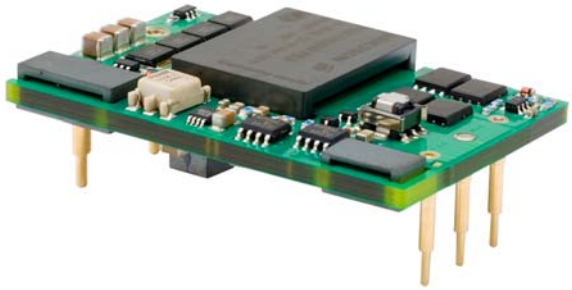
ERICSSON

Preliminary Technical Specification

PKM 4402NG PI IBC 5:1 Ratio, Input 38-55 V, Output 63A	EN/LZT 146 343 P4A May 2006

Key Features

- Industry standard Quarter-brick
  57.9 x 36.8 x 11.1mm (2.28 x 1.45 x 0.44 in.)
- High efficiency, typ. 97 % at 9.6 Vout 50% load & 48Vin
- 1500 Vdc input to output isolation
- Meets safety requirements according to IEC/EN/UL 60950
- More than 1.39 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
- Optional baseplate
- Optional case to ground pin (only with baseplate)
- Highly automated manufacturing ensures quality
- ISO 9001/14001 certified supplier

Safety Approvals

c UL us

Design for Environment

Pb RoHS compliant

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.
Positive Remote Control Logic	P	PKM 4402NG PIP
Lead length 3.69 mm (0.145 in)	LA	PKM 4402NG PILA
Lead length 4.57 mm (0.180 in)	LB	PKM 4402NG PILB
Baseplate	HS	PKM 4402NG PIHS
Case to ground pin (1)	G	PKM 4402NG PIHSG

Note: (1) Case to ground pin only available with baseplate
Note: (2) If several options needed below sequence is to be used
LOGIC OPTION → BASEPLATE → CASE GROUND → PIN LENGTH
Example: PKM4402NGPIPHSGLA

Reliability

The Mean Time Between Failure (MTBF) is calculated at full output power and an operating ambient temperature (T_A) of +40°C. Different methods could be used to calculate the predicted MTBF and failure rate which may give different results. Ericsson Power Modules currently uses two different methods, Ericsson failure rate data system DependTool and Telcordia SR332.

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

The Ericsson failure rate data system is based on field tracking data. The data corresponds to actual failure rates of components used in Information Technology and Telecom (IT&T) equipment in temperature controlled environments
(T_A = -5...+65°C). Telcordia SR332 is a commonly used standard method intended for reliability calculations in IT&T 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 in other applications other than lead in solder, lead in high melting temperature type solder, lead in glass of electronics components, lead in electronic ceramic parts and lead as an alloying element in copper containing up to 4% lead by weight, mercury, hexavalent chromium, PBB and PBDE and of 0.01% by weight in homogeneous materials for cadmium.

Exemptions in the RoHS directive utilized in the products:
- Lead as an alloying element in copper alloy containing up to 4% lead by weight (used in connection pins made of Brass)
- 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 in solder for servers, storage and storage array systems, network infrastructure equipment for switching, signaling, transmission as well as network management for telecommunication
(Note: the products are manufactured in lead-free soldering processes and the lead present in the solder is only located in the terminal plating finishes on some components)

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. EC61204-7 "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 UL60950 recognized and certified in accordance with EN60950.

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/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 Ericsson Power Modules 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.

