

EXB30S SERIES

Application Note 108



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- **Ultra high efficiency topology, 92% typical at 5V**
- **Operating ambient temperature of -40°C to +85°C (natural convection)**
- **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**
- **Basic insulation (input to output)**
- **Industry standard half-brick pin-out**

1. Introduction

The EXB30 series is a new generation of DC/DC converters which were designed in response to the growing need for low operating voltage and higher efficiencies. They offer unprecedented efficiency figures and a wide range of low output voltage solutions.

In addition the automated manufacture methods and use of planar magnetics together with an extensive qualification program have produced one of the most reliable range of converters on the market.

2. Models and Features

The EXB30 series comprises five separate models as shown in Table 1. All popular integrated circuit operating voltages are covered by the entire range.

Model	Input Voltage	Output Voltage
EXB30-48S05	36-75VDC	4.0V to 5.5V
EXB30-48S3V3	36-75VDC	2.64V to 3.63V
EXB30-48S2V5	36-75VDC	2.0V to 2.75V
EXB30-48S2V0	36-75VDC	1.6V to 2.2V
EXB30-48S12	36-75VDC	7.2V to 13.2V

Table 1 - EXB30 Models

Features

- Industry standard half-brick pinout and footprint: 61.0 x 57.9 x 10.9mm (2.40 x 2.28 x 0.43 inches)
- Wide operating ambient temperature range of -40°C to +85°C
- Output voltage adjustability
- Remote sense compensation
- Primary-side controlled remote on/off
- Constant switching frequency
- Brickwall overcurrent protection
- Continuous short circuit protection
- Overtemperature protection
- Output overvoltage protection
- Input undervoltage and overvoltage protection

3. General Description

Electrical Description

The EXB30 power module is a DC/DC converter that operates over an input voltage range of 36VDC to 75VDC and provides an isolated regulated DC output. The modules have maximum power ratings of 30W and excellent efficiencies are achieved by optimum driving of the synchronous rectification stage. The standard feature set includes remote on/off, remote sense and output trim for maximum flexibility in distributed power applications.

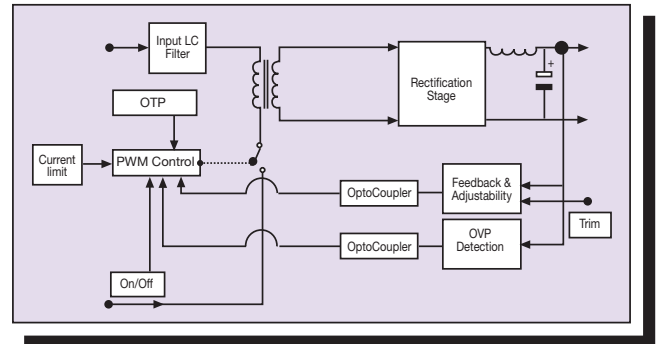


Figure 1 - Simplified Schematic

The DC input is filtered by an LC filter 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 300kHz approximately.

The output voltage at the sense pins of the module 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 sense pin.

The output overvoltage clamp consists of a second control loop, independent from the main regulation loop, that senses the voltage on the output power pins. This OVP loop has typically a 15% higher setpoint relative to the main loop. Further details on the OVP feature can be found in the applications section.

An Over-Temperature Protection (OTP) circuit on the primary side shuts down the PWM controller if the converter is in danger of being damaged. There is typically 5°C of thermal hysteresis which is used to protect the unit.

The remote on/off function allows the user to disable the converter, hence forcing the unit into a lower power dissipation mode.

The power transformer which is a planar construction uses the PCB for the primary winding while SMT copper windings are used for the secondary winding. Electrically, the transformer operates just the same as a conventional transformer. However, the advantages of a planar design are as follows:

- Excellent thermal characteristics
- Low leakage inductance
- Excellent repeatability properties

In the low voltage models the rectification stage consists of synchronous rectifiers that are controlled by proprietary circuitry on the secondary side which optimise the driving scheme for high efficiency power conversion. The rectification stage for the 12V model consists of schottky diodes.

Physical Construction

The EXB30 is constructed using a single multi-layer FR4 PCB. SMT components are placed on both sides of the PCB and in general, the heavier power components are mounted on the top side in order to optimise heat dissipation.

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

- **Cost:** No potting compound, 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. In addition open frame converters are more easily re-cycled.
- **Reliability:** Open Frame modules are more reliable for a number of reasons.

A separate paper discussing the benefits of 'open frame low to medium DC/DC converters' Design Note 102 is available from Artesyn Technologies. The effective elimination of potting and a case has been made possible by the use of modern automated manufacturing techniques and in particular the 100% use of SMT components, the use of planar magnetics and the exceptionally high efficiencies.

4. Features and Functions

Wide Operating Temperature Range

The wide ambient temperature range of the EXB30 module is a consequence of the extremely high efficiency achieved and consequent low power dissipation. Operation from -40°C to a maximum ambient temperature of +85°C is achieved without the requirement for heatsinks or forced air cooling, making the EXB30 ideally suited to cost and space sensitive applications.

Remote Sense Compensation

The EXB30 models have a remote sense feature to compensate for moderate voltage drops in the distribution system. Thus accurate voltage regulation can be achieved directly at the load terminals. Further details concerning the remote sense compensation feature are presented in the applications section.

Output Voltage Adjustment

The output voltage on the 2V, 2.5V, 3.3V and 5V models is trimmable by -20% to +10% of the nominal output voltage. The 12V output voltage can be trimmed by -40% to +10%. Details on how to trim all models are provided in the applications section.

