ERICSSON

Technical Specification

| | |
|---|---|
| **PKE 5000 series** Direct Converters<br>Input 18-75 V, Output up to 4.5 A / 15 W | 2/28701-BMR710 Rev. D April 2016 |
| |  |

## Key Features

- Industry standard case dimensions
  25.4 x 25.4 x 10.8 mm (1.00 x 1.00 x 0.43 inch)
- High efficiency, typ. 88% at 12 Vout Full load
- 1500 Vdc input to output isolation
- Meets safety requirements according to IEC/UL 60950-1
- MTBF 1 Mh


## General Characteristics

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

**Safety Approvals**

c UL us

**Design for Environment**

RoHS compatible

Meets requirements in high-temperature lead-free soldering processes.

## Contents

## Ordering Information

| Product program | Output |
|---|---|
| PKE 5210 PI | 3.3 V, 4.5 A / 15 W |
| PKE 5211 PI | 5.0 V, 3 A / 15 W |
| PKE 5213 PI | 12 V, 1.25 A / 15 W |
| PKE 5215 PI | 15 V, 1 A / 15 W |

Product number and Packaging

| PKE 521X PI$n_1$ | |
|---|---|
| Options | $n_1$ |
| Remote Control logic | o |

| Options | Description | |
|---|---|---|
| $n_1$ | | Negative * |
| | P | Positive |

Example negative logic product with tray packaging would be PKE 5213 PI.

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

## General Information

### Reliability

The failure rate ($\lambda$) and mean time between failures (MTBF= $1/\lambda$) is calculated at max output power and an operating ambient temperature ($T_A$) of +25°C. Ericsson Power Modules uses Telcordia SR-332 Issue 2 Method 1 to calculate the mean steady-state failure rate and standard deviation ($\sigma$).

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

| Mean steady-state failure rate, $\lambda$ | Std. deviation, $\sigma$ |
|---|---|
| 1000 nFailures/h | 86 nFailures/h |

MTBF (mean value) for the PKE 5000 series = 1 Mh.
MTBF at 90% confidence level = 0.9 Mh

### 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 Ericsson Power Modules products are found in the Statement of Compliance document.

Ericsson 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 Ericsson Power Modules General Terms and Conditions of Sale.

### Limitation of Liability

Ericsson 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).

## Safety Specification

### General information

PKE 3000 and PKE 5000 series DC/DC converters are designed in accordance with the safety standards IEC 60950-1 and UL 60950-1 *Safety of Information Technology Equipment*.

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

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

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

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

PKE 3000 and PKE 5000 series DC/DC converters are UL 60950-1 recognized. 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 provide basic or functional insulation between input and output according to IEC/UL 60950-1 (see Safety Certificate), different conditions shall be met if the output of a basic insulated product shall be considered as safety extra low voltage (SELV).

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

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

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

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

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

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:

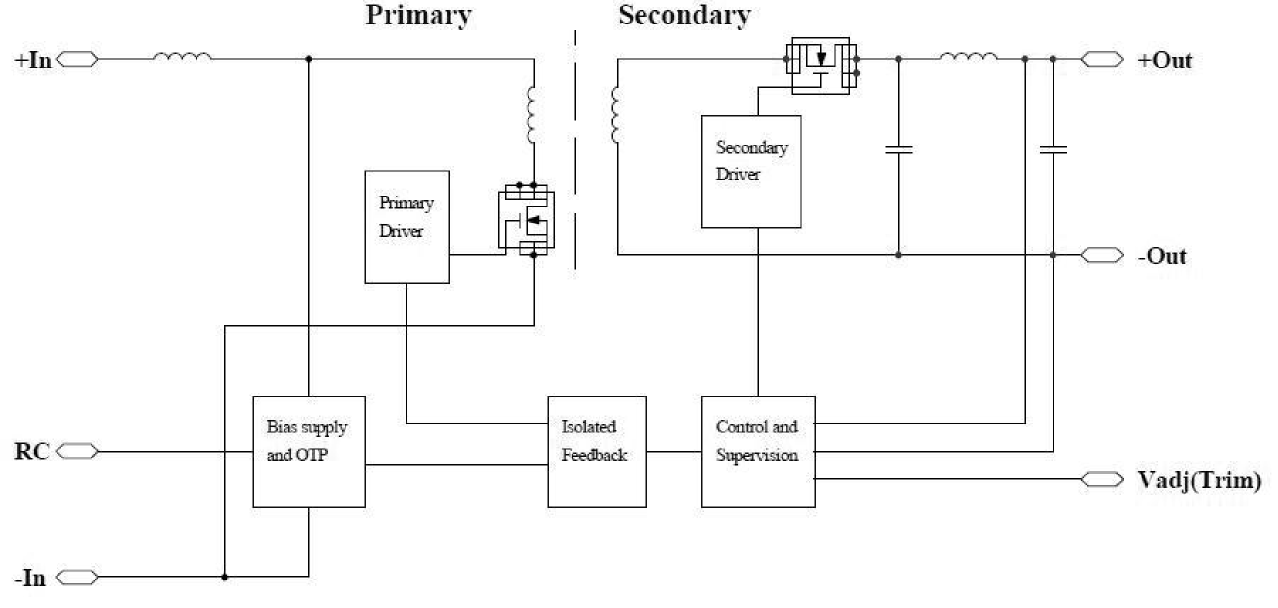
- Isolate the fault from the input power source so as not to affect the operation of other parts of the system
- Protect the distribution wiring from excessive current and power loss thus preventing hazardous overheating

## Absolute Maximum Ratings

| Characteristics | | | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| $T_{P1}$ | Operating Temperature (see Thermal Consideration section) | | -40 | | +110 | °C |
| $T_S$ | Storage temperature | | -55 | | +125 | °C |
| $V_I$ | Input voltage | | 18 | | 75 | V |
| $V_{iso}$ | Isolation voltage (input to output test voltage) | | | | 1500 | Vdc |
| $V_{tr}$ | Input voltage transient (tp 100ms) | | | | 100 | V |
| $V_{RC}$ | Remote Control pin voltage (see Operating Information section) | {Positive logic option} | 0 | | 6 | V |
| | | {Negative logic option} | 0 | | 6 | V |
| $V_{adj}$ | Adjust pin voltage (see Operating Information section) | | 0 | | $V_o$ | V |

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

## Fundamental Circuit Diagram



## Electrical Specification
## 3.3 V, 4.5 A / 15 W

**PKE 5210 PI**

$T_{P1}$ = -40 to +90ºC, $V_I$ = 18 to 75 V, unless otherwise specified under Conditions.
Typical values given at: $T_{P1}$ = +25°C, $V_I$= 48 $V_I$ max $I_O$, unless otherwise specified under Conditions.
Additional $C_{out}$ =22µF ceramic capacitor. See Operating Information section for selection of capacitor types.

| Characteristics | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| $V_I$ | Input voltage range | | 18 | | 75 | V |
| $V_{Ioff}$ | Turn-off input voltage | Decreasing input voltage | 14 | 15 | 16 | V |
| $V_{Ion}$ | Turn-on input voltage | Increasing input voltage | 15 | 16 | 17 | V |
| $C_I$ | Internal input capacitance | | | 1.14 | | µF |
| $P_O$ | Output power | | 0 | | 15 | W |
| η | Efficiency | 50% of max $I_O$ | | 84.1 | | % |
| | | max $I_O$ | | 87.0 | | % |
| | | 50% of max $I_O$, $V_I$ = 24 V | | 87.8 | | % |
| | | max $I_O$, $V_I$ = 24 V | | 86.8 | | % |
| $P_d$ | Power Dissipation | max $I_O$ | | 2.1 | 5.0 | W |
| $P_{li}$ | Input idling power | $I_O$ = 0 A, $V_I$ = 48 V | | 1.028 | | W |
| $P_{RC}$ | Input standby power | $V_I$ = 48 V (turned off with RC) | | 0.388 | | W |
| $f_s$ | Switching frequency | {0-100} % of max $I_O$ | 340 | 400 | 460 | kHz |

