PKJ 7200 series Direct Converters Input
60-160 V, Output up to 16.8 A / 200 W

Key Features
- Industry standard case dimensions
  61.0*57.9*12.7 mm (2.40*2.28*0.5 in)
- High Efficiency up to 93%
- 4000 Vdc input to output isolation
- Meets safety requirements according to
  IEC/EN/UL 62368-1
- Meet Requirements of standard EN50155
- EN45545-2 compliant

General Characteristics
- Input under voltage shutdown
- Remote control
- Output over voltage protection
- Over temperature protection
- Output short-circuit protection
- Output voltage adjust function
- ISO 9001/14001 certified supplier

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Ordering Information

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<th>Output</th>
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</thead>
<tbody>
<tr>
<td>PKJ7213PI</td>
<td>12V, 16.8A / 200 W</td>
</tr>
<tr>
<td>PKJ7217KPI</td>
<td>13.8V, 14.5A / 200 W</td>
</tr>
<tr>
<td>PKJ7215PI</td>
<td>15V, 13.5A / 200 W</td>
</tr>
<tr>
<td>PKJ7216ZPI</td>
<td>24V, 8.4A / 200 W</td>
</tr>
<tr>
<td>PKJ7216JP1</td>
<td>48V, 4.2A / 200 W</td>
</tr>
<tr>
<td>PKJ7216HPI</td>
<td>54V, 3.8A / 200 W</td>
</tr>
</tbody>
</table>

Product number and Packaging

PKJ721XXPI n1

<table>
<thead>
<tr>
<th>Options</th>
<th>n1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote Control logic</td>
<td>p</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>n1</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>Negative*</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
</tr>
</tbody>
</table>

Example: a product with positive logic, tray packaging would be PKJ7211XXPIP.

* 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 products are found in the Statement of Compliance document.

Flex 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 General Terms and Conditions of Sale.

Limitation of Liability

Flex 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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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 60950-1 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 (Viso) 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
PKJ 7200 series Direct Converters
Input 60-160 V, Output up to 16.8 A / 200 W

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>-40</td>
<td>+110</td>
<td>+125</td>
<td>°C</td>
</tr>
<tr>
<td>$T_S$ Storage temperature</td>
<td>-55</td>
<td>+125</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>$V_i$ Input voltage</td>
<td>60</td>
<td>110</td>
<td>160</td>
<td>V</td>
</tr>
<tr>
<td>$V_{iso}$ Isolation voltage (Input to Output)</td>
<td>4000</td>
<td>Vdc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{iso}$ Isolation voltage (Input to Baseplate)</td>
<td>2250</td>
<td>Vdc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{iso}$ Isolation voltage (Baseplate to Output)</td>
<td>1600</td>
<td>Vdc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_v$ Input voltage transient (tp 1s)</td>
<td>200</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{RC}$ Remote Control pin voltage</td>
<td>0</td>
<td>5</td>
<td></td>
<td>V</td>
</tr>
</tbody>
</table>

Positive logic option

Negative logic option

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 For PKJ7217KPI(P)
PKJ 7200 series Direct Converters Input
60-160 V, Output up to 16.8 A / 200 W

Fundamental Circuit Diagram For PKJ7213PI(P), PKJ7215PI(P), PKJ7216ZPI(P), PKJ7216JPI(P), PKJ7216HPI(P)
PKJ 7200 series Direct Converters
Input 60-160 V, Output up to 16.8 A / 200 W

Electrical Specification
12 V, 16.8 A / 200 W

PKJ7213PI(P)

T_{P1} = -40 to +110°C, V_{i} = 60 to 160 V, sense pins connected to output pins unless otherwise specified under Conditions.

Typical values given at: T_{P1} = +25°C, V_{i} = 110 V, max I_{O}, unless otherwise specified under Conditions.

At least 100uF E-Cap be added in the input terminal for stabilize input voltage source.

