Intermediate Bus Converter Narrow input range 42-53 V Output 12 V/ 25 A

Contents

Key Features

- High efficiency up to 96%
- high power density, 300 W, in Quarter-brick.
- Single sided board design for low cost
- Over voltage protection
- Current limit
- Over temperature protection
- 1500 V input to output isolation
- Non-regulated output voltage

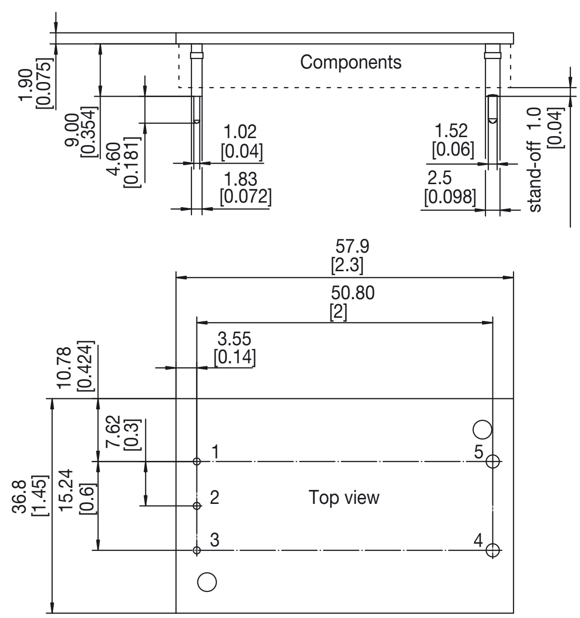
The PKM 4000NF series DC/DC converters are designed as intermediate bus converters to be used in distributed power architectures. The high efficiency and high reliability of the converters makes them particularly suited for the communications equipment of today and tomorrow.
These products are manufactured using the most advanced technologies and materials to comply with environmental requirements. Designed to meet high reliability requirements of systems manufacturers, the PKM-NF responds to world-class specifications.

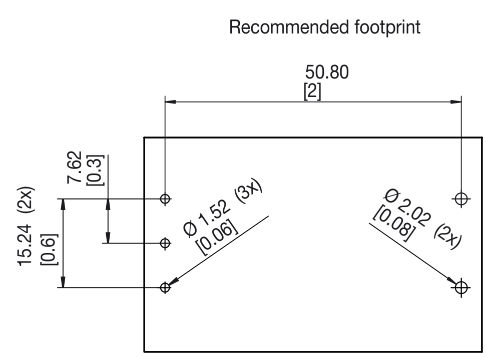
Ericsson Power Modules is an ISO 9001/14001 certified supplier.

Product Program

V_I	V_O/I_O max Output 1	P_O max	Ordering No.
42 - 53 V	12 V/25 A	300 W	PKM 4303NF PI
Option		**Suffix**	**Example**
Positive Remote Control logic		P	PKM 4303NF PIPLB
Lead length 3.69 mm (0.145 in)		LA	PKM 4303NF PILA
Lead length 4.57 mm (0.180 in)		LB	PKM 4303NF PILB

Mechanical Data





Dimensions in mm[inches]
Tolerances:
x.x ±0.5 [0.02]
x.xx ±0.25 [0.01]

Connections

Pin	Designation	Function
1	+ In	Positive input
2	RC	Remote Control To turn on and turn off the output
3	- In	Negative input
4	- Out	Negative output
5	+ Out	Positive output

