

BMR 653 series Intermediate Bus Converters
Input 36-75 V, Output up to 60 A / 675 W

Key Features

- Industry standard Quarter-brick footprint
- 57.9 x 36.8 x 22.8 mm (2.28 x 1.45 x 0.9 in.)
- High efficiency, typ. 96 % at 12 Vout half load & 48Vin
- 1500 Vdc input to output isolation
- Meets safety requirements according to IEC/EN/UL 60950
- More than 0.6 million hours MTBF

General Characteristics

- Line regulated
- Input under voltage protection
- Over temperature protection
- Output over voltage protection
- Output short-circuit protection
- Remote control
- Optional latching OTP, OVP
- Highly automated manufacturing ensures quality
- ISO 9001/14001 certified supplier



Safety Approvals



E210157

Design for Environment



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

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Ordering Information

Product program	Output
BMR 653 31/1	12 V, 60 A / 675 W

Product number and Packaging

BMR 653 31/1n ₁	
Options	n ₁
Delivery package information	o

Options	Description
n ₁	/B Tray

Example a product with tray packaging would be BMR 653 31/1/B.

General Information**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.

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).

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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 and DC/DC regulators are defined as component power supplies. As components they cannot fully comply with the provisions of any Safety requirements without "Conditions of Acceptability". Clearance between conductors and between conductive

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parts of the component power supply and conductors on the board in the final product must meet the applicable Safety requirements. Certain conditions of acceptability apply for component power supplies with limited stand-off (see Mechanical Information for further information). 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 μ A 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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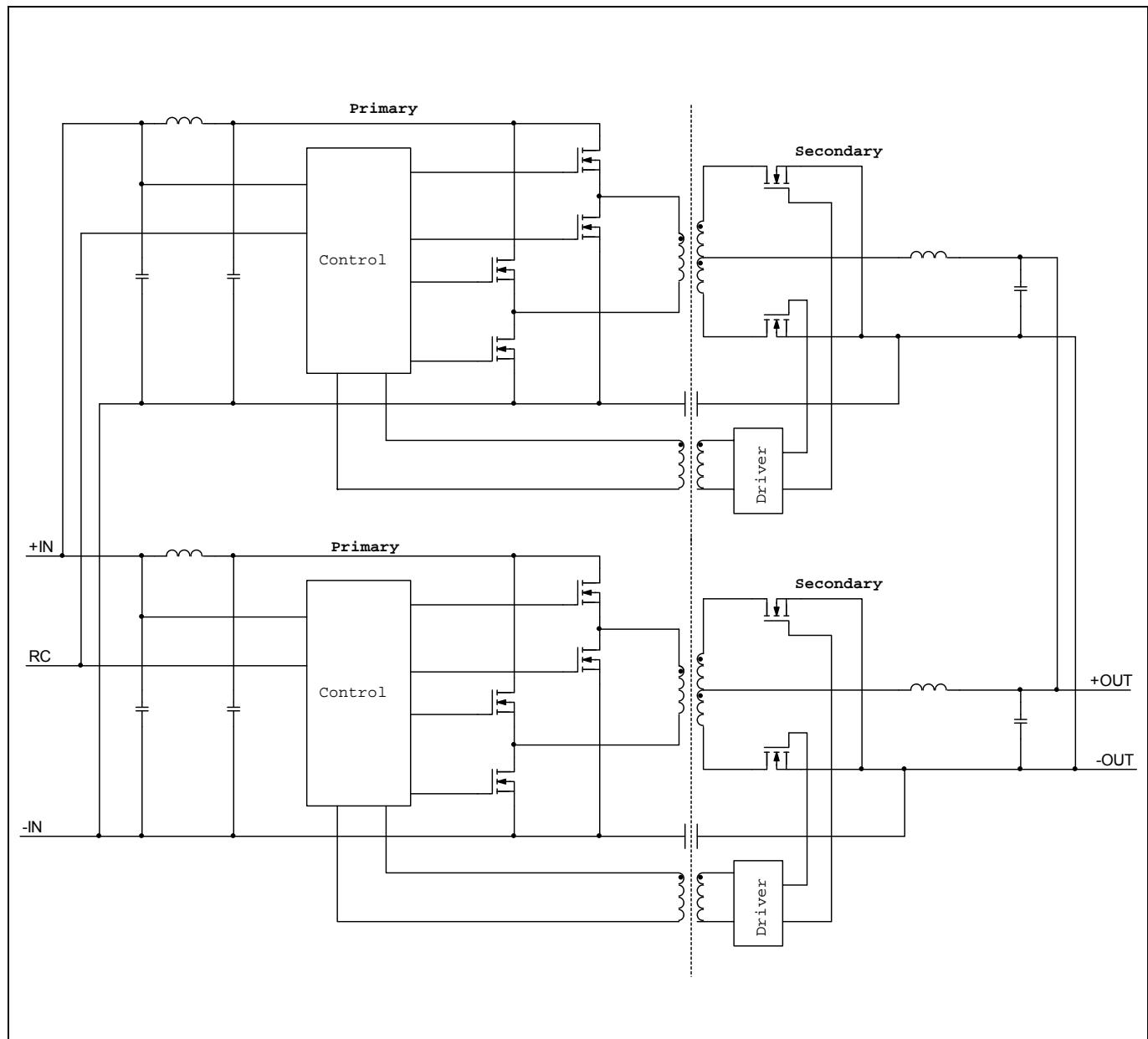
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Absolute Maximum Ratings

