



## ULTRAVOLT® EFL SERIES

ENHANCED FLOATING HOT DECK  
LOW-VOLTAGE POWER SUPPLIES WITH  
ISOLATED DIGITAL AND ANALOG I/O





# **Enhanced** floating hot deck low- voltage power supplies

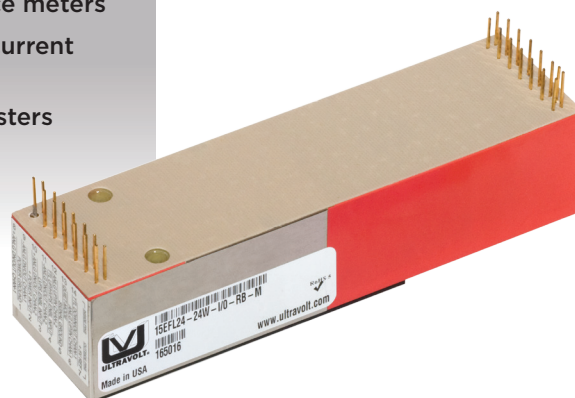
The EFL series of floating hot deck, low-voltage (LV) power supplies offers an integrated solution for systems requiring LV power and controls with high voltage isolation. Combining a highly isolated, DC-to-DC, multi-output low-voltage power supply (LVPS) with an advanced isolated digital and analog I/O topology, the EFL sub-system provides both power and controls to floating-hot-deck circuitry. This solution, when combined with one or more UltraVolt® HVPS or other circuitry, can provide high-performance solutions for a variety of applications.

## Features

- › Precision analog control
- › Linearity of  $\pm 0.05\%$  and accuracy of  $\pm 0.2\%$
- › 10ppm temperature coefficient
- › Isolated up to 15 kV or 30 kV
- › Isolation resistance of 150 G $\Omega$  (15 kV) or 2 G $\Omega$  (30 kV)
- › 4 regulated floating LV power outputs
- › Isolated digital and analog I/O to and from floating hot deck

## Typical Applications

- › Floating/stacked ion or e-beam biases
- › Floating filament bias
- › Floating pulsed and gated grids
- › Floating capacitance meters
- › Floating high side current monitors
- › Floating leakage testers





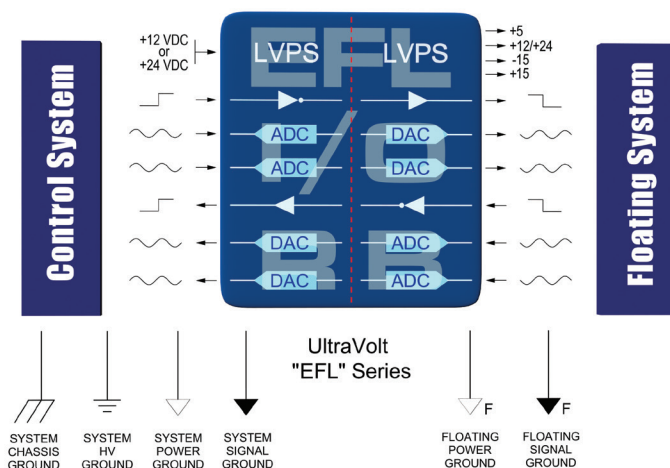
## NORMAL, HALF-QUIET, AND QUIET MODES

All EFLs feature a mode control. Three different models—normal, half-quiet, and quiet—are selectable via the voltage level at the mode pin. A voltage between -1.0 and +0.8 V keeps the unit in normal mode; the up and down analog channels follow their inputs. If the mode feature is not used, the mode pin must be grounded for the EFL to operate properly.

A voltage more negative than -4.00 V places the EFL in half-quiet mode. The up channels do not respond to changes in their inputs in half-quiet mode.

A voltage greater than +3.75 V and less than +5.0 V places the EFL in quiet mode. In quiet mode, the up and down channels do not respond to changes in their inputs.

The voltage level at the mode pin must not exceed +5.0 V at any time. Please contact Advanced Energy® for an analysis of your requirements.