<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>60</td>
<td>160</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>V_{off}</td>
<td>Turn-off input voltage</td>
<td>Decreasing input voltage</td>
<td>54</td>
<td>56</td>
<td>58</td>
</tr>
<tr>
<td>V_{on}</td>
<td>Turn-on input voltage</td>
<td>Increasing input voltage</td>
<td>56</td>
<td>58</td>
<td>60</td>
</tr>
<tr>
<td>C_{i}</td>
<td>Internal input capacitance</td>
<td>2840</td>
<td>nF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P_{O}</td>
<td>Output power</td>
<td>0</td>
<td>200</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>\eta</td>
<td>Efficiency</td>
<td>50% of max I_{O}, V_{i} = 110 V</td>
<td>89.5</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>&amp;</td>
<td>max I_{O}, V_{i} = 110 V</td>
<td>90.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P_{D}</td>
<td>Power Dissipation</td>
<td>max I_{O}</td>
<td>21.2</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>I_{i}</td>
<td>Input idling power</td>
<td>I_{0} = 0 A, V_{i} = 110 V</td>
<td>1</td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>t_{s}</td>
<td>Switching frequency</td>
<td>0-100 % of max I_{O}</td>
<td>300</td>
<td>kHz</td>
<td></td>
</tr>
<tr>
<td>V_{O}</td>
<td>Output voltage initial setting and accuracy</td>
<td>T_{P1} = +25°C, V_{i} = 110 V, I_{O} = 16.8 A</td>
<td>11.88</td>
<td>12</td>
<td>12.12</td>
</tr>
<tr>
<td>&amp;</td>
<td>Output adjust range</td>
<td>See operating information</td>
<td>10.8</td>
<td>12.2</td>
<td>V</td>
</tr>
<tr>
<td>&amp;</td>
<td>Output voltage tolerance band</td>
<td>0-100% of max I_{O}</td>
<td>11.88</td>
<td>12</td>
<td>12.12</td>
</tr>
<tr>
<td>&amp;</td>
<td>Iddling voltage</td>
<td>I_{0} = 0 A</td>
<td>11.88</td>
<td>12</td>
<td>12.12</td>
</tr>
<tr>
<td>&amp;</td>
<td>Line regulation</td>
<td>max I_{O}</td>
<td>-60</td>
<td>60</td>
<td>mV</td>
</tr>
<tr>
<td>&amp;</td>
<td>Load regulation</td>
<td>V_{i} = 110 V, 25-100% of max I_{O}</td>
<td>-120</td>
<td>120</td>
<td>mV</td>
</tr>
<tr>
<td>V_{r}</td>
<td>Load transient voltage deviation</td>
<td>V_{i} = 110 V, Load step 50-75-50% of max I_{O}, di/dt = 100mA/\mu s</td>
<td>\pm 500</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td>t_{r}</td>
<td>Load transient recovery time</td>
<td></td>
<td>100</td>
<td>500</td>
<td>\mu s</td>
</tr>
<tr>
<td>t_{1}</td>
<td>Ramp-up time (from 10-90% of V_{O})</td>
<td>10-100% of max I_{O}, T_{P1} = 25°C, V_{i} = 110 V</td>
<td>15</td>
<td>ms</td>
<td></td>
</tr>
<tr>
<td>t_{2}</td>
<td>Start-up time (from V_{i} connection to 90% of V_{O})</td>
<td></td>
<td>21</td>
<td>ms</td>
<td></td>
</tr>
<tr>
<td>t_{RC}</td>
<td>RC start-up time (from V_{O} connection to 90% of V_{O})</td>
<td>max I_{O}</td>
<td>20.5</td>
<td>ms</td>
<td></td>
</tr>
<tr>
<td>RC</td>
<td>Sink current</td>
<td>See operating information</td>
<td>0.5</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>t_{t}</td>
<td>Trigger level</td>
<td>Decreasing / Increasing RC-voltage</td>
<td>0.8/2.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>t_{f}</td>
<td>V_{i} shut-down fall time (from V_{i} off to 10% of V_{O})</td>
<td>max I_{O}</td>
<td>2</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>&amp;</td>
<td>I_{0} = 0 A</td>
<td></td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I_{0}</td>
<td>Output current</td>
<td></td>
<td>0</td>
<td>16.8</td>
<td>A</td>
</tr>
<tr>
<td>I_{lim}</td>
<td>Current limit threshold</td>
<td>T_{P1} &lt; max T_{P1}</td>
<td>20</td>
<td>28.0</td>
<td>A</td>
</tr>
<tr>
<td>I_{sc}</td>
<td>Short circuit current</td>
<td>T_{P1} = 25°C, see Note 1</td>
<td>0.323</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>C_{cap}</td>
<td>Recommended Capacitive Load</td>
<td>T_{P1} = 25°C</td>
<td>3000</td>
<td>\mu F</td>
<td></td>
</tr>
<tr>
<td>V_{OHP}</td>
<td>Output ripple &amp; noise</td>
<td>See ripple &amp; noise section, V_{O}</td>
<td>max I_{O}, see Note 2</td>
<td>60</td>
<td>120</td>
</tr>
<tr>
<td>OVP</td>
<td>Over voltage protection</td>
<td>T_{P1} = +25°C, V_{i} = 110 V, 0-100% of max I_{O}</td>
<td>13.8</td>
<td>18</td>
<td>V</td>
</tr>
</tbody>
</table>

Note 1: RMS current at OCP in hic-up mode.

Note 2: Measured by 20MHz bandwidth with a 10uF/25V X7R MLCC and a 22uF/25V POS-CAP
Typical Characteristics
12 V, 16.8 A / 200 W

Efficiency
Efficiency vs. load current and input voltage at +25°C.

Power Dissipation
Dissipated power vs. load current and input voltage at +25°C.

Output Current Derating
Available load current vs. ambient air temperature and airflow at V=110 V. See Thermal Consideration section.

Current Limit Characteristics
Output voltage vs. load current at I_o > max I_o at +25°C.

Available load current vs. ambient air temperature and airflow at V=110 V with 0.5” heatsink. See Thermal Consideration section.

Available load current vs. ambient air temperature and airflow at V=110 V with 0.79” heatsink. See Thermal Consideration section.
Typical Characteristics
12 V, 16.8 A / 200 W

Available load current vs. cold wall temperature. \( V_I = 110 \text{ V} \). See Thermal Consideration section.
**Typical Characteristics**

**12 V, 16.8 A / 200 W**

### Start-up

Start-up enabled by connecting V in at:

- $T_P = +25^\circ C$, $V_i = 110 \text{ V}$,
- $I_o = 16.8 \text{ A}$ resistive load.

Top trace: output voltage (5 V/div.).
Bottom trace: input voltage (50 V/div.).
Time scale: (500 ms/div.).

### Shut-down

Shut-down enabled by disconnecting V in at:

- $T_P = +25^\circ C$, $V_i = 110 \text{ V}$,
- $I_o = 16.8 \text{ A}$ resistive load.

Top trace: output voltage (5 V/div.).
Bottom trace: input voltage (50 V/div.).
Time scale: (500 ms/div.).

### Output Ripple & Noise

Output voltage ripple at:

- $T_P = +25^\circ C$, $V_i = 110 \text{ V}$,
- $I_o = 16.8 \text{ A}$ resistive load.

Trace: output voltage (20 mV/div.).
Time scale: (5 µs/div.).
20 MHz bandwidth.

### Output Load Transient Response

Output voltage response to load current step-change (8.4-12.6-8.4 A) at:

- $T_P = +25^\circ C$, $V_i = 110 \text{ V}$.

Top trace: output voltage (500 mV/div.).
Bottom trace: load current (5 A/div.).
Time scale: (500 us/div.).

### Output Voltage Adjust (TRIM UP/TRIM DOWN)

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

**Output Voltage Adjust, Increase:**

$$R_{ADJ,UP} = \left( \frac{7.246}{\Delta} - 62 \right) k\Omega$$

**Output Voltage Adjust, Decrease:**

$$R_{ADJ,DOWN} = \left( \frac{9.125}{\Delta} - 78.371 \right) k\Omega$$

**Example:**

To trim up the 12V model by 8% to 12.96V the required external resistor is:

$$R_{ADJ,UP} = \left( \frac{7.246}{0.08} - 62 \right) = 28.58k\Omega$$

**Example:**

To trim down the 12V model by 7% to 11.16V the required external resistor is:

$$R_{ADJ,DOWN} = \left( \frac{9.125}{0.07} - 78.371 \right) = 51.99k\Omega$$

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**Technical Specification**

**PKJ 7200 series** Direct Converters

Input 60-160 V, Output up to 16.8 A / 200 W

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**PKJ7213PI(P)**

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Technical Specification
Electrical Specification

**13.8 V, 14.5 A / 200 W**

$T_{P1} = -40$ to $+110^\circ C$, $V_i = 60$ to $160$ V, sense pins connected to output pins unless otherwise specified under Conditions.