Characteristics		min	typ	max	Unit
T_p1	Operating Temperature (see Thermal Consideration section)	-40		+125	°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)			1500	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	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



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12 V, 675W Electrical Specification $T_{P1} = -40$ to $+90^\circ\text{C}$, $V_I = 36$ to 75 V, unless otherwise specified under Conditions.Typical values given at: $T_{P1} = +25^\circ\text{C}$, $V_I = 48$ V, max P_O , unless otherwise specified under Conditions.Additional $C_{in} = 0$ μF .

Characteristics	Conditions	min	typ	max	Unit
V_I	Input voltage range	36		75	V
V_{loff}	Turn-off input voltage	Decreasing input voltage	33.0	34.2	34.8
V_{lon}	Turn-on input voltage	Increasing input voltage	34.6	35.2	35.7
C_I	Internal input capacitance		35.2		μF
P_O	Output power	$V_I = 36$ V	0	672	W
		$V_I = 48$ V	0	675	
		$V_I = 75$ V	0	680	
η	Efficiency	50 % of max P_O , $V_I = 48$ V	96.7		%
		max P_O , $V_I = 48$ V	95.7		
P_d	Power Dissipation	max P_O	33.6	38.4	W
P_{li}	Input idling power	$P_O = 0$ W, $V_I = 48$ V	5.8		W
P_{RC}	Input standby power	$V_I = 48$ V (turned off with RC)	0.2		W
f_s	Switching frequency	0 to 100 % of max P_O	225	250	275
					kHz

