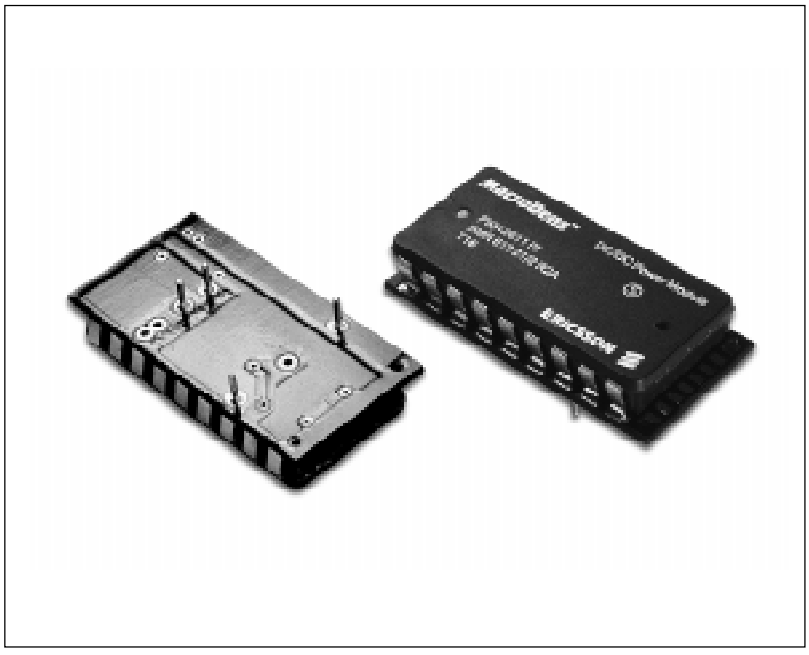
6–6.6 W DC/DC Power Modules
24 V Input Series

- *Standard industry foot-print and pin-out*
- *83% efficiency (typ at 5V)*
- *Output current up to 2 A*
- *Complies with fully and semi aqueous cleaning processes*
- *1,500Vdc isolation voltage*
- *Low EMI measured according to CISPR 22 and FCC part 15J*
- *L × W × H in mm (inches) 50.8×25.4×10.7 (2.0×1.0×0.41)*



Patents
US: D357901 DE: M94022763

The PKH 2000 I series is a range of DC/DC power modules for 24 V DC systems. The PKH is based on the highly reliable and proven Macro Dens™ PKF series and adopted to the industry standard central pin-out.
The PKH power modules have high efficiency and very low idling input current, which makes them ideal as distributed power sources in decentralized power systems with battery back-up.
They are optimized for free convection cooling and are designed for an operational ambient temperature range of –40 to +75°C in compliance with present and future application needs. In addition to the industry standard functionality turn-on and turn-off can be realized by using the optional RC pin. They can also operate in parallel for redundancy and power upgrading.
The PKH series is manufactured in highly automated production lines using SMT, laser trimming, 100% burn-in and ATE final inspection.
Since 1991, Ericsson Components AB is an ISO 9001 certified supplier. *For product program, please see back cover.*

ERICSSON

General

Absolute Maximum Ratings

Characteristics		min	max	Unit
T_C	Case temperature at full output power	–45	+95	°C
T_S	Storage temperature	–55	+125	°C
V_I	Continuous input voltage[1)]	–0.5	+40	Vdc
V_{ISO}	Isolation voltage (input to output test voltage)	1,500		Vdc
W_{tr}	Transient input energy		0.1	Ws
V_{RC}	Remote control voltage pin 10,11	–5	+40	Vdc

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.

Input $T_C < T_{Cmax}$ unless otherwise specified

Characteristics		Conditions	min	typ	max	Unit
V_I	Input voltage range[1)]		18		36	V
V_{Ioff}	Turn-off input voltage	(See typical characteristics)	16	17	18	V
V_{Ion}	Turn-on input voltage	(See typical characteristics)		18	19	V
C_I	Input capacitance			2.4		µF
P_{Ii}	Input idling power	$I_O=0, T_C=-30…+85°C$	(V_I = 24V) (V_I = 30V)	100 120	160 180	mW
P_{RC}	Input stand-by power	$T_C=-30…+85°C$ RC connected to pin 18	(V_I = 24V) (V_I = 30V)	20 40		mW