Typical values given at: $T_{P1} = +25^\circ C$, $V_i = 110$ V, max $I_o$, unless otherwise specified under Conditions.

At least 100uF E-Cap be added in the input terminal for stabilize input voltage source.

At least 330uF E-Cap be added in the converter output for stabilize output voltage source. External capacitor need to close to the converter.

### 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>$V_i$ Input voltage range</td>
<td></td>
<td>60</td>
<td>160</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{off}$ Turn-off input voltage</td>
<td>Decreasing input voltage</td>
<td>54</td>
<td>56</td>
<td>58</td>
<td>V</td>
</tr>
<tr>
<td>$V_{on}$ Turn-on input voltage</td>
<td>Increasing input voltage</td>
<td>56</td>
<td>58</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$C_i$ Internal input capacitance</td>
<td></td>
<td>3400</td>
<td></td>
<td>nF</td>
<td></td>
</tr>
<tr>
<td>$\eta$ Efficiency 50% of max $I_o$, $V_i = 110$ V</td>
<td></td>
<td>91.3</td>
<td></td>
<td>93.1</td>
<td>%</td>
</tr>
<tr>
<td>$P_d$ Power Dissipation max $I_o$</td>
<td></td>
<td>14.8</td>
<td></td>
<td></td>
<td>W</td>
</tr>
<tr>
<td>$P_i$ Input idling power $I_o = 0$ A, $V_i = 110$ V</td>
<td></td>
<td>6.8</td>
<td></td>
<td></td>
<td>W</td>
</tr>
<tr>
<td>$f_s$ Switching frequency 0-100 % of max $I_o$</td>
<td></td>
<td>230</td>
<td></td>
<td></td>
<td>kHz</td>
</tr>
</tbody>
</table>

| $V_{Oa}$ Output voltage initial setting and accuracy | $T_{P1} = +25^\circ C$, $V_i = 110$ V, $I_o = 16.8$ A | 13.662 | 13.8 | 13.938 | V |
| $V_O$ Output adjust range | See operating information | 12.42 | 15.18 |       | V |
| Output voltage tolerance band 0-100% of max $I_o$ | 13.662 | 13.8 | 13.938 | V |
| Idling voltage $I_o = 0$ A | 13.662 | 13.8 | 13.938 | V |
| Line regulation max $I_o$ | -69 | 69 | mV |
| Load regulation $V_i = 110$ V, 25-100% of max $I_o$ | -138 | 138 | mV |
| $V_t$ Load transient voltage deviation $V_i = 110$ V, Load step 50-75-50% of max $I_o$, $di/dt = 100$mA/$\mu$s | ±500 | mV |
| $t_b$ Load transient recovery time | 100 | 500 | $\mu$s |
| $t_r$ Ramp-up time (from 10-90% of $V_o$) | 10-100% of max $I_o$, $T_{P1} = 25^\circ C$, $V_i = 110$ V | 15 | ms |
| $t_s$ Start-up time (from $V_i$ connection to 90% of $V_o$) | 74 | ms |
| $t_{RC}$ RC start-up time (from $V_{RC}$ connection to 90% of $V_o$) | max $I_o$ | 15 | ms |
| $R_C$ Sink current | See operating information | 0.5 | mA |
| Trigger level Decreasing / Increasing RC-voltage | 0.8/2.5 | V |
| $t_t$ V_{sh} shut-down fall time (from $V_i$ off to 10% of $V_o$) | max $I_o$ | 16 | ms |
| $I_o$ Output current | 0 | 14.5 | A |
| $I_{lim}$ Current limit threshold | $T_{P1} < max T_{P1}$ | 17 | 21 | A |
| $I_{sc}$ Short circuit current | $T_{P1} = 25^\circ C$, see Note 1 | 0.101 | A |
| $C_{cap}$ Recommended Capacitive Load | $T_{P1} = 25^\circ C$ | 0 | 3000 | $\mu$F |
| $V_{ros}$ Output ripple & noise | See ripple & noise section, $V_{Oa}$ | max $I_o$ | 80 | 150 | mVp-p |
| $OVP$ Over voltage protection | $T_{P1} = +25^\circ C$, $V_i = 110$ V, 0-100% of max $I_o$ | 15.3 | 18 | V |

Note 1: RMS current at OCP in hic-up mode.

Note 2: Measured by 20MHz bandwidth with a 10uF/25V X7R MLCC and a 22uF/25V POS-CAP
**Typical Characteristics**

### 13.8 V, 14.5 A / 200 W

#### Efficiency

Efficiency vs. load current and input voltage at +25°C.

#### Power Dissipation

Dissipated power vs. load current and input voltage at +25°C.

#### Output Current Derating

Available load current vs. ambient air temperature and airflow at \( V_I = 110 \) V. See Thermal Consideration section.

#### Current Limit Characteristics

Output voltage vs. load current at \( I_O > max \ I_O \) at +25°C.
Typical Characteristics
13.8 V, 14.5 A / 200 W

Output Current Derating – Cold wall sealed box

Available load current vs. cold wall temperature. VI = 110 V. See Thermal Consideration section.
Typical Characteristics
13.8 V, 14.5 A / 200 W

Start-up

Start-up enabled by connecting \( V_i \) at:
\[ T_{vi} = +25^\circ C, \ V_i = 110 \text{ V}, \ \ \ i_o = 14.5 \text{ A resistive load}. \]

Top trace: output voltage (10 V/div.).
Bottom trace: input voltage (50 V/div.).
Time scale: (100 ms/div.).

Shut-down

Shut-down enabled by disconnecting \( V_i \) at:
\[ T_{vi} = +25^\circ C, \ V_i = 110 \text{ V}, \ \ \ i_o = 14.5 \text{ A resistive load}. \]

Top trace: output voltage (10 V/div.).
Bottom trace: input voltage (50 V/div.).
Time scale: (100 ms/div.).

