# PXD15-xxSxx Single Output DC/DC Converter

9 to 75 Vdc input, 3.3 to 15 Vdc Single Output, 15W

TDK·Lambda

### Features

- Low profile: 2.0X1.0X0.4 inches (50.8X25.4X10.2mm)
- 2:1 wide input voltage of 9-18, 18-36 and 36-75VDC
- 15 Watts output power
- Input to output isolation: 1600Vdc, min
- Operating case temperature range :100°C max
- Over-current protection, auto-recovery
- Output over voltage protection
- ISO 9001 certified manufacturing facilities
- UL60950-1, EN60950-1 and IEC60950-1 licensed
- CE Mark meet 2006/95/EC, 93/68/EEC and 2004/108/EC
- Compliant to RoHS EU directive 2002/95/EC

### Applications

- Distributed power architectures
- Communication equipment
- Computer equipment

### Option

- Positive logic & Negative logic Remote on/off

## General Description

The PXD15-xxSxx series offers15 watts of output power from a 2 x 1 x 0.4 inch package. This series has a 2:1 wide input voltage of 9-18, 18-36 or 36-75VDC.

## Table of contents


| | | | |
|---|---|---|---|
| Absolute maximum rating | P2 | Solder, clearing, and drying considerations | P8 |
| Output Specifications | P2 | Characteristic curve | P9 |
| Input Specifications | P3 | Test configurations | P17 |
| General Specifications | P3 | Part number structure | P18 |
| Remote on/off control | P4 | Mechanical data | P18 |
| Thermal Consideration | P5 | Safety and installation instruction | P19 |
| Output over current protection | P7 | MTBF and Reliability | P19 |
| Short circuit protection | P7 | | |

| Absolute Maximum Rating | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Device** | **Min** | **Typ** | **Max** | **Unit** |
| Input Voltage Continuous Transient (100ms) | 12Sxx | | | 36 | Vdc |
| | 24Sxx | | | 50 | Vdc |
| | 48Sxx | | | 100 | Vdc |
| Operating temperature range(With De-rating curve) | Standard | -40 | | +85 | °C |
| Operating case range | All | | | 100 | °C |
| Storage temperature | All | -55 | | +105 | °C |
| I/O Isolation voltage | All | 1600 | | | Vdc |
| I/O Isolation capacitance | All | | | 300 | pF |

| Output Specifications | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Device** | **Min** | **Typ** | **Max** | **Unit** |
| Operating Output Range | xxS3P3 | 3.267 | 3.30 | 3.333 | Vdc |
| | xxS05 | 4.95 | 5.00 | 5.05 | Vdc |
| | xxS12 | 11.88 | 12.00 | 12.12 | Vdc |
| | xxS15 | 14.85 | 15.00 | 15.15 | Vdc |
| Line Regulation(LL to HL at Full Load) | All | -0.5 | | 0.5 | % |
| Load Regulation(Min. to 100% Full Load) | All | -0.5 | | 0.5 | % |
| Output Ripple & Noise (20MHz bandwidth) | All | | | 50 | mVp-p |
| Temperature Coefficient | All | -0.02 | | +0.02 | %/°C |
| Transient Response Recovery Time (25% load step change) | All | | 250 | | uS |
| Output Current | xxS3P3 | 0 | | 4000 | |
| | 12S05 | 15 | | 3000 | |
| | 12S12 | 0 | | 1250 | |
| | 12S15 | 0 | | 1000 | mA |
| | 24S05 | 15 | | 3000 | mA |
| | 24S12 | 0 | | 1250 | mA |
| | 24S15 | 10 | | 1000 | mA |
| | 48S05 | 0 | | 3000 | |
| | 48S12 | 10 | | 1250 | |
| | 48S15 | 0 | | 1000 | |
| Output Over Voltage Protection Zener diode clamp | xxS3P3 | | 3.9 | | Vdc |
| | xxS05 | | 6.2 | | Vdc |
| | xxS12 | | 15 | | Vdc |
| | xxS15 | | 18 | | Vdc |
| Output Over Current Protection | All | | 150 | | % FL. |
| Output Short Circuit Protection | All | Hiccup, automatics recovery | | | |
| Output Capacitor Load | xxS3P3 | | | 10200 | μF |
| | xxS05 | | | 7050 | μF |
| | xxS12 | | | 1035 | μF |
| | xxS15 | | | 705 | μF |

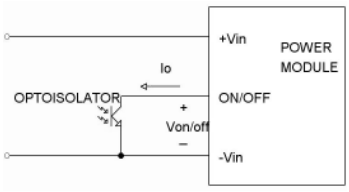
| Input Specifications | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | | **Device** | **Min** | **Typ** | **Max** | **Unit** |
| Operating Input voltage | | 12Sxx | 9 | 12 | 18 | Vdc |
| | | 24Sxx | 18 | 24 | 36 | Vdc |
| | | 48Sxx | 36 | 48 | 75 | Vdc |
| Input reflected ripple current (please see he testing configurations part.) | | All | | 20 | | mA p-p |
| Start up time (nominal vin and constant resistive load power up) | | All | | 20 | | mS |
| Remote ON/OFF | | | | | | |
| Negative Logic | DC-DC ON | All | 0 | | 1.2 | Vdc |
| | DC-DC OFF | All | 3.5 | | 12 | Vdc |
| Positive Logic | DC-DC ON | All | 3.5 | | 12 | Vdc |
| | DC-DC OFF | All | 0 | | 1.2 | Vdc |

| General Specifications | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Device** | **Min** | **Typ** | **Max** | **Unit** |
| Efficiency Vin=nom and full load | 12S3P3 | | 79 | | % |
| | 12S05 | | 82 | | % |
| | 12S12 | | 86 | | % |
| | 12S15 | | 86 | | % |
| | 24S3P3 | | 80 | | % |
| | 24S05 | | 84 | | % |
| | 24S12 | | 85 | | % |
| | 24S15 | | 85 | | % |
| | 48S3P3 | | 81 | | % |
| | 48S05 | | 83 | | % |
| | 48S12 | | 87 | | % |
| | 48S15 | | 86 | | % |
| Isolation resistance | All | $10^9$ | | | Ω |
| Isolation Capacitance | All | | | 300 | pF |
| Switching Frequency ( Vin, nom and full load) | All | | 500 | | KHz |
| Weight | All | | 27 | | g |
| MTBF | All | | $2.041 \times 10^6$ | | hours |

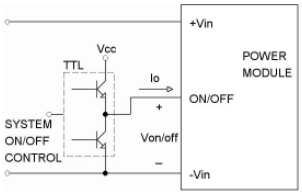
## Remote On/Off Control

The Remote ON/OFF pin is used to turn the DC/DC converter on and off. The user must use a switch to control the logic voltage (high or low) level of the pin referenced to -Vin. The switch can be a open collector transistor, FET. or opto-Coupler. The switch must be capable of sinking up to 0.5 mA for a low-level logic voltage. For a high logic level for the ON/OFF signal, the allowable leakage current of the switch at 12V is 0.5mA.

