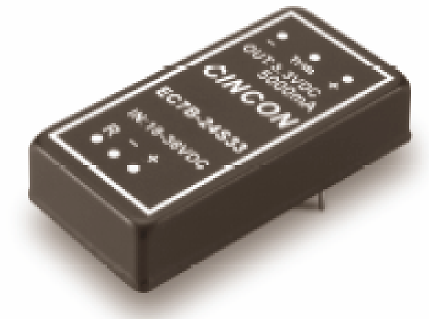
EC7B SERIES 20W DC-DC Converters

Application Note V10 May 2007

ISOLATED DC-DC Converter
EC7B SERIES
APPLICATION NOTE



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Content

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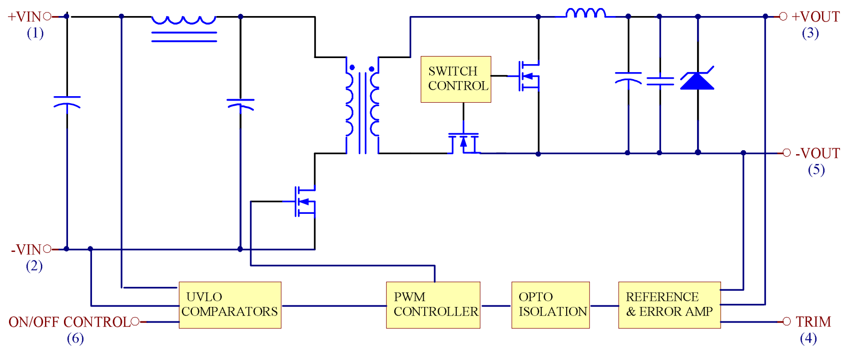
1. Introduction

The EC7B series offer 20 watts of output power with Industry Standard in a 2 x 1 x 0.40inches(50.8 x 25.4 x 10.2mm) The EC7B series has a 2:1 wide input voltage range of 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℃ to 85℃. The modules are fully protected against UVLO (under voltage lock-out), short circuit, and over-voltage conditions. Furthermore, the standard functions include remote on/off control and output voltage trimming. All models are very suitable for telecommunications, distributed power architectures, battery operated equipment, industrial, and mobile equipment applications.

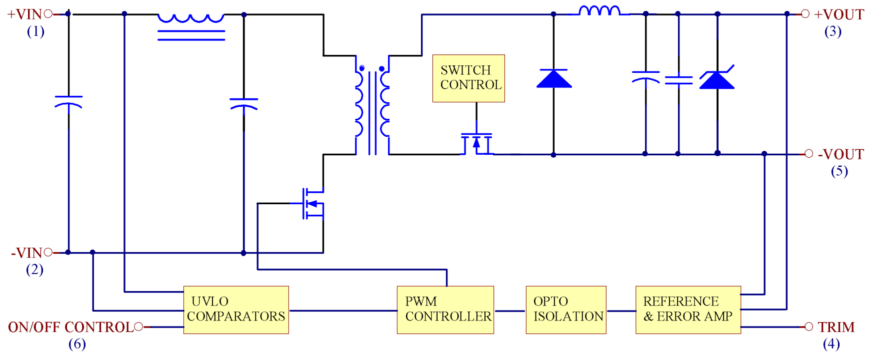
2. DC-DC Converter Features

- 20W Isolated Output
- Efficiency to 90%
- Fixed Switching Frequency
- 2: 1 Input Range
- Regulated Outputs
- Continuous Short Circuit Protection
- Pi Input Filter

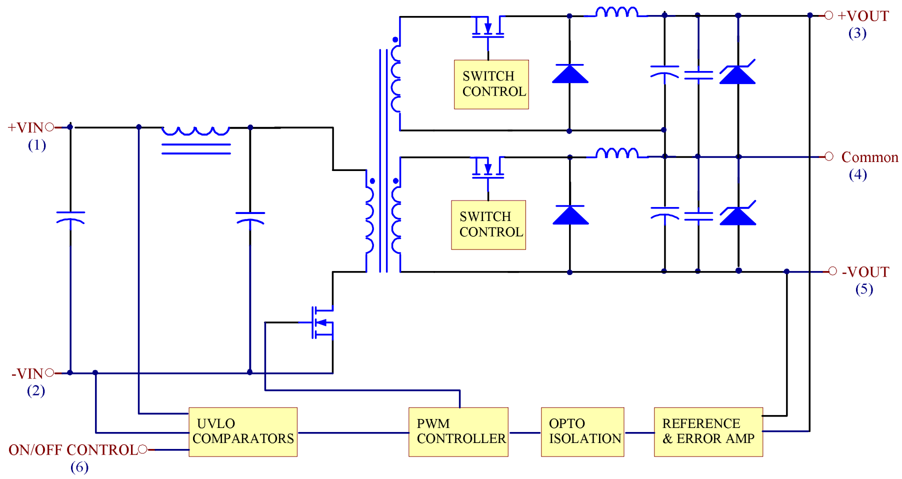
3. Electrical Block Diagram



(a) EC7B-XXS18、EC7B-XXS25、EC7B-XXS33、EC7B-XXS05



(b) EC7B-XXS12、EC7B-XXS15



(C)EC7B-XXDXX
Figure1 Electrical Block Diagram

4. Technical Specifications

(All specifications are typical at nominal input, full load at 25℃ unless otherwise noted.)

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
ABSOLUTE MAXIMUM RATINGS						
Input Voltage						
Continuous		12XXX 24XXX 48XXX	0 0 0		18 36 75	Vdc
Transient (100ms)	100ms	12XXX 24XXX 48XXX			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		12XXX 24XXX 48XXX	9 18 36	12 24 48	18 36 75	Vdc
Input Under-Voltage Lockout						
Turn-On Voltage Threshold		12XXX 24SXX 48SXX	8 16.5 33	8.5 17 34	8.8 17.5 34.5	Vdc
Turn-Off Voltage Threshold		12XXX 24SXX 48SXX	7.7 15.5 31.5	8 16 32	8.3 16.5 33	Vdc
Lockout Hysteresis Voltage		12XXX 24SXX 48SXX		0.6 0.9 1.8		Vdc
Maximum Input Current	100% Load, Vin= 9 V 100% Load, Vin=18V 100% Load, Vin=36V	12XXX 24SXX 48SXX		2570 1285 645		mA
No-Load Input Current		12D12 12D15		40 40		mA
		24S18 24S25 24S33 24S05 24S12 24S15 24D12 24D15		30 30 40 60 20 20 20 20		
		48S18 48S25 48S33 48S05 48S12 48S15 48D12 48D15		30 30 30 40 15 15 10 10		
Off Converter Input Current	Shutdown input idle current	All			10	mA
Inrush Current (I^2t)		All			0.01	A^2s
Input Reflected-Ripple Current	P-P thru 12uH inductor, 5Hz to 20MHz	All		3		mA
OUTPUT CHARACTERISTIC						
Output Voltage Set Point	Vin nominal, Io=Io.max, Tc=25℃	Vo=1.8Vdc Vo=2.5Vdc Vo=3.3Vdc Vo=5Vdc Vo=12Vdc Vo=15Vdc	1.773 2.4625 3.25 4.925 11.82 14.775	1.8 2.5 3.3 5.0 12 15	1.827 2.5375 3.3495 5.075 12.18 15.225	Vdc
Output Voltage Regulation						
Load Regulation	Io=Full Load to No Load	All			±1	%