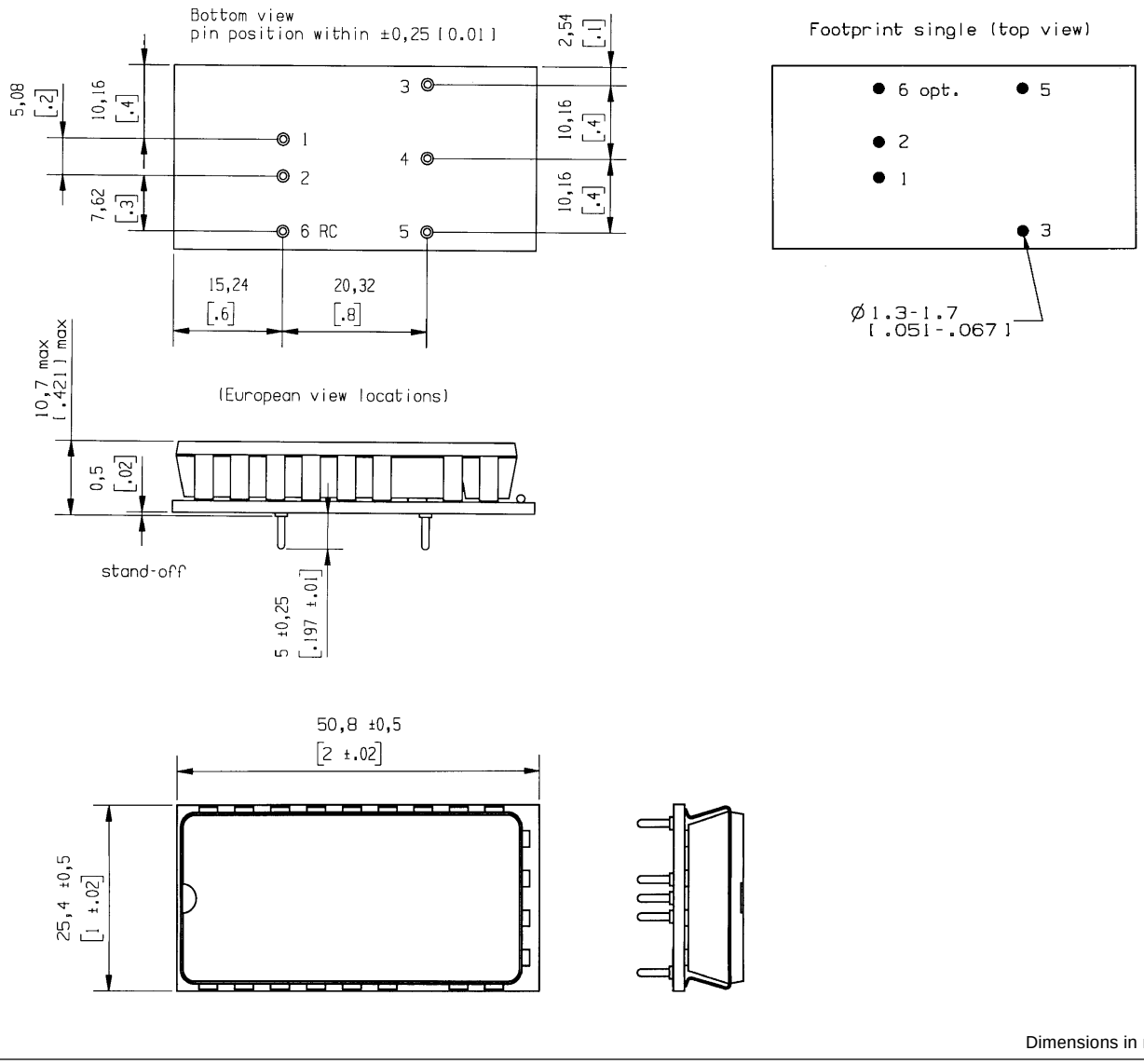
[1)] The power modules will operate down to $V_I \leq 18V$, when V_I decreases, but will turn on at $V_I \leq 19V$, when V_I increases (see also Operating information).