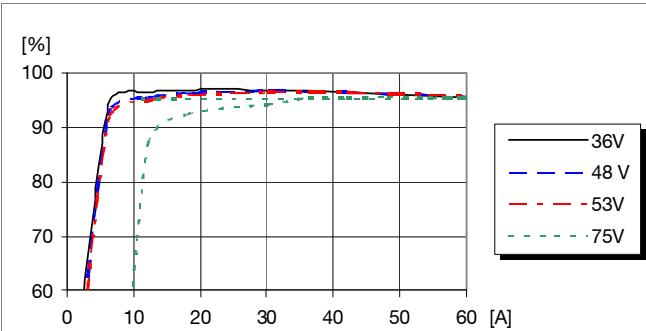
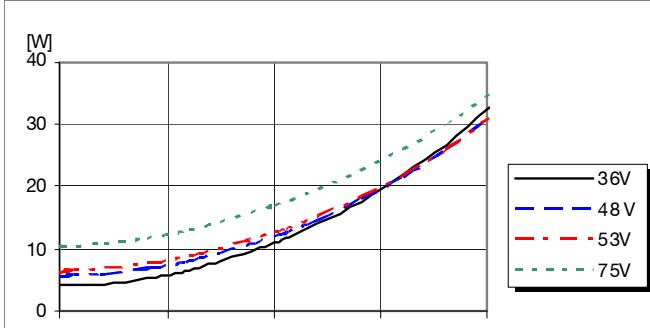
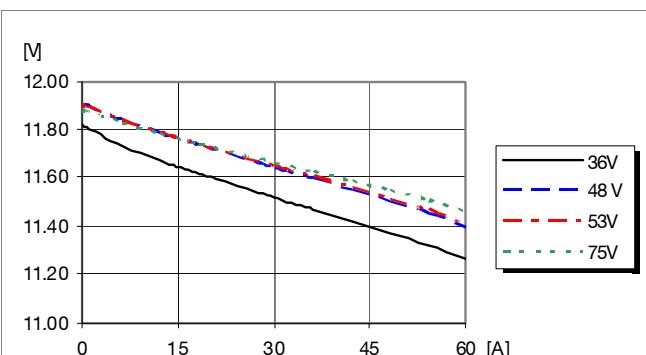
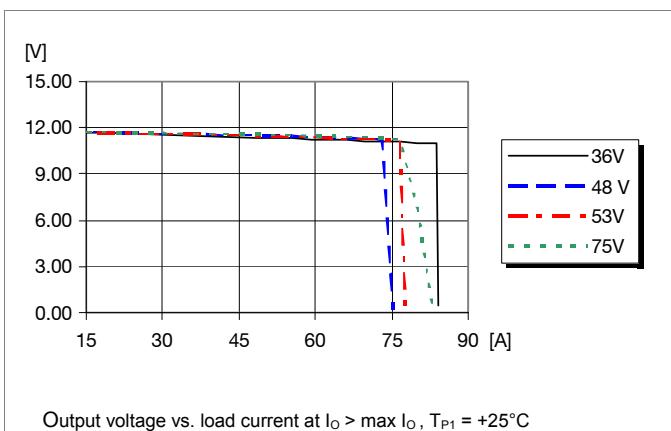
V_{OI}	Output voltage initial setting and accuracy	$T_{P1} = +25^\circ\text{C}$, $V_I = 48$ V, $P_O = 0$ W	11.1	12.0	12.3	V
V_O	Output voltage tolerance band	0 to 100 % of max P_O	10.8		12.5	V
	Idling voltage	$P_O = 0$ W	11.7		12.0	V
	Line regulation	See Note 2 regarding V_O		0.2		V
	Load regulation	$V_I = 48$ V, 0-100 % of max P_O	400	520	900	mV
V_{tr}	Load transient voltage deviation	$V_I = 53$ V, Load step 25-75-25 % of max P_O , $di/dt = 5$ A/ μs , see note 1		±200		mV
t_{tr}	Load transient recovery time			100	180	μs
t_r	Ramp-up time (from 10-90 % of V_O)		3.4	7.0	23.9	ms
t_s	Start-up time (from V_I connection to 90 % of V_O)	0 to 100 % of max P_O	10.1	12.6	30.5	ms
t_f	V_I shut-down fall time (from V_I off to 10 % of V_O)	max P_O		0.1		ms
		$P_O = 0$ W		2.7		s
	RC start-up time	max P_O		11.8		ms
t_{RC}	RC shut-down fall time (from RC off to 10 % of V_O)	max P_O		6		ms
		$P_O = 0$ W		2.4		s
I_O	Output current	$V_I = 36$ V	0		60	A
		$V_I = 48$ V	0		60	A
		$V_I = 75$ V	0		60	A
I_{lim}	Current limit threshold	$T_{P1} < \text{max } T_{P1}$	73	80	90	A
I_{sc}	Short circuit current	$T_{P1} = 25^\circ\text{C}$, see note 2		82	95	A
V_{Oac}	Output ripple & noise	See ripple & noise section, max P_O see note 3		120		mVp-p
OVP	Input over voltage protection		76	80	90	V

