PKM4516AD Series Fully Regulated DC-DC Converters
Input 36-75 V, Output up to 18 A / 504 W

Key Features
- Industry standard Quarter-brick
  58.4 x 36.8 x 12.7 mm (2.3 x 1.45 x 0.5 in)
- High efficiency, typ. 95.5% at 28Vout half load
- 2250 Vdc input to output isolation
- Meets safety requirements according to IEC/EN/UL 62368-1
- Functional Insulation
- MTBF 7.96 Million hours

General Characteristics
- Output over voltage protection
- Input under voltage shutdown
- Over temperature protection
- Monotonic start-up
- Output short-circuit protection
- Remote sense
- Remote control
- Output voltage adjust function
- Highly automated manufacturing ensures quality
- ISO 9001/14001 certified supplier

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Safety Approvals
Design for Environment
Meets requirements in high-temperature lead-free soldering processes.
Technical Specification

PKM4516AD Series Fully Regulated DC-DC Converters
Input 36-75 V, Output up to 18 A / 504 W

Ordering Information

<table>
<thead>
<tr>
<th>Product program</th>
<th>Output</th>
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</thead>
<tbody>
<tr>
<td>PKM4516AD</td>
<td>28 V, 18A / 504 W</td>
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Product number and Packaging

<table>
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<tr>
<th>Options</th>
<th>n1</th>
<th>n2</th>
<th>n3</th>
<th>n4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting</td>
<td>o</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remote Control logic</td>
<td>o</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical Option</td>
<td>o</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead length</td>
<td>o</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

General Information

Reliability

The failure rate (λ) and mean time between failures (MTBF = 1/λ) is calculated at max output power and an operating ambient temperature (T_A) of +40°C. Flex Power Modules uses Telcordia SR-332 Issue 3 Method 1 to calculate the mean steady-state failure rate and standard deviation (σ).

Telcordia SR-332 Issue 4 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 failure rate, λ</th>
<th>Std. deviation, σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>126 nFailures/h</td>
<td>8.0 nFailures/h</td>
</tr>
</tbody>
</table>

Flex Power Modules fulfills and will continuously fulfill all its obligations under regulation (EC) No 1907/2006 concerning the registration, evaluation, authorization and restriction of chemicals (REACH) as they enter into force and is through product materials declarations preparing for the obligations to communicate information on substances in the products.

Quality Statement

The products are designed and manufactured in an industrial environment where quality systems and methods like ISO 9000, Six Sigma, and SPC are intensively in use to boost the continuous improvements strategy. Infant mortality or early failures in the products are screened out and they are subjected to an ATE-based final test. Conservative design rules, design reviews and product qualifications, plus the high competence of an engaged work force, contribute to the high quality of the products.

Warranty

Warranty period and conditions are defined in Flex Power Modules General Terms and Conditions of Sale.

Limitation of Liability

Flex Power Modules does not make any other warranties, expressed or implied including any warranty of merchantability or fitness for a particular purpose (including, but not limited to, use in life support applications, where malfunctions of product can cause injury to a person’s health or life).

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The information and specifications in this technical specification is believed to be correct at the time of publication. However, no liability is accepted for inaccuracies, printing errors or for any consequences thereof. Flex reserves the right to change the contents of this technical specification at any time without prior notice.

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, PB 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.
PKM4516AD Series Fully Regulated DC-DC Converters
Input 36-75 V, Output up to 18 A / 504 W

Safety Specification

General information
Flex Power DC/DC converters and DC/DC regulators are designed in accordance with the safety standards IEC 62368-1, EN 62368-1 and UL 62368-1 Audio/video, information and communication technology equipment - Part 1: Safety requirements

IEC/EN/UL 62368-1 contains requirements to prevent injury or damage due to the following hazards:

- Electrical shock
- Electrically-caused fire
- Injury caused by hazardous substances
- Mechanically-caused injury
- Skin burn
- Radiation-caused injury

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 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 shall comply with the requirements in IEC/EN/UL 62368-1. 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 62368-1 with regards to safety.

Flex Power DC/DC converters, Power interface modules and DC/DC regulators are UL 62368-1 recognized and certified in accordance with EN 62368-1. 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 & Power interface modules
The product may provide basic or functional insulation between input and output according to IEC/EN/UL 62368-1 (see Safety Certificate), different conditions shall be met if the output of a basic or a functional insulated product shall be considered as ES1 energy source.

