

PKY 2000 PI series	EN/LZT 146 385 R2B March 2011
DC/DC converters, Input 18-36 V, Output 21.5 A/600 W	© Ericsson Power Modules AB

Key Features

- Full-brick Industry Standard  
116.8 x 61.0 x 12.7 mm (4.6 x 2.4 x 0.50 in.)
- High efficiency, typ. 95 % at 28 Vout within 30%-100% load range.
- 1500 Vdc input to output isolation
- Meets isolation requirements equivalent to basic insulation according to IEC/EN/UL 60950
- 2.6 million hours MTBF

General Characteristics

- Excellent thermal performance
- Output over voltage protection
- Input over voltage protection
- Input under voltage shutdown
- Over temperature protection
- Monotonic startup
- Remote sense
- Remote control
- Over current protection
- Output voltage adjust function
- Power Good Function.
- AUX voltage 10V, 50mA
- Highly automated manufacturing ensures quality
- ISO 9001/14001 certified supplier



Safety Approvals



Design for Environment



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

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## General Information

### Ordering Information

See Contents for individual product ordering numbers.

Option	Suffix	Ordering No.
Standard		PKY 2616 PI
Non-threaded stand off	M	PKY 2616 PIM
Negative Remote Control logic	N	PKY 2616 PIN

Note: As an example a negative logic with non-threaded stand off product would be PKY 2616 PINM.

### Reliability

The failure rate ( $\lambda$ ) and mean time between failures (MTBF= $1/\lambda$ ) is calculated at max output power and an operating ambient temperature ( $T_A$ ) of +40°C. 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, $\sigma$
381nFailures/h	37.3 nFailures/h

MTBF (mean value) for the PKY series = 2.6 Mh.

MTBF at 90% confidence level = 2.3 Mh

### Compatibility with RoHS requirements

The products are compatible with the relevant clauses and requirements of the RoHS directive 2002/95/EC 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).

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

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## Safety Specification

### General information

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

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

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

On-board DC/DC converters 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 should comply with the requirements in IEC 60950-1, EN 60950-1 and UL 60950-1 *Safety of Information Technology Equipment*. There are other more product related standards, e.g. IEEE 802.3 *CSMA/CD (Ethernet) Access Method*, and ETS-300132-2 *Power supply interface at the input to telecommunications equipment, operated by direct current (dc)*, but all of these standards are based on IEC/EN/UL 60950-1 with regards to safety.

Ericsson Power Modules DC/DC converters and DC/DC regulators are UL 60950-1 recognized and certified in accordance with EN 60950-1.

The flammability rating for all construction parts of the products meet requirements for V-0 class material according to IEC 60695-11-10, *Fire hazard testing, test flames* – 50 W horizontal and vertical flame test methods.

The products should be installed in the end-use equipment, in accordance with the requirements of the ultimate application. Normally the output of the DC/DC converter is considered as SELV (Safety Extra Low Voltage) and the input source must be isolated by minimum Double or Reinforced Insulation from the primary

circuit (AC mains) in accordance with IEC/EN/UL 60950-1.

### Isolated DC/DC converters

It is recommended that a slow blow fuse is to be used 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.

The galvanic isolation is verified in an electric strength test. The test voltage ( $V_{iso}$ ) between input and output is 1500 Vdc or 2250 Vdc (refer to product specification).

### 24 V DC systems

The input voltage to the DC/DC converter is SELV (Safety Extra Low Voltage) and the output remains SELV under normal and abnormal operating conditions.

### 48 and 60 V DC systems

If the input voltage to the DC/DC converter is 75 Vdc or less, then the output remains SELV (Safety Extra Low Voltage) under normal and abnormal operating conditions.

Single fault testing in the input power supply circuit should be performed with the DC/DC converter connected to demonstrate that the input voltage does not exceed 75 Vdc.

If the input power source circuit is a DC power system, the source may be treated as a TNV-2 circuit and testing has demonstrated compliance with SELV limits in accordance with IEC/EN/UL60950-1.

### Non-isolated DC/DC regulators

The input voltage to the DC/DC regulator is SELV (Safety Extra Low Voltage) and the output remains SELV under normal and abnormal operating conditions.

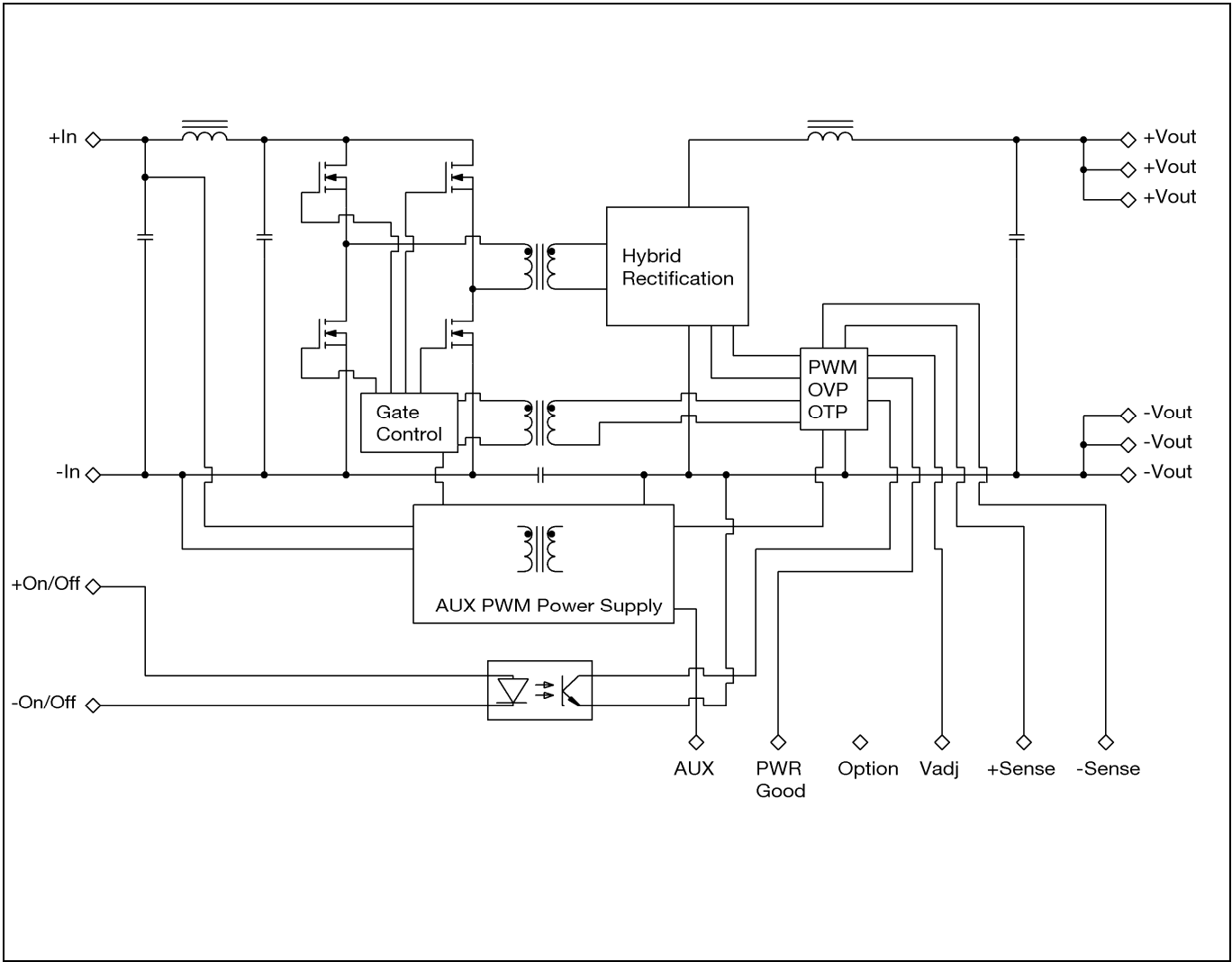
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Absolute Maximum Ratings