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Line Regulation	Vin=High line to Low line	XXSXX XXDXX			±0.2 ±0.5	%
Temperature Coefficient	Ta=-40℃ to 85℃	All			±0.03	%/℃
Output Voltage Ripple and Noise						
Peak-to-Peak	Full Load, 0.1uF ceramic capacitor 20MHz bandwidth	All			75	mV
Operating Output Current Range		Vo=1.8Vdc Vo=2.5Vdc Vo=3.3Vdc Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±12Vdc Vo=±15Vdc	0 0 0 0 0 0 0 0		6 6 5 4 1.67 1.33 0.835 0.67	A
Output DC Current-Limit Inception	Output Voltage =90% Nominal Output Voltage		110	125	140	%
Maximum Output Capacitance	Full load	Vo=1.8Vdc Vo=2.5Vdc Vo=3.3Vdc Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±12Vdc Vo=±15Vdc			6000 6000 5000 4000 1680 1400 840 680	uF
DYNAMIC CHARACTERISTICS						
Output Voltage Current Transient						
Step Change in Output Current	75% Io.max to 100% Io.max. 0.1A/us	All			±5	%
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 On/Off Control	Von/off to 90%Vo,set	12DXX 24DXX 48DXX XXSXX		0.5 3 3 5		ms
Turn-On Delay Time, From Input	Vin,min. to 90%Vo,set	12DXX 24DXX 24S18 24S25 24S33 24S05 24S12 24S15 48S18 48S25 48S33 48S05 48S12 48S15		1 4 6 6 6 6 12 12 4 4 4 4 20 20		ms
Output Voltage Rise Time	10%Vo,set to 90%Vo,set	All		2.25		ms
EFFICIENCY						
100% Load		12D12 12D15 24S18 24S25 24S33 24S05 24S12 24S15 24D12 24D15		88 88 86 87 89 90 89 89 89 89		%

		48S18 48S25 48S33 48S05 48S12 48S15 48D12 48D15		86 87 89 90 89 89 89 89		
ISOLATION CHARACTERISTICS						
Input to Output	1 minute	All			1500	Vdc
Isolation Resistance		All	100			MΩ
Isolation Capacitance		All		1000		pF
FEATURE CHARACTERISTICS						
Switching Frequency		All		350		KHz
ON/OFF Control, Negative Remote On/Off logic						
Logic Low (Module On)	Von/off at Ion/off=1.0mA	All			1.2	V
Logic High (Module Off)	Von/off at Ion/off=0.0uA	All	5.5 or Open Circuit		75	V
ON/OFF Control, Positive Remote On/Off logic						
Logic Low (Module Off)	Von/off at Ion/off=1.0mA	All			1.2	V
Logic High (Module On)	Von/off at Ion/off=0.0uA	All	5.5 or Open Circuit		75	V
ON/OFF Current (for both remote on/off logic)	Ion/off at Von/off=0.0V	All			1	mA
Leakage Current (for both remote on/off logic)	Logic High, Von/off=15V	All			30	uA
Off Converter Input Current	Shutdown input idle current	All		4	10	mA
Output Voltage Trim Range	Pout≦max rated power	All	-10		+10	%
Output Over-Voltage Protection		Vo=1.8Vdc Vo=2.5Vdc Vo=3.3Vdc Vo=5Vdc Vo=12Vdc Vo=15Vdc Vo=±12Vdc Vo=±15Vdc		3.3 3.9 3.9 6.2 15 18 15 18		V
GENERAL SPECIFICATIONS						
MTBF	Io=100%of Io.max;Ta=25℃ per MIL-HDBK-217F	All		1		M hours
Weight	open frame	All		35		grams

5. Main Features and Functions

5.1 Operating Temperature Range

The EC7B series converters can be operated within a wide ambient temperature range of -40℃ to 85℃.The consideration must be given to the de-rating curves when ascertaining maximum power that can be drawn from the converter. The maximum power drawn from open frame models is influenced by the same factors, such as:

- Input voltage range.
- Output load current.
- Forced air or natural convection.
- Mounting orientation of converter PCB with respect to the airflow.
- Mother board PCB design, especially ground and power planes.

5.2 Output Voltage Adjustment

Section 6.8 describes in detail as to how to trim the output voltage with respect to its set point. The output voltage on all models is adjustable in the range from +10% to –10%.

5.3 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 a hiccup mode protection.

5.4 Output Over Voltage Protection

The output overvoltage protection consists of circuitry that internally clamps the output voltage. If a more accurate output over voltage protection circuit is required then this can be used external control the remote on/off pin.

5.5 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 (>5.5Vdc or open circuit). Setting the pin low (<1.2Vdc) will turn the converter 'Off'. The signal level of the remote on/off input is defined with respect to ground. If not using the remote on/off pin, leave the pin open (module will be on). The part number suffix "N" is negative remote ON/OFF version. The unit is turned off if the remote ON/OFF pin is high (>5.5Vdc or open circuit). The converter is turned on if the ON/OFF pin input is low (<1.2Vdc). The recommended ON/OFF drive circuit as shown as Figure2.