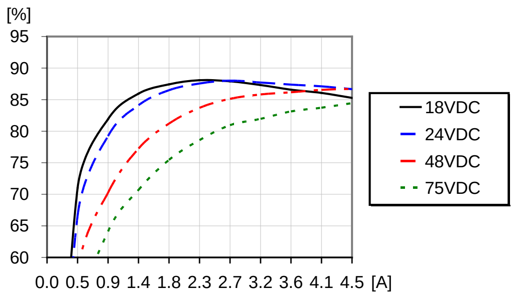
| | | | | | | |
|---|---|---|---|---|---|---|
| $V_{Oi}$ | Output voltage initial setting and accuracy | $T_{P1}$ = +25°C, $V_I$ = 48 V, $I_O$ = 4.5 A | 3.26 | 3.30 | 3.34 | V |
| $V_O$ | Output adjust range | See operating information | 2.97 | | 3.63 | V |
| | Output voltage tolerance band | 0-100% of max $I_O$ | 3.2 | | 3.4 | V |
| | Idling voltage | $I_O$ = 0 A | 3.2 | | 3.4 | V |
| | Line regulation | max $I_O$ | | 2 | 10 | mV |
| | Load regulation | $V_I$ = 48 V, 10-100% of max $I_O$ | | 10 | 33 | mV |
| $V_{tr}$ | Load transient voltage deviation | $V_I$ = 48 V, Load step 25-75-25% of max $I_O$, di/dt = 1 A/µs | | ±195 | ±700 | mV |
| $t_{tr}$ | Load transient recovery time | | | 193 | 500 | µs |
| $t_r$ | Ramp-up time (from 10−90% of $V_{Oi}$) | 10-100% of max $I_O$ | 0.1 | 0.65 | 5 | ms |
| $t_s$ | Start-up time (from $V_I$ connection to 90% of $V_{Oi}$) | | 1 | 6 | 30 | ms |
| $t_f$ | $V_I$ shut-down fall time (from $V_I$ off to 10% of $V_O$) | max $I_O$ | | 0.23 | | ms |
| | | $I_O$ = 0A | | 1.31 | | s |
| $t_{RC}$ | RC start-up time | max $I_O$ | | 6.0 | | ms |
| | RC shut-down fall time (from RC off to 10% of $V_O$) | max $I_O$ | | 0.1 | | ms |
| | | $I_O$ = 0A | | 1.52 | | s |
| $I_O$ | Output current | | 0 | | 4.5 | A |
| $I_{lim}$ | Current limit threshold | $V_I$ = 48 V,$T_{P1}$ < max $T_{P1}$ | 4.8 | 8.5 | 12.2 | A |
| $I_{sc}$ | Short circuit current | $T_{P1}$ = 25ºC, {see Note 1} | 4.8 | 8.5 | 12.2 | A |
| $C_{out}$ | Recommended Capacitive Load | $T_{P1}$ = 25ºC, {see Note 2} | 0 | | 5000 | µF |
| $V_{Oac}$ | Output ripple & noise | See ripple & noise section, $V_{Oi}$ | | 21 | 75 | mVp-p |
| OVP | Over voltage protection | $T_{P1}$ = +25°C, $V_I$ = 48 V, 0-100% of max $I_O$ | | 3.9 | | V |
| RC | Sink current, {see Note 3} | See operating information | 10 | | | mA |
| | Trigger level | See operating information | 2.5 | | | V |

{Note 1: hiccup mode }
{Note 2: Test condition: Electronic Capacitor and 10% ~ full load }
{Note 3: Sink current drawn by external device connected to the RC pin. Minimum sink current required to guarantee activated RC function.}

## Typical Characteristics
## 3.3 V, 4.5 A / 15 W

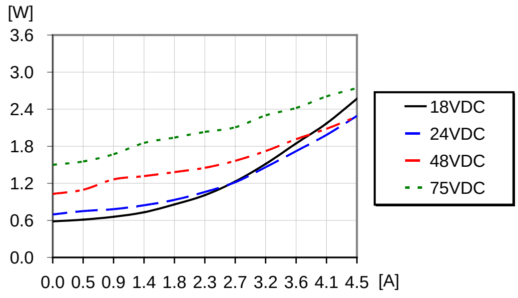
**PKE 5210 PI**

### Efficiency



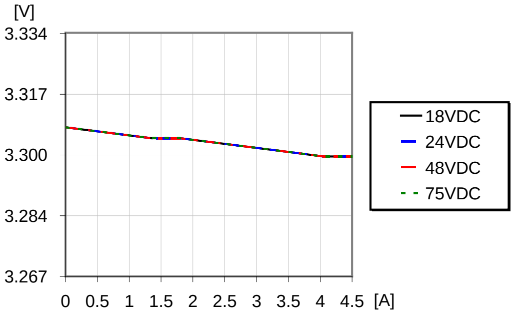

Efficiency vs. load current and input voltage at $T_{P1}$ = +25°C.

### Power Dissipation



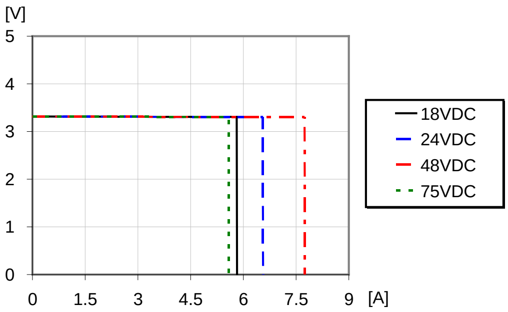

Dissipated power vs. load current and input voltage at $T_{P1}$ = +25°C.

### Output Characteristics



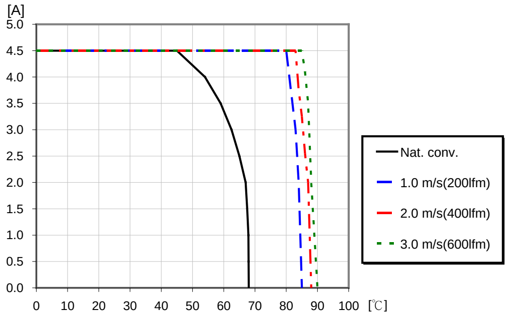

Output voltage vs. load current at $T_{P1}$ = +25°C.

### Current Limit Characteristics



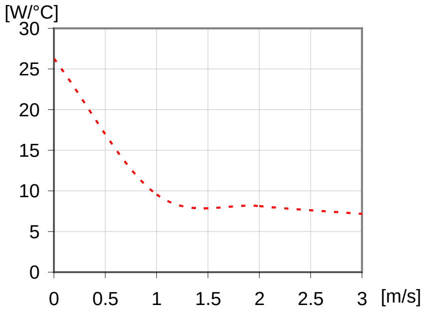

Output voltage vs. load current at $I_O$ > max $I_O$ , $T_{P1}$ = +25°C.

### Output Current Derating




Available load current vs. ambient air temperature and airflow at $V_I$ = 48 V. See Thermal Consideration section.

### Thermal Resistance

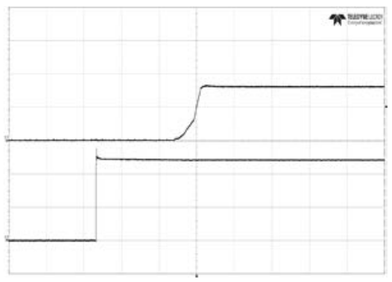



Thermal resistance vs. airspeed measured at the converter. Tested in wind tunnel with airflow and test conditions as per the Thermal consideration section.

## Typical Characteristics
## 3.3 V, 4.5 A / 15 W

**PKE 5210 PI**

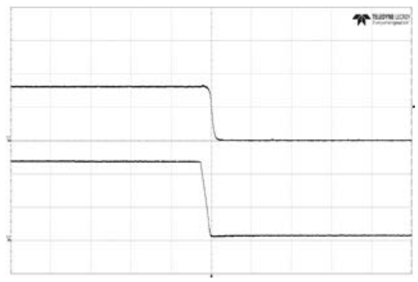
### Start-up



Start-up enabled by connecting $V_I$ at:
$T_{P1}$ = +25°C, $V_I$ = 48 V,
$I_O$ = 4.5 A electrical load.

Top trace: output voltage (2 V/div.).
Bottom trace: input voltage (20 V/div.).
Time scale: (2 ms/div.).

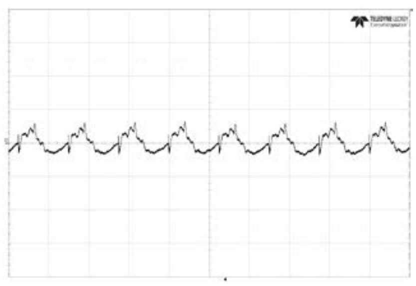
### Shut-down



Shut-down enabled by disconnecting $V_I$ at:
$T_{P1}$ = +25°C, $V_I$ = 48 V,
$I_O$ = 4.5 A electrical load.

Top trace: output voltage (2 V/div.).
Bottom trace: input voltage (20 V/div.).
Time scale: (1 ms/div.).

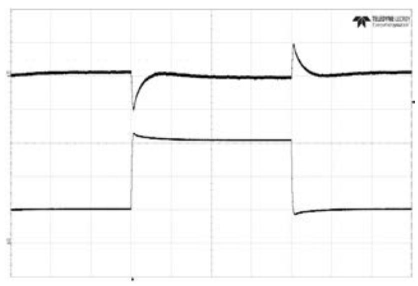
### Output Ripple & Noise



Output voltage ripple at:
$T_{P1}$ = +25°C, $V_I$ = 48 V,
$I_O$ = 4.5 A electrical load.

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

### Output Load Transient Response



Output voltage response to load current step-change (1.125-3.375-1.125 A) at:
$T_{P1}$ =+25°C, $V_I$ = 48 V.

Top trace: output voltage ({200 mV/div.).
Bottom trace: load current (1 A/div.).
Time scale: (0.5 ms/div.).

### Output Voltage Adjust (see operating information)

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

To adjust the output voltage upwards, a resistor is connected between pins 5 and 6. The output voltage increases when the resistance decreases. The resistance value is given by the equation:
Rou= 5.6 × (1.1406$V_{oi}$— $V_{od}$)/($V_{od}$ — $V_{oi}$),(KOhm); Vod is the desired output voltage and Voi is the initial output voltage.

To adjust the output voltage downwards, a resistor is connected between pins 4 and 5. The output voltage decreases when the resistance decreases. The resistance value is given by the equation:

Rod= 6.3875 × (1.1585$V_{od}$ —$V_{oi}$)/( $V_{oi}$ — $V_{od}$),(KOhm); Vod is the desired output voltage and Voi is the initial output voltage.