Remote On/Off

The Remote On/Off function allows the unit to be controlled by an external signal which puts the module into a low power dissipating sleep mode. Methods of using this function are given in the applications section.

Constant Switching Frequency

The switching frequency for all models is fixed at approximately 300kHz and is independent of line and load levels. This makes the overall power system more predictable and greatly simplifies the design of the input filter required for EMC compliance.

Brickwall Current Limit and Short Circuit Protection

All models of the EXB30 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. A slight tailout characteristic may be evident in some models when the output voltage is reduced to very low values, i.e. under short circuit conditions. A short circuit is defined as a resistance of 20mΩ or less.

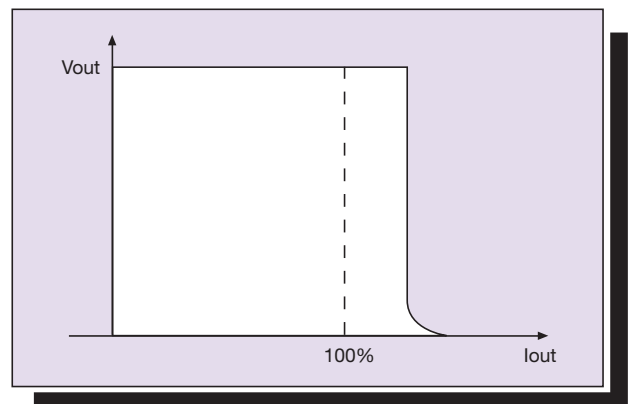


Figure 2 - Typical Brickwall V-I Characteristic

The current limit inception point is dependent on the input voltage, ambient temperature and has a parametric spread also. For all models the inception point is typically 115% of rated full load. It may go as high as 150% or as low as 100% over all operating conditions and the lifetime of the product.

None of the specifications are guaranteed when the unit is operated in an overcurrent condition. The unit will not be damaged in an overcurrent condition as it will protect itself through the use of the OTP function before any damage occurs. However the lifetime of the unit may be reduced.

In a severe short circuit the unit may enter a 'hiccup' current mode and may be operated continuously in this condition. The duty cycle of this hiccup is dependent on input voltage, temperature etc. While the unit is specified to operate into a continuous short circuit, extended or frequent short circuits will reduce the lifetime of the converter.

The current limit characteristic for the EXB30-48S12 is unlike that for the low voltage models. The unit will exhibit brickwall current limit for approximately 100ms after which the unit enters a hiccup mode. The duty cycle of the hiccup depends on the level of overcurrent. This mode of operation will continue indefinitely until the overcurrent condition is corrected.

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

Over Temperature Protection

This feature is included as standard in order to protect the converter and the circuitry it powers from overheating in the event of a runaway thermal condition such as a fan failure at high temperatures or continuous operation above T_{max} at full power.

Prolonged operation under short circuit conditions at high ambient temperatures might also cause the OTP circuit to trip.

The actual ambient temperature it trips at is dependent on quite a number of factors. The airflow over the unit is the most dominant parameter. The trip point is also affected by the input voltage, output trim voltage, user PCB layout, output load and model.

For all models under full load conditions the trip point will be at a minimum ambient of 90°C in still air using the recommended layout in the Applications section. Still air or natural convection is defined as less than 0.1m/s airflow.

As the load is decreased and the unit is operated at higher temperatures, the trip point also rises. This trip point will at all times protect the unit and will be a minimum of 5°C within the safe operating temperature of the device.

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. Faults of this type include optocoupler failure, blown sense resistor or error amplifier failure. The unit is also protected in the event that the output is trimmed above the recommended maximum specification.

The OVP circuit consists of an auxiliary control loop running in parallel to the main control loop using a separate optocoupler. However, unlike the main loop, the OVP loop senses the voltage at the output power terminals of the module, Vo+ and Vo-. The sensed voltage is compared to a separate OVP reference and a compensated error signal is generated such that the output voltage is regulated to the OVP clamp level. The clamp levels are set quite accurately and are given in Table 2.

Output Voltage	Clamp Level
12V	14.2V
5V	5.6V
3.3V	3.8V
2.5V	3.0V
2.0V	2.3V
12.0V	14.2V

Table 2 - OVP Trip Point

Input Undervoltage and Overvoltage Protection

The EXB30 series is fitted with a detection circuit at the input side which inhibits operation of the converter when the input voltage is outside the normal operating range. For 48V models, the converter is disabled when the input voltage is below 32V or above 78V approximately. The lower trip value protects against deep discharge of telecom batteries while the upper level protects the module from operating beyond the maximum input voltage rating. The thresholds also have inherent hysteresis to provide immunity against slow ramping input voltages. The module operates in a low power dissipation mode when protected.

5. Safety

Isolation

The EXB30 has been submitted to independent safety agencies and has EN60950 and UL1950 Safety approvals. Basic insulation is provided and the unit is approved for use between the classes of circuits listed in Table 3.

Insulation	
Between	And
TNV-1 Circuit	Earthed SELV Circuit Unearthed SELV Circuit
TNV-2 Circuit TNV-3 Circuit	Earthed SELV Circuit Unearthed SELV Circuit or TNV-1 Circuit
Earthed or Unearthed Hazardous Voltage Secondary Circuit	Earthed SELV Circuit ELV Circuit Unearthed Hazardous Voltage Secondary Circuit TNV-1 Circuit

Table 3 - Insulation Categories for Basic

The TNV or Telecommunication Voltage definitions are given in Table V.1 of IEC950 from which EN60950 and UL1950 are derived.

