NEW Product

EXQ125 Single
Application Note

ARTESYN® TECHNOLOGIES

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- **Ultra-high efficiency topology, 91% at 3.3V, 88% typical at 1.8V**
- **Industry standard footprint**
- **Wide baseplate temperature, -40°C to +100°C**
- **90% to 110% output trim**
- **No minimum load**
- **Overvoltage protection**
- **Remote ON/OFF**

Features

- Industry standard quarter brick pinout and footprint: 57.91 x 36.83 x 12.70mm (2.28 x 1.45 x 0.5 inches)
- Wide operating temperature range (–40°C to +100°C baseplate temperature)
- ±10% output voltage adjustability
- No minimum load requirement
- Primary side referenced positive logic remote on/off control
- Remote sense compensation
- Constant switching frequency
- Brickwall overcurrent protection
- Continuous short circuit protection
- Non-latching output over-voltage protection (OVP)
- Over-temperature (OTP) protection
- Input under/over-voltage lockout protection (U/OVLO)

1. Introduction

This application note describes the features and functions of the Artesyn Technologies EXQ125 series of high power density open-frame quarter-brick modules targeted specifically at the telecommunications, industrial electronics, mobile telecommunications and distributed power markets.
The series offers a wide input voltage range of 33-75VDC and the recommended baseplate operating temperature is –40°C to +100°C. Ultra-high efficiency operation is achieved through the use of proprietary synchronous rectification and control techniques. A wide output voltage trim range is provided and the module is fully protected against overcurrent, overvoltage and overtemperature. A positive logic remote ON/OFF input is included as standard to send the unit into a low power dissipation sleep mode. Negative logic remote ON/OFF is available as an option. An independent clamped mode and non-latching over-voltage protection (OVP) feature is provided while over-temperature protection (OTP) protects the unit from excessive thermal stress. A remote sense compensation feature is included to provide accurate voltage regulation at the load terminals.

The series has been designed primarily for telecommunication applications and complies with ETS 300 386-1 immunity and emission standards for high priority of service class. In addition, the series complies with ETS 300 019-1-3/-2-3 environmental standards (all classes) including shock, vibration, humidity and thermal performance. EN60950 and UL/cUL1950 safety approvals have been obtained. Finally, a high level of reliability has been designed into all models through the extensive use of conservative derating criteria. Automated manufacturing methods together with an extensive qualification program have produced a highly reliable range of converters.

2. Models

The EXQ125 series consists of three models listed in Table 1.

Model	Input Voltage	Output Voltage	Output Current
EXQ125-48S3V3	33-75VDC	3.3V	25A
EXQ125-48S2V5	33-75VDC	2.5V	30A
EXQ125-48S1V8	33-75VDC	1.8V	30A

Table 1 - EXQ125 Models

3. General Description

3.1 Electrical Description

A block diagram of the EXQ125 converter is shown in Figure 1. Extremely high efficiency power conversion is achieved through the use of synchronous rectification techniques [patents pending].

The EXQ125 is implemented using a current-mode controlled interleaved flyback topology. Power is magnetically transferred across the isolation barrier via isolating power transformers. In all models the secondary side rectification stage consists of synchronous rectifiers controlled by proprietary circuitry to optimise the timing which is critical for high efficiency power conversion. A regulated output voltage is provided and governed by the voltage sensed at the module sense pins, V_{sense+} and V_{sense-}.

The output is adjustable over a range of 90% to 110% of the nominal output voltage using the TRIM pin which is referenced to V_{sense-}.

The converter can be shut down via a primary side referenced remote ON/OFF input. This input is compatible with popular logic devices. Both 'positive' and 'negative' logic control are available. Positive logic indicates that the converter is enabled if the remote ON/OFF input is high (or floating) and disabled if the remote ON/OFF input is low. Conversely, negative logic implies the converter is enabled if the remote ON/OFF input is low and disabled if the remote ON/OFF input is high (or floating).

The output is monitored for over-voltages. If an over-voltage due to an internal fault is detected on the output, the converter will clamp at the over-voltage set point.

The converter is also equipped with over-temperature sensors. If the converter is over-loaded or the baseplate temperature gets too high, the converter will shut down until the temperature falls below a minimum threshold. There is typically 3 to 5ºC of thermal hysteresis included to protect the unit.

An internal second order input filter (LC) smoothes the input current and reduces conducted and radiated EMI. Further improvement can be achieved through the use of an optional external input filter. See section 6.1 for further details.

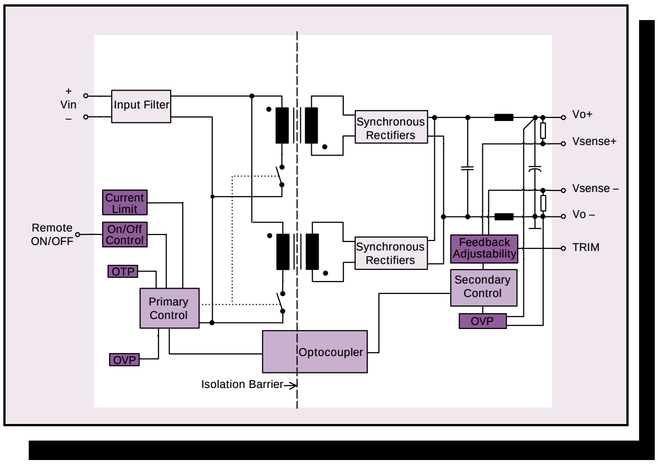


Figure 1 - Electrical Block Diagram

3.2 Physical Construction

The EXQ125 is constructed using a multi-layer FR4 PCB and an insulated metal substrate (IMS). SMT power components are placed on one side of the IMS while low power control components are placed on both sides of the FR4. Heat dissipation of the power components mounted on the baseplate is optimised while at the same time critical control components are thermally isolated.