## Electrical Specification
## 5 V, 3 A / 15 W

**PKE 5211 PI**

$T_{P1}$ = -40 to +90ºC, $V_I$ = 18 to 75 V, unless otherwise specified under Conditions.
Typical values given at: $T_{P1}$ = +25°C, $V_I$= 48 $V_I$ max $I_O$, unless otherwise specified under Conditions.
Additional $C_{out}$ =22µF ceramic capacitor. See Operating Information section for selection of capacitor types.

| Characteristics | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| $V_I$ | Input voltage range | | 18 | | 75 | V |
| $V_{Ioff}$ | Turn-off input voltage | Decreasing input voltage | 14 | 15 | 16 | V |
| $V_{Ion}$ | Turn-on input voltage | Increasing input voltage | 15 | 16 | 17 | V |
| $C_I$ | Internal input capacitance | | | 1.14 | | µF |
| $P_O$ | Output power | | 0 | | 15 | W |
| η | Efficiency | 50% of max $I_O$ | | 84.3 | | % |
| | | max $I_O$ | | 88.2 | | |
| | | 50% of max $I_O$, $V_I$ = 24 V | | 88.3 | | |
| | | max $I_O$, $V_I$ = 24 V | | 89.0 | | |
| $P_d$ | Power Dissipation | max $I_O$ | | 1.9 | 5.0 | W |
| $P_{li}$ | Input idling power | $I_O$ = 0 A, $V_I$ = 48 V | | 1.409 | | W |
| $P_{RC}$ | Input standby power | $V_I$ = 48 V (turned off with RC) | | 0.388 | | W |
| $f_s$ | Switching frequency | {0-100} % of max $I_O$ | 340 | 400 | 460 | kHz |

| | | | | | | |
|---|---|---|---|---|---|---|
| $V_{Oi}$ | Output voltage initial setting and accuracy | $T_{P1}$ = +25°C, $V_I$ = 48 V, $I_O$ = 3 A | 4.94 | 5.00 | 5.06 | V |
| $V_O$ | Output adjust range | See operating information | 4.50 | | 5.50 | V |
| | Output voltage tolerance band | 0-100% of max $I_O$ | 4.8 | | 5.2 | V |
| | Idling voltage | $I_O$ = 0 A | 4.8 | | 5.2 | V |
| | Line regulation | max $I_O$ | | 2 | 10 | mV |
| | Load regulation | $V_I$ = 48 V, 10-100% of max $I_O$ | | 10 | 50 | mV |
| $V_{tr}$ | Load transient voltage deviation | $V_I$ = 48 V, Load step 25-75-25% of max $I_O$, di/dt = 1 A/µs | | ±220 | ±700 | mV |
| $t_{tr}$ | Load transient recovery time | | | 250 | 500 | µs |
| $t_r$ | Ramp-up time (from 10−90% of $V_{Oi}$) | 10-100% of max $I_O$ | 0.1 | 0.58 | 5 | ms |
| $t_s$ | Start-up time (from $V_I$ connection to 90% of $V_{Oi}$) | | 1 | 5 | 30 | ms |
| $t_f$ | $V_I$ shut-down fall time (from $V_I$ off to 10% of $V_O$) | max $I_O$ | | 0.36 | | ms |
| | | $I_O$ = 0A | | 0.95 | | s |
| $t_{RC}$ | RC start-up time | max $I_O$ | | 5.3 | | ms |
| | RC shut-down fall time (from RC off to 10% of $V_O$) | max $I_O$ | | 0.24 | | ms |
| | | $I_O$ = 0A | | 0.99 | | s |
| $I_O$ | Output current | | 0 | | 3 | A |
| $I_{lim}$ | Current limit threshold | $V_I$ = 48 V,$T_{P1}$ < max $T_{P1}$ | 3.3 | 6.0 | 8.8 | A |
| $I_{sc}$ | Short circuit current | $T_{P1}$ = 25ºC, {see Note 1} | 3.3 | 6.0 | 8.8 | A |
| $C_{out}$ | Recommended Capacitive Load | $T_{P1}$ = 25ºC, {see Note 2} | 0 | | 3000 | µF |
| $V_{Oac}$ | Output ripple & noise | See ripple & noise section, $V_{Oi}$ | | 14 | 75 | mVp-p |
| OVP | Over voltage protection | $T_{P1}$ = +25°C, $V_I$ = 48 V, 0-100% of max $I_O$ | | 6.2 | | V |
| RC | Sink current, {see Note 3} | See operating information | 10 | | | mA |
| | Trigger level | See operating information | 2.5 | | | V |

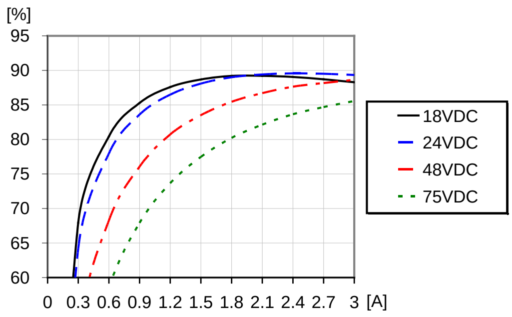
{Note 1: hiccup mode }
{Note 2: Test condition: Electronic Capacitor and 10% load ~ full load }
{Note 3: Sink current drawn by external device connected to the RC pin. Minimum sink current required to guarantee activated RC function.}

## Typical Characteristics

## 5 V, 3 A / 15 W

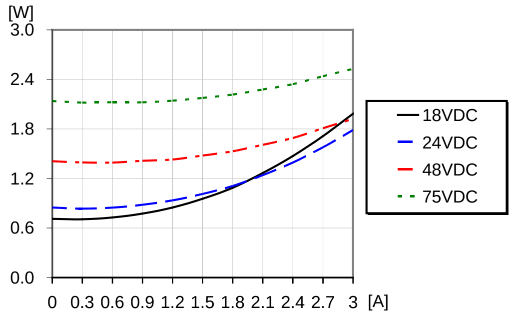
**PKE 5211 PI**

### Efficiency



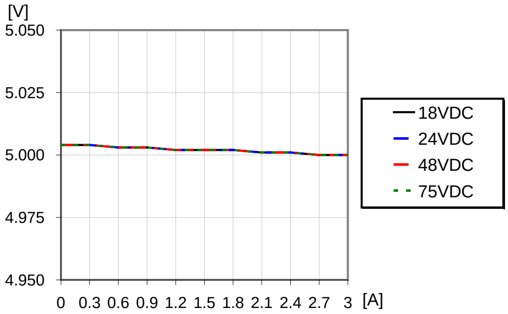

Efficiency vs. load current and input voltage at $T_{P1}$ = +25°C.

### Power Dissipation



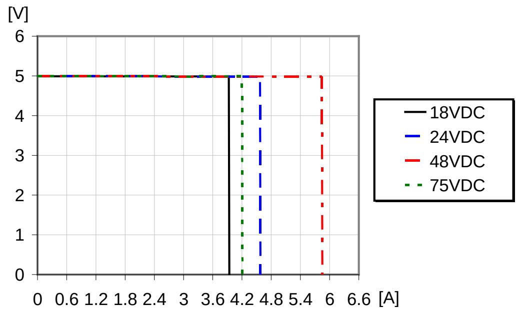

Dissipated power vs. load current and input voltage at $T_{P1}$ = +25°C.

### Output Characteristics



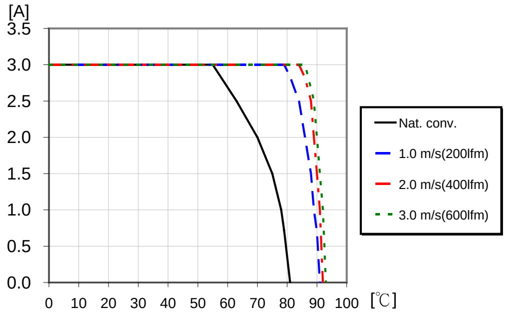

Output voltage vs. load current at $T_{P1}$ = +25°C.

### Current Limit Characteristics



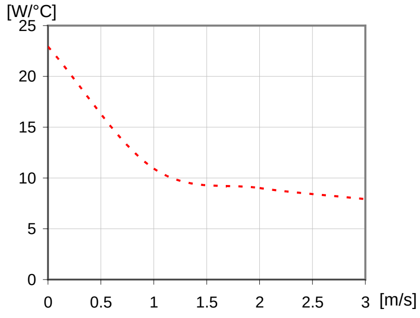

Output voltage vs. load current at $I_O$ > max $I_O$ , $T_{P1}$ = +25°C.

### Output Current Derating




Available load current vs. ambient air temperature and airflow at $V_I$ = 48 V. See Thermal Consideration section.

### Thermal Resistance

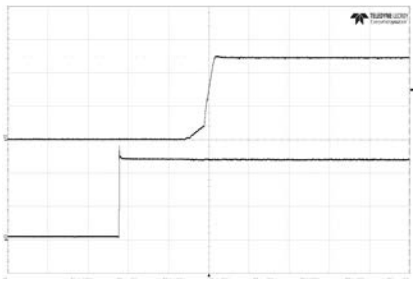



Thermal resistance vs. airspeed measured at the converter. Tested in wind tunnel with airflow and test conditions as per the Thermal consideration section.

