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Key Features

- Industry standard Eighth-brick
  58.4 x 22.7 x 8.10 mm (2.300 x 0.894 x 0.323 in.)
- High efficiency, typ. 92 % at half load
- 2250 Vdc input to output isolation
- Meets isolation requirements equivalent to basic insulation according to IEC/EN/UL 60950
- More than 1.5 million hours predicted MTBF at +40ºC ambient temperature

General Characteristics

- Suited for narrow board pitch applications (15 mm/0.6 in)
- Output over voltage protection
- Input under voltage shutdown
- Over temperature protection
- Output short-circuit protection
- Remote sense
- Remote control
- Output voltage adjust function
- Highly automated manufacturing ensures quality
- ISO 9001/14001 certified supplier
- Optimized for high capacity load

Safety Approvals

c ⧖ US

Pending

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.
Positive Remote Control Logic	P	PKB 4717 PIPNB
Increased stand-off height	M	PKB 4717 PINBM
Lead length 3.69 mm (0.145 in)	LA	PKB 4717 PINBLA
Lead length 4.57 mm (0.180 in)	LB	PKB 4717 PINBLB

Note: As an example a positive logic, increased standoff, short pin product would be PKB 4717 PIPNBMLA.

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:
-   1.5 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 ICT equipment in temperature controlled environments (T_A = -5...+65°C).
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 all construction parts of the products 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 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.

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Absolute Maximum Ratings

	Characteristics		min	typ	max	Unit
T_{ref}	Operating Temperature (see Thermal Consideration section)		-45		+110	°C
T_S	Storage temperature		-55		+125	°C
V_I	Input voltage		-0.5		+80	V
V_{iso}	Isolation voltage (input to output test voltage)				2250	Vdc
V_{tr}	Input voltage transient (t_p 100 ms)				100	V
V_{RC}	Remote Control pin voltage (see Operating Information section)	Positive logic option	-0.5		6	V
		Negative logic option	-0.5		40	V
V_{adj}	Adjust pin voltage (see Operating Information section)		-0.5		$2 \times V_{oi}$	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
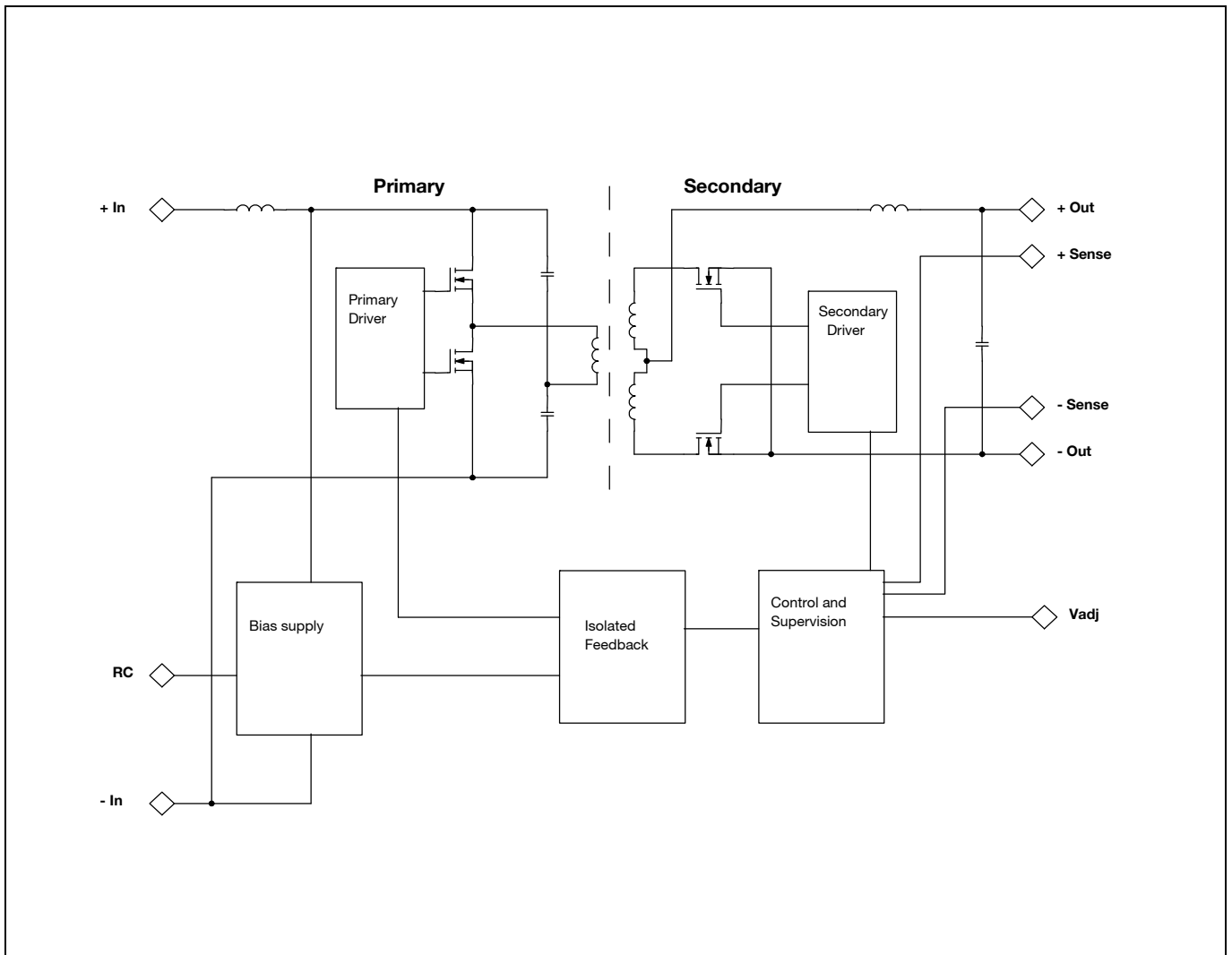
7.2 V/10.5 A Electrical Specification   PKB 4717 PINB