Note 1: $C_{out}=100\mu\text{F}$ ceramic cap + $3300\mu\text{F}$ electrolytic capNote 2: $C_{in}=100\mu\text{F}$ electrolytic capacitor needed when do short circuit current testNote 3: $C_{out}=100\mu\text{F}$ ceramic cap + $3300\mu\text{F}$ electrolytic cap

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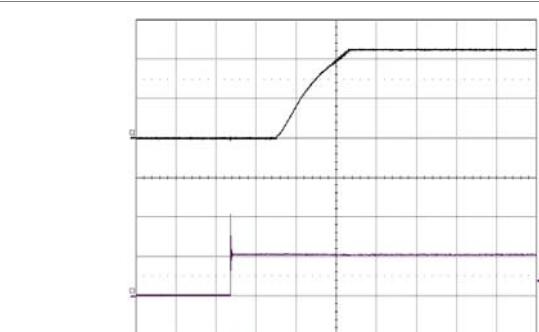
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12 V, 675W Typical Characteristics**Efficiency**Efficiency vs. load current and input voltage at $T_{P1} = +25^\circ\text{C}$ **Power Dissipation**Dissipated power vs. load current and input voltage at $T_{P1} = +25^\circ\text{C}$ **Output Characteristics**Output voltage vs. load current at $T_{P1} = +25^\circ\text{C}$ **Current Limit Characteristics**Output voltage vs. load current at $I_o > \text{max } I_o, T_{P1} = +25^\circ\text{C}$

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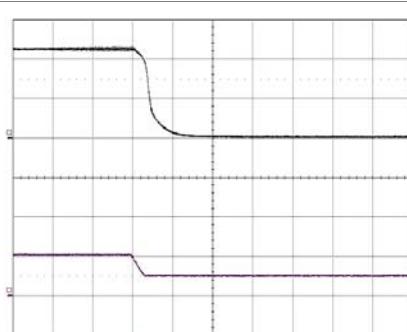
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12 V, 675W Typical Characteristics**Start-up**

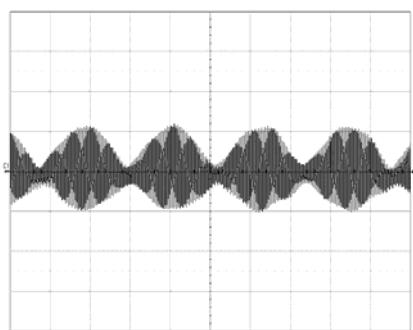
Start-up enabled by connecting V_i at:
 $T_{P1} = +25^\circ\text{C}$, $V_i = 53 \text{ V}$,
 $I_o = 60 \text{ A}$ resistive load.

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

Shut-down

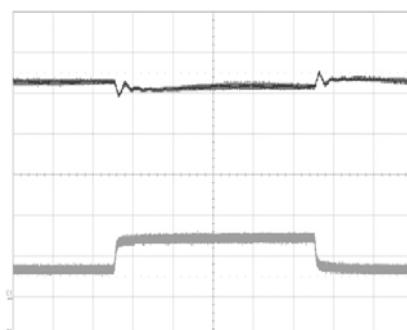
Shut-down enabled by disconnecting V_i at:
 $T_{P1} = +25^\circ\text{C}$, $V_i = 53 \text{ V}$,
 $I_o = 60 \text{ A}$ resistive load.

Top trace: output voltage (5 V/div.).
 Bottom trace: input voltage (50 V/div.).
 Time scale: (0.1ms/div.).