Environmental Characteristics

Characteristics	Test procedure & conditions		
Vibration (Sinusoidal)	IEC 68-2-6 F_c	Frequency Amplitude Acceleration Number of cycles	10…500 Hz 0.75 mm 10 g 10 in each axis
Random vibration	IEC 68-2-34 E_d	Frequency Acceleration density spectrum Duration Reproducability	10…500 Hz 0.5 g^2/Hz 10 min in 3 directions medium (IEC 62-2-36)
Shock (Half sinus)	IEC 68-2-27 E_a	Peak acceleration Shock duration	200 g 3 ms
Temperature change	IEC 68-2-14 N_a	Temperature Number of cycles	–40°C…+125°C 500
Damp heat	IEC 68-2-3 C_a	Temperature Duration	40°C 56 days
Soldering heat resistance	IEC 68-2-20 T_b 1A	Temperature, solder Duration	260°C 10…13 s

Preliminary Data Sheet EN/LZT 137 38 R2 © Ericsson Components AB, May 1999

Mechanical Data



Dimensions in mm (in)

Connections

Pin	Designation	Function
1	+ In	Positive input.
2	– In	Negative input
3	Out 1	Output 1, positive voltage ref. to RTN.
5	RTN	Output return.
(6)	RC	Remote control. Used to turn on and turn off the output. Optional pin.

Weight

Typical 24 g (0.86 oz).

Design

Overmoulded DC/DC power module soldered to a printed circuit board (PCB), provided with nickel and tin plated bronze pins. The flammability rating of the PCB meets min. UL 94-V1.

Safety

The PKH Series DC/DC power modules are designed in accordance with EN 60 950, *Safety of information technology equipment including electrical business equipment*. Semko certification no. 9819405.

The PKH power modules are recognized by UL and meet the applicable requirements in UL 1950 *Safety of information technology equipment*, the applicable Canadian safety requirements and UL 1012 *Standard for power supplies*.

The DC/DC power module shall be installed in an end-use equipment and considerations should be given to measuring the case temperature to comply with T_{Cmax} when in operation. Abnormal component tests are conducted with the input protected by an external 3 A fuse. The need for repeating these tests in the end-use appliance shall be considered if installed in a circuit having higher rated devices.

The isolation is an operational insulation in accordance with EN 60 950.

The DC/DC power module is intended to be supplied by isolated secondary circuitry and shall be installed in compliance with the requirements of the ultimate application. One pole of the input and one pole of the output is to be grounded or both are to be kept floating.

The terminal pins are only intended for connection to mating connectors of internal wiring inside the end-use equipment.

These DC/DC power modules may be used in telephone equipment in accordance with paragraph 34 A.1 of UL 1459 (Standard for Telephone Equipment, second edition).

The galvanic isolation is verified in an electric strength test. Test voltage (V_{ISO}) between input and output is 1,500 V dc for 60 s. In production the test duration may be decreased to 1 s.

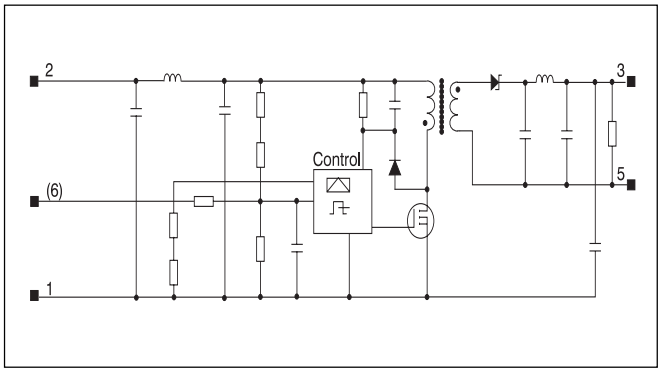
The capacitor between input and output has a value of 1 nF and the leakage current is less than 1µA @ 26 V dc.

The case is designed in non-conductive epoxy. Its flammability ratings meets UL 94V-0. The oxygen index is 34%.

Electrical Data

Fundamental circuit diagrams

Single output, PKH 2000 Series



PKH 2610A PI

T_C = –30+…85°C, V_I = 18...36V.