Weight

33 g

Pins

Material: Copper
Plating: Gold over Nickel

Absolute Maximum Ratings

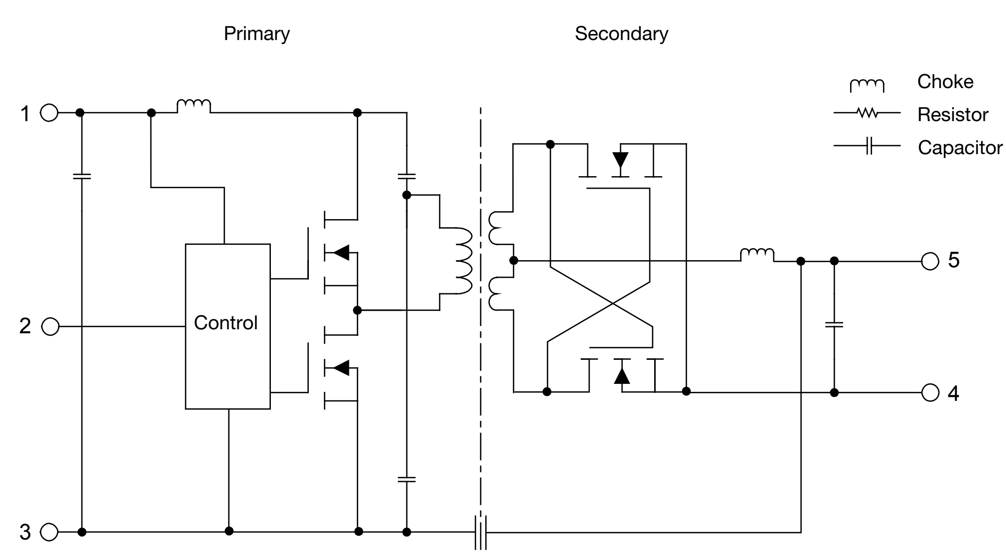
Characteristics			min	typ	max	Unit
T_{PCB}	See Thermal Consideration section for definition.		-40		110	˚C
T_S	Storage temperature		-55		+125	˚C
V_I	Input voltage		-0.3		+60	Vdc
V_{ISO}	Isolation voltage (input to output test voltage)				1500	Vdc
V_{tr}	Input voltage transient				+60	Vdc
V_{RC}	Remote control voltage	Negative logic Positive logic	-0.5 -0.5		18 11	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

Characteristics		Conditions	min	typ	max	Unit
V_I	Input voltage range		42	48	53	Vdc
V_{Ioff}	Turn-off input voltage	Ramping from higher voltage		38.5		Vdc
V_{Ion}	Turn-on input voltage	Ramping from lower voltage		40		Vdc
C \ L	Internal input filter component values			2 \ 0.6		µF \ µH
I_{Imax}	Maximum input current	$V_I = V_I$min			7.5	A
P_{Ii}	Input idling power	$I_o = 0$ A, $V_I = 48$ V		4		W
P_{RC}	Input stand-by power	$V_I = 48$ V, RC activated		0.3		W
	Recommended external input capacitance		33	47		µF

Fundamental Circuit Diagram



Product Qualification Specification (Pending)

Characteristics			
Random Vibration	IEC 68-2-64 Fh JESD 22-B103-B	Frequency Acceleration density Duration	5 ... 500 Hz 0.1 g^2/Hz 10 min each direction
Sinusoidal vibration	IEC 68-2-6 F_c JESD 22-B103-B	Frequency Amplitude Acceleration Number of cycles	10 ... 1000 Hz 0.75 mm 10 g 10 in each axis
Mechanical shock (half sinus)	IEC 68-2-27 E_a JESD 22-B104-B	Peak acceleration Duration	100 g 6 ms
Temperature cycling	IEC 68-2-14 N_a JESD 22-A104-B	Temperature Number of cycles	-40 ... +125 °C 300
Accelerated damp heat	IEC 68-2-67 C_y JESD 22-A101-B	Temperature Humidity Duration	+85 °C 85 % RH 1000 hours
Solder heat stability	IEC 68-2-20 T_b 1A	Temperature, solder Duration	260 °C 10 ...13 s
Resistance to cleaning solvents	IEC 68-2-45 XA method 2	Water Isopropyl alcohol Glykol ether	+55 ± 5 °C +35 ± 5 °C +35 ± 5 °C
Cold (in operation)	IEC 68-2-1A, test A_d	Temperature Duration	-40 °C 2 h
High temperature storage	IEC 68-2-2 B_a JESD 22-A103-B	Temperature Duration	+125 °C 1000 h

Safety Specification

General information.

Ericsson Power Modules DC/DC converters and DC/DC regulators are designed in accordance with safety standards IEC/EN/UL 60 950, *Safety of Information Technology Equipment.*

IEC/EN/UL60950 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”. 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 Directives for the final product.

Component power supplies for general use should comply with the requirements in IEC60950, EN60950 and UL60950 “Safety of information technology equipment”.

There are other more product related standards, e.g. IEC61204-7 “Safety standard for power supplies", IEEE802.3af “Ethernet LAN/MAN Data terminal equipment power”, and ETS300132-2 “Power supply interface at the input to telecommunications equipment; part 2: DC”, but all of these standards are based on IEC/EN/UL60950 with regards to safety.

Ericsson Power Modules DC/DC converters and DC/DC regulators are UL 60 950 recognized and certified in accordance with EN 60 950.

The flammability rating for all construction parts of the products meets UL 94V-0.