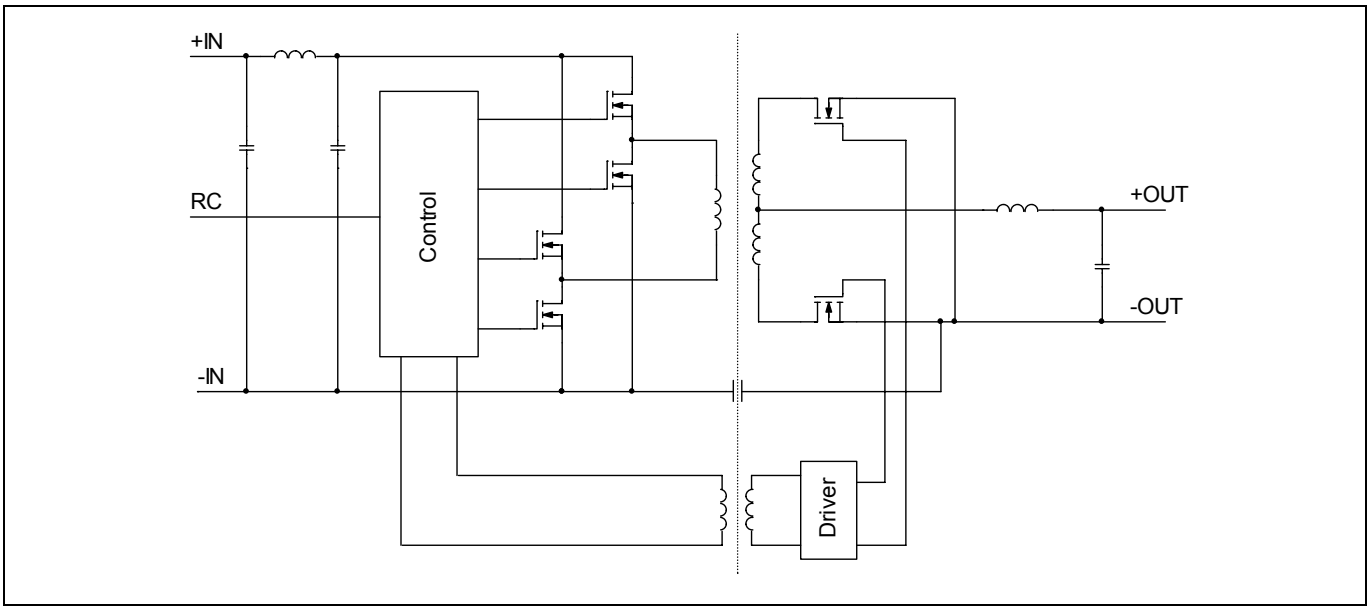
Non-isolated DC/DC regulators
The input voltage to the DC/DC regulator is SELV (Safety Extra Low Voltage) and the output remains SELV under normal and abnormal operating conditions.

Absolute Maximum Ratings

Characteristics			min	typ	max	Unit
T_{ref}	Operating Temperature (see Thermal Consideration section)		-40		+125	°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 500 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/63 A Electrical Specification PKM 4402NG

T_{ref} = -30 to +100ºC, V_I = 38 to 55 V, I_O = 0 to 63 A unless otherwise specified under Conditions.
Typical values given at: T_{ref} = +25°C, V_I= 48 V, max I_O, unless otherwise specified under Conditions.

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	31.6	32.9	34.2	V
V_{Ion}	Turn-on input voltage	Increasing input voltage	32.8	33.9	34.6	V
C_I	Internal input capacitance			11		µF
P_O	Output power	V_I = 55 V	0		674	W
		V_I = 48 V	0		587	W
		V_I = 38 V	0		462	W
η	Efficiency	50 % of max I_O		97.2		%
		max I_O		96.4		
		50 % of max I_O , V_I = 53 V		97.3		
		max I_O , V_I = 53 V		96.6		
P_d	Power Dissipation	max I_O		20	29	W
P_{li}	Input idling power	I_O= 0, V_I = 48 V		4	7	W
P_{RC}	Input standby power	V_I = 48 V (turned off with RC)		100		mW
f_s	Switching frequency		100	125	150	kHz

V_{Oi}	Output voltage initial setting and accuracy	T_{ref} = +25°C, V_I = 48 V, I_O = 0	9.48	9.54	9.60	V
V_O	Output voltage tolerance band		7.1		11.0	V
	Idling voltage	I_O = 0	7.5		11.0	V
	Line regulation	max I_O, from min V_I to max V_I		3.3	3.4	V
	Load regulation	from min I_O to max I_O		0.3	0.5	V
V_{tr}	Load transient voltage deviation	V_I = 48 V, Load step 25-75-25 % of max I_O, di/dt = 5 A/µs, see Note 2		±0.8		V
t_{tr}	Load transient recovery time			0.1		ms
t_r	Ramp-up time (from 10–90 % of V_{oi})	max I_O	2	4	6	ms
t_s	Start-up time (from V_I connection to 90% of V_{oi})		5	7	8	ms
t_f	Vin shutdown fall time (from V_I off to 10% of V_O)	max I_O		0.1		ms
		I_O = 0 A		3		s
t_{RC}	RC start-up time	max I_O		6		ms
	RC shutdown fall time (from RC off to 10% of V_O)	max I_O		0.01		ms
		I_O = 0 A		4		s
I_O	Output current		0		63	A
I_{lim}	Current limit threshold	T_{ref} < max T_{ref}	70	85	100	A
I_{sc}	Short circuit current	T_{ref} = 25ºC, see Note 3		90	100	A
V_{Oac}	Output ripple & noise	See ripple & noise section, max I_O		125	300	mVp-p
OVP	Input over voltage protection	T_{ref} = +25°C	57	58		V

