Key Features
- Industry standard low profile Eighth-brick
  58.4 x 22.7 x 10.1 mm (2.3 x 0.894 x 0.397 in.)
- High efficiency, typ. 95.5% at 12 Vout, half load
- 1500 Vdc input to output isolation
- Meets safety requirements according to IEC/EN/UL 60950-1
- MTBF 3.4 Mh

General Characteristics
- Fully regulated
- Input under voltage protection
- Over temperature protection
- Output over voltage protection
- Output short-circuit protection
- Remote control
- Optional baseplate
- Highly automated manufacturing ensures quality
- ISO 9001/14001 certified supplier

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## Ordering Information

<table>
<thead>
<tr>
<th>Product program</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>PKB 4204</td>
<td>12 V, 20 A / 240 W</td>
</tr>
</tbody>
</table>

## Product number and Packaging

<table>
<thead>
<tr>
<th>Options</th>
<th>PKB 4204</th>
<th>n1</th>
<th>n2</th>
<th>n3</th>
<th>n4</th>
<th>n5</th>
<th>n6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting</td>
<td></td>
<td>o</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remote control logic</td>
<td></td>
<td>o</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseplate</td>
<td></td>
<td></td>
<td>o</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased stand-off</td>
<td></td>
<td></td>
<td></td>
<td>o</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pin length</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>o</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delivery package</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>o</td>
<td></td>
</tr>
</tbody>
</table>

### Options Description

- **n1**: PI Through hole, SI Surface mount
- **n2**: Negative *, P Positive
- **n3**: Open frame *, HS Baseplate
- **n4**: M Increased stand-off
- **n5**: 5.30 mm *, LA 3.69 mm, LB 4.57 mm
- **n6**: /B Tray

Example: a standard through hole, positive logic, baseplate with increased stand-off short pin product would be PKB4204PIPHSMLA.

* Standard variant (i.e. no option selected).

## Compatibility with RoHS requirements

The products are compatible with the relevant clauses and requirements of the RoHS directive 2011/65/EU and have a maximum concentration value of 0.1% by weight in homogeneous materials for lead, mercury, hexavalent chromium, PBB and PBDE and of 0.01% by weight in homogeneous materials for cadmium.

Exemptions in the RoHS directive utilized in Flex Power Modules products are found in the Statement of Compliance document.

## Quality Statement

### Reliability

The failure rate ($\lambda$) and mean time between failures (MTBF= $1/\lambda$) is calculated at max output power and an operating ambient temperature ($T_A$) of +40°C. Flex Power Modules uses Telcordia SR-332 Issue 2 Method 1 to calculate the mean steady-state failure rate and standard deviation ($\sigma$).

Telcordia SR-332 Issue 2 also provides techniques to estimate the upper confidence levels of failure rates based on the mean and standard deviation.

<table>
<thead>
<tr>
<th>Mean steady-state</th>
<th>Std. deviation, $\sigma$</th>
</tr>
</thead>
<tbody>
<tr>
<td>293 nFailures/h</td>
<td>37.7 nFailures/h</td>
</tr>
</tbody>
</table>

MTBF (mean value) for the PKB 4000 series = 3.4 Mh.

MTBF at 90% confidence level = 2.9 Mh
Safety Specification

General information

Flex Power Modules DC/DC converters and DC/DC regulators are designed in accordance with the safety standards IEC 60950-1, EN 60950-1 and UL 60950-1 Safety of Information Technology Equipment.

IEC/EN/UL 60950-1 contains requirements to prevent injury or damage due to the following hazards:

- Electrical shock
- Energy hazards
- Fire
- Mechanical and heat hazards
- Radiation hazards
- Chemical hazards

On-board DC/DC converters, Power interface modules and DC/DC regulators are defined as component power supplies. As components they cannot fully comply with the provisions of any safety requirements without “conditions of acceptability”. Clearance between conductors and between conductive parts of the component power supply and conductors on the board in the final product must meet the applicable safety requirements. Certain conditions of acceptability apply for component power supplies with limited stand-off (see Mechanical Information and Safety Certificate for further information). It is the responsibility of the installer to ensure that the final product housing these components complies with the requirements of all applicable safety standards and regulations for the final product.

