

## EVK011A0B Series (Eighth-Brick) DC-DC Converter Power Modules

36–60Vdc Input; 12.0Vdc Output; 11A Output Current



**RoHS Compliant**



### Applications

- Distributed Power Architectures
- Wireless Networks
- Access and Optical Network Equipment
- Enterprise Networks including Power over Ethernet (PoE)

### Options

- Negative Remote On/Off logic
- Over current/Over temperature/Over voltage protections (Auto-restart)

### Features

- Compliant to RoHS Directive 2011/65/EU and amended Directive (EU) 2015/863.
- Compliant to REACH Directive (EC) No 1907/2006
- Compatible in a Pb-free or SnPb reflow environment
- High efficiency – 95% at 12V full load
- Industry standard, DOSA compliant, Eighth brick footprint  
57.9mm x 22.9mm x 8.95mm  
(2.28in x 0.90in x 0.352in)
- Wide Input voltage range: 36-60 Vdc
- Tightly regulated output
- Constant switching frequency
- Positive Remote On/Off logic
- Input under/over voltage protection
- Output overcurrent/voltage protection
- Over-temperature protection
- Remote sense
- No minimum load required
- No reverse current during output shutdown
- Output Voltage adjust: 80% to 110% of  $V_{o,nom}$
- Operating temperature range (-40°C to 85°C)
- ANSI/UL\* 62368-1 and CAN/CSA† C22.2 No. 62368-1 Recognized, DIN VDE‡ 0868-1/A11:2017 (EN62368-1:2014/A11:2017)
- CE mark meets 2014/35/EU directive§
- Meets the voltage and current requirements for ETSI 300-132-2 and complies with and licensed for Basic insulation
- 2250 Vdc Isolation tested in compliance with IEEE 802.3¶ PoE standards
- ISO\*\*9001 and ISO 14001 certified manufacturing facilities

\* UL is a registered trademark of Underwriters Laboratories, Inc.

† CSA is a registered trademark of Canadian Standards Association.

‡ VDE is a trademark of Verband Deutscher Elektrotechniker e.V.

§ This product is intended for integration into end-user equipment. All of the required procedures of end-use equipment should be followed.

¶ IEEE and 802 are registered trademarks of the Institute of Electrical and Electronics Engineers, Incorporated.

\*\* ISO is a registered trademark of the International Organization of Standards

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### Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only, functional operation of the device is not implied at these or any other conditions in excess of those given in the operations sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect the device reliability.

| Parameter   | Device | Symbol         | Min  | Max  | Unit            |
|---|--------|----------------|------|------|-----------------|
| Input Voltage   |        |                |      |      |                 |
| Continuous  | All    | $V_{IN}$       | -0.3 | 60   | V <sub>dc</sub> |
| Transient ( $\leq 10$ ms)   | All    | $V_{IN,trans}$ | -0.3 | 75   | V <sub>dc</sub> |
| Operating Ambient Temperature<br>(see Thermal Considerations section) | All    | $T_A$          | -40  | 85   | °C              |
| Storage Temperature   | All    | $T_{stg}$      | -55  | 125  | °C              |
| I/O Isolation voltage (100% factory Hi-Pot tested)                    | All    | —              | —    | 2250 | V <sub>dc</sub> |

### Electrical Specifications

Unless otherwise indicated, specifications apply over all operating input voltage, resistive load, and temperature conditions.

| Parameter   | Device | Symbol            | Min | Typ | Max | Unit              |
|---|--------|-------------------|-----|-----|-----|-------------------|
| Operating Input Voltage   | All    | $V_{IN}$          | 36  | 48  | 60  | V <sub>dc</sub>   |
| Maximum Input Current<br>( $V_{IN} = V_{IN,min}$ to $V_{IN,max}$ , $I_O = I_{O,max}$ )  | All    | $I_{IN,max}$      |     | 4.0 | 4.4 | A <sub>dc</sub>   |
| Input No Load Current<br>( $V_{IN} = V_{IN,nom}$ , $I_O = 0$ , module enabled)  | All    | $I_{IN,No\ load}$ |     |     | 75  | mA                |
| Input Stand-by Current<br>( $V_{IN} = V_{IN,nom}$ , module disabled)  | All    | $I_{IN,stand-by}$ |     |     | 20  | mA                |
| Inrush Transient  | All    | $I^2t$            |     |     | 0.5 | A <sup>2</sup> s  |
| Input Reflected Ripple Current, peak-to-peak<br>(5Hz to 20MHz, 1 $\mu$ H source impedance; $V_{IN,min}$ to $V_{IN,max}$ , $I_O = I_{O,max}$ ; See Test configuration section) | All    |                   |     | 20  |     | mA <sub>p-p</sub> |
| Input Ripple Rejection (120Hz)  | All    |                   |     | 50  |     | dB                |

#### CAUTION: This power module is not internally fused. An input line fuse must always be used.

This power module can be used in a wide variety of applications, ranging from simple standalone operation to an integrated part of sophisticated power architectures. To preserve 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 time-delay fuse with a maximum rating of 8 A (see Safety Considerations section). Based on the information provided in this data sheet on inrush energy and maximum dc input current, the same type of fuse with a lower rating can be used. Refer to the fuse manufacturer's data sheet for further information.

