

# ULTRAVOLT 10A AND 15A SERIES

## PRECISION DC TO HIGH VOLTAGE DC CONVERTERS

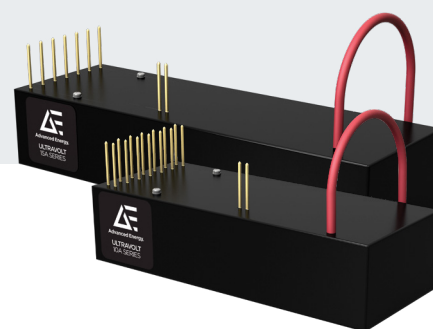
The UltraVolt® 10A and 15A series of regulated DC-to-DC converters provide general purpose high voltage power for a wide range of applications.

### PRODUCT HIGHLIGHTS

- Regulated 0 to 10 kV or 0 to 15 kV DC high voltage output
- Single output: positive and negative polarity models
- Choice of 4, 15, or 30 W maximum output power
- 12 or 24 VDC input
- Maximum load capability down to 0 VDC
- Output ripple performance as low as 80 ppm (0.8 Vpp)
- Available temperature coefficients to 25 ppm/°C
- Ease of installation with PCB or chassis-mount options
- Simplified integration with available 0 to 5 VDC or 0 to 10 VDC interface
- Reliable modular design
- Factory-configured performance, control, and integration options
- UL/cUL recognized, CE mark (LVD and RoHS), IEC-60950-1

### TYPICAL APPLICATIONS

- DC to high voltage DC bias supplies for general purpose uses
- High-potential testing
- PMT/APD detectors and optical spectrometers
- Electrostatics, electrophoresis, and electrospray
- Mass spectrometers



### AT A GLANCE

#### Maximum Output Voltage

10 or 15 kV DC

#### Maximum Output Power

30 W

#### Type

Single Output

#### Ripple

To 80 ppm (0.8 Vpp)

#### Control Interface

Analog

#### Temperature Coefficient

To 25 ppm/°C

## ULTRAVOLT 10A AND 15A SERIES

### ELECTRICAL SPECIFICATIONS

| Model   |   | 10A Series      |          |        | 15A Series      |          |        |
|---|---|-----------------|----------|--------|-----------------|----------|--------|
| High Voltage Output Range (Adjustable Regulated, Positive or Negative) <sup>1</sup> |   | 0 to 10,000 VDC |          |        | 0 to 15,000 VDC |          |        |
| High Voltage Outputs  |   | Single          |          |        | Single          |          |        |
| Input Voltage (VDC, Nominal)  |   | 12 VDC          | 24 VDC   |        | 12 VDC          | 24 VDC   |        |
| Power Output (Watts, Nominal)   |   | 4 W             | 15 W     | 30 W   | 4 W             | 15 W     | 30 W   |
| DC Input  |   |                 |          |        |                 |          |        |
| Vin (Input Voltage) Range   | VDC (positive polarity only)              | 11 to 16        | 23 to 30 |        | 11 to 16        | 23 to 30 |        |
| Vin (Nominal)   | VDC                                       | 12              | 24       |        | 12              | 24       |        |
| Iin (Input Current, Nominal)  | A @ 100% HVout, 100% LOAD                 | < 0.5           | < 1.5    | < 1.6  | < 0.5           | < 1.5    | < 1.6  |
|   | A @ 100% HVout, 0% LOAD                   | < 0.2           | < 0.25   | < 0.25 | < 0.2           | < 0.25   | < 0.25 |
|   | A @ disable/standby state                 | < 0.03          |          |        | < 0.03          |          |        |
| DC Output   |   |                 |          |        |                 |          |        |
| HVout (Output Voltage)  | VDC (positive polarity models = +HVout)   | 0 to +10,000    |          |        | 0 to +15,000    |          |        |
|   | VDC (negative polarity models = -HVout)   | 0 to -10,000    |          |        | 0 to -15,000    |          |        |
| Iout (Output Current)   | mA (max) @ 0 to 100% HVout, Vin (nominal) | 0.40            | 1.5      | 3.0    | 0.26            | 1.0      | 2.0    |
| Pout (Output Power)   | Watts (max)                               | 4               | 15       | 30     | 4               | 15       | 30     |
| Ripple <sup>2,3</sup>   | ppm (standard configuration)              | < 120           | < 400    | < 760  | < 240           | < 430    | < 800  |
|   | ppm (with -F-M option)                    | < 80            | < 340    | < 720  | < 210           | < 280    | < 730  |
|   | ppm (with -F-M-C option)                  | < 200           | < 300    | < 500  | < 200           | < 300    | < 500  |
|   | Vpp (standard configuration)              | < 1.2           | < 4      | < 7.6  | < 3.6           | < 6.5    | < 12   |
|   | Vpp (with -F-M option)                    | < 0.8           | < 3.4    | < 7.2  | < 3.2           | < 4.2    | < 11   |
|   | Vpp (with -F-M-C option)                  | < 2             | < 3      | < 5    | < 3             | < 4.5    | < 7.5  |