Component power supplies for general use should comply with the requirements in IEC/EN/UL 60950/1 Safety of Information Technology Equipment. Product related standards, e.g. IEEE 802.3af Power over Ethernet, and ETS-300132-2 Power interface at the input to telecom equipment, operated by direct current (dc) are based on IEC/EN/UL 60950-1 with regards to safety.

Flex Power Modules DC/DC converters, Power interface modules and DC/DC regulators are UL 60950-1 recognized and certified in accordance with EN 60950-1. The flammability rating for all construction parts of the products meet requirements for V-0 class material according to IEC 60695-11-10, Fire hazard testing, test flames – 50 W horizontal and vertical flame test methods.

Isolated DC/DC converters

The product may provide basic or functional insulation between input and output according to IEC/EN/UL 60950-1 (see Safety Certificate), different conditions shall be met if the output of a basic or a functional insulated product shall be considered as safety extra low voltage (SELV).

For basic insulated products (see Safety Certificate) the output is considered as safety extra low voltage (SELV) if one of the following conditions is met:

- The input source provides supplementary or double or reinforced insulation from the AC mains according to IEC/EN/UL 60950-1.
- The input source provides functional or basic insulation from the AC mains and the product’s output is reliably connected to protective earth according to IEC/EN/UL 60950-1.

For functional insulated products (see Safety Certificate) the output is considered as safety extra low voltage (SELV) if one of the following conditions is met:

- The input source provides double or reinforced insulation from the AC mains according to IEC/EN/UL 60950-1.
- The input source provides basic or supplementary insulation from the AC mains and the product’s output is reliably connected to protective earth according to IEC/EN/UL 60950-1.
- The input source is reliably connected to protective earth and provides basic or supplementary insulation according to IEC/EN/UL 60950-1 and the maximum input source voltage is 60 Vdc.

Galvanic isolation between input and output is verified in an electric strength test and the isolation voltage (Viso) meets the voltage strength requirement for basic insulation according to IEC/EN/UL 60950-1.

It is recommended to use a slow blow fuse at the input of each product. If an input filter is used in the circuit the fuse should be placed in front of the input filter. In the rare event of a component problem that imposes a short circuit on the input source, this fuse will provide the following functions:

- Isolate the fault from the input power source so as not to affect the operation of other parts of the system
- Protect the distribution wiring from excessive current and power loss thus preventing hazardous overheating
## Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>min</th>
<th>typ</th>
<th>max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{P1}$ (Operating Temperature)</td>
<td>-30</td>
<td>+90</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>$T_{S}$ (Storage temperature)</td>
<td>-55</td>
<td>+125</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>$V_i$ (Input voltage)</td>
<td>-0.5</td>
<td>+80</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{iso}$ (Isolation voltage)</td>
<td>-</td>
<td>1500</td>
<td>Vdc</td>
<td></td>
</tr>
<tr>
<td>$V_{tr}$ (Input voltage transient)</td>
<td>-</td>
<td>100</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{RC}$ (Remote Control pin)</td>
<td>Positive logic option</td>
<td>-0.5</td>
<td>15</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Negative logic option</td>
<td>-0.5</td>
<td>15</td>
<td>V</td>
</tr>
</tbody>
</table>

Stress in excess of Absolute Maximum Ratings may cause permanent damage. Absolute Maximum Ratings, sometimes referred to as no destruction limits, are normally tested with one parameter at a time exceeding the limits in the Electrical Specification. If exposed to stress above these limits, function and performance may degrade in an unspecified manner.

## Fundamental Circuit Diagram
## Electrical Specification

**PKB 4204 Series**  DC-DC Converters  
Input 40-75 V, Output up to 20 A / 240 W

**PKB 4204 PI**

**Input**  
40-75 V, **Output** up to 20 A / 240 W

- **T_{in} = -30 to +90°C, V_{in} = 40 to 75 V**, unless otherwise specified under **Conditions**.
- **Typical values given at**: **T_{in} = +25°C, V_{in} = 53 V**, max I_o, unless otherwise specified under **Conditions**.
- **Additional C_{in} = 220 µF, C_{out} = 220 µF**. See **Operating Information** section for selection of capacitor types.

### Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Conditions</th>
<th>min</th>
<th>typ</th>
<th>max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_i</td>
<td>Input voltage range</td>
<td>40</td>
<td>75</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>V_{off}</td>
<td>Decreasing input voltage</td>
<td>32</td>
<td>33</td>
<td>34</td>
<td>V</td>
</tr>
<tr>
<td>V_{on}</td>
<td>Increasing input voltage</td>
<td>34</td>
<td>35</td>
<td>36</td>
<td>V</td>
</tr>
<tr>
<td>C_i</td>
<td>Internal input capacitance</td>
<td>11</td>
<td></td>
<td>µF</td>
<td></td>
</tr>
<tr>
<td>I_{RC, pin sink current}</td>
<td>RC pin sink current</td>
<td>0.7</td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>V_{RC}</td>
<td>RC open circuit voltage</td>
<td>6.18</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>V_{RC-th}</td>
<td>RC transition threshold</td>
<td>2.10</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>P_o</td>
<td>Output power</td>
<td>V_{i} = 40 V</td>
<td>0</td>
<td>240</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>V_{i} = 48 V</td>
<td>0</td>
<td>240</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>V_{i} = 53 V</td>
<td>0</td>
<td>240</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>V_{i} = 75 V</td>
<td>0</td>
<td>240</td>
<td></td>
<td></td>
</tr>
<tr>
<td>η</td>
<td>Efficiency</td>
<td>50% of max I_o, V_{i} = 48 V</td>
<td>95.5</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>max I_o, V_{i} = 48 V</td>
<td>95.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>50% of max I_o, V_{i} = 53 V</td>
<td>95.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>max I_o, V_{i} = 53 V</td>
<td>94.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P_s</td>
<td>Power Dissipation</td>
<td>max I_o</td>
<td>12.5</td>
<td>17</td>
<td>W</td>
</tr>
<tr>
<td>P_s</td>
<td>Input idling power</td>
<td>I_o = 0 A, V_{i} = 53 V</td>
<td>3.5</td>
<td></td>
<td>W</td>
</tr>
<tr>
<td>P_{RC}</td>
<td>Input standby power</td>
<td>V_{i} = 53 V (turned off with RC)</td>
<td>0.11</td>
<td></td>
<td>W</td>
</tr>
<tr>
<td>f_s</td>
<td>Switching frequency</td>
<td>0-100% of max I_o</td>
<td>180</td>
<td></td>
<td>kHz</td>
</tr>
</tbody>
</table>

### Notes

- **Note 1**: Constant current V_o < 0.5 V.
- **Note 2**: See Operating Information section.
PKB 4204 Series  DC-DC Converters
Input 40-75 V, Output up to 20 A / 240 W

Typical Characteristics
12 V, 20 A / 240 W

Efficiency

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Efficiency [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 V</td>
<td>75%</td>
</tr>
<tr>
<td>48 V</td>
<td>80%</td>
</tr>
<tr>
<td>53 V</td>
<td>85%</td>
</tr>
<tr>
<td>75 V</td>
<td>90%</td>
</tr>
</tbody>
</table>

Power Dissipation

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Power [W]</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 V</td>
<td>5 W</td>
</tr>
<tr>
<td>48 V</td>
<td>10 W</td>
</tr>
<tr>
<td>53 V</td>
<td>15 W</td>
</tr>
<tr>
<td>75 V</td>
<td>20 W</td>
</tr>
</tbody>
</table>

Output Characteristics

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Output Voltage [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 V</td>
<td>12.50</td>
</tr>
<tr>
<td>48 V</td>
<td>12.00</td>
</tr>
<tr>
<td>53 V</td>
<td>11.50</td>
</tr>
<tr>
<td>75 V</td>
<td>11.00</td>
</tr>
</tbody>
</table>

Current Limit Characteristics

<table>
<thead>
<tr>
<th>Current</th>
<th>Output Voltage [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 A</td>
<td>14</td>
</tr>
<tr>
<td>24 A</td>
<td>12</td>
</tr>
<tr>
<td>26 A</td>
<td>10</td>
</tr>
<tr>
<td>28 A</td>
<td>8</td>
</tr>
<tr>
<td>30 A</td>
<td>6</td>
</tr>
<tr>
<td>32 A</td>
<td>4</td>
</tr>
</tbody>
</table>
**PKB 4204 Series DC-DC Converters**

*Input 40-75 V, Output up to 20 A / 240 W*

### Typical Characteristics

**12 V, 20 A / 240 W**

#### Start-up

- **Start-up enabled by connecting VI at:**
  - TP1 = +25°C, VI = 53 V,
  - IO = 20 A resistive load.