T_{ref} = -40 to +90ºC, V_I = 36 to 75 V, sense pins connected to output pins unless otherwise specified under Conditions.
Typical values given at: T_{ref} = +25°C, V_I= 53 V_I max I_O, unless otherwise specified under Conditions.

Characteristics		Conditions	min	typ	max	Unit
V_I	Input voltage range		36		75	V
V_{Ioff}	Turn-off input voltage	Decreasing input voltage	30	31	35	V
V_{Ion}	Turn-on input voltage	Increasing input voltage	32	34	36	V
C_I	Internal input capacitance			3		µF
P_O	Output power	Output voltage initial setting	0		75	W
SVR	Supply voltage rejection (ac)	f = 100 Hz sinewave, 1 Vp-p		66		dB
η	Efficiency	50 % of max I_O		91.7		%
		max I_O		90.7		
		50 % of max I_O, V_I = 48 V		92.0		
		max I_O, V_I = 48 V		90.7		
P_d	Power Dissipation	max I_O		7.8	9.8	W
P_{Ii}	Input idling power	I_O = 0 A, V_I = 53 V		1.7		W
P_{RC}	Input standby power	V_I = 53 V (turned off with RC)		0.15		W
f_s	Switching frequency	0-100 % of max I_O (see Note 1)		200		kHz

			min	typ	max	Unit
V_{Oi}	Output voltage initial setting and accuracy	T_{ref} = +25°C, V_I = 53 V, I_O = 10.5 A	7.05	7.2	7.35	V
V_O	Output adjust range	See operating information (see Note 2)	6		8	V
	Output voltage tolerance band	10-100 % of max I_O	6.98		7.42	V
	Idling voltage	I_O = 0 A	7.05		7.35	V
	Line regulation	max I_O		2	4	mv
	Load regulation	V_I = 53 V, 0-100 % of max I_O		2	4	mv
V_{tr}	Load transient voltage deviation	V_I = 53 V, Load step 25-75-25 % of max I_O, di/dt = 1 A/µs		±330		mv
t_{tr}	Load transient recovery time			100		µs
t_r	Ramp-up time (from 10–90 % of V_{Oi})	10-100 % of max I_O		6.5	11.6	ms
t_s	Start-up time (from V_I connection to 90 % of V_{Oi})			9.8	23.5	ms
t_f	V_I shut-down fall time (from V_I off to 10 % of V_O)	max I_O		0.2		ms
		I_O = 0 A		2.6		s
t_{RC}	RC start-up time	max I_O		8		ms
	RC shut-down fall time (from RC off to 10 % of V_O)	max I_O		0.2		ms
		I_O = 0 A		2.6		s
I_O	Output current		0		10.5	A
I_{lim}	Current limit threshold	T_{ref} < max T_{ref}		14		A
I_{sc}	Short circuit current	T_{ref} = 25ºC		16		A
V_{Oac}	Output ripple & noise	See ripple & noise section, max I_O, V_{Oi}		50	120	mVp-p
OVP	Over voltage protection	T_{ref} = +25°C, V_I = 53 V, 0-100 % of max I_O	10		11	V

Note 1: Frequency may be adjusted with RT-pin. See Operating Information section.
Note 2: When input voltage is 36 V and output is trimmed up to 8V, output current can only be 20%~50% Max Io.