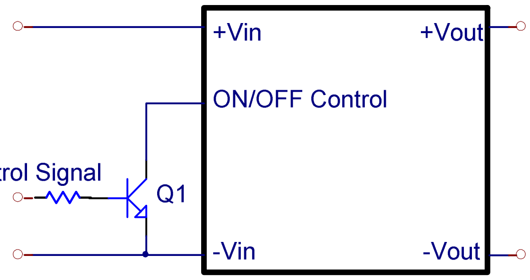


Figure2 Remote ON/OFF Input Drive Circuit

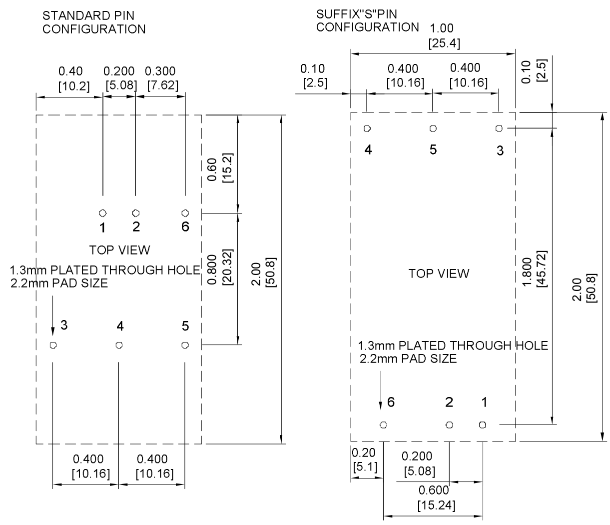
5.6 UVLO (Under-Voltage Lockout)

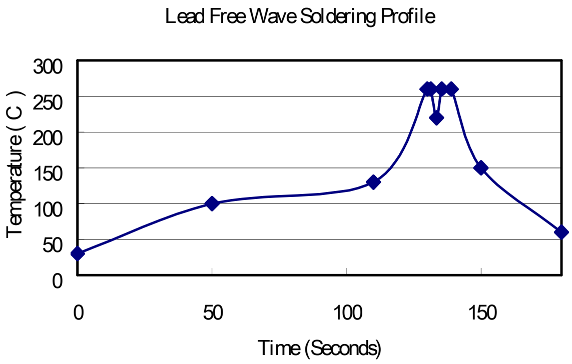
Input under voltage lockout is standard with the EC7B unit. The unit will shut down when the input voltage drops below a threshold, and the unit will turn on when the input voltage goes to the upper threshold.

6. Applications

6.1 Recommended Layout PCB Footprints and Soldering Information

The system designer or the end user must ensure that other components and metal in the vicinity of the converter meet the spacing requirements to which the system is approved. Low resistance and low inductance PCB layout traces are the norm and should be used where possible. Due consideration must also be given to proper low impedance tracks between power module, input and output grounds. The recommended footprint and soldering profile is shown as Figure 3 .





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℃)

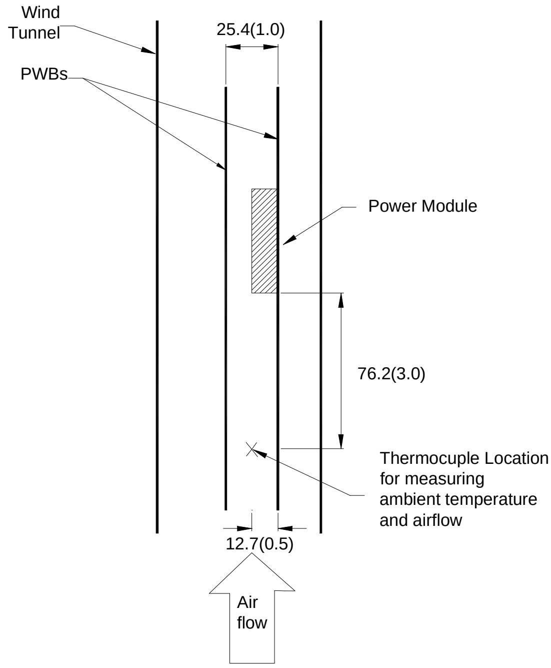
Figure3 Recommended PCB Layout Footprint And Soldering Profile

6.2 Convection Requirements for Cooling

The power models are metal case and can be used by high ambient temperature at natural convection, but it is necessary to check case temperature not exceed 100℃ at center of case. To predict the approximate cooling needed for the power module, refer to the Power De-rating curves in section 6.4. These de-rating curves are approximations of the ambient temperatures and airflows required to keep the power module temperature below its maximum rating.

6.3 Thermal Considerations

The power module operates in a variety of thermal environments; however, sufficient cooling should be provided to help ensure reliable operation of the unit. Heat is removed by conduction, convection, and radiation to the surrounding environment. The thermal data presented is based on measurements taken in a set-up as shown in Figure4. The test data are presented at the section 6.4. Note that the airflow is parallel to the long axis of the module as shown in Figure4. The output power of the module should not exceed the rated power for the module (V_O, set x I_O, max).



Note: Dimensions are in millimeters and (inches)

Figure4 Thermal Test Setup

6.4 Power De-Rating Curves for EC7B Series

Operating Ambient temperature Range : -40℃ ~ 85℃

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

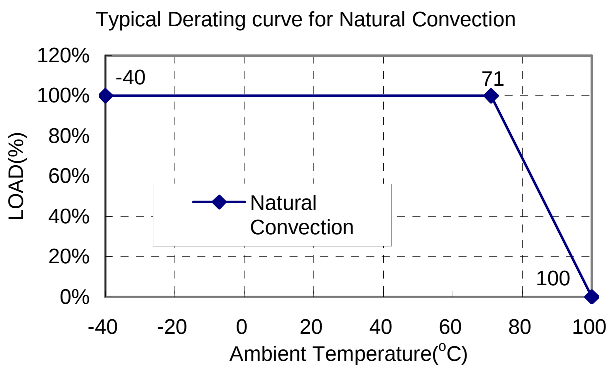
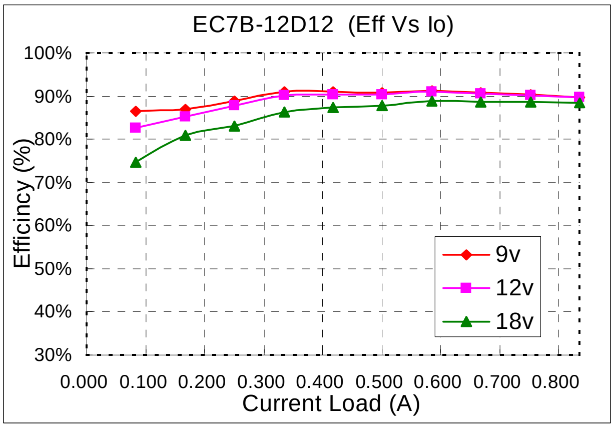
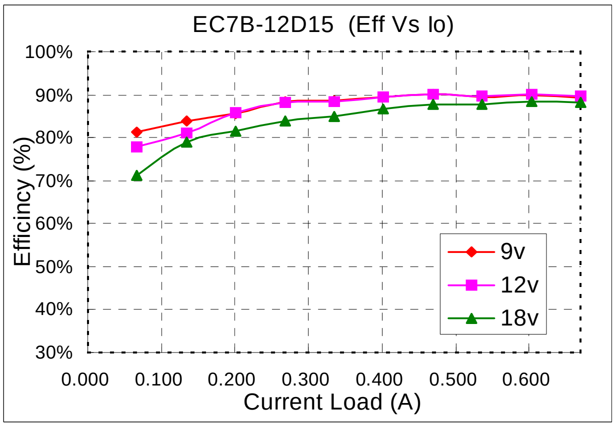
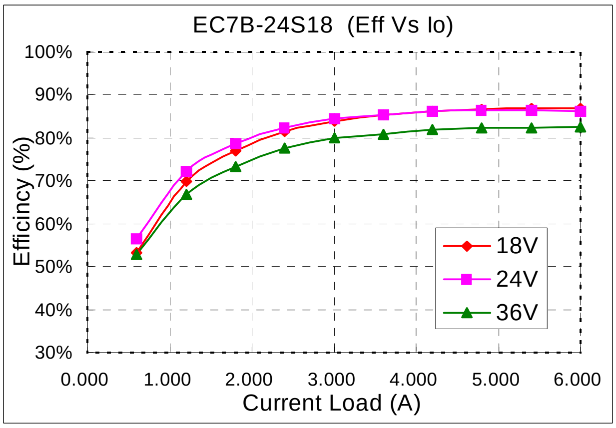


