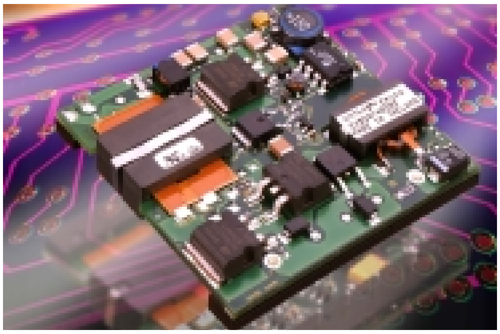
EXB50 SERIES

Application Note 113 Rev. 03 - January 2001

NEW Product



- **Ultra high efficiency topology, 91% typical on EXB50-48S05 model**
- **Operating ambient temperature of -40°C to +70°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**

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1. Introduction

The EXB50 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 manufacturing methods, the use of planar magnetics and an extensive qualification program have produced one of the most reliable ranges of converters on the market.

2. Models and Features

The EXB50 series comprises three separate models as shown in Table 1. All popular integrated circuit operating voltages are covered by the entire range.

Model	Input Voltage	Output Voltage
EXB50-48S05	36-75VDC	3.0 to 5.5V
EXB50-48S3V3	36-75VDC	1.98 to 3.63V
EXB50-48S2V0	36-75VDC	1.2 to 2.2V
EXB50-48S12V0	36-75VDC	7.2 to 13.2V
EXB50-24S05	18-36VDC	3.0 to 5.5V
EXB50-24S3V3	18-36VDC	1.98 to 3.63V
EXB50-24S2V0	18-36VDC	1.2 to 2.2V

Table 1 - EXB50 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 +70˚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 EXB50 power module are DC/DC converters that provide an isolated regulated DC output. There are two distinct input voltage ranges, the 24V series covers the input voltage range 18 to 36VDC and 48V series covers the range 36V to 75VDC The modules have maximum power ratings of 50W 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.

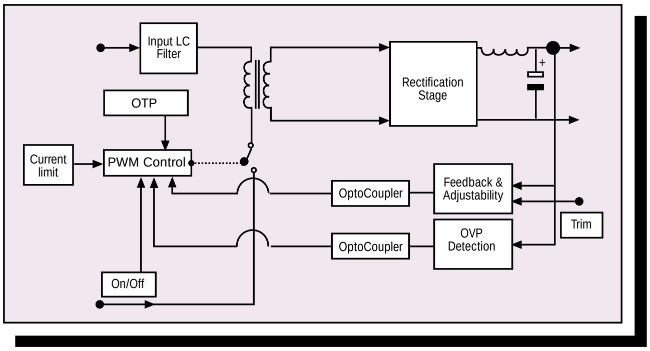


Figure 1 - Simplified Schematic

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 20% 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 10˚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 is of planar construction. It 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 EXB50 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 EXB50 module is a consequence of the extremely high efficiency achieved and resultant low power dissipation. Operation from -40˚C to a maximum ambient temperature of +70˚C is achieved without the requirement for heatsinks or forced air cooling, making the EXB50 ideally suited to cost and space sensitive applications. The maximum temperature of the EXB50-24S05 is 60˚C.

Remote Sense Compensation
The EXB50 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 all models is trimmable by -40% to +10% of the nominal output voltage. 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.

Current Limit and Short Circuit Protection
All models of the EXB50 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 is dependent on the input voltage, ambient temperature and has a parametric spread also. For all models the inception point is typically 115%. It may go as high as 140% over all operating conditions.

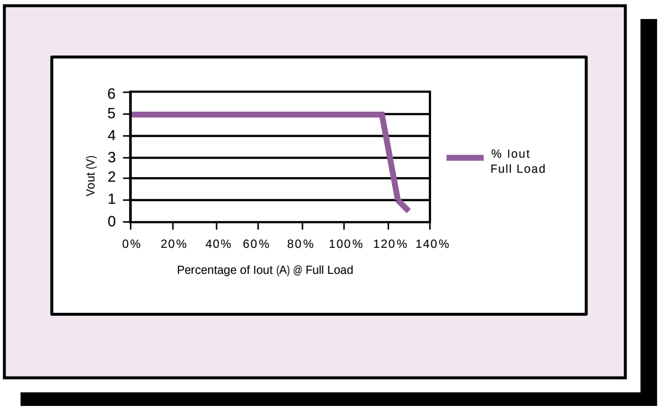


Figure 2 - Typical Brickwall V-I Characteristic for Low Voltage Models

If the overcurrent condition (or a short circuit on the output) persists for greater than 100ms the unit may enter a 'hiccup' foldback 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 Tmax at full power.

The actual ambient temperature at which the overtemperature circuit trips 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.

Under full load conditions the trip point will be at a minimum ambient of 75°C (65°C in EXB50-24S05) 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
5V	6.0V
3.3V	3.9V
2.0V	2.4V
12V	14.2V

Table 2 - OVP Trip Point

Input Undervoltage and Overvoltage Protection
The EXB50 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. For 24V models, the converter is disabled when the input voltage is below 15V or above 40V 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 EXB50 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 EXB50 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 EXB50 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 3.15A HRC (High Rupture Capacity) is the recommended fuse rating for the 48V series and an 6.15A is recommended for the 24V series.

