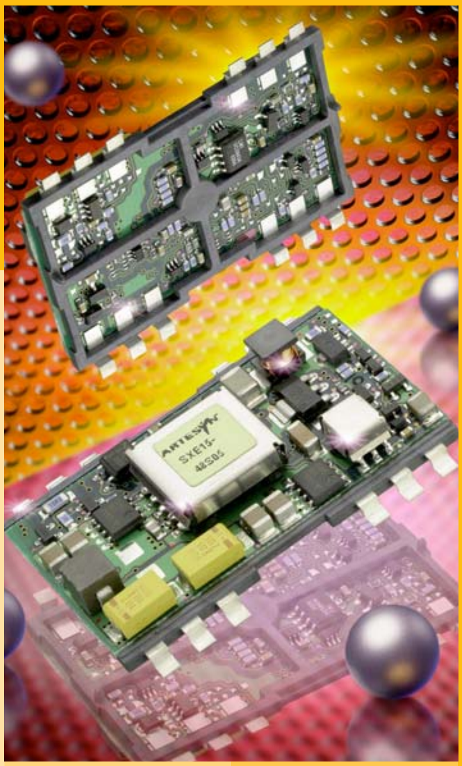
CXE/SXE/SXN15

Application Note 116



ARTESYN® TECHNOLOGIES

Rev. 02 / 18 October 2002

- **Efficient topology utilising synchronous rectification, 87% typical at 5V**
- **Operating ambient temperature up to and exceeding 70°C (natural convection). 100ºC operation possible with derating**
- **Approved to EN60950, UL/cUL1950**
- **Complies with ETS 300 019-1-3/2-3**
- **Complies with ETS 300 132-2 input voltage and current requirements**
- **Fully compliant with ETS 300 386-1**

Foreword

This application note covers the CXE15 (single), SXE15 (single and dual) and SXN15 (single and dual) series. The examples in this application note relate to the SXE15 product but can be assumed to be the same for all products across the series unless specified otherwise.

1. Introduction

The SXE15 series is a new generation of DC/DC converters designed in response to the growing need for lower operating voltages and higher efficiencies. They offer unprecedented efficiency figures and a wide range of low output voltage solutions.

In addition, automated manufacturing methods and an extensive qualification program have produced one of the most reliable ranges of converters on the market.

2. Models

The SXE15 series comprises seven separate models as shown in Table 1. All popular integrated circuit operating voltages are covered by the range.

Model	Input Voltage	Output Voltage
SXE15-48S12*	33-75VDC	12V
SXE15-48S05	33-75VDC	5V
SXE15-48S3V3	33-75VDC	3.3V
SXE15-48S2V5	33-75VDC	2.5V
SXE15-48S1V8	33-75VDC	1.8V
SXE15-48D05-3V3**	33-75VDC	5V, 3.3V
SXE15-48D3V3-2V5**	33-75VDC	3.3V, 2.5V

*This model available in SXE series only

**There are no dual output models in the CXE range

Table 1 - Output Voltages

Features

- Wide operating ambient temperature range of up to and exceeding +70°C with natural convection and 100ºC with derating
- Output voltage adjustability
- Primary-side controlled Remote ON/OFF
- Constant switching frequency
- Brickwall overcurrent protection
- Continuous short circuit protection
- Input undervoltage protection

3. General Description

3.1 Electrical Description

The SXE15 power module is a DC/DC converter that operates over an input voltage range of 33VDC to 75VDC and provides either one or two isolated regulated DC outputs. The modules have a maximum power rating of 15W and excellent efficiencies are achieved by optimal driving of the synchronous rectification stage.

The standard feature set includes Remote ON/OFF and output trim for maximum flexibility in distributed power applications.

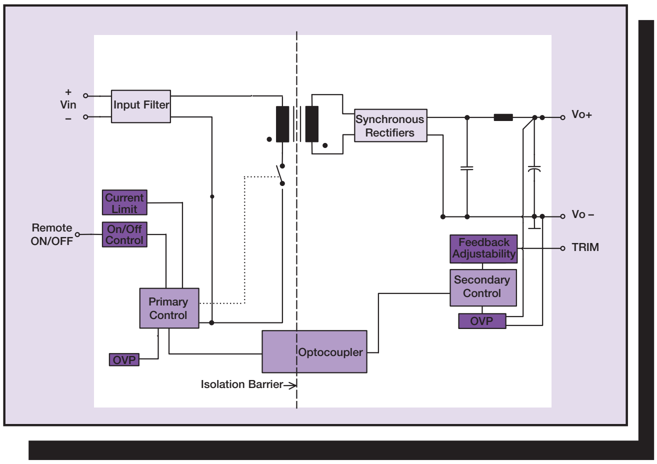


Figure 1 - Electrical Block Diagram

The DC input is filtered by an LC stage before it reaches the main power transformer. A current controlled PWM controller is used to provide a precisely regulated output voltage. The main power switch is a MOSFET running at a constant switching frequency of approximately 265kHz.

The output voltage is sensed and compared with a secondary side reference and a compensated error signal is fed back via an optocoupler to the PWM controller. The secondary side trim pin allows the user to adjust the output voltage by connecting a resistor between trim and either the positive or negative output voltage pin.

3.2 Physical Construction

The SXE15 is constructed using a single multi-layer FR4 PCB. SMT components are placed on both sides of the PCB with, in general, the heavier power components mounted on the top side in order to optimise heat dissipation.

The converter is sold as an open frame product and no case is provided. The open frame design has several advantages over encapsulated closed devices. Among these advantages are:

- **Cost:** no encapsulation, case or associated process costs involved.
- **Thermals:** the heat is removed from the heat generating components without heating more sensitive, less tolerant components such as opto-couplers.
- **Environmental:** some encapsulants are not kind to the environment and create problems in incinerators. Further more open frame converters are more easily re-cycled.
- **Reliability:** open Frame modules are more reliable for a number of reasons, such as better thermals and removal of TCE stresses associated with encapsulants.

Design Note 102 "Open Frame Low to Medium Power DC/DC Converter Modules" is available on the internet at http//www.artesyn.com/html/design_notes.html. Readers are encouraged to familiarise themselves with its content. This paper details many of the advantages of open frame products over their cased and potted counterparts. The effective elimination of the encapsulant and case has been made possible by the use of modern automated manufacturing techniques and, in particular, the 100% use of SMT components and exceptionally high power conversion efficiencies.

4. Features and Functions

4.1 Wide Operating Temperature Range

The wide ambient temperature range of the SXE15 module is a consequence of its extemely high conversion efficiency and the resultant low power dissipation. Operation from -40˚C to a maximum ambient temperature of up to and exceeding +70˚C at full rated power is achieved without the requirement for heatsinks or forced air cooling. Derated operation is achieved at 100ºC ambient. Consult the factory for details.

4.2 Output Voltage Adjustment

The output voltage on all models is trimmable by -10% to +10% of the nominal output voltage. Details on how to trim all models are provided in the applications section of this document.

4.3 Remote ON/OFF

The Remote ON/OFF function allows the unit to be controlled by an external signal that puts the module into a low power dissipating sleep mode. Examples of how this function may be employed are detailed in the applications section of this document.