The EXB30 has an approved insulation system that satisfies the requirements of the safety standards.

In order for the user to maintain the insulation requirements of these safety standards it is necessary for the required creepage and clearance distances to be maintained between the input and output.

Creepage is the distance along a surface such as a PCB and for the EXB30 the creepage requirement between primary and secondary is 1.4mm or 55 thou. Clearance is the distance through air and the requirement is 0.7mm or 27 thou.

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 then the fuse may be in either input line.

A 2A HRC (High Rupture Capacity) is the recommended fuse rating for the EXB30 product.

6. EMC

The EXB30 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. Following is the list of standards which apply and which it has complied with.

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 (FCC Part 15) is very difficult to do as the standard calls for 1m leads to be attached to the input and output ports and aligned such as to maximise the disturbance. In such a set-up it is possible to form a perfect dipole antenna that very few DC/DC converters could pass.

However the standard also states that 'An attempt should be made to maximise 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. The EXB30 is primarily intended for PCB mounting in Telecommunication Rack systems.

For the purpose of the radiated test, an EXB30-48S3V3 was mounted on a test PCB (230 x 170mm) with Vin- connected to a copper ground plane on the PCB. A resistive load was connected by lead lengths of approximately 10cm and the lead length to the power source was 50cm. The unit was supplied with 48V input and the output was 3.3V at 8A. The measurements were carried out at a 10m measurement distance on an open area test site using a Rhode & Schwarz ESV receiver and a Farnell 352C Spectrum Analyser with a Schwarzbeck BBA9106 broadband VHF antenna. An independent test house performed the testing and a copy of the report is available on request. The results of the test are given in Table 4. All the responses were broadband in nature and there was no detectable response above 147.41MHz. (The 'V' denotes the antenna polarization for maximum response was Vertical). As evident, Class A radiated emission requirements of EN55022 are met with margin (limit is 40dB μ V/m).

Frequency (MHz)	Response (dB μ V/m)	Limit (dB μ V/m)
35.56	22.30V	40.00
42.28	25.60V	40.00
44.03	29.60V	40.00
48.34	21.30V	40.00
61.96	18.10V	40.00
78.88	20.20V	40.00
81.97	20.90V	40.00
109.62	27.40V	40.00
110.47	26.00V	40.00
147.41	35.30V	40.00

Table 4 - Radiated Emissions on EXB30-48S3V3 with Ground Plane (within Class A limits)

Secondly, an external pi-filter was connected at the input to the unit, details of which are given in Figure 5. The measured emission levels are given in Table 5. There was no detectable response above 146.54MHz. As evident, Class B radiated emission requirements of EN55022 are met with margin (limit is 30dB μ V/m).

Frequency (MHz)	Response (dB μ V/m)	Limit (dB μ V/m)
75.38	19.25V	30.00
81.20	21.20V	30.00
84.43	26.80V	30.00
116.78	24.50V	30.00
118.23	24.70V	30.00
119.99	25.95V	40.00
146.54	21.80V	30.00

Table 5 - Radiated Emissions on EXB30-48S3V3 with Ground Plane and External pi-filter (within Class B limits)

In both cases the unit passed the Class B limit which is 30 dB μ V/m with a significant margin.

Conducted emissions

The required standard for conducted emissions is EN55022 Class A (FCC Part 15). The EXB30 has a substantial LC filter on board which greatly reduces conducted emissions. However, to meet Class A and Class B, external pi-filters are connected as described in Figures 5 and 6 respectively. Putting these extra components on board the EXB30 would have added to the cost and footprint of the module. Additionally, this 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.

The conducted noise plots for the EXB30-48S05 are shown in Figures 3 and 4. The filter circuits to achieve these results are shown in Figures 5 and 6. All other models have similar curves and are available on request.

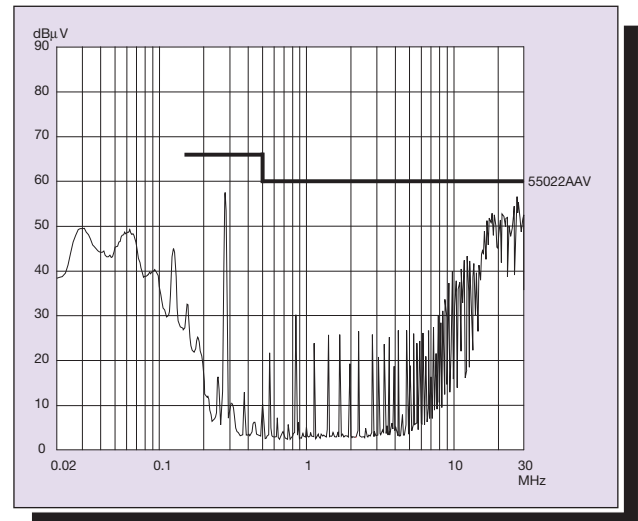


Figure 3 - Conducted Noise Measurements on EXB30-48S05 (meets Class A average)

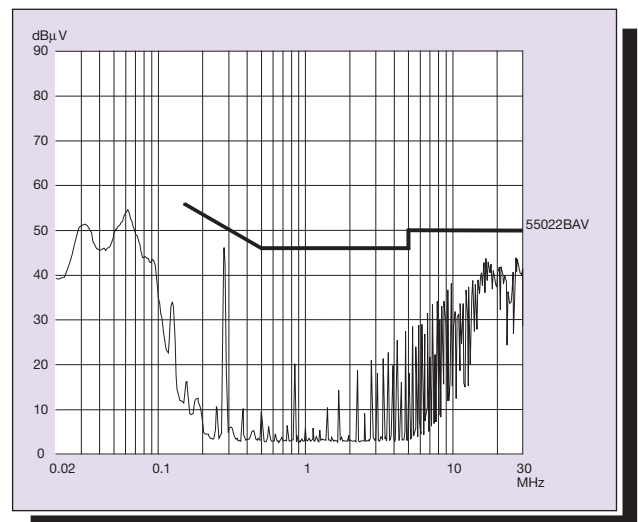


Figure 4 - Conducted Noise Measurements on EXB30-48S05 (meets Class B average)