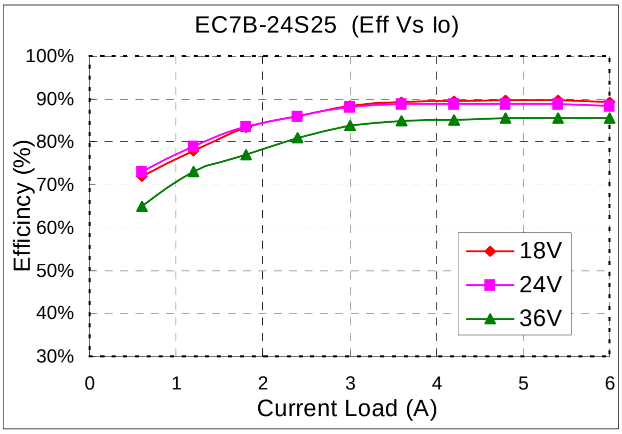
Figure5 Typical Derating curve for Natural Convection

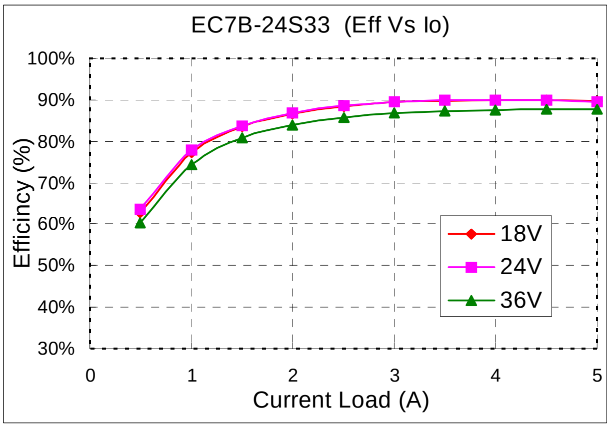
6.5 Efficiency vs. Load Curves

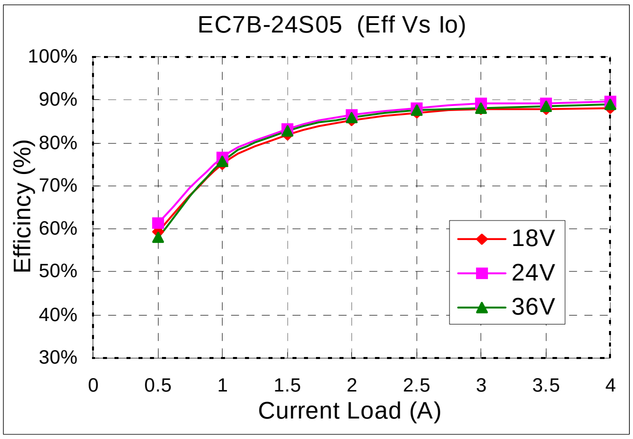


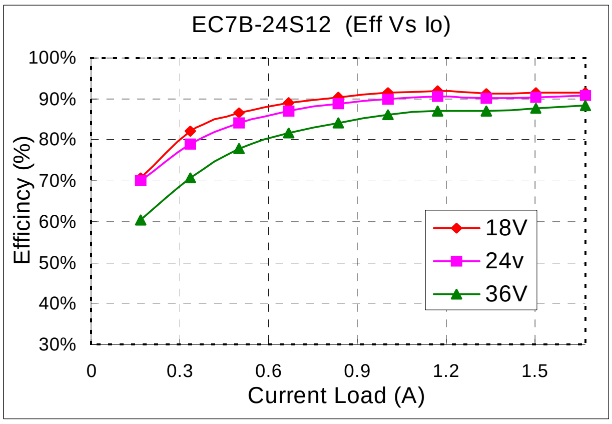


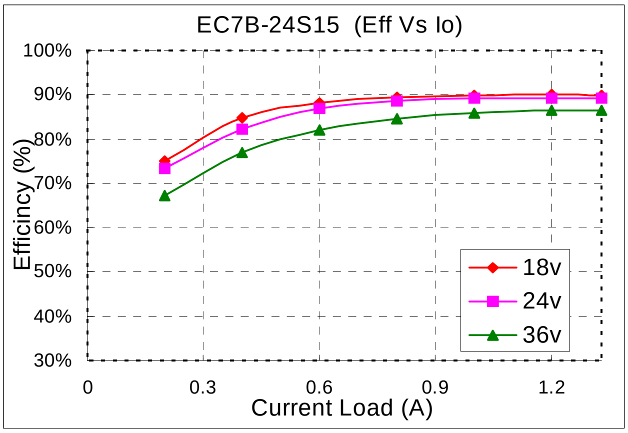


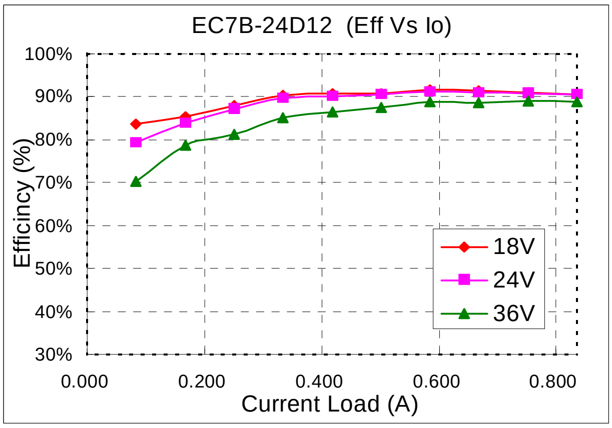


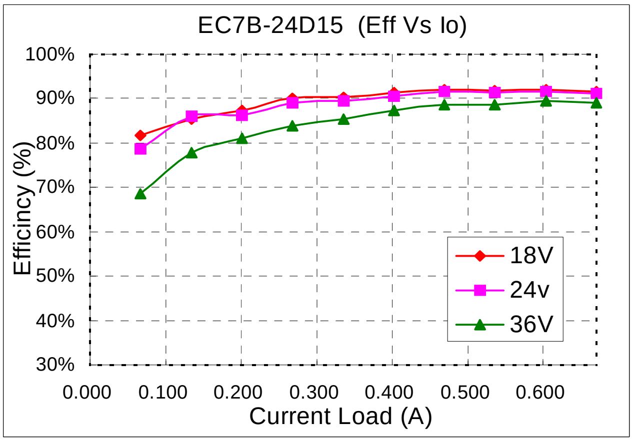


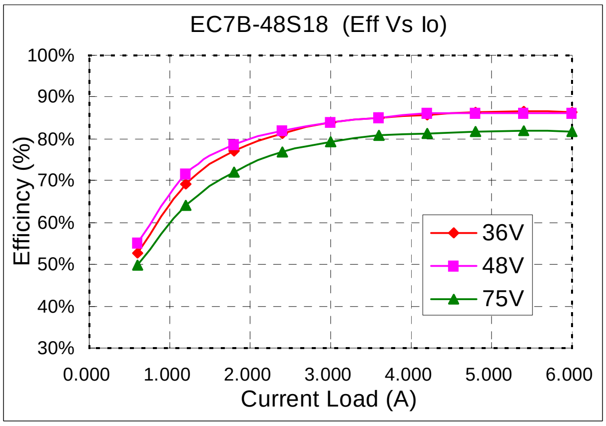


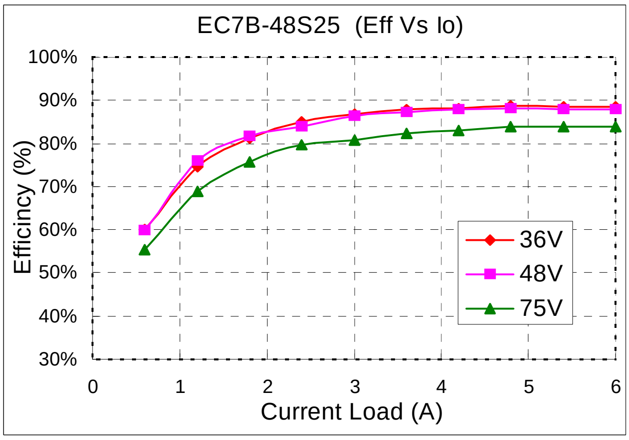

EC7B-24S12 (Eff Vs Io)
Efficincy (%)
Current Load (A)
18V
24v
36V

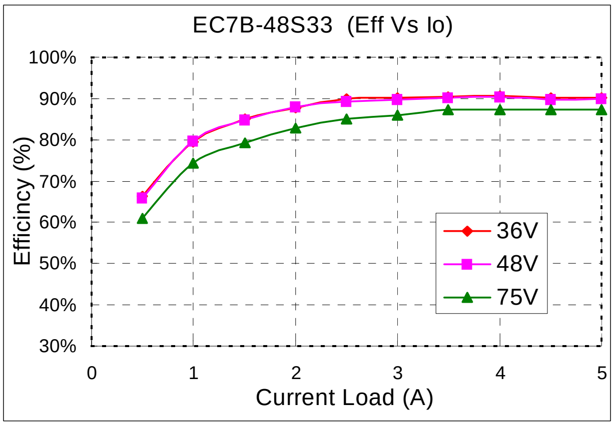

EC7B-24S15 (Eff Vs Io)
Efficincy (%)
Current Load (A)
18v
24v
36v


EC7B-24D12 (Eff Vs Io)
Efficincy (%)
Current Load (A)
18V
24V
36V

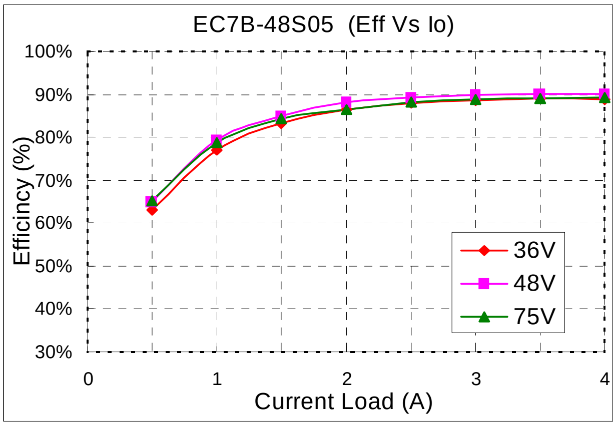

EC7B-24D15 (Eff Vs Io)
Efficincy (%)
Current Load (A)
18V
24V
36V


EC7B-48S18 (Eff Vs Io)
Efficincy (%)
Current Load (A)
36V
48V
75V

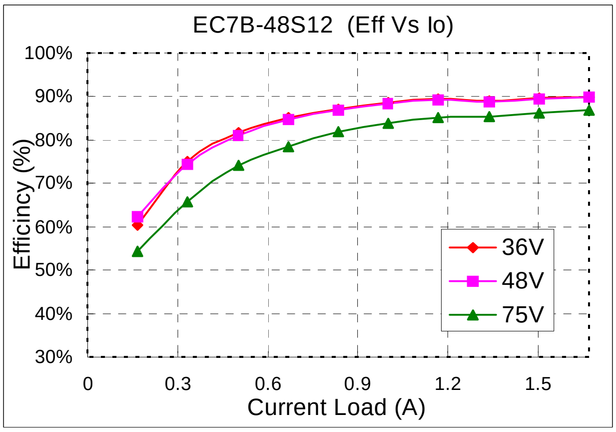

EC7B-48S25 (Eff Vs Io)
Efficincy (%)
