ERICSSON

Technical Specification

PKB 4302NG PI Intermediate Bus Converters, Input 38-55 V, 42 A / 300 W	EN/LZT 146 381 R1A July 2008 © Ericsson Power Modules AB

Key Features

- Industry standard Eighth-brick
  58.4 x 22.7 x 10.7 mm (2.3 x 0.894 x 0.42 in.)
- High efficiency, typ. 96.8 % at 50% load
- 1500 Vdc input to output isolation
- Meets isolation requirements equivalent to basic insulation according to IEC/EN/UL 60950
- Baseplate option
- More than 1.6 million hours MTBF

General Characteristics

- N+1 parallelable
- Input under voltage protection
- Input over voltage shutdown
- Over temperature protection
- Output short-circuit protection
- Remote control
- Highly automated manufacturing ensures quality
- ISO 9001/14001 certified supplier

Safety Approvals

Design for Environment

RoHS compatible

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

Contents

General Information

Ordering Information

See Contents for individual product ordering numbers.

Option	Suffix	Ordering No.
Standard		PKB 4302NG PI
Positive Remote Control Logic	P	PKB 4302NG PIP
Baseplate	HS	PKB 4302NG PIHS
Lead length 3.69 mm (0.145 in)	LA	PKB 4302NG PILA
Lead length 4.57 mm (0.180 in)	LB	PKB 4302NG PILB
Lead length 2.79 mm (0.110 in)	LC	PKB 4302NG PILC

Note 1: As an example a short pin, baseplate product would be PKB 4302NG PIHSLA.

Reliability

The Mean Time Between Failure (MTBF) is calculated at full output power and an operating ambient temperature (T_A) of +40°C, which is a typical condition in Information and Communication Technology (ICT) equipment. Different methods could be used to calculate the predicted MTBF and failure rate which may give different results. Ericsson Power Modules currently uses Telcordia SR332.

Predicted MTBF for the series is:
- 1.6 million hours according to Telcordia SR332, issue 1, Black box technique.

Telcordia SR332 is a commonly used standard method intended for reliability calculations in ICT equipment. The parts count procedure used in this method was originally modelled on the methods from MIL-HDBK-217F, Reliability Predictions of Electronic Equipment. It assumes that no reliability data is available on the actual units and devices for which the predictions are to be made, i.e. all predictions are based on generic reliability parameters.

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 include:
- Lead in high melting temperature type solder (used to solder the die in semiconductor packages)
- Lead in glass of electronics components and in electronic ceramic parts (e.g. fill material in chip resistors)
- Lead as an alloying element in copper alloy containing up to 4% lead by weight (used in connection pins made of Brass)

Quality Statement

The products 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.

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

Ericsson Power Modules DC/DC converters and DC/DC regulators are designed in accordance with safety standards IEC/EN/UL60950, *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. 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 UL60950 recognized and certified in accordance with EN60950.

The flammability rating for the board meets requirements for V-0 class material according to IEC 60695-11-10.

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/UL60950.

Isolated DC/DC converters

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 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 1 μA 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 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 TNV2 circuit and testing has demonstrated compliance with SELV limits and isolation requirements equivalent to Basic Insulation in accordance with IEC/EN/UL60950.

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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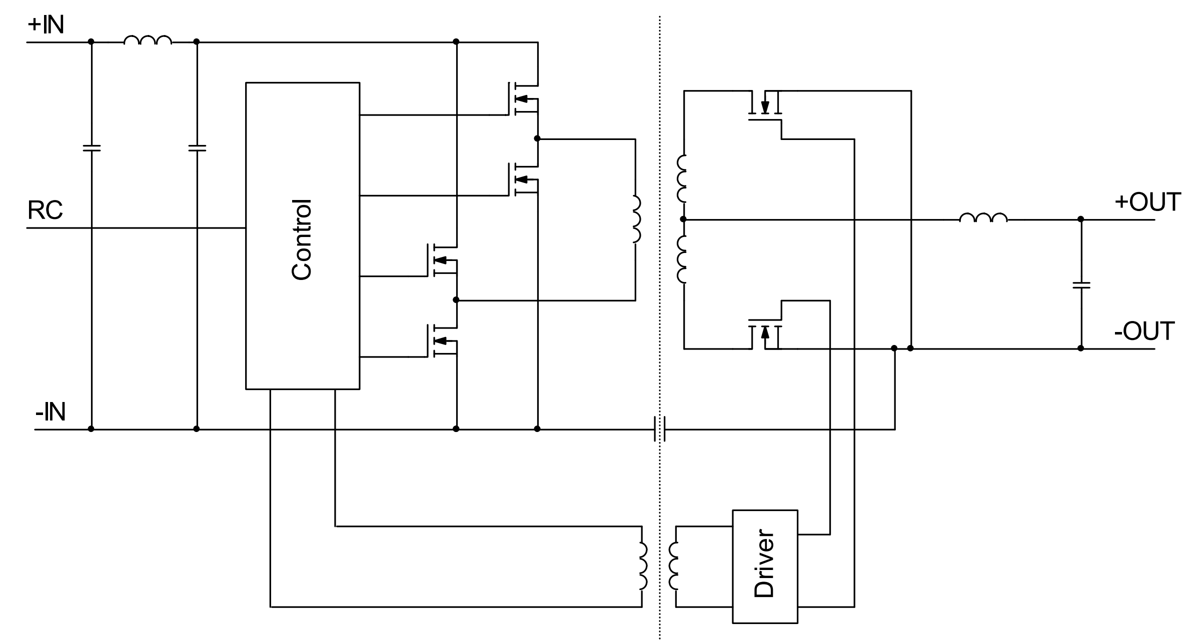
Absolute Maximum Ratings