Characteristics		min	typ	max	Unit
$T_{ref}$	Operating Temperature (see Thermal Consideration section)	-40		+110	°C
$T_S$	Storage temperature	-55		+125	°C
$V_I$	Input voltage	-0.5		+40	V
$V_{iso}$	Isolation voltage	1500			Vdc
$V_{tr}$	Input voltage transient ( $t_p$ 100 ms)			+50	V
$V_{RC}$	Remote Control pin voltage (see Operating Information section)	Positive logic option		+12	V
		Negative logic option		+12	V
$V_{adj}$	Adjust pin voltage (see Operating Information section)	-0.5		+10	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 of Output data or Electrical Characteristics. If exposed to stress above these limits, function and performance may degrade in an unspecified manner.

Fundamental Circuit Diagram



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## 28V, 21.5A/600W Electrical Specification

## PKY 2616 PI

$T_{ref} = -40$  to  $+100^{\circ}\text{C}$ ,  $V_I = 18$  to  $36$  V, sense pins connected to output pins unless otherwise specified under Conditions.

Typical values given at:  $T_{P1} = +25^{\circ}\text{C}$ ,  $V_I = 27$  V,  $I_O = \max$ , unless otherwise specified under Conditions.

Additional  $C_{in} = 220$   $\mu\text{F}$ . See Operating Information section for selection of capacitor types.

Characteristics		Conditions	min	typ	max	Unit
$V_I$	Input voltage range		18		36	V
$V_{loff}$	Turn-off input voltage	Decreasing input voltage	15.8	16	16.9	V
$V_{lon}$	Turn-on input voltage	Increasing input voltage	16.6	17	17.6	V
$C_I$	Internal input capacitance			66		$\mu\text{F}$
$P_O$	Output power	Output voltage initial setting	0		600	W
$\eta$	Efficiency	50 % of max $I_O$ , $V_I = 27$ V		95		%
		max $I_O$ , $V_I = 27$ V	93.0	94,5		
		50 % of max $I_O$ , $V_I = 24$ V		95		
		max $I_O$ , $V_I = 24$ V	93.0	94,5		
$P_d$	Power Dissipation	max $I_O$ , $V_I = 27$ V		34.9	50	W
$P_{li}$	Input idling power	$I_O = 0$ A, $V_I = 27$ V		3	6.0	W
$P_{RC}$	Input standby power	$V_I = 27$ V (turned off with RC)		0.2	0.3	W
$f_s$	Switching frequency	1-100 % of max $I_O$	145	150	155	kHz
$V_{IOVP}$	Input over voltage protection	0-100 % of max $I_O$	38.8	40.1	41.1	V

$V_{Oi}$	Output voltage initial setting and accuracy	$T_{P1} = +25^{\circ}\text{C}$ , $V_I = 27$ V, $I_O = 21.5$ A	27.72	28.0	28.28	V
$V_O$	Output adjust range	See operating information	15.0		32.0	V
	Output voltage tolerance band	10-100 % of max $I_O$	27.58		28.42	V
	Idling voltage	$I_O = 0$ A	27.44		28.56	V
	Line regulation	max $I_O$		20	80	mV
	Load regulation	$V_I = 27$ V, 1-100 % of max $I_O$		30	80	mV
$V_{tr}$	Load transient voltage deviation	$V_I = 27$ V, Load step 25-75-25 % of max $I_O$ , $di/dt = 1$ A/ $\mu\text{s}$		$\pm 1500$		mV
$t_{tr}$	Load transient recovery time			30		$\mu\text{s}$
$t_r$	Ramp-up time (from 10-90 % of $V_{Oi}$ )	10-100 % of max $I_O$		10	15	ms
$t_s$	Start-up time (from $V_I$ connection to 90 % of $V_{Oi}$ )			17	22	ms
$t_f$	$V_I$ shut-down fall time (from $V_I$ off to 10 % of $V_O$ )	max $I_O$		0.06		ms
		$I_O = 0$ A		2.7		s
$t_{RC}$	RC start-up time	max $I_O$		15		ms
	RC shut-down fall time (from RC off to 10 % of $V_O$ )	max $I_O$		0.06		ms
		$I_O = 0$ A		2.7		s
$I_O$	Output current		0		21.5	A
$I_{lim}$	Current limit threshold	$T_{P1} < \max T_{P1}$	22	27	33.5	A
$I_{sc}$	Short circuit current	$T_{P1} = 25^{\circ}\text{C}$ , see Note 1		27.5	34	A
$C_{out}$	Recommended Capacitive Load	$T_{P1} = 25^{\circ}\text{C}$	0		see Note 2	$\mu\text{F}$
$V_{Oac}$	Output ripple & noise	See ripple & noise section, max $I_O$ , $V_{Oi}$		170	350	mVp-p
OVP	Over voltage protection	$T_{P1} = +25^{\circ}\text{C}$ , $V_I = 27$ V, 0-100 % of max $I_O$	36.6	39	41.4	V
$V_{aux}$	Auxiliary output voltage	$T_{P1} = +25^{\circ}\text{C}$ , $V_I = 27$ V, 0-100 % of max $I_O$	8	10	12	V
$I_{aux}$	Auxiliary output current	max $I_O$ , $V_I = 18-36$ V	0		0.05	A

Note 1: See Operating Information section.