Current Load (A)
36V
48V
75V



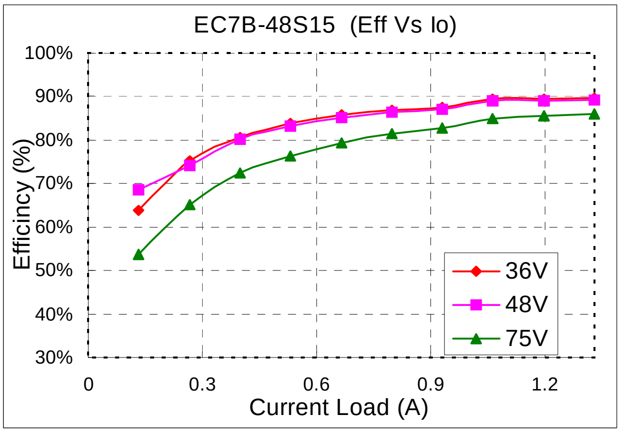
EC7B-48S33 (Eff Vs Io)
Efficincy (%)
100%
90%
80%
70%
60%
50%
40%
30%
0
1
2
3
4
5
Current Load (A)
36V
48V
75V



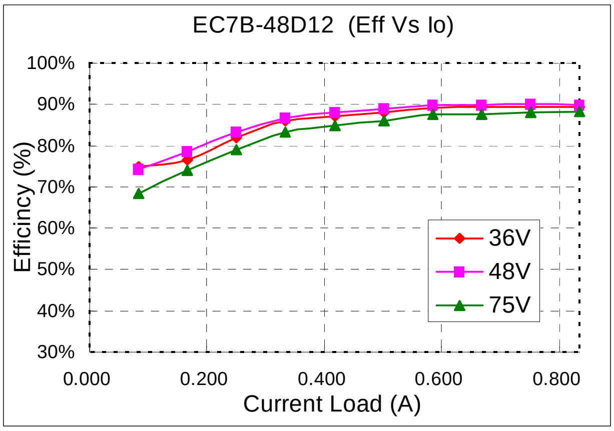
EC7B-48S05 (Eff Vs Io)
Efficincy (%)
100%
90%
80%
70%
60%
50%
40%
30%
0
1
2
3
4
Current Load (A)
36V
48V
75V



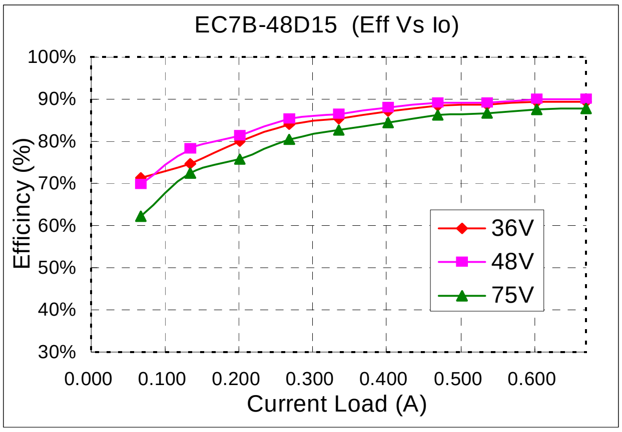
EC7B-48S12 (Eff Vs Io)
Efficincy (%)
100%
90%
80%
70%
60%
50%
40%
30%
0
0.3
0.6
0.9
1.2
1.5
Current Load (A)
36V
48V
75V



EC7B-48S15 (Eff Vs Io)
Efficincy (%)
100%
90%
80%
70%
60%
50%
40%
30%
0
0.3
0.6
0.9
1.2
Current Load (A)
36V
48V
75V



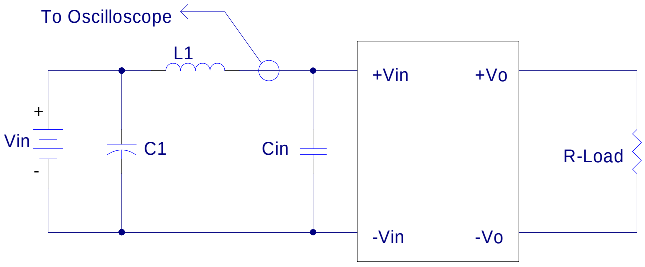
EC7B-48D12 (Eff Vs Io)
Efficincy (%)
100%
90%
80%
70%
60%
50%
40%
30%
0.000
0.200
0.400
0.600
0.800
Current Load (A)
36V
48V
75V



EC7B-48D15 (Eff Vs Io)
Efficincy (%)
100%
90%
80%
70%
60%
50%
40%
30%
0.000
0.100
0.200
0.300
0.400
0.500
0.600
Current Load (A)
36V
48V
75V