Note 1: The module withstands a input voltage of 57 V for 500 ms

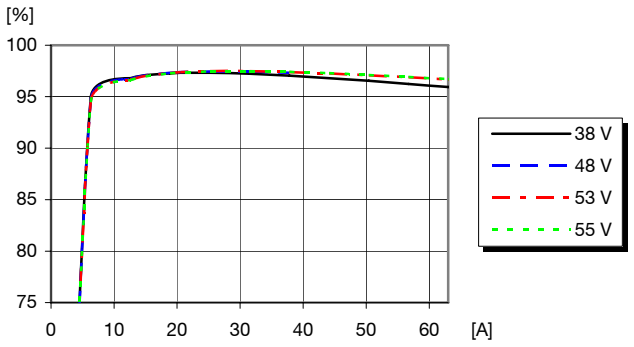
Note 2: Output filter 2 x 220 µF, 100 Ωm, tantalum + 33 µF, ceramic

Note 3: RMS current in hick-up mode, measured over 3 mΩ

9.6 V/63 A Typical Characteristics

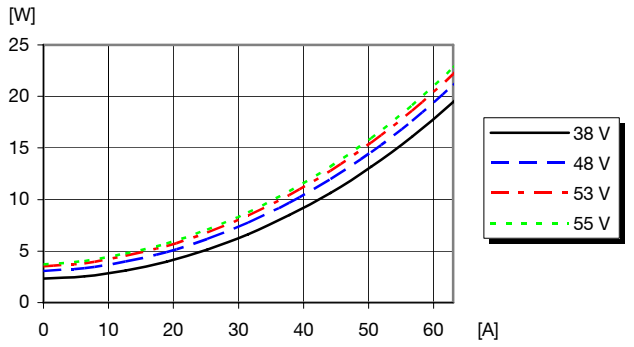
PKM 4402NG

Efficiency



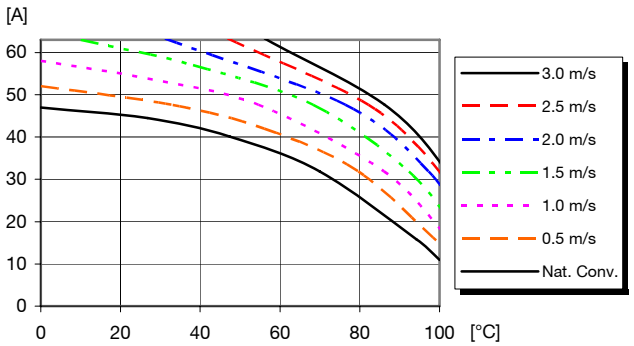
Efficiency vs. load current and input voltage at T_{ref} = +25°C

Power Dissipation



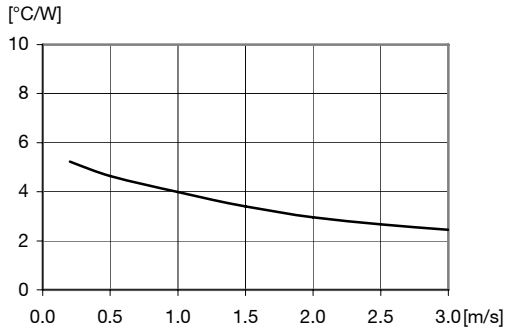
Dissipated power vs. load current and input voltage at T_{ref} = +25°C

Output Current Derating



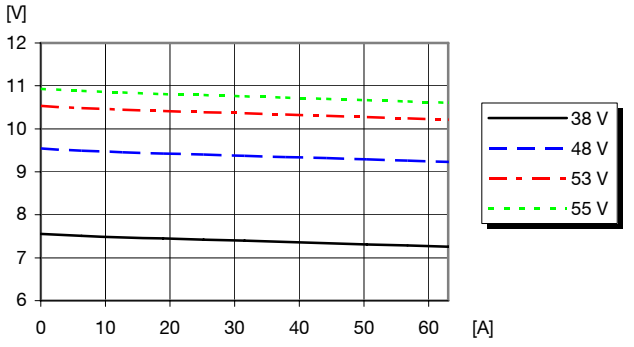
Available load current vs. ambient air temperature and airflow at V_I = 48 V. See Thermal Consideration section.