Output Ripple & Noise

Output voltage ripple at:
\[ T_{vi} = +25^\circ C, \ V_i = 110 \text{ V}, \ \ \ i_o = 14.5 \text{ A resistive load}. \]
Trace: output voltage (50 mV/div.).
Time scale: (20 µs/div.).
20 MHz bandwidth.

Output Load Transient Response

Output voltage response to load current step-change (7.25-10.875-7.25 A) at:
\[ T_{vi} = +25^\circ C, \ V_i = 110 \text{ V}. \]
Top trace: output voltage (100 mV/div.).
Bottom trace: load current (10 A/div.).
Time scale: (20 ms/div.).

Output Voltage Adjust (TRIM UP/TRIM DOWN)

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

Output Voltage Adjust, Increase:
\[ R_{ADJ,UP} = \left( \frac{8.403}{\Delta} - 56 \right) k\Omega \]

Output Voltage Adjust, Decrease:
\[ R_{ADJ,DOWN} = \left( \frac{8.215}{\Delta} - 72.619 \right) k\Omega \]

Example:
To trim up the 13.8V model by 8% to 14.9V the required external resistor is:
\[ R_{ADJ,UP} = \left( \frac{8.403}{0.08} - 56 \right) = 49.03k\Omega \]

Example:
To trim down the 13.8V model by 7% to 12.83V the required external resistor is:
\[ R_{ADJ,DOWN} = \left( \frac{8.215}{0.07} - 72.619 \right) = 44.73k\Omega \]
## Electrical Specification

### PKJ 7200 series

**Direct Converters Input**

60-160 V, Output up to 16.8 A / 200 W

### PKJ7215PI(P)

15 V, 13.5 A / 200 W

- **$T_{θ1}$** = -40 to +110°C, $V_i$ = 60 to 160 V, sense pins connected to output pins unless otherwise specified under Conditions.
- Typical values given at: $T_{θ1} = +25°C$, $V_i$ = 110 V, max $I_o$, unless otherwise specified under Conditions.
- At least 100uF E-Cap be added in the input terminal for stabilize input voltage source.

### Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Conditions</th>
<th>min</th>
<th>typ</th>
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<td>V</td>
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<td>Output voltage initial setting and accuracy</td>
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<td>Output ripple &amp; noise</td>
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<td>Over voltage protection</td>
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<td></td>
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</tr>
</tbody>
</table>

| $V_i$ | $V_i$ = 110 V, $V_i$ = 110 V, $V_i$ = 110 V | 14.85 | 15 | 15.15 | V |
| $V_{O}$ | Output adjust range | 13.5 | 16.5 | V |
| $V_{Otr}$ | Load transient voltage deviation | 14.85 | 15 | 15.15 | V |
| $t_{Otr}$ | Load transient recovery time | -75 | 75 | mV |
| $P_o$ | Output power | 0 | 200 | W |
| $η$ | Efficiency | 50% of max $I_o$, $V_i$ = 110 V | 89.5 | | % |
| $P_d$ | Power Dissipation | max $I_o$ | 21.9 | | W |
| $P_s$ | Input idling power | $I_o$ = 0 A, $V_i$ = 110 V | 1 | | W |
| $t_s$ | Switching frequency | 0-100% of max $I_o$ | 300 | | kHz |

Note 1: RMS current at OCP in hic-up mode.

Note 2: Measured by 20MHz bandwidth with a 10uF/25V X7R MLCC and a 22uF/25V POS-CAP

---

**Typical values given at: $TP_1 = +25°C$, $V_i$ = 110 V, max $I_o$, unless otherwise specified under Conditions.**

**Recommend Capacitive Load:**

- $C_{oout}$ = Recommended Capacitive Load

**Output ripple & noise:**

- See ripple & noise section, $V_{O}$, max $I_o$, see Note 2

**Over voltage protection:**

- $TP_1 = +25°C$, $V_i$ = 110 V, 0-100% of max $I_o$
Typical Characteristics

15 V, 13.5 A / 200 W

**Efficiency**

- Efficiency vs. load current and input voltage at +25°C.

**Power Dissipation**

- Dissipated power vs. load current and input voltage at +25°C.

**Output Current Derating**

- Available load current vs. ambient air temperature and airflow at V_I=110 V. See Thermal Consideration section.

**Current Limit Characteristics**

- Output voltage vs. load current at I_O > max I_O at +25°C.

Available load current vs. ambient air temperature and airflow at V_I=110 V with 0.5" heatsink. See Thermal Consideration section.

Available load current vs. ambient air temperature and airflow at V_I=110 V with 0.79" heatsink. See Thermal Consideration section.
**PKJ 7200 series** Direct Converters Input
60-160 V, Output up to 16.8 A / 200 W

**Typical Characteristics**
15 V, 13.5 A / 200 W

**Output Current Derating**– Cold wall sealed box

Available load current vs. cold wall temperature. VI = 110 V. See Thermal Consideration section.
Typical Characteristics
15 V, 13.5 A / 200 W

Start-up

Start-up enabled by connecting V in at:
T_P = +25°C, V_i = 110 V,
I_o = 13.5 A resistive load.

Top trace: output voltage (5 V/div.).
Bottom trace: input voltage (50 V/div.).
Time scale: (500 ms/div.).

Output Ripple & Noise

Output voltage ripple at:
T_P = +25°C, V_i = 110 V,
I_o = 13.5 A resistive load.
Trace: output voltage (20 mV/div.).
Time scale: (5 µs/div.).
20 MHz bandwidth.

Output Load Transient Response

Output voltage response to load current step-change (6.75-10.125-6.75 A) at:
T_P = +25°C, V_i = 110 V.
Top trace: output voltage (500 mV/div.).
Bottom trace: load current (5 A/div.).
Time scale: (500 µs/div.).