<sup>1</sup> Standard product specifications shown unless noted. Custom configurations are available.

<sup>2</sup> Nominal ripple measured @ 100% HVout, 100% LOAD into 300 pF bypass capacitor. Valid for 10 to 100% HVout range.

<sup>3</sup> ppm = parts per million @ 100% HVout. Vpp = VDC peak to peak @ 100% HVout.

#### Stability and Regulation

|                         |   |
|-------------------------|---|
| Stability               | 0.01% (100 ppm) @ 100% HVout (after 30 min warmup interval)         |
|                         | 0.02% (200 ppm) @ 100% HVout (per 8 h interval)                     |
| Line Regulation         | 0.01% (100 ppm) @ 100% HVout, 100% Pout, Vin (nominal)              |
| Static Load Regulation  | 0.01% (100 ppm) @ 100% HVout, 0 to 100% LOAD                        |
| Temperature Coefficient | 50 ppm/°C (standard configuration over operating temperature range) |
|                         | 25 ppm/°C (with -25PPM option over operating temperature range)     |
| Power-On Rise Time      | < 150 msec @ 100% LOAD, < 50 msec @ 0% LOAD                         |
|                         | Contact factory for other options.                                  |

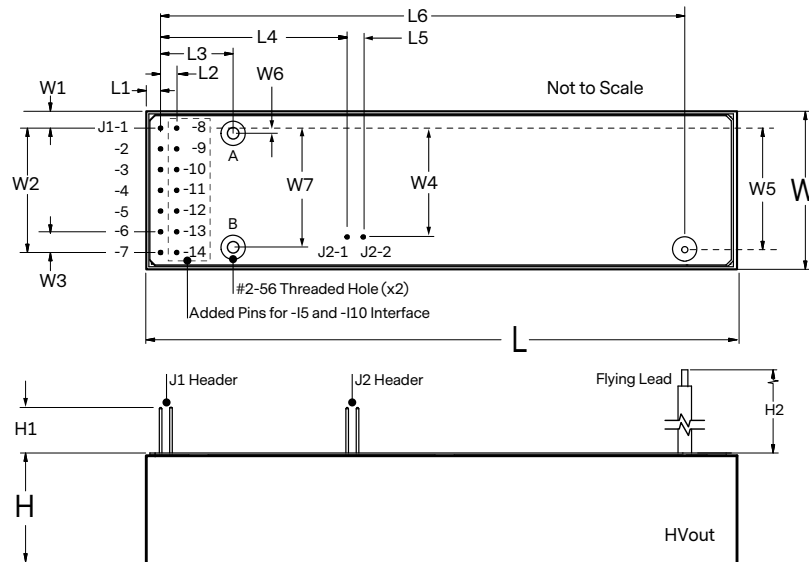
#### Environmental

|                             |  |
|-----------------------------|--|
| Operating Temperature Range | -40 to 65°C (-40 to 149°F) case temperature  |
| Storage                     | -55 to 105°C (-67 to 222°F) case temperature |
| Humidity                    | 0 to 95% RH, non-condensing                  |
| Altitude                    | Sea level to 3000 m (10,000 ft)              |
|                             | Sea level to high vacuum (with -P3 option)   |