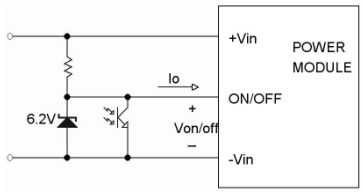
Remote ON/OFF Implementation Circuits



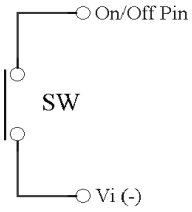

Isolated-Control Remote ON/OFF



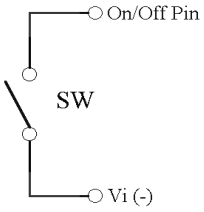

Level Control Using TTL Output




Level Control Using Line Voltage



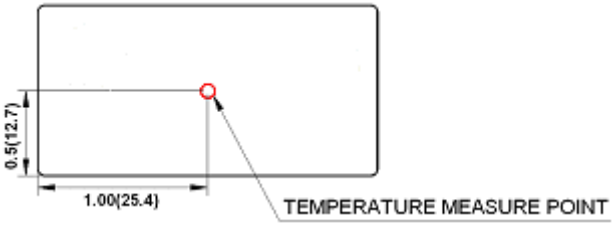

PXD15-xxSxx is turned off
with Low-level logic




PXD15-xxSxx is turned on
with High-level logic

## Thermal Consideration

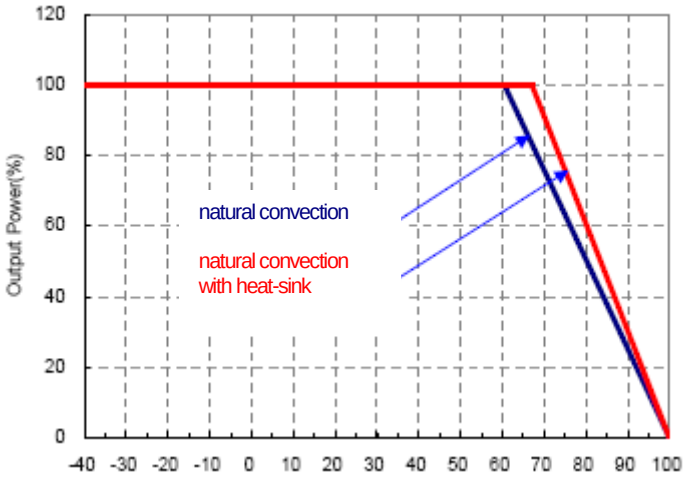
The power module operates in a variety of thermal environments. Sufficient cooling should be provided to help ensure reliable operation of the unit. Heat is removed by conduction, convection, and radiation to the surrounding environment. Proper cooling can be verified by measuring the point as shown in the figure below. The temperature at this location should not exceed 100°C. When Operating, adequate cooling must be provided to maintain the test point temperature at or below 100°C. Although the maximum temperature of the power modules is 100°C, lowering this temperature will increase the reliability of the unit.



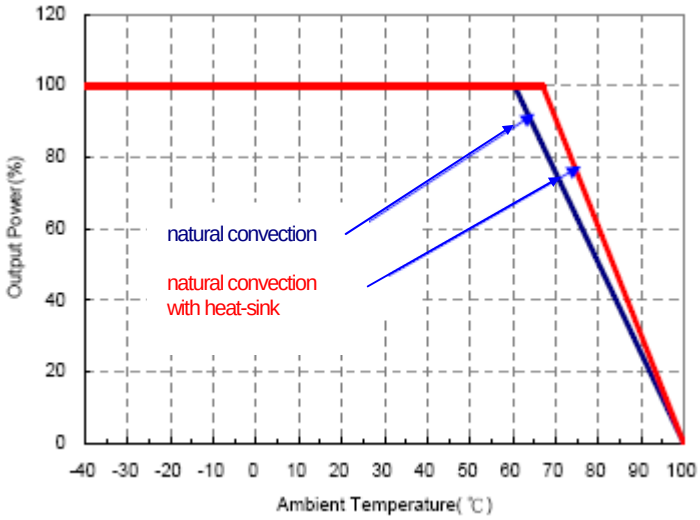

Measurement shown in inches(mm) TOP VIEW

Following are de-rating curves for PXD15-12S05, PXD15-24S3P3, PXD15-48S12

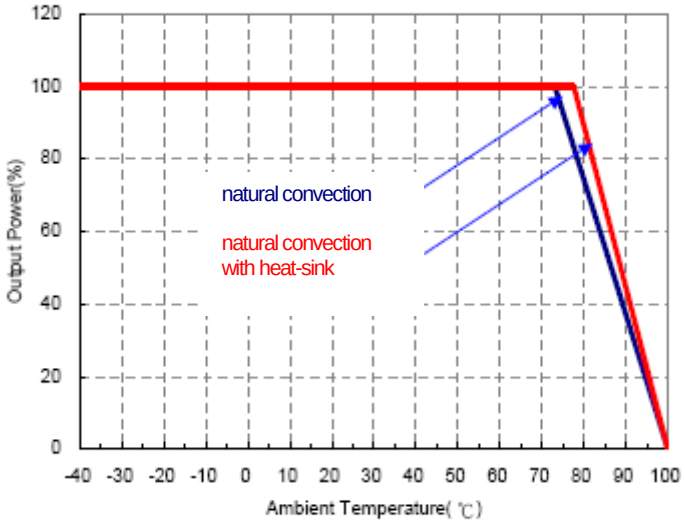
PXD15-12S05



PXD15-24S3P3




PXD15-48S12



## Output over current protection

When excessive output currents occur in the system, circuit protection is required on all converters. Normally, overload current is maintained at approximately 150 percent of rated current for PXD15-xxDxx series..

Hiccup-mode is a method used in a converter whose purpose is to protect the converter from being damaged during an over-current fault condition. It also enables the converter to restart when the fault is removed. There are other ways of protecting the converter when it is over-loaded, such as the maximum current limiting or the current foldback method.