Output Ripple & Noise

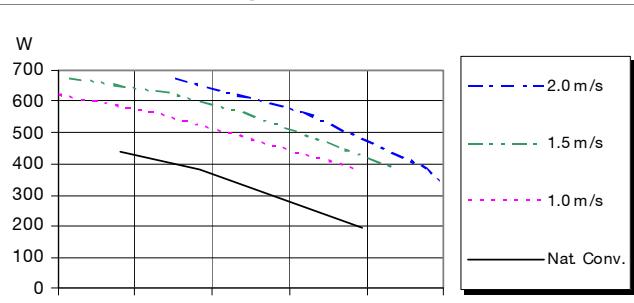
Output voltage ripple at:
 $T_{P1} = +25^\circ\text{C}$, $V_i = 53 \text{ V}$,
 $I_o = 60 \text{ A}$ resistive load.

Trace: output voltage (50 mV/div.).
 Time scale: (100 $\mu\text{s}/\text{div.}$).

Output Load Transient Response

Output voltage response to load current step-
 change (15-45-15 A) at:
 $T_{P1} = +25^\circ\text{C}$, $V_i = 53 \text{ V}$.

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

Typical Characteristics at $V_i = 53 \text{ V}$ **Output Power Derating (Open frame)**

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

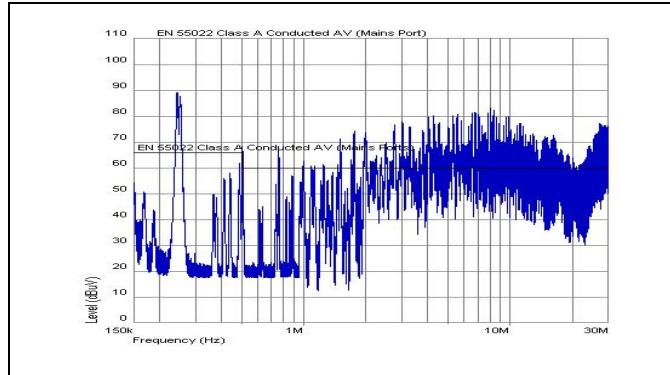
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EMC Specification

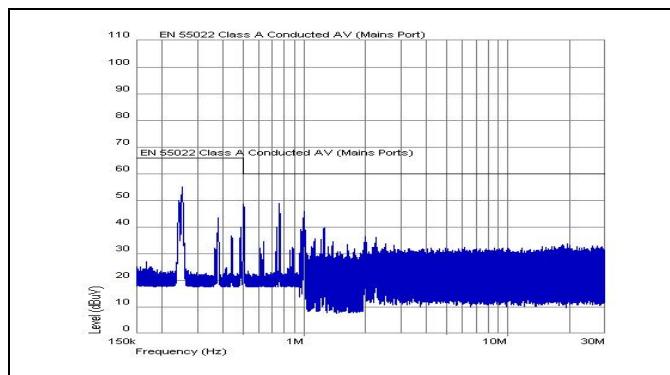
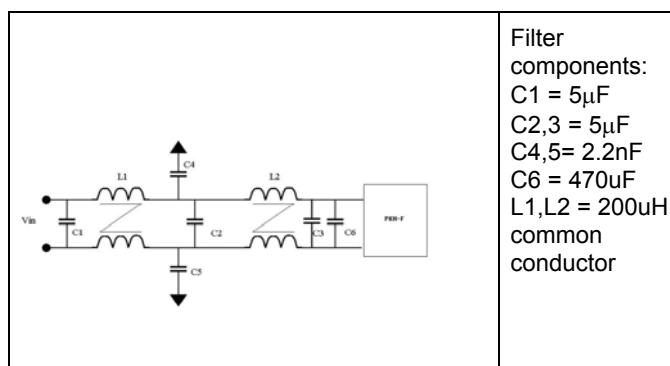
Conducted EMI measured according to EN55022, CISPR 22 and FCC part 15J (see test set-up). See Design Note 009 for detailed information. The fundamental switching frequency is 250 kHz for PKM-F @ $V_I = 53$ V, max I_O .