Characteristics			min	typ	max	Unit
T_{P1}	Operating Temperature (see Thermal Consideration section)	Open frame	-40		+125	°C
		Base plate option	-40		+110	°C
T_S	Storage temperature		-55		+125	°C
V_I	Input voltage		-0.5		+60	V
V_{iso}	Isolation voltage (input to output test voltage)				1500	Vdc
V_{tr}	Input voltage transient (t_p 100 ms)				60	V
V_{RC}	Remote Control pin voltage (see Operating Information section)	Positive logic option	-0.5		15	V
		Negative logic option	-0.5		15	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



9.6 V, 300 W Electrical Specification — PKB 4302NG PI

Minimum and maximum values given at T_{P1} = -30 to +100°C for open frame, -30 to +85°C for base plate option, V_I = 38 to 55 V, P_O = 0 to 300 W unless otherwise specified under Conditions.
Typical values given at: T_{P1} = +25°C, V_I = 48 V, max P_O, unless otherwise specified under Conditions.
Additional C_{in} = 220 µF. See Operating Information section for selection of capacitor types.

Characteristics		Conditions	min	typ	max	Unit
V_I	Input voltage range	See Note 1	38		55	V
V_{Ioff}	Turn-off input voltage	Decreasing input voltage	31	32	34	V
V_{Ion}	Turn-on input voltage	Increasing input voltage	33	34	35	V
C_I	Internal input capacitance			13		µF
P_O	Output power		0		300	W
η	Efficiency	50 % of max P_O , V_I = 48 V		96.8		%
		max P_O , V_I = 48 V		96.8		
P_d	Power Dissipation	max P_O		10	17	W
P_{Ii}	Input idling power	P_O = 0 W, V_I = 48 V		3		W
P_{RC}	Input standby power	V_I = 48 V (turned off with RC)		0.07		W
f_s	Switching frequency		120	166	210	kHz

V_{Oi}	Output voltage initial setting and accuracy	T_{P1} = +25°C, V_I = 48 V, P_O = 0 W	9.55	9.6	9.65	V
V_O	Output voltage tolerance band		7.2		11.0	V
	Idling voltage	P_O = 0 W	7.5		11.0	V
	Line regulation	See Note 2 regarding V_O		3.4		V
	Load regulation	0-100 % of max P_O	0.17	0.25	0.38	V
V_{tr}	Load transient voltage deviation	V_I = 48 V, Load step 25-75-25 % of max P_O, di/dt = 5 A/µs. See Note 3		±0.2	±0.4	V
t_{tr}	Load transient recovery time			10	30	µs
t_r	Ramp-up time (from 10–90 % of V_{Oi})	0-100 % of max P_O	0.2	6	8	ms
t_s	Start-up time (from V_I connection to 90 % of V_{Oi})		2	10	12	ms
t_f	V_I shut-down fall time (from V_I off to 10 % of V_O)	max P_O		1		ms
		1 % of max P_O		50		ms
t_{RC}	RC start-up time	max P_O		10		ms
	RC shut-down fall time (from RC off to 10 % of V_O)	max P_O		1.5		ms
		1 % of max P_O		4		ms
I_O	Output current	V_I = 38 V, see note 4	0		41.5	A
		V_I = 48 V, see note 4	0		32.3	A
		V_I = 55 V, see note 4	0		28.0	A
I_{lim}	Current limit threshold	T_{P1} < max T_{P1}	47	52	62	A
I_{sc}	Short circuit current	T_{P1} = 25°C, see Note 5		35		A
V_{Oac}	Output ripple & noise	See ripple & noise section, max P_O		25	100	mVp-p
OVP	Input over voltage protection			62		V

Note 1: Withstands an input voltage of 60 V for 500 ms

Note 2: $V_O = V_I/5$ – load regulation. Example: at V_I = 48 V and max P_O, V_O = 48/5-0.25 = 9.35 V

Note 3: A 3.2 mF output capacitor used at load transient test

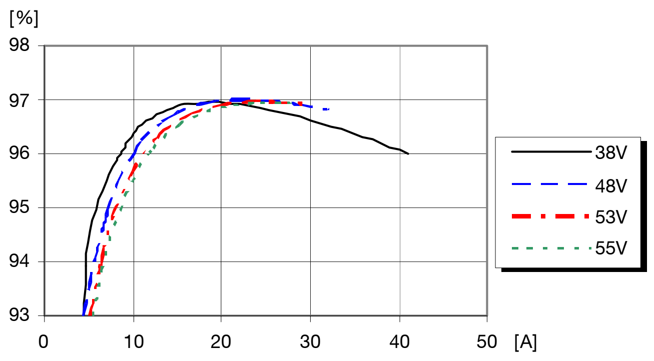
Note 4: The maximum output power is limited to 300 W

Note 5: Hiccup characteristics (specified short circuit currents are RMS-values)