Output Voltage Adjust (TRIM UP/TRIM DOWN)

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

Output Voltage Adjust, Increase:

\[ R_{ADJ,UP} = \left( \frac{9.186}{\Delta} - 68 \right) \, k\Omega \]

Output Voltage Adjust, Decrease:

\[ R_{ADJ,DOWN} = \left( \frac{9.5738}{\Delta} - 86.76 \right) k\Omega \]

Example:
To trim up the 15V model by 8% to 16.2V the required external resistor is:

\[ R_{ADJ,UP} = \left( \frac{9.186}{0.08} - 68 \right) = 46.83k\Omega \]

Example:
To trim down the 15V model by 7% to 13.95V the required external resistor is:

\[ R_{ADJ,DOWN} = \left( \frac{9.5738}{0.07} - 86.76 \right) = 50k\Omega \]
### Electrical Specification

**PKJ 7200 series Direct Converters Input**

60-160 V, Output up to 16.8 A / 200 W

**24 V, 8.4 A / 200 W**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Conditions</th>
<th>min</th>
<th>typ</th>
<th>max</th>
<th>Unit</th>
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<td>$V_{i}$</td>
<td>Input voltage range</td>
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<td>V</td>
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<td>$V_{ir}$</td>
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<td>58</td>
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<tr>
<td>$V_{on}$</td>
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<td>Increasing input voltage</td>
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<td>58</td>
<td>60</td>
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<td>$C_{i}$</td>
<td>Internal input capacitance</td>
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<td>2840</td>
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<tr>
<td>$P_{o}$</td>
<td>Output power</td>
<td>0</td>
<td></td>
<td>200</td>
<td>W</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Efficiency</td>
<td>50% of max $I_{o}$, $V_i = 110$ V</td>
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<td>%</td>
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<tr>
<td></td>
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<td>max $I_{o}$, $V_i = 110$ V</td>
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<td>91.3</td>
<td>%</td>
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<td>$P_{r}$</td>
<td>Power Dissipation</td>
<td>max $I_{o}$</td>
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<td>W</td>
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<tr>
<td>$P_{s}$</td>
<td>Input idling power</td>
<td>$I_0 = 0$ A, $V_i = 110$ V</td>
<td>1</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>300</td>
<td></td>
<td>kHz</td>
</tr>
</tbody>
</table>

**Note 1:** RMS current at OCP in hic-up mode.

**Note 2:** Measured by 20MHz bandwidth with 10 uF+0.1 uF X7R MLCC
**Typical Characteristics**

**PKJ 7200 series** Direct Converters Input
60-160 V, Output up to 16.8 A / 200 W

### Efficiency

![Efficiency Graph](image1)

Efficiency vs. load current and input voltage at +25°C.

### Power Dissipation

![Power Dissipation Graph](image2)

Dissipated power vs. load current and input voltage at +25°C.

### Output Current Derating

![Output Current Derating Graph](image3)

Available load current vs. ambient air temperature and airflow at \( V_i = 110 \) V. See Thermal Consideration section.

### Current Limit Characteristics

![Current Limit Characteristics Graph](image4)

Output voltage vs. load current at \( I_o > \max I_o \) at +25°C.

Available load current vs. ambient air temperature and airflow at \( V_i = 110 \) V with 0.5” heatsink. See Thermal Consideration section.
Typical Characteristics

24 V, 8.4 A / 200 W

Output Current Derating – Cold wall sealed box

Available load current vs. cold wall temperature. VI = 110 V. See Thermal Consideration section.
Typical Characteristics
24 V, 8.4 A / 200 W

Start-up

Start-up enabled by connecting VI at:
- $T_P = +25^\circ\text{C}$, $V_I = 110$ V,
- $I_O = 8.4$ A resistive load.

Top trace: output voltage (10 V/div.),
Bottom trace: input voltage (50 V/div.),
Time scale: (200 ms/div.).

Shut-down enabled by disconnecting VI at:
- $T_P = +25^\circ\text{C}$, $V_I = 110$ V,
- $I_O = 8.4$ A resistive load.

Top trace: output voltage (10 V/div.),
Bottom trace: input voltage (50 V/div.),
Time scale: (200 ms/div.).

Output Ripple & Noise

Output voltage ripple at:
- $T_P = +25^\circ\text{C}$, $V_I = 110$ V,
- $I_O = 8.4$ A resistive load.

Trace: output voltage (50 mV/div.),
Time scale: (5 µs/div.),
20 MHz bandwidth.

Output Load Transient Response

Output voltage response to load current step-change (6.3-4.2-6.3 A) at:
- $T_P = +25^\circ\text{C}$, $V_I = 110$ V.

Top trace: output voltage (500 mV/div.),
Bottom trace: load current (2 A/div.),
Time scale: (500 us/div.).

Output Voltage Adjust (TRIM UP/TRIM DOWN)

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

Output Voltage Adjust, Increase:

$$R_{ADJ,UP} = \left( \frac{14.6061}{\Delta} - 120 \right) k\Omega$$

Output Voltage Adjust, Decrease:

$$R_{ADJ,DOWN} = \left( \frac{17.2133}{\Delta} - 151.819 \right) k\Omega$$

Example:

To trim up the 24V model by 8% to 25.92V the required external resistor is:

$$R_{ADJ,UP} = \left( \frac{14.6061}{0.08} - 120 \right) = 62.58k\Omega$$

Example:

To trim down the 24V model by 7% to 22.32V the required external resistor is:

$$R_{ADJ,DOWN} = \left( \frac{17.2133}{0.07} - 151.819 \right) = 94.08k\Omega$$

Output Voltage=24V
PKJ 7200 series  Direct Converters Input  
60-160 V, Output up to 16.8 A / 200 W

Electrical Specification

48 V, 4.2 A / 200 W

PKJ7216JP1(P)

TP1 = -40 to +110°C, Vi = 60 to 160 V, sense pins connected to output pins unless otherwise specified under Conditions.

Typical values given at: TP1 = +25°C, Vi = 110 V, max IO, unless otherwise specified under Conditions.

At least 100μF E-Cap be added in the input terminal for stabilize input voltage source.

### Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Conditions</th>
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<th>max</th>
<th>Unit</th>
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<td>kHz</td>
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</table>

| $V_{o1}$                            | Output voltage initial setting and accuracy     |      |      |      | V    |
|                                      | T_{P1} = +25°C, V_i = 110 V, I_o = 4.2 A        | 47.52| 48   | 48.48| V    |
| $V_{o2}$                            | Output adjust range                             |      |      |      | V    |
| $V_{ol}$                            | See operating information                       | 43.2 | 52.8 | V    |
| $V_{ol}$                            | Output voltage tolerance band                   |      |      |      | V    |
| I_o = 0% of max I_o                 | 100%-100% of max I_o                            | 47.52| 48   | 48.48| V    |
| I_o = 0% of max I_o                 | Idling voltage                                  | 47.52| 48   | 48.48| V    |
| $V_{ol}$                            | Line regulation                                 |      |      |      | V    |
| I_o = 0% of max I_o                 | max I_o                                         | -240 | 240  |     | mV   |
| I_o = 0% of max I_o                 | Load regulation                                 |      |      |      | V    |
| I_o = 0% of max I_o                 | max I_o                                         | -480 | 480  |     | mV   |
| $V_{t}$                             | Load transient voltage deviation                |      |      |      | mV   |
| $V_i = 110 V$, Load step 50-75-50%  | of max I_o, $\frac{di}{dt} = 100m\text{A}/\mu\text{s}$ | ±800 |      |      | mV   |
| $t_{o}$                             | Load transient recovery time                    |      |      |      | μs   |
|                                     | 10-100% of max I_o, $T_{P1} = 25°C, V_i = 110 V$ | 250  | 500  |      | μs   |
| $t_{r}$                             | Ramp-up time (from 10-90% of $V_{o2}$)          |      |      |      | ms   |
|                                    | 10-100% of max I_o, $T_{P1} = 25°C, V_i = 110 V$ | 11   |      |      | ms   |
| $t_{s}$                             | Start-up time (from $V_o$ connection to 90% of $V_{o2}$) | 14   |      |      | ms   |
| $t_{RC}$                            | RC start-up time (from $V_{o2}$ connection to 90% of $V_o$) | 10   |      |      | ms   |
| $R_{c}$                             | Sink current                                    |      |      |      | mA   |
|                                    | See operating information                       | 0.5  |      |      | mA   |
| $t_{v}$                             | Trigger level                                   |      |      |      | V    |
|                                    | Decreasing / Increasing RC-voltage              |      | 0.8/2.5 |      | V    |
|                                  | max I_o                                         |      | 2.5  |      | ms   |
|                                  | I_o = 0 A                                       |      | 5    |      | s    |
| $I_o$                               | Output current                                  |      |      |      | A    |
| $I_{LOM}$                           | Current limit threshold                         |      |      |      | A    |
|                                    | $T_{P1} < \text{max } T_{P1}$                   | 5.1  | 8.0  |      | A    |
| $I_{SC}$                            | Short circuit current                           |      |      |      | A    |
|                                    | $T_{P1} = 25°C, \text{see Note 1}$              | 0.301|      |      | A    |
| $C_{int}$                           | Recommended Capacitive Load                     |      | 3000 | μF   |
|                                    | $T_{P1} = 25°C$                                 | 0    |      |      | μF   |
| $V_{OAC}$                           | Output ripple & noise                            |      |      |      | mVp-p|
|                                    | See ripple & noise section, $V_{o1}$             | 100  | 200  |      | mVp-p|
| $OVP$                               | Over voltage protection                         |      |      |      | V    |
|                                    | $T_{P1} = +25°C, V_i = 110 V, 0-100% of max I_o | 55.2 | 72   |      | V    |

Note 1: RMS current at OCP in hic-up mode.

Note 2: Measured by 20MHz bandwidth with 10 μF+0.1 μF X7R MLCC
**PKJ 7200 series** Direct Converters Input 60-160 V, Output up to 16.8 A / 200 W

**Typical Characteristics**

48 V, 4.2 A / 200 W

**Efficiency**

![Efficiency graph](image)

Efficiency vs. load current and input voltage at +25°C.

**Power Dissipation**

![Dissipation graph](image)

Dissipated power vs. load current and input voltage at +25°C.

**Output Current Derating**

![Derating graph](image)

Available load current vs. ambient air temperature and airflow at V_in=110 V. See Thermal Consideration section.

**Current Limit Characteristics**

![Current limit graph](image)

Output voltage vs. load current at I_0 > max I_0 at +25°C.

Available load current vs. ambient air temperature and airflow at V_in=110 V with 0.5" heatsink. See Thermal Consideration section.
**PKJ 7200 series** Direct Converters Input
60-160 V, Output up to 16.8 A / 200 W

**Typical Characteristics**
48 V, 4.2 A / 200 W

**Output Current Derating – Cold wall sealed box**

Available load current vs. cold wall temperature. \( V_I = 110 \, V \). See Thermal Consideration section.
**PKJ 7200 series** Direct Converters
Input 60-160 V, Output up to 16.8 A / 200 W

**Typical Characteristics**

**48 V, 4.2 A / 200 W**

**Start-up**

Start-up enabled by connecting \( V_i \) at:

\[
T_{pu} = +25^\circ C, \; V_i = 110 V, \\
I_o = 4.2 \text{ A resistive load.}
\]

Top trace: output voltage (20 V/div.).
Bottom trace: input voltage (50 V/div.).
Time scale: (500 ms/div.).

**Shut-down**

Shut-down enabled by disconnecting \( V_i \) at:

\[
T_{pu} = +25^\circ C, \; V_i = 110 V, \\
I_o = 4.2 \text{ A resistive load.}
\]

Top trace: output voltage (20 V/div.).
Bottom trace: input voltage (50 V/div.).
Time scale: (500 ms/div.).

**Output Ripple & Noise**

Output voltage ripple at:

\[
T_{pu} = +25^\circ C, \; V_i = 110 V, \\
I_o = 4.2 \text{ A resistive load.}
\]

Trace: output voltage (100 mV/div.).
Time scale: (5 µs/div.).
20 MHz bandwidth.

**Output Load Transient Response**

Output voltage response to load current step-change (2.1-3.15-2.1 A) at:

\[
T_{pu} = +25^\circ C, \; V_i = 110 V.
\]

Top trace: output voltage (500 mV/div.).
Bottom trace: load current (2 A/div.).
Time scale: (500 us/div.).