4.4 Constant Switching Frequency

The switching frequency for all models is fixed at approximately 265kHz and is independent of line and load conditions. This makes the overall power system more predictable and greatly simplifies the design of the input filter required for EMC compliance.

4.5 Current Limit and Short Circuit Protection

All models of the SXE15 have a built-in brickwall current limit function and full continuous short circuit protection. Thus, the V-I (output voltage - output current) characteristic will be almost vertical at the current limit inception point as shown in Figure 2. The current limit inception point depends on the input voltage and ambient temperature, and also has a parametric spread. For example, the inception point of the CXE15-48S05 is typically 120% and may go as high as 144% (See long form datasheet on our website for details).

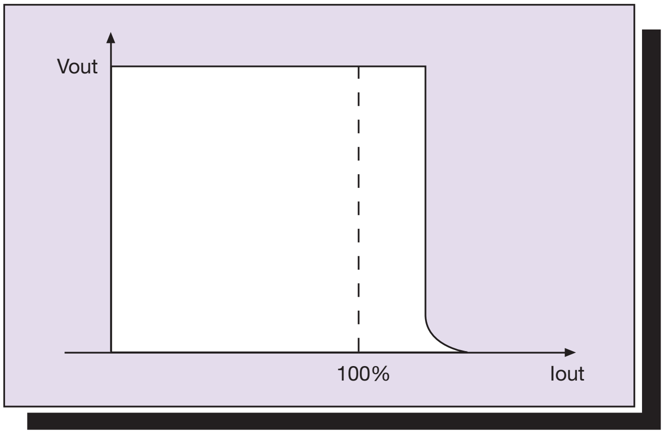


Figure 2 - Typical Brickwall V-I Characteristic

None of the specifications are guaranteed when the unit is operated in an overcurrent condition. The unit can be operated continuously in this condition, but its lifetime of the unit will be reduced.

4.6 Output Overvoltage Protection

The clamped overvoltage protection (OVP) feature is used to protect the module and the user's circuitry when a fault occurs in the main control loop. The unit is also protected in the event that the output is trimmed above the recommended maximum specification.

The OVP circuit works by sensing the level of the primary bias voltage from the main transformer. This winding is voltage coupled to the secondary winding and can therefore detect any changes in the voltage level at the output. When an OV condition is detected by this circuit the unit enters a max duty cycle mode, clamping the output voltage to the level determined in Table 2.

Output Voltage	Clamp Level
12V	15V
5V	6.0V
3.3V	4.0V
2.5V	3.0V
1.8V	2.2V

Table 2 - OVP Clamp Levels

4.7 Input Undervoltage Protection

The SXE15 series is fitted with a detection circuit at the input side that inhibits operation of the converter when the input voltage is below the normal operating range. The converter is disabled when the input voltage is below 33V (typ). This UV trip protects against deep discharge of telecom batteries. The threshold has inherent hysteresis to provide immunity against slow ramping input voltages. The module operates in a low power dissipation mode when protected.

5. Safety

5.1 Isolation
The SXE15 series has been designed in accordance with EN60950 and CAN/CSA-C22.2 No. 60950-00 and UL60950 'Safety of Information Technology Equipment'.

The SXE15 DC/DC converter is intended for inclusion in other equipment and the installer must ensure that it is in compliance with all the requirements of the end application.

For many applications models with operational insulation will be sufficient provided that one pole of the output is connected to protective earth. Units with operational isolation are less costly and will have 1-2% higher efficiency than the equivalent model with basic isolation.

The galvanic isolation is verified in an electric strength test during production; the test voltage between input and output is 1.5kVDC. Also, note that the flammability ratings of the terminal support header blocks and internal plastic constructions meet UL94V-0.

5.2 Input Fusing
In order to comply with safety requirements, the user must provide a fuse in the unearthed input line if an earthed input is used. The reason for putting the fuse in the unearthed line is to avoid earth being disconnected in the event of a failure. If an earthed input is not being used, the fuse can be placed in either input line.

A 2 Amp slow-blow/anti-surge 200V HRC (High Rupture Capacity) fuse should be used for all models.

6. EMC

The SXE15 has been designed to comply with the EMC requirements of ETSI 300 386-1. It meets the most stringent requirements of Table 5; "Public telecommunications equipment, locations other than telecommunication centres, High Priority of Service."

Conducted Emissions
The required standard for conducted emissions is EN55022 (FCC Part 15). The SXE15 Single has a substantial LC filter on board that greatly reduces conducted emissions. However, to meet Class A and Class B limits, an external filter should be connected to the converter's input. External filter components are required because of space constraints on the 1" x 2" PCB. Additionally, having complete internal filtering would have removed the flexibility that end-users have to add a single filter to the input of all converters on a card, thereby reducing cost and space in the application.

A typical conducted noise plot for the SXE15-48S3V3 is shown in Figure 3 (average measurement). The filter circuit to achieve the Class B standard is shown in Figure 4. All other models have similar EMI plots and these are available on request. Class A filter information may also be obtained from Artesyn Technologies upon request.

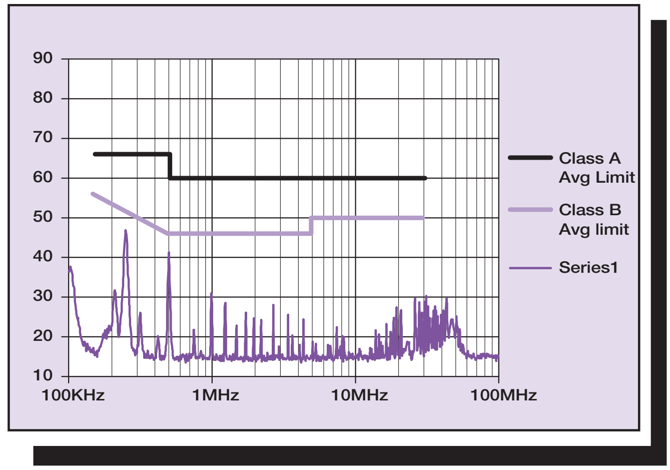


Figure 3 - SXE15-48S3V3 Conducted Noise with Recommended Class B External Filter

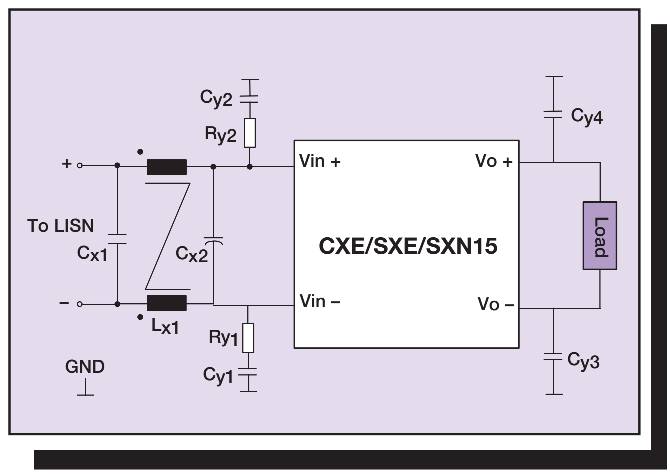


Figure 4 - Recommended Class B Filter

The part numbers for the components used are given below:

Cx1, ITW Paktron 4μF, 100V, SMT film capacitor, 405K100CS4
Cx2, ITW Paktron 4μF, 100V, SMT film capacitor, 405K100CS4,
Cy1, Cy2, AVX 5.6nF, 1.5kV, 1812SC562KA1
Cy3, Cy4, AVX 0.1μF, 100V, 12061C104KAT
Ry1, Ry1, 5.6Ω resistor
Lx1, Pulse Eng PO354

Radiated Emissions
The applicable standard is EN55022 Class B (FCC Part 15). Testing DC/DC converters as a stand-alone component to the exact requirements of EN55022 is very difficult, because the standard calls for 1m leads to be attached to the input and output ports and aligned such as to maximize the disturbance. In such a set-up it is possible to form a perfect dipole antenna and very few DC/DC converters would pass the test.

