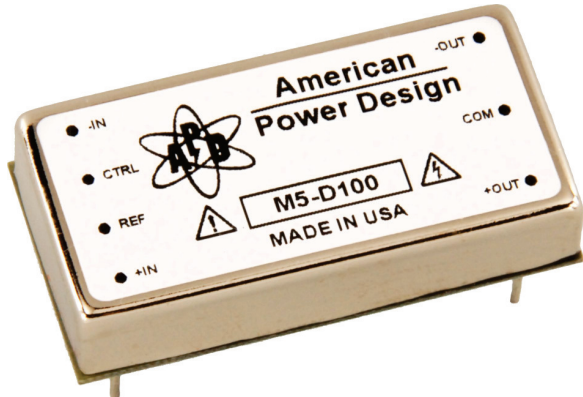




## M5 SERIES 5 WATT PROGRAMABLE DC/DC CONVERTERS



### FEATURES

- ▶ **Customer Selects Output Voltage**
- ▶ Outputs to 1000 Vdc
- ▶ Fully Programmable Outputs
- ▶ Single and Dual Outputs
- ▶ Wide Input Ranges  
(10-20Vdc, 18-36Vdc)
- ▶ 1000 Vdc Output Isolation
- ▶ Continuous Short Circuit Protection
- ▶ UL Certified Encapsulant Meets 94V-0 Flammability

The M5 Series high voltage DC/DC converter offers 100% programmable single or dual high voltage outputs using a 0-5Vdc analog signal. Each model is enclosed in a six-sided shielded metal case and has 1000Vdc of isolation allowing one model to be utilized for both positive or negative applications. All models will tolerate a short circuit indefinitely.

### ELECTRICAL SPECIFICATIONS

|                                  |                           |                                   |                   |
|----------------------------------|---------------------------|-----------------------------------|-------------------|
| Voltage Accuracy .....           | +/- 3%                    | Control Pin Impedance .....       | 30k Ohm           |
| Line Regulation .....            | +/- 2%                    | Control Pin Maximum Voltage ..... | 5.1Vdc            |
| Load Regulation .....            | +/- 3% (20% to full Load) | Input Filter .....                | Low ESR Capacitor |
| Output Ripple .....              | < 0.3 % P-P               | Efficiency .....                  | 82% (typ.)        |
| Reference Voltage Output .....   | 5Vdc @ 1mA                | Short Circuit Protection .....    | Continuous        |
| Reference Voltage Accuracy ..... | < 4%                      | Switching Frequency .....         | 130 kHz           |
|                                  |                           | Output Isolation .....            | 1000 Vdc          |
|                                  |                           | Input / Output Capacitance .....  | < 80pF            |

### GENERAL SPECIFICATIONS

|                               |               |                |                     |
|-------------------------------|---------------|----------------|---------------------|
| Temp. Stability .....         | +/- 0.02%/°C  | EMI/RFI .....  | Six Sided Shield    |
| Temp. (Operating, Case) ..... | -25 to +70°C  | Derating ..... | None                |
| Temp. (Storage) .....         | -40 to +125°C | Cooling .....  | Free-Air Convection |