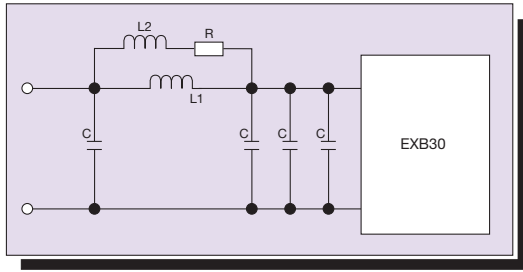


Figure 5 - Required Filter for Class A

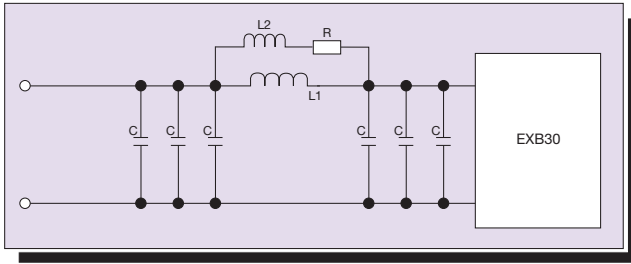


Figure 6 - Required Filter for Class B

The part numbers for the parts used in each case are given below:

- C 470nF 100V AVX ceramic capacitor part number 18121C474KATMA
- L1 47μH TDK inductor part number SLF10145T-470M1R4
- L2 27μH Siemens inductor part number B82422-H1273-K100
- R 10Ω 1206 1/4W resistor
- Bead MMG SM Ferrite Bead part number B82422-H1273-K100

7. Use in a Manufacturing Environment

Resistance to Soldering Heat

The EXB30 is intended for PCB mounting. Artesyn has determined how well it can resist the temperatures associated with the soldering of PTH components without affecting its performance or reliability. The method used to verify this is MIL-STD-202 method 210D. Within this method two test conditions were specified, Soldering Iron condition A and Wave Solder condition C.

For the soldering iron test the UUT was placed on a PCB with the recommended PCB layout pattern shown in the applications section. A soldering iron set to 350°C ± 10°C was applied to each terminal for 5 seconds. The UUT was then removed from the test PCB and was examined under a microscope for any reflow of the pin solder or physical change to the terminations. None was found.

For the wave soldering test the UUT was again mounted on a test PCB. The unit was wave soldered using the conditions shown in Table 8.

Temperature	Time	Temperature Ramp
260°C ±5°C	10s±1	Preheat 4°C/s to 160°C. 25mm/s rate

Table 8 - Wave Solder Test Conditions

The UUT was inspected after soldering and no physical change on pin terminations was found.

Water Washing

The EXB30 is suitable for water washing as it doesn't have any pockets where water may congregate long-term. The user should ensure that a sufficient drying process and period is available to remove the water from the unit after washing

ESD Control

The EXB30 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 they are unpacked and handled using an approved ESD control procedures. Failure to do so could affect the lifetime of the converter.

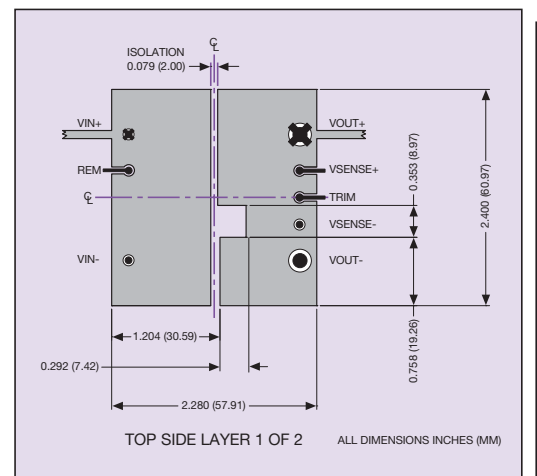
8. Applications

Optimum PCB Layout

2Oz/ft² or 70μm copper should be used for connection to the pins. The PCB acts as a heatsink and draws heat from the unit via conduction through the pins and radiation. The two layers also act as EMC shields. (The recommended layouts do not guarantee system EMC compliance as this is dependent on the end application). If the recommended layout or 2Oz/ft² copper isn't used then the user needs to ensure that the hot-spots highlighted in the thermal section are kept within their limits.

These recommended PCB layouts will maintain 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 EXB30 meet the spacing requirements that the system is approved to.