## Typical Characteristics
## 5 V, 3 A / 15 W

**PKE 5211 PI**

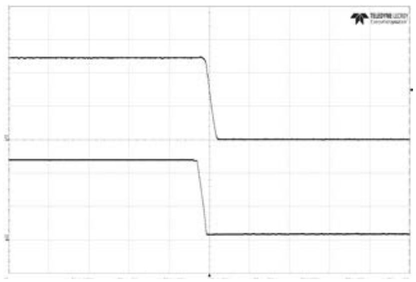
### Start-up



Start-up enabled by connecting $V_I$ at:
$T_{P1}$ = +25°C, $V_I$ = 48 V,
$I_O$ = 3 A electrical load.

Top trace: output voltage (2 V/div.).
Bottom trace: input voltage (20 V/div.).
Time scale: (2 ms/div.).

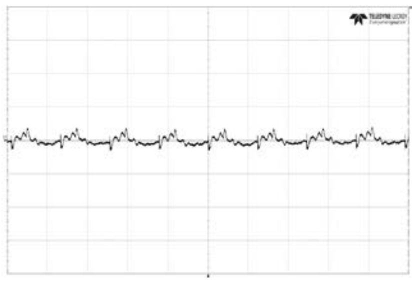
### Shut-down



Shut-down enabled by disconnecting $V_I$ at:
$T_{P1}$ = +25°C, $V_I$ = 48 V,
$I_O$ = 3 A electrical load.

Top trace: output voltage (2 V/div.).
Bottom trace: input voltage (20 V/div.).
Time scale: (1 ms/div.).

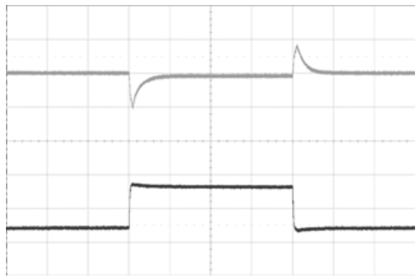
### Output Ripple & Noise



Output voltage ripple at:
$T_{P1}$ = +25°C, $V_I$ = 48 V,
$I_O$ = 3 A electrical load.

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

### Output Load Transient Response



Output voltage response to load current step-change (0.75-2.25-0.75 A) at:
$T_{P1}$ =+25°C, $V_I$ = 48 V.

Top trace: output voltage ({200 mV/div.).
Bottom trace: load current (1 A/div.).
Time scale: (0.5 ms/div.).

### Output Voltage Adjust (see operating information)

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

To adjust the output voltage upwards, a resistor is connected between pins 5 and 6. The output voltage increases when the resistance decreases. The resistance value is given by the equation:
Rou= 3.3 × (1.1515$V_{oi}$— $V_{od}$)/($V_{od}$ — $V_{oi}$),(KOhm); Vod is the desired output voltage and Voi is the initial output voltage.

To adjust the output voltage downwards, a resistor is connected between pins 4 and 5. The output voltage decreases when the resistance decreases. The resistance value is given by the equation:

Rod= 3.8 × (1.1316$V_{od}$ —$V_{oi}$)/( $V_{oi}$ — $V_{od}$),(KOhm); Vod is the desired output voltage and Voi is the initial output voltage.

## Electrical Specification
## 12 V, 1.25 A / 15 W

**PKE 5213 PI**

$T_{P1}$ = -40 to +90ºC, $V_I$ = 18 to 75 V, unless otherwise specified under Conditions.
Typical values given at: $T_{P1}$ = +25°C, $V_I$= 48 V, max $I_O$, unless otherwise specified under Conditions.
Additional $C_{out}$ =22µF ceramic capacitor. See Operating Information section for selection of capacitor types.

| Characteristics | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| $V_I$ | Input voltage range | | 18 | | 75 | V |
| $V_{Ioff}$ | Turn-off input voltage | Decreasing input voltage | 14 | 15 | 16 | V |
| $V_{Ion}$ | Turn-on input voltage | Increasing input voltage | 15 | 16 | 17 | V |
| $C_I$ | Internal input capacitance | | | 1.14 | | µF |
| $P_O$ | Output power | | 0 | | 15 | W |
| η | Efficiency | 50% of max $I_O$ | | 86.3 | | % |
| | | max $I_O$ | | 88.7 | | |
| | | 50% of max $I_O$, $V_I$ = 24 V | | 87.4 | | |
| | | max $I_O$, $V_I$ = 24 V | | 89.6 | | |
| $P_d$ | Power Dissipation | max $I_O$ | | 1.9 | 5.0 | W |
| $P_{li}$ | Input idling power | $I_O$ = 0 A, $V_I$ = 48 V | | 0.760 | | W |
| $P_{RC}$ | Input standby power | $V_I$ = 48 V (turned off with RC) | | 0.388 | | W |
| $f_s$ | Switching frequency | {0-100} % of max $I_O$ | 340 | 400 | 460 | kHz |

| | | | | | | |
|---|---|---|---|---|---|---|
| $V_{Oi}$ | Output voltage initial setting and accuracy | $T_{P1}$ = +25°C, $V_I$ = 48 V, $I_O$ = 1.25 A | 11.85 | 12.00 | 12.15 | V |
| $V_O$ | Output adjust range | See operating information | 10.8 | | 13.2 | V |
| | Output voltage tolerance band | 0-100% of max $I_O$ | 11.52 | | 12.48 | V |
| | Idling voltage | $I_O$ = 0 A | 11.52 | | 12.48 | V |
| | Line regulation | max $I_O$ | | 2 | 24 | mV |
| | Load regulation | $V_I$ = 48 V, 10-100% of max $I_O$ | | 5 | 120 | mV |
| $V_{tr}$ | Load transient voltage deviation | $V_I$ = 48 V, Load step 25-75-25% of max $I_O$, di/dt = 1 A/µs | | ±250 | ±700 | mV |
| $t_{tr}$ | Load transient recovery time | | | 200 | 500 | µs |
| $t_r$ | Ramp-up time (from 10−90% of $V_{Oi}$) | 10-100% of max $I_O$ | 0.1 | 0.91 | 5 | ms |
| $t_s$ | Start-up time (from $V_I$ connection to 90% of $V_{Oi}$) | | 1 | 5 | 30 | ms |
| $t_f$ | $V_I$ shut-down fall time (from $V_I$ off to 10% of $V_O$) | max $I_O$ | | 0.61 | | ms |
| | | $I_O$ = 0A | | 0.25 | | s |
| $t_{RC}$ | RC start-up time | max $I_O$ | | 7.0 | | ms |
| | RC shut-down fall time (from RC off to 10% of $V_O$) | max $I_O$ | | 0.41 | | ms |
| | | $I_O$ = 0A | | 0.20 | | s |
| $I_O$ | Output current | | 0 | | 1.25 | A |
| $I_{lim}$ | Current limit threshold | $V_I$ = 48 V,$T_{P1}$ < max $T_{P1}$ | 1.3 | 2.5 | 3.7 | A |
| $I_{sc}$ | Short circuit current | $T_{P1}$ = 25ºC, {see Note 1} | 1.3 | 2.5 | 3.7 | A |
| $C_{out}$ | Recommended Capacitive Load | $T_{P1}$ = 25ºC, {see Note 2} | 0 | | 470 | µF |
| $V_{Oac}$ | Output ripple & noise | See ripple & noise section, $V_{Oi}$ | | 13 | 75 | mVp-p |
| OVP | Over voltage protection | $T_{P1}$ = +25°C, $V_I$ = 48 V, 0-100% of max $I_O$ | | 15 | | V |
| RC | Sink current, {see Note 3} | See operating information | 10 | | | mA |
| | Trigger level | See operating information | 2.5 | | | V |

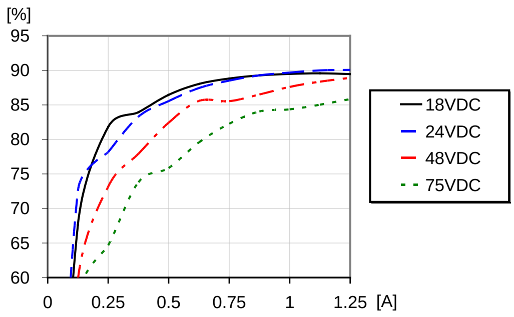
{Note 1: hiccup mode }
{Note 2: Test condition: Electronic Capacitor and 10% load ~ full load }
{Note 3: Sink current drawn by external device connected to the RC pin. Minimum sink current required to guarantee activated RC function.}

| **PKE 5000 series** Direct Converters<br>Input 18-75 V, Output up to 4.5 A / 15 W | 2/28701-BMR710 Rev. D April 2016 |
|---|---|
| | © Ericsson AB |

**PKE 5213 PI**

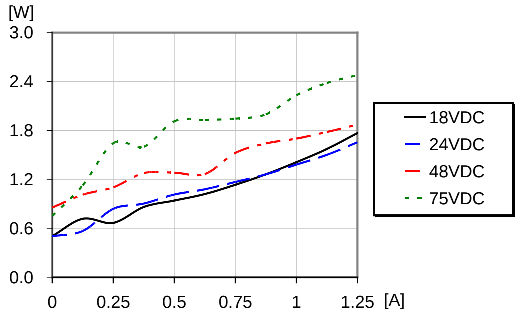
## Typical Characteristics
## 12 V, 1.25 A / 15 W

### Efficiency



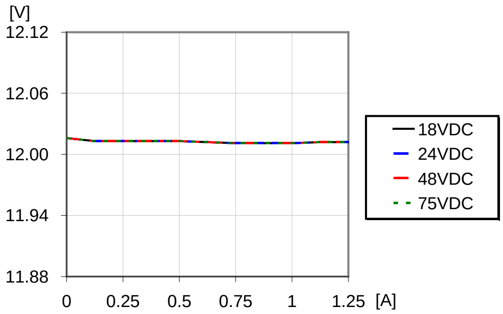

Efficiency vs. load current and input voltage at $T_{P1}$ = +25°C.