The converter is sold as an open-frame and no case or case pin are 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 DC/DC converters (Design Note 102) is available from the Artesyn Technologies website.

4. Features and Functions

4.1 Wide Operating Temperature Range

The wide ambient operating temperature range of the EXQ125 module is a result of the extremely high power conversion efficiency and resultant low power dissipation combined with the excellent thermal performance of the PCB substrate. The maximum output power that the module can deliver depends on a number of parameters, primarily:

- The target application input voltage range
- The output load current
- If present, air velocity in a forced convection environment
- Mounting orientation of target application PCB, i.e. vertical/horizontal mount, or mechanically tied down (especially important in natural convection conditions)
- Target application PCB design, especially ground planes which can be effective heatsinks for the power converter

The converter can be operated from –40ºC to a maximum baseplate temperature of +100ºC. A number of design graphs are included in the long-form datasheet that simplify the design task and allow the power system designer to determine the maximum output current at which the EXQ125 module may be operated for a given baseplate temperature and airflow.

4.2 Over-Temperature Protection

The EXQ125 converter is equipped with a non-latching over-temperature protection. A temperature sensor monitors the temperature of the main substrate. If the temperature exceeds a threshold of 115°C (typical) the converter will shut down, disabling the output. When the substrate temperature has decreased by 3ºC to 5°C, the converter will automatically restart.

The EXQ125 converter might experience over-temperature conditions in case of a persistent over-load on the output. Over-load conditions can be caused by external faults. OTP might also be entered due to a loss of control of the environmental conditions (e.g. increase in converter temperature due to a failing fan).

4.3 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 section 8.4.

4.4 Output Over-Voltage 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. However, unlike the main loop, the OVP loop senses the voltage at the output power terminals of the module. 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. Note that even an optocoupler is not required during operation of the OVP clamp circuit. OVP clamp levels are typically set at 120-125% of the nominal output voltage setpoint for all models.

4.5 Safe Operating Area

The Safe Operating Area (SOA) of the EXQ125 converter is shown in Figure 2. Assuming the converter is operated within its thermal hotspot constraints, it can deliver an output current $I_{o,max}$ governed by Figure 2. Note however that the SOA does not remain valid across the full trim range of the converter. For example, if the unit if trimmed up by 10%, the output current must be correspondingly derated by 10%. The module will still deliver $I_{o,max}$ when trimmed down.

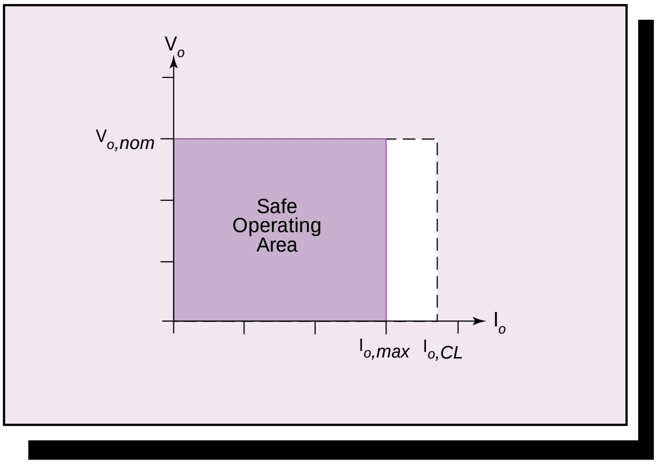


Figure 2 - Maximum Output Current Safe Operating Area

It should be noted that the SOA shown in Figure 2 is valid only if the converter is operated within its thermal specification. See section 8.2 for further discussion.

4.6 Brickwall Current Limit and Short Circuit Protection

All EXQ125 models have a built in brickwall current limit function and full continuous short circuit protection. Thus the V–I characteristic in current limit, as indicated by the dashed line in Figure 2, will be almost vertical at the current limit inception point, $I_{o,CL}$. This means that the output current should be almost constant irrespective of the output voltage during overload. The current limit inception point is dependent upon baseplate temperature and line voltage and has a parametric spread also. For all models the inception is typically 115% of rated full load. The brickwall current limit scheme has many advantages including increased capacitive load start-up capability (see section 8.7).

Note however that none of the module 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.

4.7 Remote ON/OFF

The remote ON/OFF input allows external circuitry to put the EXQ125 converter into a low dissipation sleep mode. The EXQ125 converters are available as standard with an active-high remote ON/OFF input. Active-low logic can be specified as an option, denoted by the suffix '-R'.

Active-high units of the EXQ125 series are turned on if the remote ON/OFF pin is high (or floating). Pulling the pin low will turn off the unit. Active-low units of the EXQ125 series are turned on if the remote ON/OFF pin is low. Pulling the pin high (or floating) will turn off the unit. The signal level of the remote ON/OFF input is defined with respect to Vin–.

To simplify the design of the external control circuit, logic signal thresholds are specified over the full temperature range. The maximum remote ON/OFF input open circuit voltage, as well as the acceptable leakage currents are specified (Refer to Long Form Datasheet available on the website.)

The remote ON/OFF input can be driven in a variety of ways as shown in Figures 3, 4 and 5. If the remote ON/OFF signal originates on the primary side, the remote ON/OFF input can be driven through a discrete device (e.g. a bipolar signal transistor) or directly from a logic gate output. The output of the logic gate may be an open-collector (or open-drain) device. If the drive signal originates on the secondary side, the remote ON/OFF input can be isolated and driven through an optocoupler.