Note: If a voltage > 0.8 V is applied to the mode pin, it must source less than 400  $\mu$ A.

| PARAMETER                           | CONDITIONS                                                            | MODELS                             |               |                   | UNITS       |
|-------------------------------------|-----------------------------------------------------------------------|------------------------------------|---------------|-------------------|-------------|
| Input Power                         |                                                                       | 12 W                               | 24 W          | 36 W (15 kV only) |             |
| Voltage Range                       | Full Power                                                            | +12 $\pm$ 5%                       | +24 $\pm$ 10% | +24 $\pm$ 10%     | VDC         |
| Current                             | Standby (Disabled)                                                    | < 150                              | < 100         | < 100             | mA          |
| Current                             | No Load                                                               | < 0.50                             | < 0.50        | < 0.50            | A           |
| Current                             | Max Load                                                              | < 2.50                             | < 2.30        | < 3.00            | A           |
| AC Ripple Current                   | Nominal Input, Full Load                                              | < 50                               | < 50          | < 50              | mA pk to pk |
| Local Controls: Reference           |                                                                       | All Types                          |               |                   |             |
| Output Voltage                      | T = +25°C, Initial Value                                              | +5.1 $\pm$ 2%                      |               |                   | VDC         |
| Output Impedance                    | T = +25°C                                                             | 464 $\pm$ 1%                       |               |                   | $\Omega$    |
| Stability                           | Over Full Temperature Range                                           | 0.4                                |               |                   | mV/°C       |
| Local Controls: LVPS Enable/Disable |                                                                       | All Types                          |               |                   |             |
| Power Supply On                     | Open, or a Voltage Above TTL High (I <sub>source</sub> < 400 $\mu$ A) | +3.2 to 5                          |               |                   | VDC         |
| Power Supply Off                    | Grounded, or a Voltage Below TTL Low                                  | < 0.8 (I <sub>sink</sub> 1 mA min) |               |                   | VDC         |
| Input/Output Isolation              |                                                                       | 15EFL                              | 30EFL         |                   |             |
| Isolation Voltage                   | Continuous                                                            | 15                                 | 30            |                   | kV          |
| Isolation Resistance                | All Inputs to All Outputs                                             | 150                                | 2             |                   | G $\Omega$  |
| Leakage Capacitance                 | All Inputs to All Outputs                                             | < 40 std, < 50 "-E"                | < 40 std      |                   | pF          |