Note 2: Please consult Ericsson FAE for detailed reference.

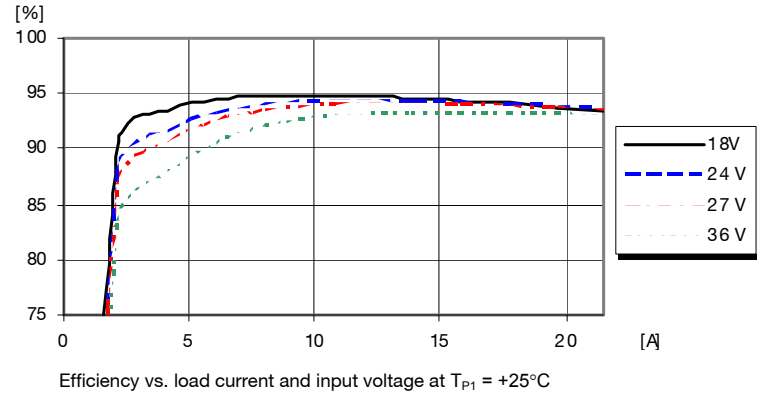
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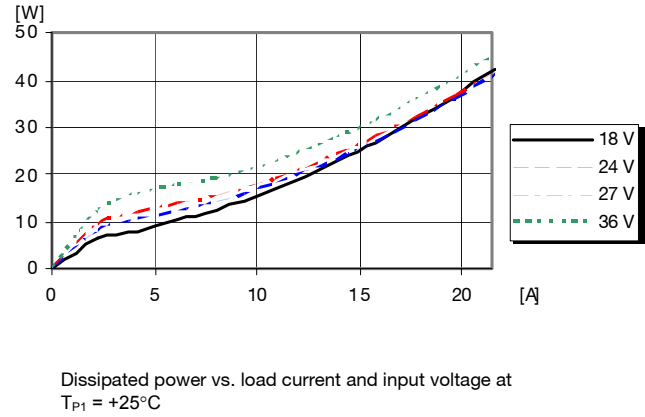
28V, 21.5A/600W Typical Characteristics

PKY 2616 PI

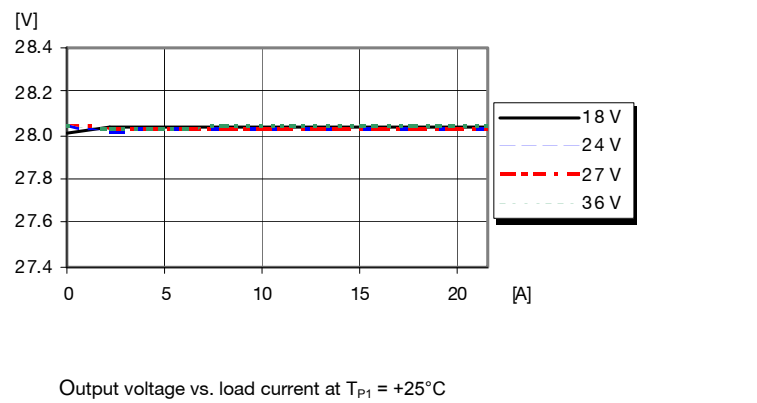
Efficiency



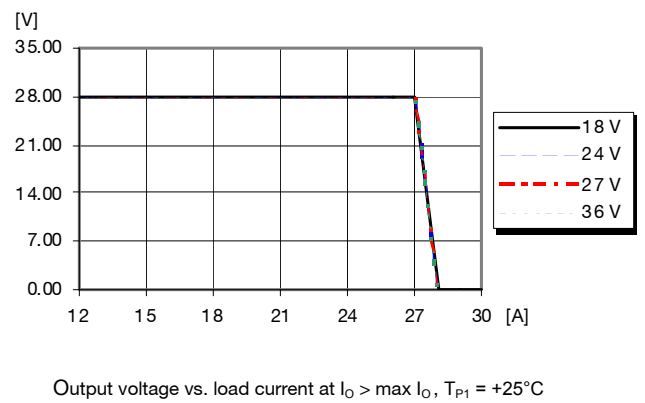
Power Dissipation



Output Characteristics



Current Limit Characteristics



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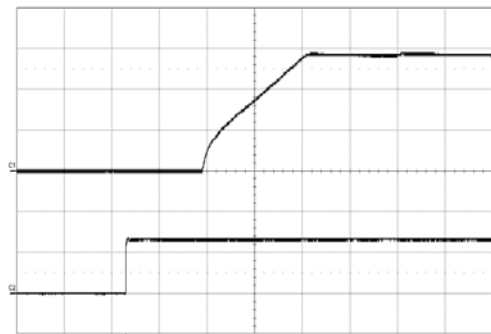
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## 28V, 21.5A/600W Typical Characteristics

## PKY 2616 PI

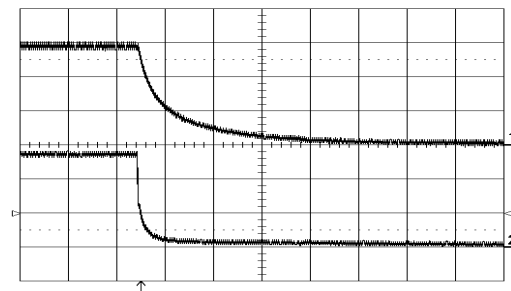
### Start-up



Start-up enabled by connecting  $V_i$  at:  
 $T_{P1} = +25^\circ\text{C}$ ,  $V_i = 27\text{ V}$   
 $I_o = 21.5\text{ A}$  resistive load.

Top trace: output voltage 10 V/div.  
Bottom trace: input voltage 20 V/div.  
Time scale: 5 ms/div.