### Power Dissipation



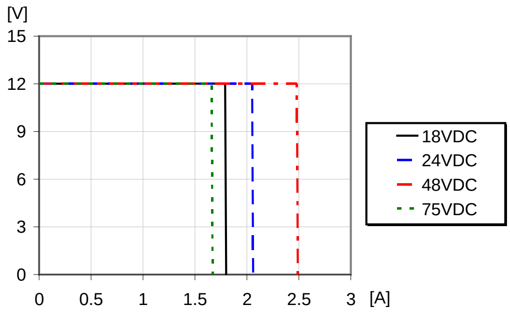

Dissipated power vs. load current and input voltage at $T_{P1}$ = +25°C.

### Output Characteristics



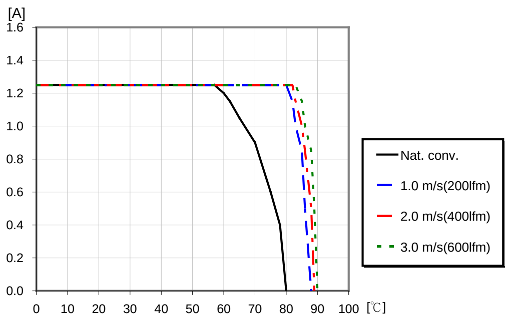

Output voltage vs. load current at $T_{P1}$ = +25°C.

### Current Limit Characteristics



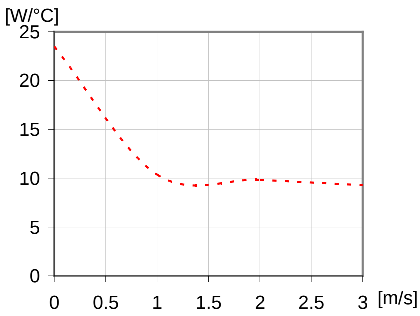

Output voltage vs. load current at $I_O$ > max $I_O$ , $T_{P1}$ = +25°C.

### Output Current Derating




Available load current vs. ambient air temperature and airflow at $V_I$ = 48 V. See Thermal Consideration section.

### Thermal Resistance

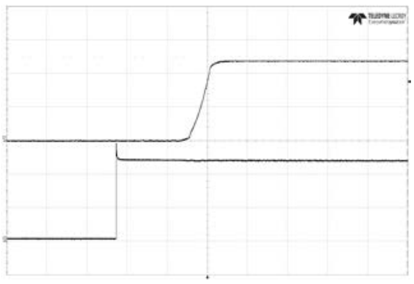



Thermal resistance vs. airspeed measured at the converter. Tested in wind tunnel with airflow and test conditions as per the Thermal consideration section.

## Typical Characteristics
## 12 V, 1.25 A / 15 W

**PKE 5213 PI**

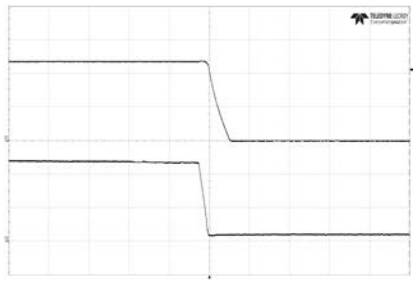
### Start-up



Start-up enabled by connecting $V_I$ at:
$T_{P1}$ = +25°C, $V_I$ = 48 V,
$I_O$ = 1.25 A electrical load.

Top trace: output voltage (5 V/div.).
Bottom trace: input voltage (20 V/div.).
Time scale: (2 ms/div.).

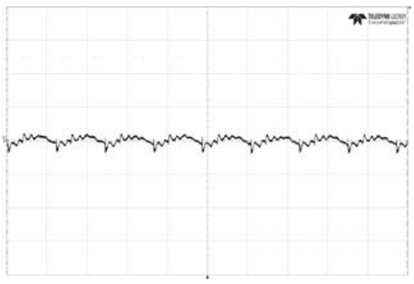
### Shut-down



Shut-down enabled by disconnecting $V_I$ at:
$T_{P1}$ = +25°C, $V_I$ = 48 V,
$I_O$ = 1.25 A electrical load.

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

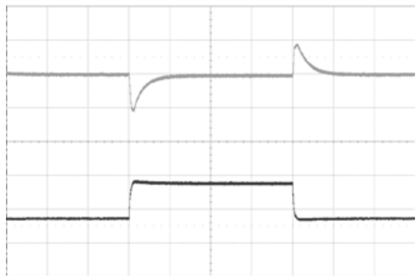
### Output Ripple & Noise



Output voltage ripple at:
$T_{P1}$ = +25°C, $V_I$ = 48 V,
$I_O$ = 1.25 A electrical load.

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

### Output Load Transient Response



Output voltage response to load current step-change (0.312-0.937-0.312 A) at:
$T_{P1}$ =+25°C, $V_I$ = 48 V.

Top trace: output voltage ({200 mV/div.).
Bottom trace: load current (0.5 A/div.).
Time scale: (0.5 ms/div.).

### Output Voltage Adjust (see operating information)

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

To adjust the output voltage upwards, a resistor is connected between pins 5 and 6. The output voltage increases when the resistance decreases. The resistance value is given by the equation:
Rou= 22 × (1.1633$V_{oi}$— $V_{od}$)/($V_{od}$ — $V_{oi}$),(KOhm); Vod is the desired output voltage and Voi is the initial output voltage.

To adjust the output voltage downwards, a resistor is connected between pins 4 and 5. The output voltage decreases when the resistance decreases. The resistance value is given by the equation:

Rod= 25.5924 × (1.1390$V_{od}$ —$V_{oi}$)/( $V_{oi}$ — $V_{od}$),(KOhm); Vod is the desired output voltage and Voi is the initial output voltage.

## Electrical Specification
## 15 V, 1 A / 15 W

**PKE 5215 PI**

$T_{P1}$ = -40 to +90ºC, $V_I$ = 18 to 75 V, unless otherwise specified under Conditions.
Typical values given at: $T_{P1}$ = +25°C, $V_I$= 48 V, max $I_O$, unless otherwise specified under Conditions.
Additional $C_{out}$ =22µF ceramic capacitor. See Operating Information section for selection of capacitor types.

| Characteristics | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|
| $V_I$ | Input voltage range | | 18 | | 75 | V |
| $V_{Ioff}$ | Turn-off input voltage | Decreasing input voltage | 14 | 15 | 16 | V |
| $V_{Ion}$ | Turn-on input voltage | Increasing input voltage | 15 | 16 | 17 | V |
| $C_I$ | Internal input capacitance | | | 1.14 | | µF |
| $P_O$ | Output power | | 0 | | 15 | W |
| η | Efficiency | 50% of max $I_O$ | | 84.4 | | % |
| | | max $I_O$ | | 88.1 | | |
| | | 50% of max $I_O$, $V_I$ = 24 V | | 86.9 | | |
| | | max $I_O$, $V_I$ = 24 V | | 89.6 | | |
| $P_d$ | Power Dissipation | max $I_O$ | | 2.0 | 5.0 | W |
| $P_{li}$ | Input idling power | $I_O$ = 0 A, $V_I$ = 48 V | | 0.460 | | W |
| $P_{RC}$ | Input standby power | $V_I$ = 48 V (turned off with RC) | | 0.390 | | W |
| $f_s$ | Switching frequency | {0-100} % of max $I_O$ | 340 | 400 | 460 | kHz |