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Technical Specification   6

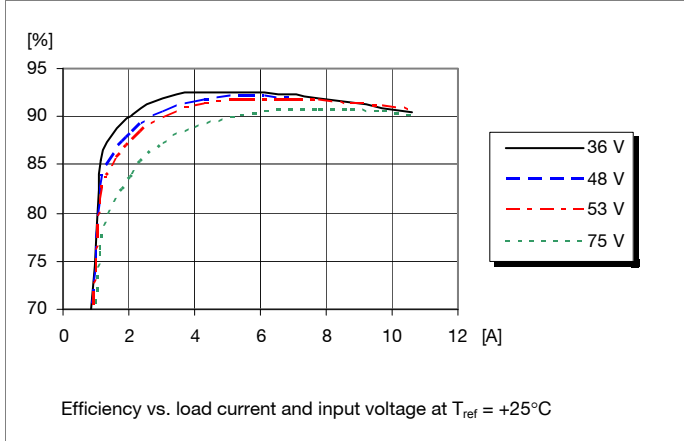PKB 4717 PINB
DC/DC converters, Input 36-75 V, Output 10.5 A/75 W
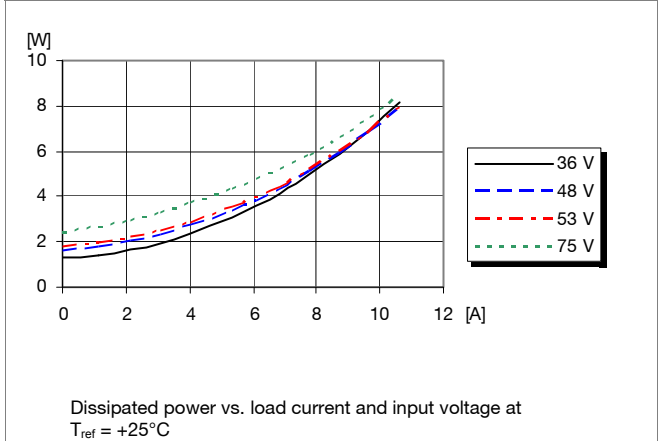
EN/LZT 146 382 R1A June 2007

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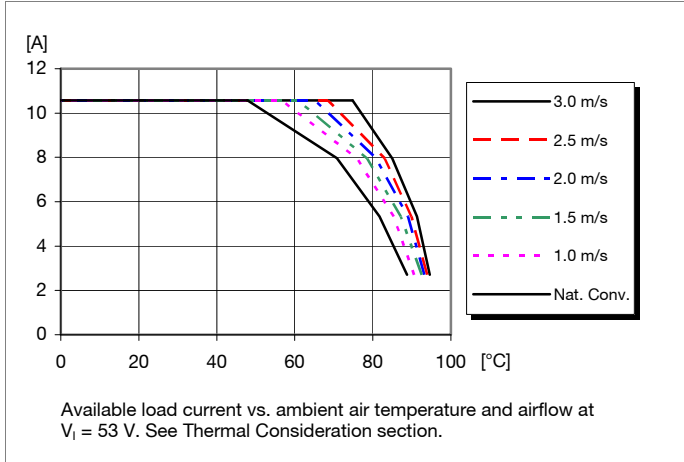
7.2 V/10.5 A Typical Characteristics

PKB 4717 PINB

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 = 53 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
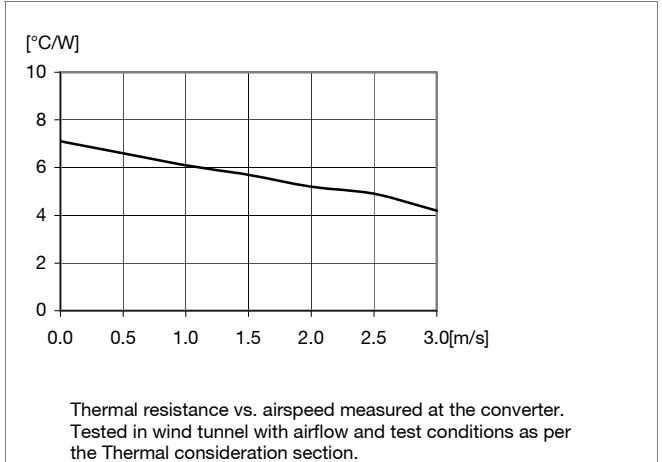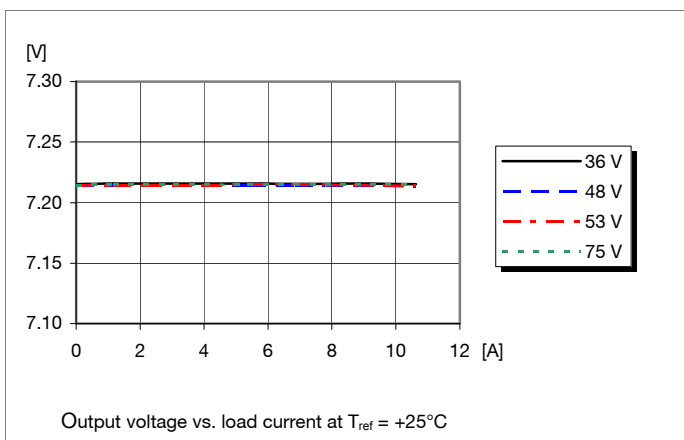
Current Limit Characteristics
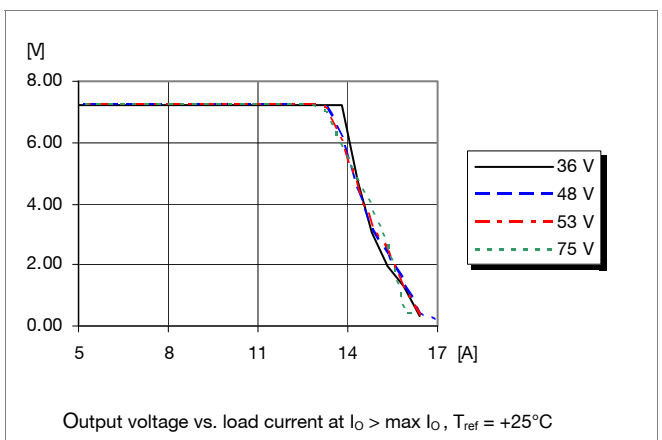
Output voltage vs. load current at I_O > max I_O , T_{ref} = +25°C