One of the problems resulting from over current is that excessive heat may be generated in power devices; especially MOSFET and Schottky diodes and the temperature of these devices may exceed their specified limits. A protection mechanism has to be used to prevent these power devices from being damaged.

The operation of hiccup is as follows. When the current sense circuit sees an over-current event, the controller shuts off the converter for a given time and then tries to re-start the converter. If the over-load condition has been removed, the converter will start-up and operate normally; otherwise, the controller will see another over-current event and shut off the converter again, repeating the previous cycle. Hiccup operation has none of the drawbacks of the other two protection methods, although it's circuit is more complicated because it requires a timing circuit. The excess heat due to overload lasts for only a short duration in the hiccup cycle, hence the junction temperature of the power devices is much lower.

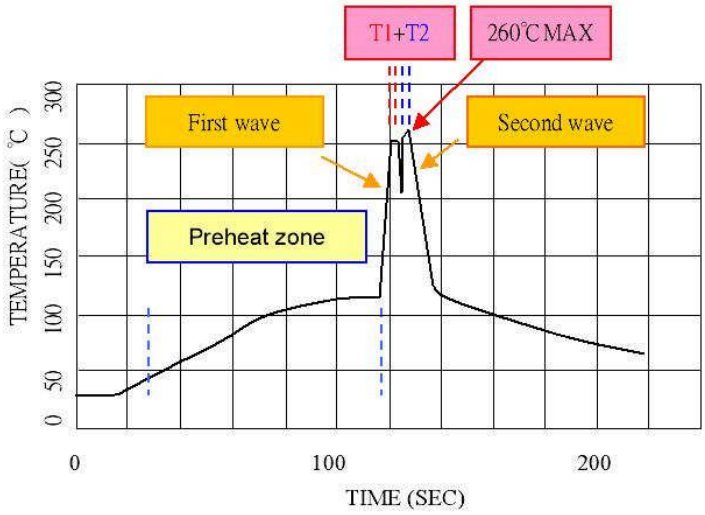
## Short Circuitry Protection

Continuous, hiccup and auto-recovery mode.

During short circuit, converter still shut down. The average current during this condition will be very low and the device can be safety in this condition.

## Soldering and Reflow Consideration

Lead free wave solder profile for PXD15-xxSxx DIP type




| Zone | Reference Parameter |
|---|---|
| Preheat zone | Rise temp. speed : 3°C / sec max.<br>Preheat temp. : 100~130°C |
| Actual heating | Peak temp. : 250~260°C<br>Peak time (T1+T2 time) : 4~6 sec |

**Reference Solder:** Sn-Ag-Cu/Sn-Cu

**Hand Welding:** Soldering iron-Power 90W

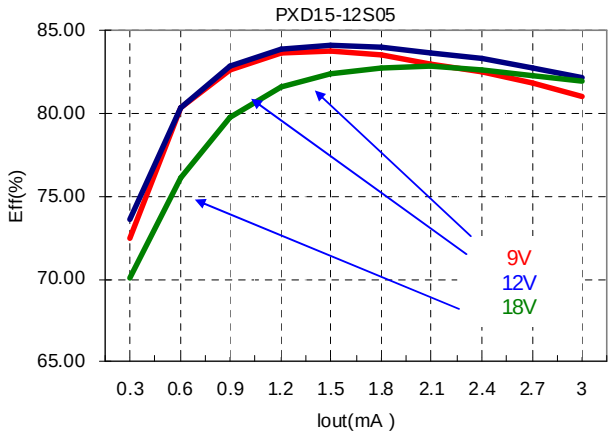
Welding Time:2-4 sec

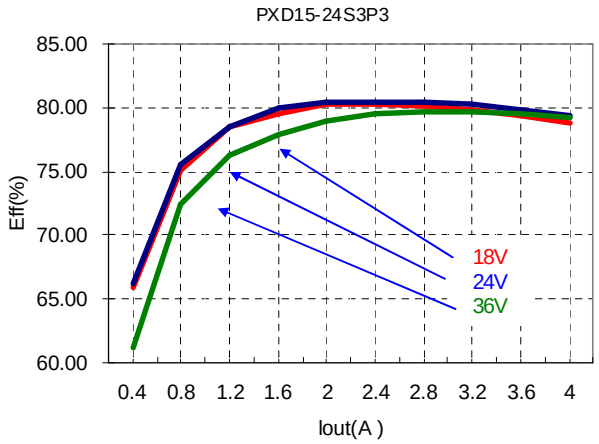
Temp.: 80-400 °C

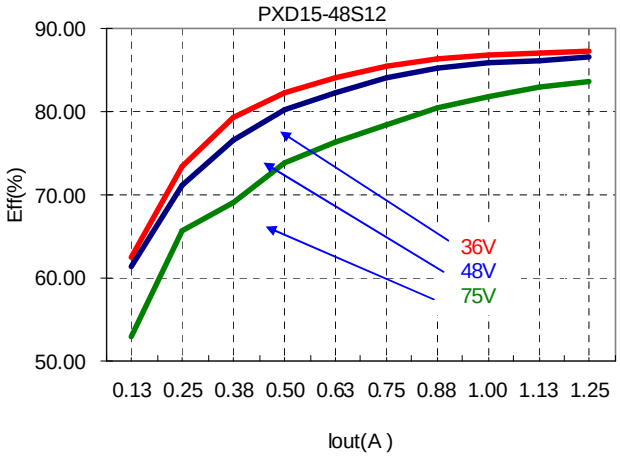
## Characteristic Curve

**Efficiency**

a. Efficiency with load change under different line condition at room temperature

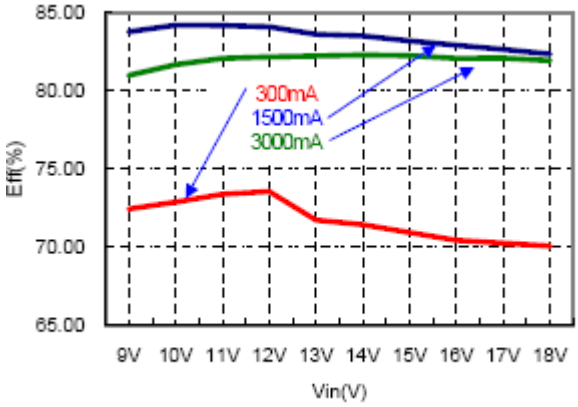


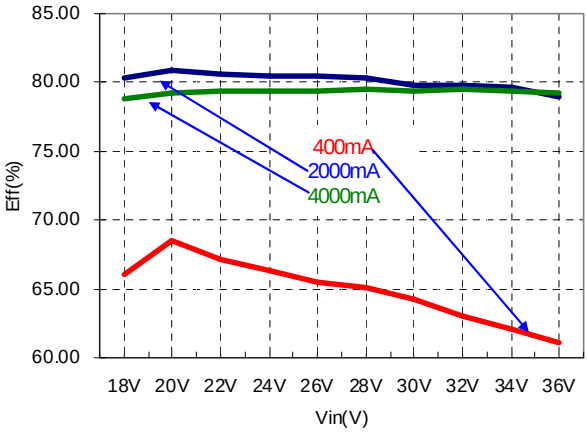



b. Efficiency with line change under different load condition at room temperature