6.6 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 Figure6 represents typical measurement methods for reflected ripple current. C1 and L1 simulate a typical DC source impedance. The input reflected-ripple current is measured by current probe to oscilloscope with a simulated source Inductance (L1).



L1 : 12uF
C1: 220uF ESR<0.1ohm @100KHz
Cin: 33uF ESR<0.7ohm @100KHz

Figure6 Input Reflected-Ripple Test Setup

6.7 Test Set-Up

The basic test set-up to measure parameters such as efficiency and load regulation is shown in Figure7. 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 no 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.

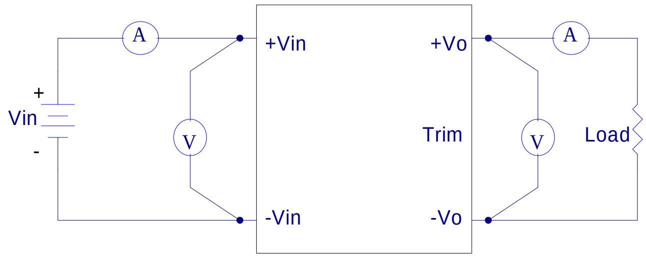


Figure7 EC7B Series Test Setup

6.8 Output Voltage Adustment.

In order to trim the voltage up or down one needs to connect the trim resistor either between the trim pin and - Vout for trim-up and between trim pin and +Vout for trim-down. The output voltage trim range is ±10%. This is shown in Figure8 and Figure9:

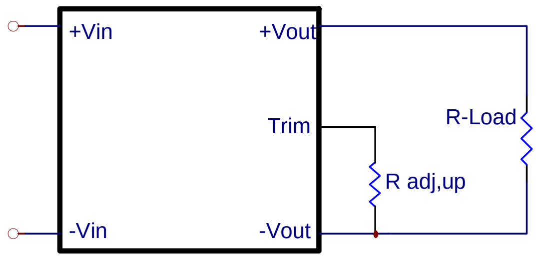


Figure8 Trim up voltage Setup

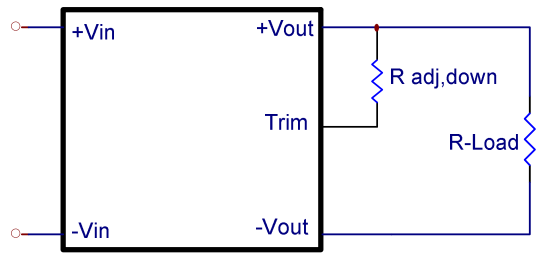


Figure9 Trim down Output Setup

The value of Radj,up & Radj,down defined as:

24S18、48S18：

$$R_{adj,up} = \frac{2.88}{\Delta Vo} - 4.3(K\Omega)$$

$$R_{adj,\,down} = \frac{(2.32Vo - 2.88)}{\Delta Vo} - 4.3(K\Omega)$$

24S25、48S25：

$$R_{adj,\,up} = \frac{3.01}{\Delta Vo} - 8.66(K\Omega)$$

$$R_{adj,\,down} = \frac{(2.43Vo - 3.01)}{\Delta Vo} - 8.66(K\Omega)$$

24S33、48S33：

$$R_{adj,\,up} = \frac{3.72}{\Delta Vo} - 10.1(K\Omega)$$

$$R_{adj,\,down} = \frac{(3Vo - 3.72)}{\Delta Vo} - 12(K\Omega)$$

24S05、48S05：

$$R_{adj,\,up} = \frac{6}{\Delta Vo} - 8.66(K\Omega)$$

$$R_{adj,\,down} = \frac{(2.4Vo - 6)}{\Delta Vo} - 8.66(K\Omega)$$

24S12、48S12：

$$R_{adj,\,up} = \frac{33.44}{\Delta Vo} - 22(K\Omega)$$

$$R_{adj,\,down} = \frac{48.28Vo}{\Delta Vo} - 28.8(K\Omega)$$

24S15、48S15：

$$R_{adj,\,up} = \frac{39.63}{\Delta Vo} - 27(K\Omega)$$

$$R_{adj,\,down} = \frac{67.8}{\Delta Vo} - 35.06(K\Omega)$$

Where: Vo is the desired output voltage

$$\Delta Vo = |Vo - Vo_{nom}|$$

To give an example of the above calculation, to set a voltage of 5.3Vdc using EC7B-48S05, Radj,up is given by:

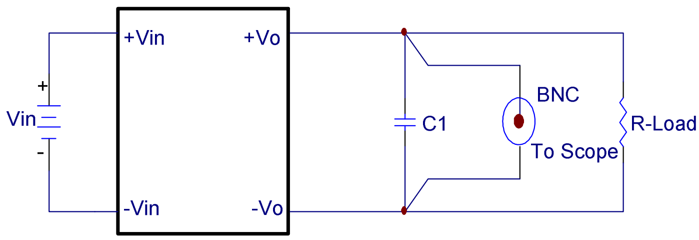
$$\Delta Vo = |5.0 - 5.3| = 0.3Vdc$$

$$R_{adj,\,up} = \frac{6}{0.3} - 8.66 = 40.45(K\Omega)$$

Connect it between TRIM pin to -Vo pin.

6.9 Output Ripple and Noise Measurement

The test set-up for noise and ripple measurements is shown in Figure10. 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. The output ripple/noise is measured with 0.1uF ceramic capacitor across output.



Output test BNC at 50mm to 75mm(2" to 3") from the module
C1：0.1uF ceramic capacitor

Figure10 Output Voltage Ripple and Noise Measurement Set-Up

6.10 Output Capacitance

The EC7B 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. For high current applications point has already been made in layout considerations for low resistance and low inductance tracks. Output capacitors with its associated ESR values have an impact on loop stability and bandwidth. Cincon's converters are designed to work with load capacitance up-to 1000uF per amp.

7. Safety & EMC

7.1 Input Fusing and Safety Considerations.

The EC7B 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 5A for 12DXX models,3A for 24XXX models, and 2A for 48XXX models. Figure11 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.

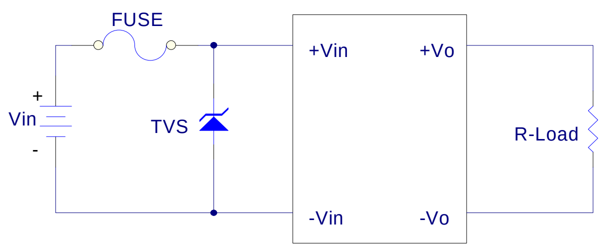


Figure11 Input Protection

7.2 EMC Considerations

The figure12 shows a suggested configuration to meet the conducted emission limits of EN55022 Class A and Class B. Please refer to figure13 and figure14.

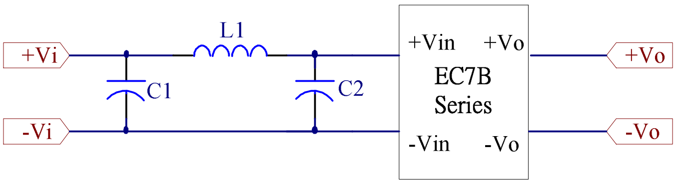


Figure12 Suggested Configuration for EN55022 Class A and Class B

Table1 Recommended component value for EN55022 Class A

MODEL NO.	C1	C2	L1
EC7B-12DXX	10uF/25V	10uF/25V	8uH
EC7B-24S18 EC7B-24S25 EC7B-24S33 EC7B-24S05 EC7B-24S12 EC7B-24S15	NC NC NC 10uF/50V 10uF/50V 10uF/50V	NC	Short
EC7B-24DXX	10uF/25V	10uF/25V	8uH
EC7B-48S18 EC7B-48S25 EC7B-48S33 EC7B-48S05 EC7B-48S12 EC7B-48S15	NC NC NC 22uF/100V 22uF/100V 22uF/100V	NC	Short
EC7B-48DXX	10uF/100V	10uF/100V	8uH