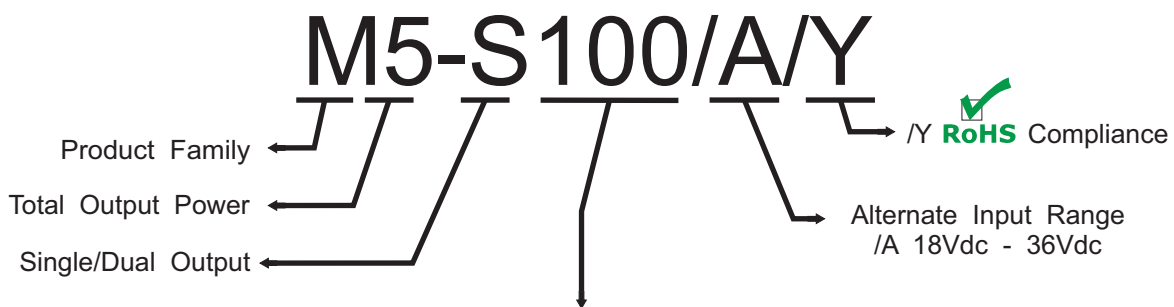
### PHYSICAL SPECIFICATIONS

|                  |                     |                     |                                  |
|------------------|---------------------|---------------------|----------------------------------|
| Dimensions ..... | 1 x 2 x 0.41 inches | Case Material ..... | Nickel Plated Metal              |
| Weight .....     | 1.2 Oz              |                     | (With Non-Conductive Base Plate) |



## M5 SERIES 5 WATT PROGRAMABLE DC/DC CONVERTERS

| REPRESENTATIVE MODEL LISTING |         |                            |            |            |              |
|------------------------------|---------|----------------------------|------------|------------|--------------|
| OUTPUT SPECIFICATIONS        |         | MODEL NUMBER / INPUT RANGE |            |            |              |
| VOLTAGE                      | CURRENT | 10-20VDC                   |            | 18-36VDC   |              |
|                              |         | Non-RoHS                   | RoHS       | Non-RoHS   | RoHS         |
| 0V - 24 Vdc                  | 208 mA  | M5-S24                     | M5-S24/Y   | M5-S24/A   | M5-S24/A/Y   |
| 0V - +/- 24 Vdc              | 104 mA  | M5-D24                     | M5-D24/Y   | M5-D24/A   | M5-D24/A/Y   |
| 0V - 48 Vdc                  | 104 mA  | M5-S48                     | M5-S48/Y   | M5-S48/A   | M5-S48/A/Y   |
| 0V - +/- 48 Vdc              | 52 mA   | M5-D48                     | M5-D48/Y   | M5-D48/A   | M5-D48/A/Y   |
| 0V - 100Vdc                  | 50 mA   | M5-S100                    | M5-S100/Y  | M5-S100/A  | M5-S100/A/Y  |
| 0V - +/- 100Vdc              | 25 mA   | M5-D100                    | M5-D100/Y  | M5-D100/A  | M5-D100/A/Y  |
| 0V - 150 Vdc                 | 33 mA   | M5-S150                    | M5-S150/Y  | M5-S150/A  | M5-S150/A/Y  |
| 0V - +/- 150 Vdc             | 16 mA   | M5-D150                    | M5-D150/Y  | M5-D150/A  | M5-D150/A/Y  |
| 0V - 200 Vdc                 | 25 mA   | M5-S200                    | M5-S200/Y  | M5-S200/A  | M5-S200/A/Y  |
| 0V - +/- 200 Vdc             | 12 mA   | M5-D200                    | M5-D200/Y  | M5-D200/A  | M5-D200/A/Y  |
| 0V - 300 Vdc                 | 16 mA   | M5-S300                    | M5-S300/Y  | M5-S300/A  | M5-S300/A/Y  |
| 0V - +/- 300 Vdc             | 8 mA    | M5-D300                    | M5-D300/Y  | M5-D300/A  | M5-D300/A/Y  |
| 0V - 400 Vdc                 | 12 mA   | M5-S400                    | M5-S400/Y  | M5-S400/A  | M5-S400/A/Y  |
| 0V - +/- 400 Vdc             | 6 mA    | M5-D400                    | M5-D400/Y  | M5-D400/A  | M5-D400/A/Y  |
| 0V - 500 Vdc                 | 10 mA   | M5-S500                    | M5-S500/Y  | M5-S500/A  | M5-S500/A/Y  |
| 0V - +/- 500 Vdc             | 5 mA    | M5-D500                    | M5-D500/Y  | M5-D500/A  | M5-D500/A/Y  |
| 0V - 600 Vdc                 | 8 mA    | M5-S600                    | M5-S600/Y  | M5-S600/A  | M5-S600/A/Y  |
| 0V - 800 Vdc                 | 6 mA    | M5-S800                    | M5-S800/Y  | M5-S800/A  | M5-S800/A/Y  |
| 0V - 1000 Vdc                | 5 mA    | M5-S1000                   | M5-S1000/Y | M5-S1000/A | M5-S1000/A/Y |