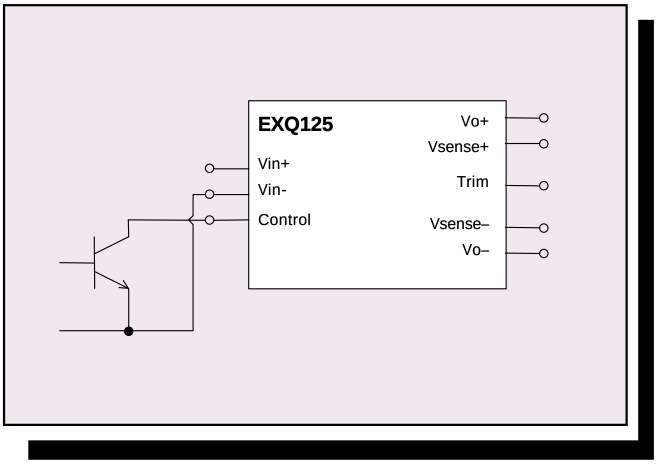


Figure 3 - Remote ON/OFF Input Drive Circuits for Non-Isolated Bipolar

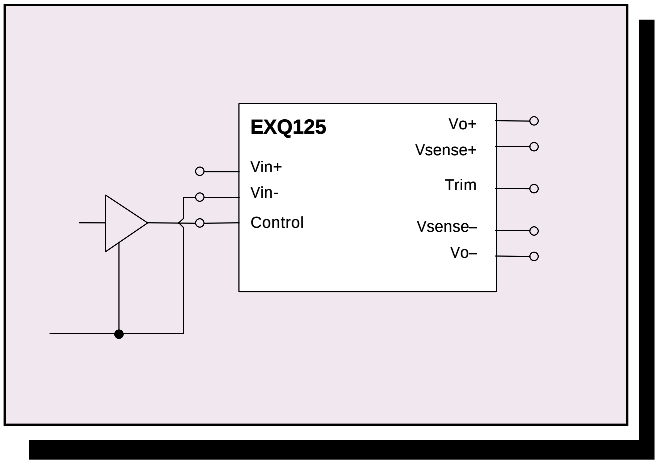


Figure 4 - Remote ON/OFF Input Drive Circuits for Logic Driver

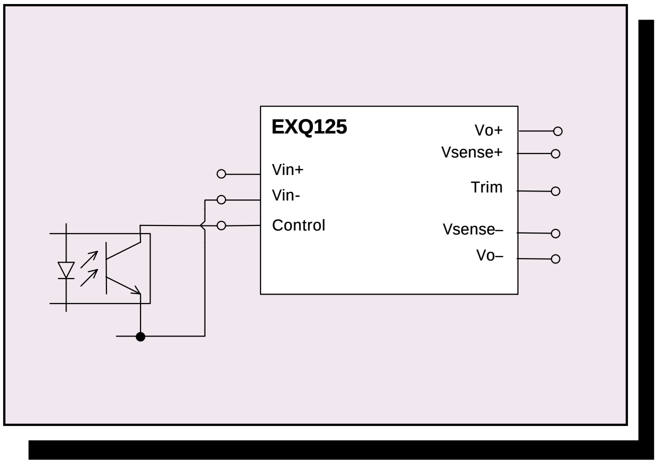


Figure 5 - Remote ON/OFF Input Drive Circuits for Isolated through Optocoupler

5. Safety

5.1 Electrical Isolation
The EXQ125 series of power modules have been submitted to independent safety agencies and has EN60950 and UL1950 safety approvals. Operational insulation is provided between the input and output of the power supply in accordance with EN60950. The DC/DC power module should be installed in end-use equipment in compliance with the requirements of the application and is intended to be supplied by an isolated secondary circuit. It has been judged on the basis of the required spacings in the Standard of Safety and Information Technology Equipment, including electrical business equipment, CAN/CSA-C22.2, No. 850-95 UL1950, third edition, including revisions through revision date March 1, 1998 which are based on the fourth amendment to IEC950, second edition, sub-clause 2.9.

When the supply to the DC/DC power module meets all the requirements for SELV (<60VDC), the output is considered to remain within SELV limits and not at hazardous energy level. If connected to a 60VDC power system, reinforced insulation must be provided in the power supply that isolates the input from the mains.

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

5.2 Input Fusing
This EXQ125 power module can be used in a wide variety of applications, ranging from simple stand-alone operation to an integrated part of a sophisticated distributed power architecture. To preserve maximum flexibility, internal fusing is not included. However, 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 reasons 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 may be in either input line. The recommended fuse rating for the EXQ125 converter is 5A, HRC (high rupture capacity), anti-surge, rated for 200V. A fuse should be used at the input of each EXQ125 module. If a fault occurs in the module such that the input source is shorted, the fuse will provide the following two functions:

- Isolate the failed module from the input supply bus so that the remainder of the system may continue operation
- Protect the distribution wiring from overheating

Based on the information provided in the long form data sheet on inrush energy and maximum DC input current, the same type of fuse with a lower rating can be used, depending on model. Refer to the fuse manufacturer's data for further information.

6. EMC

The EXQ125 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. The following sections detail the list of standards which apply and with which the product complies.

Conducted Emissions
The applicable standard for conducted emissions is EN55022 (FCC Part 15). Conducted noise can appear as both differential mode and common mode noise currents. Differential mode noise is measured between the two input lines with the major components occurring at the converter fundamental switching frequency and harmonics thereof. Common mode noise, generated in switching converters and can contribute to both radiated emissions and input conducted emissions, is measured between the input lines and system ground and can be broadband in nature. The EXQ125 series of converters bypasses common mode noise internally by using two paralleled 1nF, 2kV capacitors between Vin- and Vo+. Common mode noise currents flowing in the application circuitry will therefore be greatly minimized. Furthermore, the EXQ125 has a substantial second order differential mode filter on board to enable it to meet the above standard using a simple externally connected differential and common mode filter. The circuit diagram of the filter required for Class B compliance is presented Figure 6. A similar filter can be derived for Class A compliance using the same component set.

Differential mode noise is attenuated by a π -filter comprised of the series inductance presented by the leakage inductance of the common mode choke, L_{x1}, and the X-capacitors, C_{x1} and C_{x2}. The converter side capacitor is typically an electrolytic with a relatively significant ESR component that helps maintain input system stability.