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 60 950.

Isolated DC/DC converters.

It is recommended that a fast blow fuse with a rating twice the maximum input current per selected product 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 in the input filter or in the DC/DC converter that imposes a short circuit on the input source, this fuse will provide the following functions:

- Isolate the faulty DC/DC converter 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 for 60 seconds (refer to product specification). Leakage current is less than 1µA at nominal input voltage.

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 Ericsson Power Modules DC/DC converter is 75 V dc 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 V dc.

If the input power source circuit is a DC power system, the source may be treated as a TNV2 circuit and testing has demonstrated compliance with SELV limits and isolation requirements equivalent to Basic Insulation in accordance with IEC/EN/UL 60 950.

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.

It is recommended that a slow blow fuse with a rating twice the maximum input current per selected product be used at the input of each DC/DC regulator.

PKM 4303NF PI - Data

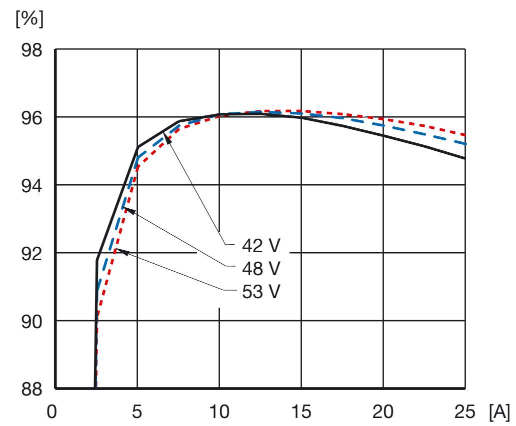
T_{PCB} = -40 ... 90 °C, V_I = 42 ... 53 V unless otherwise specified.
Typ values specified at: T_{PCB} = +25 °C and $V_I$nom. $V_I$nom = 48 V, $I_O$nom = 25 A

Characteristics		Conditions	Output min	Output typ	Output max	Unit
V_{Oi}	Output voltage set point	T_{PCB} = +25 °C, $V_I$nom, I_O = 0		12		V
V_O	Output voltage tolerance band	I_O = 0...1 x $I_O$max	9.6		13.4	V
	Line regulation	I_O = 0, T_{PCB} = +25 °C		V_O = V_I/4		
	Load regulation	I_O = 0...1 x $I_O$max, $V_I$nom		0.6	0.8	V
V_{tr}	Load transient voltage deviation	$V_I$nom, Load step = 0.25 x $I_O$nom		±550		mV
t_{tr}	Load transient recovery time			200		µs
T_{coeff}	Temperature coefficient	T_{PCB} < T_{PCB}max, $I_O$nom		-0.6		mV/°C
t_s	Start-up time	From V_I connected to V_O = 0.9 x V_{OI} I_O = 0 ...1 x $I_O$nom		6	7	ms
t_r	Ramp-up time	V_O = 0.1 ... 0.9 x V_{Oi} I_O = 0 ...1 x $I_O$nom		4	5	ms
I_O	Output current		0		25	A
I_{lim}	Current limit threshold	T_{PCB} < T_{PCB}max		30		A
V_{Oac}	Output ripple	See Ripple and Noise, $I_O$max		100		mV_{p-p}
η	Efficiency - 50% load	I_O = 0.5 x $I_O$nom, $V_I$nom, T_{PCB} = 25 °C		96.0		%
η	Efficiency - 100% load	$I_O$nom, $V_I$nom, T_{PCB} = 25 °C		95.3		%
P_d	Power Dissipation	$I_O$nom, $V_I$nom, T_{PCB} = 25 °C		14		W
f_s	Switching frequency			170		kHz
V_I OVP	Over voltage protection 1)		54	58	60	V
MTBF	Predicted reliability			TBD		million hours