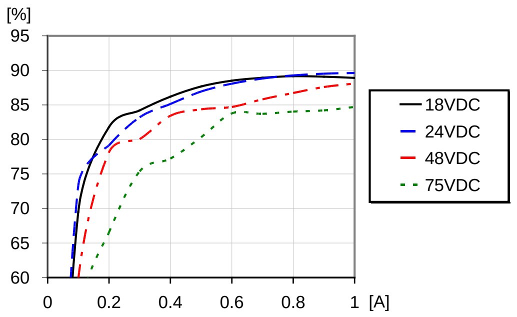
| | | | | | | |
|---|---|---|---|---|---|---|
| $V_{Oi}$ | Output voltage initial setting and accuracy | $T_{P1}$ = +25°C, $V_I$ = 48 V, $I_O$ = 1 A | 14.82 | 15.00 | 15.18 | V |
| $V_O$ | Output adjust range | See operating information | 13.50 | | 16.50 | V |
| | Output voltage tolerance band | 0-100% of max $I_O$ | 14.4 | | 15.6 | V |
| | Idling voltage | $I_O$ = 0 A | 14.4 | | 15.6 | V |
| | Line regulation | max $I_O$ | | 2 | 30 | mV |
| | Load regulation | $V_I$ = 48 V, 10-100% of max $I_O$ | | 4 | 150 | mV |
| $V_{tr}$ | Load transient voltage deviation | $V_I$ = 48 V, Load step 25-75-25% of max $I_O$, di/dt = 1 A/µs | | ±200 | ±700 | mV |
| $t_{tr}$ | Load transient recovery time | | | 250 | 500 | µs |
| $t_r$ | Ramp-up time (from 10−90% of $V_{Oi}$) | 10-100% of max $I_O$ | 0.1 | 0.85 | 5 | ms |
| $t_s$ | Start-up time (from $V_I$ connection to 90% of $V_{Oi}$) | | 1 | 6 | 30 | ms |
| $t_f$ | $V_I$ shut-down fall time (from $V_I$ off to 10% of $V_O$) | max $I_O$ | | 0.88 | | ms |
| | | $I_O$ = 0A | | 0.57 | | s |
| $t_{RC}$ | RC start-up time | max $I_O$ | | 7.1 | | ms |
| | RC shut-down fall time (from RC off to 10% of $V_O$) | max $I_O$ | | 0.61 | | ms |
| | | $I_O$ = 0A | | 0.63 | | s |
| $I_O$ | Output current | | 0 | | 1.0 | A |
| $I_{lim}$ | Current limit threshold | $V_I$ = 48 V,$T_{P1}$ < max $T_{P1}$ | 1.1 | 2.0 | 2.9 | A |
| $I_{sc}$ | Short circuit current | $T_{P1}$ = 25ºC, {see Note 1} | 1.1 | 2.0 | 2.9 | A |
| $C_{out}$ | Recommended Capacitive Load | $T_{P1}$ = 25ºC, {see Note 2} | 0 | | 470 | µF |
| $V_{Oac}$ | Output ripple & noise | See ripple & noise section, $V_{Oi}$ | | 14 | 75 | mVp-p |
| OVP | Over voltage protection | $T_{P1}$ = +25°C, $V_I$ = 48 V, 0-100% of max $I_O$ | | 18 | | V |
| RC | Sink current, {see Note 3} | See operating information | 10 | | | mA |
| | Trigger level | See operating information | 2.5 | | | V |

{Note 1: hiccup mode }
{Note 2: Test condition: Electronic Capacitor and 10% load ~ full load }
{Note 3: Sink current drawn by external device connected to the RC pin. Minimum sink current required to guarantee activated RC function.}

## Typical Characteristics
## 15 V, 1 A / 15 W

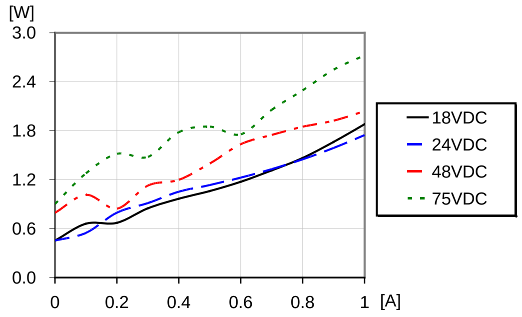
**PKE 5215 PI**

### Efficiency



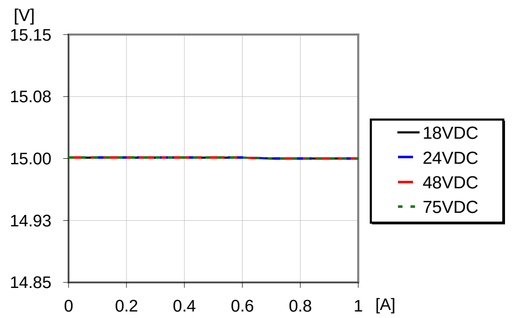

Efficiency vs. load current and input voltage at $T_{P1}$ = +25°C.

### Power Dissipation



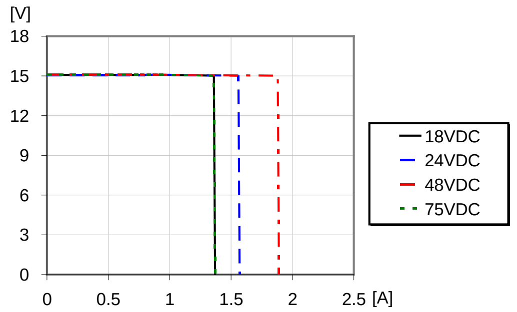

Dissipated power vs. load current and input voltage at $T_{P1}$ = +25°C.

### Output Characteristics



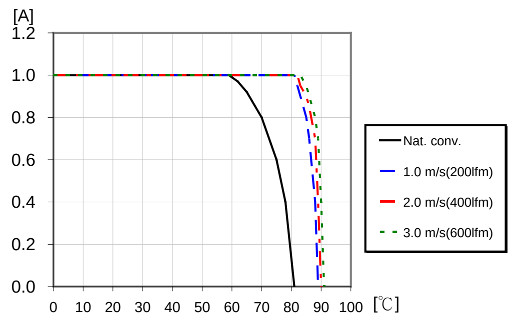

Output voltage vs. load current at $T_{P1}$ = +25°C.

### Current Limit Characteristics



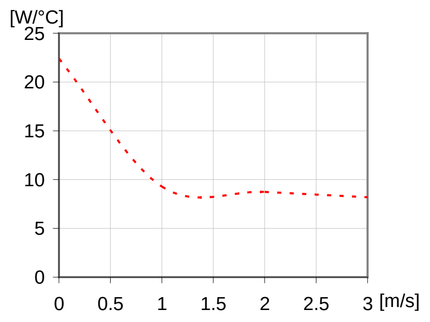

Output voltage vs. load current at $I_O$ > max $I_O$ , $T_{P1}$ = +25°C.

### Output Current Derating




Available load current vs. ambient air temperature and airflow at $V_I$ = 48 V. See Thermal Consideration section.

### Thermal Resistance

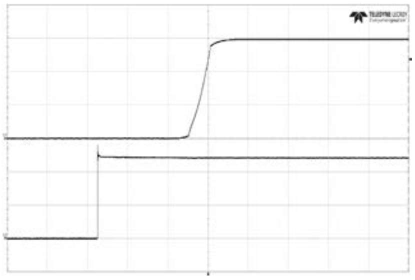



Thermal resistance vs. airspeed measured at the converter. Tested in wind tunnel with airflow and test conditions as per the Thermal consideration section.

## Typical Characteristics
## 15 V, 1 A / 15 W

**PKE 5215 PI**

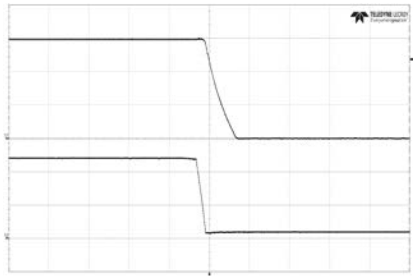
### Start-up



Start-up enabled by connecting $V_I$ at:
$T_{P1}$ = +25°C, $V_I$ = 48 V,
$I_O$ = 1 A electrical load.

Top trace: output voltage (5 V/div.).
Bottom trace: input voltage (20 V/div.).
Time scale: (2 ms/div.).

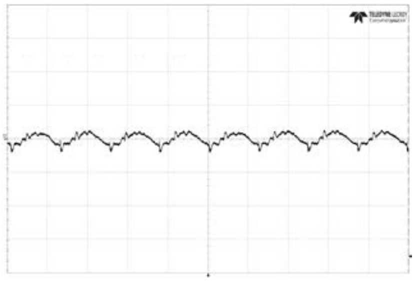
### Shut-down



Shut-down enabled by disconnecting $V_I$ at:
$T_{P1}$ = +25°C, $V_I$ = 48 V,
$I_O$ = 1 A electrical load.

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

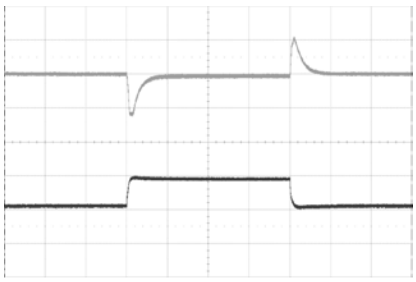
### Output Ripple & Noise



Output voltage ripple at:
$T_{P1}$ = +25°C, $V_I$ = 48 V,
$I_O$ = 1 A electrical load.

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

### Output Load Transient Response



Output voltage response to load current step-change (0.25-0.75-0.25 A) at:
$T_{P1}$ =+25°C, $V_I$ = 48 V.

Top trace: output voltage ({200 mV/div.).
Bottom trace: load current (0.5 A/div.).
Time scale: (0.5 ms/div.).

### Output Voltage Adjust (see operating information)

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

To adjust the output voltage upwards, a resistor is connected between pins 5 and 6. The output voltage increases when the resistance decreases. The resistance value is given by the equation:
Rou= 30 × (1.1499$V_{oi}$— $V_{od}$)/($V_{od}$ — $V_{oi}$),(KOhm); Vod is the desired output voltage and Voi is the initial output voltage.