**Output Voltage Adjust (TRIM UP/TRIM DOWN)**

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

Output Voltage Adjust, Increase:

\[
R_{ADJ,UP} = \left( \frac{29.221}{\Delta} - 220 \right) \text{ k} \Omega
\]

Output Voltage Adjust, Decrease:

\[
R_{ADJ,DOWN} = \left( \frac{34.46}{\Delta} - 283.682 \right) \text{ k} \Omega
\]

**Example:**

To trim up the 48V model by 8% to 51.84V the required external resistor is:

\[
R_{ADJ,UP} = \left( \frac{29.221}{0.08} - 220 \right) = 145.27 \text{ k} \Omega
\]

**Example:**

To trim down the 48V model by 7% to 44.64V the required external resistor is:

\[
R_{ADJ,DOWN} = \left( \frac{34.46}{0.07} - 283.682 \right) = 208.61 \text{ k} \Omega
\]
**PKJ 7200 series Direct Converters Input**
60-160 V, Output up to 16.8 A / 200 W

**Electrical Specification**

54 V, 3.8 A / 200 W

Typical values given at: Tp1 = +25°C, V1 = 110 V, max I0, unless otherwise specified under Conditions.

**Note 1:** At least 100μF E-Cap be added in the input terminal for stabilize input voltage source.

**Note 2:** Measured by 20MHz bandwidth with 10 uF+0.1 uF X7R MLCC

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</table>

| VCI                              | Output voltage initial setting and accuracy | TP1 = +25°C, V1 = 110 V, I0 = 3.8 A | 53.46 | 54 | 54.54 | V |
| VCI                              | Output adjust range                      | See operating information           | 48.6  | 59.4 | V |
| VCI                              | Output voltage tolerance band             | 0-100% of max I0                    | 53.46 | 54 | 54.54 | V |
| VCI                              | Idling voltage                           | I0 = 0 A                            | 53.46 | 54 | 54.54 | V |
| VCI                              | Line regulation                          | max I0                              | -270  | 270 | mV |
| VCI                              | Load regulation                          | V1 = 110 V, 25-100% of max I0       | -540  | 540 | mV |
| VCI                              | Load transient voltage deviation         | V1 = 110 V, Load step 50-75-50% of max I0, di/dt = 100mA/μs, Cout = 47μF | ±800 | mV |
| fC                               | Load transient recovery time             |                                    | 200   | 500 | μs |
| fR                               | Ramp-up time (from 10-90% of VCI)         |                                    | 11    |     | ms |
| fR                               | Start-up time (from VCI connection to 90% of VCI) | 25 |   | ms |
| fR                               | RC start-up time (from VCI connection to 90% of VCI) | max I0 | 10 | ms |
| RC                               | Sink current                             | See operating information           | 0.5   |     | mA |
| RC                               | Trigger level                            | Decreasing / Increasing RC-voltage  | 0.8/2.5 |     | V |
| fR                               | VCI shut-down fall time (from VCI off to 10% of VCI) | max I0 | 1.5 | ms |
| fR                               |                                             | I0 = 0 A                            | 4.5   |     | s |
| I0                               | Output current                           |                                              | 0     | 3.8  | A   |
| Ith                              | Current limit threshold                  |                              | 4.8   | 6.3  | A   |
| Is                               | Short circuit current                    | TP1 = 25°C, see Note 1              | 0.48  |     | A   |
| Copt                             | Recommended Capacitive Load              |                      | 1500   |     | μF  |
| VCI                              | Output ripple & noise                    |                             | 120   | 200  | mVP-p |
| OVP                              | Over voltage protection                  | TP1 = +25°C, V1 = 110 V, 0-100% of max I0 | 62.1 | 81 | V   |
**PKJ 7200 series** Direct Converters

Input: 60-160 V, Output up to 16.8 A / 200 W

### Typical Characteristics

**54 V, 3.8 A / 200 W**

#### Efficiency

![Efficiency graph]

*Efficiency vs. load current and input voltage at +25°C.*

#### Power Dissipation

![Power Dissipation graph]

*Dissipated power vs. load current and input voltage at +25°C.*

#### Output Current Derating

![Output Current Derating graph]

*Available load current vs. ambient air temperature and airflow at V_I=110 V. See Thermal Consideration section.*

#### Current Limit Characteristics

![Current Limit Characteristics graph]

*Output voltage vs. load current at I_O > max I_O at +25°C.*

**PKJ7216HPI(P)**

### Output Voltage Derating

![Output Voltage Derating graph]

*Available load current vs. ambient air temperature and airflow at V_I=110 V with 0.5” heatsink. See Thermal Consideration section.*

### Available load current vs. ambient air temperature and airflow at V_I=110 V with 0.79” heatsink. See Thermal Consideration section.
Output Current Derating—Cold wall sealed box

Available load current vs. cold wall temperature. $V_I = 110$ V. See Thermal Consideration section.
Typical Characteristics

54 V, 3.8 A / 200 W

Start-up enabled by connecting $V_i$ at:
$T_{P1} = +25^\circ C$, $V_i = 110 V$,
$I_o = 3.8$ A resistive load.

Top trace: output voltage (20 V/div.).
Bottom trace: input voltage (50 V/div.).
Time scale: (10 ms/div.).

Shut-down enabled by disconnecting $V_i$ at:
$T_{P1} = +25^\circ C$, $V_i = 110 V$,
$I_o = 3.8$ A resistive load.

Top trace: output voltage (20 V/div.).
Bottom trace: input voltage (50 V/div.).
Time scale: (5 ms/div.).

Output Ripple & Noise

Output ripple at:
$T_{P1} = +25^\circ C$, $V_i = 110 V$,
$I_o = 3.8$ A resistive load.

Trace: output voltage (50 mV/div.).
Time scale: (2 µs/div.).
20 MHz bandwidth.

Output Load Transient Response

Output voltage response to load current step-change (1.9-2.85-1.9 A) at:
$T_{P1} = +25^\circ C$, $V_i = 110 V$.

Top trace: output voltage (500 mV/div.).
Bottom trace: load current (2 A/div.).
Time scale: (1ms/div.)