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Technical Specification   7

PKB 4717 PINB
DC/DC converters, Input 36-75 V, Output 10.5 A/75 W
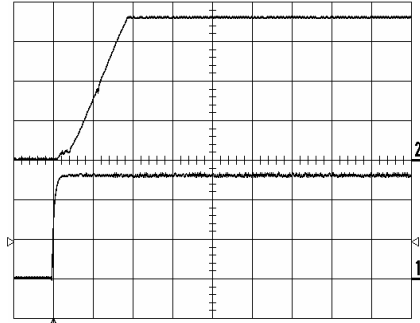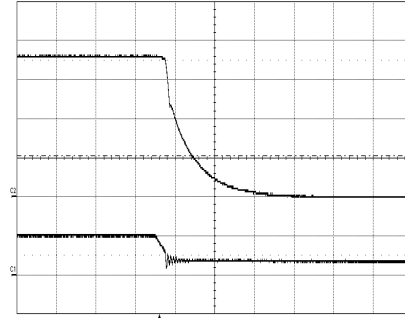
EN/LZT 146 382 R1A   June 2007

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## 7.2 V/10.5 A Typical Characteristics   PKB 4717 PINB

Start-up

Start-up enabled by connecting V_I at:
T_{ref} = +25°C, V_I = 53 V,
I_O = 10.5 A resistive load.

Top trace: output voltage (2V/div.).
Bottom trace: input voltage (20V/div.).
Time scale: (5ms/div.).

Shut-down

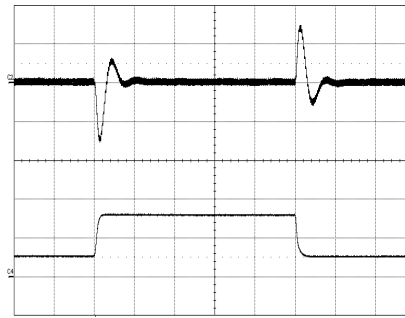

Shut-down enabled by disconnecting V_I at:
T_{ref} = +25°C, V_I = 53 V,
I_O = 10.5 A resistive load.

Top trace: output voltage (2V/div.).
Bottom trace: input voltage (50V/div.).
Time scale: (0.1ms/div.).

Output Ripple & Noise
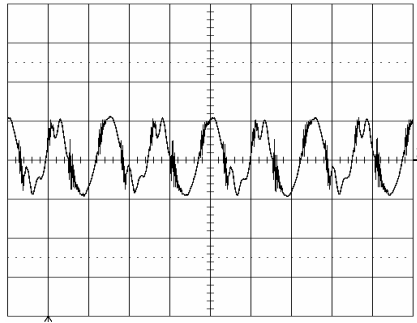
Output voltage ripple at:
T_{ref} = +25°C, V_I = 53 V,
I_O = 10.5 A resistive load.

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

Output Load Transient Response

Output voltage response to load current step-change (2.5-7.5-2.5 A) at:
T_{ref} =+25°C, V_I = 53 V.

Top trace: output voltage (200mV/div.).
Bottom trace: load current (5A/div.).
Time scale: (0.1ms/div.).