Output

Characteristics		Conditions		Output 1 min	Output 1 typ	Output 1 max	Unit
V_{Oi}	Output voltage initial setting and accuracy	T_C = +25°C, I_O = 1.0A, V_I = 26 V		3.27	3.30	3.33	V
V_O	Output voltage tolerance band	Long term drift included	I_O = 0.1…1.0 × I_{Omax}	3.14		3.80	V
			I_O = 0.3…1.0 × I_{Omax}	3.14		3.43	
	Idling voltage	I_O = 0A			3.8	4.0	V
	Line regulation	I_O = I_{Omax}	V_I = 18…36 V		50		mV
			V_I = 26…36 V		35		
	Load regulation	I_O = 0.1…1.0 × I_{Omax}, V_I = 26 V			120		mV
t_{tr}	Load transient recovery time	I_O = 0.1…1.0 × I_{Omax}, V_I = 26 V load step = 0.5 × I_{Omax}			100		µs
V_{tr}	Load transient voltage				+180		mV
					–180		mV
T_{coeff}	Temperature coefficient[1)]	I_O = I_{Omax}, T_C = 40...90 ºC			-0.55		mV/°C
t_r	Ramp-up time	I_O = I_{Omax}, 0.1…0.9 × V_O			2.3		ms
t_s	Start-up time	I_O = 0.1…1.0 × I_{Omax}, V_I = 26 V From V_I connection to V_O = 0.9 × V_{Oi}			4.4		ms
I_O	Output current			0		2	A
P_{Omax}	Max output power[1)]	Calculated value		6,6			W
I_{lim}	Current limiting threshold	T_C <T_{Cmax}		2.2	2.4	2.6	A
I_{sc}	Short circuit current	V_O = 0.2…0.5 V, T_A = +25°C			2.9		A
V_{Oac}	Output ripple & noise	I_O = I_{Omax}	20 Hz… 5 MHz		15	50	mV_{p-p}
			20 Hz…50 MHz			80	dBµV
SVR	Supply voltage rejection (ac)	f = 100 Hz sine wave, $1V_{p-p}$, V_I = 26 V (SVR = 20 log (1 V_{p-p}/V_{Op-p}))			63		dB

[1)] See Typical Characteristics, Power derating.

Miscellaneous

Characteristics		Conditions	min	typ	max	Unit
η	Efficiency	I_O = I_{Omax}, V_I = 26 V	76	81		%
P_d	Power dissipation	I_O = I_{Omax}, V_I = 26 V			1.6	W

PKH 2611 PI

T_C = –30+…85°C, V_I = 18...36 V.

Output

Characteristics		Conditions		Output 1 min	Output 1 typ	Output 1 max	Unit
V_{Oi}	Output voltage initial setting and accuracy	T_C = +25°C, I_O = 0.5A, V_I = 26 V		5.01	5.05	5.08	V
V_O	Output voltage tolerance band	Long term drift included	I_O = 0.1…1.0 × I_{Omax}	4.83		5.25	V
	Idling voltage	I_O = 0A			5.6	6.0	V
	Line regulation	I_O = I_{Omax}	V_I = 18…36 V		20		mV
			V_I = 26…36 V		10		
	Load regulation	I_O = 0.3…1.0 × I_{Omax}, V_I = 26 V			125		mV
t_{tr}	Load transient recovery time	I_O = 0.1…1.0 × I_{Omax}, V_I = 26 V load step = 0.5 × I_{Omax}			50		µs
V_{tr}	Load transient voltage				+100		mV
					–100		mV
T_{coeff}	Temperature coefficient[1)]	I_O = I_{Omax}, T_C = 40...90 ºC			-0.8		mV/°C
t_r	Ramp-up time	I_O = I_{Omax}, 0.1…0.9 × V_O			2.3		ms
t_s	Start-up time	I_O = 0.1…1.0 × I_{Omax}, V_I = 26 V From V_I connection to V_O = 0.9 × V_{Oi}			4.6		ms
I_O	Output current			0		1.2	A
P_{Omax}	Max output power[1)]	Calculated value			6		W
I_{lim}	Current limiting threshold	T_C <T_{Cmax}		1.3	1.6	2.4	A
I_{sc}	Short circuit current	V_O = 0.2…0.5 V, T_A = +25°C			2.0		A
V_{Oac}	Output ripple & noise	I_O = I_{Omax}	20 Hz… 5 MHz		20	70	mV_{p-p}
			20 Hz…50 MHz			80	dBµV
SVR	Supply voltage rejection (ac)	f = 100 Hz sine wave, 1V_{p-p}, V_I = 26 V (SVR = 20 log (1 V_{p-p}/V_{Op-p}))			60		dB

[1)] See Typical Characteristics, Power derating.