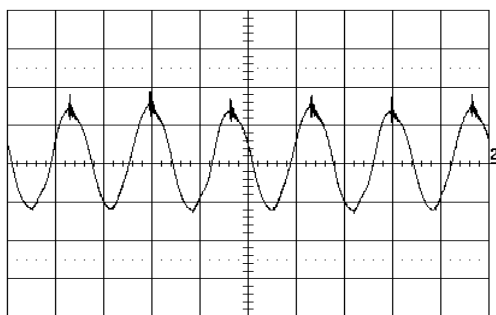
### Shut-down



Shut-down enabled by disconnecting  $V_i$  at:  
 $T_{P1} = +25^\circ\text{C}$ ,  $V_i = 27\text{ V}$   
 $I_o = 21.5\text{ A}$

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

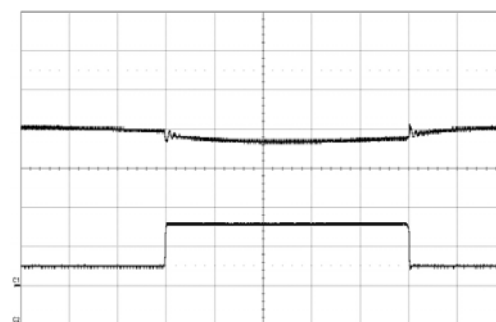
### Output Ripple & Noise



Output voltage ripple at:  
 $T_{P1} = +25^\circ\text{C}$ ,  $V_i = 27\text{ V}$   
 $I_o = 21.5\text{ A}$  resistive load.

Trace: output voltage 50 mV/div.  
Time scale: 2 us/div.

### Output Load Transient Response



Output voltage response to load current step-change 5.375-16.125-5.375A at: 1 A/us.  
 $T_{P1} = +25^\circ\text{C}$ ,  $V_i = 27\text{ V}$ .

Trace: output voltage 2 V/div.  
Time scale: 0.1 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:

Output Voltage Adjust Upwards, Increase:

$$R_{adj} = 10 \left[ V_o \frac{(100 + \Delta\%) - 100 + 2 \times \Delta\%}{2.5 \times \Delta\%} - \frac{100 + 2 \times \Delta\%}{\Delta\%} \right] \text{ k}\Omega$$

Output Voltage Adjust Downwards, Decrease:

$$R_{adj} = 10 \left( \frac{100}{\Delta\%} - 2 \right) \text{ k}\Omega$$

Example: Increase 4%  $\Rightarrow V_{out} = 29.33\text{ Vdc}$

$$10 \left[ 28.2 \frac{(100 + 4) - 100 + 2 \times 4}{2.5 \times 4} - \frac{100 + 2 \times 4}{4} \right] \text{ k}\Omega = 2663 \text{ k}\Omega$$

Example: Decrease 2%  $\Rightarrow V_{out} = 27.64\text{ Vdc}$

#### Active adjust

The output voltage may be adjusted using a current applied to the  $V_{adj}$  pin referred to -Sense. This current is calculated by using the following equations:

Output Voltage Adjust Upwards, Increase:

$$+1\% V_o = 2.5 \times 10^{-6} \text{ A into adjust pin}$$

Output Voltage Adjust Downwards, decrease:

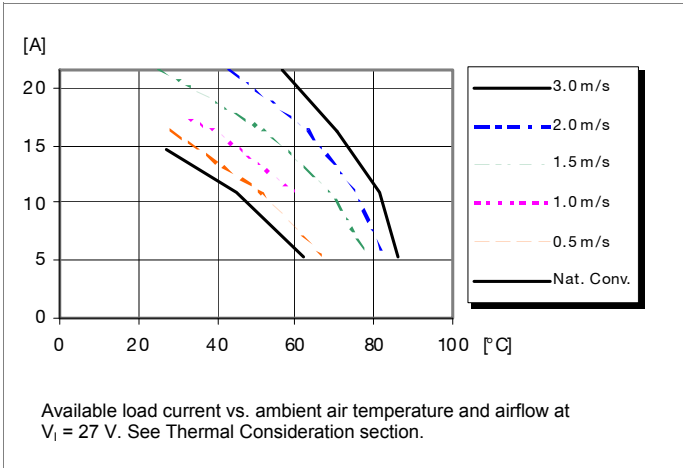
$$-1\% V_o = 2.5 \times 10^{-6} \text{ A out of adjust pin}$$

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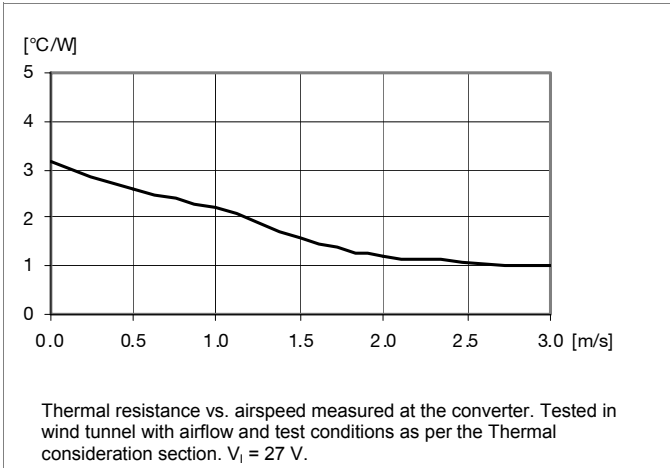
28V, 21.5A/600W Typical Characteristics