Output Voltage Adjust (see operating information)

Passive adjust
The resistor value for an adjusted output voltage is calculated by using the following equations:
Output Voltage Adjust Upwards, Increase:

$$Radj = \left(\frac{5.11 \times 7.2 (V_{out} - 1.225)}{1.225 \times V_{out} - 1.225 \times 7.2} - 10.22 \right) k\Omega$$

Output Voltage Adjust Downwards, Decrease:

$$Radj = \left(\frac{5.11 \times (2V_{out} - 7.2)}{7.2 - V_{out}} \right) k\Omega$$

Example: Upwards =>V_{out} = 7.85 Vdc

$$\left(\frac{5.11 \times 7.2 (7.85 - 1.225)}{1.225 \times 7.85 - 1.225 \times 7.2} - 10.22 \right) k\Omega = 296 \ k\Omega$$

Active adjust
The output voltage may be adjusted using a voltage applied to the Vadj pin. This voltage is calculated by using the following equations:

$$V_{adj} = \left(1.225 + 2.45 \times \frac{Vdesired - 7.2}{7.2} \right) V$$

Example: Upwards => 7.85 V

$$\left(1.225 + 2.45 \times \frac{7.85 - 7.2}{7.2} \right) V = 1.45 \ V$$

EMC Specification

Conducted EMI measured according to EN55022, CISPR 22 and FCC part 15J (see test set-up). See Design Note 009 for further information. The fundamental switching frequency is 200 kHz for PKB 4717 PINB @ V_I = 53 V, max I_O.
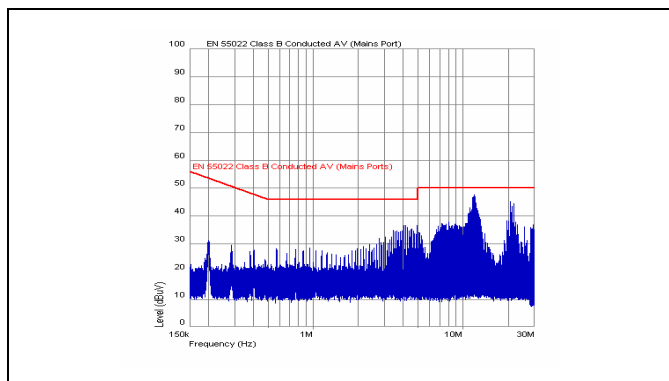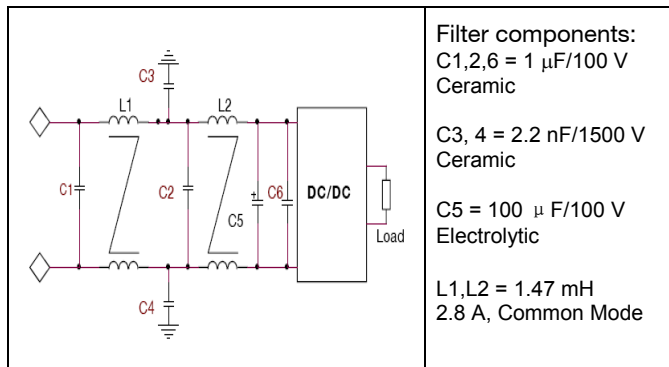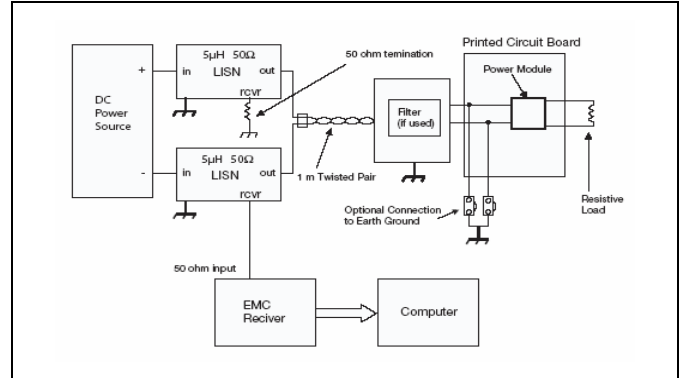
Conducted EMI Input terminal value (typ)
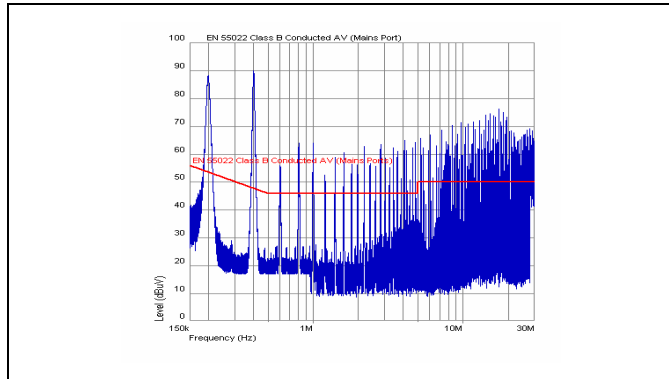
EMI without filter

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:
C1,2,6 = 1 μF/100 V Ceramic