The common-mode noise filter comprises the Y-capacitors, C_{y1} and C_{y2}, from each input line to a chassis ground plane, capacitors C_{y3} and C_{y4} from each output line to the ground plane and the common-mode choke, L_{x1}. The ground plane can be connected to the case when case tie-downs are employed. Resistors R_{y1} and R_{y2} help damp any oscillation occurring between the common mode filter inductance and Y-capacitance.

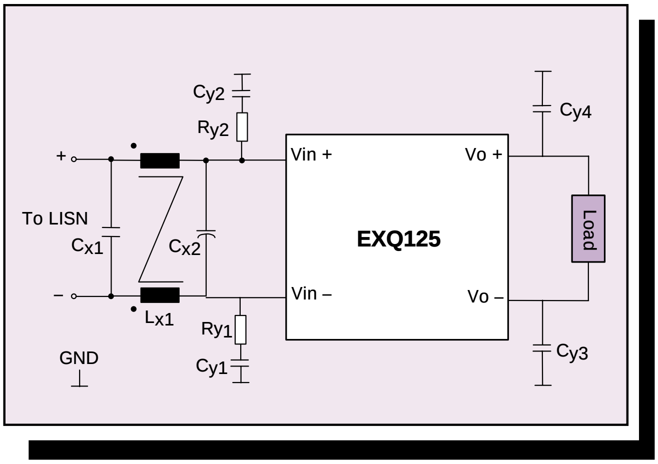


Figure 6 - Recommended Filter for Class B Compliance

The components and manufacturers' part numbers used in the above filter are as follows:

C_{x1}, ITW Paktron 4µF, 100V, SMT film capacitor, 405K100CS4
C_{x2}, UCC 33µF, 100V, electrolytic capacitor, KMF100VB33RM10X12

C_{y1}, C_{y2}, 2 x AVX 5.6nF, 1.5kV, 1812SC562KA1
C_{y3}, C_{y4}, AVX 0.1µF, 100V, 12061C104KAT
R_{y1}, R_{y1}, 5.6Ω 1206 resistor
L_{x1}, Pulse Eng PO420

General recommended layout guidelines of the specified filter are shown in Figure 7. Section 8.1 discusses this subject in more detail, particularly with reference to safety related creepage and clearance requirements.

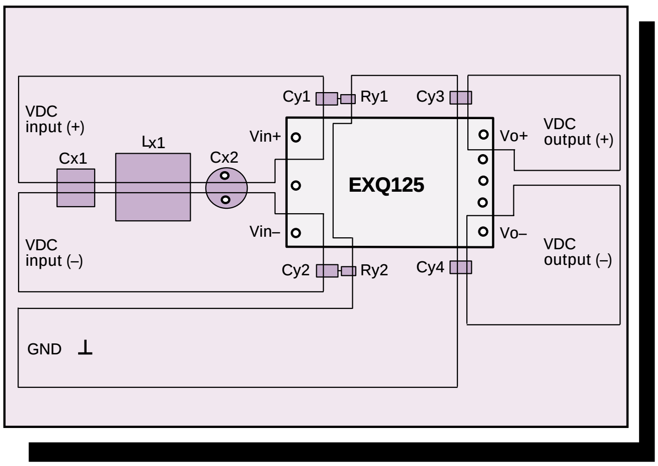


Figure 7 - Conducted EMI Filter Recommended Layout Guidelines

Typical conducted emission measurement results are shown in Figure 8. The results were obtained using the recommended external Class B input filter as outlined in Figure 6.

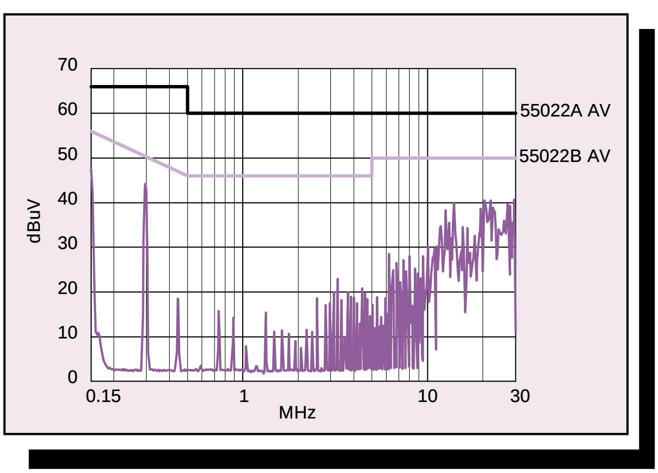


Figure 8 -Typical Spectrum of the EXQ125-483V3 (Vin=48V, Vo=3.3V, Io=25A), 5µH LISN, Class A and B Average Limit Lines are Shown

6.2 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 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 EXQ125 is primarily intended for PCB mounting in telecommunication rack systems. Signal input lines to the converter are considered to be less than 3 meters in length to meet the standards.

This testing is pending. See next revision for results. For the purpose of the radiated test, an EXQ125 will be mounted on a 6U high test-board using the recommended PCB layout (see Appendix 1). The operating conditions will be:

- Input voltage, V_{in} = 48V
- Output voltage, V_o = 3.3V
- Output current, I_o = 25A
- Baseplate temperature, $T_{baseplate}$ = 25°C

No enclosure to be used. Typical radiated emission results will be presented in Figure 9.