PKY 2616 PI

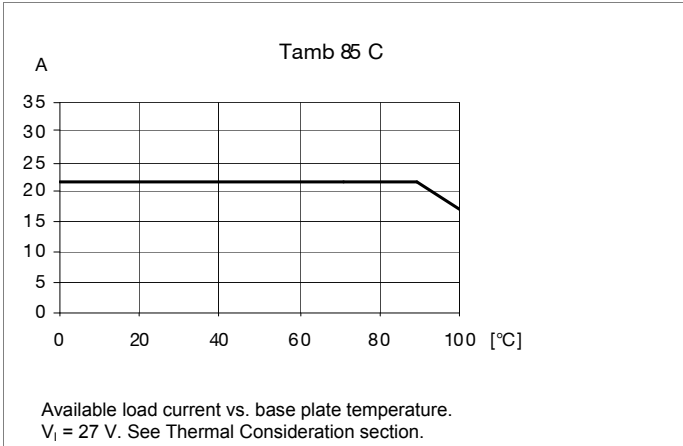
Output Current Derating – Base plate



Thermal Resistance – Base plate



Output Current Derating – Cold wall sealed box





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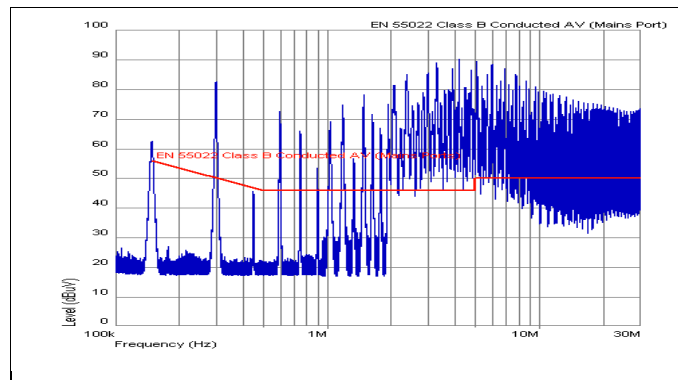
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## EMC Specification

Conducted EMI measured according to EN55022, CISPR 22 and FCC part 15J (see test set-up). See Design Note 009 for further information. The fundamental switching frequency for the PKY 2616 PI is 150 kHz.

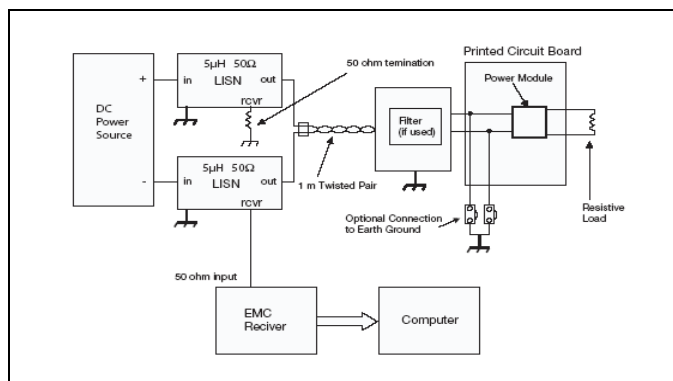
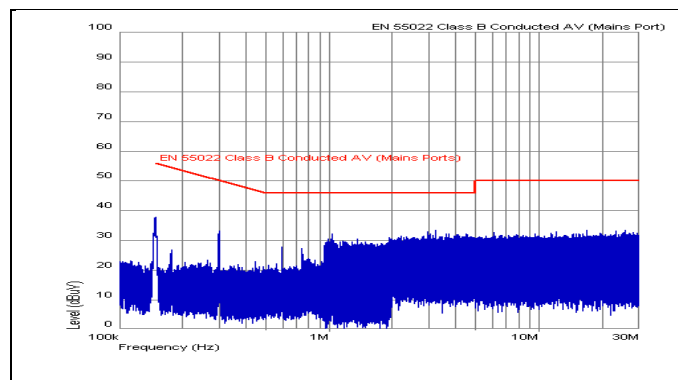
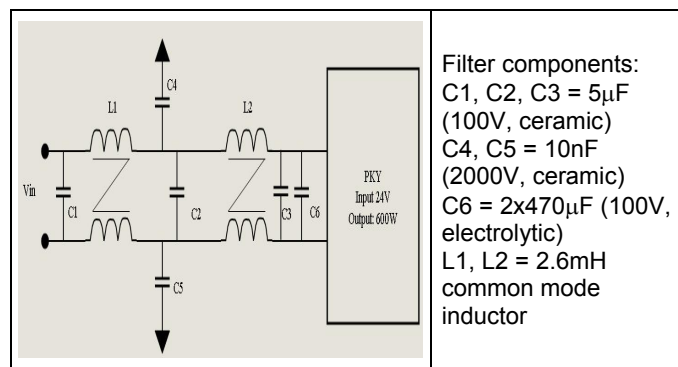
### Conducted EMI Input terminal value (typ)



EMI without filter @ $V_i=27$  V,  $I_o=I_{max}$ . External input capacitor: 220 $\mu$ F.

### External filter (class B)

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



Test set-up

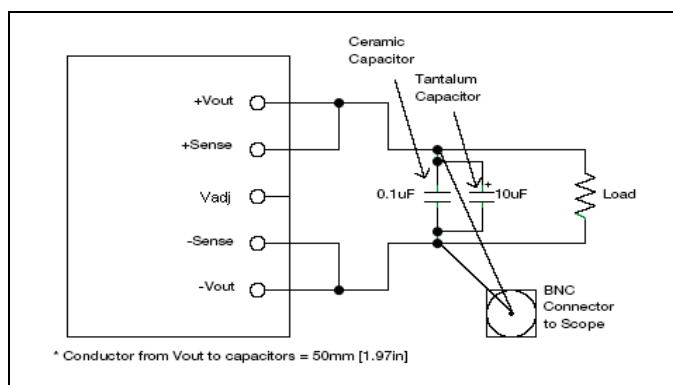
### Layout recommendation

The radiated EMI performance of the DC/DC converter will depend on the PCB 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 PCB 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.



Output ripple and noise test setup

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## Operating information

### Input Voltage

The input voltage range is 18 to 36Vdc.

At input voltages exceeding 36 V, the power loss will be higher than at normal input voltage and  $T_{ref}$  must be limited to absolute max +110°C. The absolute maximum continuous input voltage is 40 Vdc.

### Turn-off Input Voltage

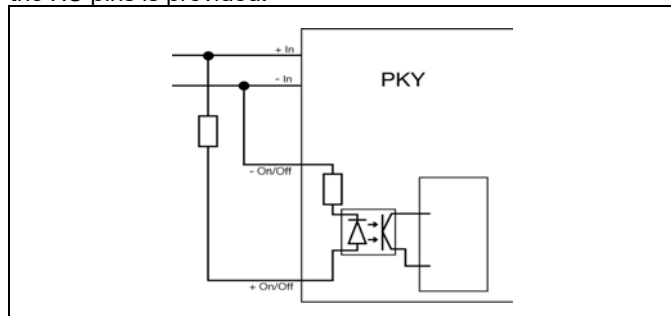
The DC/DC converters monitor the input voltage and will turn on and turn off at predetermined levels.