C3, 4 = 2.2 nF/1500 V Ceramic

C5 = 100 μ F/100 V Electrolytic

L1,L2 = 1.47 mH 2.8 A, Common Mode

EMI with filter

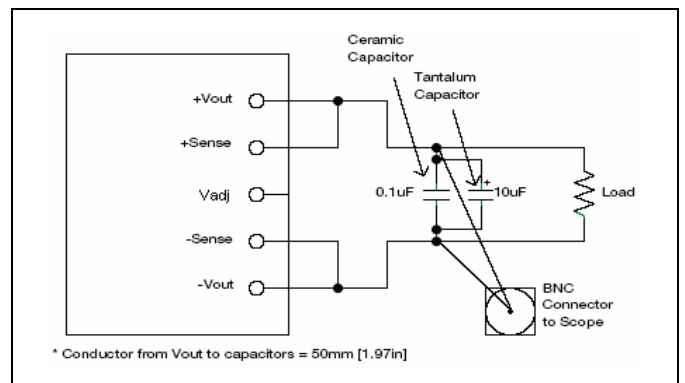*Test set-up*

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

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|	
PKB 4717 PINB DC/DC converters, Input 36-75 V, Output 10.5 A/75 W	EN/LZT 146 382 R1A June 2007
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Operating information

Input Voltage

The input voltage range 36 to 75Vdc meets the requirements {of the European Telecom Standard ETS 300 132-2 for normal input voltage range in –48 and –60 Vdc systems, -40.5 to -57.0 V and –50.0 to -72 V respectively.

At input voltages exceeding 75 V, the power loss will be higher than at normal input voltage and T_{ref} must be limited to absolute max +110°C. The absolute maximum continuous input voltage is 80 Vdc.

Turn-off Input Voltage

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

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

Remote Control (RC)
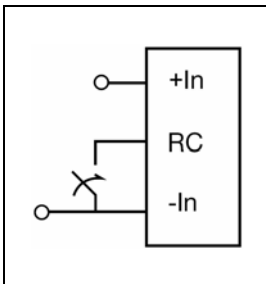
The products are fitted with a remote control function referenced to the primary negative input connection (- In), with negative logic option available. The RC function allows the converter to be turned on/off by an external device like a semiconductor or mechanical switch. The RC pin has an internal pull up resistor to + In.

The maximum required sink current is 1 mA. When the RC pin is left open, the voltage generated on the RC pin is 12 – 15 V.

See Design Note 021 for detailed information.

Input and Output Impedance

The impedance of both the input source and the load will interact with the impedance of the DC/DC converter. It is important that the input source has low characteristic impedance. The converters are designed for stable operation without external capacitors connected to the input or output. The performance in some applications can be enhanced by addition of external capacitance as described under External Decoupling Capacitors. If the input voltage source contains significant inductance, the addition of a 100 µF capacitor across the input of the converter will ensure stable operation. The capacitor is not required when powering the DC/DC converter from an input source with an inductance below 10 µH.

External Decoupling Capacitors

When powering loads with significant dynamic current requirements, the voltage regulation at the point of load can be improved by addition of decoupling capacitors at the load. The most effective technique is to locate low ESR ceramic and electrolytic capacitors as close to the load as possible, using several parallel capacitors to lower the effective ESR.

The ceramic capacitors will handle high-frequency dynamic load changes while the electrolytic capacitors are used to handle low frequency dynamic load changes. Ceramic capacitors will also reduce any high frequency noise at the load.

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

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

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

Output Voltage Adjust (V_{adj})

The DC/DC converters have an Output Voltage Adjust pin (V_{adj}). This pin can be used to adjust the output voltage above or below Output voltage initial setting.

When increasing the output voltage, the voltage at the output pins (including any remote sense compensation) must be kept below the threshold of the over voltage protection, (OVP) to prevent the converter from shutting down. At increased output voltages the maximum power rating of the converter remains the same, and the max output current must be decreased correspondingly.

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

To decrease the output voltage, the resistor should be connected between the V_{adj} pin and –Sense pin.
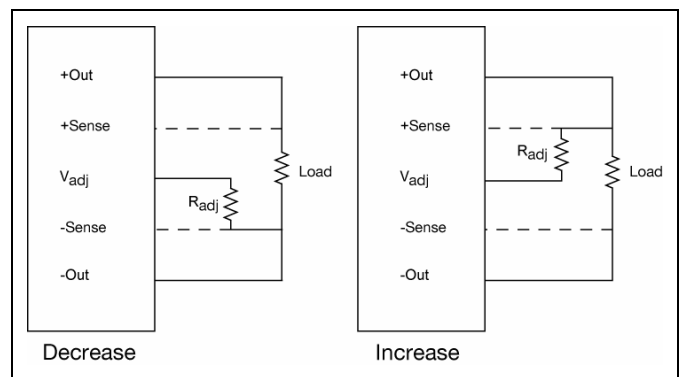
Operating information continued

Remote Sense

The DC/DC converters have remote sense that can be used to compensate for voltage drops between the output and the point of load. The sense traces should be located close to the PCB ground layer to reduce noise susceptibility. The remote sense circuitry will compensate for up to 10% voltage drop between output pins and the point of load.