6. EMC

The EXB50 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 Class A (FCC Part 15). The EXB50 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 and6 respectively. Putting these extra components on board the EXB50 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 EXB50-48S05 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.

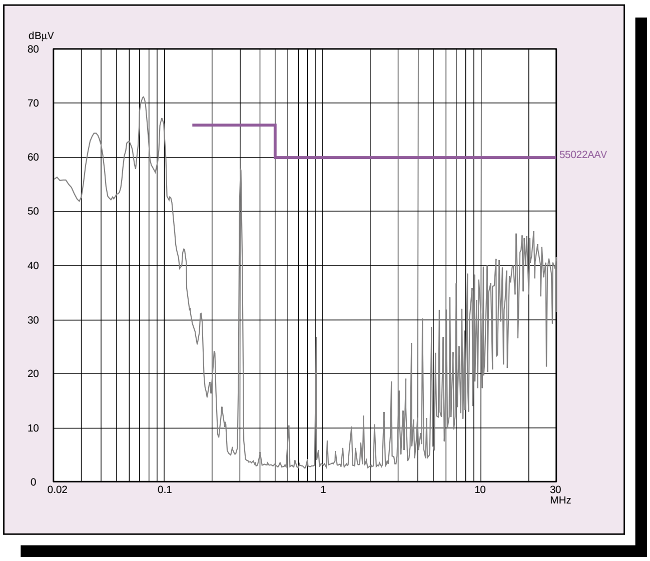


Figure 3 - Conducted Noise Measurements on EXB50-48S05 (meets Class A average)

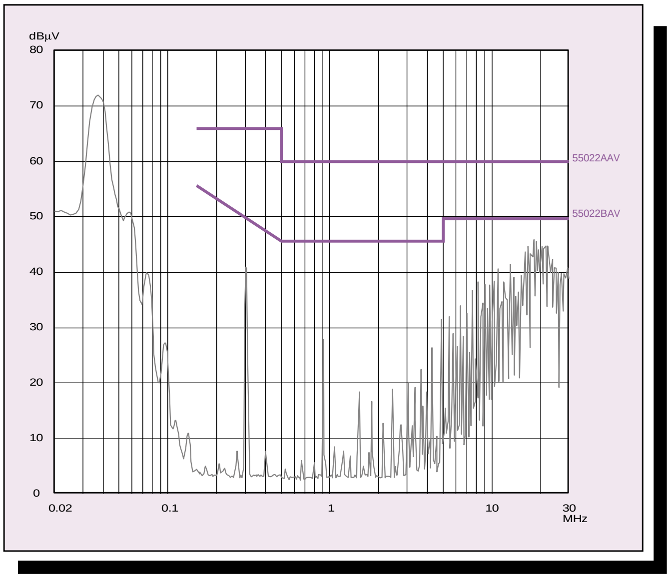


Figure 4 - Conducted Noise Measurements on EXB50-48S05 (meets Class B average)

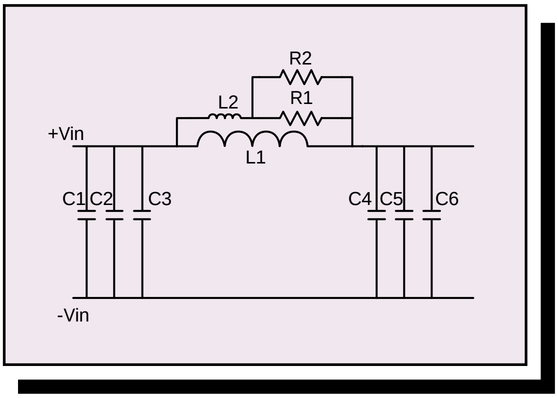


Figure 5 - Required Filter for Class A compliance on 48V and 24V models

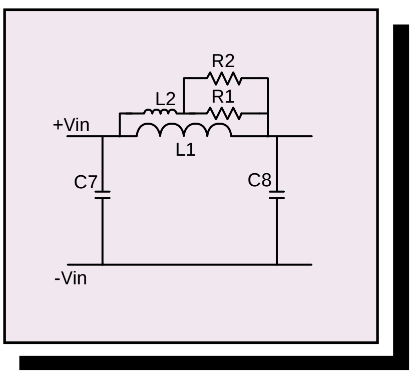


Figure 6a - Required Filter for Class B compliance on 48V models

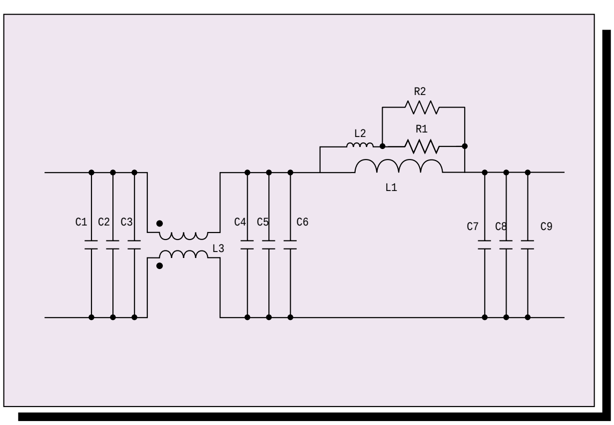


Figure 6b - Required Filter for Class B compliance on 24V models

Manufacturers part numbers for components used on 48V series are as follows:

Ref. Des	Description	Manufacturer/Part No
C1-C6	100V, 470nF cer. capacitor	AVX: 1812C474KATMA
C7, C8	100V, 4µF cer. capacitor	AVX: SM141C425PAJ120
L1	33µH, 2.1A inductor	Sumida: CDRH125,330
L2	33µH, chip inductor	TDK: ML453232-330J
R1, R2	10Ω, 1206 resistor	Vishay: CRCW120610RFRT1

Manufacturers part numbers for components used on 24V series are as follows:

Ref. Des	Description	Manufacturer/Part No
C1-C9	100V, 680nF cer. capacitor	AVX: 1812C684MAT
L1	15µH, 4.5A inductor	Sumida: CDRH125,150
L2	15µH, chip inductor	TDK: ML453232-150J
L3	2 X1.2 mH, common mode choke	Siemens 82722-J2302-N1
R1, R2	10Ω, 1206 resistor	Vishay: CRCW120610RFRT1

The components specified are for indication only, the end user needs to ensure that these components are within specification for their application.

7. Use in a Manufacturing Environment

Resistance to Soldering Heat

The EXB50 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 4.

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

Table 4 - Wave Solder Test Conditions

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

Water Washing

The EXB50 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

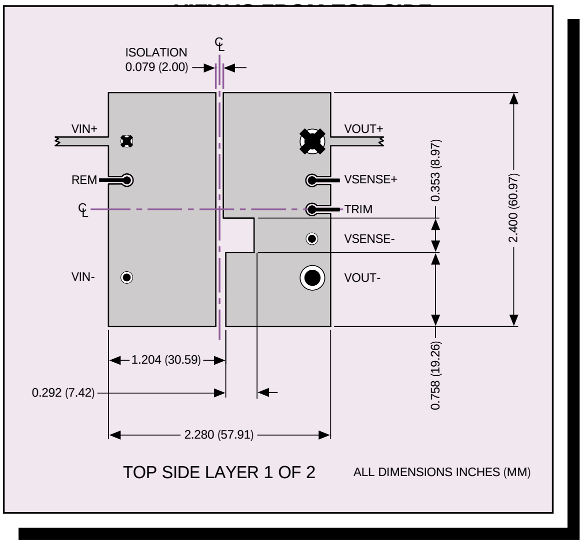
The EXB50 units are manufactured in an ESD controlled environment and supplied in conductive packaging to prevent ESD damage occurring before or during shipping. It is essential that they are unpacked and handled using an approved ESD control procedures. Failure to do so could affect the lifetime of the converter.

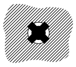
8. Applications

Optimum PCB Layout
Figures 7 and 8 shows the optimum PCB layout for a double-sided PCB. 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. Also, if the unit is not mounted vertically the end user must ensure that the hot spots are kept within their limits. This may result in a reduced output power capability, particularly if there is no forced air present.

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 EXB50 meet the spacing requirements that the system is approved to.

For compliance with safety regulations there are a number of keep-out areas on the top side of the user board. These are shown in Figure 9.