#### Regulatory

|                |  |
|----------------|--|
| Certifications | UL/cUL recognized, IEC-60950-1, CE mark (LVD and RoHS) |
|----------------|--|

## MECHANICAL SPECIFICATIONS



| Dimensions |   | 10A Series |      | 15A Series |      |
|------------|---|------------|------|------------|------|
| Key        | Description <sup>1, 2, 3</sup>          | mm         | in   | mm         | in   |
| L          | Overall Length                          | 94.6       | 3.73 | 119.4      | 4.70 |
| L1         | Case Exterior to J1-1                   | 3.2        | 0.13 | 3.2        | 0.13 |
| L2         | Centerline, J1-1 to J1-8                | 2.5        | 0.10 | 2.5        | 0.10 |
| L3         | Centerline, J1-1 to Hole A (Hole B)     | 17.8       | 0.70 | 17.8       | 0.70 |
| L4         | Centerline, J1-1 to J2-1                | 45.7       | 1.80 | 45.7       | 1.80 |
| L5         | Centerline, J2-1 to J2-2                | 2.5        | 0.10 | 2.5        | 0.10 |
| L6         | Centerline, J1-1 to Flying Lead         | 77.5       | 3.05 | 102.5      | 4.04 |
| W          | Overall Width                           | 38.7       | 1.53 | 38.7       | 1.53 |
| W1         | Case Exterior to J1-1                   | 3.8        | 0.15 | 3.8        | 0.15 |
| W2         | Centerline, J1-1 to J1-7                | 30.5       | 1.20 | 30.5       | 1.20 |
| W3         | Centerline, J1-6 to J1-7                | 5.1        | 0.20 | 5.1        | 0.20 |
| W4         | Centerline, J1-1 to J2-1                | 26.7       | 1.05 | 26.7       | 1.05 |
| W5         | Centerline, J1-1 to Flying Lead         | 29.7       | 1.17 | 29.7       | 1.17 |
| W6         | Centerline, J1-1 to Hole A              | 1.3        | 0.05 | 1.3        | 0.05 |
| W7         | Centerline, Hole A to Hole B            | 27.9       | 1.10 | 27.9       | 1.10 |
| H          | Case Height (Case Exterior to PCB, max) | 25.4       | 1.00 | 25.4       | 1.00 |
| H1         | Base of PCB to J1/J2 Header Tip         | 11.2       | 0.44 | 11.2       | 0.44 |
| H2         | Length of Standard Flying Lead          | 470        | 18.5 | 470        | 18.5 |

| Volumes and Weights |                                 | 10A Series      |                 | 15A Series      |                 |
|---------------------|---------------------------------|-----------------|-----------------|-----------------|-----------------|
|                     |                                 | cm <sup>3</sup> | in <sup>3</sup> | cm <sup>3</sup> | in <sup>3</sup> |
|                     | Volume (Module Body Only)       | 93.1            | 5.7             | 117.5           | 7.2             |
|                     |                                 | g               | oz              | g               | oz              |
|                     | Weight (Standard Configuration) | 183             | 6.5             | 209             | 7.4             |

| Construction    |  |
|-----------------|--|
| Standard Case   | Injection-molded plastic (Diallyl Phthalate, DAP, per ASTM-D-5948) |
| Optional Case   | RF-tight aluminum (-C option) (Anodized per MIL-A-8625 Type II)    |
| Optional Shield | Six-sided Mu-Metal (-M option)                                     |
| Labels          | Static-dissipative polyester                                       |
| Cooling         | Natural convection and conduction                                  |
| Encapsulation   | Silicone-based RTV (contact factory for other options)             |
| Pins            | Gold-plated bronze   |