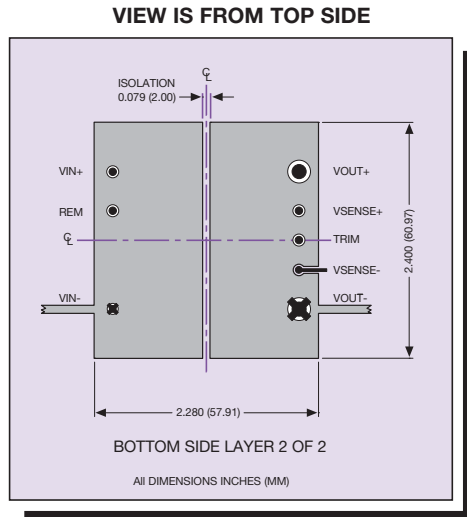
VIEW IS FROM TOP SIDE



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)

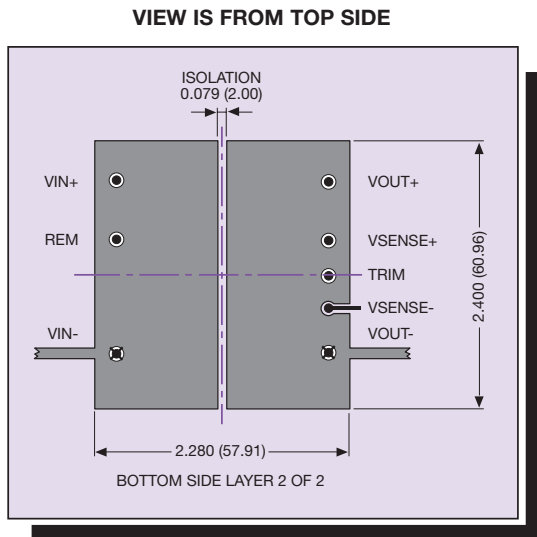
Figure 7 - Optimum PCB Layout for EMC and Thermals for Single Outputs on a Single-Sided PCB



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 8.1 - Optimum PCB Layout for EMC and Thermals for Single Outputs on a Double-Sided PCB (Top)



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 8.2 - Optimum PCB Layout for EMC and Thermals for Single Outputs on a Double-Sided PCB (Bottom)

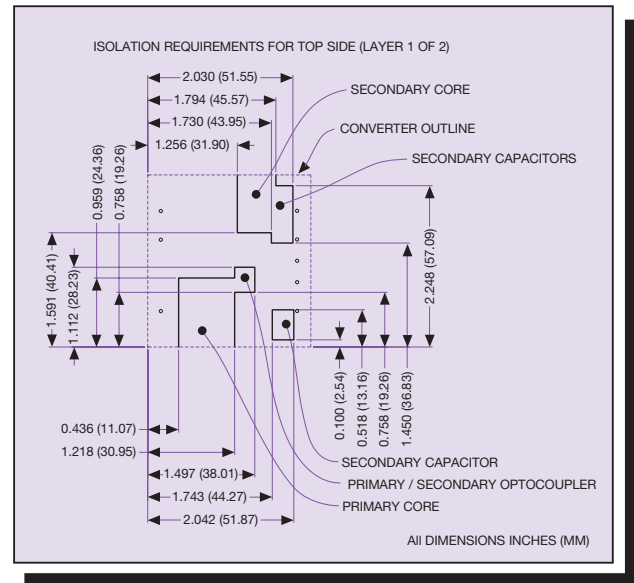


Figure 9 - Keep Out Areas on Top Side of User PCB to Meet Safety Spacing Requirements

Optimum Thermal Performance

The EXB30 can operate in still air up to a maximum ambient temperature of 85°C using the recommended PCB layouts shown in the previous section. Still air, which is sometimes called natural convection is defined as $<0.1\text{m/s}$ airflow (20CFM). The output power may be derated so that the maximum ambient operating temperature can be extended to 95°C as shown in Figure 10a. The 12V output is rated to supply an output current of 2.5A at an operating ambient temperature of 85°C. At 80°C the output current can be increased to 3.0A as shown in figure 10b.

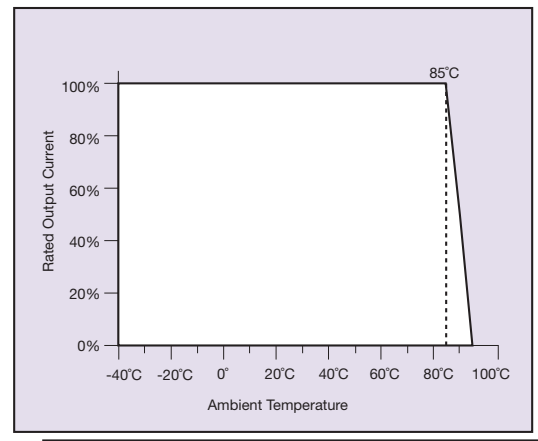


Figure 10a - Output Power vs. Ambient Temperature in Natural Convection for EXB30 series (Low Voltage Models)

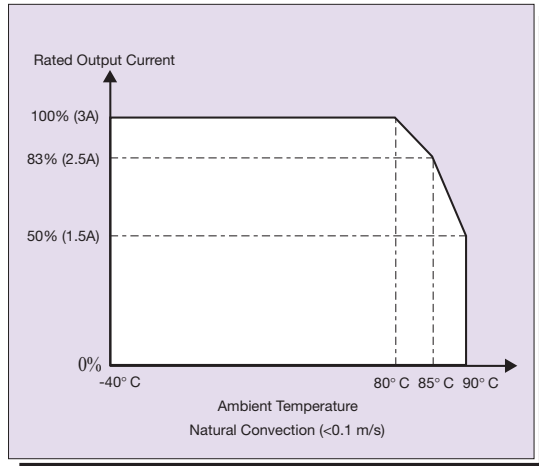


Figure 10b - Output Power vs. Ambient Temperature in Natural Convection for EXB30 12V model.

If forced air cooling is used then the converter may be used up to 95°C at full output power dependent on the airflow. Figure 11 is a graph of the increased maximum ambient temperature at full power versus the airflow across the converter.