## EVK011A0B Series (Eighth-Brick) DC-DC Converter Power Modules

36–60Vdc Input; 12.0Vdc Output; 11A Output Current

### Electrical Specifications (continued)

| Parameter  | Device            | Symbol            | Min         | Typ         | Max               | Unit   |
|--|-------------------|-------------------|-------------|-------------|-------------------|--|
| Nominal Output Voltage Set-point<br>$V_{IN}=V_{IN, min}, I_O=I_{O, max}, T_A=25^{\circ}C$  | All               | $V_{O, set}$      | 11.76       | 12.0        | 12.24             | V <sub>dc</sub>                                    |
| Output Voltage<br>(Over all operating input voltage, resistive load, and temperature conditions until end of life)   | All               | $V_O$             | -3.0        | —           | +3.0              | % $V_{O, set}$                                     |
| Output Regulation<br>Line ( $V_{IN}=V_{IN, min}$ to $V_{IN, max}$ )<br>Load ( $I_O=I_{O, min}$ to $I_{O, max}$ )<br>Temperature ( $T_{ref}=T_{A, min}$ to $T_{A, max}$ )   | All<br>All<br>All | —<br>—<br>—       | —<br>—<br>— | —<br>—<br>— | 0.2<br>0.2<br>1.0 | % $V_{O, set}$<br>% $V_{O, set}$<br>% $V_{O, set}$ |
| Output Ripple and Noise on nominal output<br>( $V_{IN}=V_{IN, nom}, I_O=I_{O, max}, T_A=T_{A, min}$ to $T_{A, max}$ )<br>RMS (5Hz to 20MHz bandwidth)<br>Peak-to-Peak (5Hz to 20MHz bandwidth)                                     | All<br>All        | —<br>—            | —<br>—      | —<br>—      | 30<br>100         | mV <sub>rms</sub><br>mV <sub>pk-pk</sub>           |
| External Capacitance   | All               | $C_O$             | 100         | —           | 2,000             | μF   |
| Output Current   | All               | $I_O$             | 0           | —           | 11                | A <sub>dc</sub>                                    |
| Output Current Limit Inception (Hiccup Mode )<br>( $V_O=90%$ of $V_{O, set}$ )   | All               | $I_{O, lim}$      | 105         | 115         | 130               | % $I_O$  |
| Output Short-Circuit Current<br>( $V_O \leq 250mV$ ) ( Hiccup Mode )   | All               | $I_{O, s/c}$      | —           | 3           | 5                 | A <sub>rms</sub>                                   |
| Efficiency<br>$V_{IN}=V_{IN, nom}, T_A=25^{\circ}C$<br>$I_O=I_{O, max}, V_O=V_{O, set}$  | All               | $\eta$            | —           | 95          | —                 | %  |
| Switching Frequency (Input ripple is $\frac{1}{2} f_{sw}$ )  | All               | $f_{sw}$          | —           | 330         | —                 | kHz  |
| Dynamic Load Response<br>( $dI_O/dt=0.1A/\mu s; V_{IN}=V_{IN, nom}; T_A=25^{\circ}C$ )<br>Load Change from $I_O=50%$ to $75%$ or $25%$ to $50%$ of $I_{O, max}$ ;<br>Peak Deviation<br>Settling Time ( $V_O < 10%$ peak deviation) | All<br>All        | $V_{pk}$<br>$t_s$ | —<br>—      | 3<br>200    | —<br>—            | % $V_{O, set}$<br>μs                               |
| ( $dI_O/dt=1A/\mu s; V_{IN}=V_{IN, nom}; T_A=25^{\circ}C$ )<br>Load Change from $I_O=50%$ to $75%$ or $25%$ to $50%$ of $I_{O, max}$ ;<br>Peak Deviation<br>Settling Time ( $V_O < 10%$ peak deviation)                            | All<br>All        | $V_{pk}$<br>$t_s$ | —<br>—      | 5<br>200    | —<br>—            | % $V_{O, set}$<br>μs                               |

### Isolation Specifications

| Parameter  | Device | Symbol    | Min | Typ  | Max  | Unit            |
|--|--------|-----------|-----|------|------|-----------------|
| Isolation Capacitance                              | All    | $C_{iso}$ | —   | 1000 | —    | pF              |
| Isolation Resistance                               | All    | $R_{iso}$ | 10  | —    | —    | MΩ              |
| I/O Isolation Voltage (100% factory Hi-pot tested) | All    | All       | —   | —    | 2250 | V <sub>dc</sub> |

### General Specifications

| Parameter   | Device | Symbol | Min | Typ          | Max | Unit                   |
|---|--------|--------|-----|--------------|-----|------------------------|
| Calculated Reliability based upon Telcordia SR-332<br>Issue 2: Method I Case 3 ( $I_O=80\%I_{O, max}, T_A=40^{\circ}C$ , airflow = 200 lfm, 90% confidence) | All    | FIT    | —   | 315.1        | —   | 10 <sup>9</sup> /Hours |
|   | All    | MTBF   | —   | 3,173,243    | —   | Hours                  |
| Weight (Open Frame)   | All    | —      | —   | 19<br>(0.67) | —   | g<br>(oz.)             |

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36–60Vdc Input; 12.0Vdc Output; 11A Output Current

## Feature Specifications

Unless otherwise indicated, specifications apply over all operating input voltage, resistive load, and temperature conditions. See Feature Descriptions for additional information.

| Parameter   | Device | Symbol         | Min  | Typ  | Max  | Unit            |
|---|--------|----------------|------|------|------|-----------------|
| <b>Remote On/Off Signal Interface</b><br>( $V_{IN}=V_{IN, min}$ to $V_{IN, max}$ ; open collector or equivalent, Signal referenced to $V_{IN}$ -terminal)<br>Negative Logic: device code suffix "1"<br>Logic Low = module On, Logic High = module Off<br>Positive Logic: No device code suffix required<br>Logic Low = module Off, Logic High = module On<br>Logic Low - Remote On/Off Current<br>Logic Low - On/Off Voltage<br>Logic High Voltage – (Typ = Open Collector)<br>Logic High maximum allowable leakage current   | All    | $I_{on/off}$   | —    | —    | 1.0  | mA              |
|   | All    | $V_{on/off}$   | -0.7 | —    | 1.0  | V <sub>dc</sub> |
|   | All    | $V_{on/off}$   | 2.0  | —    | 5.0  | V <sub>dc</sub> |
|   | All    | $I_{on/off}$   | —    | —    | 10   | μA              |
| <b>Turn-On Delay<sup>1</sup> and Rise Times</b><br>( $I_o=I_{o, max}$ , $V_{IN}=V_{IN, nom}$ , $T_A = 25$ °C)<br>Case 1: On/Off input is set to Logic Low (Module ON) and then input power is applied ( $T_{delay}$ from instant at which $V_{IN} = V_{IN, min}$ until $V_o = 10\%$ of $V_{O, set}$ )<br>Case 2: Input power is applied for at least 1 second and then the On/Off input is set from OFF to ON ( $T_{delay}$ from instant $V_{on/off}$ toggles until $V_o = 10\%$ of $V_{O, set}$ ).<br>Output voltage Rise time (time for $V_o$ to rise from 10% of $V_{O, set}$ to 90% of $V_{O, set}$ ) | All    | $T_{delay}$    | —    | 25   | 30   | msec            |
|   | All    | $T_{delay}$    | —    | 12   | 20   | msec            |
|   | All    | $T_{rise}$     | —    | 10   | 15   | msec            |
| <b>Output voltage overshoot – Startup</b><br>$I_o= I_{o, max}$ ; $V_{IN}=V_{IN, min}$ to $V_{IN, max}$ , $T_A = 25$ °C  | All    |                |      | —    | 3    | % $V_{O, set}$  |
| <b>Remote Sense Range</b><br>(Max voltage drop is 0.5V)   | All    | $V_{SENSE}$    |      |      | 10   | % $V_{O, set}$  |
| <b>Output Voltage Adjustment Range<sup>2</sup></b>  | All    |                | 80   |      | 110  | % $V_{O, set}$  |
| <b>Output Overvoltage Protection</b>  | All    | $V_{O, limit}$ | 13.8 | —    | 16.5 | V <sub>dc</sub> |
| <b>Input Undervoltage Lockout</b><br>Turn-on Threshold<br>Turn-off Threshold<br>Hysteresis  | All    | $V_{UVLO}$     | 30   | 34.5 | 36   | V <sub>dc</sub> |
|   |        |                | 30   | 32.5 | —    | V <sub>dc</sub> |
|   |        |                | 1.5  | 2.0  | —    | V <sub>dc</sub> |
| <b>Input Overvoltage Lockout</b><br>Turn-off Threshold<br>Turn-on Threshold<br>Hysteresis   | All    | $V_{OVLO}$     | —    | 64   | 66   | V <sub>dc</sub> |
|   |        |                | 60   | 62   | —    | V <sub>dc</sub> |
|   |        |                | 1    | 2    | —    | V <sub>dc</sub> |