| Parameter                           | Conditions                      | Models                                           |          |                   | Units      |
|-------------------------------------|---------------------------------|--------------------------------------------------|----------|-------------------|------------|
| Isolated Power Outputs              |                                 | 12 W                                             | 24 W     | 36 W (15 kV only) |            |
| Output #1 Power                     | Nominal Input, Max Iout         | 12                                               | 24       | 36                | W          |
| Output #1 Voltage                   | Nominal Input Voltage Range     | +12 ±2%                                          | +24 ±2%  | +24 ±2%           | VDC        |
| Output #1 Current                   | Min to Max                      | 0 to 1                                           | 0 to 1   | 0 to 1.5          | A          |
| Output #1 Line Regulation           | Nominal Input Range, Full Load  | < 0.1%                                           | < 0.1%   | < 0.1%            | VDC        |
| Output #1 Load Regulation           | No Load to Full Load            | < 0.25%                                          | < 0.30%  | < 0.40%           | VDC        |
| Output #1 Ripple                    | Full Load                       | < 2.5%                                           | < 1.5%   | < 1.5%            | V pk to pk |
| Output #2 and #4 Voltage            | Nominal Input Voltage Range     | ±15 ±5%                                          | ±15 ±5%  | ±15 ±5%           | VDC        |
| Output #2 and #4 Current            | Min to Max                      | 0 to 50                                          | 0 to 50  | 0 to 50           | mA         |
| Output #2 and #4 Line Regulation    | Nominal Input Range, Full Load  | < 0.3%                                           | < 0.3%   | < 0.3%            | VDC        |
| Output #2 and #4 Load Regulation    | No Load to Full Load            | < 5%                                             | < 1%     | < 1%              | VDC        |
| Output #2 and #4 Ripple             | Full Load                       | < 2.5%                                           | < 2.5%   | < 2.5%            | V pk to pk |
| Output #3 Voltage                   | Nominal Input Voltage Range     | +5.1 ±1%                                         | +5.1 ±1% | +5.1 ±1%          | VDC        |
| Output #3 Current                   | Min to Max                      | 500                                              | 500      | 500               | mA         |
| Output #3 Line Regulation           | Nominal Input Range, Full Load  | < 1%                                             | < 1%     | < 1%              | VDC        |
| Output #3 Load Regulation           | No Load to Full Load            | < 1%                                             | < 1%     | < 1%              | VDC        |
| Output #3 Ripple                    | Full Load                       | < 4%                                             | < 4%     | < 4%              | V pk to pk |
| Isolated Controls: TTL Channel "Up" |                                 | All Types                                        |          |                   |            |
| Local Input                         | Source Voltage, Sink Current    | 0 ≤ 0.5 (Isink 3 mA min)                         |          |                   |            |
|                                     |                                 | 1 ≥ 2.4 (300 μA max or open collector)           |          |                   | VDC        |
| Isolated Output                     | Inverted and Buffered TTL       | 1 ≥ 2.4, 0 ≤ 0.55 ± (sources 0.8 mA, sinks 3 mA) |          |                   | VDC        |
| Baud Rate                           | Duty Cycle                      | < 15                                             |          |                   | ms         |
| Isolated Controls: Analog "Up"      |                                 | 12 V                                             | 24 V     |                   |            |
| Local Input Voltage                 | Range                           | 0 to +5                                          | 0 to +10 |                   | VDC        |
| Isolated Output Voltage             | Range                           | 0 to +5                                          | 0 to +10 |                   | VDC        |
| Local Input Impedance               |                                 | 20.0 K                                           |          |                   | Ω          |
| Initial Offset Error                |                                 | < ±2                                             |          |                   | mV         |
| Gain Error                          | Full Scale                      | < ±0.2%                                          |          |                   | VDC        |
| Linearity Error                     | Full Scale                      | < ±0.05%                                         |          |                   | VDC        |
| Stability                           | 30 Min Warmup, Per 8 h, per day | < 0.02%                                          |          |                   | VDC        |
| Temperature Coefficient             | 0 to +55 °C                     | < ±10                                            |          |                   | ppm/°C     |
| Bandwidth                           | Symmetric or Asymmetric Signal  | DC to 4                                          |          |                   | Hz         |



### -RB' ISOLATED CONTROLS: TTL CHANNEL "DOWN"

| Parameter                 | Conditions                   | All Types                                        | Units |
|---------------------------|------------------------------|--------------------------------------------------|-------|
| Isolated 'Hot Deck' Input | Source Coltage, Sink Current | $0 \leq 0.5$ (Isink 1 mA Min)                    | VDC   |
|                           |                              | $1 \geq 2.4$ (300 $\mu$ A max or open collector) |       |
| Local Output              | Inverted and Buffered TTL    | $1 > 2.4$ (sources 0.8 mA)                       | VDC   |
|                           |                              | $0 < 0.55$ (sinks 10 mA)                         |       |
| Propagation Delay         | Duty Cycle                   | $< 15$                                           | ms    |

### ISOLATED CONTROLS: ANALOG CHANNELS #1 and #2 "DOWN"\*

| Parameter                                 | Conditions                               | All Types                              | Units      |
|-------------------------------------------|------------------------------------------|----------------------------------------|------------|
| Isolated 'Hot Deck' +Input                | Range                                    | 0 to +5 for 12 V and 0 to +10 for 24 V | VDC        |
| Isolated 'Hot Deck' -Input                | Range                                    | 0 to -5 for 12 V and 0 to -10 for 24 V | VDC        |
| Isolated 'Hot Deck' + or -Input impedance | Signal Source                            | $> 10$                                 | M $\Omega$ |
| Local Output +Voltage                     | Range                                    | 0 to +5 for 12 V and 0 to +10 for 24 V | VDC        |
| Local Output -Voltage                     | Range                                    | 0 to -5 for 12 V and 0 to -10 for 24 V | VDC        |
| Initial Offset Error                      | Signal Source                            | $< \pm 2$                              | mVDC       |
| Gain Error                                | Full Scale                               | $< \pm 0.2\%$                          | VDC        |
| Linearity Error                           | Full Scale                               | $< \pm 0.05\%$                         | VDC        |
| Stability                                 | 30 Min Warmup, Per 8 h, Per Day          | $< 0.01\% / < 0.02\%$                  | VDC        |
| Temperature Coefficient                   | -20 to +55°C                             | $< \pm 10$                             | ppm/°C     |
| Bandwidth                                 | Symmetric or Asymmetric Signal           | DC to 4                                | Hz         |
| Temperature                               | Conditions                               | All Types                              |            |
| Operating                                 | Full Load, Case Measurement              | -20 to +55                             | °C         |
| Storage                                   | Non-operating, Case Measurement          | -55 to +85                             | °C         |
| Thermal Shock                             | Mil-Std-810, Method 503-4, Proc. II      | -20 to +55                             | °C         |
| Altitude                                  |                                          | All Types                              |            |
| Operating                                 | All Operating Conditions                 | Sea level to vacuum                    | -          |
| Storage                                   | Non-operating                            | Sea level to vacuum                    | -          |
| Shock and Vibration                       |                                          | All Types                              |            |
| Shock                                     | Mil-Std-810, Method 516.5, Proc. IV      | 20                                     | Gs         |
| Vibration                                 | Mil-Std-810, Method 514.5, Fig. 514.5C-3 | 10                                     | Gs         |