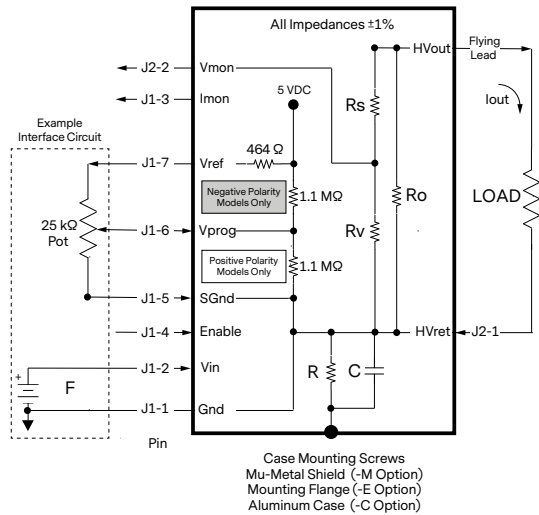
<sup>1</sup> Approximate nominal dimensions and weights for standard configuration shown. Contact factory for -M, -C or -E case options.

<sup>2</sup> Standard case (DAP plastic) tolerances are  $\pm 1.27$  mm ( $\pm 0.050$  in). Pin-to-pin tolerances are  $\pm 0.76$  mm ( $\pm 0.015$  in).

<sup>3</sup> Refer to outline drawings and 3D models for detailed information.

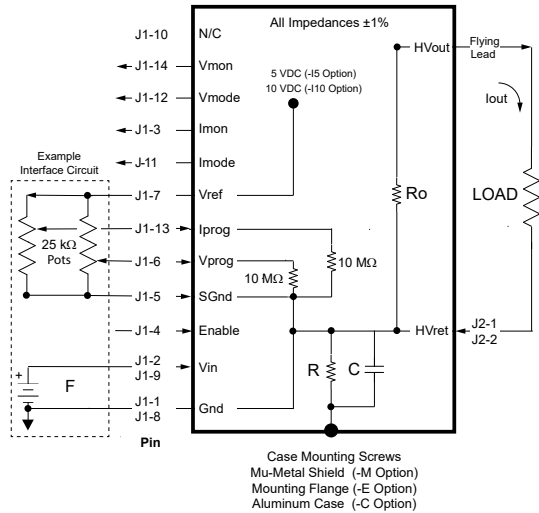
## INTERFACE

The 10A and 15A series' standard interface permits voltage control and monitoring of both voltage and current output using analog DC signals whose range and polarity vary by model. The 10A model also offers UltraVolt's optional -I5 or -I10 interface which provides simplified control and monitoring of both voltage and current using 0 to 5 VDC or 0 to 10 VDC full-scale analog signals.



### Standard Interface

| Pin         | Label  | Type   | Description                           |
|-------------|--------|--------|---------------------------------------|
| J1-1        | Gnd    | Ground | DC Input Power Ground                 |
| J1-2        | Vin    | Input  | DC Input Power                        |
| J1-3        | Imon   | Output | Monitor HVout Current Level           |
| J1-4        | Enable | Input  | Enable HVout <sup>1</sup>             |
| J1-5        | SGnd   | Ground | Signal Ground                         |
| J1-6        | Vprog  | Input  | Set HVout Voltage Level               |
| J1-7        | Vref   | Output | Control Signal Reference <sup>2</sup> |
| J2-1        | HVret  | Ground | High Voltage Return <sup>9</sup>      |
| J2-2        | Vmon   | Output | Monitor HVout Voltage Level           |
| Flying Lead | HVout  | Output | High Voltage Output                   |



### -I5 and -I10 Interface (Optional)

| Pin         | Label  | Type   | Description                                 |
|-------------|--------|--------|---|
| J1-1        | Gnd    | Ground | DC Input Power Ground                       |
| J1-2        | Vin    | Input  | DC Input Power                              |
| J1-3        | Imon   | Output | Monitor HVout Current Level <sup>3, 8</sup> |
| J1-4        | Enable | Input  | Enable HVout <sup>4</sup>                   |
| J1-5        | SGnd   | Ground | Signal Ground                               |
| J1-6        | Vprog  | Input  | Set HVout Voltage Level                     |
| J1-7        | Vref   | Output | Control Reference Signal <sup>5, 6</sup>    |
| J1-8        | Gnd    | Ground | DC Input Power Ground                       |
| J1-9        | Vin    | Input  | DC Input Power                              |
| J1-10       | N/C    |        | No Connection                               |
| J1-11       | Imode  | Output | Current Mode Indicator <sup>7</sup>         |
| J1-12       | Vmode  | Output | Voltage Mode Indicator <sup>7</sup>         |
| J1-13       | Iprog  | Input  | Set HVout Current Level                     |
| J1-14       | Vmon   | Output | Monitor HVout Voltage Level <sup>3, 8</sup> |
| J2-1        | HVret  | Ground | High Voltage Return <sup>9</sup>            |
| J2-2        | HVret  | Ground | High Voltage Return <sup>9</sup>            |
| Flying Lead | HVout  | Output | High Voltage Output                         |