However, the standard also states that 'an attempt should be made to maximize the disturbance consistent with the typical application by varying the configuration of the test sample'. In addition, ETS 300 386-1 states that the testing should be carried out on the enclosure. For most applications the signal input lines to the converter should be less than 3 metres long and this is sufficient to meet the requirements of the standard.

The scans (measured at approx. 3 metres in an anechoic chamber) were taken at an accredited test site. The module orientation, along with the height and polarisation of the antenna, was investigated to ensure that maximum emissions were obtained. The test showed that the product meets the Class A standard and these results are available from Artesyn Technologies on request

7. Use in a Manufacturing Environment

7.1 Soldering Considerations

Large surface mount components typically require more solder paste than smaller components to ensure a reliable solder joint. The SXE15 series surface mount converters have been evaluated for solder joint reliability to MIL-STD-202F and IPC 610 Class B standards. This evaluation was completed on SXE15 and SXN15 samples using 2.7mm^3 of solder paste. The required volume can be achieved by printing 0.254mm (10mil) paste onto the recommended land pattern.

Although this volume is recommended, tests have been conducted using lower volumes with successful results. Contact Artesyn Technologies for details.

7.2 Reflow Considerations

The gull-wing leads are plated with tin-lead to prevent corrosion and ensure good solderability. Eutectic solder typically melts at 183°C. The lead temperatures must exceed this for a minimum of 30 seconds in order to to guarantee a reliable solder joint.

The temperature of each gull-wing lead varies during reflow due to differences in internal components, PCB lands and connecting paths. Pin 1 is a good choice for conservative temperature measurement, because it is connected to heavy copper paths.

Figure 5 shows the lead temperature of pin 1 during a typical recommended reflow profile.

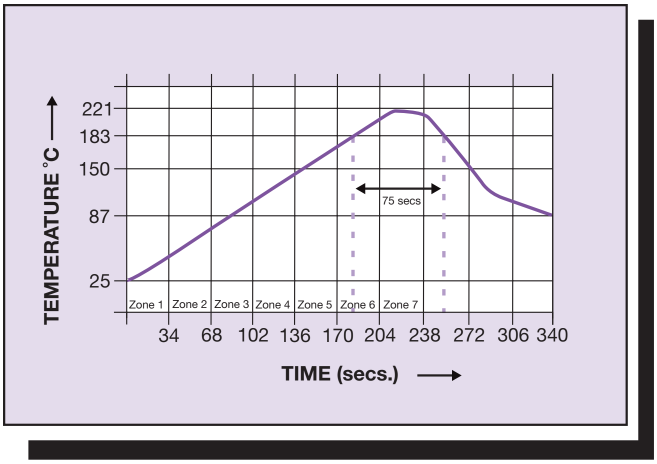


Figure 5 - Recommended Reflow Profile for SXE15 and SXN15

7.3 Water Washing

Where possible a no-clean solder paste system should be used for solder attaching the SXE15 product onto application boards. The SXE15 is suitable for water washing applications, because it does not have entrapment areas where water and residues may become trapped long term. However, the user must ensure that the drying process is sufficient to remove all water from the converter after washing - never power the converter unless it is fully dried. The user's process must clean the soldered assembly in accordance with ANSI/J-STD-001.

7.4 ESD Control

SXE15 units are manufactured in an ESD controlled environment and supplied in conductive packaging to prevent ESD damage occurring before or during shipping. It is essential that the units are unpacked and handled using an approved ESD control procedure. Failure to do so could affect the lifetime of the converter.

8. Applications

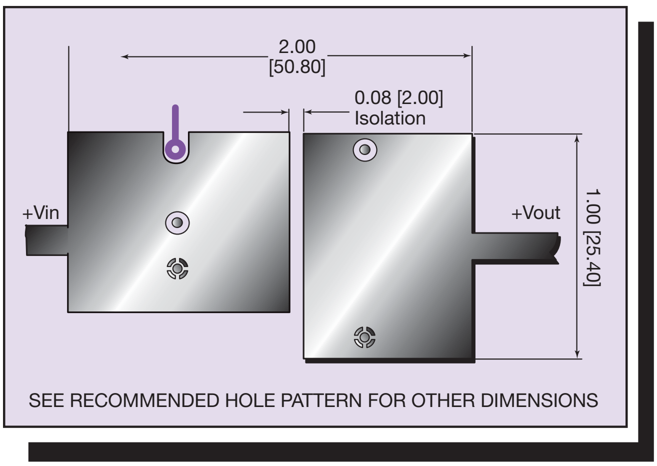
8.1 Optimum PCB Layout

Figures 6, 7, 8 and 9 show the optimum PCB layout with the recommended copper thickness of 2oz/ft² or 70µm copper. The PCB acts as a heatsink and draws heat from the unit via conduction through the pins and by radiation. The copper layer also acts as an EMC shield. If the recommended layout or 2oz/ft² copper isn't used then the user needs to ensure that the hot-spot highlighted in the thermal section is kept within the recommended limits (see Section 8.3). The hotspot must also be monitored if the unit is not mounted vertically. This may result in reduced output power, particularly if there is no forced air present.

The recommended PCB layouts will not compromise the creepage and clearance requirements discussed in the safety section of this application note. However, the end user must ensure that other components and metal located in the vicinity of the SXE15 meet the spacing requirements to which the system is approved.

Note also that the recommended layouts do not guarantee system EMC compliance, since this depends upon the end application.