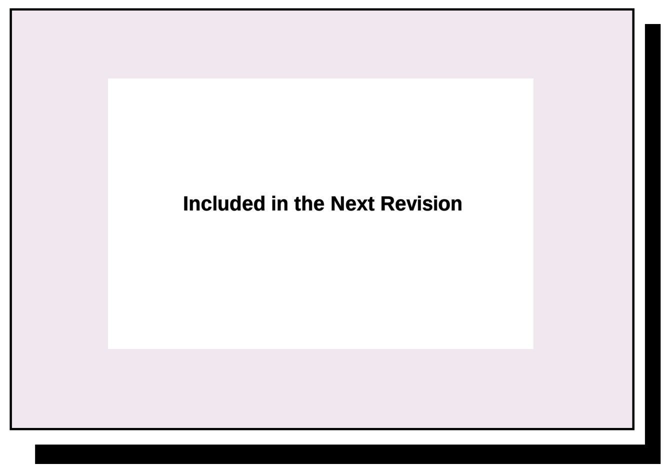


Figure 9 - Typical Radiated Emission EXQ125-48S3V3 (Vin=48V, Io=25A)

7. Use in a Manufacturing Environment

7.1 Resistance to Soldering Heat
The EXQ125 series are intended for PCB mounting. Artesyn Technologies has determined how well it can resist the temperatures associated with 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 350ºC±10ºC 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 solder test the UUT was again mounted on a test PCB. The unit was wave soldered using the conditions shown in Table 2. The UUT was inspected after soldering and no physical change was found on the pin terminations.

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

Table 2 -Wave Solder Test Conditions

7.2 Water Washing
The EXQ125 is suitable for water washing as it does not have any pockets where water may congregate long term. The user should ensure that a sufficient drying process and period are available to remove the water from the unit after washing never power the converter unless it is fully dried.

7.3 ESD Control
The EXQ125 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 approved ESD control procedures. Failure to do so could affect the lifetime of the converter.

7.4 Mounting Brick Type Converters to System PCB
The EXQ125 should be mounted to the end use printed circuit board according to Application Note 103. The threaded inserts on each EXQ125 are insert molded which gives added strength during mounting. Contact Artesyn Technologies if further assistance is needed on PCB mounting.

7.5 Heat Sink Mounting
Depending on the thermal requirements of the application, and the available space, heatsinks can provide increased thermal performance. The converter can be screw mounted on the end use PCB, and also have a heatsink attached to the top side. The industry standard footprint allows the use of many types of off the shelf heatsinks. If multiple converters are to be mounted to a single heatsink or cold plate, care must be taken during assembly. Contact Artesyn Technologies for further information.

8. Applications

8.1 Optimum PCB Layout
The PCB acts as a heat sink and draws heat from the unit via conduction through the pins and radiation. It is recommended that power and return planes be used. A three-wire system including a chassis or system ground is also possible and a ground plane here is also beneficial. These planes act as EMC shields (note that the recommended layout shown in Figure 7 does not guarantee system EMC compliance as this is dependant upon the end application). A recommended layout for an end user's double sided PCB, which maintains the creepage and clearance requirements discussed in the safety section of this application note, is presented in Appendix 1. However the end user must ensure that other components and metal located in the vicinity of the EXQ125 meet the spacing requirements that the system is approved to. Low resistance and low inductance PCB layout traces should be used where possible, particularly where high currents are flowing such as the output side.

8.2 Optimum Thermal Performance
The electrical operating conditions of the EXQ125, namely:

- Input voltage, V_{in}
- Output voltage, V_o
- Output current, I_o

determine how much power is dissipated within the converter. Together with the environmental operating conditions, namely:

- Ambient temperature
- Air velocity
- Thermal efficiency of the end system application
- Parts mounted on system PCB that may block airflow
- Real airflow characteristics at the converter location

the particular baseplate temperature of the converter will be determined. The maximum acceptable baseplate temperature measured at the thermal reference points is 100°C. The thermal reference point is shown in Figure 10.

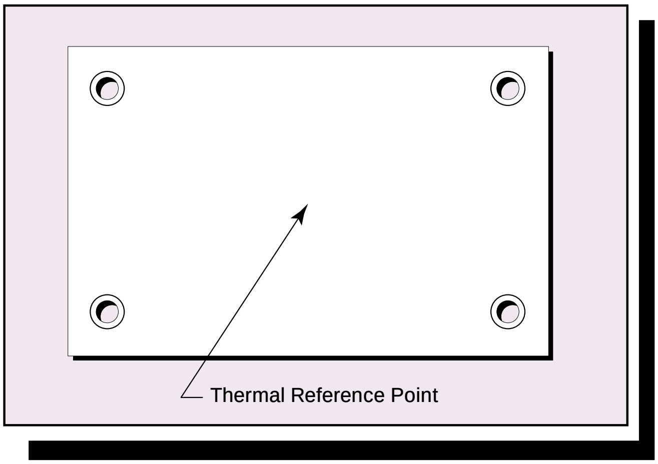


Figure 10 - Baseplate Temperature Check Point

To simplify the thermal design task a number of graphs are given in the data sheet and are repeated here in Figures 11, 12 and 13. The set of derating graphs show the load current of the EXQ125 converters versus the ambient air temperature and forced air velocity. However, since the thermal performance is heavily dependant upon the final system application the user needs to ensure the baseplate is kept within its recommended temperature rating. It is recommended that the temperature of the baseplate is measured using a thermocouple or an IR camera. In order to comply with the inherent stringent Artesyn derating criteria the baseplate temperature should ever exceed 100°C. Alternatively please contact Artesyn Technologies for further support.