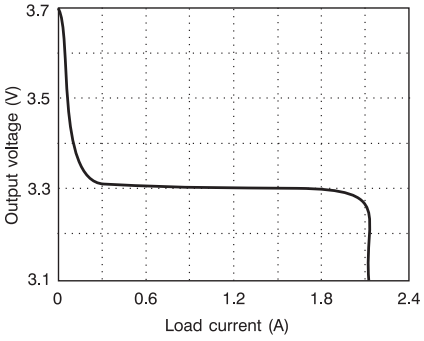
Miscellaneous

Characteristics		Conditions	min	typ	max	Unit
η	Efficiency	I_O = I_{Omax}, V_I = 26 V	81	84		%
P_d	Power dissipation	I_O = I_{Omax}, V_I = 26 V			1.5	W

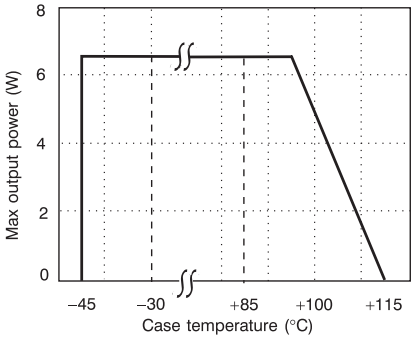
Typical Characteristics

PKH 2610A PI

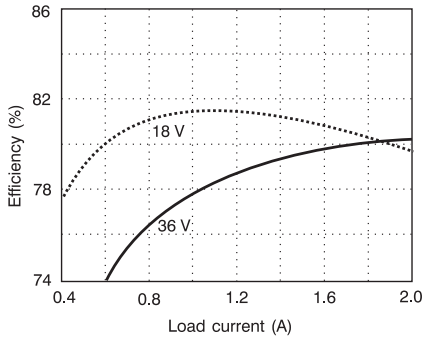
Output characteristic (typ)



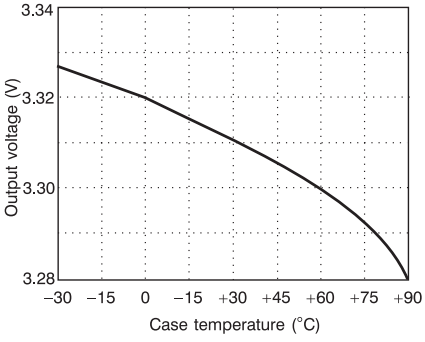
Power derating



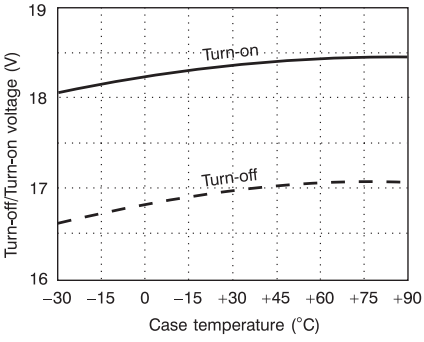
Efficiency (typ) @ T_A = 25°C



Temperature coefficient

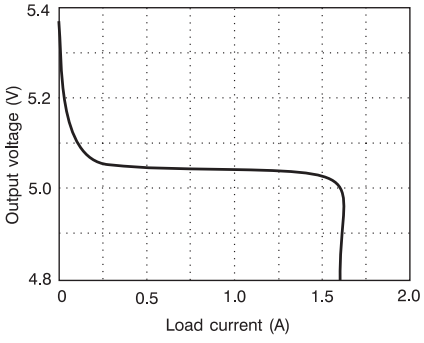


Turn-on/turn-off input voltage

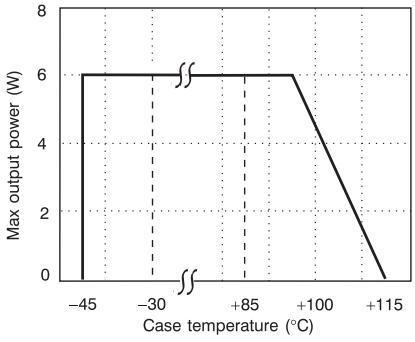


PKH 2611 PI

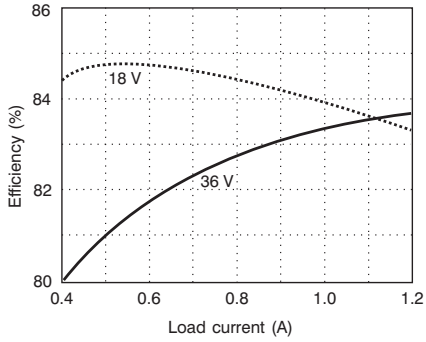
Output characteristic (typ)