If the remote sense is not needed +Sense should be connected to +Out and -Sense should be connected to -Out.

Over Temperature Protection (OTP)

The converters are protected from thermal overload by an internal over temperature shutdown function of the control IC. When T_{ref} as defined in thermal consideration section exceeds 120°C the 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 >10°C below the temperature threshold.

Over Voltage Protection (OVP)

The converters have output over voltage protection that will shut down the converter in over voltage conditions. The converter will make continuous attempts to start up (non-latching mode) and resume normal operation automatically after removal of the over voltage condition.

Over Current Protection (OCP)

The converters include current limiting circuitry for protection at continuous overload.
The output voltage will decrease towards zero for output currents in excess of max output current (max I_O). The 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 $V_{in} = 53$ 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 positions P1, P2 and P3. The temperature at these positions should not exceed the max values provided in the table below.

Note that the max value is the absolute maximum rating (non destruction) and that the electrical Output data is guaranteed up to T_{ref} +90°C.

See Design Note 019 for further information.

Position	Device	Designation	max value
P_1	Pcb	T_{ref}	110° C
P_2	Mosfet	T_{ref}	120° C
P_3	Mosfet	T_{ref}	120° C
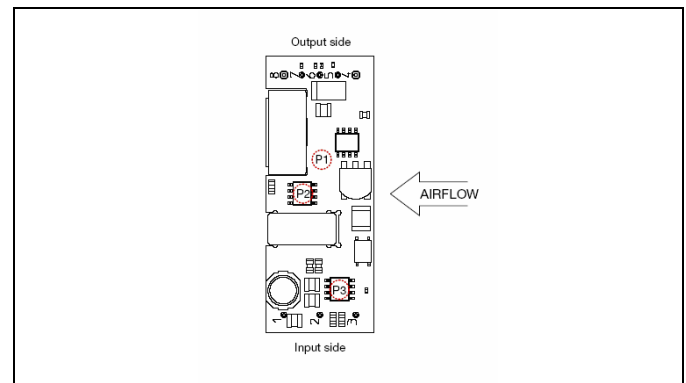
PKB 4717 PINB DC/DC converters, Input 36-75 V, Output 10.5 A/75 W	EN/LZT 146 382 R1A June 2007
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Thermal Consideration continued

Definition of reference temperature (T_{ref})

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

Ambient Temperature Calculation

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

1. The power loss is calculated by using the formula $((1/\eta) - 1) \times$ output power = power losses (Pd). η = efficiency of converter. E.g 89.5 % = 0.895

2. Find the thermal resistance (Rth) in the Thermal Resistance graph found in the Output section for each model. Calculate the temperature increase (ΔT).
 $\Delta T = Rth \times Pd$

3. Max allowed ambient temperature is:
Max Tref - ΔT.

E.g PKB 4717 PINB at 1m/s with full load:

1. $((\dfrac{1}{0.895}) - 1) \times 75$ W = 8.79 W

2. 8.79 W $\times$ 6.0°C/W = 53°C

3. 110 °C - 53°C = max ambient temperature is 57°C

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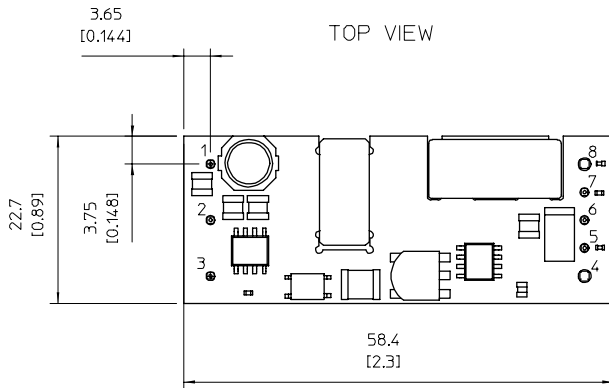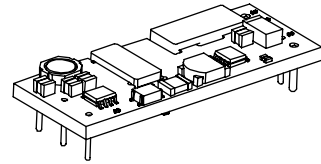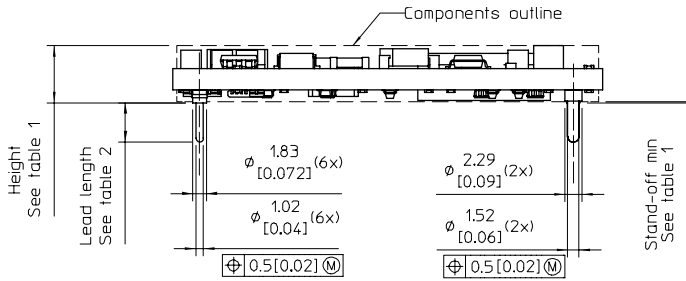
Connections

