA-24D05	4.7uF/50V 1812	NC	12uH	6.8uF/50V 1812	NC	33uH
EC2SA-24D12	4.7uF/50V 1812	NC	12uH	6.8uF/50V 1812	NC	33uH
EC2SA-24D15	4.7uF/50V 1812	NC	12uH	6.8uF/50V 1812	NC	33uH
EC2SA-48S33	1uF/100V 1812	NC	68uH	2.2uF/100V 1812	NC	150uH
EC2SA-48S05	1uF/100V 1812	NC	68uH	2.2uF/100V 1812	NC	150uH
EC2SA-48S12	1uF/100V 1812	NC	68uH	2.2uF/100V 1812	NC	150uH
EC2SA-48S15	1uF/100V 1812	NC	68uH	2.2uF/100V 1812	NC	150uH
EC2SA-48D05	1uF/100V 1812	NC	68uH	2.2uF/100V 1812	NC	150uH
EC2SA-48D12	1uF/100V 1812	NC	68uH	2.2uF/100V 1812	NC	150uH
EC2SA-48D15	1uF/100V 1812	NC	68uH	2.2uF/100V 1812	NC	150uH

Note: All of capacitors are ceramic capacitors.

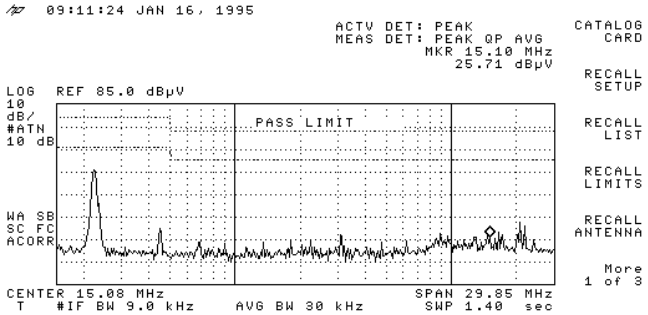