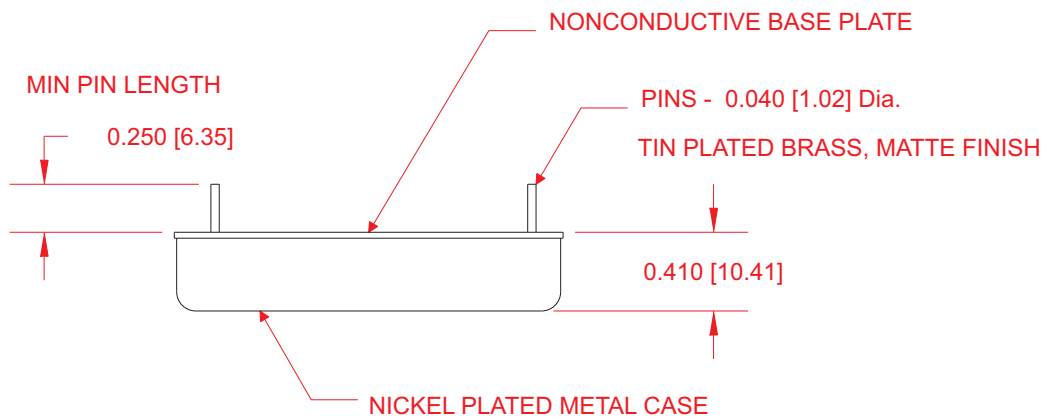
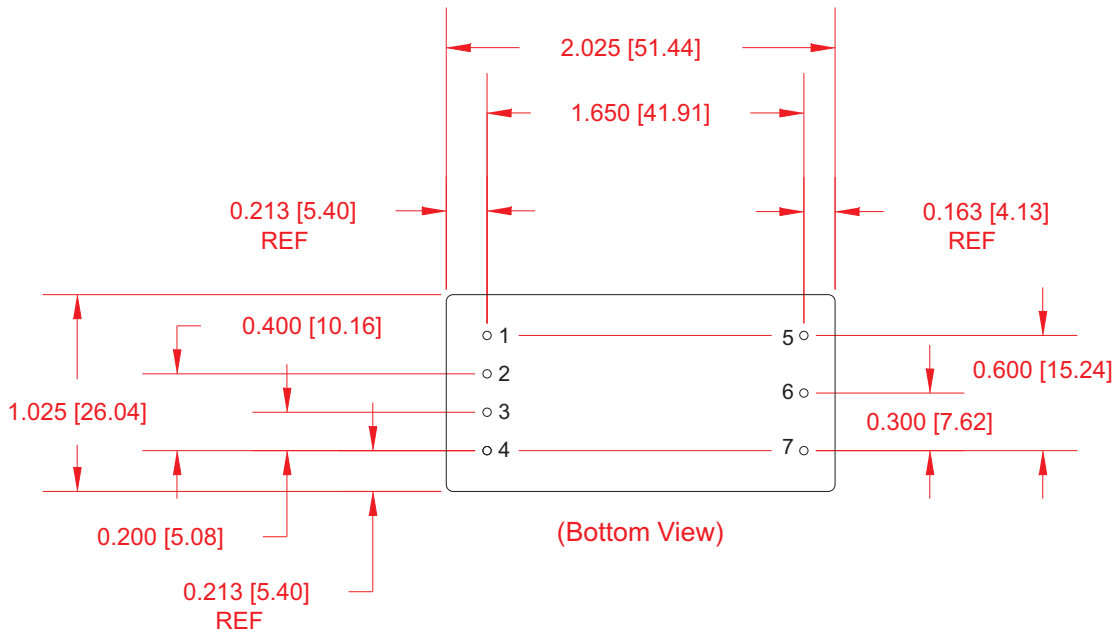