Notes:

- The module has an adaptable extended Turn-On Delay interval,  $T_{delay}$ , of 4 seconds. The extended  $T_{delay}$  will occur when the module restarts following either: 1) the rapid cycling of  $V_{in}$  from normal levels to less than the Input Undervoltage Lockout (which causes module shutdown), and then back to normal; or 2) toggling the on/off signal from on to off and back to on without removing the input voltage. The normal Turn-On Delay interval,  $T_{delay}$ , will occur whenever a module restarts with input voltage removed from the module for the preceding 1 second.
- Maximum trim up possible only for  $V_{in}>40V$ .

# EVK011A0B Series (Eighth-Brick) DC-DC Converter Power Modules

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## Characteristic Curves

The following figures provide typical characteristics for the EVK011A0B (12V, 11A) at 25°C. The figures are identical for either positive or negative remote On/Off logic.

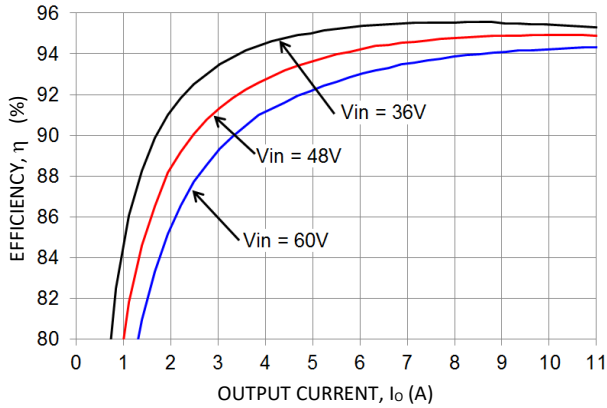


Figure 1. Converter Efficiency versus Output Current.

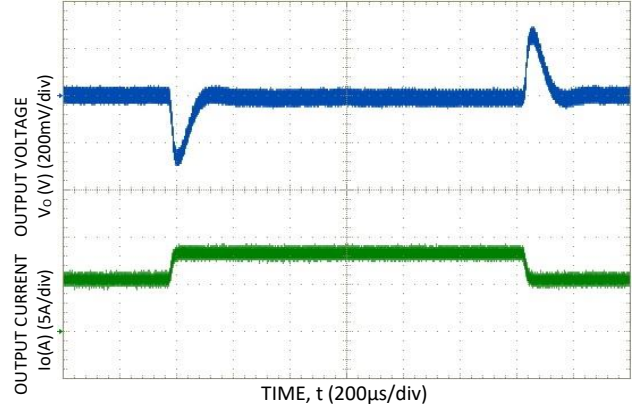


Figure 4. Transient Response to 1.0A/μs Dynamic Load Change from 50% to 75% to 50% of full load ( $V_{IN} = V_{IN,NOM}$ ),  $C_O=100\mu F$ .

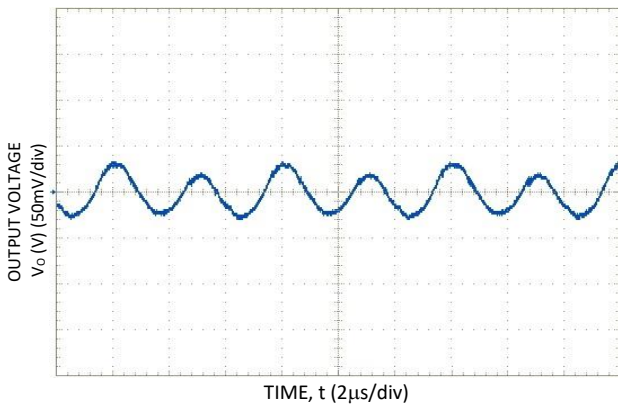


Figure 2. Typical output ripple and noise ( $V_{IN} = V_{IN,NOM}$ ,  $I_o = I_{o,max}$ ).

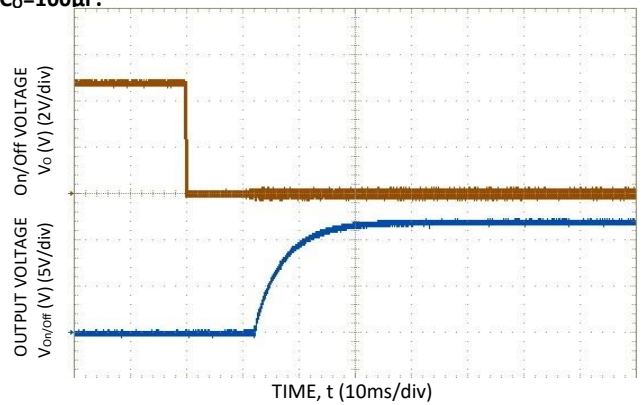


Figure 5. Typical Start-up Using Remote On/Off, negative logic version shown ( $V_{IN} = V_{IN,NOM}$ ,  $I_o = I_{o,max}$ ).

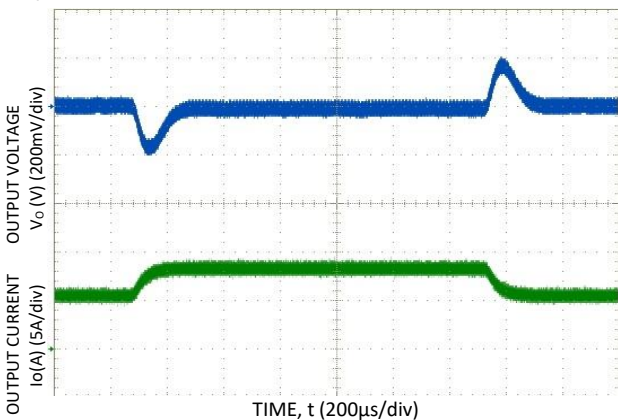


Figure 3. Transient Response to 0.1A/μs Dynamic Load Change from 50% to 75% to 50% of full load ( $V_{IN} = V_{IN,NOM}$ ),  $C_O=100\mu F$ .