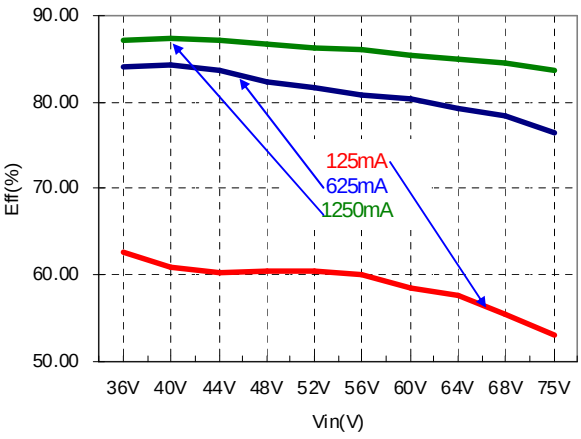
PXD15-12S05



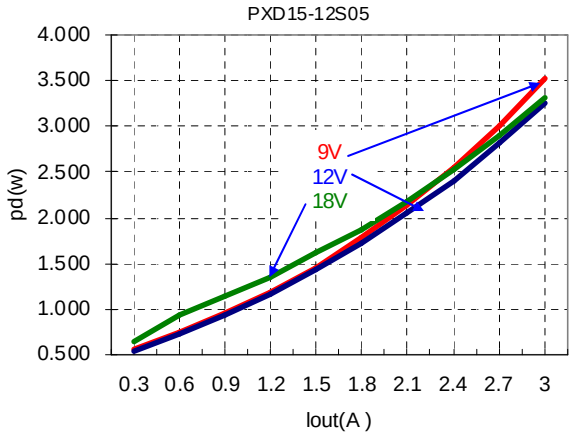

PXD15-24S3P3

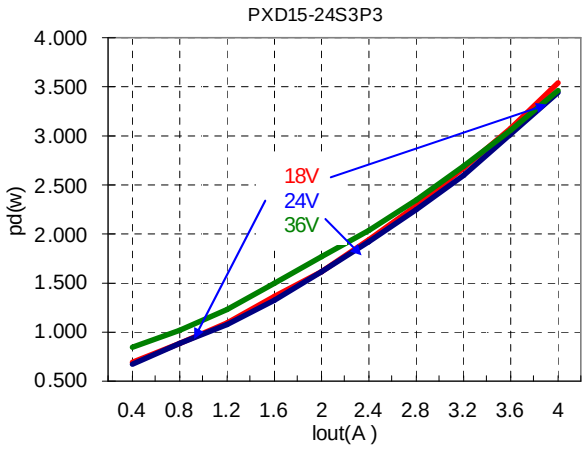


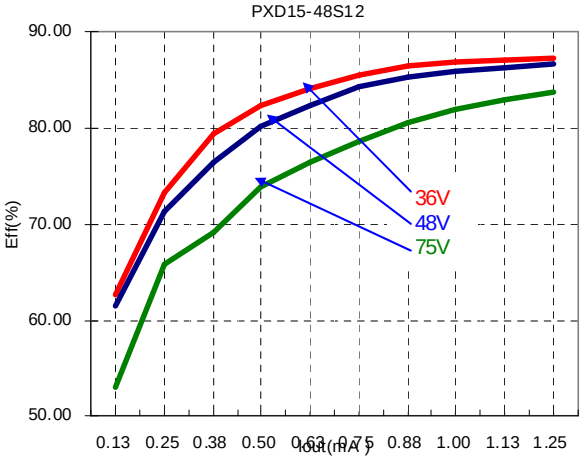

PXD15-48S12



**Power dissipation curve**

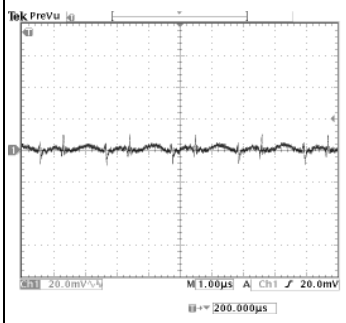


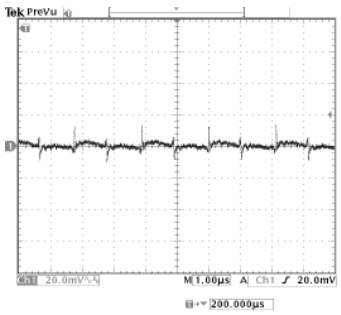
**Output ripple & noise**

PXD15-12S05



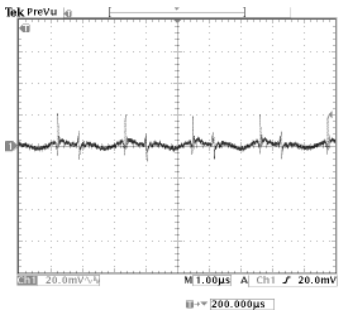

Low Line, Full Load

Output Ripple Noise=19.6mV




Normal Line, Full Load

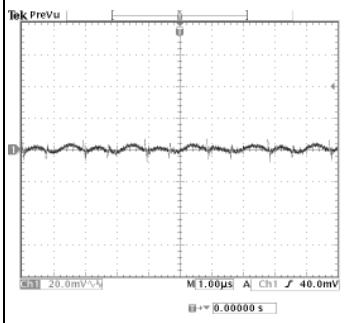
Output Ripple Noise=22.8mV




High Line, Full Load

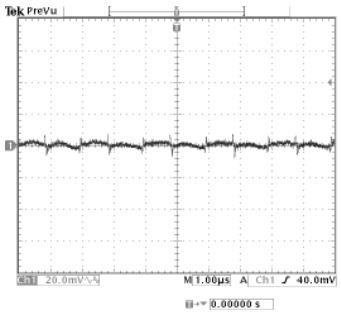
Output Ripple Noise=29.6mV

PXD15-24S3P3



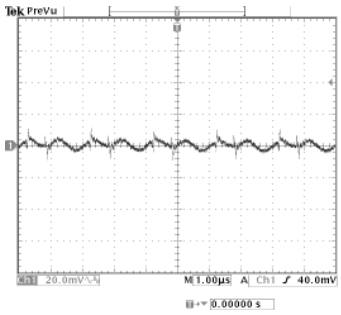

Low Line, Full Load

Output Ripple Noise=15.2mV




Normal Line, Full Load

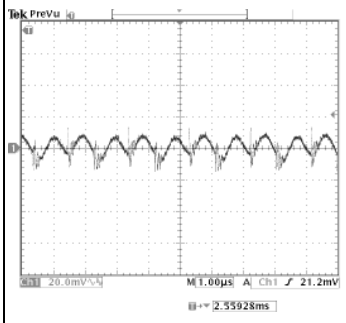
Output Ripple Noise=15.6mV




High Line, Full Load

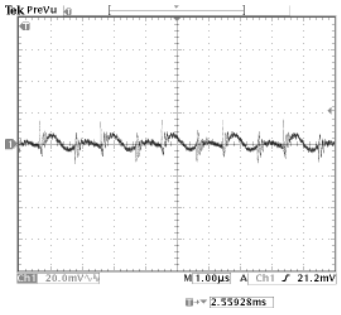
Output Ripple Noise=20.0mV

PXD15-48S12



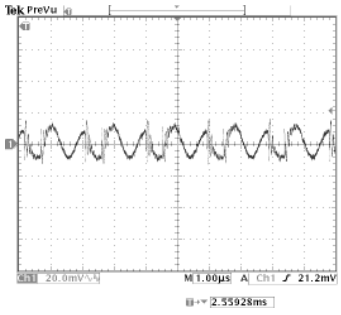

Low Line, Full Load

Output Ripple Noise= 28. 4




Normal Line, Full Load

Output Ripple Noise=27.6mV

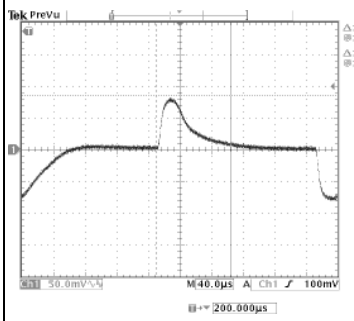



High Line, Full Load

Output Ripple Noise=29.6mV

**Transient Peak and Response**

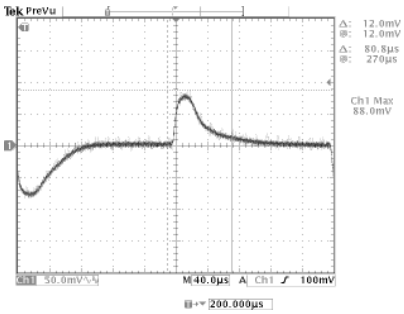
PXD15-12S05



Low Line, Full Load

Transient Peak 85.0mV

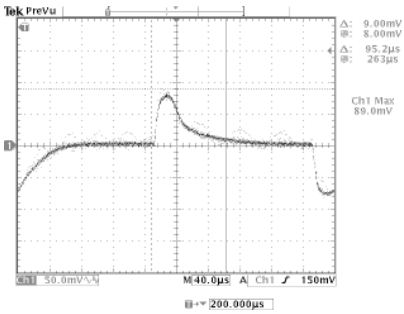
Transient Response 95.2uS



Normal Line, Full Load

Transient Peak 88.0mV

Transient Response 80.8uS

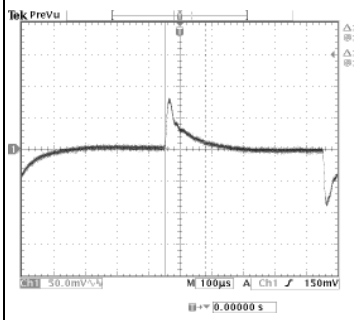


High Line, Full Load

Transient Peak 89.0mV

Transient Response 95.2uS

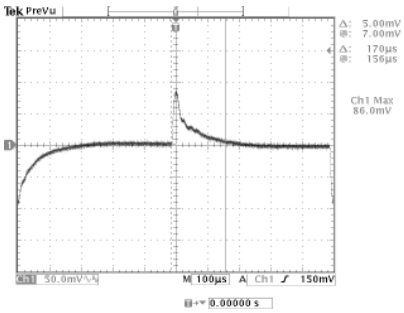
PXD15-24S3P3



Low Line, Full Load