### Customer Selects Output Voltage

The M5 Series are designed such that the customer may order any output voltage from 24Vdc to 1000Vdc at no additional charge. (500Vdc max for dual outputs)



## M5 SERIES 5 WATT PROGRAMABLE DC/DC CONVERTERS



| PIN # | SINGLE   | DUAL     |
|-------|----------|----------|
| 1     | + Input  | + Input  |
| 2     | 5V Ref   | 5V Ref   |
| 3     | Control  | Control  |
| 4     | - Input  | - Input  |
| 5     | + Output | + Output |
| 6     | No Pin   | Com      |
| 7     | - Output | - Output |

*Dimensions are in Inches  
[Metric equivalents in brackets]*



## M5 SERIES 5 WATT PROGRAMABLE DC/DC CONVERTERS

### APPLICATION NOTES

#### INPUT AND OUTPUT IMPEDANCE

The M5 Series of power converters have been designed to be stable with no external capacitors when used in low inductance input and output circuits. However, in some applications, the inductance associated with the distribution from the power source to the input of the converter can affect the stability of the converter. The addition of a 100  $\mu\text{F}$  electrolytic capacitor with an ESR  $< 1 \text{ Ohm}$  across the input helps ensure stability of the converter. In many applications, the user has to use decoupling capacitance at the load.

#### SHORT CIRCUIT PROTECTION

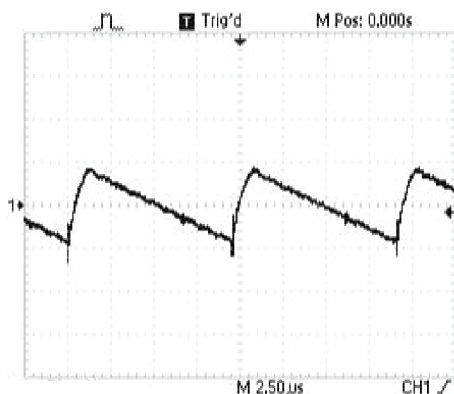
The M5 Series is equipped with short circuit protection. The converter will fold-back the input power whenever a short circuit is applied to its output and automatically recover after the overload condition is removed.

#### ISOLATION

The output of the M5 Series is galvanically isolated from both the input and case, capacitance is  $< 80\text{pF}$  and resistance is  $> 10\text{G Ohm}$ . The converters case is connected directly to  $-In$  to aid in reducing unwanted noise.

#### RIPPLE AND NOISE

Figure below shows a typical output voltage ripple waveform, measured at full rated load current with no additional output filtering. External low ESR capacitors may be added across output to further reduce ripple.



#### STARTUP TRANSIENT

Figure below shows a typical output voltage during turn-on, measured at 20% load current with no additional output filtering.

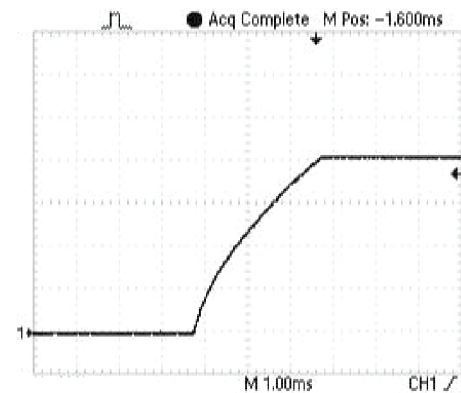
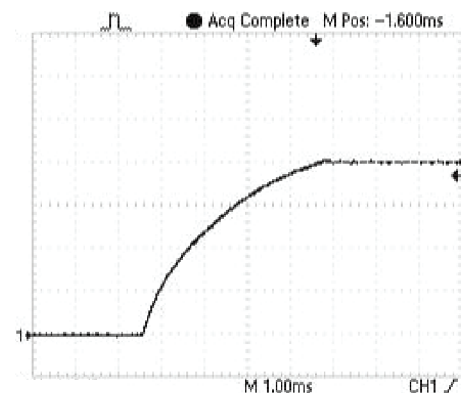


Figure below shows a typical output voltage during turn-on, measured at full rated load current with no additional output filtering.