<sup>1</sup> Signal inputs: LOW < 0.5 VDC, HIGH > 2.4 VDC (Default or N/C = ENABLED = HIGH)

<sup>2</sup> 5 VDC  $\pm 2\%$  through 464  $\Omega$  impedance load

<sup>3</sup> Can source an output impedance load > 10 k $\Omega$

<sup>4</sup> Signal input: LOW < 0.5 VDC, HIGH > 2.4 VDC (Default or N/C = DISABLED = LOW)

<sup>5</sup> -I5 interface: 5 VDC  $\pm 0.1\%$  @ 5 mA (nominal at case temperature = 25°C, 77°F)

<sup>6</sup> -I10 interface: 10 VDC  $\pm 0.1\%$  @ 5 mA (nominal at case temperature = 25°C, 77°F)

<sup>7</sup> LOW = Mode ENABLED (open drain) will sink up to 30 mA.

<sup>8</sup> Voltage/current monitors will source/sink to 2 mA.

<sup>9</sup> For proper operation and safety, always route HVret signal through HVret connection.

## INTERFACE CONTROL PARAMETERS

| MODEL  |   | 10A Series      |        |       | 15A Series      |        |       |
|--|---|-----------------|--------|-------|-----------------|--------|-------|
| High Voltage Output Range  |   | 0 to 10,000 VDC |        |       | 0 to 15,000 VDC |        |       |
| Input Voltage (VDC, Nominal)   |   | 12 VDC          | 24 VDC |       | 12 VDC          | 24 VDC |       |
| Power Output (Watts, Nominal)  |   | 4 W             | 15 W   | 30 W  | 4 W             | 15 W   | 30 W  |
| Standard Interface (Monitor/Control Voltage, Monitor Current)          |   |                 |        |       |                 |        |       |
| Scale Factors <sup>1, 2, 3</sup>                                       | SVm (V/V) where HVout Monitor = SVm x Vmon        | 1000            |        |       | 1000            |        |       |
| Positive Polarity Models   | SVp (V/V) where HVout Control = SVp x Vprog       | 2155            |        |       | 3233            |        |       |
| Negative Polarity Models   | SVp (V/V) where HVout Control = SVp x (5 - Vprog) | -2155           |        |       | -3233           |        |       |
|  | Slm (mA/V) where Iout Monitor = Slm x Imon        | 0.167           | 0.184  | 0.381 | 0.158           | 0.181  | 0.378 |
|  | Slp (mA/V) where Iout Control = Slp x Iprog       | N/A             |        |       | N/A             |        |       |
| Impedances <sup>4</sup>  | Ro (HVout impedance, ±1%)                         | 500 MΩ          |        |       | 750 MΩ          |        |       |
|  | Rs (Vmon upper tap impedance, ±1%)                | 500 MΩ          |        |       | 750 MΩ          |        |       |
|  | Rv (Vmon lower tap impedance, ±1%)                | 523 kΩ          |        |       | 806 kΩ          |        |       |
| -I5 Interface (0 to 5 VDC, Monitor/Control Both Voltage and Current)   |   |                 |        |       |                 |        |       |
| Scale Factors <sup>5, 6, 8, 9</sup>                                    | SVm (V/V) where HVout Monitor = SVm x Vmon        | 2000            |        |       | N/A             |        |       |
|  | SVp (V/V) where HVout Control = SVp x Vprog       | 2000            |        |       | N/A             |        |       |
|  | Slm (mA/V) where Iout Monitor = Slm x Imon        | 0.08            | 0.30   | 0.60  | N/A             |        |       |
|  | Slp (mA/V) where Iout Control = Slp x Iprog       | 0.08            | 0.30   | 0.60  | N/A             |        |       |