Transient Peak 81.0mV

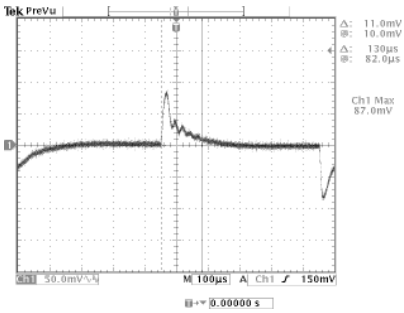
Transient Response130uS



Normal Line, Full Load

Transient Peak 86.0mV

Transient Response 170uS

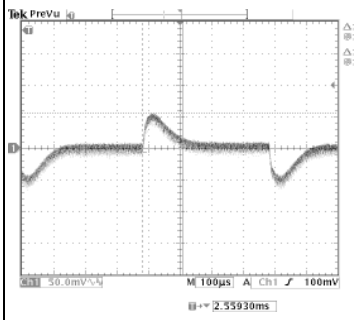


High Line, Full Load

Transient Peak 45.6mV

Transient Response 200uS

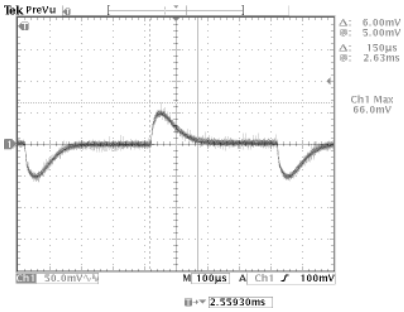
PXD15-48S12



Low Line, Full Load

Transient Peak 56mV

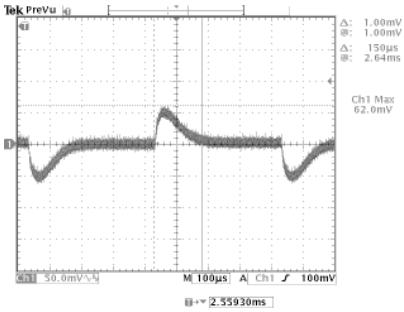
Transient Response130uS



Normal Line, Full Load

Transient Peak 66mV

Transient Response 150uS



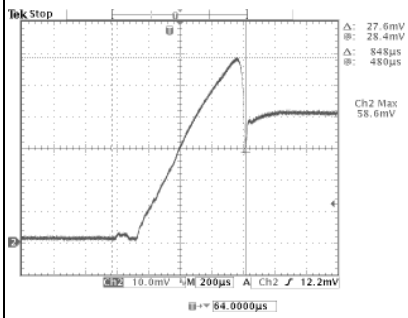
High Line, Full Load

Transient Peak 62mV

Transient Response 150uS

**Inrush Current**

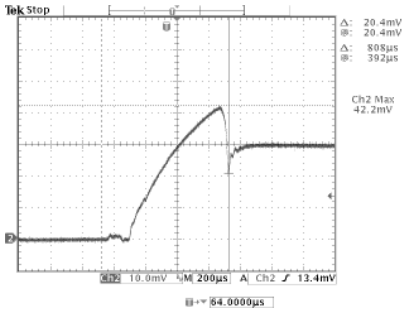
PXD15-12S05




Low Line, Full Load

Inrush current=(58.6/10) X500mA=2930mA

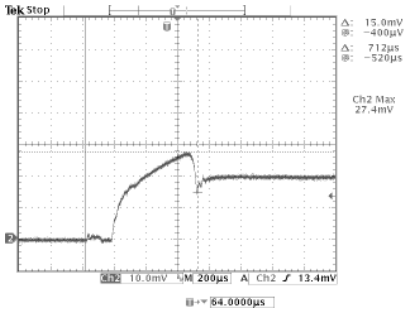
Duration: 848uS




Normal Line, Full Load

Inrush current=(42.2/10) x500mA=2210mA

Duration: 808uS

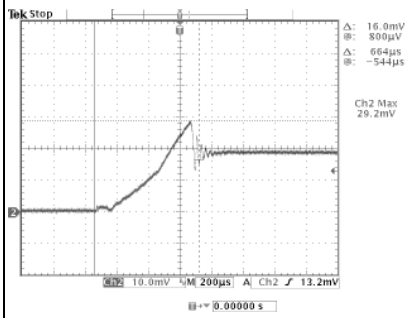



High Line, Full Load

Inrush current=(27.4/10) x500mA=1370mA

Duration: 712uS

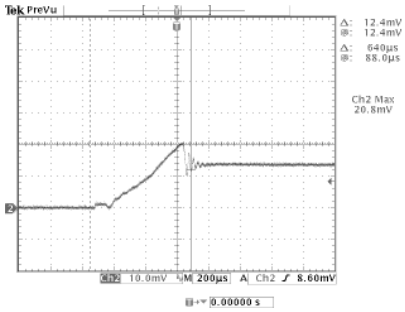
PXD15-24S3P3




Low Line, Full Load

Inrush current=(29.2/10) X500mA=1460mA

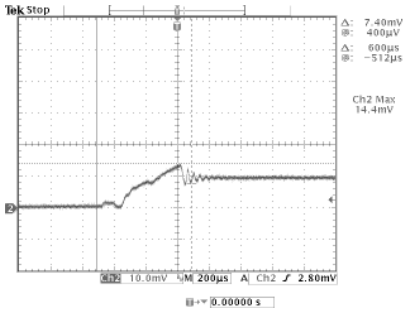
Duration: 664uS




Normal Line, Full Load

Inrush current=(20.8/10) x500mA=1040mA

Duration: 640uS

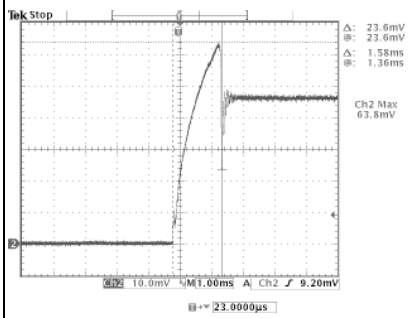



High Line, Full Load

Inrush current=(14.4/10) x500mA=720mA

Duration: 600uS

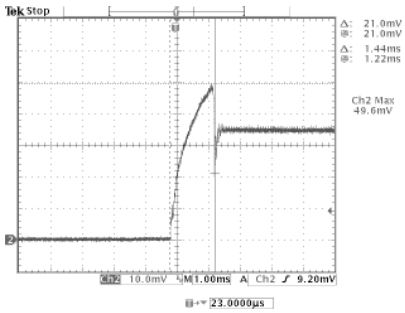
PXD15-48S12




Low Line, Full Load

Inrush current=(63.8/10) X100mA=638mA

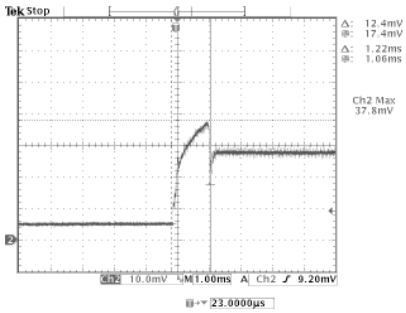
Duration: 1.58mS




Normal Line, Full Load

Inrush current=(49.6/10) x100mA=496mA