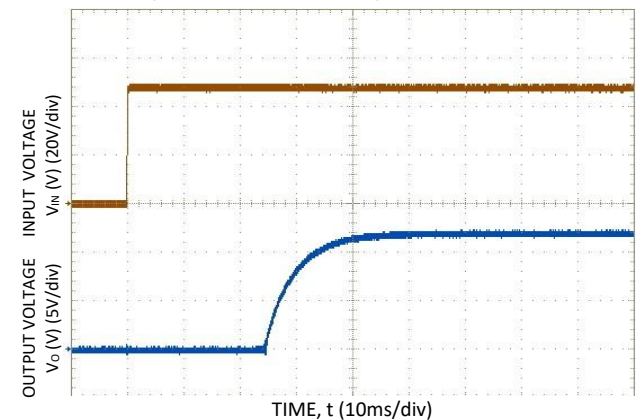
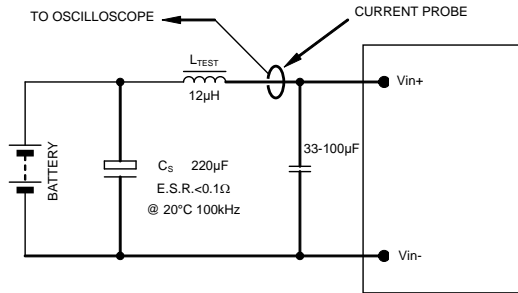


Figure 6. Typical Start-up Using Input Voltage ( $V_{IN} = V_{IN,NOM}$ ,  $I_o = I_{o,max}$ ).

# EVK011A0B Series (Eighth-Brick) DC-DC Converter Power Modules

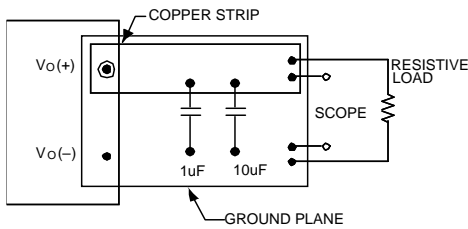
36–60Vdc Input; 12.0Vdc Output; 11A Output Current

## Test Configurations



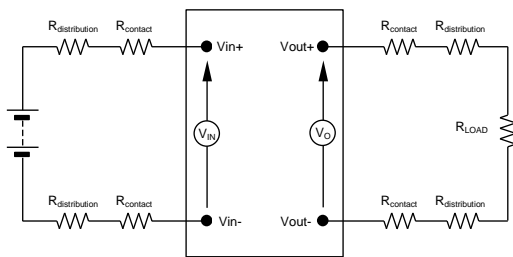
NOTE: Measure input reflected ripple current with a simulated source inductance ( $L_{TEST}$ ) of 12µH. Capacitor  $C_S$  offsets possible battery impedance. Measure current as shown above.

Figure 7. Input Reflected Ripple Current Test Setup.



NOTE: All voltage measurements to be taken at the module terminals, as shown above. If sockets are used then Kelvin connections are required at the module terminals to avoid measurement errors due to socket contact resistance.

Figure 8. Output Ripple and Noise Test Setup.



NOTE: All voltage measurements to be taken at the module terminals, as shown above. If sockets are used then Kelvin connections are required at the module terminals to avoid measurement errors due to socket contact resistance.

Figure 9. Output Voltage and Efficiency Test Setup.

$$\text{Efficiency } \eta = \frac{V_o \cdot I_o}{V_{IN} \cdot I_{IN}} \times 100 \%$$

## Design Considerations

### Input Filtering

The power module should be connected to a low ac-impedance source. Highly inductive source impedance can affect the stability of the power module. For the test configuration in Figure 7 a 33-100µF electrolytic capacitor (ESR<0.1Ω at 100kHz), mounted close to the power module helps ensure the stability of the unit. Consult the factory for further application guidelines.

### Safety Considerations

For E agency approval the power module must be installed in compliance with the spacing and separation requirements of the end-use safety agency standards, i.e., UL ANSI/UL 62368-1 and CAN/CSA C22.2 No. 62368-1 Recognized, DIN VDE 0868-1/A11:2017 (EN62368-1:2014/A11:2017)

If the input source is non-SELV (ELV or a hazardous voltage greater than 60 Vdc and less than or equal to 75Vdc), for the module’s output to be considered as meeting the requirements for safety extra-low voltage (SELV) or ES1, all of the following must be true:

- The input source is to be provided with reinforced insulation from any other hazardous voltages, including the ac mains.
- One  $V_{IN}$  pin and one  $V_{OUT}$  pin are to be grounded, or both the input and output pins are to be kept floating.
- The input pins of the module are not operator accessible.
- Another SELV or ES1 reliability test is conducted on the whole system (combination of supply source and subject module), as required by the safety agencies, to verify that under a single fault, hazardous voltages do not appear at the module’s output.

**Note:** Do not ground either of the input pins of the module without grounding one of the output pins. This may allow a non-SELV/ES1 voltage to appear between the output pins and ground.

The power module has extra-low voltage (ELV) outputs when all inputs are SELV or ES1.

All flammable materials used in the manufacturing of these modules are rated 94V-0, or tested to the UL60950 A.2 for reduced thickness.

For input voltages exceeding –60 Vdc but less than or equal to –75 Vdc, these converters have been evaluated to the applicable requirements of BASIC INSULATION between secondary DC MAINS DISTRIBUTION input (classified as TNV-2 in Europe) and unearthed SELV outputs.

The input to these units is to be provided with a maximum 8 A time-delay fuse in the ungrounded lead.

# EVK011A0B Series (Eighth-Brick) DC-DC Converter Power Modules

36–60Vdc Input; 12.0Vdc Output; 11A Output Current

## Feature Description

### Remote On/Off

Two remote on/off options are available. Positive logic turns the module on during a logic high voltage on the ON/OFF pin, and off during a logic low. Negative logic remote On/Off, device code suffix “1”, turns the module off during a logic high and on during a logic low.

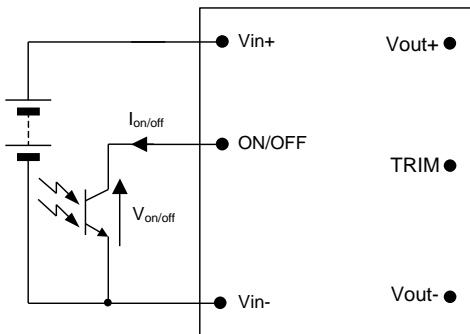


Figure 10. Remote On/Off Implementation.