- **Top trace:** output voltage (5 V/div).
- **Bottom trace:** input voltage (20 V/div).
- **Time scale:** (5 ms/div).

#### Shut-down

- **Shut-down enabled by disconnecting VI at:**
  - TP1 = +25°C, VI = 53 V,
  - IO = 20 A resistive load.

- **Top trace:** output voltage (5 V/div).
- **Bottom trace:** input voltage (20 V/div).
- **Time scale:** (1 ms/div).

#### Output Ripple & Noise

- **Output voltage ripple at:**
  - TP1 = +25°C, VI = 53 V,
  - IO = 20 A resistive load.

- **Trace:** output voltage (50 mV/div).
- **Time scale:** (2 µs/div).

#### Output Load Transient Response

- **Output voltage response to load current step-change (10-15-10 A) at:**
  - TP1 = +25°C, VI = 53 V.

- **Top trace:** output voltage (1 V/div).
- **Bottom trace:** load current (5 A/div).
- **Time scale:** (0.1 ms/div).
**Typical Characteristics**

12 V, 20 A / 240 W

**Output Current Derating – Open frame**

Available load current vs. ambient air temperature and airflow at $V_I = 53$ V. See Thermal Consideration section.

**Thermal Resistance – Open frame**

Thermal resistance vs. airspeed measured at the converter. Tested in wind tunnel with airflow and test conditions as per the Thermal consideration section. $V_I = 53$ V.

**Output Current Derating – Base plate**

Available load current vs. ambient air temperature and airflow at $V_I = 53$ V. See Thermal Consideration section.

**Thermal Resistance – Base plate**

Thermal resistance vs. airspeed measured at the converter. Tested in wind tunnel with airflow and test conditions as per the Thermal consideration section. $V_I = 53$ V.
PKB 4204 Series  DC-DC Converters
Input 40-75 V, Output up to 20 A / 240 W

EMC Specification
Conducted EMI measured according to EN55022, CISPR 22 and FCC part 15J (see test set-up). See Design Note 009 for detailed information. The fundamental switching frequency is 180 kHz for PKB 4204 PI at $V_I = 53$ V, max $I_O$.

Conducted EMI Input terminal value (typ)

Optional external filter for class B
Suggested external input filter in order to meet class B in EN 55022, CISPR 22 and FCC part 15J.

Filter components:
C1,2,3 = 1 μF
C4,5 = 2.2 nF
C6 = 220 μF
L1,2 = 0.81 mH

Layout recommendations
The radiated EMI performance of the product will depend on the PWB layout and ground layer design. It is also important to consider the stand-off of the product. If a ground layer is used, it should be connected to the output of the product and the equipment ground or chassis.

A ground layer will increase the stray capacitance in the PWB and improve the high frequency EMC performance.

Output ripple and noise
Output ripple and noise measured according to figure below. See Design Note 022 for detailed information.
Operating information

Input Voltage
The input voltage range 40 to 75 Vdc meets the requirements of the European Telecom Standard ETS 300 132-2 for normal input voltage range in –48 and –60 Vdc systems, -40.5 to -57.0 V and –50.0 to -72 V respectively.
At input voltages exceeding 75 V, the power loss will be higher than at normal input voltage and $P_{o}$ must be limited to absolute max +125°C. The absolute maximum continuous input voltage is 80 Vdc.

Turn-on Input Voltage
The products monitor the input voltage and will turn on at predetermined levels.

Remote Control (RC)

The products are fitted with a remote control function referenced to (the primary negative input connection (-In), with negative and positive logic options available. The RC function allows the product to be turned on/off by an external device like a semiconductor or mechanical switch. The RC pin has an internal pull up resistor to +In.

The device should be capable of sinking 0.7 mA. When the RC pin is left open, the voltage generated on the RC pin is 1 – 5 V. The standard product is provided with “negative logic” remote control and will be off until the RC pin is connected to the –In. To turn on the product the voltage between RC pin and –In should be less than 1 V. To turn off the product the RC pin should be left open, or connected to a voltage higher than 6 V referenced to –In. In situations where it is desired to have the product to power up automatically without the need for control signals or a switch, the RC pin can be wired directly to –In.

The second option is “positive logic” remote control, which can be ordered by adding the suffix “P” to the end of the part number. When the RC pin is left open, the product starts up automatically when the input voltage is applied. Turn off is achieved by connecting the RC pin to the –In. To ensure safe turn off the voltage difference between RC pin and the –In pin shall be less than 1 V. The product will restart automatically when this connection is opened.