9.6 V, 300 W Typical Characteristics

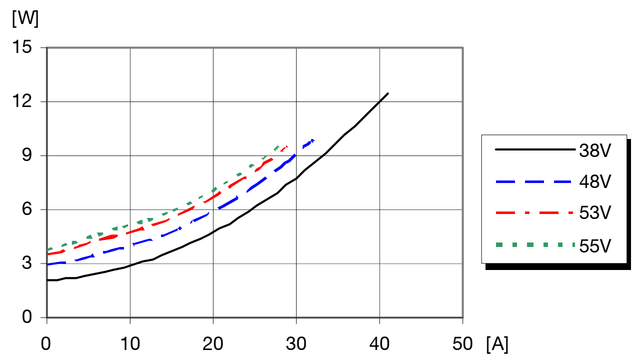
PKB 4302NG PI

Efficiency



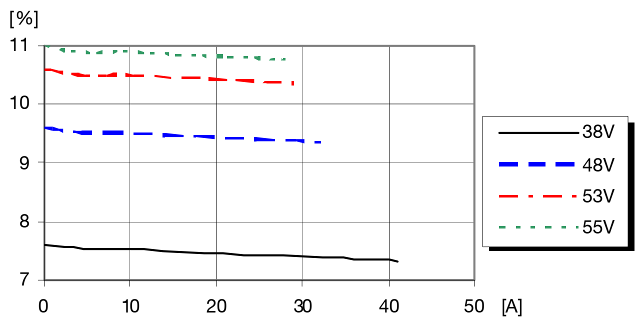
Efficiency vs. load current and input voltage at T_{P1} = +25°C

Power Dissipation



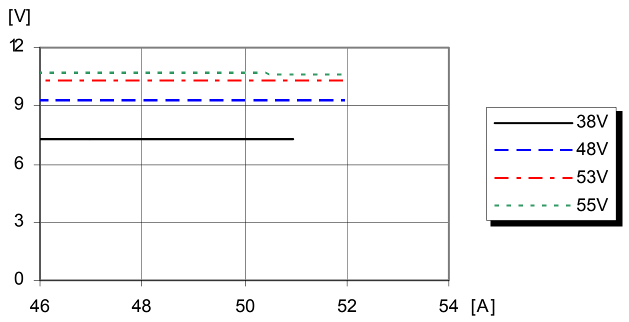
Dissipated power vs. load current and input voltage at T_{P1} = +25°C

Output Characteristics



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

Current Limit Characteristics

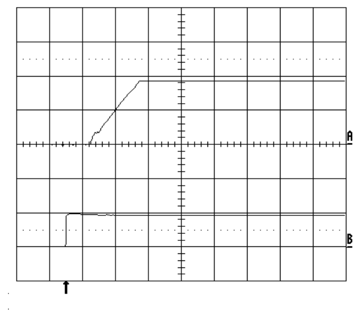


Output voltage vs. load current at I_O > max I_O, T_{P1} = +25°C

9.6 V, 300 W Typical Characteristics

PKB 4302NG PI

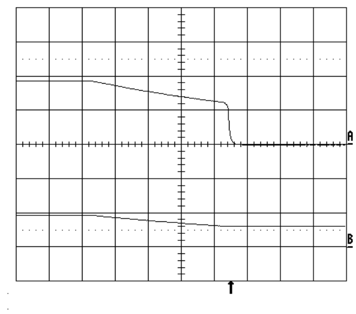
Start-up



Start-up enabled by connecting V_I at:
T_{P1}= +25°C, V_I = 48 V,
I_O = 32 A resistive load.

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

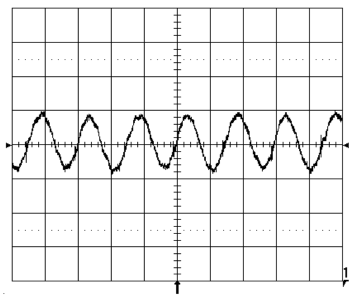
Shut-down



Shut-down enabled by disconnecting V_I at:
T_{P1}= +25°C, V_I = 48 V,
I_O = 32 A resistive load.

Top trace: output voltage (5 V/div.).
Bottom trace: input voltage (50 V/div.).
Time scale: (0.2 ms/div.).

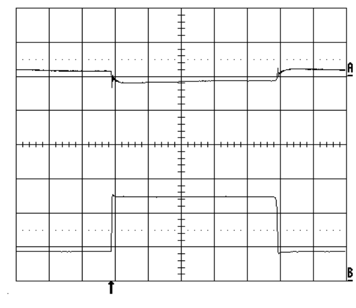
Output Ripple & Noise



Output voltage ripple at:
T_{P1}= +25°C, V_I = 48 V,
I_O = 32 A resistive load.

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

Output Load Transient Response



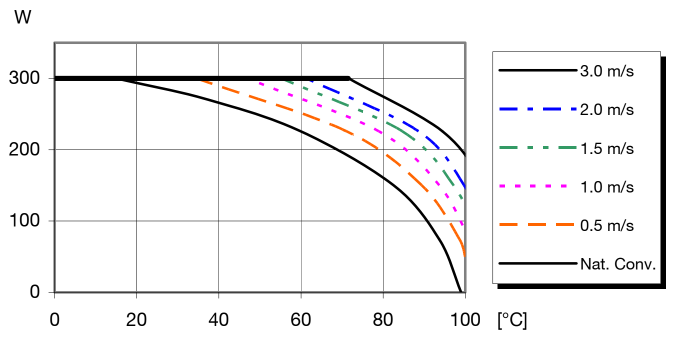
Output voltage response to load current step-change (8-24-8 A) at:
T_{P1}=+25°C, V_I = 48 V.

Top trace: output voltage (0.5 V/div.).
Bottom trace: load current (10 A/div.).
Time scale: (0.2 ms/div.).