1) V_O = V_I/4 at I_O = 0

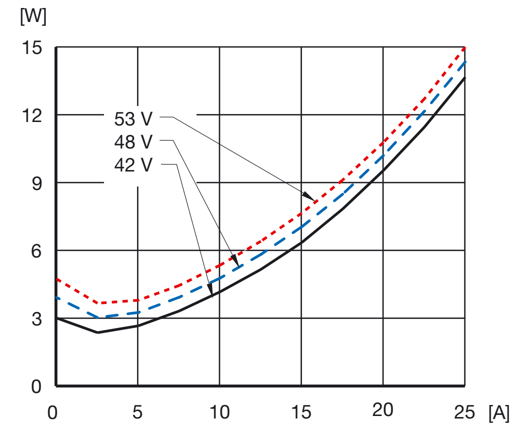
PKM 4303NF PI - Typical Characteristics

Efficiency



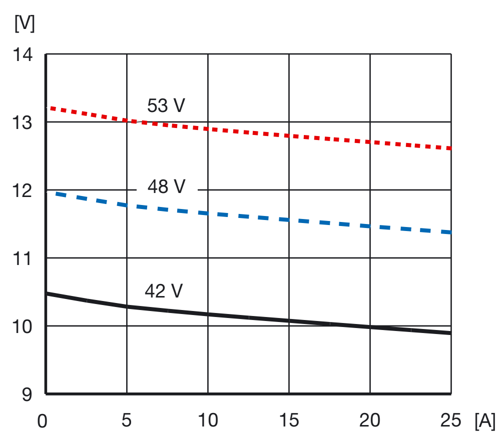
Efficiency vs. load current and input voltage at $T_{PCB} = +25$ °C

Power Dissipation



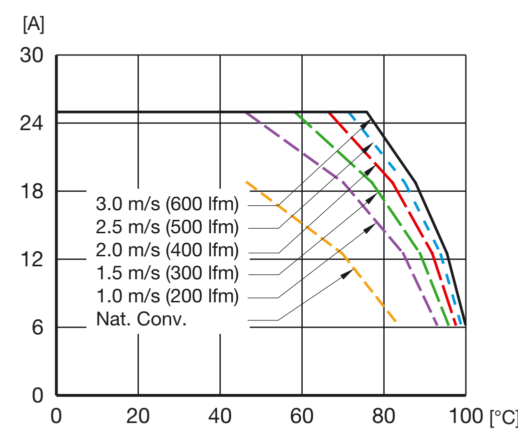
Dissipated power vs. load current and input voltage at $T_{PCB} = +25$ °C

Output Characteristics



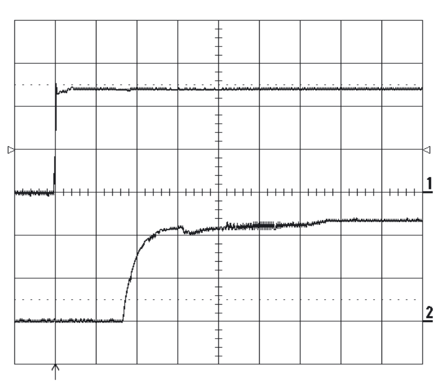
Output voltage load characteristic.

Output Current Derating



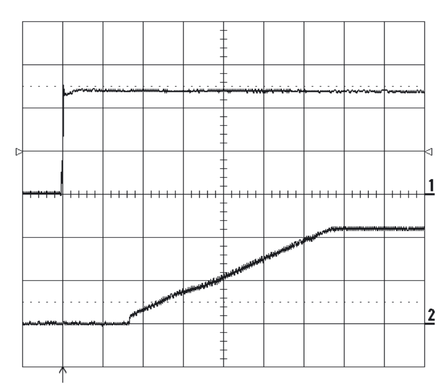
Available load current vs. ambient air temperature and airflow at $V_{in} = 48$ V. Converter mounted vertically with airflow and test conditions as per the Thermal Consideration section.

Start-Up 0 A



Start-up enabled by connecting V_{in}.
$I_O = 0$ A, $T_{PCB} = +25$ °C, $V_{in} = 48$ V.
Trace 1: input voltage (20 V/div.).
Trace 2: output voltage (5 V/div.).
Time scale: 1 ms/div.

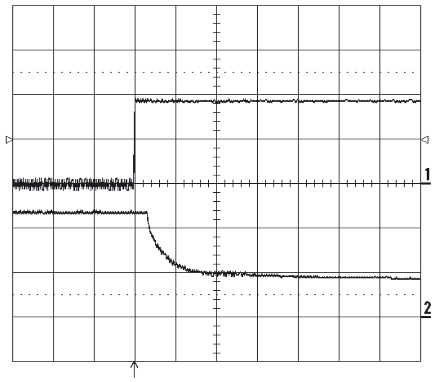
Start-up 25 A



Start-up enabled by connecting V_{in}.
$I_O = 25$ A resistive load, $T_{PCB} = +25$ °C, $V_{in} = 48$ V.
Trace 1: input voltage (20 V/div.).
Trace 2: output voltage (5 V/div.).
Time scale: 1 ms/div.