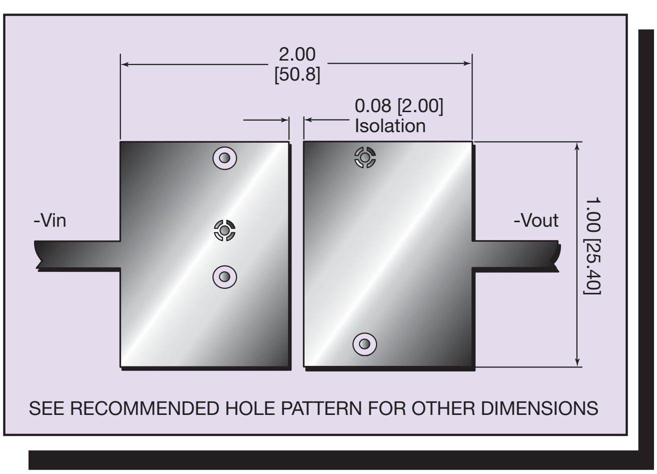
VIEW IS FROM TOP SIDE



THERMAL RELIEF IN CONDUCTOR PLANES
REFERENCE IPC-D-275 SECTION 5.3.2.3
ALL DIMENSIONS IN INCHES (mm)
ALL TOLERANCES ARE ±0.10 (0.004)

Figure 6 - Optimum PCB Layout for EMC and Thermals for CXE15 on a double-sided PCB (including Keep-Out areas) Plot 1 of 2

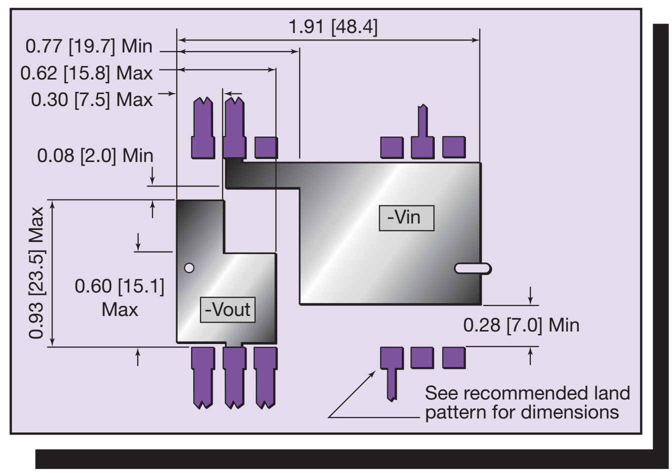
VIEW IS FROM TOP SIDE



THERMAL RELIEF IN CONDUCTOR PLANES
REFERENCE IPC-D-275 SECTION 5.3.2.3
ALL DIMENSIONS IN INCHES (mm)
ALL TOLERANCES ARE ±0.10 (0.004)

Figure 7 - Optimum PCB Layout for EMC and Thermals for SXN15 on a double-sided PCB (including Keep-Out areas) Plot 2 of 2

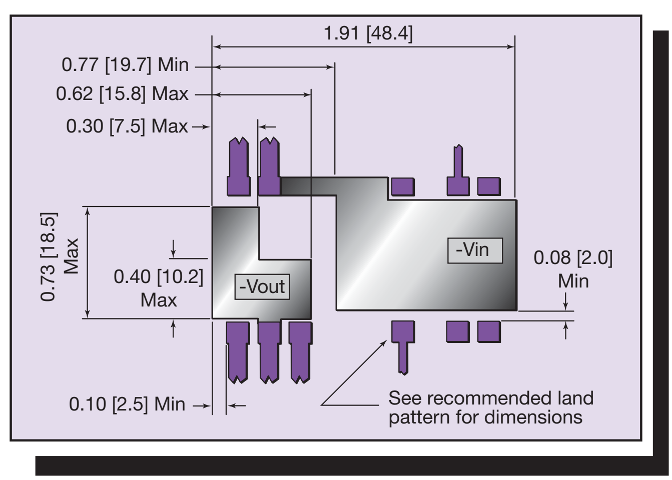
VIEW IS FROM TOP SIDE



THERMAL RELIEF IN CONDUCTOR PLANES
REFERENCE IPC-D-275 SECTION 5.3.2.3
ALL DIMENSIONS IN INCHES (mm)
ALL TOLERANCES ARE ±0.10 (0.004)

Figure 8 - Optimum PCB Layout for EMC and Thermals for SXE15 on a single-sided PCB (including Keep-Out areas)

VIEW IS FROM TOP SIDE



THERMAL RELIEF IN CONDUCTOR PLANES
REFERENCE IPC-D-275 SECTION 5.3.2.3
ALL DIMENSIONS IN INCHES (mm)
ALL TOLERANCES ARE ±0.10 (0.004)

Figure 9 - Optimum PCB Layout for EMC and Thermals for SXN15 on a single-sided PCB (including Keep-Out areas)

8.2 Safe Area of Operation

The Safe Operating Area (SOA) of the SXE15 single output converter is shown in Figure 10 and that for the dual output model is shown in Figure 11.

According to Figure 10, the SXE15 single output model can deliver the rated output current I_{rated} provided the hotspot temperature (see Section 8.3) is within the prescribed limits. Note however that the SOA does not remain valid across the full trim range of the converter. For example, if the unit is trimmed up by 10%, the output current must be correspondingly derated so that the output power remains at 15W. The module will still deliver full rated output current when the output is trimmed down.

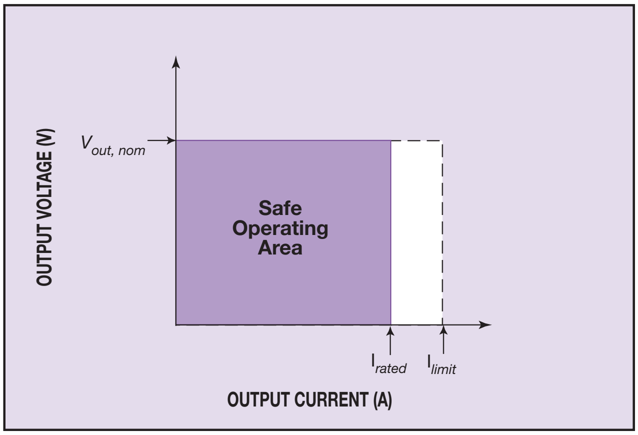


Figure 10 - Safe Operating Area (Single Output Models)

According to Figure 11, the SXE15 dual output models can deliver the rated output current I_{rated} from either output if the other is at no-load (0A), provided the hotspot temperature (See Section 8.3) is within the prescribed limits. If, as is most likely, both outputs are loaded, the maximum allowable current line in Figure 11 must be used as in the following example:

Consider output 1 is loaded 75%. The maximum allowed current on output 2 is determined by drawing a horizontal line from the vertical axis until it meets the maximum allowable current line. A vertical line is drawn from the intersection of the horizontal and the maximum allowable current line until it meets the horizontal axis. The value this line intersects is the maximum allowed current on output 2 for a 75% loading on output 1.

Note, however, that the SOA does not remain valid across the full trim range of the converter. For example, if the unit is trimmed up by 10%, the output current must be correspondingly derated. The module will still deliver full rated output current when the output is trimmed down.

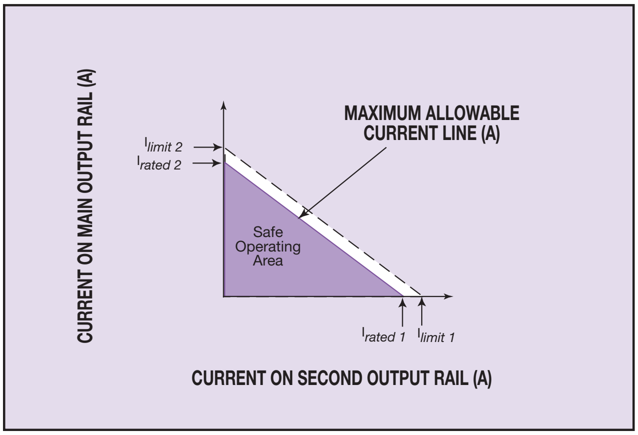


Figure 11- Safe Operating Area (Dual Output Models)

8.3 Optimum Thermal Performance

The SXE15 can operate in still air up to the maximum ambient temperature indicated in Table 3 when the recommended PCB layouts shown in Section 8.1 are used. Natural convection is defined as <0.1m/s airflow (20CFM). The SXE15 series has also been characterised for operation when forced air cooling is available. Figure 12 shows how forced air cooling will allow operation of the SXE15-48S3V3 in a higher ambient (up to 85ºC) at full output power. A full range of plots is available in the long form data sheets. Operation up to 100ºC ambient is also possible with derating. Consult the factory for details.