9.6 V, 300 W Typical Characteristics

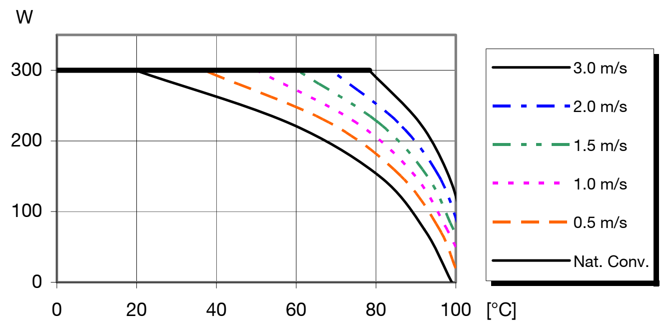
PKB 4302NG PI

Output Power Derating at V_I = 38 V - Open frame



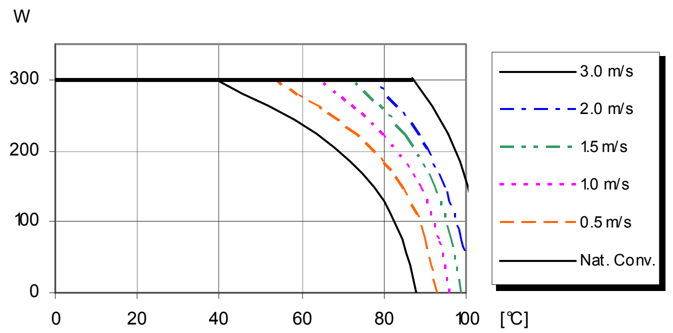
Available output power vs. ambient air temperature and airflow.
See Thermal Consideration section.

Output Power Derating at V_I = 38 V - Base plate



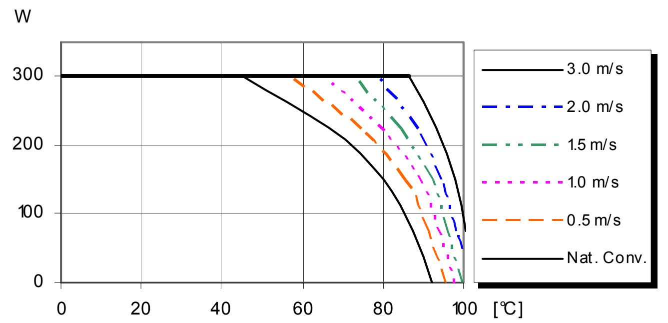
Available output power vs. ambient air temperature and airflow.
See Thermal Consideration section.

Output Power Derating at V_I = 48 V - Open frame



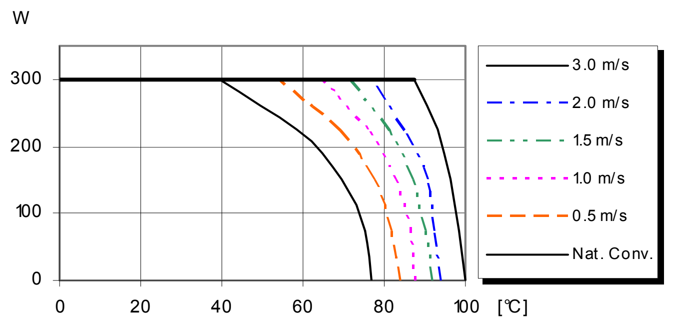
Available output power vs. ambient air temperature and airflow.
See Thermal Consideration section.

Output Power Derating at V_I = 48 V - Base plate



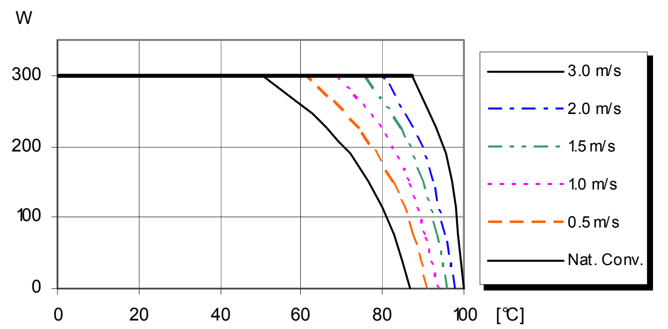
Available output power vs. ambient air temperature and airflow.
See Thermal Consideration section.

Output Power Derating at V_I = 55 V - Open frame



Available output power vs. ambient air temperature and airflow.
See Thermal Consideration section.

Output Power Derating at V_I = 55 V - Base plate

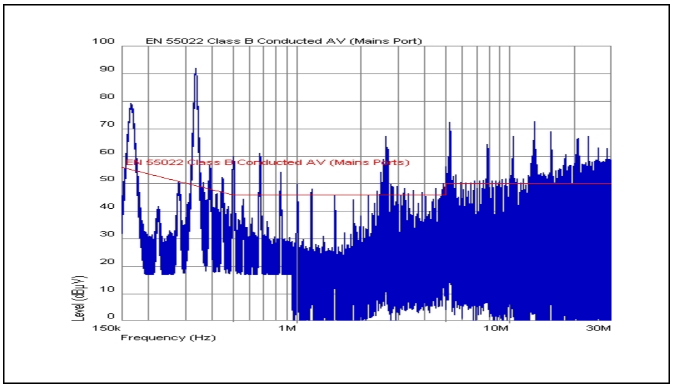


Available output power vs. ambient air temperature and airflow.
See Thermal Consideration section.

EMC Specification

Conducted EMI measured according to EN55022, CISPR 22 and FCC part 15J (see test set-up). See Design Note 009 for detailed information. The fundamental switching frequency is 166 kHz at 48 V input.