Table2 Recommended component value for EN55022 Class B

MODEL NO.	C1	C2	L1
EC7B-12D12 EC7B-12D12	22uF/25V	22uF/25V	8uH
EC7B-24SXX	22uF/50V	22uF/50V	8uH
EC7B-24D12 EC7B-24D15	22uF/50V	22uF/50V	8uH
EC7B-48SXX	22uF/100V	22uF/100V	8uH
EC7B-48D12 EC7B-48D15	22uF/100V	22uF/100V	8uH

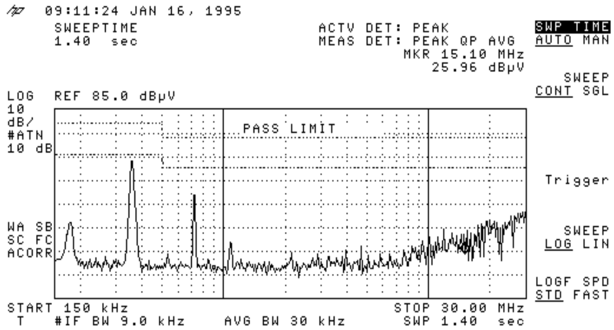


Figure13 EMC signature meet Class A for EC7B-24S12 using above filter refer to Table 1

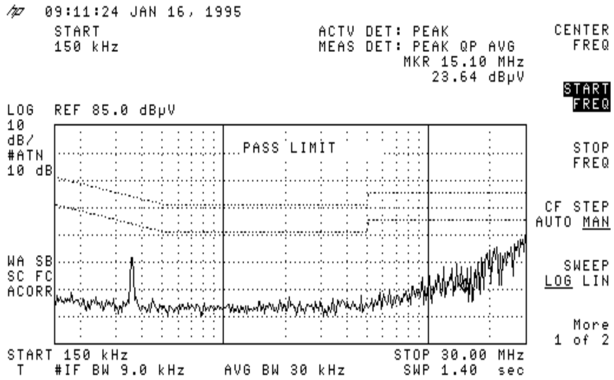


Figure14 EMC signature meet Class B for EC7B-24S12 using above filter refer to Table 2

Test Condition: Input Voltage: Nominal, Output Load: Full Load

8. Part Number

EC7B – XX X XX X

EC7B SERIES

non：standard
S：Outside Pinning

S：Single Output
D：Dual Output

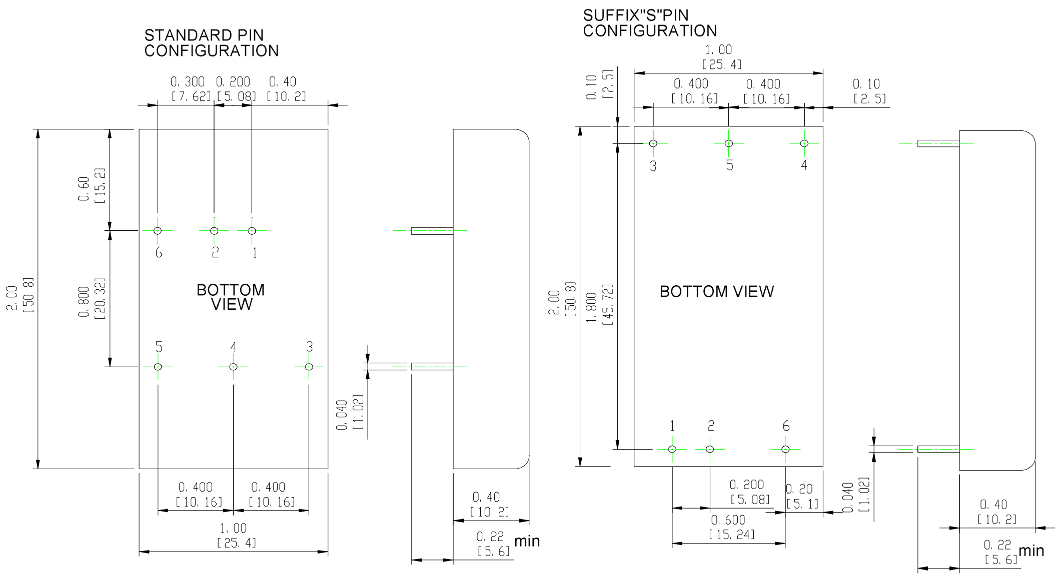
18：Output Voltage 1.8 VDC
25：Output Voltage 2.5 VDC
33：Output Voltage 3.3 VDC
05：Output Voltage 5 VDC
12：Output Voltage 12 VDC
15：Output Voltage 15 VDC

12：Nominal Input Voltage 12VDC
24：Nominal Input Voltage 24VDC
48：Nominal Input Voltage 48VDC

9. Mechanical Outline Diagrams

9.1 Mechanical Outline Diagrams

All Dimensions In Inches (mm)
Tolerances Inches .XX= ?04 , .XXX= ?010
Millimeters .XX= ?.0 , .XXX= ?.25



PIN CONNECTION		
Pin	Single	Dual
1.	+Vin	+Vin
2.	-Vin	-Vin
3.	+Vout	+Vout
4.	Trim	Common
5.	-Vout	-Vout
6.	Remote ON/OFF	

Figure15 EC7B Mechanical Outline Diagram

9.2 Packaging Details

The EC7B series are supplied in long and short tubes as standard. Modules are shipped in quantities of 12 modules per short tube and 20 modules per long tube. Details of tube dimensions are shown below.

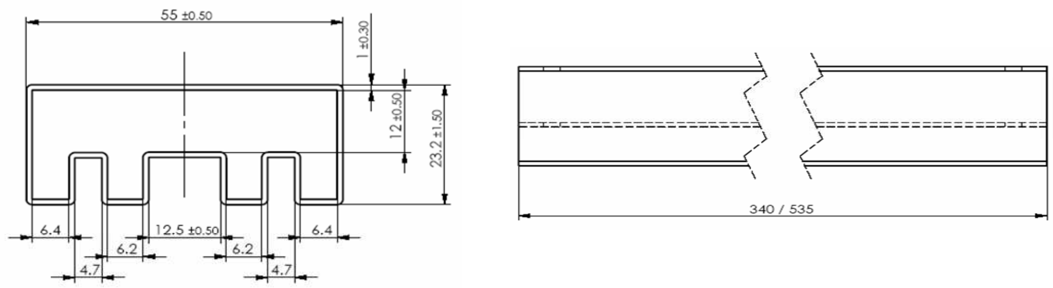


Figure16 DIP Packages Tube for EC7B

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