| Impedances <sup>4</sup>  | Ro (HVout impedance, ±1%)                         | 375 MΩ          |        |       | N/A             |        |       |
| -I10 Interface (0 to 10 VDC, Monitor/Control Both Voltage and Current) |   |                 |        |       |                 |        |       |
| Scale Factors <sup>5, 7, 8, 9</sup>                                    | SVm (V/V) where HVout Monitor = SVm x Vmon        | 2000            |        |       | N/A             |        |       |
|  | SVp (V/V) where HVout Control = SVp x Vprog       | 2000            |        |       | N/A             |        |       |
|  | Slm (mA/V) where Iout Monitor = Slm x Imon        | 0.04            | 0.15   | 0.3   | N/A             |        |       |
|  | Slp (mA/V) where Iout Control = Slp x Iprog       | 0.04            | 0.15   | 0.3   | N/A             |        |       |
| Impedances <sup>4</sup>  | Ro (HVout impedance, ±1%)                         | 375 MΩ          |        |       | N/A             |        |       |
| Other Interface Values   |   |                 |        |       |                 |        |       |
| Impedances <sup>4</sup>  | R (standard case via mounting screws, ±1%)        | 232 kΩ          |        |       | 232 kΩ          |        |       |
|  | R (standard case with -I5 /-I10 option, ±1%)      | 100 kΩ          |        |       | N/A             |        |       |
|  | R (with -M option, ±1%)                           | 232 kΩ          | 0 Ω    |       | 232 kΩ          | 0 Ω    |       |
|  | R (with -E option, ±1%)                           | 232 kΩ          |        |       | 232 kΩ          |        |       |
|  | R (with -C option, ±1%)                           | 232 kΩ          |        |       | 232 kΩ          |        |       |
|  | R (with -M-E option, ±1%)                         | 0 Ω             |        |       | 0 Ω             |        |       |
|  | R (with -M-C option, ±1%)                         | 0 Ω             |        |       | 0 Ω             |        |       |
| Capacitance <sup>4</sup>   | C (@ 50 VDC ±10%, 1/8 W, max)                     | 0.01 μF         | 0 μF   |       | 0.01 μF         | 0 μF   |       |
| Input Voltage Protection   | F (fuse or other protection recommended)          | See note 10     |        |       | See note 10     |        |       |

<sup>1</sup> For positive polarity models, Vprog varies from 0 to 4.64 VDC. For negative polarity models, Vprog varies inversely from 5 to 0.36 VDC.

<sup>2</sup> Slm factor is ±2% @ 100% LOAD, 100% HVout. Valid for 10 to 100% Iout range.

<sup>3</sup> SVm factor is ±2% assuming a 10 MΩ measurement impedance. Valid from 10 to 100% HVout.

<sup>4</sup> See interface schematics for definition.

<sup>5</sup> For details on -I5/-I10 interfacing, see technical note TN-I5-I10-1.

<sup>6</sup> For the -I5 interface, Imon, Iprog, Vmon, and Vprog input/output signals vary from 0 to 5 VDC (full-scale).

<sup>7</sup> For the -I10 interface, Imon, Iprog, Vmon, and Vprog input/output signals vary from 0 to 10 VDC (full-scale).

<sup>8</sup> SVm factor is ±1% for both -I5 and -I10 Interfaces. SVp factor is also ±1% and is valid from 10 to 100% HVout.

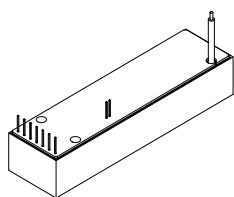
<sup>9</sup> Slm factor is ±1% for both -I5 and -I10 Interfaces. Slp factor is also ±1% and is valid from 10 to 100% Iout.

<sup>10</sup> For details on fuse selection, see technical note TN-23.