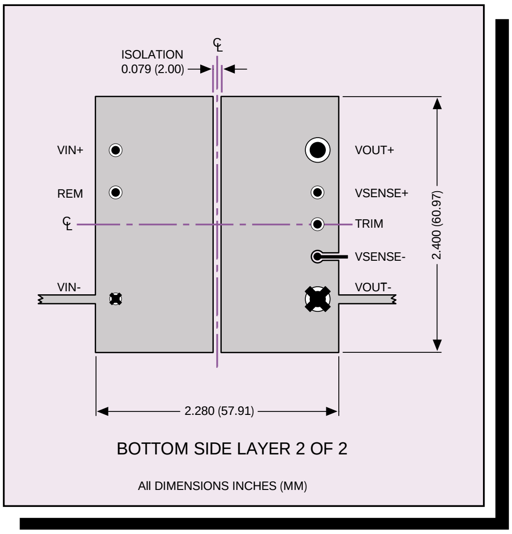


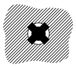


THERMAL RELIEF IN CONDUCTOR PLANES
REFERENCE IPC-D-275 SECTION 5.3.2.3

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

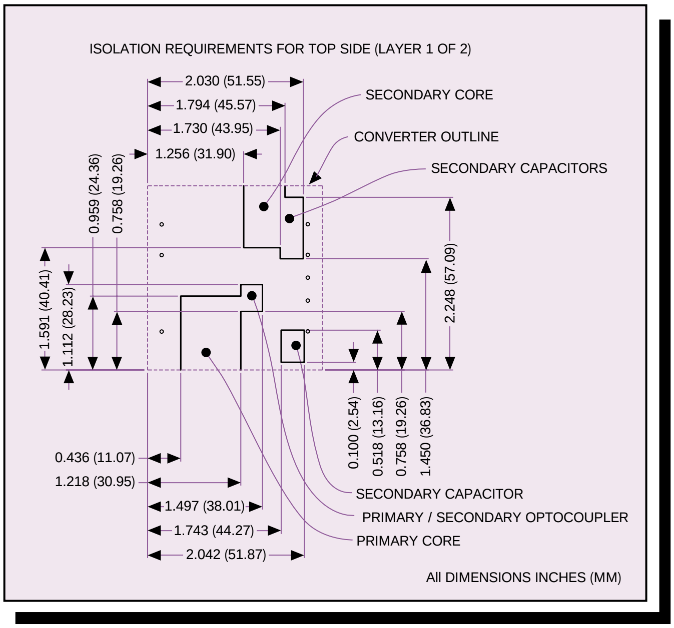


Figure 9 - Keep Out Areas on Top Side of User PCB to Meet Safety Spacing Requirements

Optimum Thermal Performance
The EXB50 can operate in still air up to a maximum ambient temperature of 70°C using the recommended PCB layouts shown in the previous section. Still air, which is sometimes called natural convection is defined as <0.1m/s airflow (20CFM). The output current may be derated so that the maximum ambient operating

temperature can be extended to 90°C as shown in Figure 10.

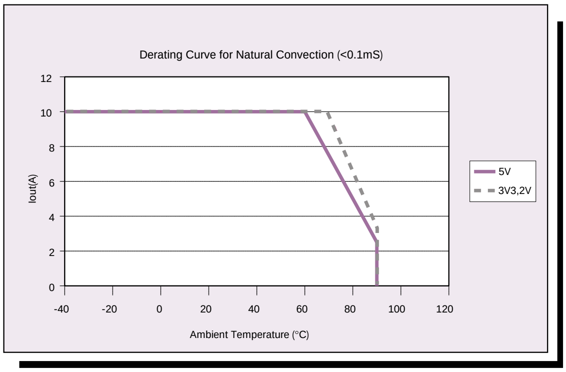


Figure 10a - Output Current vs. Ambient Temperature in Natural Convection for 24V input models

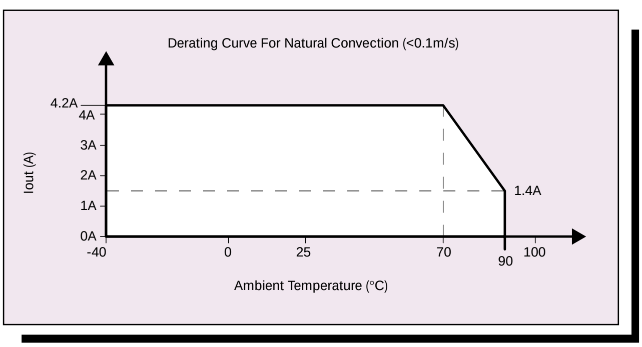


Figure 10b - Output Current vs. Ambient Temperature in Natural Convection for the EXB50-48S12

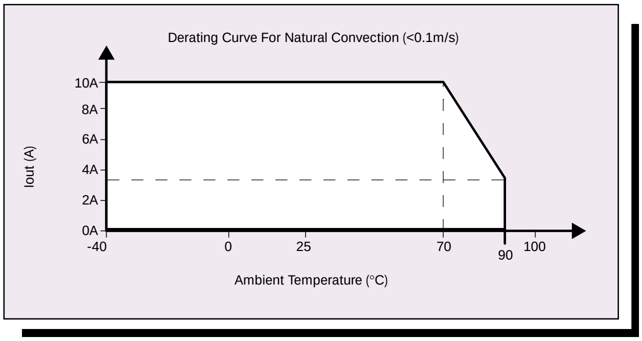


Figure 10c - Output Current vs. Ambient Temperature in Natural Convection for 48V input models

If forced air cooling is used then the converter may be used up to 90°C at full output power dependent on the airflow across the converter. Figure 11 is a graph of the increased maximum ambient temperature at full power versus the airflow across the converter.

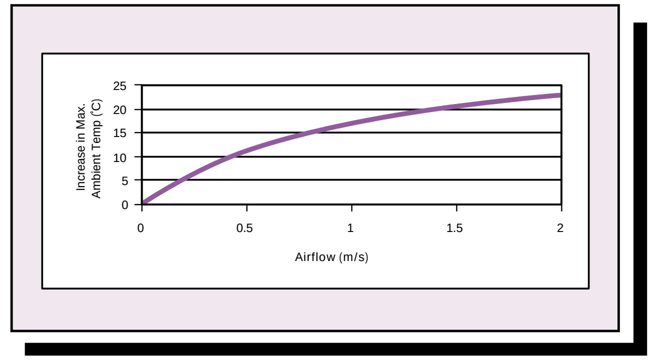


Figure 11 - Increase in Maximum Ambient Temperature at Full Power with Forced Airflow

With an airflow of 1.5m/sec the allowed increase in ambient temperature is 20˚C. Figure 12 shows the derating curve for the EXB50 series with 1.5m/s forced airflow.