Input and Output Impedance
The impedance of both the input source and the load will interact with the impedance of the product. It is important that the input source has low characteristic impedance. The products are designed for stable operation without external capacitors connected to the input or output. The performance in some applications can be enhanced by addition of external capacitance as described under External Decoupling Capacitors. If the input voltage source contains significant inductance, the addition of a 22 – 100 µF capacitor across the input of the product will ensure stable operation. The minimum required capacitance value depends on the output power and the input voltage. The higher output power the higher input capacitance is needed. Approximately doubled capacitance value is required for a 24 V input voltage source compared to a 48V input voltage source.

External Decoupling Capacitors
When powering loads with significant dynamic current requirements, the voltage regulation at the point of load can be improved by addition of decoupling capacitors at the load. The most effective technique is to locate low ESR ceramic and electrolytic capacitors as close to the load as possible, using several parallel capacitors to lower the effective ESR. The ceramic capacitors will handle high-frequency dynamic load changes while the electrolytic capacitors are used to handle low frequency dynamic load changes. Ceramic capacitors will also reduce any high frequency noise at the load. It is equally important to use low resistance and low inductance PWB layouts and cabling. For semi-regulated or fixed turns ratio IBC (intermediate bus converters), there is no limit on the value of external output capacitance, but there are practical performance considerations that need to be made when using very large capacitor values such as ramp-up time of the DC/DC converter output voltage during start-up or turn-off discharge considerations.
For further information, please contact your local Flex Power Modules representative.

Parallel Operation
It is not recommended to parallel the products without using external current sharing circuits.

Over Temperature Protection (OTP)
The products are protected from thermal overload by an internal over temperature shutdown circuit. When $T_{o}$ as defined in thermal consideration section exceeds 125°C the product will shut down. The product will make continuous attempts to start up (non-latching mode) and resume normal operation automatically when the temperature has dropped >10°C below the temperature threshold.

Over Voltage Protection (OVP)
The products have output over voltage protection that will shut down the product in over voltage conditions. The product will make continuous attempts to start up (non-latching mode) and resume normal operation automatically after removal of the over voltage condition.

Over Current Protection (OCP)
The products include current limiting circuitry for protection at continuous overload. The output voltage will decrease towards zero for output currents in excess of max output current (max $I_{o}$). The product will resume normal operation after removal of the overload. The load distribution should be designed for the
maximum output short circuit current specified.

**Thermal Consideration**

**General**
The products are designed to operate in different thermal environments and sufficient cooling must be provided to ensure reliable operation.

For products mounted on a PWB without a heat sink attached, cooling is achieved mainly by conduction, from the pins to the host board, and convection, which is dependant on the airflow across the product. Increased airflow enhances the cooling of the product. The Output Current Derating graph found in the Output section for each model provides the available output current vs. ambient air temperature and air velocity at $V_{I}=53$ V.

The product is tested on a 254 x 254 mm, 35 µm (1 oz), 16-layer test board mounted vertically in a wind tunnel with a cross-section of 305 x 305 mm.

For products with base plate used in a sealed box/cold wall application, cooling is achieved mainly by conduction through the cold wall. The Output Current Derating graphs are found in the Output section for each model. The product is tested in a sealed box test set up with ambient temperatures 85, 55 and 25°C. See Design Note 028 for further details.

**Definition of product operating temperature**
The product operating temperatures is used to monitor the temperature of the product, and proper thermal conditions can be verified by measuring the temperature at positions P1, P2, P3 and P4. The temperature at these positions ($T_{P1}$, $T_{P2}$, $T_{P3}$, $T_{P4}$) should not exceed the maximum temperatures in the table below. The number of measurement points may vary with different thermal design and topology. Temperatures above maximum $T_{P1}$, measured at the reference point P1 are not allowed and may cause permanent damage.

<table>
<thead>
<tr>
<th>Position</th>
<th>Description</th>
<th>Max value</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Reference point</td>
<td>$T_{P1}=125^\circ C$</td>
</tr>
<tr>
<td>P2</td>
<td>Mosfet case</td>
<td>$T_{P2}=125^\circ C$</td>
</tr>
<tr>
<td>P3</td>
<td>Mosfet case</td>
<td>$T_{P3}=125^\circ C$</td>
</tr>
<tr>
<td>P4</td>
<td>Optocouple</td>
<td>$T_{P4}=100^\circ C$</td>
</tr>
</tbody>
</table>
Ambient Temperature Calculation
For products with base plate the maximum allowed ambient temperature can be calculated by using the thermal resistance.