Model	Rated Ambient Temperature in absence of forced Air Cooling
SXE15-48S12	70
SXE15-48S05	65
SXE15-48S3V3	65
SXE15-48S2V5	70
SXE15-48S1V8	70
SXE15-48D05-3V3	65
SXE15-48D3V3-2V5	65

Table 3 - Maximum Ambient at Full Power, Natural Convection

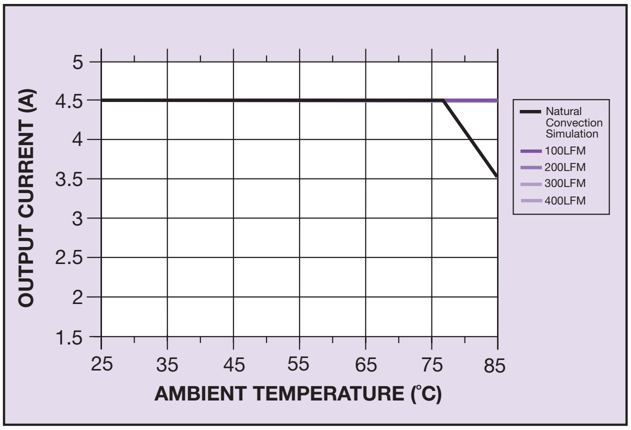


Figure 12 - Output Current vs. Ambient Temperature in Natural Convection and Airflow for SXE15-48S3V3

During airflow testing the SXE15 was mounted vertically, with air flowing lengthwise along the converter from the input to the output side as shown in Figure 13.

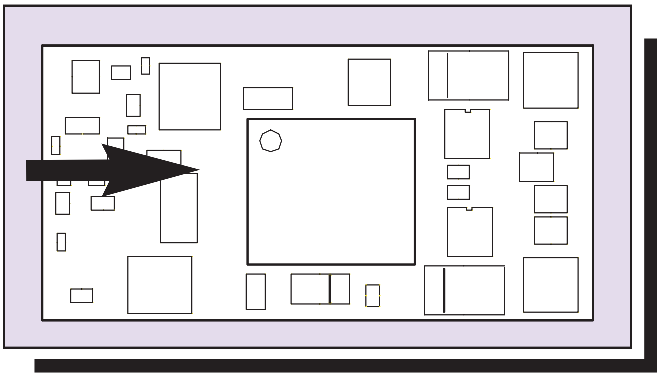


Figure 13 - Recommended Direction of Forced Air. Air Flow is from Input Pins to Output Pins on all Models

The most accurate method of ensuring that the converter is operating within its guidelines in a chosen application is to measure the temperature of a hot-spot. There is one such position on the CXE15, SXE15 and SXN15. Its temperature depends on the input line voltage, output load and the ambient temperature. This hot spot, the main transformer, is shown in Figures 14 to 16.

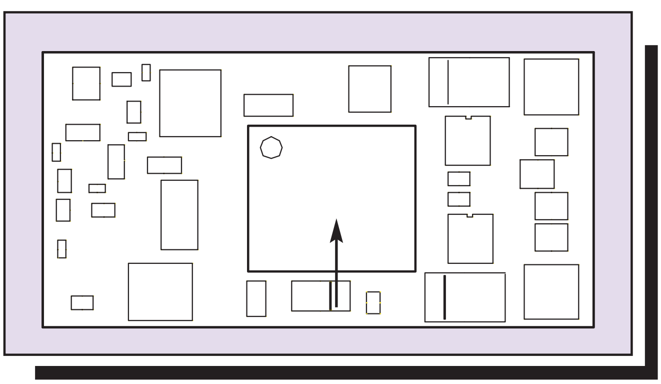


Figure 14 - Hot Spot Location on CXE15 Single

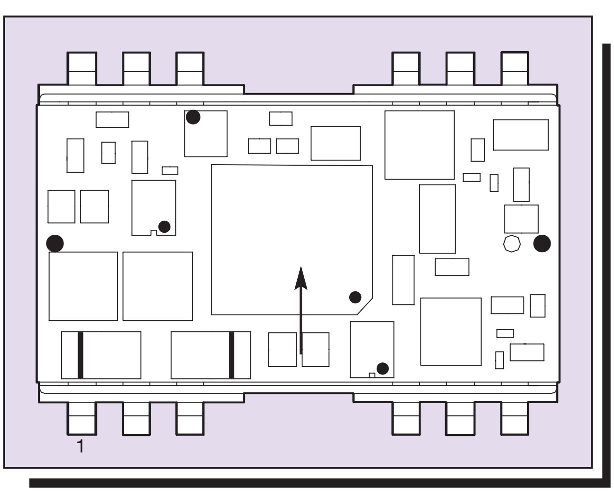


Figure 15 - Hot Spot Location on SXE15 Single

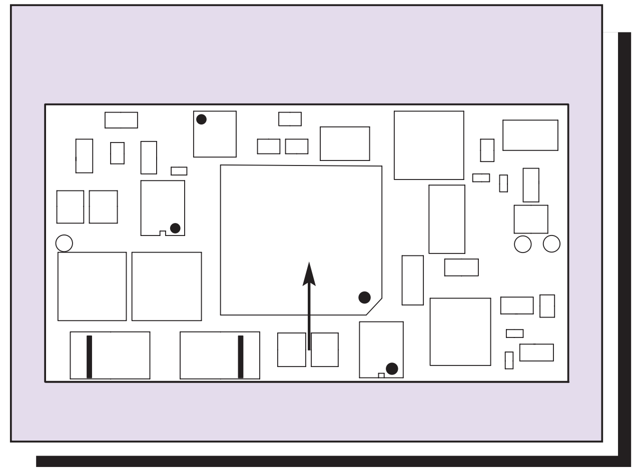


Figure 16 - Hot Spot Location on SXN15 Single

In order to comply with Artesyn's derating criteria and relevant safety standards the temperature of the hotspot should never rise above 115˚C.

8.3 Remote ON/OFF Control

The Remote ON/OFF control feature allows the user to switch the converter on and off when an appropriate signal is applied to the remote pin. This is a primary referenced function that allows the converter be put in a low power dissipation sleep mode.

8.4 Specification for the Remote ON/OFF

See signal electrical interface on the SXE15 Single and SXE15 Dual data sheets.

8.5 Isolated Closure Remote ON/OFF

An isolated closure is a closure with both high and low impedance states that sinks current, but does not source current. For on/off control the closure is between the on/off pin and Vin-. This can be a device such as a mechanical switch, open collector transistor or opto-isolator.