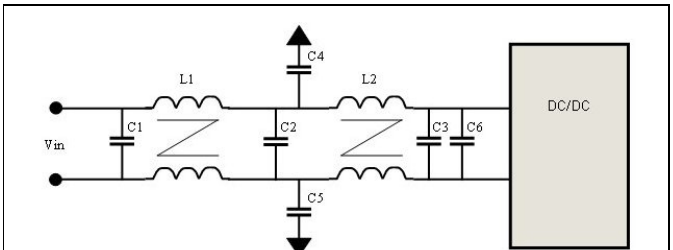
Conducted EMI Input terminal value (typ)



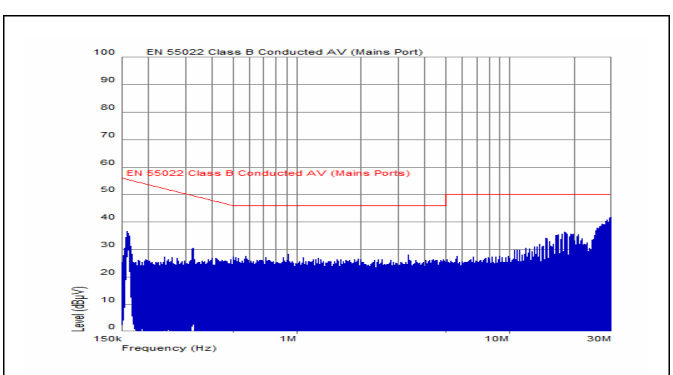
EMI without filter

External filter (class B)

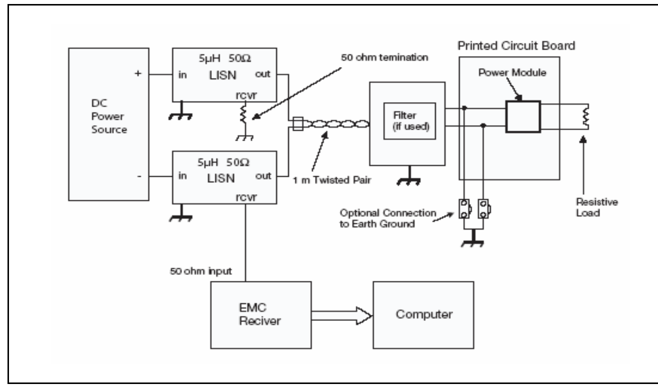
Example of an external input filter in order to meet class B in EN 55022, CISPR 22 and FCC part 15J.



C1, C2, C3 = 1 µF	(100 V, ceramic)
C4, C5 = 2.2 nF	(2 kV, ceramic)
C6 = 220 µF	(100 V, electrolytic)
L1, L2 = 809 µH	(common mode)



EMI with filter



Test set-up

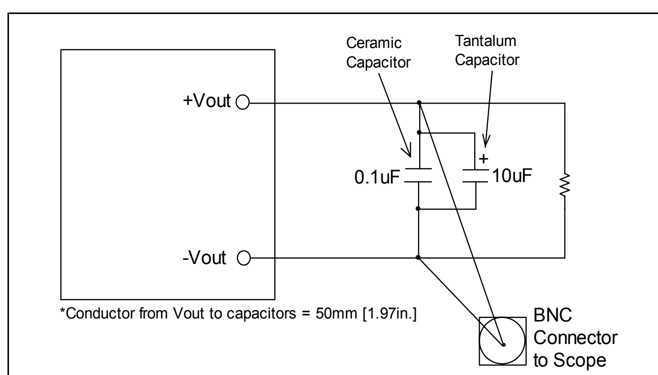
Layout recommendation

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 DC/DC converter.
If a ground layer is used, it should be connected to the output of the DC/DC converter 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

Operating information

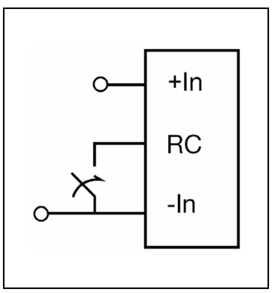
Input Voltage

The input voltage range of the DC/DC converters is especially adapted to meet the requirements of non-battery backup -48 V systems.

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 on and off input voltage is 1.0 V.

Remote Control (RC)



The products are fitted with a remote control function referenced to the primary negative input connection (- In), with positive logic option 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 maximum required sink current is less than 1 mA. When the RC pin is left open, the voltage generated on the RC pin is 5-10 V. The second option is “positive logic” remote control, which can be ordered by adding the suffix “P” to the end of the part number. The DC/DC converter will turn on when the input voltage is applied with the RC pin open. Turn off is achieved by connecting the RC pin to the - In. To ensure safe turn off the voltage difference between RC pin and the - In pin shall be less than 0.8 V. The DC/DC converter will restart automatically when this connection is opened. Design note 21 explains more in detail about the RC pin.

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. Minimum recommended external input capacitance is 220 µF. The performance in some applications can be enhanced by addition of external capacitance as described under External Decoupling Capacitors.

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.
For non regulated DC/DC converters, such as PKB-NG intermediate bus converters, there is no limit on the value of output capacitance that may be used. The user should be aware, however, that large values of capacitance will affect the ramp-up time of the DC/DC converter output voltage during start-up.
For further information please contact your local Ericsson Power Modules representative.

Parallel Operation

TBD

Over Temperature Protection (OTP)

The dc/dc converters are protected from thermal overload by an internal over temperature shutdown circuit.
When T_{P1} as defined in thermal consideration section exceeds 125°C the DC/DC converter will shut down. The DC/DC converter will make continuous attempts to start up (non-latching mode) and resume normal operation automatically when the temperature has dropped below the temperature threshold.

Over Voltage Protection (OVP)

The DC/DC converters have over voltage protection that will shut down the DC/DC converter in over voltage conditions. The DC/DC converter will make continuous attempts to start up (non-latching mode) and resume normal operation automatically after removal of the over voltage condition.
The output voltage depends on the input voltage. The internal OVP circuit detects the input voltage and is activated at an input voltage threshold between the maximum and absolute maximum level.