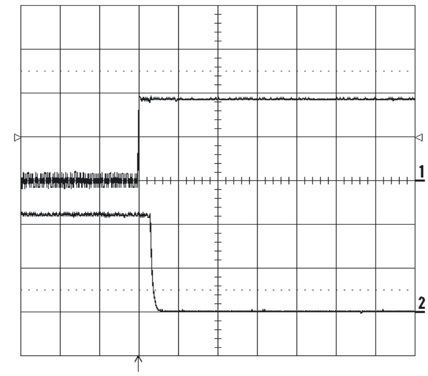
PKM 4303NF PI - Typical Characteristics

Turn-off 0 A



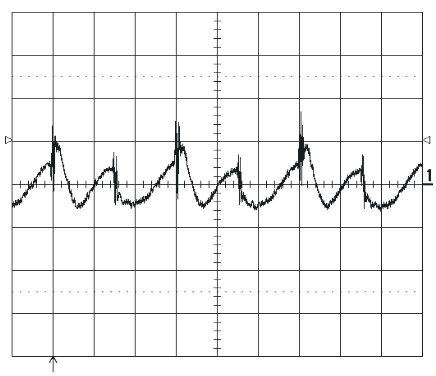
Turn-off by activating RC.
I_O = 0 A, T_{PCB} = +25 °C, V_{in} = 48 V.
Trace 1: V_{RC} (5 V/div.).
Trace 2: output voltage (5 V/div.).
Time scale: 0.2 ms/div.

Turn-off 25 A



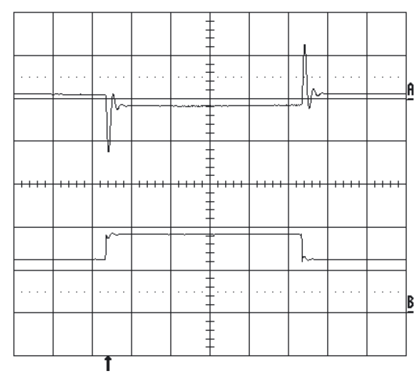
Turn-off by activating RC.
I_O = 25 A resistive load, T_{PCB} = +25 °C, V_{in} = 48 V.
Trace 1: V_{RC} (5 V/div.).
Trace 2: output voltage (5 V/div.).
Time scale: 0.2 ms/div.

Output Ripple



Output voltage ripple (50 mV/div.) at T_{PCB} = +25 °C, V_{in} = 48 V,
I_O = 25 A resistive load with C external = 10 μF tantalum and
1 μF ceramic capacitors.
Band width = 30 MHz.
Time scale: 2 μs / div.

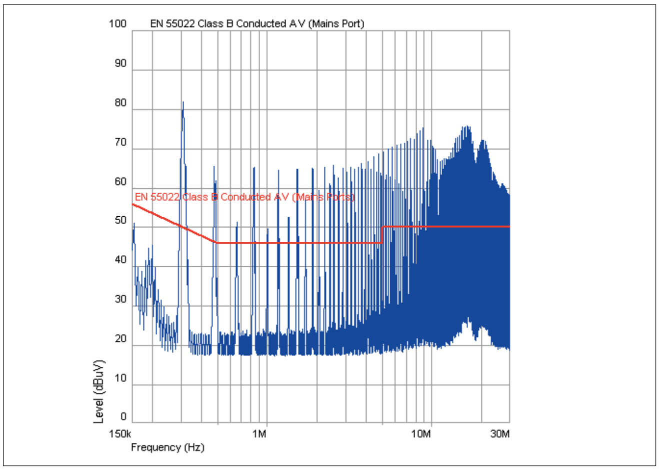
Transient



Output voltage response to load current step-change
(12.5-18.75-12.5 A) at T_C = +25 °C, V_{in} = 48 V.
Trace A: output voltage (0.5 V/div.).
Trace B: output current (10 A/div).
dI/dt = 4 A/μs, Time scale: 0.1 ms/div.

EMC Specification

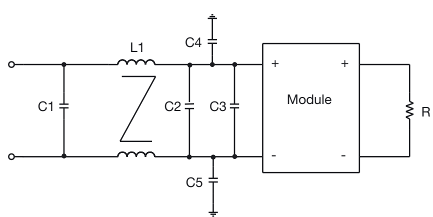
The conducted EMI measurement is performed using a module placed directly on the test bench.
The fundamental switching frequency is 170 kHz.