Duration: 1.44mS



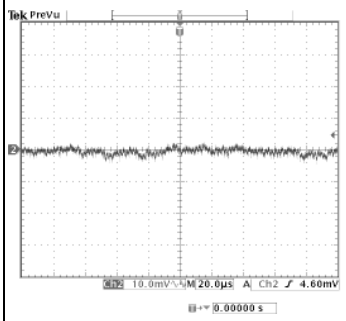

High Line, Full Load

Inrush current=(37.8/10) x100mA=378mA

Duration: 1.22mS

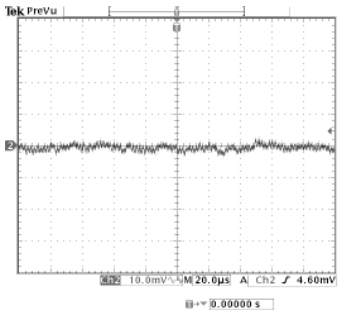
**Input Ripple Current**

PXD15-12S05



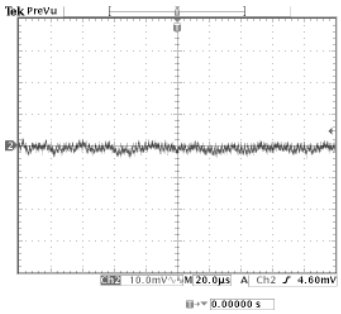

Low Line, Full Load

Ripple current=(7.6/10) x5=3.8mA




Normal Line, Full Load

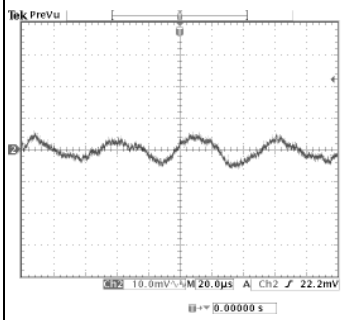
Ripple current=(5.8/10) x5=2.9mA




High Line, Full Load

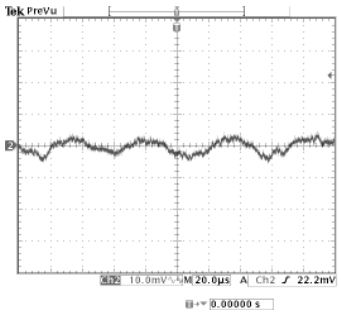
Ripple current=(6.4/10) x5=3.2mA

PXD15-24S3P3



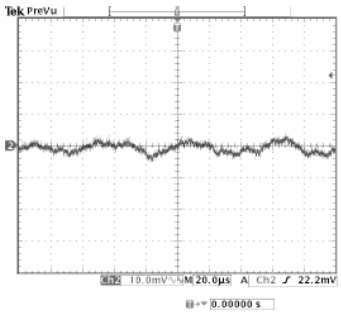

Low Line, Full Load

Ripple current=(12/10) x5=6.0mA




Normal Line, Full Load

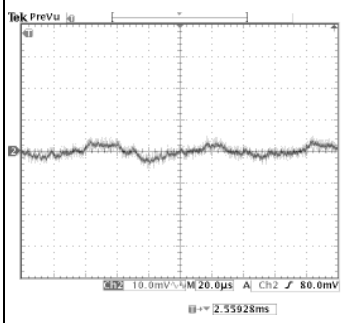
Ripple current=(10.2/10) x5=5.1mA




High Line, Full Load

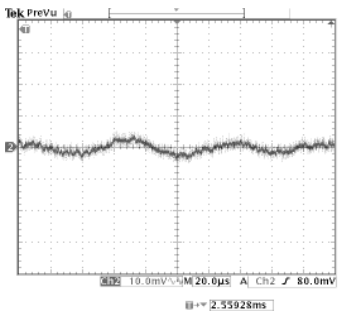
Ripple current=(9/10) x5=4.5mA

PXD15-48S12



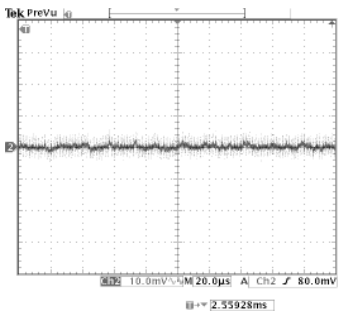

Low Line, Full Load

Ripple current=(10.4/10) x5=5.2mA




Normal Line, Full Load

Ripple current=(7.8/10) x5=3.9mA

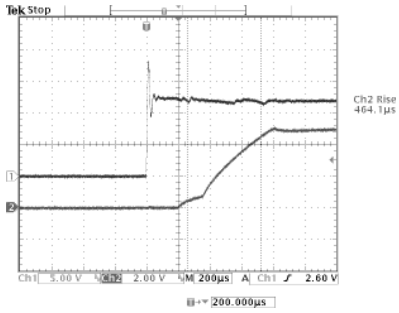



High Line, Full Load

Ripple current=(9.8/10) x5=4.9mA

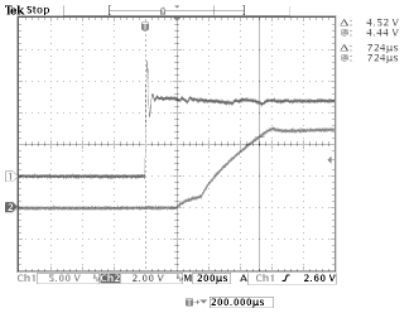
**Delay Time and Rise Time**

PXD15-12S05




Normal Line, Full Load

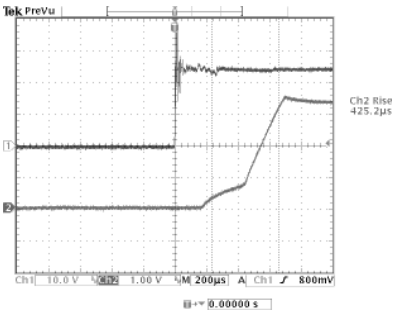
Rise Time=464.1uS




Normal Line, Full Load

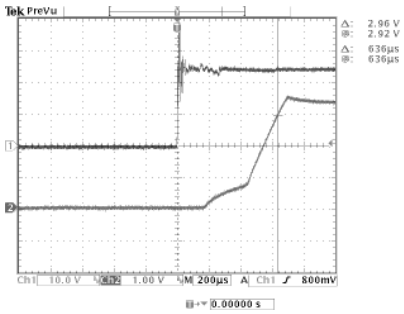
Delay Time= 724uS

PXD15-24S3P3




Normal Line, Full Load

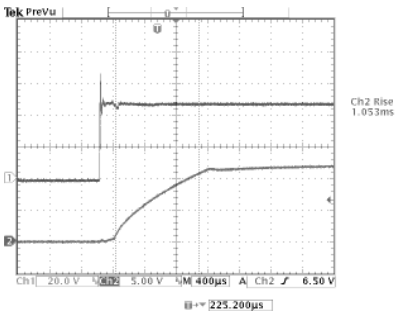
Rise Time=425.2uS




Normal Line, Full Load

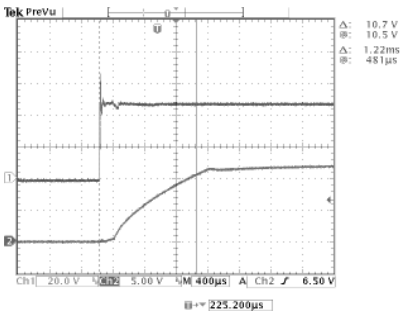
Delay Time= 636uS

PXD15-48S12




Normal Line, Full Load

Rise Time=1.053mS

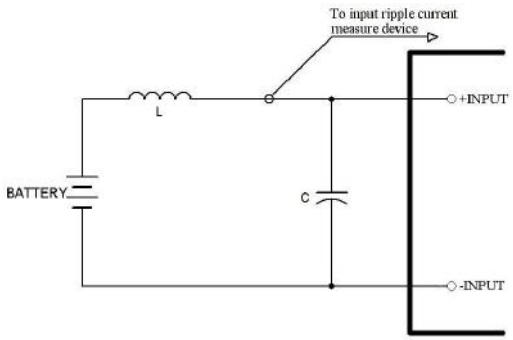