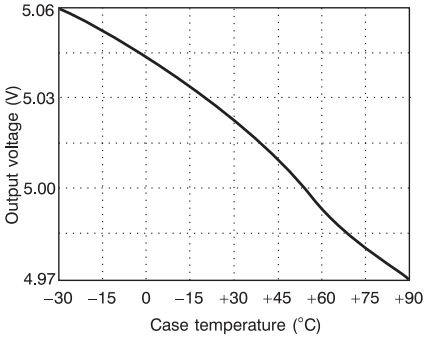
Power derating



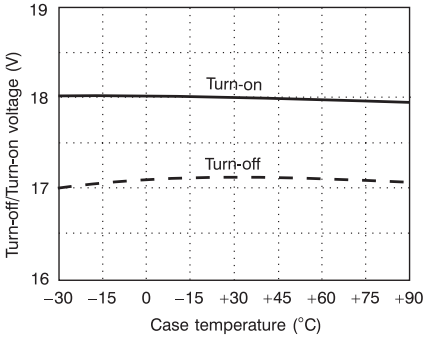
Efficiency (typ) @ T_A = 25°C



Temperature coefficient



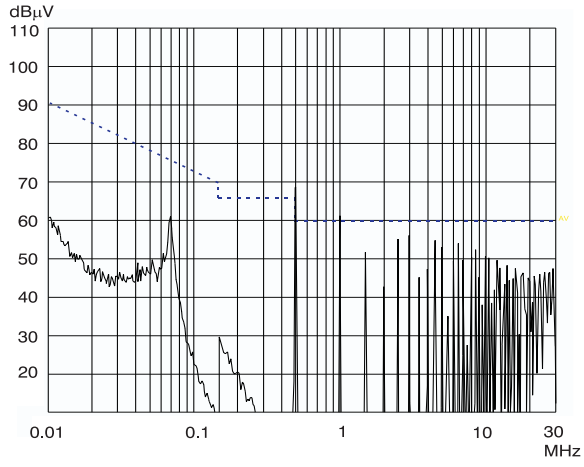
Turn-on/turn-off input voltage



EMC Specifications

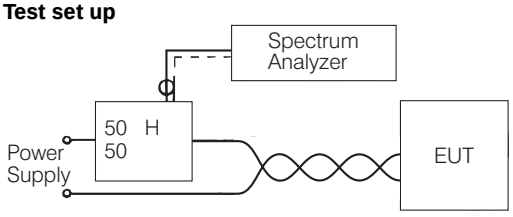
The PKH power module is mounted on a double sided printed circuit board (PCB) with groundplane during EMC measurements. The fundamental switching frequency is 485 kHz ±15%
@ I_O = (0.5...1.0) × I_{Omax}.

Conducted EMI (input terminals)



PKH series typical conducted EMI performance

Test set up



The PKH 2000 I series meets class A in VDE 0871/0878, FCC Part 15J, and CISPR 22 (EN 55022), except for the fundamental switching frequency.

Conducted EMS

Electro Magnetic Susceptibility is measured by injection of electrical disturbances on the input terminals. No deviation outside the V_O tolerance band will occur under the following conditions:

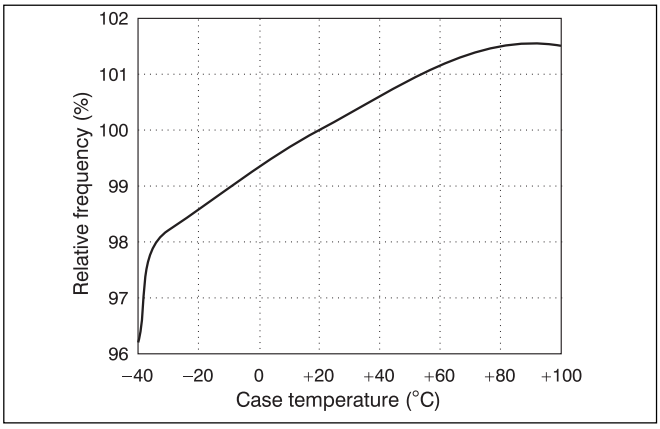
Frequency range	Voltage level
0.15...300 MHz	1.0 V_{rms}