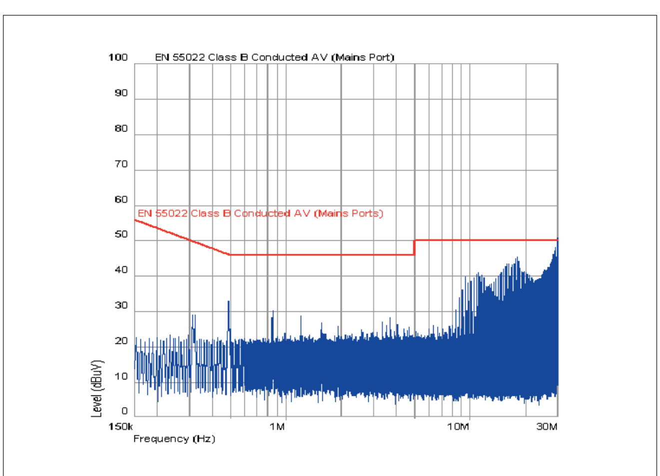
without filter.

External filter (class B)

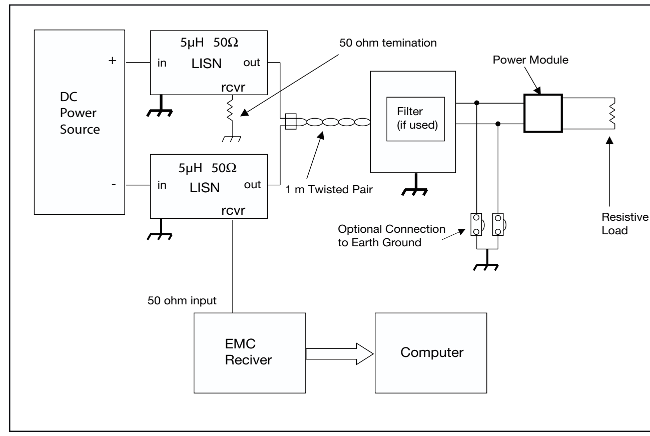
Recommended external input filter.



C1; 6 x 1 µF (100 V, ceramic)
C2; 100 µF (100 V, electrolytic)
C3; 6 x 1 µF (100 V, ceramic)
C4, C5; 2.2 nF (2 kV, ceramic)
L1; 0,809 µH / 9.7 A common mode inductor



with filter.



Test set-up.

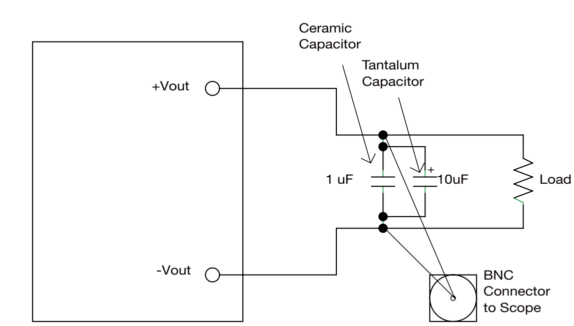
Layout Recommendation

The radiated EMI performance of the DC/DC converter will be optimised by including a ground plane in the PCB area under the DC/DC converter. This approach will return switching noise to ground as directly as possible, with improvements to both emissions and susceptibility. If one ground trace is used, it should be connected to the input return. Make sure to use appropriate safety isolation between the groundplane and the DC/DC converters internal output side components, including the transformer ferrite.

Alternatively, two ground traces may be used, with the trace under the input side of the DC/DC converter connected to the input return and the trace under the output side of the DC/DC converter connected to the output return. Make sure to use appropriate safety isolation spacing between these two return traces. The use of two traces as described will provide the capability of routing the input noise and output noise back to their respective returns.

Output ripple and noise

The circuit below has been used for the ripple and noise measurements on the PKM 4000 NF Series DC/DC converters.



* Conductor from Vout to capacitors = 50mm [1.97in]

Output ripple and noise test setup

Operating Information

Input Voltage

The input voltage range is limited to 42...53Vdc.

Turn-On/Off Input Voltage

The converters monitor the input voltage and will turn on and turn off at predetermined levels, where the turn on input voltage is the highest.

Remote Control (RC)

The converters have remote control function referenced to the primary side (negative input), with negative and positive logic options available. The RC pin has an internal pull up resistor to +IN. The needed maximum sink current is 1 mA. When the RC pin is left open, the voltage generated on the RC pin by the DC/DC converter is 7.0-11.0 V. The maximum allowable leakage current of the switch is 10 μA.