1. The power loss is calculated by using the formula \(((1/\eta) - 1) \times \text{output power} = \text{power loss} (P_d)\).
\[ \eta = \text{efficiency of product. E.g. 89.5} \% = 0.895 \]

2. Find the thermal resistance (Rth) in the Thermal Resistance graph found in the Output section for each model. **Note that the thermal resistance can be significantly reduced if a heat sink is mounted on the top of the base plate.**

Calculate the temperature increase (\(\Delta T\)).
\[ \Delta T = R\text{th} \times P_d \]

3. Max allowed ambient temperature is:
\[ \text{Max } T_{\text{P1}} - \Delta T. \]

E.g. PKB 4204 PI at 1m/s:
1. \((1/0.945 - 1) \times 240 \text{ W} = 13.9 \text{ W} \]
2. \((13.9 \text{ W} \times 4.2^\circ C/W) = 58.38^\circ C \]
3. \((125^\circ C - 58.38^\circ C) = \text{max ambient temperature is } 66.62^\circ C \]

The actual temperature will be dependent on several factors such as the PWB size, number of layers and direction of airflow.
PKB 4204 Series  DC-DC Converters
Input 40-75 V, Output up to 20 A / 240 W

Mechanical Information - Hole Mount, Open Frame Version

Technical Specification
EN/LZT 146 439 R2A  November 2017
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Table 1

<table>
<thead>
<tr>
<th>Height option</th>
<th>Height max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>40.1 (1.577)</td>
</tr>
<tr>
<td>M</td>
<td>41.9 (1.658)</td>
</tr>
</tbody>
</table>

Table 2

<table>
<thead>
<tr>
<th>Pin option</th>
<th>Lead length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>3.35 (0.132)</td>
</tr>
<tr>
<td>LA</td>
<td>3.69 (0.145) cut</td>
</tr>
<tr>
<td>LB</td>
<td>4.07 (0.160) cut</td>
</tr>
</tbody>
</table>

Notes
1. Stand-off to non-conductive components
   min 0.1 (0.004) for Standard option
   min 0.9 (0.035) for M option
2. Stand-off to conductive components
   min 0.9 (0.035) for Standard option
   min 2.7 (0.106) for M option

Pin 7:
- Material: Copper alloy
- Plating: 0.14 µm Gold over 2 µm Nickel

Weights:
- Typical: 26 g

All dimensions in mm [inch].
Tolerances unless specified:
- ±0.50 (±0.02)
- ±0.25 (±0.01)
- Not applicable on footprint or typical values.

Recommended keep away area for user components.

The stand-off in combination with insulating material ensures that requirements as per EC/EN/UL6950 are met and 1500 V isolation maintained even if open via or traces are present under the DC/DC converter.
PKB 4204 Series  DC-DC Converters
Input 40-75 V, Output up to 20 A / 240 W

Technical Specification
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© Flex

Mechanical Information - Hole Mount, Base Plate Version

Product height 10.0

Pin positions according to recommended footprint

Table 1

<table>
<thead>
<tr>
<th>Pin #/Pin</th>
<th>Lead length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>Ø2.0 (0.20)</td>
</tr>
<tr>
<td>LA</td>
<td>Ø2.5 (0.25)</td>
</tr>
<tr>
<td>LB</td>
<td>Ø2.5 (0.25)</td>
</tr>
</tbody>
</table>

Notes:
1. Stand-off is non-conductive components
   min. Ø1 (0.04"
   Stand-off to conductive components
   min. Ø0.9 (0.04"

2. For screw attachment apply mounting torque of max. 0.44 Nm (3.2 lb ft)
   - M3 screws must not protrude more than 2.7 (0.10"
   into the base plate.

Costs:
Material: Aluminum alloy
Plating: Material: Copper alloy
Plating: 0.1 mm Gold over 2 µm Nickel

Recommended layout areas for user components:
The stand-off in conjunction with insulating material ensures that requirements as per
IEC/EN60950 are met and the 1500 V isolation mentioned even at open bias or stresses
are present under the DC/DC converter.