For basic insulated products (see Safety Certificate) the output is considered as ES1 energy source 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 62368-1.
- 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 62368-1.

For functional insulated products (see Safety Certificate) the output is considered as ES1 energy source 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 62368-1.
- 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 62368-1.
- The input source is reliably connected to protective earth and provides basic or supplementary insulation according to IEC/EN/UL 62368-1 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 (Vac) meets the voltage strength requirement for basic insulation according to IEC/EN/UL 62368-1.

It is recommended to use a slow blow fuse at the input of each DC/DC converter. 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_A) Ambient Operating Temperature</td>
<td>-40</td>
<td>+100</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>(T_{P2}) Base plate Operating Temperature</td>
<td>-40</td>
<td>+100</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>(T_{P1}) Operating Temperature (see Thermal Consideration section in 3/1301-BMR68201)</td>
<td>-40</td>
<td>+125</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>(C_{out}) Output Capacitive Load</td>
<td>220</td>
<td>9000</td>
<td>µF</td>
<td></td>
</tr>
<tr>
<td>(V_{iso}) Isolation voltage (input to output test voltage)</td>
<td>2250</td>
<td></td>
<td>Vdc</td>
<td></td>
</tr>
<tr>
<td>(V_{iso}) Isolation voltage (input to baseplate qualification test voltage)</td>
<td>1500</td>
<td></td>
<td>Vdc</td>
<td></td>
</tr>
<tr>
<td>(V_{iso}) Isolation voltage (baseplate to output qualification test voltage)</td>
<td>750</td>
<td></td>
<td>Vdc</td>
<td></td>
</tr>
<tr>
<td>(V_{tr}) Input voltage transient 100ms</td>
<td>100</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>(V_{RC}) Remote Control pin voltage (see Operating Information section)</td>
<td>-0.5</td>
<td>6</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>(V_{adj}) Adjust pin voltage (see Operating Information section)</td>
<td>-0.5</td>
<td>5</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the Electrical Specification section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**Fundamental Circuit Diagram**

![Fundamental Circuit Diagram](image-url)
## Electrical Specification

**28.0 V, 18 A / 504 W**

PKM4516AD

T<sub>p1</sub> = -40 to +100°C, V<sub>i</sub> = 36 to 75 V, unless otherwise specified under Conditions.

Typical values given at: T<sub>p1</sub> = +25°C, V<sub>i</sub> = 48 V, max I<sub>0</sub>, unless otherwise specified under Conditions.