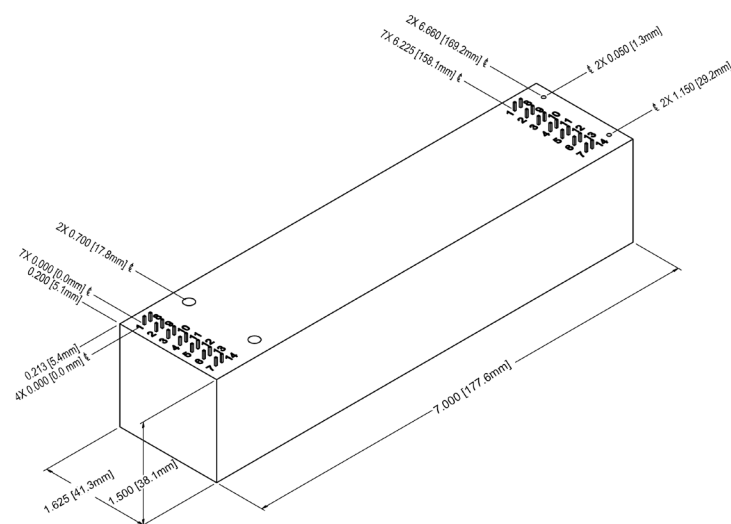
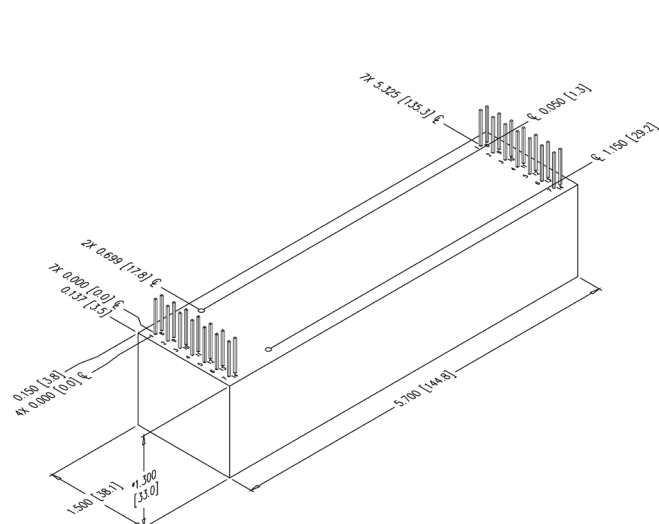
Note: Analog channels #1 and #2 DOWN parameters are valid for outputs in the range of 10 to 100% of maximum.