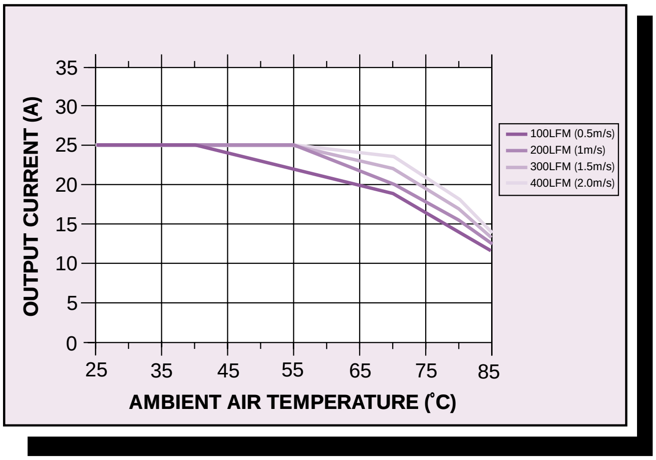


Figure 11 - Maximum Output Current vs. Ambient Temperature and Airflow for EXQ125-48S3V3 Model

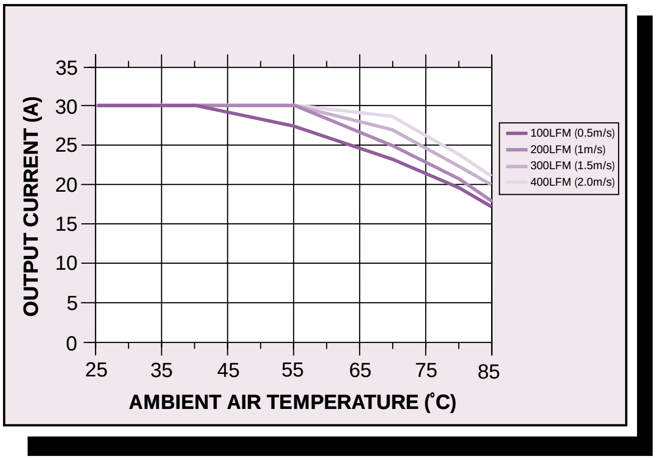


Figure 12 - Maximum Output Current vs. Ambient Temperature and Airflow for EXQ125-48S2V5 Model

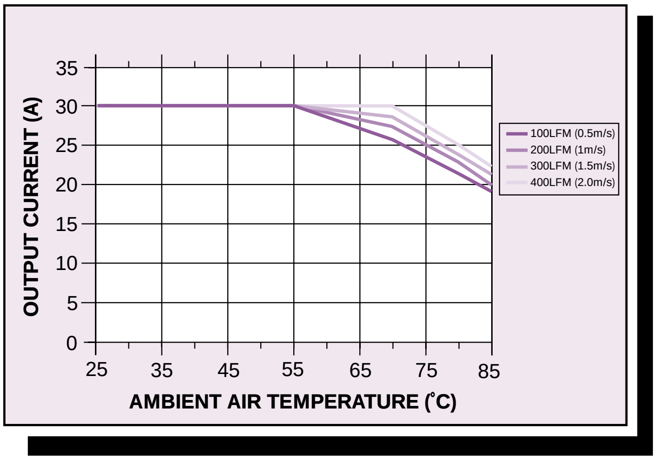


Figure 13 - Maximum Output Current vs. Ambient Temperature and Airflow for EXQ125-48S1V8 Model

8.3 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. A small 100nF ceramic capacitor can be connected at the point of load to decouple any noise on the sense wires. The module will compensate for a maximum drop of 10% of the nominal output voltage. However, if the unit if already trimmed up, the available remote sense compensation range will be correspondingly reduced. Remember that when using remote sense compensation all the resistance, parasitic inductance and capacitance of the distribution system are incorporated within the feedback loop of the power module. This can have an effect on the module compensation, affecting the stability and dynamic response.

8.4 Output Voltage Adjustment

The output can be externally trimmed by ±10% by connecting an external resistor between the TRIM pin and either the V_{sense+} or V_{sense-} pin. With an external resistor between TRIM and V_{sense-}, R_{TRIM_DOWN}, the output voltage setpoint decreases. Conversely, connecting an external resistor between TRIM and V_{sense+}, R_{TRIM_UP}, the output voltage set point increases. A trim pot with its terminals connected to the positive and negative sense pins and the wiper connected to the trim pin allows a variable trim, either up or down. This is shown in Figures 14, 15 and 16.