Over Current Protection (OCP)

The DC/DC converters include current limiting circuitry for protection at continuous overload.
The DC/DC converters will go into hiccup mode for output currents in excess of max output current (max I_O). The output will go through repeated cycles of shut-down and restart. The DC/DC converter will resume normal operation after removal of the overload. The load distribution should be designed for the maximum output short circuit current specified.

Thermal Consideration

General

The converters are designed to operate in different thermal environments and sufficient cooling must be provided to ensure reliable operation.
Cooling is achieved mainly by conduction, from the pins to the host board, and convection, which is dependant on the airflow across the converter. Increased airflow enhances the cooling of the converter.

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 = 38 V, 48 V and 55 V.

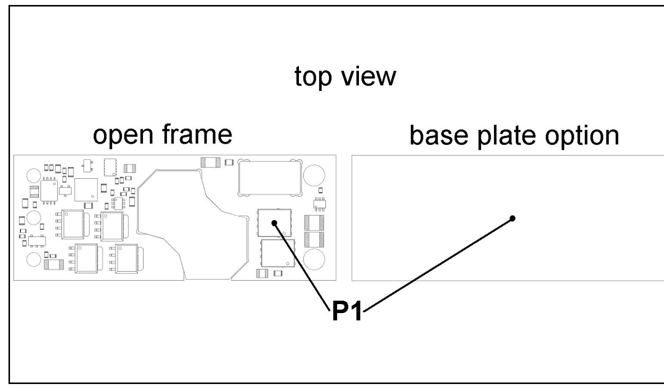
The DC/DC converter is tested on a 254 x 254 mm, 35 µm (1 oz), 16-layer test board mounted vertically in a wind tunnel with a cross-section of 305 x 305 mm.

Proper cooling of the DC/DC converter can be verified by measuring the temperature at the reference point, P1 (a transistor for open frame and the base plate for base plate option).
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_{P1} 100°C for open frame and up to T_{P1} 85°C for base plate option.

See Design Note 019 for detailed information.

Position	Description	Max value
P1	transistor (for open frame)	125 °C
P1	base plate (for base plate option)	110 °C



Definition of reference temperature (T_{P1})

The reference temperature is used to monitor the temperature limits of the product. Temperatures above maximum T_{P1} are not allowed and may cause degradation or permanent damage to the product. T_{P1} is also used to define the temperature range for normal operating conditions.
T_{P1} is defined by the design and used to guarantee safety margins, proper operation and high reliability of the module.

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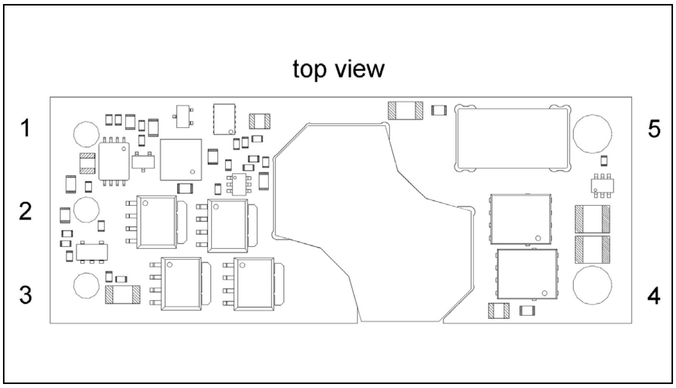
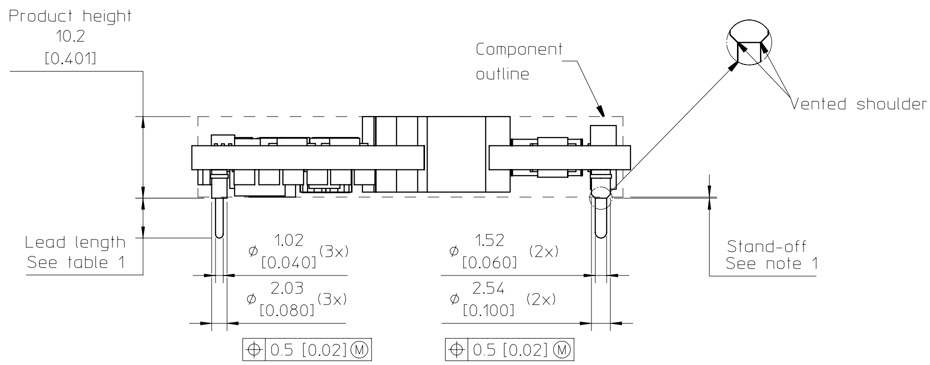
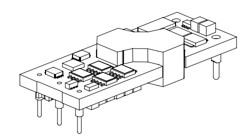
Connections



Pin	Designation	Function
1	+In	Positive input
2	RC	Remote control
3	-In	Negative input
4	-Out	Negative output
5	+Out	Positive output