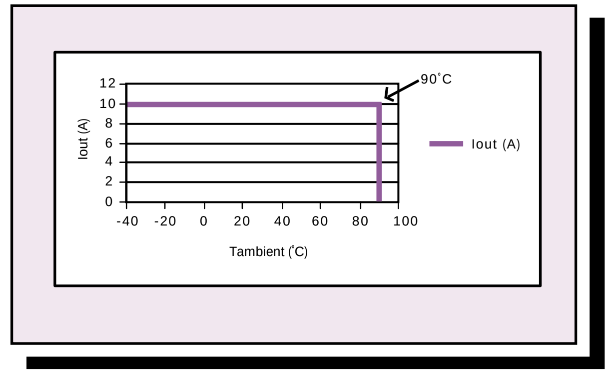


Figure 12 - Thermal Derating for 48S05 with 1.5m/s Forced Airflow

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 four such positions on the EXB50. 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 13a for the low voltage models and are the main primary switch, two synchronous rectifiers and a secondary side Schottky diode. The figure shown is that of the EXB50-48S05, hot spot components are in the same location on all other low voltage models. For the 12V model, three hot spot positions are shown in Figure 13b (i.e. main primary switch, diode rectifier and bias supply controller)

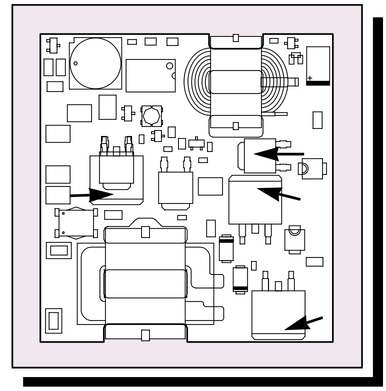


Figure 13a - Hot Spot Locations on EXB50 for 2V, 3.3V and 5V Models

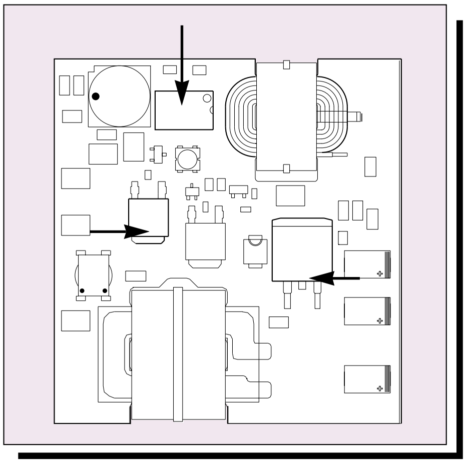


Figure 13b - Hot Spot Locations on EXB50 for 12V Model

In order to maintain the Artesyn derating criteria and comply with safety standards the temperatures of the hotspots should never rise above 120˚C. Thermocouples should be mounted as closely as possible to the tabs of the power devices during component temperature testing.

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 power dissipation sleep mode.

The EXB50 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 EXB50 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.

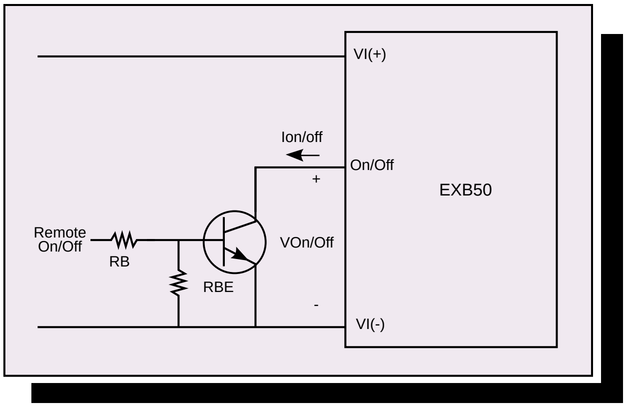


Figure 14 - Isolated Closure using a Transistor

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.

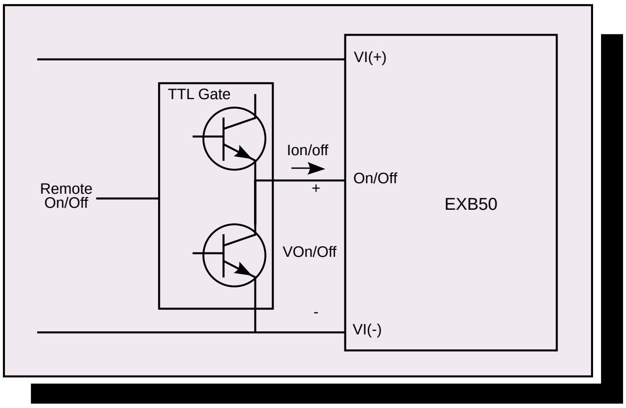


Figure 15 - Level Control using TTL Output

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 susceptability 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. On the 12V model similiar 100nF ceramic capicitors should be conneced beween Vo+ and Vsense+ and between Vo- and Vsense- as close to the module as possible.