To turn the power module on and off, the user must supply a switch (open collector or equivalent) to control the voltage ( $V_{on/off}$ ) between the ON/OFF terminal and the  $V_{IN(-)}$  terminal (see Figure 10). Logic low is  $0V \leq V_{on/off} \leq 1.0V$ . The maximum  $I_{on/off}$  during a logic low is 1mA, the switch should be maintain a logic low level whilst sinking this current.

During a logic high, the typical maximum  $V_{on/off}$  generated by the module is 5V, and the maximum allowable leakage current at  $V_{on/off} = 5V$  is  $1\mu A$ .

If not using the remote on/off feature:

For positive logic, leave the ON/OFF pin open.

For negative logic, short the ON/OFF pin to  $V_{IN(-)}$ .

### Remote Sense

Remote sense minimizes the effects of distribution losses by regulating the voltage at the remote-sense connections (See Figure 11). The voltage between the remote-sense pins and the output terminals must not exceed the output voltage sense range given in the Feature Specifications table:

$$[V_o(+)-V_o(-)] - [SENSE(+)-SENSE(-)] \leq 0.5V$$

Although the output voltage can be increased by both the remote sense and by the trim, the maximum increase for the output voltage is not the sum of both. The maximum increase is the larger of either the remote sense or the trim. The amount of power delivered by the module is defined as the voltage at the output terminals multiplied by the output current. When using remote sense and trim, the output voltage of the module can be increased, which at the same output current would increase the power output of the module. Care should be taken to ensure that the maximum output power of the module remains at or below the maximum rated power (Maximum rated power =  $V_o, set \times I_o, max$ ).

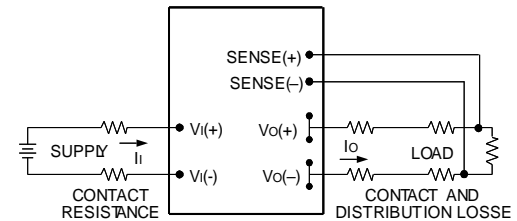


Figure 11. Circuit Configuration for remote sense .

### Input Undervoltage Lockout

At input voltages below the input undervoltage lockout limit, the module operation is disabled. The module will only begin to operate once the input voltage is raised above the undervoltage lockout turn-on threshold,  $V_{UV/ON}$ .

Once operating, the module will continue to operate until the input voltage is taken below the undervoltage turn-off threshold,  $V_{UV/OFF}$ .

### Overtemperature Protection

To provide protection under certain fault conditions, the unit is equipped with a thermal shutdown circuit. The unit will shutdown, if the thermal reference point (Figure 13), exceeds  $T_{ref1} = 133^\circ C$  or  $T_{ref2} = 140^\circ C$  (typical), but the thermal shutdown is not intended as a guarantee that the unit will survive temperatures beyond its rating. The module will automatically restart upon cool-down to a safe temperature.

### Output Overvoltage Protection

The output over voltage protection scheme of the modules has an independent over voltage loop to prevent single point of failure. This protection feature latches in the event of over voltage across the output. Cycling the on/off pin or input voltage resets the latching protection feature. If the auto-restart option (4) is ordered, the module will automatically restart upon an internally programmed time elapsing.

### Overcurrent Protection

To provide protection in a fault (output overload) condition, the unit is equipped with internal current-limiting circuitry and can endure current limiting continuously. At the point of current-limit inception, the unit enters hiccup mode. If the unit is not configured with auto-restart, then it will latch off following the over current condition. The module can be restarted by cycling the dc input power for at least one second or by toggling the remote on/off signal for at least one second. If the unit is configured with the auto-restart option (4), it will remain in the hiccup mode as long as the overcurrent condition exists; it operates normally, once the output current is brought back into its specified range. The average output current during hiccup is  $10\% I_o, max$ .



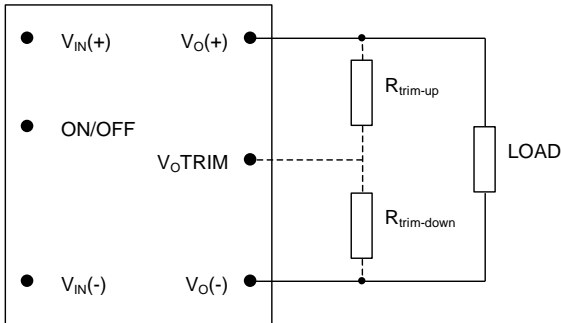
# EVK011A0B Series (Eighth-Brick) DC-DC Converter Power Modules

36–60Vdc Input; 12.0Vdc Output; 11A Output Current

## Feature Descriptions (continued)

### Output Voltage Programming

Trimming allows the output voltage set point to be increased or decreased, this is accomplished by connecting an external resistor between the TRIM pin and either the Vo(+) pin or the Vo(-) pin.



**Figure 12. Circuit Configuration to Trim Output Voltage.**

Connecting an external resistor ( $R_{trim-down}$ ) between the TRIM pin and the Vo(-) (or Sense(-)) pin decreases the output voltage set point. To maintain set point accuracy, the trim resistor tolerance should be  $\pm 1.0\%$ .

The following equation determines the required external resistor value to obtain a percentage output voltage change of  $\Delta\%$

$$R_{trim-down} = \left[ \frac{511}{\Delta\%} - 10.22 \right] k\Omega$$

Where  $\Delta\% = \left( \frac{V_{o,set} - V_{desired}}{V_{o,set}} \right) \times 100$

For example, to trim-down the output voltage of the module by 8% to 11.04V,  $R_{trim-down}$  is calculated as follows:

$$\Delta\% = 8$$

$$R_{trim-down} = \left[ \frac{511}{8} - 10.22 \right] k\Omega$$

$$R_{trim-down} = 53.655 K\Omega$$

Connecting an external resistor ( $R_{trim-up}$ ) between the TRIM pin and the Vo(+) (or Sense (+)) pin increases the output voltage set point. The following equations determine the required external resistor value to obtain a percentage output voltage change of  $\Delta\%$ :

$$R_{trim-up} = \left[ \frac{5.11 \times V_{o,set} \times (100 + \Delta\%)}{1.225 \times \Delta\%} - \frac{511}{\Delta\%} - 10.22 \right] k\Omega$$

Where  $\Delta\% = \left( \frac{V_{desired} - V_{o,set}}{V_{o,set}} \right) \times 100$

For example, to trim-up the output voltage of the module by 5% to 12.6V,  $R_{trim-up}$  is calculated as follows:

$$\Delta\% = 5$$

$$R_{trim-up} = \left[ \frac{5.11 \times 12.0 \times (100 + 5)}{1.225 \times 5} - \frac{511}{5} - 10.22 \right] k\Omega$$

$$R_{trim-up} = 938.8 k\Omega$$

The voltage between the Vo(+) and Vo(-) terminals must not exceed the minimum output overvoltage protection value shown