## M5 SERIES 5 WATT PROGRAMABLE DC/DC CONVERTERS

### APPLICATION NOTES

#### INRUSH CURRENT

The inrush current of the M5 Series has been kept as low as possible. However, a series resistor may be inserted in the input line to limit this current further.

#### LOAD TRANSIENT

Figure below shows a typical output voltage response, measured during a transition from full rated load current to 20% load current with no additional output filtering.

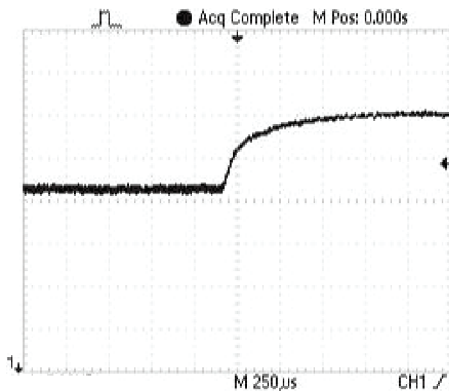
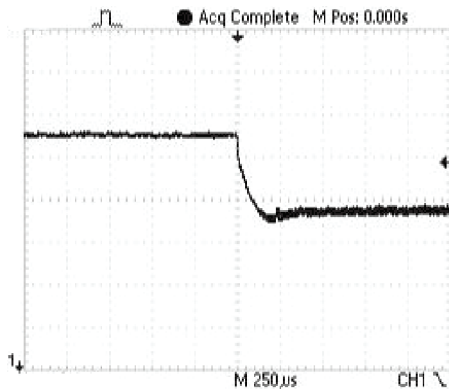
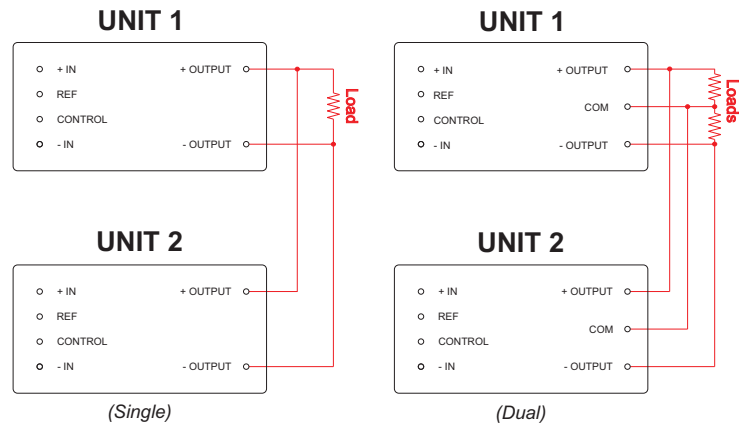


Figure below shows a typical output voltage response, measured during a transition from 20% load current to full rated load current with no additional output filtering.