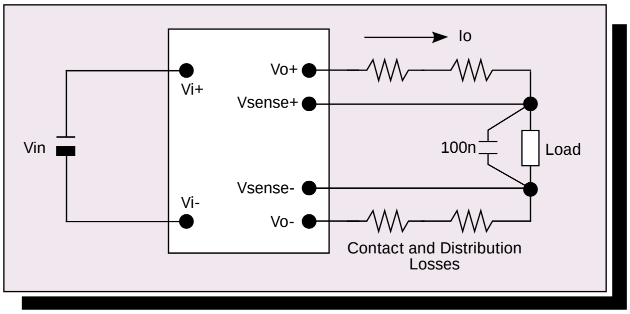


Figure 16 - Circuit Configuration for Remote Sense Operation

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. Operating at this condition long term will reduce reliability of unit.

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.

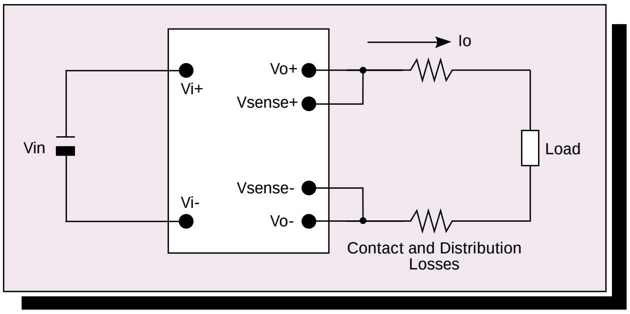


Figure 17 - Circuit Configuration when Remote Sense is not required

Output Voltage Adjustment
The output can be externally trimmed by -40% to +10% by connecting an external resistor between the TRIM pin and either of the output voltage sense pins.

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

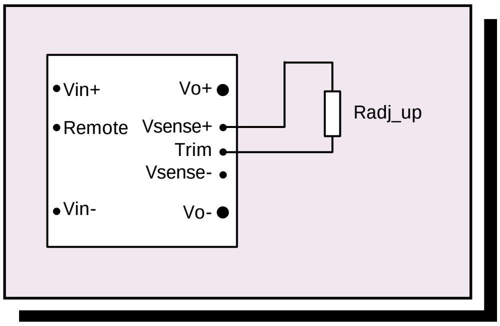


Figure 18 - Circuit Configuration to Increase Output Voltage

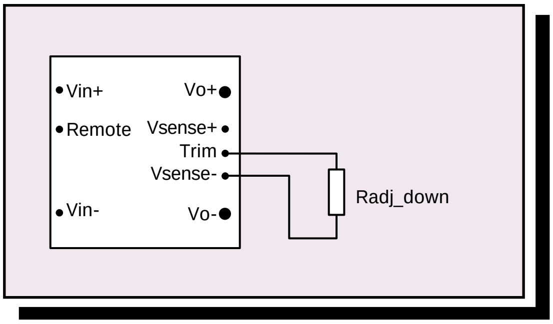


Figure 19 - Circuit Configuration to Reduce Output Voltage

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

$$R_{ADJ\_DOWN} = \left(\frac{1}{\Delta} - 2\right) k\Omega$$

$$R_{ADJ\_UP} = \left[\frac{(1+\Delta) * Vo,nom}{\Delta * 1.225} - \frac{1+2 * \Delta}{\Delta}\right] k\Omega$$

Where,

Vo,nom	is the default output voltage of the module.
Δ	% change expressed in decimals, e.g. for 30% trim down, Δ = 0.3
R_{ADJ_DOWN}	the resistor required to achieve the desired trimmed down output voltage
R_{ADJ_UP}	the resistor required to achieve the desired trimmed up output voltage

Example:
To trim up the 5V model by 6% to 5.3V the required external resistor is:

$$R_{ADJ\_UP} = \left[\frac{1 + 0.06 * 5}{0.06 * 1.225} - \frac{1 + 2 * 0.06}{0.06}\right] k\Omega$$

$$R_{ADJ\_UP} = \left[\frac{5.3}{0.0735} - \frac{1.12}{0.06}\right] k\Omega$$

$$R_{ADJ\_UP} = 53.5k\Omega$$

To trim down the 2V model by 25% to 1.5V the required external resistor is:

$$R_{ADJ\_DOWN} = \left(\frac{1}{0.25} - 2\right) k\Omega$$

$$R_{ADJ\_DOWN} = (4 - 2) k\Omega$$

$$R_{ADJ\_DOWN} = 2 k\Omega$$

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.

For the 5V model only, when the output voltage is trimmed up by a certain percentage, the output current must be derated by the same amount so that the maximum output power of 50W is not exceeded.