Thermal Resistance



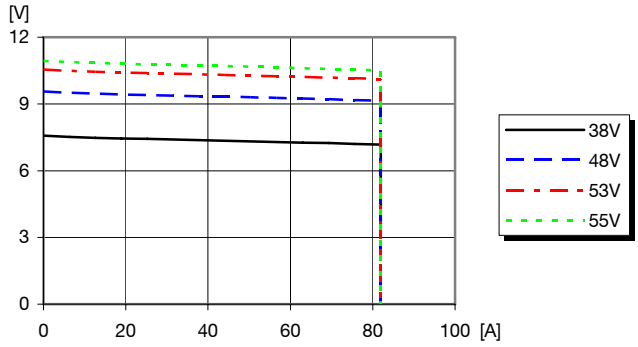
Thermal resistance vs. airspeed measured at the converter. Tested in wind tunnel with airflow and test conditions as per the Thermal consideration section.

Output Characteristics



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

Current Limit Characteristics

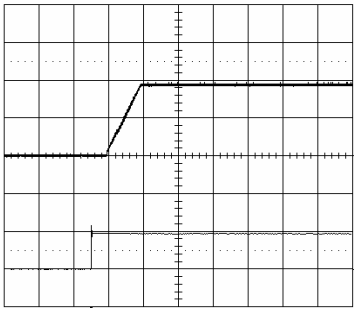


Output voltage vs. load current at I_O > max I_O, T_{ref} = +25°C

9.6 V/63 A Typical Characteristics

PKM 4402NG

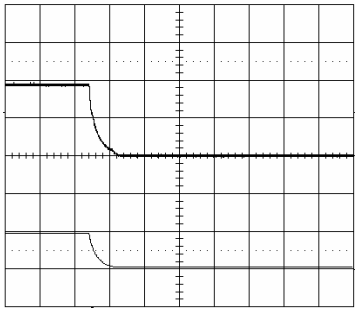
Start-up



Start-up enabled by connecting V_I at:
T_{ref} = +25°C, I_O = 63 A resistive load,
V_I = 48 V.

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

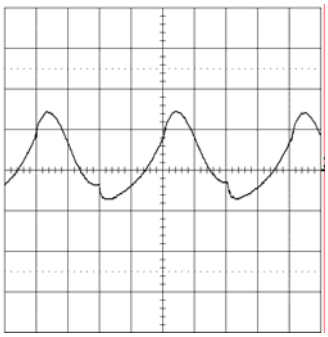
Shut-down



Shut-down enabled by disconnecting V_I at:
T_{ref} = +25°C, I_O = 63 A resistive load,
V_I = 48 V.

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

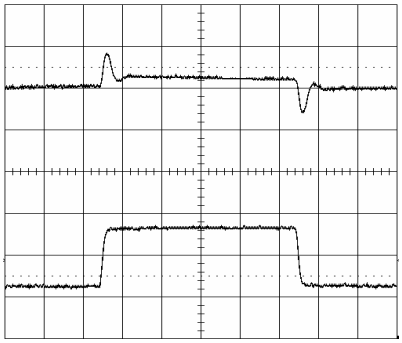
Output Ripple & Noise



Output voltage ripple (50mV/div.) at:
T_{ref} = +25°C, I_O = 63 A resistive load,
V_I = 48 V Time scale: 2 µs/div.

See the filter in the Output ripple and noise section (EMC Specification).

Output Load Transient Response



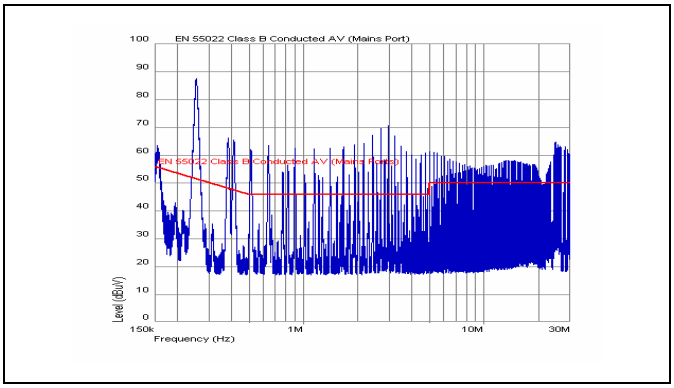
Output voltage response to load current step-change (15.75-47.25-15.75 A) at:
T_{ref} =+25°C, V_I = 48 V.

Top trace: output voltage (1 V/div.).
Bottom trace: load current (20 A/div.).
Time scale: 0.1 ms/div.