Additional C<sub>ss</sub> = 200 µF, C<sub>ur</sub> = 820 uF. 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&lt;sub&gt;i&lt;/sub&gt;</td>
<td>Input voltage range</td>
<td>36</td>
<td>31</td>
<td>75</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;off&lt;/sub&gt;</td>
<td>Turn-off input voltage</td>
<td>30</td>
<td>33</td>
<td>33</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;on&lt;/sub&gt;</td>
<td>Turn-on input voltage</td>
<td>31</td>
<td>33</td>
<td>34</td>
<td>V</td>
</tr>
<tr>
<td>P&lt;sub&gt;0&lt;/sub&gt;</td>
<td>Output power</td>
<td>0</td>
<td>504</td>
<td>504</td>
<td>W</td>
</tr>
<tr>
<td>η</td>
<td>Efficiency</td>
<td>50%</td>
<td>max I&lt;sub&gt;0&lt;/sub&gt;</td>
<td>94.1</td>
<td>95.5</td>
</tr>
<tr>
<td></td>
<td>Eff just before OTP</td>
<td>94</td>
<td>95</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>P&lt;sub&gt;Dissipation&lt;/sub&gt;</td>
<td>Power Dissipation</td>
<td>max I&lt;sub&gt;0&lt;/sub&gt;</td>
<td>27</td>
<td>32</td>
<td>W</td>
</tr>
<tr>
<td>P&lt;sub&gt;I&lt;/sub&gt;</td>
<td>Input idling power</td>
<td>I&lt;sub&gt;0&lt;/sub&gt; = 0 A, V&lt;sub&gt;i&lt;/sub&gt; = 48 V</td>
<td>6</td>
<td></td>
<td>W</td>
</tr>
<tr>
<td>P&lt;sub&gt;Standby&lt;/sub&gt;</td>
<td>Input standby power</td>
<td>V&lt;sub&gt;i&lt;/sub&gt; = 48 V (turned off with RC)</td>
<td>0.5</td>
<td></td>
<td>W</td>
</tr>
<tr>
<td>f&lt;sub&gt;s&lt;/sub&gt;</td>
<td>Switching frequency</td>
<td>0-100 % of max I&lt;sub&gt;0&lt;/sub&gt;</td>
<td>170</td>
<td>180</td>
<td>190</td>
</tr>
<tr>
<td>V&lt;sub&gt;Dt&lt;/sub&gt;</td>
<td>Output voltage initial setting</td>
<td>T&lt;sub&gt;p1&lt;/sub&gt; = +25°C, V&lt;sub&gt;i&lt;/sub&gt; = 48 V, I&lt;sub&gt;0&lt;/sub&gt; = 18 A</td>
<td>27.44</td>
<td>28</td>
<td>28.56</td>
</tr>
<tr>
<td></td>
<td>and accuracy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Output adjust range</td>
<td>See operating information</td>
<td>14</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Output voltage tolerance band</td>
<td>0-100% of max I&lt;sub&gt;0&lt;/sub&gt;,</td>
<td>27.16</td>
<td>28.84</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Idling voltage</td>
<td>I&lt;sub&gt;0&lt;/sub&gt; = 0 A</td>
<td>27.16</td>
<td>28.84</td>
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<td></td>
<td></td>
<td>Line regulation</td>
<td>max I&lt;sub&gt;0&lt;/sub&gt;</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Load regulation</td>
<td>V&lt;sub&gt;i&lt;/sub&gt; = 48 V, 0-100% of max I&lt;sub&gt;0&lt;/sub&gt;</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V&lt;sub&gt;ts&lt;/sub&gt;</td>
<td>Load transient voltage deviation</td>
<td>V&lt;sub&gt;i&lt;/sub&gt; = 48 V, Load step 25-75-25% of max I&lt;sub&gt;0&lt;/sub&gt;, di/dt = 1 A/µs, C&lt;sub&gt;B&lt;/sub&gt; = 820 uF</td>
<td>±300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>t&lt;sub&gt;1&lt;/sub&gt;</td>
<td>Load transient recovery time</td>
<td>See note 3</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>t&lt;sub&gt;r&lt;/sub&gt;</td>
<td>Ramp-up time (from 10-90% of V&lt;sub&gt;ss&lt;/sub&gt;)</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>t&lt;sub&gt;s&lt;/sub&gt;</td>
<td>Start-up time (from V&lt;sub&gt;i&lt;/sub&gt; connection to 90% of V&lt;sub&gt;ss&lt;/sub&gt;)</td>
<td>75</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>t&lt;sub&gt;Eq&lt;/sub&gt;</td>
<td>RC start-up time (from V&lt;sub&gt;ss&lt;/sub&gt; connection to 90% of V&lt;sub&gt;ss&lt;/sub&gt;)</td>
<td>max I&lt;sub&gt;0&lt;/sub&gt;</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V&lt;sub&gt;OS&lt;/sub&gt;</td>
<td>Output voltage tolerance band</td>
<td>V&lt;sub&gt;i&lt;/sub&gt; = 48 V,</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V&lt;sub&gt;OS&lt;/sub&gt;</td>
<td>Output ripple &amp; noise</td>
<td>See ripple &amp; noise section, V&lt;sub&gt;OS&lt;/sub&gt;</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OVP</td>
<td>Over voltage protection</td>
<td>T&lt;sub&gt;p1&lt;/sub&gt; = +25°C, V&lt;sub&gt;i&lt;/sub&gt; = 48 V, 0-100% of max I&lt;sub&gt;0&lt;/sub&gt;</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OTP</td>
<td>Over temperature protection</td>
<td>T&lt;sub&gt;p2&lt;/sub&gt;</td>
<td>100</td>
</tr>
</tbody>
</table>

Note 1: Sink current drawn by external device connected to the RC pin

Note 2: RMS current at OCP in hic-up mode

Note 3: In cold measurements a low temperature capacitor is added.
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Typical Characteristics
28.0 V, 18 A / 504 W

**Efficiency**

- Efficiency vs. load current and input voltage at \( T_{P1} = +25^\circ C \).