Graphs of the required resistor for all models are shown in Figure 20 for trim down and in Figure 21 for trim up.

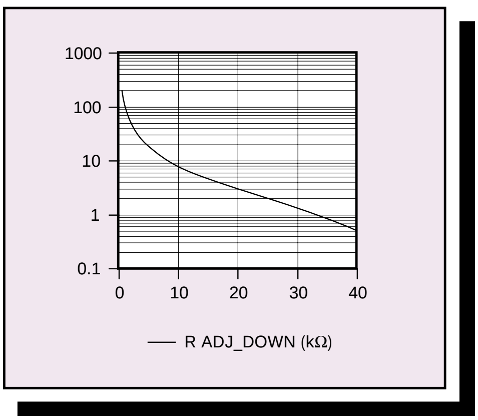


Figure 20 - Trim Down
Resistor vs. Percentage Change in Output Voltage

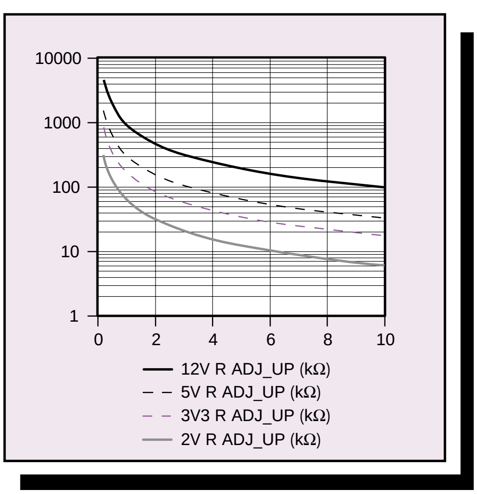


Figure 21 - Trim Up
Resistor vs. Percentage Change in Output Voltage

Output Voltage Adjustment Accuracy
The accuracy of the adjusted output voltage is dependant on the tolerance of the external trim resistor and the tolerance of some internal components.

If the required value of trim resistor used esternally (as calculated from the above equations) is accurate to within 5%, then the nominal setpoint accuracy of the required output voltage will increase from a maximum of 1.5% to 2.25%

Output Capacitance
The EXB50 series of DC/DC converters has 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 supply the lower frequency dynamic current variations. Note that the absolute maximum value of output capacitance is 10,000µF for the 5V, 3.3V and 2V models and 2,000µF for the 12V model. For larger capacitance values than this please contact the local Artesyn Technologies representative.

Output Noise and Ripple Measurement

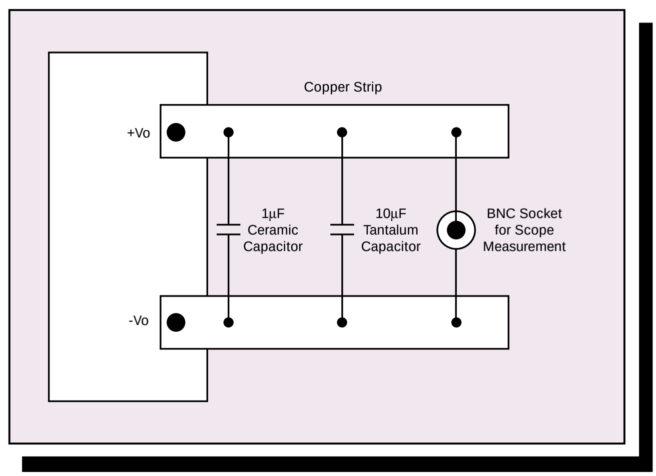


Figure 22 - Output Noise and Ripple Set-up

The above circuit has been used for noise measurement on EXB50 series converters. A 50Ω coax lead should be used with a termination impedance of 50Ω. This will prevent impedance mismatch reflections which would otherwise disturb the noise reading at higher frequencies.

Reflected Input Current Measurement:
The circuit shown in Figure 23 has been used to measure the reflected input current. Capacitor Cin 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 EXB50 to reduce the reflected input ripple current.

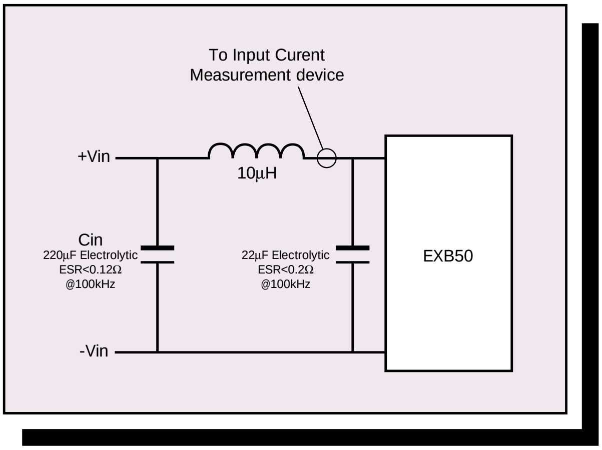


Figure 23 - Reflected Ripple Current Measurement Set-up with Recommended Filter for Ripple Current Reduction

It provides the following features:

1 Inrush current is limited to a programmable value by controlling the gate voltage of an external N-channel pass transistor.
2 The pass transistor is turned-off if the input voltage is less than the programmable undervoltage threshold or greater than the overvoltage threshold. A programmable electronic circuit breaker protects the system against shorts.
3 The LT1640H is designed for modules with a high enable input. The PWRGD signal can be used to directly enable a power module.