Weight: Typical 45 g
All dimensions in mm [inch]
Tolerances unless specified
±0.50 [0.02] ±0.25 [0.01]
PKB 4204 Series  DC-DC Converters
Input 40-75 V, Output up to 20 A / 240 W

Mechanical Information - Surface Mount Version

Product Height

Component outline

TOP VIEW

Pin positions according to recommended footprint

RECOMMENDED FOOTPRINT - TOP VIEW

Notes
1. Stand-off to non-conductive components = 0.2 (5.08 mm)
2. Stand-off to conductive components = 0.2 (5.08 mm)

Layout considerations
Use sufficient numbers of vias connected to output pin pads for optimal thermal and current connectivity.

Finish
Nickel/Copper alloy
Plating 0.4 µm Gold over 2 µm Nickel

Recommended keep away area for user components

This stand-off in combination with housing materials ensures that requirements as per
IEC/EN/UL60950 are met and 1500 V isolation maintained even if open vias or leads
are present under the DC-DC converter.

Weights
Typical 26 g
All tolerances in mm (in.
Material thickness [approx.]:
[approx.]
[approx.]

Technical Specification
EN/LZT 146 439 R2A
November 2017
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Soldering Information - Surface Mounting

The surface mount product is intended for forced convection or vapor phase reflow soldering in SnPb and Pb-free processes.

The reflow profile should be optimised to avoid excessive heating of the product. It is recommended to have a sufficiently extended preheat time to ensure an even temperature across the host PCB and it is also recommended to minimize the time in reflow.

A no-clean flux is recommended to avoid entrapment of cleaning fluids in cavities inside the product or between the product and the host board, since cleaning residues may affect long time reliability and isolation voltage.

Minimum Pin Temperature Recommendations

Pin number 4 is chosen as reference location for the minimum pin temperature recommendation since this will likely be the coolest solder joint during the reflow process.

SnPb solder processes

For SnPb solder processes, a pin temperature (T_{PIN}) in excess of the solder melting temperature, (T_L, 183°C for Sn63Pb37) for more than 30 seconds and a peak temperature of 210°C is recommended to ensure a reliable solder joint.

For dry packed products only: depending on the type of solder paste and flux system used on the host board, up to a recommended maximum temperature of 245°C could be used, if the products are kept in a controlled environment (dry pack handling and storage) prior to assembly.

<table>
<thead>
<tr>
<th>General reflow process specifications</th>
<th>SnPb eutectic</th>
<th>Pb-free</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average ramp-up (T_{PRODUCT})</td>
<td>3°C/s max</td>
<td>3°C/s max</td>
</tr>
<tr>
<td>Typical solder melting (liquidus) temperature T_L</td>
<td>183°C</td>
<td>221°C</td>
</tr>
<tr>
<td>Minimum reflow time above T_L</td>
<td>30 s</td>
<td>30 s</td>
</tr>
<tr>
<td>Minimum pin temperature T_{PIN}</td>
<td>210°C</td>
<td>235°C</td>
</tr>
<tr>
<td>Peak product temperature T_{PRODUCT}</td>
<td>225°C</td>
<td>260°C</td>
</tr>
<tr>
<td>Average ramp-down (T_{PRODUCT})</td>
<td>6°C/s max</td>
<td>6°C/s max</td>
</tr>
<tr>
<td>Maximum time 25°C to peak</td>
<td>6 minutes</td>
<td>8 minutes</td>
</tr>
</tbody>
</table>

For Pb-free solder processes, the product is qualified for MSL 3 according to IPC/JEDEC standard J-STD-020C.

During reflow T_{PRODUCT} must not exceed 260 °C at any time.

Dry Pack Information

Products intended for Pb-free reflow soldering processes are delivered in standard moisture barrier bags according to IPC/JEDEC standard J-STD-033 (Handling, packing, shipping and use of moisture/reflow sensitivity surface mount devices).

Using products in high temperature Pb-free soldering processes requires dry pack storage and handling. In case the products have been stored in an uncontrolled environment and no longer can be considered dry, the modules must be baked according to J-STD-033.

Thermocouple Attachment

Top of PCB near pin 2 for measurement of maximum product temperature, T_{PRODUCT}.