**Power Dissipation**

- Dissipated power vs. load current and input voltage at \( T_{P1} = +25^\circ C \).

**Output Characteristics**

- Output voltage vs. load current at \( T_{P1} = +25^\circ C \).

**Current Limit Characteristics**

- Output voltage vs. load current at \( I_O > max\ I_O, T_{P1} = +25^\circ C \).

**Max adjustable output voltage**

- Max adjustable output voltage vs. input voltage at \( T_{P1} = +25^\circ C \).
- Max adjustable output voltage \( \geq 33\ V \) at \( V_{in}=36\ V, P_o=500\ W \).
**PKM4516AD Series Fully Regulated DC-DC Converters**

**Input 36-75 V, Output up to 18 A / 504 W**

**Typical Characteristics**

28.0 V, 18 A / 504 W

### Start-up

Start-up enabled by connecting V at:

- $T_{th} = +25^\circ C$, $V_i = 48$ V,
- $I_o = 18$ A resistive load.

Top trace: Input voltage (50 V/div.),
Mid trace: Output voltage (20 V/div.),
Bottom trace: Output current (0 A/div.),
Time scale: (20 ms/div.).

### Shut-down

Shut-down enabled by disconnecting V at:

- $T_{th} = +25^\circ C$, $V_i = 48$ V,
- $I_o = 18$ A resistive load.

Top trace: Input voltage (50 V/div.),
Bottom trace: Output voltage (10 V/div.),
Time scale: (10 ms/div.).

### Output Ripple & Noise

Output voltage ripple at:

- $T_{th} = +25^\circ C$, $V_i = 48$ V,
- $I_o = 18$ A resistive load.

Trace: output voltage (200 mV/div.),
Time scale: (2 µs/div.),
20 MHz bandwidth filter 10 µF + 0.1 µF.

### Output Load Transient Response

Output voltage response to load current step-change (4.5 A – 13.5 A – 4.5 A) at:

- $T_{th} = +25^\circ C$, $V_i = 48$ V.

Top trace: output voltage (0.5 V/div.),
Bottom trace: output current (5 A/div.),
Time scale: (500 µs/div.).

### Output Voltage Adjust (see operating information)

#### Passive adjust

The resistor value for an adjusted output voltage is calculated by using the following equations:

- **Output Voltage Adjust, Decrease:**

  $$ R_{adj} = \left(\frac{100}{\Delta V%} - 2\right) k\Omega $$

- **Output Voltage Adjust, Increase:**

  $$ R_{adj} = \left(\frac{28 \times (100 + \Delta V%)}{1.225 \times \Delta V%} \right) \frac{100}{10} - 2 k\Omega $$

Example: Increase 10% => $V_o = 30.8$ Vdc

\[
\begin{align*}
\frac{28 \times (100 + 10)}{1.225 \times 10} & = 239 k\Omega \\
\end{align*}
\]

#### Active adjust

The output voltage may be adjusted using a voltage applied to the Vadj pin through a resistor Radj. This voltage is calculated by using the following equation:

$$ V_{adj} = \left(1.225 + (R_{adj} + 2) \times 1.225 \times \frac{V_{desired} - 28}{28}\right) V $$

- $V_{desired}$: desired (trimmed) output voltage (V)
- $V_{adj}$: the external trim voltage (V)
- $R_{adj}$: the external trim resistor (kΩ)
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Active adjust

When $R_{adj} = 0 \, k\Omega$, 
$$V_{adj} = \left(1.225 + 2.45 \times \frac{V_{\text{desired}} - 28}{28}\right) \, V$$

When $R_{adj} = 1 \, k\Omega$, 
$$V_{adj} = \left(1.225 + 3.675 \times \frac{V_{\text{desired}} - 28}{28}\right) \, V$$

When $R_{adj} = 2 \, k\Omega$, 
$$V_{adj} = \left(1.225 + 4.9 \times \frac{V_{\text{desired}} - 28}{28}\right) \, V$$

Desired output voltage vs. adjust voltage, $R_{adj} = 1 \, k\Omega$

Desired output voltage vs. adjust voltage, $R_{adj} = 2 \, k\Omega$

Desired output voltage vs. adjust voltage, $R_{adj} = 0 \, k\Omega$
PKM4516AD Series Fully Regulated DC-DC Converters
Input 36-75 V, Output up to 18 A / 504 W

Typical Characteristics
28 V, 18 A / 504 W

Output Current Derating – Cold wall sealed box

Available load current vs. cold wall temperature.
\[ V_i = 48 \text{ V} \]
EMC Specification
Conducted EMI measured according to EN 55032, CISPR 23 and FCC part 15J (see test set-up). See Design Note 029 for further information. The fundamental switching frequency is 180 kHz at \( V_i = 48 \) V and max \( I_o \).