### LOCAL CONNECTIONS

| Pin | Function                                     |
|-----|----------------------------------------------|
| 1   | INPUT POWER GROUND RETURN                    |
| 2   | POSITIVE POWER INPUT                         |
| 3   | LVPS ENABLE/DISABLE/SYNC IN                  |
| 4   | TTL UP                                       |
| 5   | SIGNAL GROUND RETURN                         |
| 6   | ANALOG UP CHANNEL 1                          |
| 7   | +5 V REFERENCE OUTPUT                        |
| 8   | ANALOG DOWN CHANNEL 1, +                     |
| 9   | ANALOG DOWN CHANNEL 1, -                     |
| 10  | ANALOG DOWN CHANNEL 2, +                     |
| 11  | ANALOG DOWN CHANNEL 2, -                     |
| 12  | ANALOG UP CHANNEL 2                          |
| 13  | MODE                                         |
| 14  | TTL OUTPUT (INVERTED DIGITAL DOWN CHANNEL 1) |

### ISOLATED/FLOATING CONNECTIONS

| Pin | Function                                    |
|-----|---------------------------------------------|
| 1   | ANALOG DOWN CHANNEL 1, +                    |
| 2   | ANALOG DOWN CHANNEL 1, -                    |
| 3   | ANALOG DOWN CHANNEL 2, +                    |
| 4   | ANALOG DOWN CHANNEL 2, -                    |
| 5   | +15 VDC OUTPUT                              |
| 6   | ANALOG UP CHANNEL 2                         |
| 7   | FLOATING TTL INPUT (DIGITAL DOWN CHANNEL 1) |
| 8   | FLOATING POWER GROUND RETURN                |
| 9   | FLOATING +12 VDC OR +24VDC OUTPUT           |
| 10  | FLOATING -15 VDC OUTPUT                     |
| 11  | FLOATING TTL UP                             |
| 12  | FLOATING SIGNAL GROUND RETURN               |
| 13  | FLOATING ANALOG UP CHANNEL 1                |
| 14  | FLOATING +5.1 VDC REFERENCE OUTPUT          |



### 15EFL Module

### 30EFL Module

Note: Pins appear shorter in the outline drawing than actual module to ease visibility of pinout numbers. Minimum pin height from the cover is 7.62 mm (0.300").

## PHYSICAL SPECIFICATIONS

|                     |                                                                                    |
|---------------------|------------------------------------------------------------------------------------|
| <b>Construction</b> | Epoxy-filled DAP box certified to ASTM-D-5948                                      |
| <b>Size</b>         |                                                                                    |
| <b>Volume</b>       | 15EFL: 181.9 cc (11.1 in <sup>3</sup> )<br>30EFL: 275.3 cc (16.8 in <sup>3</sup> ) |
| <b>Weight</b>       | 15EFL: 377.1 g (13.3 oz)<br>30EFL: 569.8 g (20.1 oz)                               |
| <b>Tolerance</b>    |                                                                                    |
| <b>Overall</b>      | ±1.27 mm (0.050")                                                                  |
| <b>Pin to Pin</b>   | ±0.38 mm (0.015")                                                                  |
| <b>15EFL</b>        | Mounting hole locations ±0.64 mm (0.025")                                          |
| <b>30EFL</b>        | Mounting hole locations ±0.76 mm (0.030")                                          |

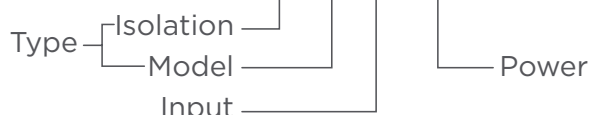
## ORDERING INFORMATION

|                          |                                                                                                            |                         |
|--------------------------|------------------------------------------------------------------------------------------------------------|-------------------------|
| <b>Type</b>              | 15 kV Isolation<br>30 kV Isolation                                                                         | 15EFL<br>30EFL          |
| <b>Input Voltage</b>     | 12 VDC Nominal<br>24 VDC Nominal                                                                           | 12<br>24                |
| <b>Power</b>             | Watts Output (12 Vin Only)<br>Watts Output (24 Vin Only)<br>Watts Output (15 kVout, 24 Vin Only)           | -12 W<br>-24 W<br>-36 W |
| <b>Standard Features</b> | (1) Digital Up Channel and (2) Analog Up Channels<br>(1) Digital Down Channel and (2) Analog Down Channels | -I/O<br>-R/B            |
| <b>Options</b>           | Partial Mu-Metal Shield                                                                                    | -M                      |
| <b>Case</b>              | Plastic Case—Diallyl Phthalate<br>"Eared" Chassis Mounting Plate (15 kV only)                              | Standard<br>-E          |



Non-RoHS compliant units are available. Please contact the factory for more information.

Example: **15EFL12-12W-I/O-RB**





For international contact information, visit  
[advanced-energy.com](http://advanced-energy.com).