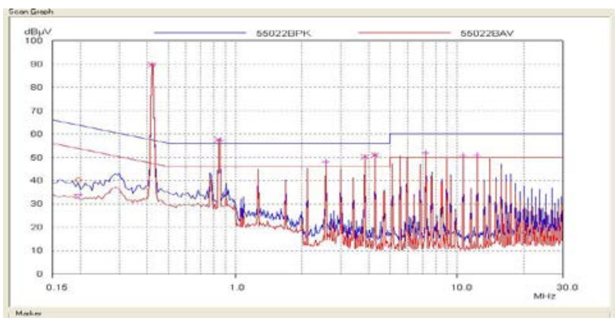
To adjust the output voltage downwards, a resistor is connected between pins 4 and 5. The output voltage decreases when the resistance decreases. The resistance value is given by the equation:

Rod= 34.497 × (1.1331$V_{od}$ —$V_{oi}$)/( $V_{oi}$ — $V_{od}$),(KOhm); Vod is the desired output voltage and Voi is the initial output voltage.

## EMC Specification

Conducted EMI measured according to EN55022, CISPR 22 and FCC part 15J (see test set-up). See Design Note 029 for further information. The fundamental switching frequency is 400 kHz for PKE 5211 PI at $V_I$ = 48 V and max $I_O$.

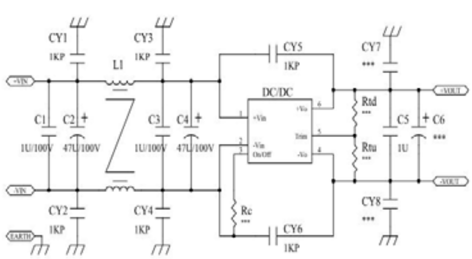
**Conducted EMI** Input terminal value (typ)



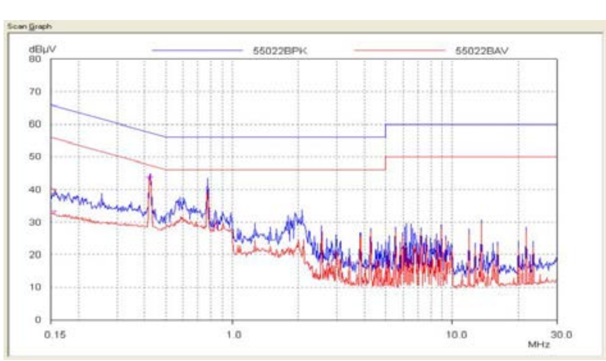

*EMI without filter*

### Optional external filter for class B

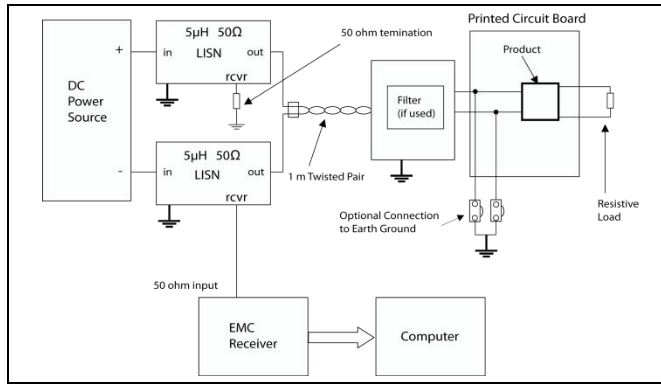
Suggested external input filter in order to meet class B in EN 55022, CISPR 22 and FCC part 15J.




Filter components:
C1,3 = 1 uF
C2,4 = 47 uF
C5 = 1 uF
CY1,2,3,4,5,6 = 1nF
L1 = 1500 uH




*EMI with filter*




*Test set-up*

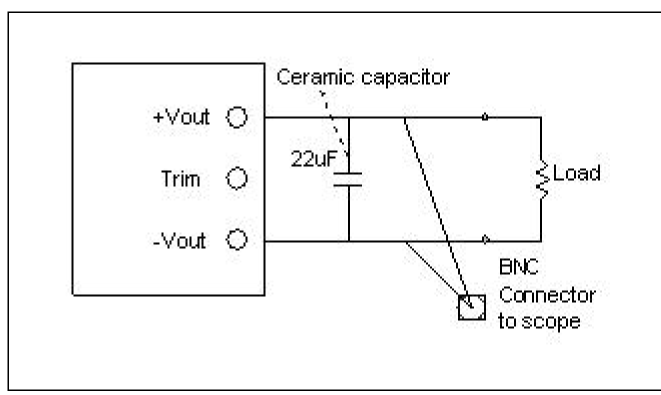
### Layout recommendations

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.

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.




*Output ripple and noise test setup*

| **PKE 5000 series** Direct Converters<br>Input 18-75 V, Output up to 4.5 A / 15 W | 2/28701-BMR710 Rev. D April 2016<br>© Ericsson AB |
|---|---|

## Operating information

### Input Voltage

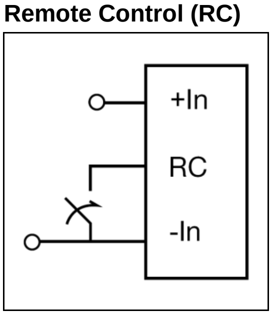
The input voltage range is 18 to 75 Vdc.
At input voltages exceeding 75 V, the power loss will be higher than at normal input voltage and $T_{P1}$ must be limited to absolute max +110°C. The absolute maximum continuous input voltage is 75 Vdc.

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 value 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 about 1 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 – 6 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 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 22 - 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. Approximately doubled capacitance value is required for a 24 V input voltage source compared to a 48 V input voltage source.

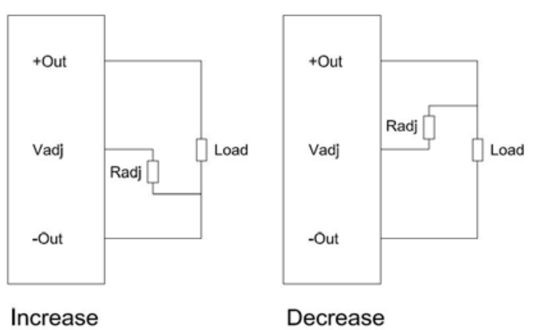
### External Decoupling Capacitors

When powering loads with significant dynamic current requirements, the voltage regulation at the point of load can be improved by addition of decoupling capacitors at the load. The most effective technique is to locate low ESR ceramic and electrolytic capacitors as close to the load as possible, using several parallel capacitors to lower the effective ESR. The ceramic capacitors will handle high-frequency dynamic load changes while the electrolytic capacitors are used to handle low frequency dynamic load changes. 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 Ericsson 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 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.




**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 115°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 >5°C below the temperature threshold.

**Over Voltage Protection (OVP)**

The converters have output over voltage protection that will prevent output voltage to exceed the specified value in technical specification.

The converter will limit the output voltage to the maximum level. Converters will 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.

| **PKE 5000 series** Direct Converters<br>Input 18-75 V, Output up to 4.5 A / 15 W | 2/28701-BMR710 Rev. D April 2016<br>© Ericsson AB |
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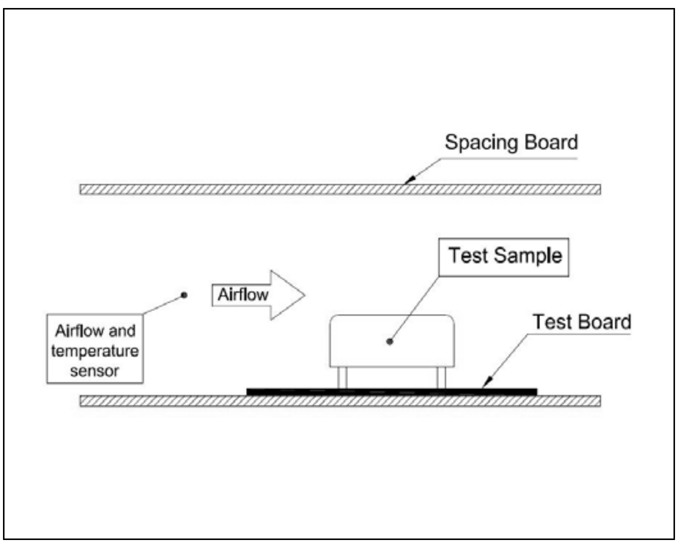
## Thermal Consideration

### General

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

For products mounted on a PWB without a heat sink attached, cooling is achieved mainly by conduction, from the pins to the host board, and convection, which is dependant on the airflow across the product. Increased airflow enhances the cooling of the product. The Output Current Derating graph found in the Output section for each model provides the available output current vs. ambient air temperature and air velocity at $V_I = 48$ V.

The product is tested on a 107 x 45 mm, 70 µm (2 oz), 1-layer test board in a wind box with 370 x 220 mm.