**Conducted EMI Input terminal value (typ)**

![EMI without filter graph]

**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:
- \( C1 = 2.2 \) µF
- \( C2 = 2.2 \) µF
- \( C3 = 2.2 \) µF + 100 µF (e-lyt)
- \( C4, C5 = 2 \times 10 \) nF
- \( L1 = 0.59 \) mH
(Pulse P0353NL)
- \( L2 = 2.2 \) µH
(Coilcraft D03316H)

![EMI with filter graph]

**Test set-up**

**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 36 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 the product's control loop. 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 of 10 kΩ to +5V. The external device must provide a minimum required sink current to guarantee a voltage not higher than maximum voltage on the RC pin (see Electrical characteristics table). When the RC pin is open, the voltage generated on the RC pin is 5 V. The standard product is provided with “negative logic” RC and will be off until the RC pin is connected to the -In. To turn off the product the RC pin should be left open, or connected to a voltage higher than 3.3 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. The product will restart automatically when this connection is opened.

See Design Note 021 for detailed information.

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 with a minimum of 100 mΩ external capacitors connected to the input. The electrolytic capacitors will be degraded in low temperature and the ESR value may increase. The needed input capacitance in low temperature should be equivalent to 100 µF at 20°C. This means that the input capacitor value may need to be substantially larger to guarantee a stable input at low temperatures. The performance in some applications can be enhanced by addition of external capacitance as described under External Decoupling Capacitors. The minimum required capacitance value depends on the output power and the input voltage. The higher output power the higher input capacitance is needed.

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. It is equally important to use low resistance and low inductance PWB layouts and cabling.

External decoupling capacitors will become part of the product’s control loop. The control loop is optimized for a wide range of external capacitance and the maximum recommended value that could be used without any additional analysis is found in the Electrical specification. The ESR of the capacitors is a very important parameter. Stable operation is guaranteed with a verified ESR value of >10 mΩ across the output connections. For further information please contact your local Flex Power Modules representative.
Output Voltage Adjust (V_adj)

The products have an Output Voltage Adjust pin (V_adj). This pin can be used to adjust the output voltage above or below Output voltage initial setting. When increasing the output voltage, the voltage at the output pins (including any remote sense compensation) must be kept below the threshold of the over voltage protection (OVP) to prevent the product from shutting down. At increased output voltages, the maximum power rating of the product remains the same, and the max output current must be decreased correspondingly.

To increase the voltage, the resistor should be connected between the V_adj pin and +Sense pin. The resistor value of the Output voltage adjust function is according to information given under the Output section for the respective product.

To decrease the output voltage, the resistor should be connected between the V_adj pin and –Sense pin.

Remote Sense

The products have remote sense that can be used to compensate for voltage drops between the output and the point of load. The sense traces should be located close to the PWB ground layer to reduce noise susceptibility. The remote sense circuitry will compensate for up to 10% voltage drop between output pins and the point of load.

If the remote sense is not needed, +Sense should be connected to +Out and -Sense should be connected to -Out.

Over Temperature Protection (OTP)

The products are protected from thermal overload by an internal over temperature shutdown circuit. 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 OCP works in a hiccup mode and will make continuous attempts to start up and will resume normal operation automatically after removal of the over current condition. The load distribution should be designed for the specified maximum output short circuit current.

Pre-bias Start-up

The product has a Pre-bias start-up functionality and will not sink current during start up if a pre-bias load is present at the output terminals.

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 dependent on the airflow across the product. Increased airflow enhances the cooling of the product.