Figure9 Conducted Class A of EC2SA-05S05

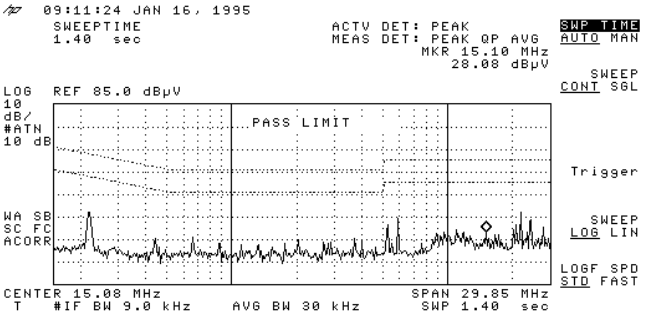


Figure13 Conducted Class B of EC2SA-05S05

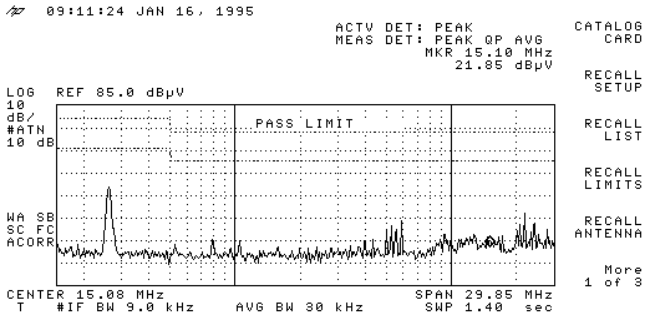


Figure10 Conducted Class A of EC2SA-12S15

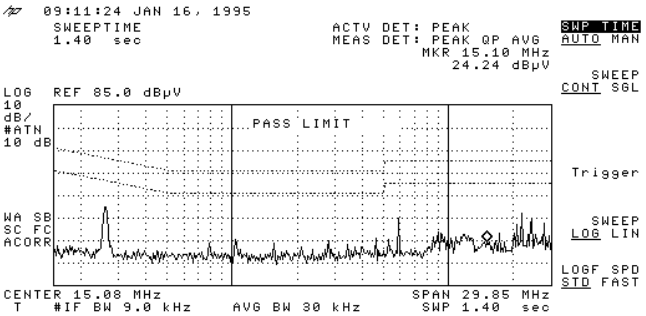


Figure14 Conducted Class B of EC2SA-12S15

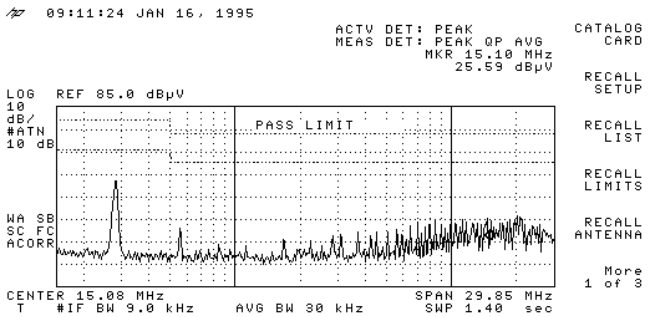


Figure11 Conducted Class A of EC2SA-24D12

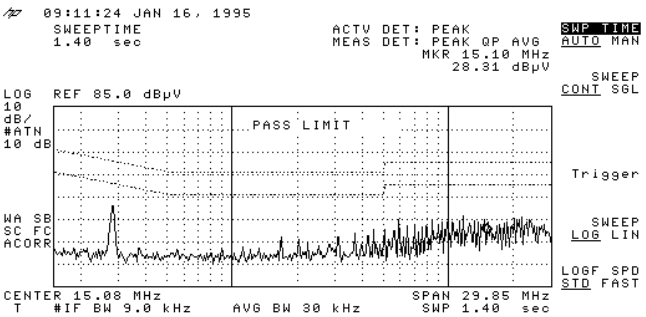


Figure15 Conducted Class B of EC2SA-24D12

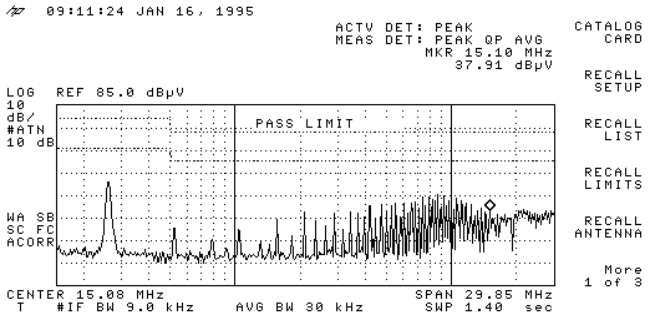


Figure12 Conducted Class A of EC2SA-48D15

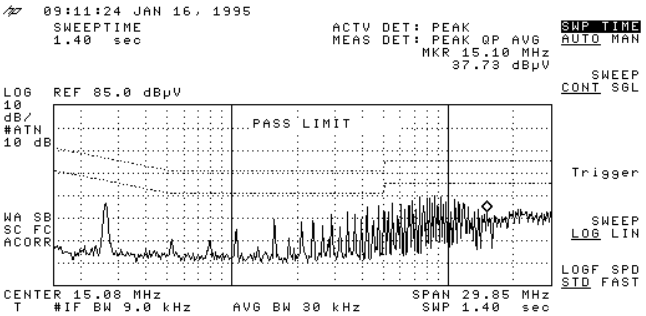
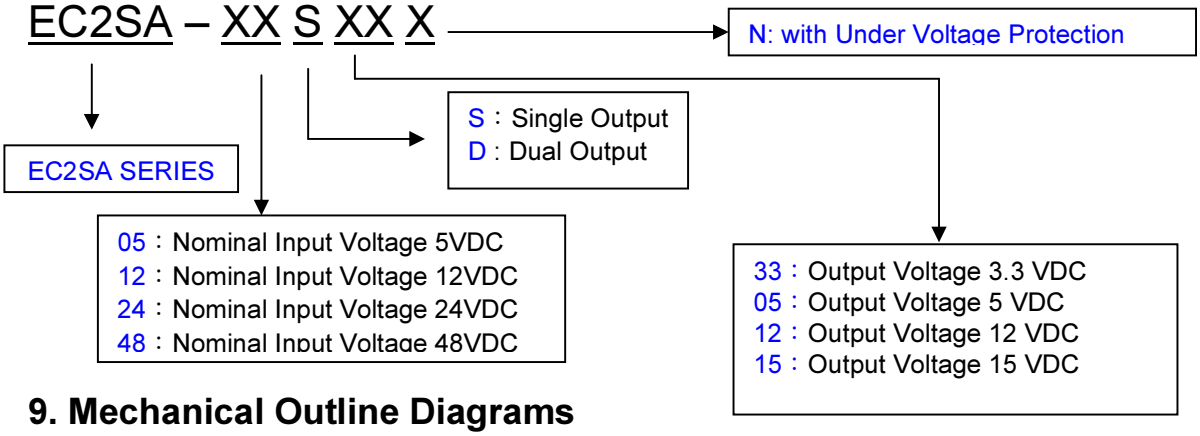