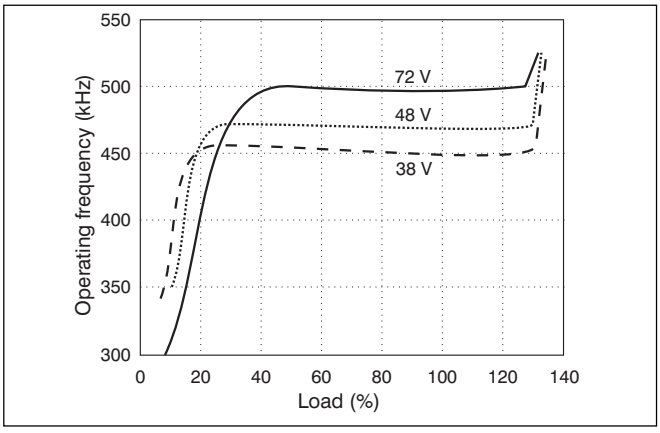
The signal is amplitude modulated with 1 kHz/80% and applied both differential and common mode.

Output Ripple & Noise ($V_O$ac)

Output ripple is measured as the peak to peak voltage of the fundamental switching frequency and with a 500 nf capacitor connected across the output.

Operating Frequency (typ)





The operating frequency vs. load and input voltage (72 V, 48 V and 38 V). T_C= +25°C.

Radiated EMS (Electro-Magnetic Fields)

Radiated EMS is measured according to test methods in IEC Standard publ. 801-3. No deviation outside the V_O tolerance band will occur under the following conditions:

Frequency range	Voltage level
0.01...200 MHz	3 V_{rms}/m
200...1,000 MHz	3 V_{rms}/m
1...12 GHz	10 V_{rms}/m

ESD

Electro Static Discharge is tested according to IEC publ. 801-2. No destruction will occur if the following voltage levels are applied to any of the terminal pins:

Test	Voltage level
Air discharge	±4 kV
Contact discharge	±2 kV

EFT

Electrical Fast Transients on the input terminals could affect the output voltage regulation causing functional errors on the Printed Board Assembly (PBA). The PKH power module withstand EFT levels of 0.5 kV keeping V_O within the tolerance band and 2.0 kV without destruction. Tested according to IEC publ. 801-4.

Operating Information

Fuse Considerations

To prevent excessive current from flowing through the input supply line, in the case of a short-circuit across the converter input, and external fuse should be installed in the non-earthed input supply line. We recommend using a fuse rated at approximately 2 to 4 times the value calculated in the formula below:

$$I_{in\,max} = \frac{P_{O\,max}}{(\eta_{min} \times V_{I\,min})}$$

Refer to the fuse manufacturer for further information.

Remote Control (RC)

Turn-on or turn-off can be realized by using the optional RC-pin – if an RC function is required, pin 6 shall be added by a certified Ericsson VAR Center. Normal operation is achieved if pin 6 is open (NC). If pin 6 is connected to pin 2 the power module turns off. To ensure safe turn-off the voltage difference between pin 6 and 2 shall be less than 1.0 V. RC is TTL open collector compatible output with a sink capacity >100 µA (see fig. 1).

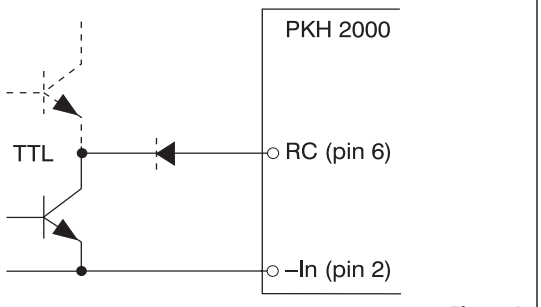


Figure 1

Over Voltage Protection (OVP)

The remote control can be utilized also for OVP by using the external circuitry in figure 2. Resistor values are for 5 V output applications, but can easily be adjusted for other output voltages and the desired OVP level.

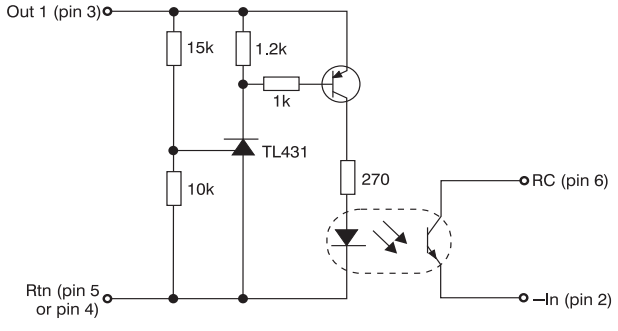


Figure 2

Capacitive Load

The PKH series has no limitation of maximum connected capacitance on the output. The power module may operate in current limiting mode during start-up, affecting the ramp-up and the start-up time. For optimum start performance a maximum of 100 µF/A of I_O is recommended. Connect capacitors at the point of load for best performance.