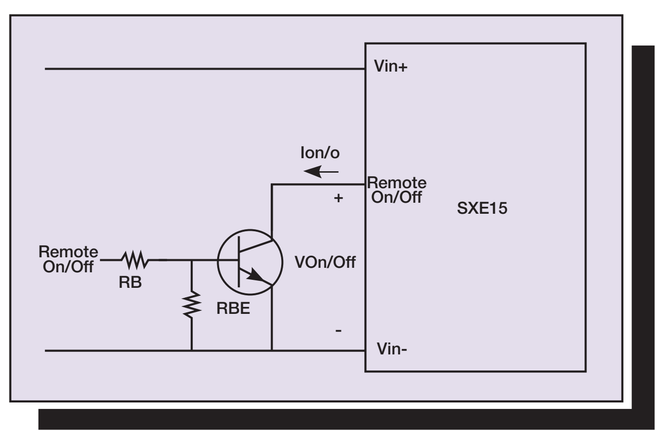


Figure 17 - Isolated Closure using a Transistor

Note that in the long form data sheet, that the maximum acceptable leakage current is 50µA. The isolation device should have a leakage current less than this value or the module may go into a low power dissipation mode (enabled).

8.7 Output Voltage Adjustment

The output can be trimmed by ±10% by connecting an external resistor between the TRIM pin and either of the output voltage pins. The single and dual output models have different trim characteristics and will be considered in turn.

Single output models:
With an external resistor between TRIM and V_{out}+, (R_{ADJ_DOWN}), the output voltage setpoint decreases (See Figure 18). Conversely, connecting an external resistor between TRIM and V_{out}-, (R_{ADJ_UP}), increases the output voltage setpoint (See Figure 19).

Dual output models:
With an external resistor between TRIM and V_{out2}+ (See Figure 20) the output voltage setpoint decreases. Conversely, connecting an external resistor between TRIM and COM (See Figure 21) increases the output voltage setpoint. In each case both output rails increase or decrease together.

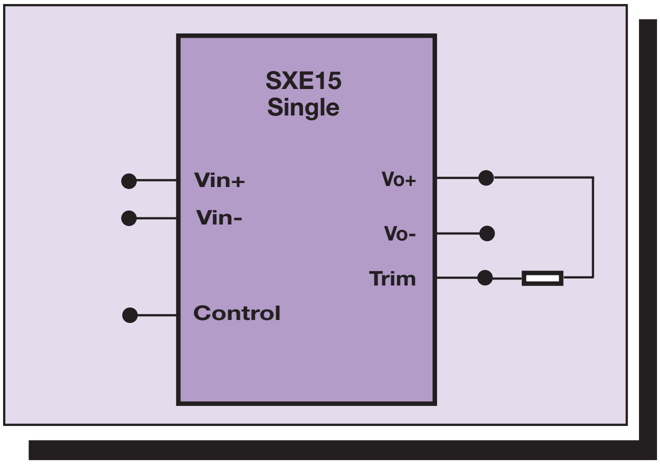


Figure 18 - Circuit Configuration to Decrease Output Voltage (Singles)

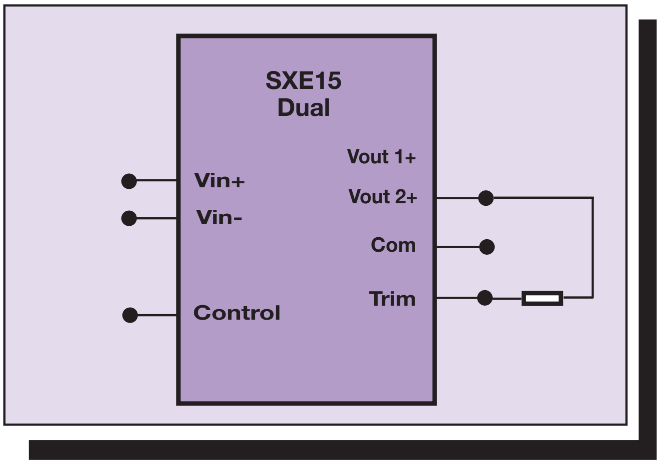


Figure 20 - Circuit Configuration to Decrease Output Voltage (Duals)

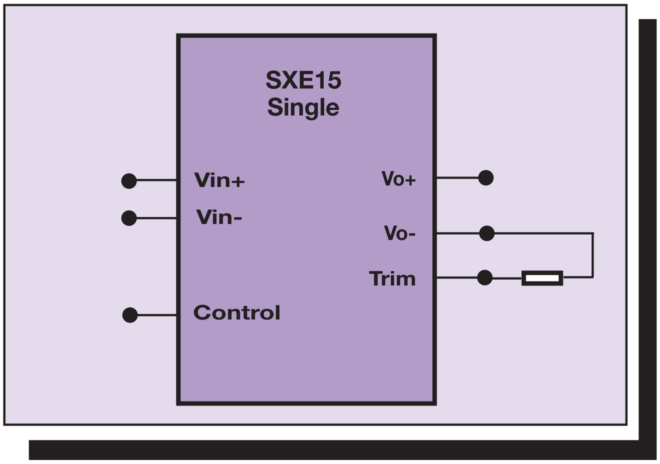


Figure 19 - Circuit Configuration to Increase Output Voltage (Singles)

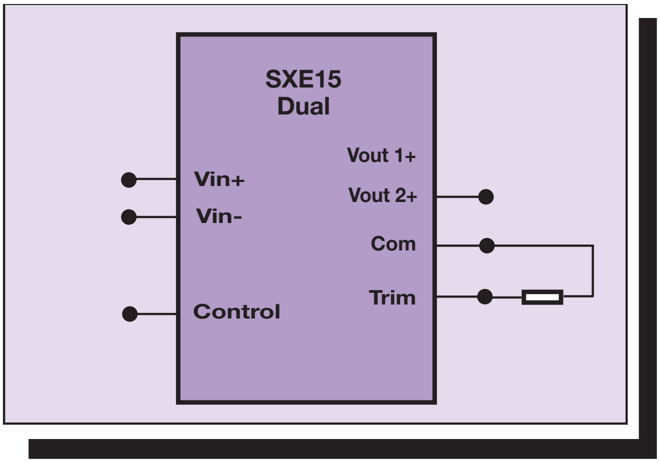


Figure 21 - Circuit Configuration to Increase Output Voltage (Duals)

8.3 Trim Behaviour of Various Models

8.3.1 Single Output Models (not including SXE15-48S12)

The equations used to determine the value of the external resistor (specified in kΩ) required to obtain the desired output voltage are:

$$Radj\_down = \left[\frac{(V_{trim\_down} - L)G}{(V_{out,\ nom} - V_{trim\_down})} - H\right] k\Omega$$

Equation 1 - Resistor Required for Trim Down Operation

$$Radj\_up = \left(\left[\frac{GL}{(V_{trim\_up} - L) - K}\right] - H\right) k\Omega$$

Equation 2 - Resistor Required for Trim Up Operation

Where,

Vout, nom	is the nominal output voltage of the module
Vtrim-down (or Vtrim-up)	is the desired output voltage
R_{ADJ_DOWN}	is the resistor required to achieve the desired (trimmed down) output voltage
R_{ADJ_UP}	is the resistor required to achieve the desired (trimmed up) output voltage
G,H	are 5110 and 2050 respectively

and the following parameters are defined for the following models only:

Model	K	L
SXE15-48S05 SXN15-48S05	2.5	2.5
SXE15-48S3V3 SXN15-48S3V3	2.06	1.24
SXE15-48S2V5 SXN15-48S2V5	1.29	1.235
SXE15-48S1V8 SXN15-48S1V8	0.585	1.232

Example:

To trim up the SXE15-48S05 model by 10% to 5.5V the required external resistor is:

$$Radj\_up = \left(\left[\frac{5110(2.5)}{(5.5 - 2.5) - 2.5}\right] - 2050\right) k\Omega = 23.5k\Omega$$

To trim down the SXE15-48S3V3 model by 10% to 2.97V the required external resistor is 24.7kΩ. The same applies for the corresponding SXN models.