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 125 kHz.

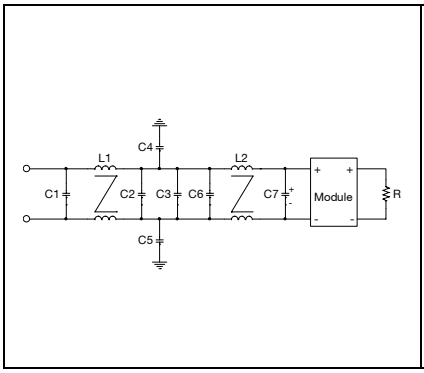
Conducted EMI Input terminal value (typ)



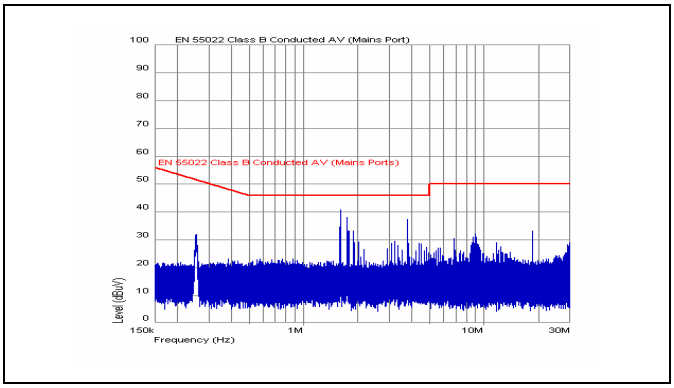
EMI without filter

External filter (class B)

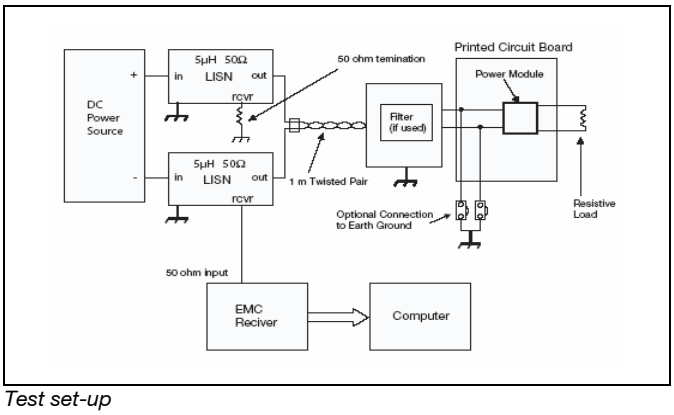
Required external input filter in order to meet class B in EN 55022, CISPR 22 and FCC part 15J.



Filter components:
C1 = 0.68 µF
(100V, ceramic)
C2, C3 = 1.0 µF
(100V, ceramic)
C4, C5 = 2.2 nF
(200V, ceramic)
C6 = 220 µF
(100V, electrolytic)
C7 = 320 µF
(400V, electrolitic)
L1, L2 = 0.403 µH
(common mode)



EMI with filter



Test set-up

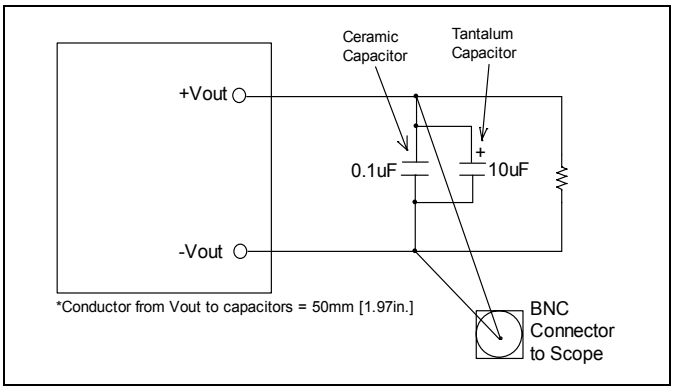
Layout recommendation

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.