Parallel Operation

Paralleling of several converters is easily accomplished by direct connection of the output voltage terminal pins. The load regulation characteristic is specifically designed for optimal paralleling performance. Load sharing between converters will be within ±10%. It is recommended not to exceed $P_O = n \times 0.9 \times P_{O\,max}$, where $P_{O\,max}$ is the maximum converter output power and n the number of paralleled converters, in order not to overload any of the converters and thereby decrease the reliability performance.

Current Limiting Protection (I_{lim})

The output power is limited at loads above the output current limiting threshold (I_{lim}), specified as a minimum value.

Input and Output Impedance

Both the source impedance of the power feeding and the load impedance will interact with the impedance of the DC/DC power module. It is most important to have the ratio between L and C as low as possible, i.e. a low characteristic impedance, both at the input and output, as the power modules have a low energy storage capability.
Use an electrolytic capacitor across the input or output if the source or load inductance is larger than 10 µH. Their equivalent series resistance together with the capacitance acts as a lossless damping filter. Suitable capacitor values are in the range of 10–100 µF.
Tantalum capacitors are not recommended due to their low ESR-value.

Packaging Information

Tubes

The PKH-series is delivered in tubes with a length of 384 mm (15.12 in), for other measurements see fig. 3.

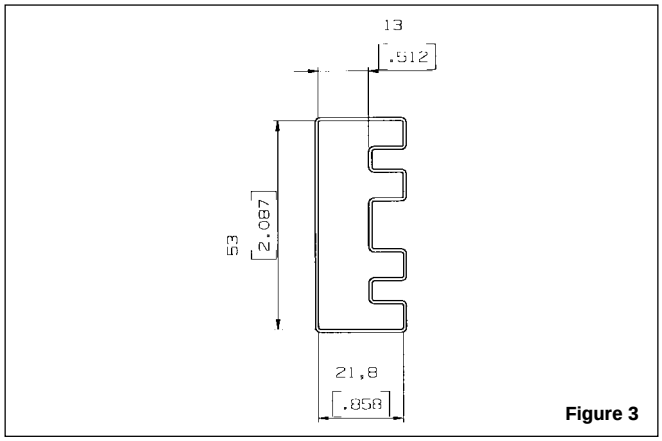


Figure 3

Specification

Material:	ESD protected Polyvinylchloride (PVC)
Colour:	Transparent
Capacity:	10 pcs./tube
Weight:	Typ. 85 g

Quality

Reliability

Meantime between failure (MTBF) of the MacroDens™ PKF series is calculated to >4.7 million hours at full output power and a pin temperature of +50 °C (T_A = +40 °C), using the Ericsson failure rate data system. The Ericsson failure rate data system is based on field failure rates and is continously updated. The data corresponds to actual failure rates of components used in Information Technology and Telecom equipment in temperature controlled environments (T_A = –5…+65 °C).The data is considered to have a confidence level of 90%. For more information see Design Note 002.

Quality Statement

The products are designed and manufactured in an industrial environment where quality systems and methods like ISO 9000, 6σ and SPC are intensively in use to boost the continuous improvements strategy. Infant mortality or early failures in the products are screened out by a burn-in procedure and an ATE-based final test. Conservative design rules, design reviews and product qualifications, as well as high competence of an engaged work force, contribute to the high quality of our products.

Warranty

Ericsson Components warrants to the original purchaser or end user that the products conform to this Data Sheet and are free from material and workmanship defects for a period of five (5) years from the date of manufacture, if the product is used within specified conditions and not opened. In case the product is discontinued, claims will be accepted up to three (3) years from the date of the discontinuation.
For additional details on this limited warranty we refer to Ericsson Components AB's "General Terms and Conditions of Sales", EKA 950701, or individual contract documents.

Limitation of liability

Ericsson Components 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).

Product Program

V_I	V_O/I_O max	P_O max	Ordering No.
	Output 1		
18–36 V	3.3 V/2.0 A 5 V/1.2 A	6.6 W 6.0 W	PKH 2610A PI PKH 2611 PI

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Preliminary Data Sheet

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