Pin 4 for measurement of minimum pin (solder joint) temperature, T_{PIN}.
Soldering Information - Hole Mounting
The hole mounted product is intended for plated through hole mounting by wave or manual soldering. The pin temperature is specified to maximum to 270°C for maximum 10 seconds.

A maximum preheat rate of 4°C/s and maximum preheat temperature of 150°C is suggested. When soldering by hand, care should be taken to avoid direct contact between the hot soldering iron tip and the pins for more than a few seconds in order to prevent overheating.

A no-clean flux is recommended to avoid entrapment of cleaning fluids in cavities inside the product or between the product and the host board. The cleaning residues may affect long time reliability and isolation voltage.

Delivery Package Information
Surface Mount Version
The products are delivered in antistatic injection molded trays (Jedec design guide 4.10D standard).

<table>
<thead>
<tr>
<th>Tray Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
</tr>
<tr>
<td>Surface resistance</td>
</tr>
<tr>
<td>Baking</td>
</tr>
<tr>
<td>Tray thickness</td>
</tr>
<tr>
<td>Box capacity</td>
</tr>
<tr>
<td>Tray weight</td>
</tr>
</tbody>
</table>

Delivery Package Information
Hole Mount, Open Frame version
Hole Mount, Base Plate version
The products are delivered in antistatic trays.
## Product Qualification Specification

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>IPC-A-610</th>
<th>Temperature range</th>
<th>Number of cycles</th>
<th>Dwell/transfer time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change of temperature (Temperature cycling)</td>
<td>IEC 60068-2-14 Na</td>
<td>-40 to 100°C</td>
<td>1000</td>
<td>15 min/0-1 min</td>
</tr>
<tr>
<td>Cold (in operation)</td>
<td>IEC 60068-2-1 Ad</td>
<td>-45°C</td>
<td>72 h</td>
<td></td>
</tr>
<tr>
<td>Damp heat</td>
<td>IEC 60068-2-67 Cy</td>
<td>85°C</td>
<td>85 % RH</td>
<td>1000 hours</td>
</tr>
<tr>
<td>Dry heat</td>
<td>IEC 60068-2-2 Bd</td>
<td>125°C</td>
<td>1000 h</td>
<td></td>
</tr>
<tr>
<td>Electrostatic discharge susceptibility</td>
<td>IEC 61340-3-1, JESD 22-A114</td>
<td>Class 2, 2000 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immersion in cleaning solvents</td>
<td>IEC 60068-2-45 XA, method 2</td>
<td>55°C</td>
<td>35°C</td>
<td>35°C</td>
</tr>
<tr>
<td>Mechanical shock</td>
<td>IEC 60068-2-27 Ea</td>
<td>100 g</td>
<td>6 ms</td>
<td></td>
</tr>
<tr>
<td>Moisture reflow sensitivity ¹</td>
<td>J-STD-020C</td>
<td>Level 1 (SnPb-eutectic)</td>
<td>225°C</td>
<td>260°C</td>
</tr>
<tr>
<td>Operational life test</td>
<td>MIL-STD-202G, method 108A</td>
<td>Duration</td>
<td>1000 h</td>
<td></td>
</tr>
<tr>
<td>Resistance to soldering heat ²</td>
<td>IEC 60068-2-20 Tb, method 1A</td>
<td>Solder temperature</td>
<td>270°C</td>
<td>10-13 s</td>
</tr>
<tr>
<td>Robustness of terminations</td>
<td>IEC 60068-2-21 Test Ua1</td>
<td>Through hole mount products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solderability</td>
<td>IEC 60068-2-58 test Td ¹</td>
<td>Preconditioning Temperature, SnPb Eutectic</td>
<td>150°C dry bake 16 h</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IEC 60068-2-20 test Ta ²</td>
<td>Temperature, Pb-free</td>
<td>215°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IEC 60068-2-21 Test Ue1</td>
<td>Preconditioning Temperature, SnPb Eutectic</td>
<td>235°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IEC 60068-2-64 Fh, method 1</td>
<td>Steam ageing</td>
<td>235°C</td>
<td></td>
</tr>
<tr>
<td>Vibration, broad band random</td>
<td>IEC 60068-2-64 Fh, method 1</td>
<td>Frequency</td>
<td>10 to 500 Hz</td>
<td>0.07 g²/Hz</td>
</tr>
</tbody>
</table>

Notes:

¹ Only for products intended for reflow soldering (surface mount products)
² Only for products intended for wave soldering (plated through hole products)