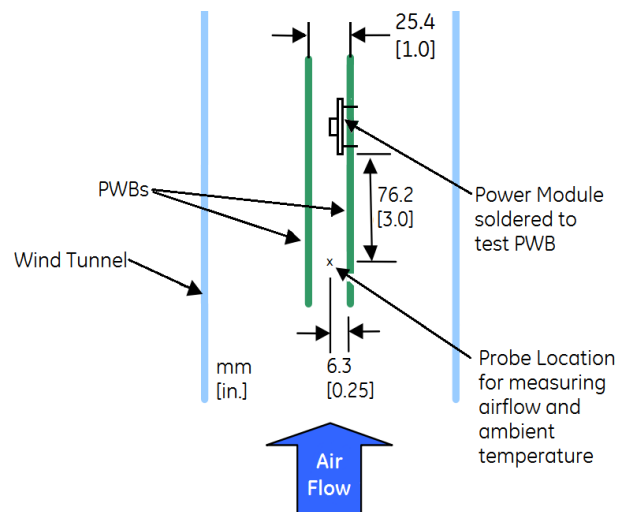
in the Feature Specifications table. This limit includes any increase in voltage due to remote-sense compensation and output voltage set-point adjustment trim.

Although the output voltage can be increased by both the remote sense and by the trim, the maximum increase for the output voltage is not the sum of both. The maximum increase is the larger of either the remote sense or the trim. The amount of power delivered by the module is defined as the voltage at the output terminals multiplied by the output current. When using remote sense and trim, the output voltage of the module can be increased, which at the same output current would increase the power output of the module. Care should be taken to ensure that the maximum output power of the module remains at or below the maximum rated power (Maximum rated power =  $V_{o,set} \times I_{o,max}$ ).

## Thermal Considerations

The power modules operate in a variety of thermal environments; however, sufficient cooling should be provided to help ensure reliable operation.

Considerations include ambient temperature, airflow, module power dissipation, and the need for increased reliability. A reduction in the operating temperature of the module will result in an increase in reliability. The thermal data presented here is based on physical measurements taken in a wind tunnel, using automated thermo-couple instrumentation to monitor key component temperatures: FETs, diodes, control ICs, magnetic cores, ceramic capacitors, opto-isolators, and module pwb conductors, while controlling the ambient airflow rate and temperature. For a given airflow and ambient temperature, the module output power is increased, until one (or more) of the components reaches its maximum derated operating temperature, as defined in IPC-9592. This procedure is then repeated for a different airflow or ambient temperature until a family of module output derating curves is obtained.



## Thermal Considerations (continued)

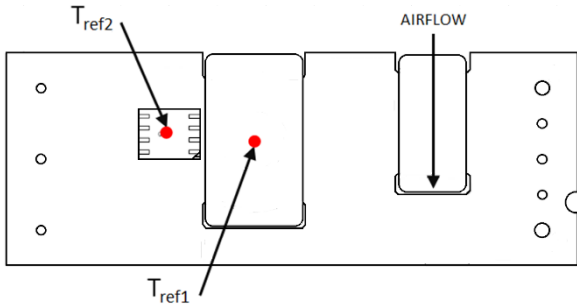


# EVK011A0B Series (Eighth-Brick) DC-DC Converter Power Modules

36–60Vdc Input; 12.0Vdc Output; 11A Output Current

Heat-dissipating components are mounted on the top side

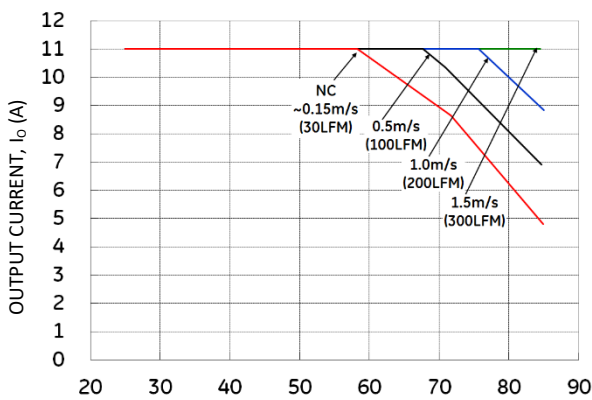
The thermal reference points,  $T_{ref1}$  and  $T_{ref2}$  used in the specifications for open frame modules is shown in Figure 13. For reliable operation  $T_{ref1}$  should not exceed 128°C, and  $T_{ref2}$  should not exceed 123°C .



**Figure 13.  $T_{ref}$  Temperature Measurement Location for open Frame Module.**

### Heat Transfer via Convection

Increased airflow over the module enhances the heat transfer via convection. Derating curves showing the maximum output current that can be delivered by the open frame module versus local ambient temperature ( $T_A$ ) for natural convection and up to 1.5m/s (300 ft./min) forced airflow are shown in Figure 14.



AMBIENT TEMPERATURE,  $T_A$  (°C)

**Figure 14. Output Current Derating for the Open Frame Module; Airflow in the Transverse Direction from Vout(+) to Vout(-);  $V_{in}$  =48V.**

Please refer to the Application Note “Thermal Characterization Process For Open-Frame Board-Mounted Power Modules” for a detailed discussion of thermal aspects including maximum device temperatures.

### Through-Hole Soldering Information

The RoHS-compliant (Z codes) through-hole products use the SAC (Sn/Ag/Cu) Pb-free solder and RoHS-compliant components. The RoHS-compliant with lead solder exemption (non-Z codes) through-hole products use Sn/Pb solder and RoHS-compliant components. Both non-Z and Z codes are designed to be processed through single or dual wave soldering machines. The pins have an RoHS-compliant finish that is compatible with both Pb and Pb-free wave soldering processes. A maximum preheat rate of 3°C/s is suggested. The wave preheat process should be such that the temperature of the power module board is kept below 210°C. For Pb solder, the recommended pot temperature is 260°C, while the Pb-free solder pot is 270°C max. Not all RoHS-compliant through-hole products can be processed with paste-through-hole Pb or Pb-free reflow process. If additional information is needed, please consult with your GE representative for more details.