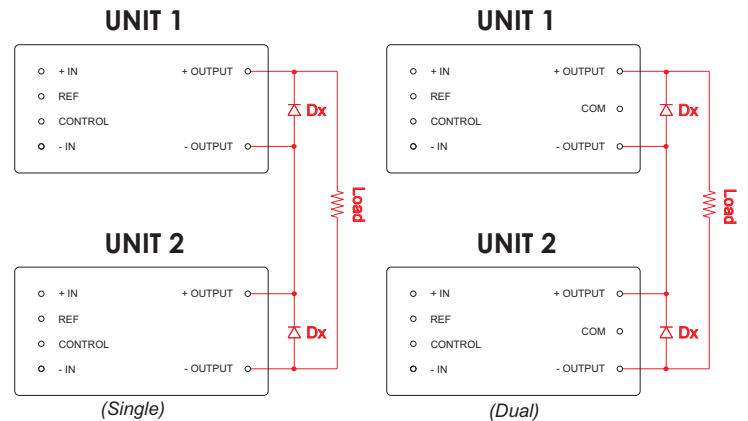
#### CONNECTION IN PARALLEL

The figures below show how to connect both single and dual outputs of several units with equal nominal output voltage in parallel.



#### CONNECTION IN SERIES

The figures below show how to connect multiple outputs in series with the use of shunt diodes, taking into consideration that the highest achieved output voltage should remain below the rated isolation voltage.



**NOTE:**  
The ratings of Dx should be 1.5 times the maximum current and voltage expected in each branch.



## M5 SERIES 5 WATT PROGRAMABLE DC/DC CONVERTERS

### APPLICATION NOTES

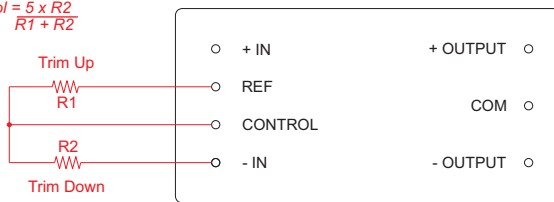
#### Remote Control

The M5 Series is equipped with an output Control pin (Pin 3). This feature allows the user to adjust the output voltage from 0 to 100% of the rated output voltage using a fixed precision resistor or adjustable trim pot in conjunction with the on board reference (Pin 2).

The figure below shows how to adjust the output voltage using a fixed precision resistor.

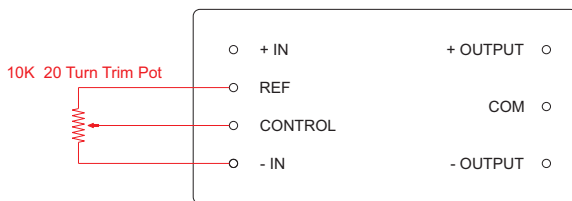
Control Voltage can be calculated by:

$$V_{control} = 5 \times \frac{R2}{R1 + R2}$$



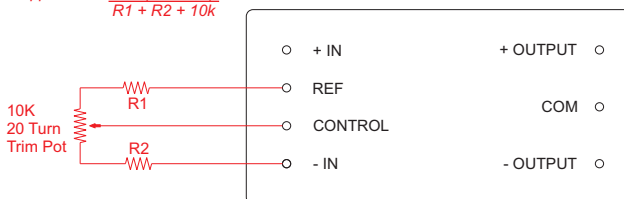
**NOTE:**  
Do not exceed 1mA when selecting R1 & R2.

The figure below shows how to adjust the output voltage using an external Trim Pot.



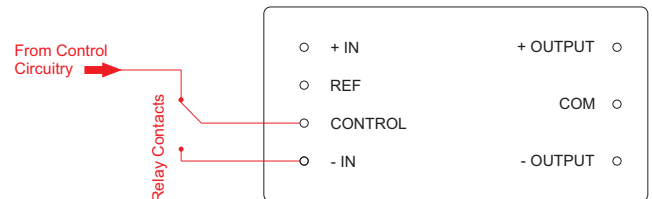
The figure below shows how to combine both of the prior configurations to form upper and lower boundaries for the adjustable range.