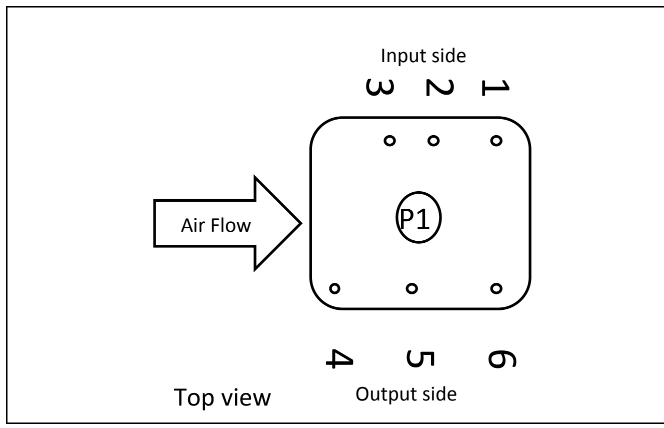



For products with base plate used in a sealed box application. Cooling is achieved mainly by airflowing. The Output Current Derating graphs are found in the Output section for each model. The product is tested in a sealed box test set up with ambient temperatures 25°C.

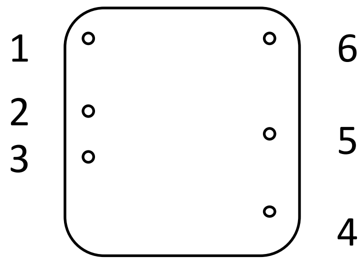
### Definition of product operating temperature

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 ($T_{P1}$) should not exceed the maximum temperatures in the table below. Temperature above maximum $T_{P1}$, measured at the reference point P1 are not allowed and may cause permanent damage.

| Position | Description | Max Temp. |
|---|---|---|
| {P1} | {Reference point} | {$T_{P1}$=110º C} |

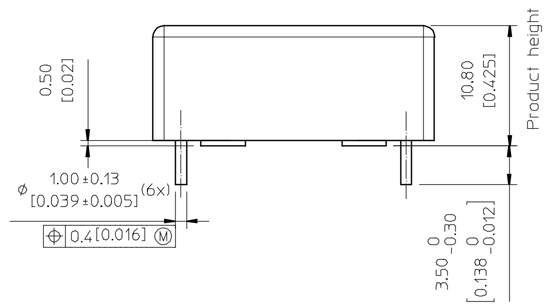


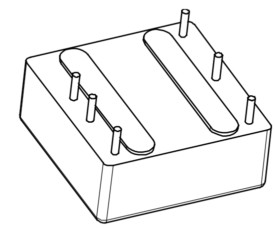
**Connections**



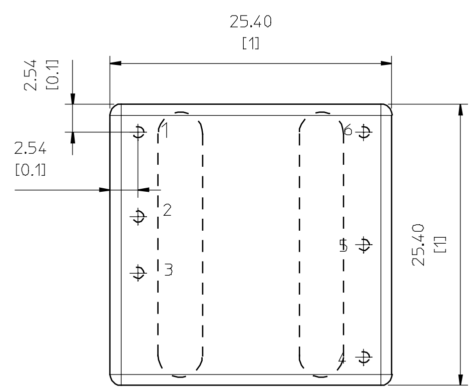

| Pin | Designation | Function |
|---|---|---|
| 1 | On/Off Control | Remote control |
| 2 | -Input | Negative input |
| 3 | +Input | Positive input |
| 4 | +Out | Positive output |
| 5 | TRIM | Output voltage adjust |
| 6 | -Out | Negative output |

**Mechanical Information -**

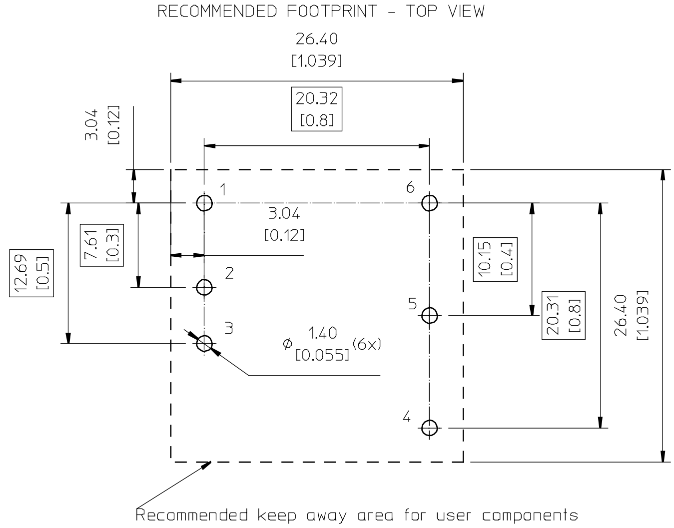


TOP VIEW
Pin positions according to recommended footprint




RECOMMENDED FOOTPRINT - TOP VIEW




Notes:

1 Pins:
-Material: Brass
-Plating: Tin plated

2 Case:
-Material: Copper
-Plating: Spray painting

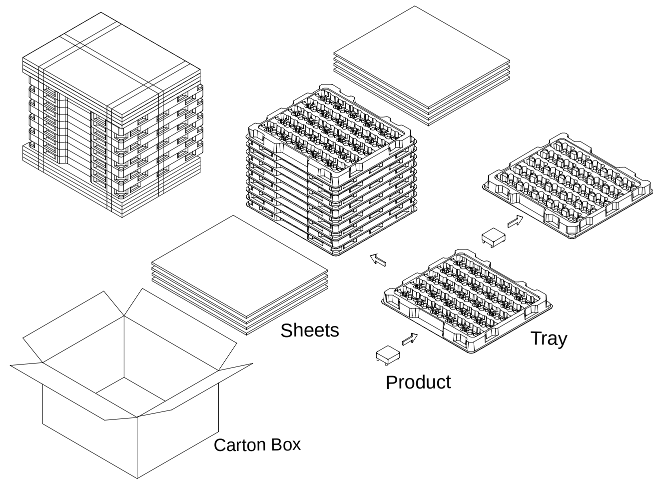
Weight: typical 16 g
All dimensions in mm [inch].
Tolerances unless specified
x.x mm ±1.016 mm [0.04], x.xx mm ±0.254 mm [0.010]
(not applied on footprint or typical values)

## 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.

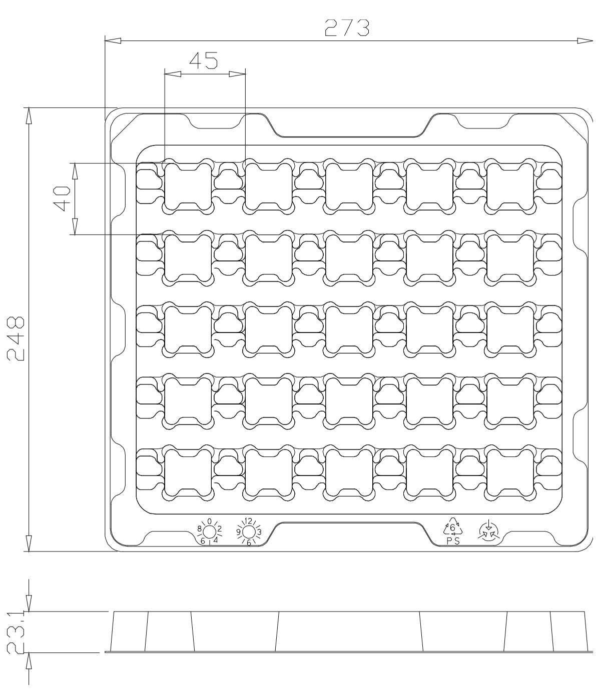
A no-clean flux is recommended to avoid entrapment of cleaning fluids in cavities inside the product or between the product and the host board. The cleaning residues may affect long time reliability and isolation voltage.




## Delivery Package Information

The products are delivered in antistatic clamshell trays

| Tray Specifications | |
|---|---|
| **Material** | Antistatic PS |
| **Surface resistance** | $10^5$ < Ohm/square < $10^{11}$ |
| **Bakability** | This tray is not bake-able |
| **Tray thickness** | 23.1 mm [0.9094 inch] |
| **Box capacity** | 250 products (10 full trays/box) |
| **Tray weight** | 60 g empty, 510 g full tray |



### Product Qualification Specification

| Characteristics | | | |
|---|---|---|---|
| External visual inspection | IPC-E-610 | | |
| Change of temperature (Temperature cycling) | IEC 60068-2-14 Na | Temperature range<br>Number of cycles<br>Dwell/transfer time | -55 to 105°C<br>20<br>30 min/3 min |
| Cold (in operation) | IEC 60068-2-1 | Temperature $T_A$<br>Duration | -45°C<br>72 h |
| Damp heat | IEC 60068-2-30 | Temperature<br>Humidity<br>Duration | 45°C<br>95 % RH<br>72 hours |
| Electrostatic discharge susceptibility | IEC 61340-3-1, JESD 22-A114 | Human body model (HBM) | Class 2, 2000 V |
| Mechanical shock | IEC 60068-2-27 Ea | Peak acceleration<br>Duration | 200 g<br>6 ms |
| Operational life test | MIL-STD-202G, method 108A | Duration | 1000 h |
| Resistance to soldering heat | IEC 60068-2-20 Tb, method 1A | Solder temperature<br>Duration | 270°C<br>10-13 s |
| Robustness of terminations | IEC 60068-2-21 Test Ua1 | Through hole mount products | All leads |
| Solderability | IEC 60068-2-20 test Ta | Temperature, SnPb Eutectic<br>Temperature, Pb-free | 235°C<br>245°C |
| Vibration, broad band random | IEC 60068-2-64 Fh, method 1 | Frequency<br>Spectral density<br>Duration | 10 to 500 Hz<br>0.07 $g^2$/Hz<br>10 min in each direction |