### Post Solder Cleaning and Drying Considerations

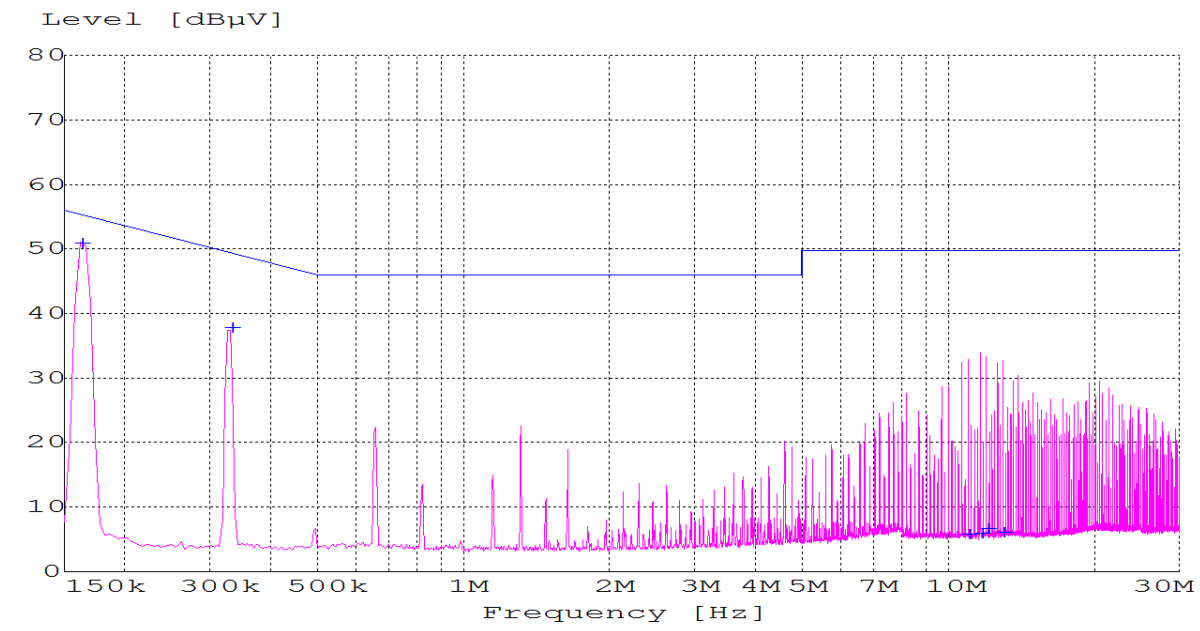
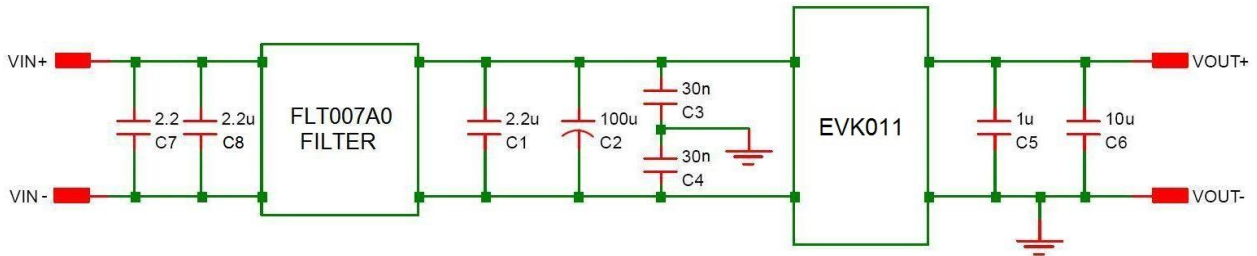
Post solder cleaning is usually the final circuit-board assembly process prior to electrical board testing. The result of inadequate cleaning and drying can affect both the reliability of a power module and the testability of the finished circuit-board assembly. For guidance on appropriate soldering, cleaning and drying procedures, refer to GE *Board Mounted Power Modules: Soldering and Cleaning* Application Note (AN04-001).

# EVK011A0B Series (Eighth-Brick) DC-DC Converter Power Modules

36–60Vdc Input; 12.0Vdc Output; 11A Output Current

## EMC Considerations

The circuit and plots in Figure 15 shows a suggested configuration to meet the conducted emission limits of EN55032 Class B.



— MES pre AV  
 — LIM EN 55022B V AV Limit

**Figure 15. EMC Considerations**

For further information on designing for EMC compliance, please refer to the FLT007A0 data sheet (DS05-028).

# EVK011A0B Series (Eighth-Brick) DC-DC Converter Power Modules

36–60Vdc Input; 12.0Vdc Output; 11A Output Current

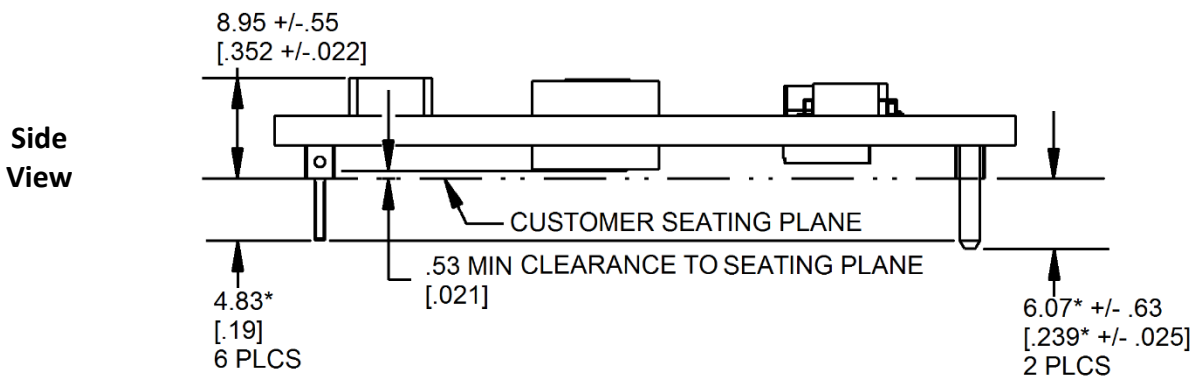
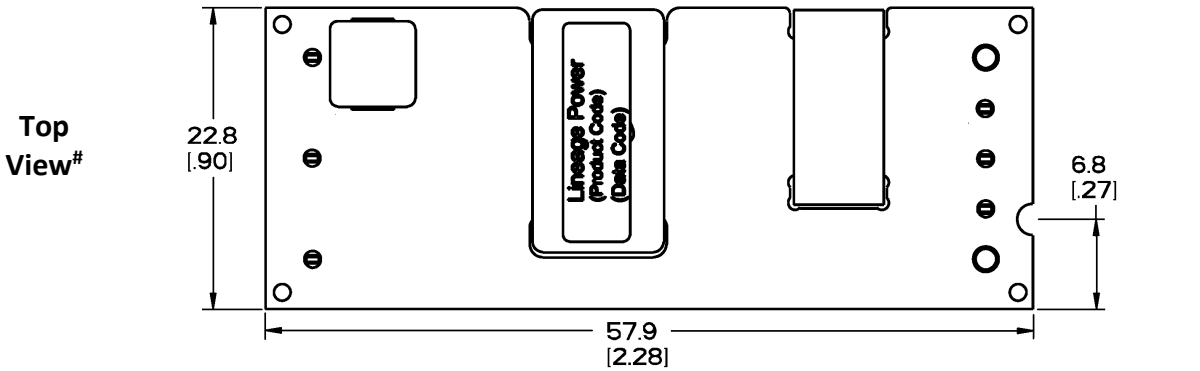
## Mechanical Outline for Through-Hole Module

Dimensions are in millimeters and [inches].