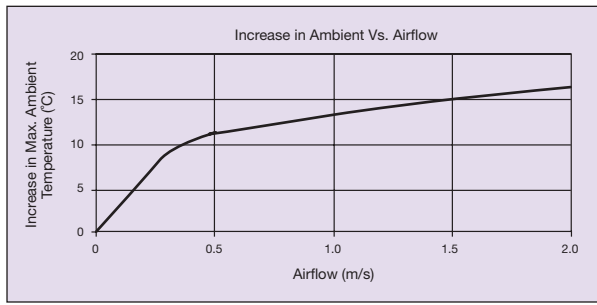


Figure 11 - Increased Maximum Ambient Temperature at Full Power with Forced Airflow

With an airflow of 1.5m/sec the allowed increase in ambient temperature is 15°C. Figure 12 shows the new derating curve for the 48S05 model operating with 1.5m/s forced airflow.

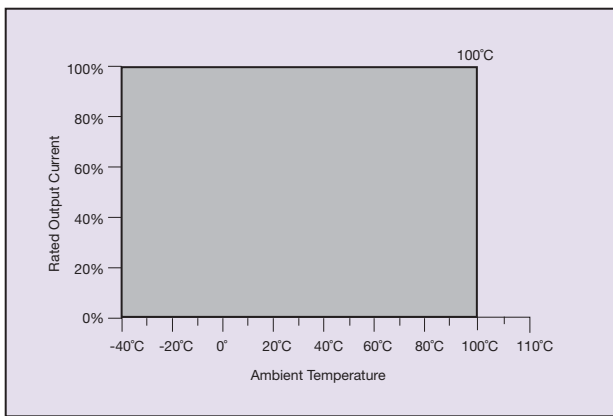


Figure 12 - Thermal Derating for 48S05 with 1.5m/s Forced Airflow

For extreme environments 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 are three such positions on the EXB30. The hottest is dependent on the input line voltage, output load and even the ambient temperature. In general they will be within 10°C of each other. These hot spots are shown in Figure 13 for the low output voltage models and are the main primary switch, two synchronous rectifiers (the thermocouples should be mounted as closely as possible to the tabs of the devices) and the bias supply controller. For the 12V model, three hot spot locations are shown in Figure 13B (i.e. main switch, diode rectifier and bias supply controller).

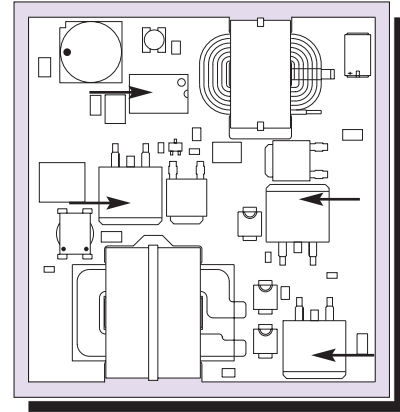


Figure 13a - Hot Spot Locations on EXB30 2V, 2.5V, 3.3V and 5V Models

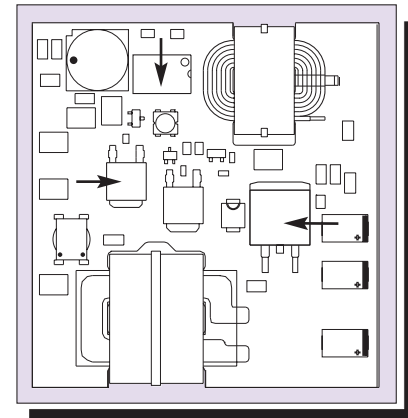


Figure 13b - Hot Spot Locations on EXB50 12V Model

In order to maintain the Artesyn derating criteria and comply with safety standards the temperatures of the hotspots should never rise above 120°C.

Remote ON/OFF Control

The remote on/off control feature allow the user to switch the converter on and off electronically when the appropriate signal is applied to the remote pin. This is a primary referenced function which allows the converter to be put in a low dissipating sleep mode.

The EXB30 models are available in a positive logic remote ON/OFF configuration. The control pin is held high through an internal resistor.

Positive Logic

This means that for the active high model, no connection is needed to the control pin for the module to be enabled. However, the control pin needs to be driven low and kept low to put the module into sleep mode.

Specification for the Remote ON/OFF

See signal electrical interface on the EXB30 data sheet.

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 VI(-), this can be a device such as a mechanical switch, open collector transistor or opto-isolator.

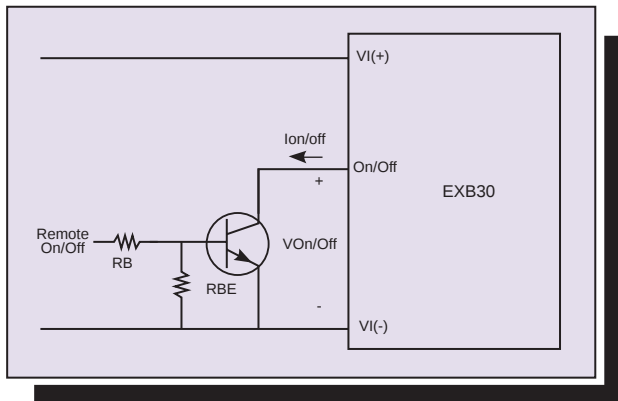


Figure 14 - Isolated Closure using a Transistor

Note in the data sheet, the 'acceptable high level leakage current'. 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 (remote off).

Level Controlled Remote ON/OFF

Units can also be controlled by applying a voltage to the remote ON/OFF pin. The figure below shows a TTL output control.