The trim equations for the CXE15 series are calculated using different K and L values. The values of K and L for the CXE15 series are defined in the following table:

Model	K	L
CXE15-48S05	2.5	2.5
CXE15-48S3V3	0.82	2.5
CXE15-48S2V5	1.235	1.27
CXE15-48S1V8	0.56	1.25

Automated trim calculators for all single output models (including SXE15-48S12, See Section 8.3.2) are available on www.artesyn.com/powerlab.

Note that when the output voltage is trimmed up by a certain percentage, the output current must be derated correspondingly so that the maximum output power of 15W is not exceeded.

Graphs of the required resistor for all models are shown in Figure 22 (trim up) and in Figure 23 (trim down).

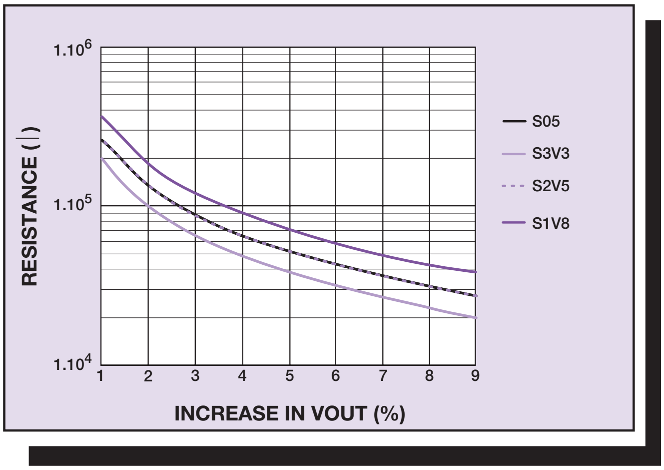


Figure 22 - Trim Up
Resistance vs. Percentage Change in Output Voltage
(Single Models not including SXE15-48S12)

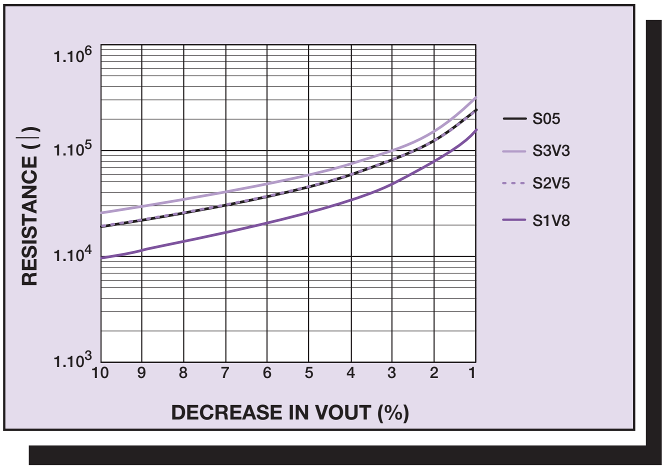


Figure 23 - Trim Down
Resistance vs. Percentage Change in Output Voltage
(Single Models not including SXE15-48S12)

8.3.2 SXE15-48S12

The SXE15 also has a 12V single output version. The trim equations for the SXE15-48S12 are shown below and the trim curves are illustrated in Figures 24 and 25.

$$Radj\_down = \frac{6.012\ Vout,adj - 40.628}{10.261 - 0.845\ Vout,adj} k\Omega$$

Equation 3 - Resistor Required for Trim Down of SXE15-48S12

$$Radj\_up = \frac{41.09 - 1.732\ Vout,adj}{0.845\ Vout,adj - 10.26} k\Omega$$

Equation 4 - Resistor Required for Trim Up of SXE15-48S12

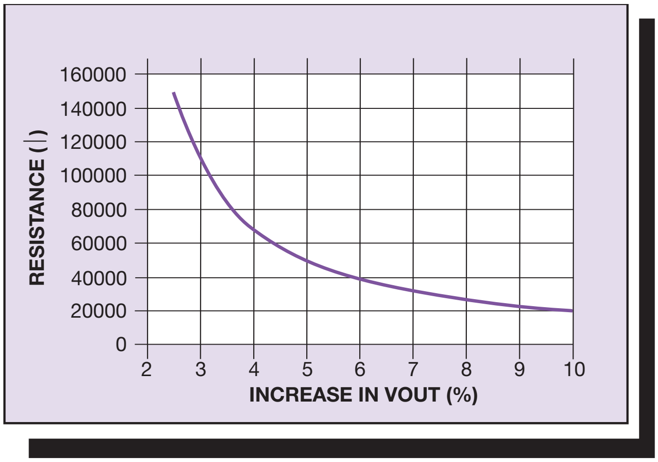


Figure 24 - Trim up
Resistor vs. Percentage Change in Output Voltage (12V Model)

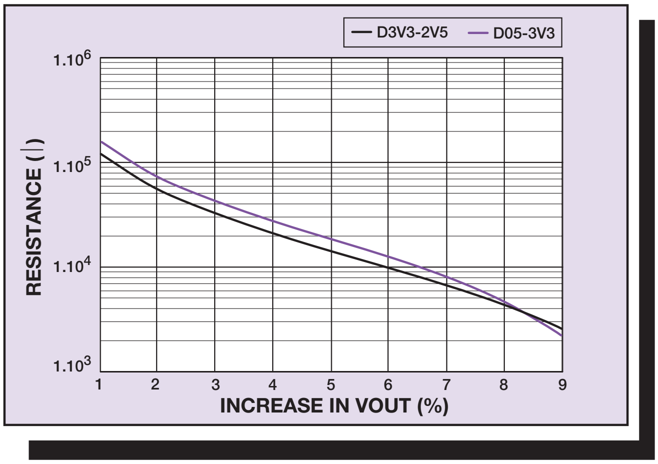


Figure 26 - Trim Up Resistor vs. Percentage Change in Output Voltage (Dual Models)

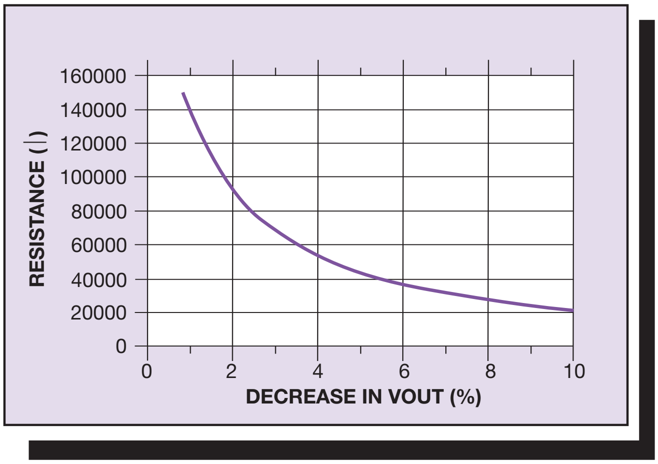


Figure 25 - Trim down
Resistor vs. Percentage Change in Output Voltage (12V Model)