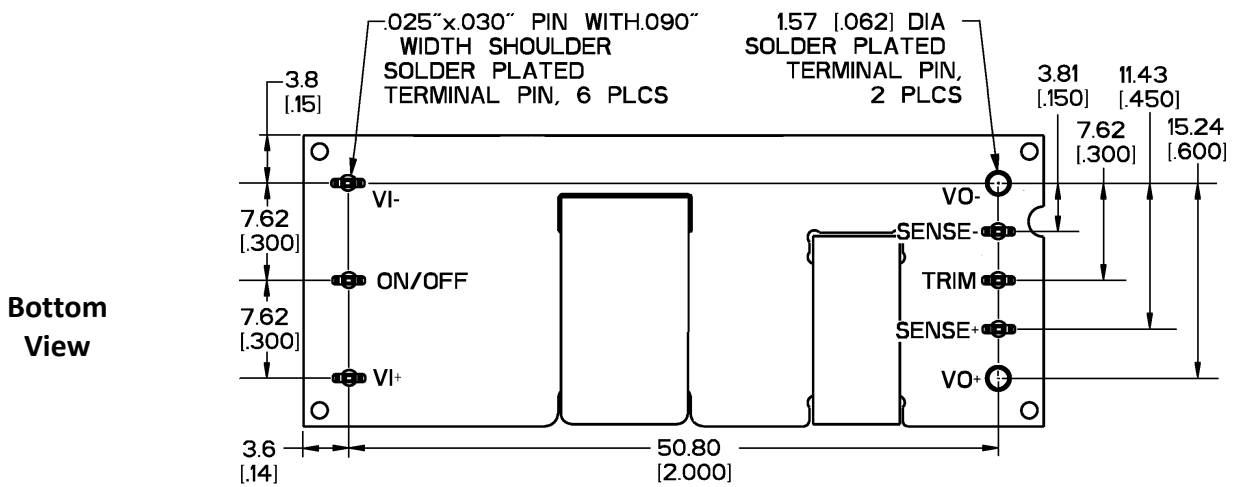
Tolerances: x.x mm ± 0.5 mm [x.xx in. ± 0.02 in.] (Unless otherwise indicated)

x.xx mm ± 0.25 mm [x.xxx in ± 0.010 in.]

#Top side label includes GE name, product designation and date code.



\* For optional pin lengths, see Table 2 Device Options and Coding Scheme



# EVK011A0B Series (Eighth-Brick) DC-DC Converter Power Modules

36–60Vdc Input; 12.0Vdc Output; 11A Output Current

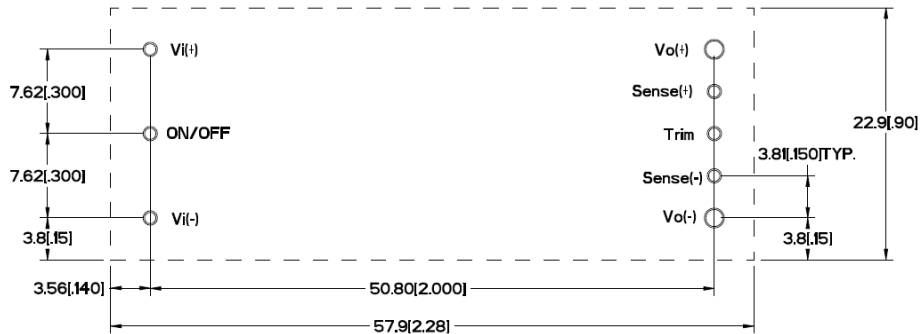
## Recommended Pad Layout

Dimensions are in millimeters and [inches].

Tolerances: x.x mm ± 0.5 mm [x.xx in. ± 0.02 in.] (Unless otherwise indicated)

x.xx mm ± 0.25 mm [x.xxx in ± 0.010 in.]

### Component Side View



**NOTES:**

1. FOR 0.030" x 0.025" PIN  
USE 0.050" DIA PLATED THROUGH HOLE
2. FOR 0.060" DIA PIN  
USE 0.076" DIA PLATED THROUGH HOLE

### TH Recommended Pad Layout (Component Side View)

# EVK011A0B Series (Eighth-Brick) DC-DC Converter Power Modules

36–60Vdc Input; 12.0Vdc Output; 11A Output Current

## Ordering Information

Please contact your GE Sales Representative for pricing, availability and optional features.

**Table 1. Device Codes**

| Product Codes | Input Voltage  | Output Voltage | Output Current | On/Off Logic | Connector Type | Comcodes  |
|---------------|----------------|----------------|----------------|--------------|----------------|-----------|
| EVK011A0B41Z  | 48V (36-60Vdc) | 12V            | 11A            | Negative     | Through hole   | 150027164 |
| EVK011A0B641Z | 48V (36-60Vdc) | 12V            | 11A            | Negative     | Through hole   | 150030268 |

**Table 2. Device Options and Coding Scheme**

|         | Characteristic                       | Character and Position | Definition  |
|---------|--------------------------------------|------------------------|---|
| Ratings | Form Factor                          | E                      | E = Eighth Brick  |
|         | Family Designator                    | V                      | V = Product Series  |
|         | Input Voltage                        | K                      | K = Wide Range, 36V-60V   |
|         | Output Current                       | 011A0                  | 011A0 = 011.0 Amps Maximum Output Current   |
|         | Output Voltage                       | B                      | B = 12.0V nominal   |
| Options | Pin Length                           | 6<br>8                 | Omit = Default Pin Length shown in Mechanical Outline Figures<br>6 = Pin Length: 3.68 mm ± 0.25mm , (0.145 in. ± 0.010 in.)<br>8 = Pin Length: 2.79 mm ± 0.25mm , (0.110 in. ± 0.010 in.) |
|         | Action following Protective Shutdown | 4                      | Omit = Latching Mode<br>4 = Auto-restart following shutdown (Overcurrent/Overvoltage)   |
|         | On/Off Logic                         | 1                      | Omit = Positive Logic<br>1 = Negative Logic   |
|         | Customer Specific                    | XY                     | XY = Customer Specific Modified Code, Omit for Standard Code  |
|         | RoHS                                 | Z                      | Omit = RoHS 5/6, Lead Based Solder Used<br>Z = RoHS 6/6 Compliant, Lead free  |

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