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 608 x 203 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 °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 and
P2. The temperature at these positions (TP1, TP2) 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 TP1,
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 Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>PCB Pin side</td>
<td>TP1=125° C</td>
</tr>
<tr>
<td>P2</td>
<td>Base plate</td>
<td>TP2=100° C</td>
</tr>
</tbody>
</table>
**PKM4516AD Series** Fully Regulated DC-DC Converters  
Input 36-75 V, Output up to 18 A / 504 W

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**Connections**

![Connections Diagram](image)

**Top side**

<table>
<thead>
<tr>
<th>Pin</th>
<th>Designation</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+In</td>
<td>Positive input</td>
</tr>
<tr>
<td>2</td>
<td>RC</td>
<td>Remote control</td>
</tr>
<tr>
<td>3</td>
<td>-In</td>
<td>Negative Input</td>
</tr>
<tr>
<td>4</td>
<td>-Out</td>
<td>Negative output</td>
</tr>
<tr>
<td>5</td>
<td>-Sense</td>
<td>Negative Remote Sense</td>
</tr>
<tr>
<td>6</td>
<td>$V_{adj}$</td>
<td>Output voltage adjust</td>
</tr>
<tr>
<td>7</td>
<td>+Sense</td>
<td>Positive remote sense</td>
</tr>
<tr>
<td>8</td>
<td>+Out</td>
<td>Positive output</td>
</tr>
</tbody>
</table>
PKM4516AD Series Fully Regulated DC-DC Converters
Input 36-75 V, Output up to 18 A / 504 W

Mechanical Information - Hole Mount, Baseplate Version

All component placements – whether shown as physical components or symbolical outline – are for reference only and are subject to change throughout the product’s life cycle, unless explicitly described and dimensioned in this drawing.
**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. Preheating of the product is preferable.

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**

The products are delivered in antistatic trays.

<table>
<thead>
<tr>
<th>Tray Specifications</th>
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<tr>
<td>Surface resistance</td>
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<tr>
<td>Bakability</td>
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<tr>
<td>Tray capacity</td>
</tr>
<tr>
<td>Box capacity</td>
</tr>
<tr>
<td>Tray weight</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
## Product Qualification Specification

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td><strong>External visual inspection</strong></td>
<td>IPC-A-610</td>
</tr>
<tr>
<td><strong>Change of temperature (Temperature cycling)</strong></td>
<td>IEC 60068-2-14 Na, Number of cycles 1000, Dwell/transfer time 15 min/0-1 min</td>
</tr>
<tr>
<td><strong>Cold (in operation)</strong></td>
<td>IEC 60068-2-1 Ad, Temperature $T_A$, Duration 45°C, 72 h</td>
</tr>
<tr>
<td><strong>Damp heat</strong></td>
<td>IEC 60068-2-67 Cy, Temperature Humidity, Duration 85°C, 85 % RH, 1000 hours</td>
</tr>
<tr>
<td><strong>Dry heat</strong></td>
<td>IEC 60068-2-2 Bd, Temperature Duration 125°C, 1000 h</td>
</tr>
<tr>
<td><strong>Electrostatic discharge susceptibility</strong></td>
<td>IEC 61340-3-1, JESD 22-A114, Human body model (HBM) Class 2, 2000 V, Machine Model (MM) Class 3, 200 V</td>
</tr>
<tr>
<td><strong>Immersion in cleaning solvents</strong></td>
<td>IEC 60068-2-45 XA, method 2, Water Glycol ether, Temperature 55°C, 35°C</td>
</tr>
<tr>
<td><strong>Mechanical shock</strong></td>
<td>IEC 60068-2-27 Ea, Peak acceleration, Duration 100 g, 6 ms</td>
</tr>
<tr>
<td><strong>Operational life test</strong></td>
<td>MIL-STD-202G, method 108A, Duration 1000 h</td>
</tr>
<tr>
<td><strong>Resistance to soldering heat</strong></td>
<td>IEC 60068-2-20 Tb, method 1A, Solder temperature, Duration 270°C, 10-13 s</td>
</tr>
<tr>
<td><strong>Robustness of terminations</strong></td>
<td>IEC 60068-2-21 Test Ua1, Through hole mount products, All leads</td>
</tr>
<tr>
<td><strong>Solderability</strong></td>
<td>IEC 60068-2-20 test Ta, Preconditioning Temperature, Pb-free, Steam ageing 245°C</td>
</tr>
<tr>
<td><strong>Vibration, broad band random</strong></td>
<td>IEC 60068-2-64 Fh, method 1, Frequency Spectral density, Duration 10 to 500 Hz, 0.07 g²/Hz, 10 min in each direction</td>
</tr>
</tbody>
</table>