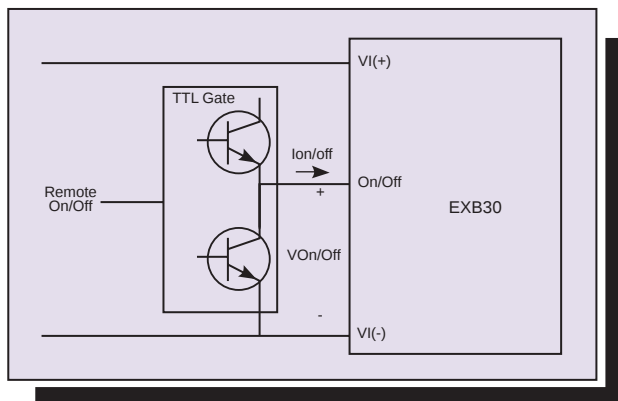


Figure 15 - Level Control using TTL Output

As per the data sheet the TTL must be capable of sinking the maximum low level input current of 100µA.

Remote Sense Compensation

The remote sense compensation feature minimises the effects of resistance in the distribution system and facilitates accurate voltage regulation at the load terminals or other selected point. The remote sense lines will carry very little current and hence do not require a large cross-sectional area. However, if the sense lines are routed on a PCB, they should be located close to a ground plane in order to minimise any noise coupled onto the lines that might impair control loop stability. In a discrete wiring situation, the use of a twisted pair or any other technique to reduce noise susceptibility is recommended. A small 100nF ceramic capacitor can be connected at the point of load to decouple any noise on the sense wires as outlined in Figure 16.

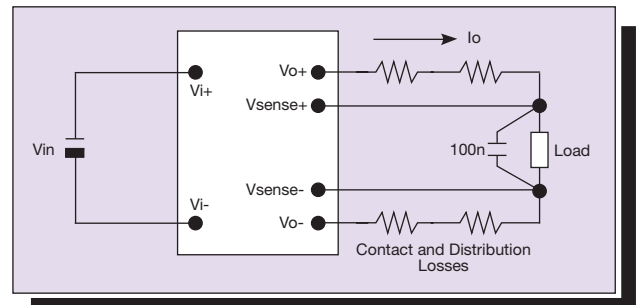


Figure 16 - Circuit Configuration for Remote Sense Operation

The power module will typically compensate for a maximum drop of 10% of the nominal output voltage. In other words, the voltage difference between the power terminals and the sense terminals must not exceed the maximum output sense range specified in the data sheet, i.e.

$$[Vo+ - Vo-] - [Vsense+ - Vsense-] < 10\% Vo(nom)$$

However, if trim up and remote sense are used in combination, the overvoltage setpoint might be reached and the output voltage at the power terminals will be clamped at this level.

If the remote sense feature is not required, it is necessary to short the sense terminals to the respective power terminals as shown in Figure 17.

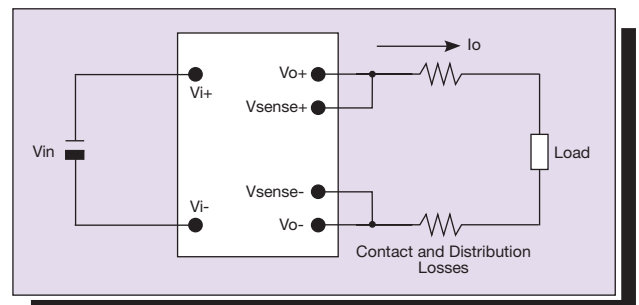


Figure 17 - Circuit Configuration when Remote Sense is not required

Output Voltage Adjustment

The output can be externally trimmed by -20% to +10% for low voltage models or -40% to +10% for the 12V model by connecting an external resistor between the TRIM pin and either the Vsense + or Vsense - pins.

With an external resistor between TRIM and Vsense-, (R_{TRIM_DOWN}), the output voltage setpoint decreases (See Figure 18). Conversely, connecting an external resistor between TRIM and Vsense+ (R_{TRIM_UP}), the output voltage setpoint increases (See Figure 19).

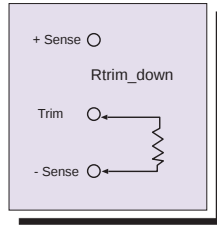


Figure 18 - Circuit Configuration to Decrease Output Voltage

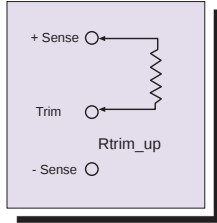


Figure 19 - Circuit Configuration to Increase Output Voltage

The equations used to determine the value of the external resistor (specified in kΩ) required to obtain the desired output voltage are shown below (Δ = % change expressed in decimals):

$$R_{TRIM_DOWN} = \left[\frac{1 - \Delta}{\Delta} \right] 10k\Omega \text{ for all models}$$

$$R_{TRIM_UP} = \left[\frac{V_o(nom)}{V_{ref}} - 1 \right] \left[\frac{1 + \Delta}{\Delta} \right] 10k\Omega$$

Where V_o (nom) is the default output voltage of the module.

V_{ref} = 2.5V, 5V and 12V models

V_{ref} = 1.225V for 2.0V, 2.5V and 3.3V models

R_{TRIM_UP} The resistor required to achieve the desired trimmed up output voltage

R_{TRIM_DOWN} resistor required to achieve the desired trimmed down output voltage

Example:

To trim up the 5V model by 5% to 5.25V the required external resistor is:

$$R_{TRIM_UP} = \left[\frac{5}{2.5} - 1 \right] \left[\frac{1 + 0.05}{0.05} \right] 10k\Omega = 210k\Omega$$

To trim down by 10% the required resistor is:

$$R_{TRIM_DOWN} = \left[\frac{1 - 0.1}{0.1} \right] 10k\Omega = 90k\Omega$$

Note that the resistor required to trim down is independent of output voltage, whereas the resistor required to trim up is largely dependent on output voltage.