The minimum hysteresis between turn on and turn off input voltage is 1V.

### Remote Control (RC)

The modules are equipped with a remote On/Off control function. An optocoupler in the remote control circuit provides a galvanic isolation (1500V DC minimum) between the remote control pins and the rest of the module's circuitry. Positive and negative RC logic options are available. Cycling (Off and On sequence) of the RC input will restart the module if latched after activation of the output overvoltage protection function.

The standard version has a "positive logic" remote control and the module will be off until a sufficient current between the RC pins is provided.



The figure above presents an example of a circuit which turns on the standard version module. The minimum current to guarantee the activation of the RC input is 1,5mA. The minimum activation voltage over the RC pins is 5.0V. To guarantee that the RC input is not activated, the current must be lower than 50µA or the voltage lower than 1,3V.

### Input and Output Impedance

The impedance of both the input source and the load will interact with the impedance of the DC/DC converter. It is important that the input source has low characteristic impedance. The converters are designed to be stable without external capacitors on input or output. However, the module performance can be enhanced by adding external capacitors as described under External Decoupling Capacitors.

If the input voltage source contains significant inductance, the

addition of a 470 µF/40 V capacitor across the input of the converter will ensure stable operation. The capacitor is not required when powering the DC/DC converter from an input source with an inductance below 10 µH.

### External Decoupling Capacitors

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

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

External decoupling capacitors will become part of the control loop of the DC/DC converter and may affect the stability margins. As a "rule of thumb", 100 µF/A of output current can be added without any additional analysis. The ESR of the capacitors is a very important parameter. Power Modules guarantee stable operation with a verified ESR value of >10 mΩ across the output connections.

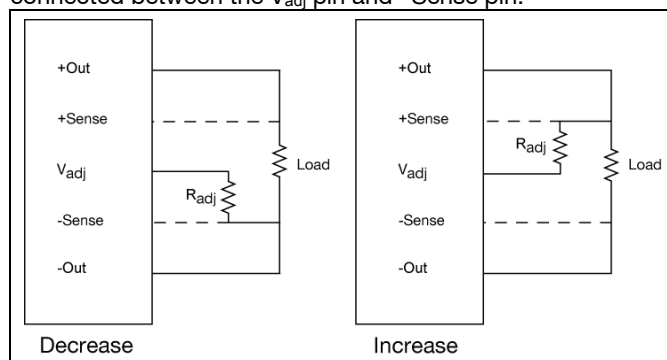
For further information please contact your local Ericsson Power Modules representative.

### Output Voltage Adjust ( $V_{adj}$ )

The product has 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 converter from shutting down. At increased output voltages the maximum power rating of the converter remains the same, and the max output current must be decreased correspondingly.

To increase the voltage the resistor should be connected between the  $V_{adj}$  pin and +Sense pin. The resistor value of the Output voltage adjust function is according to information given under the Output section for the respective product. To decrease the output voltage, the resistor should be connected between the  $V_{adj}$  pin and -Sense pin.



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## Operating information continued

### Parallel Operation

Two or more products may be paralleled for redundancy or increased output power. External active load sharing circuit are recommended to provide the maximum balanced current sharing.

### Remote Sense

The product has 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 PCB 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 product is protected from thermal overload by an internal Over Temperature Protection circuit (OTP). When the PCB temperature (TC reference point) exceeds the OTP T threshold value, the output voltage will be gradually decreased. This will decrease the power loss inside the DC/DC power module and protect the module from hazardous temperatures.

### Over Voltage Protection (OVP)

The module includes an output Over Voltage Protection (OVP) function. In the unlikely event of an output over voltage condition, the OVP circuit will shut down the output voltage. The module will be latched in "Off" state unless either the input voltage or RC input is cycled (switched Off and On again).

### Over Current Protection (OCP)

The module include current limiting circuitry for protection at continuous overload.

In case of overload, the output voltage will significantly decrease. The converter will resume normal operation after removal of the overload. The load distribution should be designed for the maximum specified output short circuit current.

### Pre-bias Start-up

The module is able to start-up properly under pre-bias output condition. During the start-up, the module does not sink current from an external pre-bias source present at the output terminals.

### Power Good

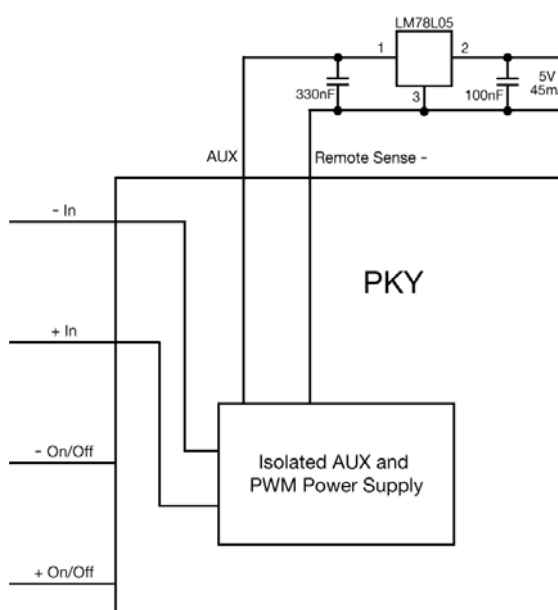
"Power Good" function is provided. It is a "negative logic" open collector output which can drive to "low" an external circuit when the module operates normally. The PG output will turn level "high" during fault conditions (e.g. over temperature or over voltage) or when the output is turned off with the remote control.

### Auxiliary output voltage (AUX)

The module provides a power source referred to – sense terminal. It is intended to be used as a power source for external circuits, e.g. remote control. The auxiliary output voltage is active whenever an input voltage in range between 17V to 40V is provided.

The nominal auxiliary output voltage is 10V. Maximum allowed load is 50mA. The auxiliary output source is not short circuit protected. If it is overloaded, the main converter will be switched off.

An example of a 5V/45mA power supply driven by the auxiliary output voltage is given in the figure below.



PKY 2000 PI series  
DC/DC converters, Input 18-36 V, Output 21.5 A/600 W

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## Thermal Consideration

### General

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

Cooling of the PKY series power modules is achieved mainly by conduction from the baseplate to a heatsink ("cold wall"). If the baseplate temperature is kept below +100°C, the module can deliver full output power at ambient temperature up to +85°C without forced airflow cooling.