Mechanical Information - Hole Mount, Open Frame Version





TOP VIEW
Pin positions according to recommended footprint

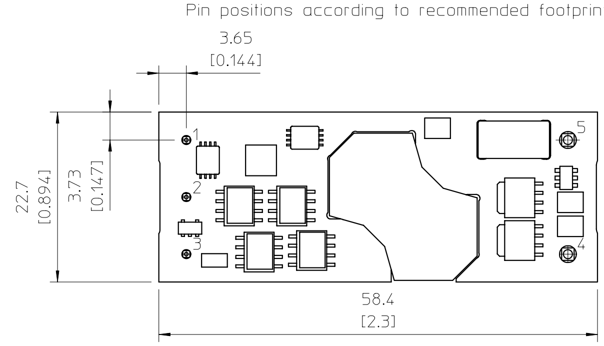


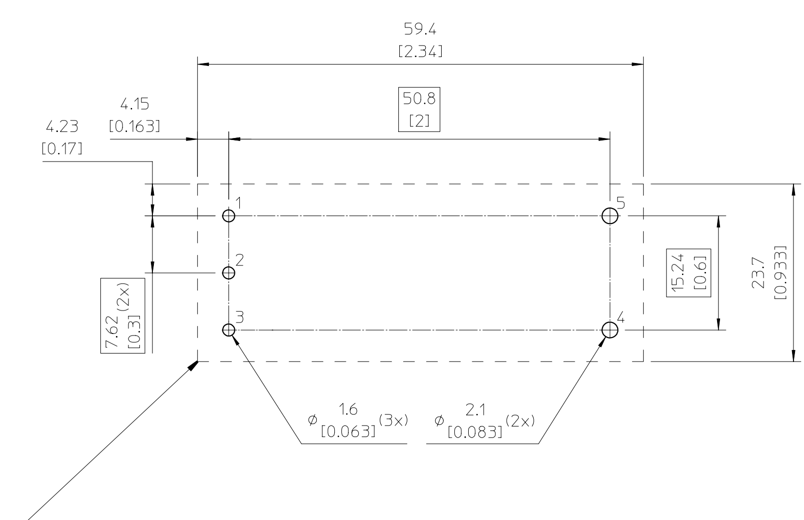
Table 1

Pin option	Lead length
Standard	5.33 [0.210]
LA	3.69 [0.145] cut
LB	4.57 [0.180] cut
LC	2.79 [0.110] cut

Notes
1- Stand off to none conductive components min 0.15 [0.006]
Stand off to conductive components min 0.7 [0.0276]
For details see safety section page 3.

Pins:
Material: Copper alloy
Plating: 0,1 μm Gold over 2 μm Nickel

RECOMMENDED FOOTPRINT - TOP VIEW

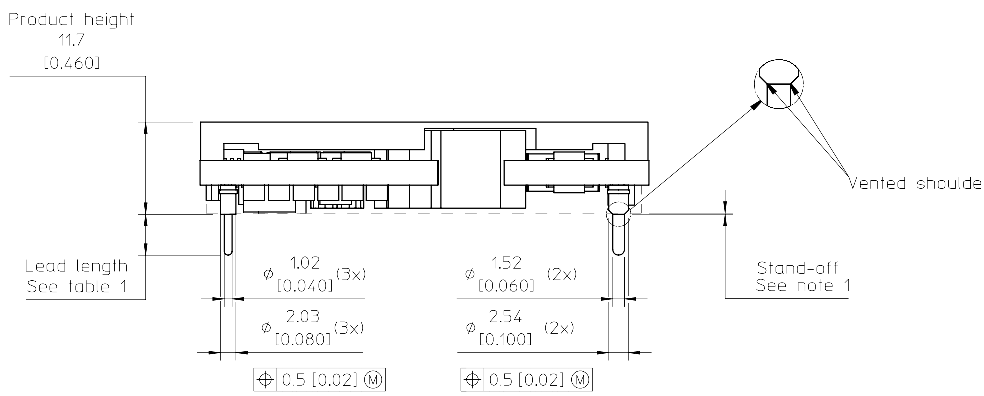


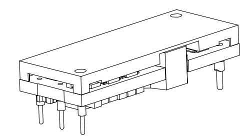
Recommended keep away area for user components
The stand-off in combination with insulating material ensures that requirements as per IEC/EN/UL60950 are met and 1500 V isolation maintained even if open vias or traces are present under the DC/DC converter.

Weight: Typical 26 g
All dimensions in mm [inch].
Tolerances unless specified
x.x ±0.50 [0.02], x.xx ±0.25 [0.01]
(not applied on footprint or typical values)

PKB 4302NG PI Intermediate Bus Converters, Input 38-55 V, 42 A / 300 W	EN/LZT 146 381 R1A July 2008 © Ericsson Power Modules AB

Mechanical Information - Hole Mount, Base Plate Version





TOP VIEW

Pin positions according to recommended footprint

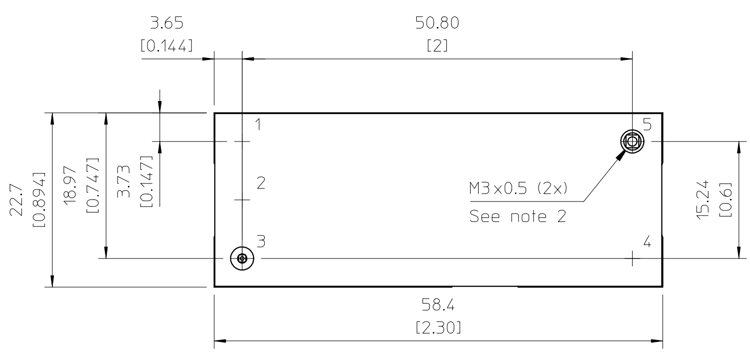
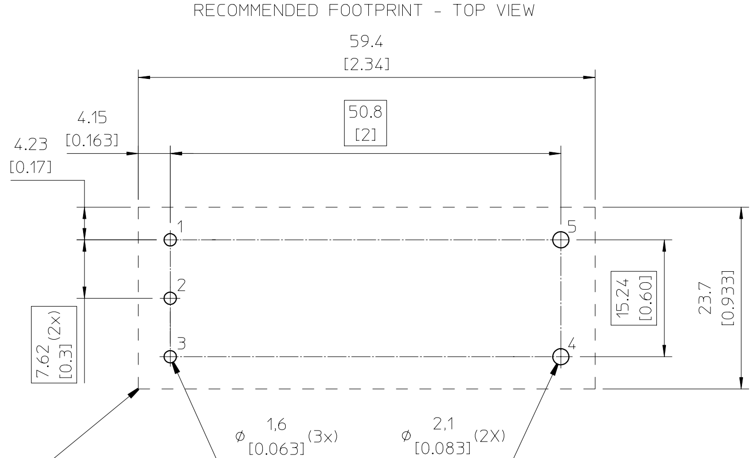