When the output voltage is trimmed up a certain percentage, the output current must be derated by the same amount so that the maximum output power is not exceeded.

Output Capacitance

The EXB30 series of DC/DC converters has been designed to be 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 supply the lower frequency dynamic current variations. Note that the absolute maximum value of output capacitance is 10,000μF for the 2V, 2.5V, 3.3V and 5V models and 2,000μF for the 12V model. For larger capacitance values than this please contact the local Artesyn Technologies representative.

Reflected Input Current Measurement:

The circuit shown in Figure 20 has been used to measure the reflected input current. Capacitor C_{in} is used to offset any impedance that may occur between the converter and the battery.

This filter may also be connected on the input side of the EXB30 to reduce the reflected input ripple current.

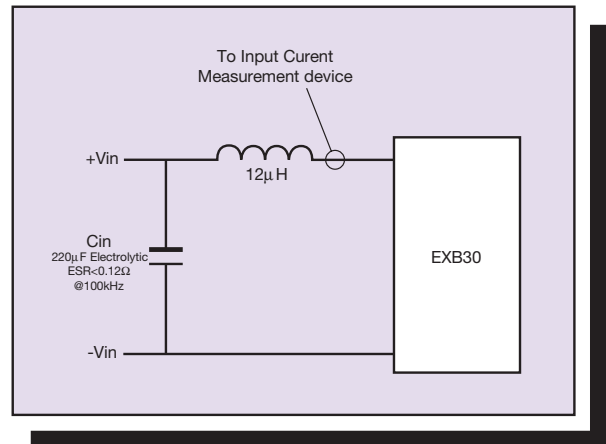


Figure 20 - Reflected Ripple Current Measurement Set-up with Recommended Filter for Ripple Current Reduction

Parallel Operation

Because of the absence of an active current sharing feature, parallel operation of multiple EXB30 converters is generally not recommended. If unavoidable, Oring-diodes have to 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.

Output Noise and Ripple Measurement

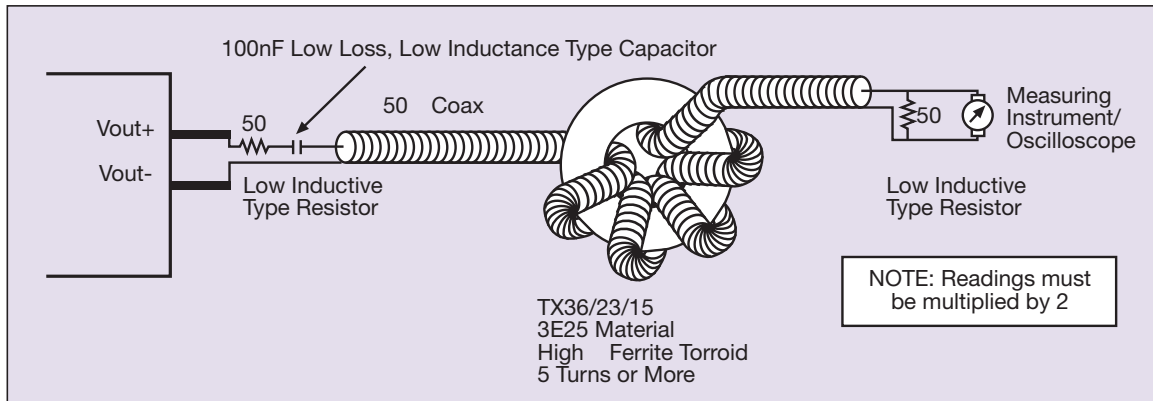


Figure 21 - Output Noise and Ripple Set-up

The above circuit has been used for noise measurement on EXB30 series converters. The large toroid will act as a common mode filter to noise which would otherwise flow through the measuring instrument or oscilloscope to disturb the measurement of the differential mode noise.

A 50Ω coax lead should be used with source and termination impedances of 50Ω. This will prevent impedance mismatch reflections which would otherwise disturb the noise reading at higher frequencies.

The 50Ω resistor which is added in series with the output of the power supply will form a voltage divider with the termination 50Ω and so ripple and noise measurement readings should be multiplied by 2.

Compatibility 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.

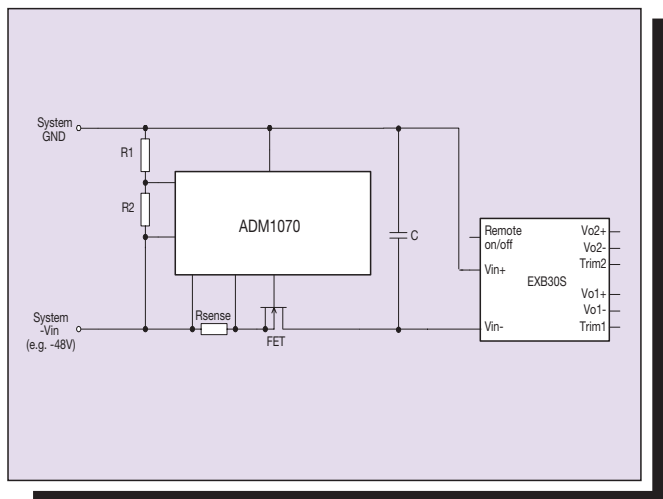


Figure 31 - Inrush Current Control using ADM1070

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 EXB30S 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 EXB30S 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.