When the converter is provided with "negative logic" remote control it will remain off until the RC pin is connected to the negative input. To turn on the converter the voltage between RC pin and negative input should be less than 0.8 V. To turn off the converter the RC pin should be left open, or connected to a voltage between 2.4 and 18 V referenced to negative input. In situations where it is desired to have the converter power up automatically without the need for control signals or a switch, the RC pin can be wired directly to the negative input.

With "positive logic" remote control the converter will turn on when the input voltage is applied with the RC pin open. The RC pin should not be connected to a positive voltage.
Turn off is achieved by connecting the RC pin to the negative input. To ensure safe turn off the voltage difference between the RC pin and the negative input pin shall be less than 0.8 V. The converter will restart when this connection is opened.

Current Limit Protection

The converters include current limiting circuitry that allows them to withstand continuous overloads or short circuit conditions on the output.

The current limiting function is enabled when the soft-start cycle during start-up is completed.

Once an over current condition is detected the output will shutdown. After a short time a new soft-start cycle is initiated. If the over current condition persists, the output voltage will go through repeated cycles of shutdown and short time delayed restart ("hiccup" mode). The converter will resume normal operation (auto resetting) after removal of the overload.

Over Voltage Protection (OVP)

The converters have OVP with hysteresis detecting the input voltage. Since the output voltage is proportional to the input voltage (except for load regulation) the OVP-function will work as an output OVP. In the event of an over-voltage condition, the converter will shut down immediately. The converter will restart if the input voltage is restored.

Over Temperature Protection (OTP)

The converters are protected from thermal overload by an internal OTP circuit with hysteresis. When the PCB temperature at a certain point exceeds approximately 130 °C the converter will shut down immediately. The converter will restart when the temperature drops.

Input And Output Impedance

The impedance of both the power source and the load will interact with the impedance of the DC/DC converter. It is most important to have a ratio between L and C as low as possible, i.e. a low characteristic impedance, both at the input and output, as the converters have a low energy storage capability. The converters have been designed to be completely stable without the need for external capacitors on the input or the output circuits. The performance in some applications can be enhanced by addition of external capacitance as described under maximum capacitive load. If the distribution of the input voltage source to the converter contains significant inductance, the addition of a 100 μF capacitor across the input of the converter will help to insure stability. This capacitor is not required when powering the DC/DC converter from a low impedance source with short, low inductance, input power leads.

Maximum Capacitive Load

When powering loads with significant dynamic current requirements, the voltage regulation at the load can be improved by addition of decoupling capacitance at the load. The most effective technique is to locate low ESR ceramic capacitors as close to the load as possible, using several capacitors to lower the effective ESR. These ceramic capacitors will handle short duration high-frequency components of dynamic load changes. In addition, higher values of electrolytic capacitors should be used to handle the mid-frequency components. It is equally important to use good design practice when configuring the DC distribution system.

Low resistance and low inductance PCB (printed circuit board) layouts and cabling should be used.

As a “rule of thumb”, 100 μF/A of output current can be used without any additional analysis. For example with a 25A converter, values of decoupling capacitance up to 2500 μF can be used without regard to stability. The absolute maximum value of output capacitance is 3 000 μF.

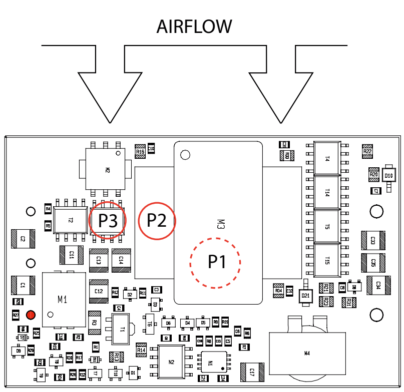
Thermal Consideration

General

The converters are designed to operate in a variety of thermal environments, however sufficient cooling should be provided to help ensure reliable operation. Heat is removed by conduction, convection and radiation to the surrounding environment. Increased airflow enhances the heat transfer via convection. The available load current vs. ambient air temperature and airflow at Vin = 48 V for each model is according to the information given under the output section. The test is done in a wind tunnel with a cross section of 305x305 mm, the DC/DC converter vertically mounted on a 16 layer PCB with a size of 254x254 mm, each layer with 35 µm (1 oz) copper. Proper cooling can be verified by measuring the temperature of selected devices.

Peak temperature can occur at positions P2 and P3. The temperature at these positions should not exceed the recommended maximum values.