Table 1

Pin option	Lead length
Standard	5.33 [0.210]
LA	3.69 [0.145] cut
LB	4.57 [0.180] cut
LC	2.79 [0.110] cut

RECOMMENDED FOOTPRINT - TOP VIEW



Recommended keep away area for user components

The stand-off in combination with insulating material ensures that requirements as per IEC/EN/UL60950 are met and 1500 V isolation maintained even if open vias or traces are present under the DC/DC converter.

Notes

1- Stand off to none conductive components min 0.15 [0.006]
Stand off to conductive components min 0.7 [0.0276]
For details see safety section page 3.

Case:
Material: Aluminium

2- For screw attachment apply mounting torque of max 0.44 Nm [3.9 lbf in].
- M3 screws must not protrude more than 2.7 [0.106] in to the base plate.

Pins:
Material: Copper alloy
Plating: 0,1 µm Gold over 2 µm Nickel

Weight: Typical 38 g
All dimensions in mm [inch].
Tolerances unless specified
x.x ±0.50 [0.02], x.xx ±0.25 [0.01]
(not applied on footprint or typical values)

PKB 4302NG PI Intermediate Bus Converters, Input 38-55 V, 42 A / 300 W	EN/LZT 146 381 R1A July 2008
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Soldering Information

When soldering through hole mounted products by wave or manual soldering, the temperature on the pins is specified to maximum 270°C for maximum 10 seconds.

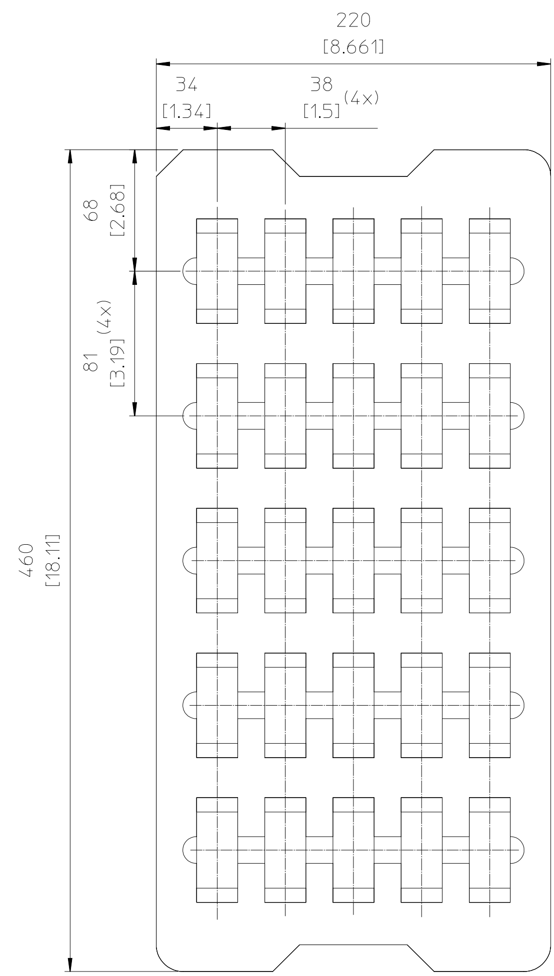
A maximum preheat rate of 4°C/s and maximum preheat temperature of +150°C is suggested. When soldering by hand, care should be taken to avoid direct contact between the hot soldering iron tip and the pins for more than a few seconds in order to prevent overheating.

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
Hole Mount, Open Frame version
Hole Mount, Base Plate version

The products are delivered in antistatic trays.

Tray Specifications	
Material	PE foam
Surface resistance	10^5 < Ohm/square < 10^{12}
Bakeability	The trays are not bakeable
Tray capacity	25 products/tray
Tray thickness	22 mm [0.87 inch]
Box capacity	75 products (3 full trays/box)
Tray weight	Open frame version 40 g empty, 690 g full tray Base plate version 40 g empty, 990 g full tray



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_A 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 Iso propanol	+55°C +35°C +35°C
Mechanical shock	IEC 60068-2-27 Ea	Peak acceleration Duration	100 g 6 ms
Moisture reflow sensitivity [1]	J-STD-020C	level 1 (SnPb-eutectic) level 3 (Pb Free)	225°C 260°C
Operational life test	MIL-STD-202G method 108A	Duration	1000 h
Resistance to soldering heat [2]	IEC 60068-2-20 Tb Method 1A	Solder temperature Duration	270°C 10-13 s
Robustness of terminations	IEC 60068-2-21 Test Ua1 IEC 60068-2-21 Test Ue1	Through hole mount products Surface mount products	All leads All leads
Solderability	IEC 60068-2-58 test Td [1] IEC 60068-2-20 test Ta [2]	Preconditioning Temperature, SnPb Eutectic Temperature, Pb-free Preconditioning Temperature, SnPb Eutectic Temperature, Pb-free	150°C dry bake 16 h 215°C 235°C 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^2/Hz 10 min in each perpendicular direction

Note 1: Only for products intended for reflow soldering (surface mount products)
Note 2: Only for products intended for wave soldering (plated through hole products)