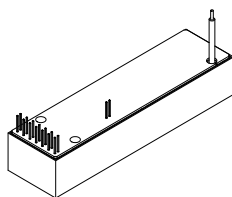
### STANDARD OPTIONS

Both the 10A and 15A series can be configured with standard options that can adapt its performance and packaging for many application requirements. Customized models to meet specialized performance, packaging, or environmental needs are also available.

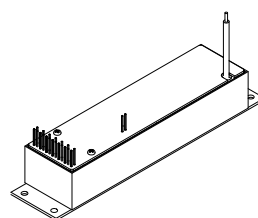
| Featured Options |  |
|------------------|--|
| -I5              | Upgrades interface to provide more precise control and monitoring of both HVout and Iout using 0 to 5 VDC (full-scale) analog signals. Also adds Iout control and voltage/current mode indication capability not available on the standard interface. Cannot be ordered with the -I10 option. Available only on 10A series models.                   |
| -I10             | Upgrades interface to provide more precise control and monitoring of both HVout and Iout using 0 to 10 VDC (full-scale) analog signals. Also adds Iout control and voltage/current mode indication capability not available on the standard interface. Cannot be ordered with the -I5 option. Available only on 10A series models with 24 VDC input. |
| -F               | Reduces high voltage ripple when used together with the Mu-Metal shield and a user-supplied external capacitive load. Available only with the the Mu-Metal shield (-M option).   |
| -M               | Adds a Mu-Metal shield to reduce the effects of external RF noise sources. Installed on six sides, this shield option is available on both standard plastic (DAP) and optional aluminum (-C option) cases.   |
| -E               | Eared mounting flange that permits the standard plastic (DAP) case to be chassis-mounted.  |
| -C               | Aluminum alloy case with integrated mounting flange that provides both added RF and environmental protection.  |
| -AP              | Adds non-conductive braiding to the standard HVout flying lead for increased durability. Terminating connector is user-supplied. Not available with the -WS option.  |
| -WS              | Replaces the standard HVout flying lead with a 470 mm long shielded coaxial cable for added RF protection. Terminating connector is user-supplied. Not available with the -AP option.  |
| -25PPM           | Upgrades module temperature coefficient rating from 50 ppm/°C to 25 ppm/°C for enhanced high voltage output stability over standard operating temperature ranges.  |
| -H               | Heatsink option  |



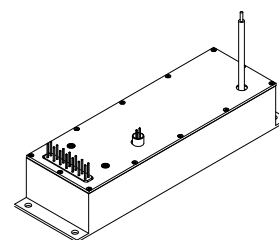
Standard Interface



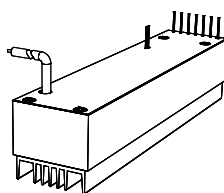
-I5 and -I10 Interface



-E Option (Eared Mounting Plate)



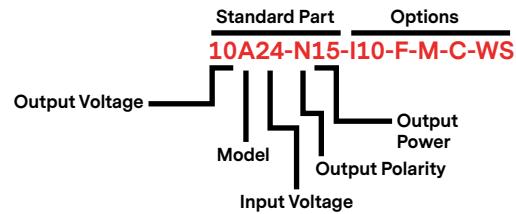
-C Option (Aluminum Case)