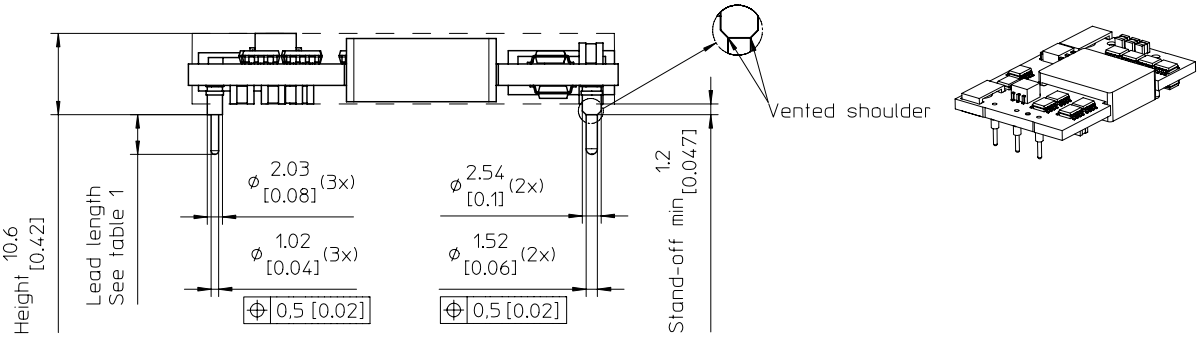
Output ripple and noise

Output ripple and noise measured according to figure below. See Design Note 022 for detailed information.



Output ripple and noise test setup

Mechanical Information



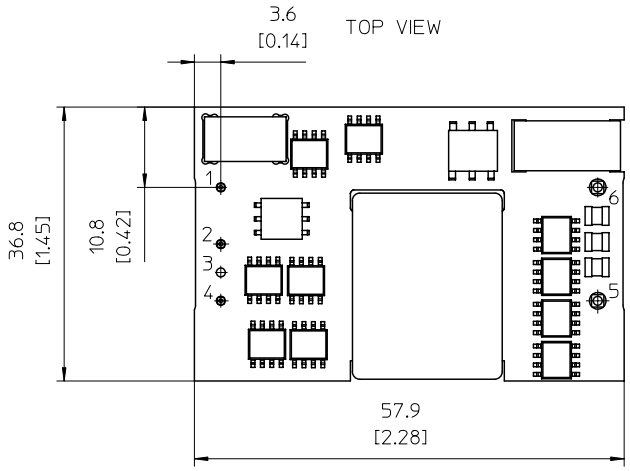


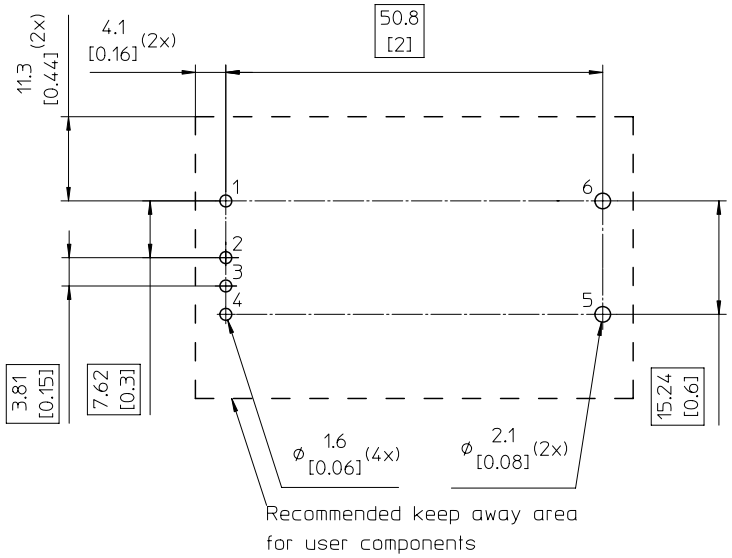
Table 1

Pin option	Lead Length
Standard	5.33 [0.210]
LA	3.68 [0.145]
LB	4.57 [0.180]

Weight: 45 g

Pins:
Material: Copper alloy
Plating: 0.1 µm Gold over 2 µm Nickel
Pin 3 is optional and only used for base plate connection

Recommended footprint - TOP VIEW



All dimensions in mm [inch]
Tolerances unless specified
x.x mm ± 0.5 mm [0.02]
x.xx mm ± 0.25 mm [0.01]
(not applied on footprint or typical values)

Soldering Information – Through Hole Mounting

The product is intended for through hole mounting in a PCB. When wave soldering is used, the temperature on the pins is specified to maximum 260 °C for maximum 10 seconds.

Maximum preheat rate of 4 °C/s and temperature of max 150 °C is suggested. When hands soldering 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 (NC) 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

The products are delivered in antistatic trays.

Tray specifications	
Material	PE foam, dissipative
Surface resistance	10E5 to 10E12 ohms/square
Tray capacity	20 converters/tray
Box capacity	20 converters
Weight	1040 g full, 140 g empty