Top view
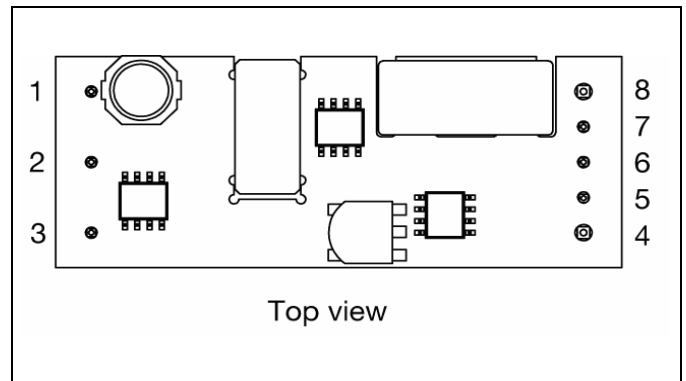
Pin	Designation	Function
1	+In	Positive input
2	RC	Remote control
3	-In	Negative input
4	-Out	Negative output
5	-Sen	Negative remote sense
6	Vadj	Output voltage adjust
7	+Sen	Positive remote sense
8	+Out	Positive output

PKB 4717 PINB DC/DC converters, Input 36-75 V, Output 10.5 A/75 W	EN/LZT 146 382 R1A June 2007
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Mechanical Information

TOP VIEW

Table 1

Height option	Height max.	Stand-off min.
Standard	8.10 [0.319]	0 [0.0]
M	9.15 [0.360]	1 [0.039]

Table 2

Pin option	Lead length
Standard	5.33 [0.210]
LA	3.69 [0.145]
LB	4.57 [0.180]

Recommended Footprint - TOP VIEW

Recommended keep away area for user components.

Weigth: Typical 20 g

Pins:
Material, pins 1-3, 5-7: Brass
Material, pins 4, 8: Copper alloy
Plating: 0.1 μm Gold over 2 μm Nickel

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)

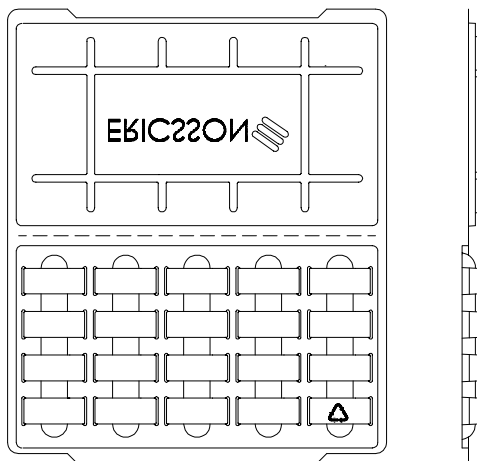| PKB 4717 PINB | EN/LZT 146 382 R1A June 2007 |
| DC/DC converters, Input 36-75 V, Output 10.5 A/75 W | © Ericsson Power Modules AB |

Soldering Information

No-clean flux is recommended to avoid entrapment of cleaning fluids in cavities inside the product or between the product and the host board. The cleaning residues may affect long time reliability and isolation voltage.

Delivery Package Information

The products are delivered in antistatic clamshell.

Clamshell Specifications	
Material	PET with antistatic coated
Surface resistance	$10^6 <$ Ohm/square $< 10^{12}$
Bake ability	The clamshells are not bakeable.
Clamshell capacity	20 products/clamshell
Clamshell thickness	20 mm [0.787 inch]
Box capacity	100 products (5 full trays/box)
Clamshell weight	130 g empty, 530 g full tray

Product Qualification Specification

Characteristics			
External visual inspection	IPC-A-610		
Dry heat	IEC 60068-2-2 Bd	Temperature Duration	+125 °C 1000 h
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
Operational life test	MIL-STD-202G method 108A	Duration	1000 h
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
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 3 perpendicular directions
Mechanical shock	IEC 60068-2-27 Ea	Peak acceleration Duration Pulse shape Directions Number of pulses	100 g 6 ms Half sine 6 18 (3 + 3 in each perpendicular direction)
Robustness of terminations	IEC 60068-2-21 Test Ua1	Plated through hole mount products	All leads
Resistance to soldering heat	IEC 60068-2-20 Tb Method 1A	Solder temperature Duration	270° C 10-13 s
Solderability	IEC 60068-2-20 test Ta	Preconditioning Temperature, SnPb Eutectic Temperature, Pb-free	Steam ageing 235° C 260° C
Immersion in cleaning solvents	IEC 60068-2-45 XA Method 2	Water Glycol ether Isopropanol	+55° C +35° C +35° C