The UV (pin 3) and OV (pin 2) pins can be used to detect undervoltage and overvoltage conditions at the power supply unit. The EXB50 has already got undervoltage and overvoltage protection in-built to ensure that the unit does not draw power from the power source for voltages less than 32V and greater than 78V. Resistors R4, R5 and R6 determine the undervoltage and overvoltage levels. Users should refer to data sheet of the LT1640 for formulae to set the required UVLO and OVLO trip levels.

The PWRGD output can be used to directly enable the EXB50. This is an open collector output with minimum output impedance of 2kΩ. The pull-up resistor (R7) required to ensure that the Remote on/off pin voltage is greater than 2V at an input voltage of 30V is 33kΩ. This results in a maximum power dissipation in R7 at Vinmax (75V) to be approximately 0.2W.

Typically the PWRGD signal is not required for inrush current control and thus, this 0.2W maximum power dissipation can be avoided if the user controls the Remote on/off pin voltage level by other means.

Parallel Operation
Because of the absence of an active current sharing feature, parallel operation of multiple EXB50 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.

Compatibility with LT®1640L/LT1640H Hot Swap Controller
The LT®1640L/LT1640H is an 8-pin, negative voltage Hot Swap® controller that allows a board to be safely inserted and removed from a live backplane. The EXB50 modules are compatible with LT1640H part.

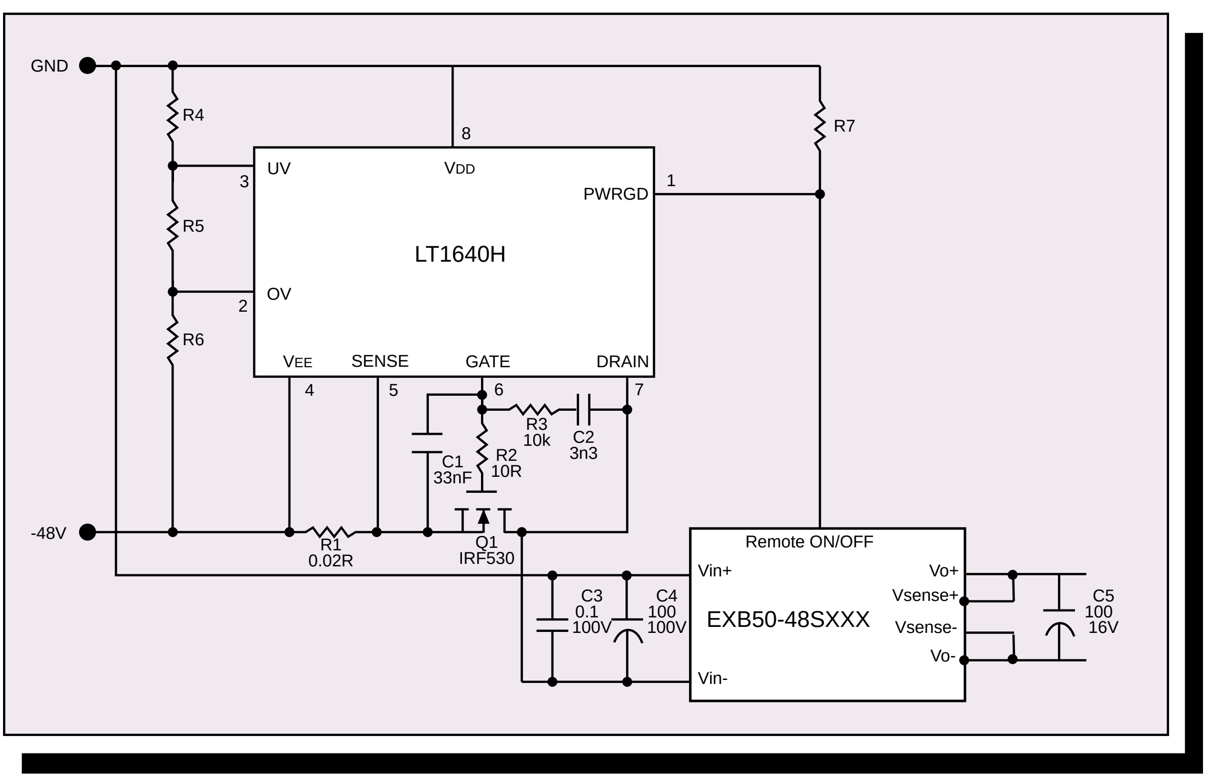


Figure 24 - LT1640H Hot Swap Controller Interface with EXB50-48SXXX