$$Upper\ Limit = 5 \times \frac{(R2 + 10k)}{R1 + R2 + 10k}$$



$$Lower\ Limit = \frac{5 \times R2}{R1 + R2 + 10k}$$

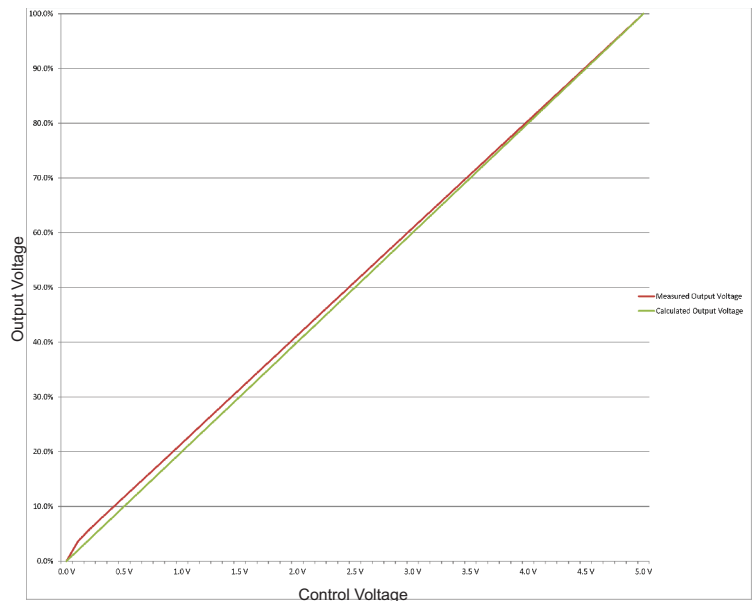
Figure below shows how to remotely mechanically shutdown the converter while maintaining any preset control voltage.



#### Output Voltage Tracking

The M5 Series is a semi-regulated and as a result there are many factors that effect the way the output voltage tracks the Control pin (Pin 3). Input regulation and load current are two of the primary influences.

Figure below show a typical plot of both the actual and calculated output voltage as a function of control voltage.



**Operating Conditions:**

Nominal Input Voltage = Fixed  
Output Load = Resistive (fixed at full output current @ 100% output voltage)



## M5 SERIES 5 WATT PROGRAMABLE DC/DC CONVERTERS

### APPLICATION NOTES

#### CLEANING AGENTS

In order to avoid possible damage, any penetration of cleaning fluids must be prevented, since the power supplies are not hermetically sealed.

#### NUCLEAR AND MEDICAL APPLICATIONS

American Power Design products are not designed, intended for use in, or authorized for use as critical components in life support systems, equipment used in hazardous environments, or nuclear control systems without the express written consent of American Power Design, Inc.

#### TECHNICAL REVISIONS

The appearance of products, including safety agency certifications pictured on labels, may change depending on the date manufactured. Specifications are subject to change without notice.

#### SAFETY REQUIREMENTS

The converters are designed to meet North American and International safety regulatory requirements per UL 60950-1/CSA 22.2 No. 60950-1-07 Second Edition, IEC 60950-1:2005, and EN 60950-1:2006. Basic Insulation is provided between input and output. To comply with safety agencies requirements, an input line fuse must be used external to the converter. The table below provides the recommended fuse rating for use with this family of products.

| Input Voltage Range | Fuse Rating |
|---------------------|-------------|
| 10-20Vdc            | 1A          |
| 18-36Vdc            | 0.5A        |

If one input fuse is used for a group of modules, the maximum fuse rating should not exceed 10A.

#### WARRANTY

All products manufactured by American Power Design, Inc. (APD) are warranted to be free of defects due to material or workmanship for a period of one year from date of shipment. At our option, APD will repair or replace any non-conforming product.

APD expressly disclaims any liability for consequential or incidental damages resulting from the use or misuse of its products by the purchaser or others.

This warranty is in lieu of all warranties expressed or implied, including the warranties of merchantability. No other warranties, obligations, or liabilities are expressed or implied.

All products being returned for repair require a return material authorization(RMA) assigned by APD prior to return shipment.