The PKY series power modules can also operate without a heatsink but sufficient airflow must be provided. 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  $V_{in} = 27\text{ V}$ .

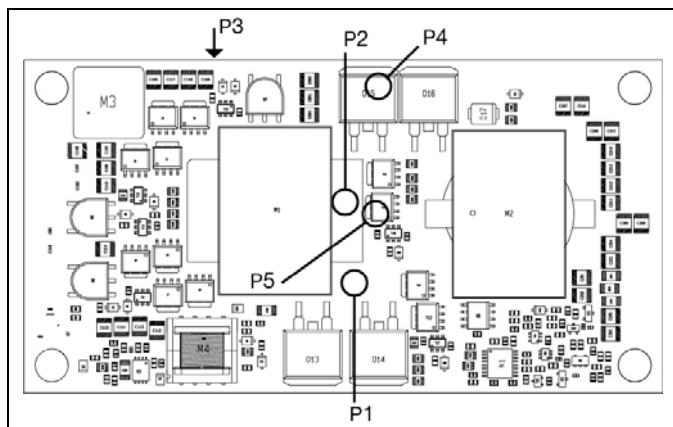
The DC/DC converter is tested on a 254 x 254 mm, 35  $\mu\text{m}$  (1 oz), 8-layer test board mounted vertically in a wind tunnel with a cross-section of 305 x 305 mm.

Proper cooling of the DC/DC converter can be verified by measuring the temperature at positions P1...P5. The temperature at these positions should not exceed the max values provided in the table below.

Note that the max value is the absolute maximum rating (non destruction) and that the electrical Output data is guaranteed up to  $T_{ref} + 100^\circ\text{C}$ .

See Design Note 019 for further information.

Position	Device	Designation	max value
P <sub>1</sub>	PCB		125° C
P <sub>2</sub>	Transformer	M1	120° C
P <sub>3</sub>	Baseplate	T <sub>ref</sub>	100° C
P <sub>4</sub>	Diode	D15	120° C
P <sub>5</sub>	MOSFET	T16	120° C



### Definition of reference temperature ( $T_{ref}$ )

The reference temperature is used to monitor the temperature limits of the product. Temperatures above maximum  $T_{ref}$  are not allowed and may cause degradation or permanent damage to the product.  $T_{ref}$  is also used to define the temperature range for normal operating conditions.  $T_{ref}$  is defined by the design and used to guarantee safety margins, proper operation and high reliability of the module.

### Calculation of the Maximum Ambient Temperature

By using the thermal resistance the maximum allowed ambient temperature can be calculated.

- The power loss is calculated by using the formula  $((1/\eta) - 1) \times \text{output power} = \text{power losses (Pd)}$ .  
 $\eta$  = efficiency of converter. E.g 94 % = 0.94
- Find the thermal resistance ( $R_{th}$ ) in the Thermal Resistance graph found in the Output section for each model.  
Calculate the temperature increase ( $\Delta T$ ).  
 $\Delta T = R_{th} \times P_d$
- Max allowed ambient temperature is:  
 $\text{Max } T_{ref} - \Delta T$ .

E. g. PKY 2616 PI at 1m/s:

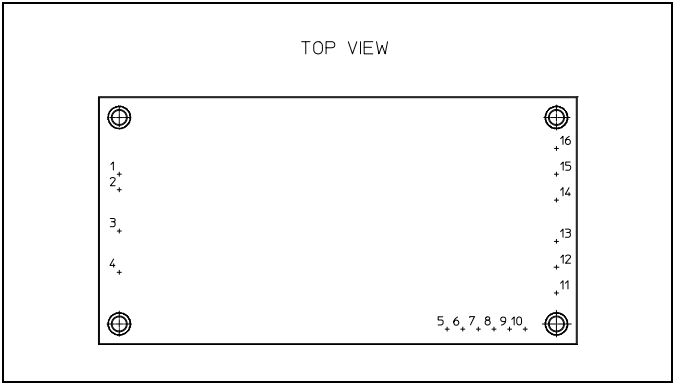
- $((\frac{1}{0.94}) - 1) \times 600\text{ W} = 38.3\text{ W}$
- $38.3\text{ W} \times 1.9^\circ\text{C/W} = 73^\circ\text{C}$
- $100^\circ\text{C} - 73^\circ\text{C} = \text{max ambient temperature is } 27^\circ\text{C}$

The actual temperature will be dependent on several factors such as the PCB size, number of layers and direction of airflow.

The above calculations of the maximum ambient temperature are based on the thermal resistance of the PKY module without a heatsink.

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Connections



Pin	Designation	Function
1	+On/Off	Remote on/off “plus” input
2	-On/Off	Remote on/off “minus” input
3	+In	Positive input
4	-In	Negative input
5	AUX	Auxiliary power supply output
6	PWR Good	Power Good output
7	Optional	N/A
8	Vadj	Output Voltage Adjust
9	+Sense	Positive remote sense
10	-Sense	Negative remote sense
11	-Vout	Negative output voltage
12	-Vout	Negative output voltage
13	-Vout	Negative output voltage
14	+Vout	Positive output voltage
15	+Vout	Positive output voltage
16	+Vout	Positive output voltage

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## Mechanical Information

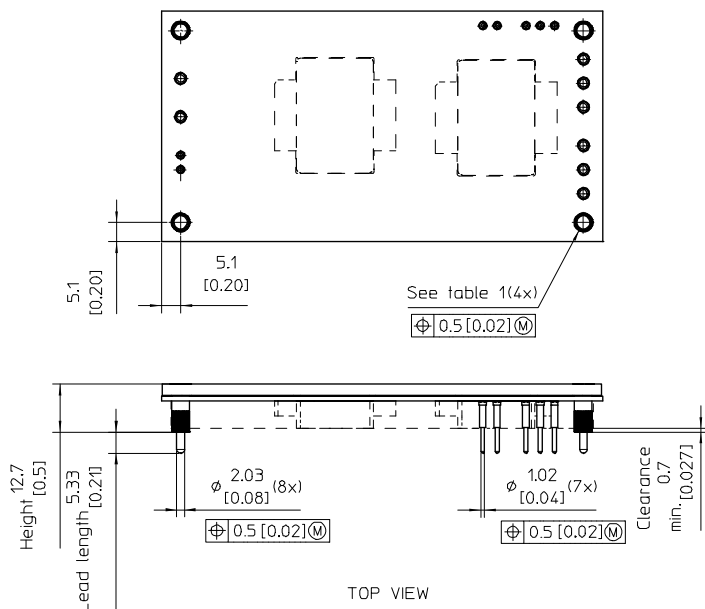


Table 1

Product	Insert	Outer $\phi$
Standard	M3x0.5 Threaded	4.62 [0.182]
M-Option	$\phi$ 3.50 [0.138] TH	4.62 [0.182]