Figure16 Conducted Class B of EC2A-48D15

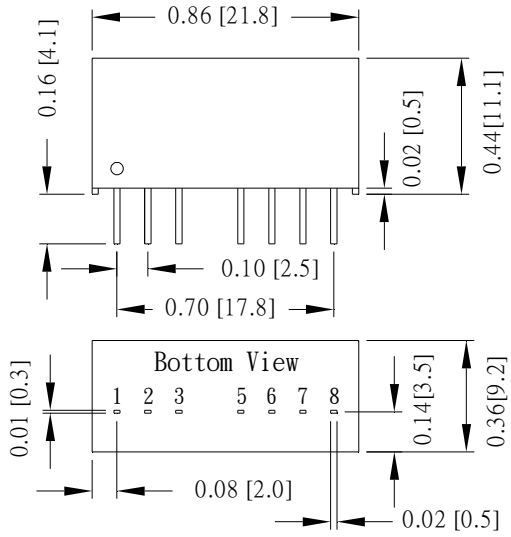
8. Part Number



9. Mechanical Outline Diagrams

9.1 Mechanical Outline Diagrams

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	CTRL	CTRL
5	NC	NC
6	+Vo	+Vo
7	-Vo	Common
8	NC	-Vo

9.2 Packaging Details

The EC2SA series SIL version are supplied in tube(11x20x330mm). Modules are shipped in quantities of 14 modules per Tube. Details of tube dimensions are shown below.

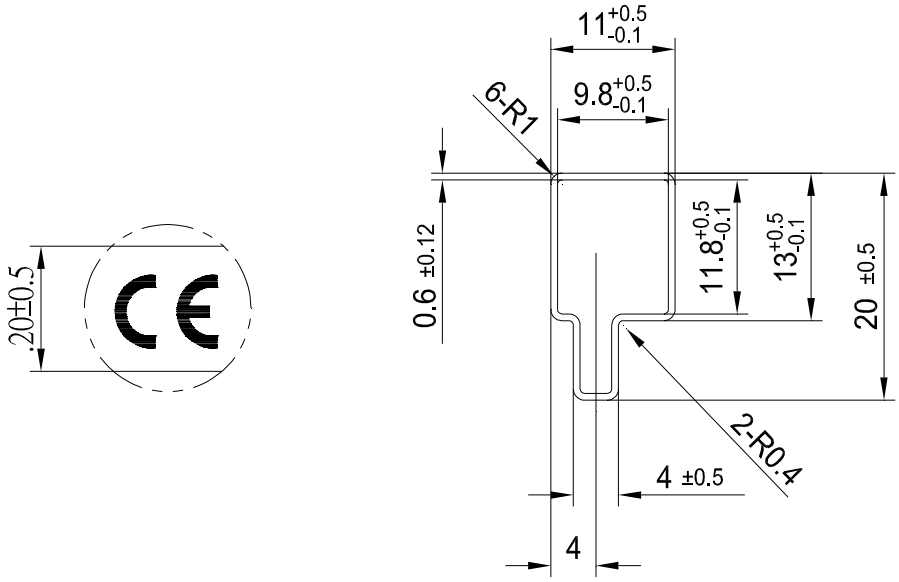


Figure17 SIL Packages Tube for EC2SA

CINCON ELECTRONICS CO., LTD.

Headquarter Office:

14F, No.306, Sec.4, Hsin Yi Rd.,
Taipei, Taiwan
Tel: 886-2-27086210
Fax: 886-2-27029852
E-mail: sales@cincon.com.tw
Web Site: http://www.cincon.com

Factory:

No. 8-1, Fu Kong Rd.,
Fu Hsing Industrial Park
Fu Hsing Hsiang, ChangHua Hsien,
Taiwan
Tel: 886-4-7690261
Fax: 886-4-7698031

Cincon American Office:

1655 Mesa Verde Ave, Ste 180,
Ventura, CA 93003
Tel: 805-639-3350
Fax: 805-639-4101
E-mail: info@cincon.com