Normal Line, Full Load

Delay Time= 1.22mS

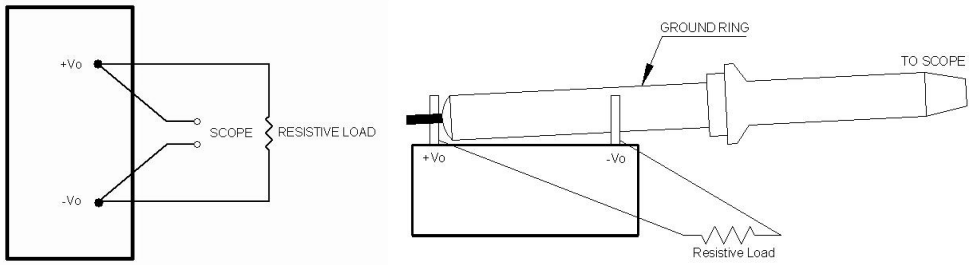
## Testing Configurations

**Input Reflected-ripple Current Measurement Test:**

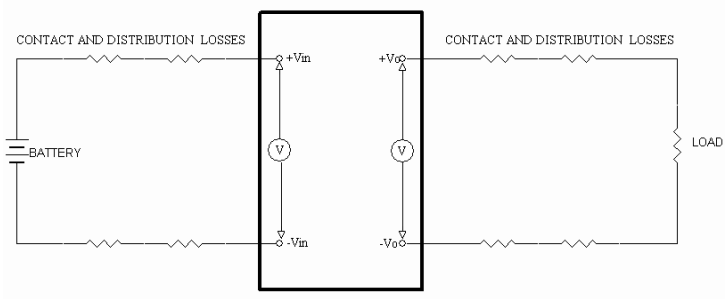



| Component | Value | Voltage | Reference |
|---|---|---|---|
| L | 12μH | ---- | ---- |
| C | 100μF | 100V | Aluminum Electrolytic Capacitor |

**Peak-to-Peak Output Ripple & Noise Measurement Test:**




**Output Voltage and Efficiency Measurement Test:**




Note: All measurements are taken at the module terminals.

$$Efficiency = \left( \frac{V_o \times I_o}{V_{in} \times I_{in}} \right) \times 100\%$$

## Part Number Structure

PXD 15 – 24 S 12

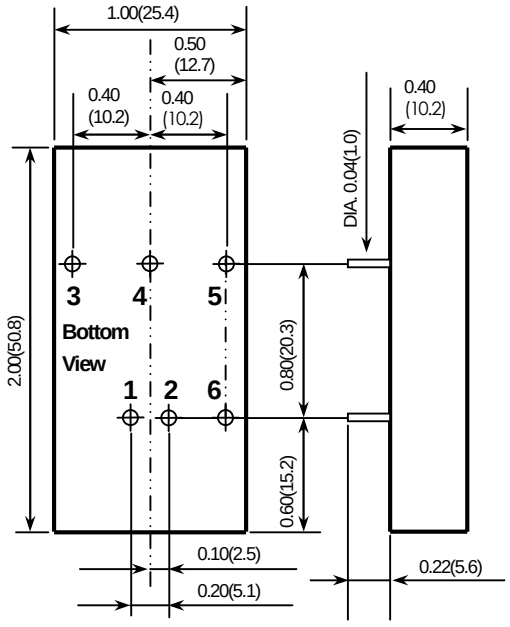
**Total Output Power**
**15 Watt**

**Input Voltage Range**
12 : 9~18V
24 : 18~36V
48 : 36~75V

**Single Output**

**Output Voltage**
3P3 : 3.3V
05 : 5V
12 : 12V
15 : 15V

## Mechanical Data




| PIN CONNECTION | |
|---|---|
| PIN | Function |
| 1 | + INPUT |
| 2 | - INPUT |
| 3 | + OUTPUT |
| 4 | NO PIN |
| 5 | - OUTPUT |
| 6 | CTRL (Option) |

1. All dimensions in Inches (mm)
2. Pin pitch tolerance ±0.0014(0.35)
3. Tolerance : x.xx±0.02 (x.x±0.5)
   x.xxx±0.01 (x.xx±0.25)

## Safety and Installation Instruction

**Isolation consideration**

The PXD15-xxSxx series features 1.6k Volt DC isolation from input to output, input to case, and output to case. The input to output resistance is greater than $10^9$ ohms. Nevertheless, if the system using the power module needs to receive safety agency approval, certain rules must be followed in the design of the system using the model. In particular, all of the creepage and clearance requirements of the end-use safety requirement must be observed. These documents include UL-60950-1, EN60950-1 and CSA 22.2-960, although specific applications may have other or additional requirements.