Position	Device	$T_{critical}$	Max Value
P1	Top side of PCB	T_{PCB}	110 °C
P2	Transformer	$T_{winding}$	110 °C
P3	MOSFET	$T_{surface}$	110 °C

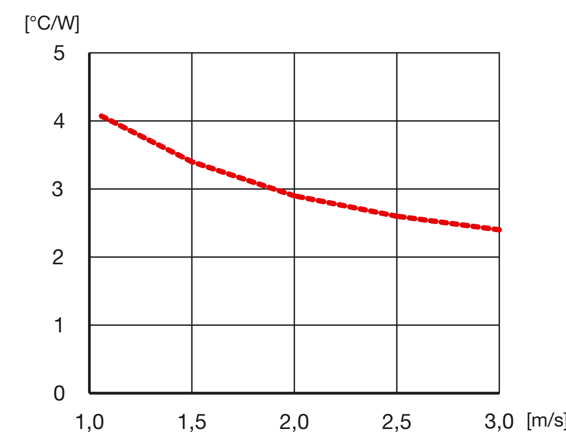


Calculation of ambient temperature

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

1. The powerloss is calculated by using the formula
   $((1/\eta) - 1) \times$ output power = power losses.
   η = efficiency of converter. E.g 95.3% = 0.953

2. Find the value of the thermal resistance for each product in the diagram by using the airflow speed at the output section of the converter. Take the thermal resistance x powerloss to get the temperature increase.



3. Max allowed calculated ambient temperature is: Max T_{PCB} of DC/DC converter – temperature increase.

E.g PKM 4303 NFPI at 1m/s:

A. $\left(\frac{1}{0.953} - 1\right) \times (11.4 \times 25)$ W = 14.1 W

B. 14.1 W × 4.2 °C/W = 59 °C

C. 110 °C - 59 °C = max ambient temperature is 51 °C

The real temperature will be dependent on several factors, such as PCB size and type, direction of airflow, air turbulence etc. It is recommended to verify the temperature by testing.

Soldering Information

The converters are intended for through hole mounting on a PCB. When wave soldering is used max temperature on the pins are specified to 215°C for 10 seconds. Maximum preheat rate of 4°C/s is suggested. When hand soldering is used a thermocouple needs to be mounted on the DC/DC converter pins to verify that pin temperatures doe not exceed 215°C for longer than 10 seconds with the used soldering tools.

No-clean flux is recommended to avoid entrapment of cleaning fluids in cavities inside of the DC/DC power module. The residues may affect long time reliability and isolation voltage.

Delivery Package Information

Standard delivery package

Tray Specification

Material:
Max surface resistance:
Color:
Capacity:
Weight:

Design for Environment (DfE)

The PKM 4000 Series DC/DC converters are designed to fulfill the wanted functionality with minimum environmental impact. The converters are presently assembled using low lead solder and electroless nickel plated copper pins.
All packaging used for shipping is recyclable.

Quality Statement

The converters are designed and manufactured in an industrial environment where quality systems and methods like ISO 9000, 6σ (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 our products.

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).

Sales Offices and Contact Information

Company Headquarters
Ericsson Power Modules AB
LM Ericssons väg 30
SE-126 25 Stockholm
Sweden

Phone: +46-8-568-69620
Fax: +46-8-568-69599

Hong Kong (Asia Pacific)
Ericsson Ltd.
12/F. Devon House
979 King's Road
Quarry Bay
Hong Kong

Phone: +852-2590-2453
Fax: +852-2590-7152

China
Ericsson Simtek Electronics Co.
33 Fuhua Road
Jiading District
Shanghai 201 818

Phone: +86-21-5951-6258
Fax: +86-21-5951-6188

Italy, Spain (Mediterranean)
Ericsson Power Modules
Via Cadorna 71
20090 Vimodrone (MI)
Italy

Phone: +39-02-265-946-07
Fax: +39-02-265-946-69

France, Switzerland, Benelux
Ericsson Power Modules AB
Bat Sologne
17 Rue des 4 vents
92380 Garches

Phone: +33-1-4741-5244
Fax: +33-1-4741-5244

UK, Eire
Ericsson Power Modules AB
United Kingdom

Phone: +44-1869-233-992
Fax: +44-1869-232-307

North and South America
Ericsson Inc. Power Modules
6300 Legacy Dr.
Plano, TX 75024

Phone: +1-972-583-5254
+1-972-583-6910
Fax: +1-972-583-7839

All other countries
Contact Company Headquarters
or visit our website:
www.ericsson.com/powermodules