### Notes

Case: Aluminium base plate  
For screw attachment, apply mounting torque of max 0.44 Nm [3.9 Lbf-in]

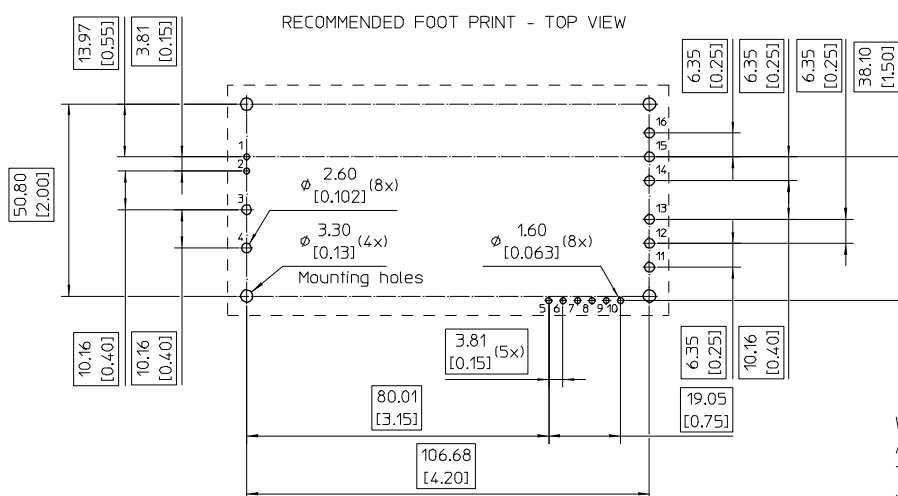
### Pins:

1,2,5-10 Material: Brass

3,4,11-16 Material: Cu-alloy

### Plating:

0.1  $\mu$ m Gold over 2  $\mu$ m Nickel



Weight: Typical 165 g

All dimensions in mm [inch].

Tolerances unless specified

x.x mm  $\pm$ 0.50 [0.02], x.xx mm  $\pm$ 0.25 [0.01]

(not applied on footprint or typical values)

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Soldering Information – Through Hole Mounting

The product is intended for manual or wave soldering. When wave soldering is used, the temperature on the pins is specified to maximum 270°C for maximum 10 seconds.

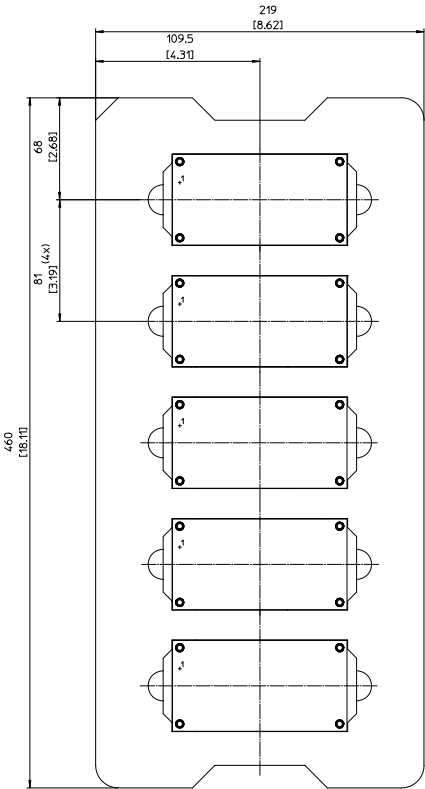
A maximum preheat rate of 4°C/s and a temperature of max +150°C is suggested. When soldering by hand, care should be taken to avoid direct contact between the hot soldering iron tip and the pins for more than a few seconds in order to prevent overheating.

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 trays.

Tray Specifications	
Material	Antistatic PE Foam
Surface resistance	10 <sup>5</sup> < Ohm/square < 10 <sup>12</sup>
Bakability	The trays are not bakable
Tray capacity	5 products/tray
Tray thickness	26.0 mm [1.024 inch]
Box capacity	5 products (1 full tray/box)
Tray weight	55 g empty, 880 g full tray



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**Product Qualification Specification**

Characteristics			
External visual inspection	IPC-A-610		
Change of temperature (Temperature cycling)	IEC 60068-2-14 Na	Temperature range Number of cycles Dwell/transfer time	-40 to +100°C 1000 15 min/0-1 min
Cold (in operation)	IEC 60068-2-1 Ad	Temperature T <sub>A</sub> Duration	-45°C 72 h
Damp heat	IEC 60068-2-67 Cy	Temperature Humidity Duration	+85°C 85 % RH 1000 hours
Dry heat	IEC 60068-2-2 Bd	Temperature Duration	+125°C 1000 h
Electrostatic discharge susceptibility	IEC 61340-3-1, JESD 22-A114 IEC 61340-3-2, JESD 22-A115	Human body model (HBM) Machine Model (MM)	Class 2, 2000 V Class 3, 200 V
Immersion in cleaning solvents	IEC 60068-2-45 XA Method 2	Water Glycol ether Isopropyl alcohol	+55°C +35°C +35°C
Mechanical shock	IEC 60068-2-27 Ea	Peak acceleration Duration	100 g 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 Duration	270°C 10-13 s
Robustness of terminations	IEC 60068-2-21 Test Ua1	Through hole mount product	All leads
Solderability	IEC 60068-2-20 test Ta <sup>2</sup>	Preconditioning Temperature, SnPb Eutectic Temperature, Pb-free	Steam ageing 235°C 245°C
Vibration, broad band random	IEC 60068-2-64 Fh, method 1	Frequency Spectral density Duration	10 to 500 Hz 0.07 g <sup>2</sup> /Hz 10 min in each perpendicular direction



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