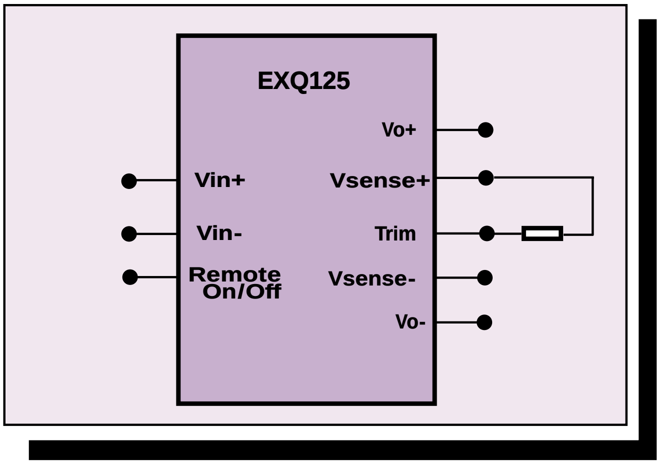


Figure 14 - Trimming Output Voltage - Trim up

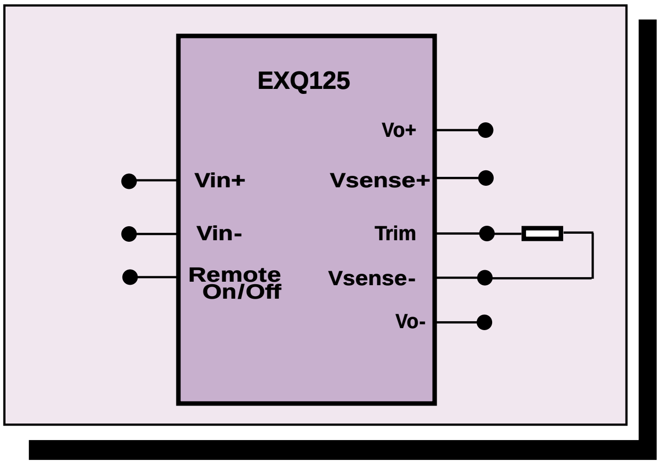


Figure 15 - Trimming Output Voltage - Trim Down

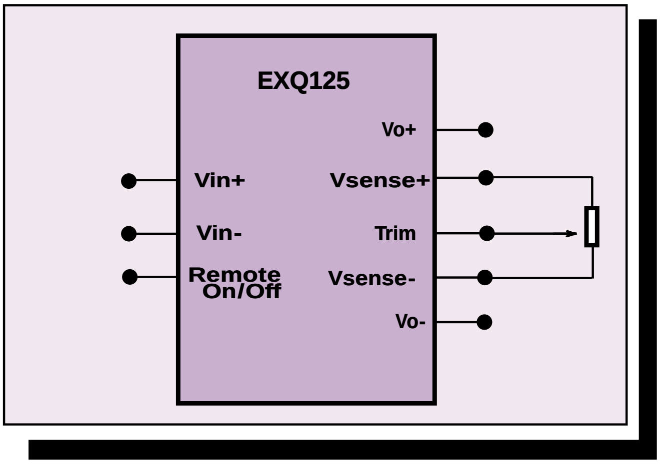


Figure 16 - Trimming Output Voltage - Variable Trim

The relevant trim equations to derive the appropriate trim resistance for the EXQ125 are as follows:

$$R_{trim\_down} = \left(\frac{5.11}{\Delta} - 10.22\right) k\Omega$$

$$R_{trim\_up} = \left(\frac{5.11 V_{out}(1 + \Delta)}{V_{ref}\,\Delta} - \frac{5.11}{\Delta} - 10.22\right) k\Omega$$

Where V_{ref} = 1.225V for all models and Δ is the percentage output voltage change expressed in decimals.

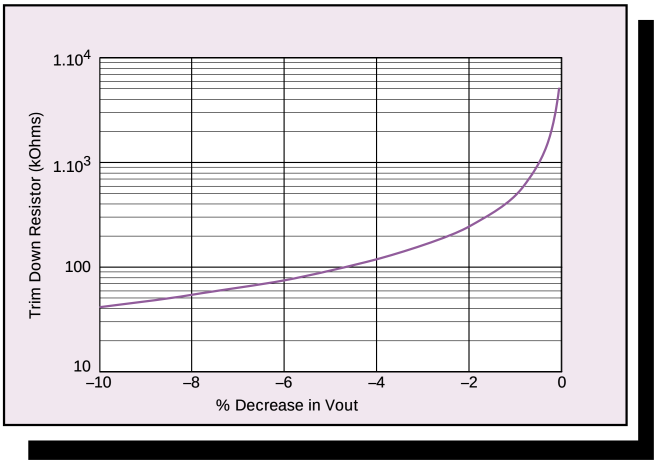


Figure 17 - Typical Trim Down Curve (resistor from TRIM to V_{sense-})[1]

[1]Trim down curve specifying resistance or voltage required for a given decrease in nominal output voltage is the same for all models.

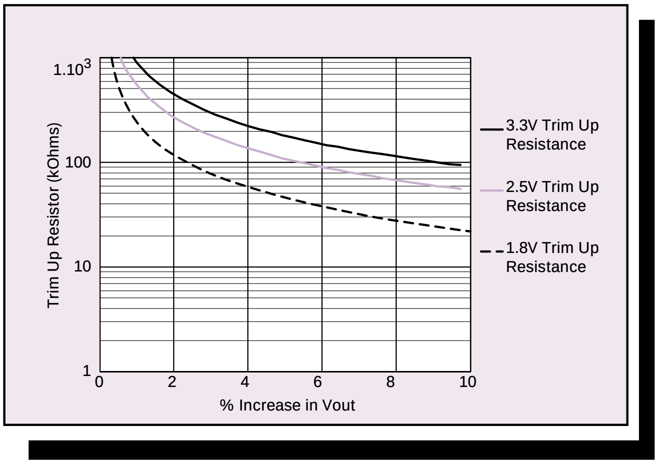


Figure 18 - Typical Trim-Up Curve (resistor from TRIM to V_{sense+})

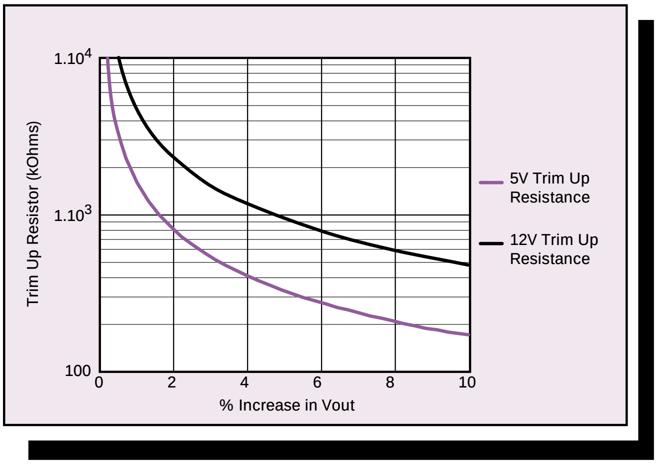


Figure 19 - Typical Trim-Up Curve (resistor from TRIM to V_{sense+})

Alternatively, a voltage source applied between the TRIM pin and Vsense- can be used to trim up or down above or below the nominal output voltage. The voltage source applied to the TRIM pin for a certain trim level is defined in Figure 20. Note that when the module is trimmed down below the recommended level of 10%, the control circuit bias voltage supply circuit draws current directly from the line. Such a dissipative supply mode will cause the bias supply to eventually overheat and trip the OTP protection circuit.