**Fusing Consideration**

Caution: This power module is not internally fused. An input line fuse must always be used. This encapsulated power module can be used in a wide variety of applications, ranging from simple stand-alone operation to an integrated part of a sophisticated power architecture. For maximum flexibility, internal fusing is not included; however, to achieve maximum safety and system protection, always use an input line fuse. The safety agencies require a slow-blow fuse with maximum rating of 6.3 A. Based on the information provided in this data sheet on inrush energy and maximum DC input current, the same type of fuse with lower rating can be used. Refer to the fuse manufacturer's data for further information.

**Minimum Load Requirement**

10%(of full load) minimum load required. The 10% minimum load requirement is in order to meet all performance specifications. The PXD15-xxSxx series does not properly maintain regulation and operate under a no- load condition. The output voltage drops off about 10%.

## MTBF and Reliability

**The MTBF of PXD15-xxSxx series of DC/DC converters has been calculated using**

1.MIL-HDBK-217F under the following conditions:

Nominal Input Voltage

Io = Io, max

Ta = 25°C ℃

The resulting figure for MTBF is $1.044\times 10^6$ hours.

2.Bell-core TR-NWT-000332 Case I:

50% stress, Operating Temperature at 40°C ℃ (Ground fixed and controlled environment)

The resulting figure for MTBF is $2.041\times 10^6$ hours.