-H Heatsink

## ORDERING INFORMATION

| Standard Part |           | STANDARD CONFIGURATION                      |   |                          |                              |   |                    |                    |  |                                   |  | OPTIONS                                       |                           |                           |  |                          |            |  |  |
|---------------|-----------|---|---|--------------------------|------------------------------|---|--------------------|--------------------|--|-----------------------------------|--|---|---------------------------|---------------------------|--|--------------------------|------------|--|--|
|               |           | Electrical Performance                      |   |                          |                              |   |                    | Standard Features  |  |                                   |  | Interfaces                                    |                           | Ripple                    | Mechanical                                 |                          |            |  | Temp   |
|               |           |   |   |                          |                              |   |                    |                    |  |                                   |  | Select One                                    |                           |                           | Select One                                 |                          | Select One |  |  |
|               |           | Number of High Voltage Outputs              | High Voltage Output Range (HVout VDC, Adjustable) | Input Voltage (Vin, VDC) | High Voltage Output Polarity | High Voltage Output Power (Pout, Watts) | Standard Interface | Plastic Case (DAP) | Standard HVout Lead (No Connector, 470 mm) | 50 ppm/°C Temperature Coefficient | -15 Interface (0 to 5 VDC Monitors/Controls) | -10 Interface (0 to 10 VDC Monitors/Controls) | Reduced Ripple Capability | Mu-Metal Shield (6 Sides) | Eared Mounting Flange (Standard Case Only) | Aluminum Case (RF Tight) | Heatsink   | Non-Conductive Braid for HVout Lead (No Connector, 470 mm) | Shielded Coaxial HVout Lead (No Connector, 470 mm) |
| 10A           | 10A12-P4  | 1   | 0 to +10,000                                      | 12                       | Pos                          | 4                                       | Included           |                    | -15  |                                   | -F   | -M  | -E                        | -C                        | -H   | -AP                      | -WS        | -25PPM   |  |
|               | 10A12-N4  | 1   | 0 to -10,000                                      | 12                       | Neg                          | 4                                       | Included           |                    | -15  |                                   | -F   | -M  | -E                        | -C                        | -H   | -AP                      | -WS        | -25PPM   |  |
|               | 10A24-J15 | 1   | 0 to +10,000                                      | 24                       | Pos                          | 15                                      | Included           |                    | -15  | -110                              | -F   | -M  | -E                        | -C                        | -H   | -AP                      | -WS        | -25PPM   |  |
|               | 10A24-N15 | 1   | 0 to -10,000                                      | 24                       | Neg                          | 15                                      | Included           |                    | -15  | -110                              | -F   | -M  | -E                        | -C                        | -H   | -AP                      | -WS        | -25PPM   |  |
|               | 10A24-P30 | 1   | 0 to +10,000                                      | 24                       | Pos                          | 30                                      | Included           |                    | -15  | -110                              | -F   | -M  | -E                        | -C                        | -H   | -AP                      | -WS        | -25PPM   |  |
|               | 10A24-N30 | 1   | 0 to -10,000                                      | 24                       | Neg                          | 30                                      | Included           |                    | -15  | -110                              | -F   | -M  | -E                        | -C                        | -H   | -AP                      | -WS        | -25PPM   |  |
| 15A           | 15A12-P4  | 1   | 0 to +15,000                                      | 12                       | Pos                          | 4                                       | Included           |                    |  |                                   | -F   | -M  | -E                        | -C                        | -H   | -AP                      | -WS        | -25PPM   |  |
|               | 15A12-N4  | 1   | 0 to -15,000                                      | 12                       | Neg                          | 4                                       | Included           |                    |  |                                   | -F   | -M  | -E                        | -C                        | -H   | -AP                      | -WS        | -25PPM   |  |
|               | 15A24-J15 | 1   | 0 to +15,000                                      | 24                       | Pos                          | 15                                      | Included           |                    |  |                                   | -F   | -M  | -E                        | -C                        | -H   | -AP                      | -WS        | -25PPM   |  |
|               | 15A24-N15 | 1   | 0 to -15,000                                      | 24                       | Neg                          | 15                                      | Included           |                    |  |                                   | -F   | -M  | -E                        | -C                        | -H   | -AP                      | -WS        | -25PPM   |  |
|               | 15A24-P30 | 1   | 0 to +15,000                                      | 24                       | Pos                          | 30                                      | Included           |                    |  |                                   | -F   | -M  | -E                        | -C                        | -H   | -AP                      | -WS        | -25PPM   |  |
|               | 15A24-N30 | 1   | 0 to -15,000                                      | 24                       | Neg                          | 30                                      | Included           |                    |  |                                   | -F   | -M  | -E                        | -C                        | -H   | -AP                      | -WS        | -25PPM   |  |
| Other Options |           | Contact factory for other available options |   |                          |                              |   |                    |                    |  |                                   |  |   |                           |                           |  |                          |            |  |  |





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