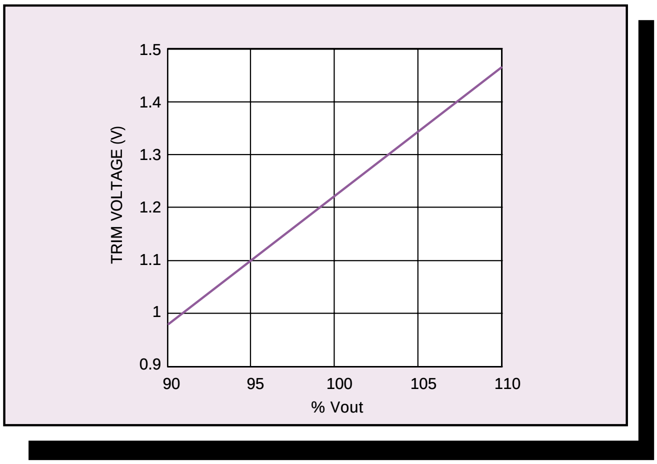


Figure 20 - Typical Trim Curve (Voltage Source from TRIM to V_{sense}[1])

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.

8.5 Parallel and Series Operation

Because of the absence of an active current sharing feature, parallel operation of multiple EXQ125 converters is generally not allowed. 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 power conversion efficiency.

Outputs of multiple EXQ125 converters can be connected in series. However, it is possible in certain connections that the common mode EMI levels may increase. Thus, it is advisable to contact the local Artesyn Technologies representative for further information.

8.6 Output Capacitance

The EXQ125 series of DC/DC converters has been designed for stable operation without the need for external capacitance at the output terminals. However, when powering loads with large dynamic current requirements, improved voltage regulation can be obtained by inserting capacitors as close as possible to the load. The most effective technique is to locate low ESR ceramic capacitors as close to the load as possible, using several capacitors to lower the overall ESR. These ceramic capacitors will handle the short duration high frequency components of the dynamic current requirement. In addition, higher values of electrolytic capacitors should be used to handle the mid-frequency components.

It is equally important to use good design practices when configuring the DC distribution system. As outlined in section 8.1, low resistance and low inductance PCB layout traces should be utilized, particularly in the high current output section. Remember that the capacitance of the distribution system and the associated ESR are within the feedback loop of the power module. This can have an effect on the module compensation and the resulting stability and dynamic response performance. Generally, as a rule of thumb, 100µF/A of output current can be used without any additional analysis. With larger values of capacitance, the stability criteria depend on the magnitude of the ESR with respect to the capacitance. As much of the capacitance as possible should be outside of the remote sensing loop and close to the load.

Note that the maximum rated value of output capacitance for models with output voltages up to and including 3.3V is 10,000µF. Higher voltage models will have reduced capacitive load rating. If required, larger capacitance values are possible please contact the local Artesyn Technologies representative for further information.

8.7 Reflected Ripple Current and Output Ripple & Noise Measurement

The measurement setup outlined in Figure 22 has been used for both input reflected/terminal ripple current and output voltage ripple and noise measurements on EXQ125 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 setup is compatible with ETS 300 386-1.

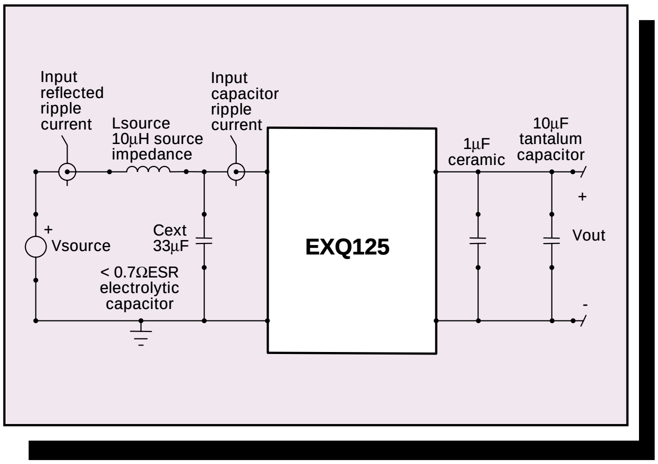
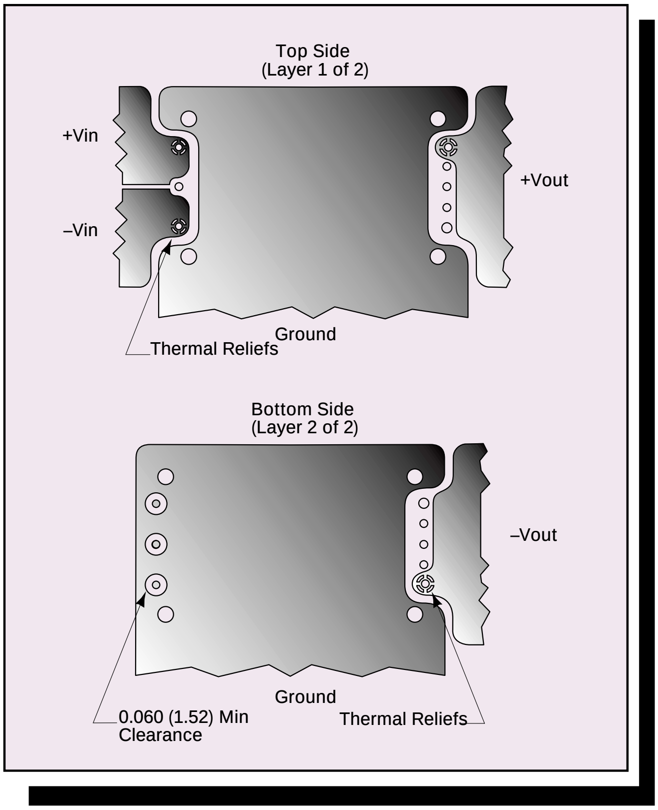


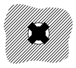
Figure 21 - Input Reflected Ripple/Capacitor Ripple Current and Output Voltage Ripple and Noise Measurement Set-Up

Appendix 1 - Recommended PCB Footprints

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 23 - Recommended Footprints