Output Voltage Adjust (TRIM UP/TRIM DOWN)

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

Output Voltage Adjust, Increase:

$$R_{ADJ,UP} = \left(\frac{32.667}{\Delta} - 270\right) k\Omega$$

Output Voltage Adjust, Decrease:

$$R_{ADJ,DOWN} = \left(\frac{40.5244}{\Delta} - 343.191\right) k\Omega$$

Example:
To trim up the 54V model by 8% to 58.32V the required external resistor is:

$$R_{ADJ,UP} = \left(\frac{32.667}{0.08} - 270\right) = 138.34k\Omega$$

Example:
To trim down the 54V model by 7% to 50.22V the required external resistor is:

$$R_{ADJ,DOWN} = \left(\frac{40.5244}{0.07} - 343.191\right) = 235.73k\Omega$$
PKJ 7200 series Direct Converters
Input 60-160 V, Output up to 16.8 A / 200 W

EMC Specification
Conducted EMI measured according to EN50121-3-2:2015
EN55032, CISPR 32 and FCC part 15J (see test set-up). See Design Note 009 for further information. The fundamental switching frequency is 300 kHz for PKJ Series at \( V_i = 110 \) V and max \( I_o \).

Conducted EMI Input terminal value (typ)

Optional external filter for class B
Suggested external input filter in order to meet EN50121-3-2:2015, class B in EN 55032, CISPR 32 and FCC part 15J.

PKJ7213, PKJ7217K, PKJ7215, PKJ7216Z Filter components:
\( C1,C6,C7: 2.2\mu F \) CERAMIC, \( C2: 82\mu F \) E.L. capacitor
\( C3,C4: 100\mu F \) E.L. capacitor, \( C5: 330\mu F \) E.L. capacitor
\( L1, L4: 4.5\mu H \), \( L2,L3: 3.25mH \), \( L5: 480\mu H \)
\( CY1,CY3,CY4,CY5: 4.7nF /250VAC \), \( CY2: 10nF/250VAC \)
\( D1: 1.5KE180A \) Littelfuse

PKJ7216J, PKJ7216H Filter components:
\( C1,C6,C7: 2.2\mu F \) CERAMIC, \( C2: 82\mu F \) E.L. capacitor
\( C3,C4: 100\mu F \) E.L. capacitor, \( C5: 330\mu F \) E.L. capacitor
\( L1, L4: 4.5\mu H \), \( L2,L3: 3.25mH \), \( L5: 480\mu H \)
\( CY1: 4.7nF/250VAC \), \( CY2,CY4,CY5: 10nF/250VAC \), \( CY3: NC \)
\( D1: 1.5KE180A \) Littelfuse
Output Negative(EN50121-3-2:2015)

EMI with filter

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 60 to 160 Vdc , At input voltages exceeding 160 V, the power loss will be higher than at normal input voltage and the power factor will be limited to absolute max +120°C. The absolute maximum continuous input voltage is 160 Vdc.

Short duration transient disturbances can occur on the DC distribution and input of the product when a short circuit fault occurs on the equipment side of a protective device (fuse or circuit breaker). The voltage level, duration and energy of the disturbance are dependant on the particular DC distribution network characteristics and can be sufficient to damage the product unless measures are taken to suppress or absorb this energy. The transient voltage can be limited by capacitors and other energy absorbing devices like zener diodes connected across the positive and negative input conductors at a number of strategic points in the distribution network. The end-user must secure that the transient voltage will not exceed the values stated in the Absolute maximum ratings. ETSI TR 100 283 examines the parameters of DC distribution networks and provides guidelines for controlling the transient and reduce its harmful effect.

Turn-off Input Voltage
The products monitor the input voltage and will turn on and turn off at predetermined levels. The minimum hysteresis between turn on and turn off input voltage is 1.7 V.

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 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 left open, the voltage generated on the RC pin is 3 - 5 V.

The standard product is provided with “negative logic” RC and will be on 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 2.5 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 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 100 µF capacitor across the input of the product will ensure stable operation. The capacitor is not required when powering the product from an input source with an inductance below 10 µH. 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 >5 mΩ across the output connections.

For further information please contact your local Flex 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 +Out 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 -Out pin.

Parallel Operation

Two products may be paralleled for redundancy if the total power is equal or less than P_{O max}. It is not recommended to parallel the products without using external current sharing circuits.

See Design Note 006 for detailed information.

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. When T_{P1} as defined in thermal consideration section exceeds 120°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 prevent output voltage to exceed the specified value in technical specification. 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 dependent 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 airflow at V_{I} = 110 V.

The product is tested on a 250 x 250 mm, 70 µm (2 oz), 4-layer test board mounted vertically in a wind tunnel with a cross-section of 256 x 250 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. 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. The temperature at this position (TP1) should not exceed the maximum temperatures in the table below. Temperature above maximum TP1, measured at the reference point P1 are not allowed and may cause permanent damage.

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<tr>
<th>Position</th>
<th>Description</th>
<th>Max Temp.</th>
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<td>Reference point</td>
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<td>Remote control</td>
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<tr>
<td>4</td>
<td>-In</td>
<td>Negative input</td>
</tr>
<tr>
<td>5</td>
<td>-Out</td>
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<td>Positive remote sense</td>
</tr>
<tr>
<td>9</td>
<td>+Out</td>
<td>Positive output</td>
</tr>
</tbody>
</table>
Mechanical Information - Enclosure Type

Notes:
1. Pins:
   Material: Copper alloy
   Plating: Matte Tin over Nickle plate

2. Weight: typical 100g
   All dimensions in inches (mm).
   Tolerance .xx= ±0.02"
   .xxx=±0.010"
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
The products are delivered in antistatic clamshell trays

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# Technical Specification

**PKJ 7200 series Direct Converters**

Input 60-160 V, Output up to 16.8 A / 200 W

![Image](28701-BMR 714 Rev B November 2019 © Flex Technical Specification)

## Product Qualification Specification

### Characteristics

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<td>Robustness of terminations</td>
<td>IEC 60068-2-21 Test Ua1</td>
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<td>Solderability</td>
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<td>Vibration, broad band random</td>
<td>IEC 61373</td>
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**Notes**

<sup>1</sup> Only for products intended for wave soldering (plated through hole products)