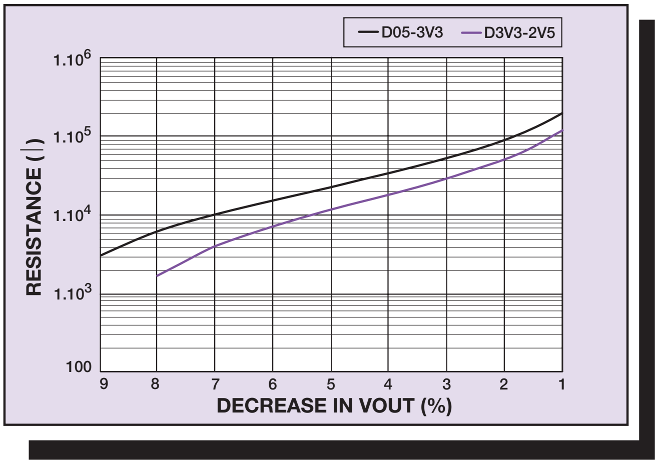


Figure 27 - Trim down Resistor vs. Percentage Change in Output Voltage (Dual Models)

8.3.3 Dual Output Models

The trim behaviour of the dual output models is shown in Figures 26 and 27. The required trim resistor is determined by selecting the desired percentage increase in V_{out}, drawing a perpendicular line from this axis until it meets the revelant trim curve and then drawing a horizontal line from this intersection until it meets the vertical axis. The desired resistance value is read off this axis. A trim calculator for the SXE15 duals is available on www.artesyn.com/powerlab. This tool is recommended for accurate estimation of the required trim resistor.

8.8 Output Capacitance

The SXE15 series is been designed for stable operation without the need for external capacitors at the input or output terminals when powered from a low impedance source. However, when powering loads with large dynamic current requirements, improved voltage regulation can be obtained by inserting decoupling capacitors as close as possible to the load. Low ESR ceramic capacitors will handle high frequency current components, while tantalum capacitors can be used to handle the lower frequency dynamic current variations. Note that the absolute maximum value of output capacitance is 10,000µF. Please contact your local Artesyn Technologies representative if you wish to use larger values of output capacitance.

8.9 Reflected Ripple Current and Output Ripple and Noise Measurement

The measurement set-up outlined in Figure 28 has been used for both input reflected/terminal ripple current and output voltage ripple and noise measurements on SXE15 series converters. When measuring output ripple and noise, a 50Ω coaxial cable with a 50Ω termination should be used to prevent impedance mismatch reflections disturbing the noise readings at higher frequencies. The input ripple current measurement set-up is compatible with ETS 300 386-1.

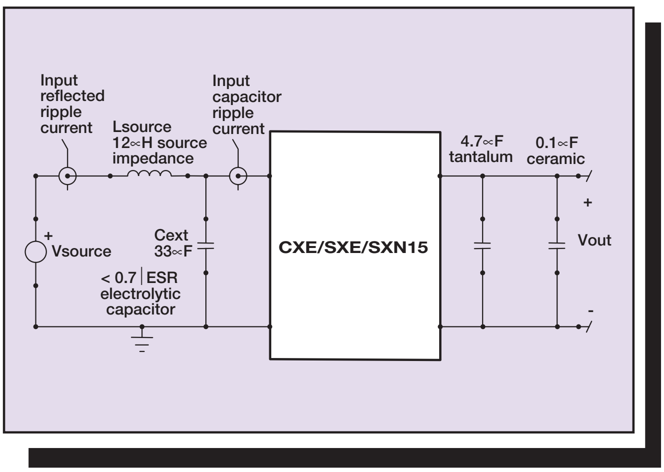


Figure 28 - Reflected Ripple Current Measurement Set-up

8.11 Parallel Operation

Because of the absence of an active current sharing feature, parallel operation of multiple SXE15 is not recommended. If unavoidable, Oring-diodes must be used to decouple the outputs. Droop resistors will support some passive current sharing. It should be noted that both measures will adversely affect the power conversion efficiency.

8.12 Compatability with ADM1070 Hot Swap Controller

Inserting circuit boards into a live -48V backplane can cause large input transient currents when large capacitances are charged. These transient currents can cause glitches on the system power supply and permanently damage components on the board. To ensure that the input voltage is stable and within tolerance before being applied to the DC-DC converter, Artesyn Technologies recommends the use of a hot-swap controller, such as the ADM1070 from Analog Devices. This device controls harmful transient currents and ensures safe insertion or removal of the application board from a live backplane.

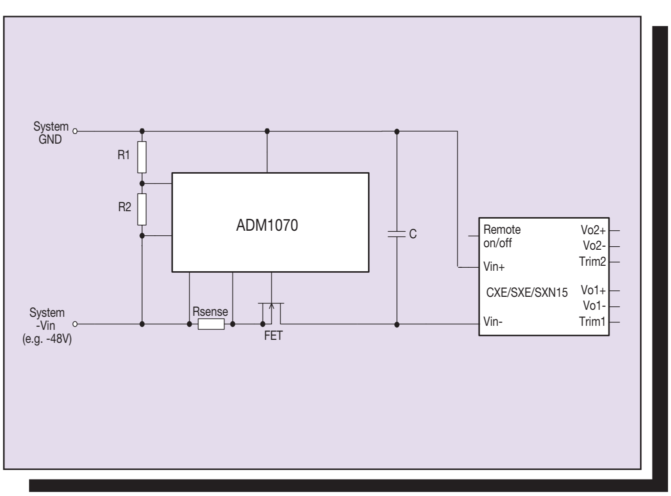


Figure 29 - Inrush Current Control using ADM1070

The ADM1070 is a 6-pin SOT-23, negative voltage hot-swap controller that allows a board to be safely inserted and removed from a live backplane. This product is compatible with the CXE/SXE/SXN15 family.

The ADM1070 provides the following features:

- Inrush current is limited to a programmable value by controlling the gate voltage of an external N-channel pass transistor
- The pass transistor is turned off if the input voltage is less than the programmable under-voltage threshold or greater than the over-voltage threshold. A programmable electronic circuit breaker protects the system against shorts.

The UV/OV pin can be used to detect under-voltage and over-voltage conditions at the power supply input. The CXE/SXE/SXN15 already has in-built under-voltage protection to ensure that the unit does not draw power from the source for voltages less than approximately 30V. Users should refer to the data sheet of the ADM1070 for details on setting the required UVLO and OVLO trip levels.

The ADM1070 features a current limiting function that protects against short circuits or excessive supply currents. The flow of current through the load is monitored by measuring the voltage across the sense resistor, R_{sense}. The action taken by the controller in the event of an input over-current condition will depend upon the severity of that condition. Please refer to the ADM1070 product datasheet on www.analog.com for details.