Conducted EMI Input terminal value (typ)

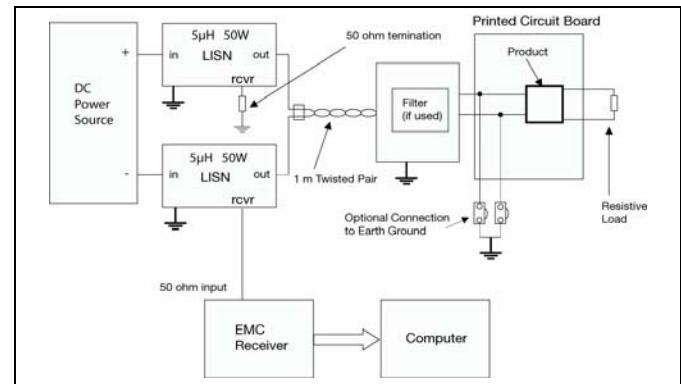
EMI without filter

External filter (class A)

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



EMI with filter



Test set-up

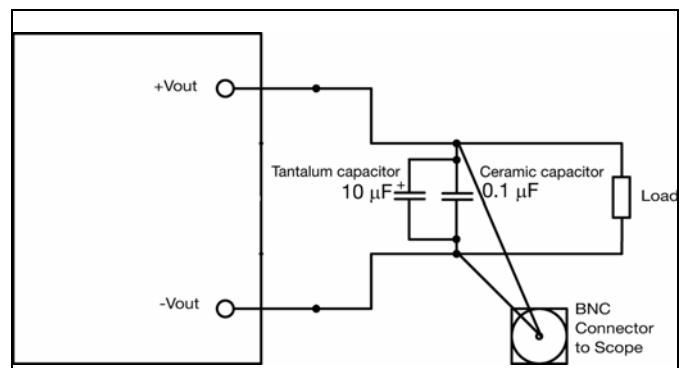
Layout recommendations

The radiated EMI performance of the product will depend on the PCB layout and ground layer design. It is also important to consider the stand-off of the product. If a ground layer is used, it should be connected to the output of the product 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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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.

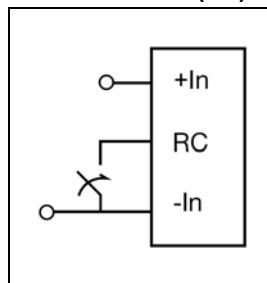
At input voltages exceeding 75 V, the power loss will be higher than at normal input voltage and T_{P1} must be limited to absolute max +125°C. The absolute maximum continuous input voltage is 80 Vdc.

Turn-off Input Voltage

The products 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 and positive logic options 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 1 mA. When the RC pin is left open, the voltage generated on the RC pin is 12 – 15 V. The standard product is provided with “negative logic” remote control and will be off until the RC pin is connected to the -In. To turn on the product the voltage between RC pin and -In should be less than 1V. To turn off the product the RC pin should be left open, or connected to a voltage higher than 13 V referenced to -In. In situations where it is desired to have the product to power up automatically without the need for control signals or a switch, the RC pin can be wired directly to -In.

The second option is “positive logic” remote control, which can be ordered by adding the suffix “P” to the end of the part number. When the RC pin is left open, the product starts up automatically when the input voltage is applied. 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 1V. The product will restart automatically when this connection is opened.

Input and Output Impedance

The impedance of both the input source and the load will interact with the impedance of the product. It is important that the input source has low characteristic impedance. The products 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 330–470 μ F capacitor across the input of the product will ensure stable operation. The capacitor is not required when powering the product from an input source with an inductance below 10 μ H. The minimum required capacitance value depends on the output power and the input voltage. The higher output power the higher input capacitance is needed.

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

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

Over Temperature Protection (OTP)

The products are protected from thermal overload by an internal over temperature shutdown circuit. When T_{P1} as defined in thermal consideration section exceeds 135°C the product will shut down. The product 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 products have output over voltage protection that will shut down the product in over voltage conditions. The product will make continuous attempts to start up (non-latching mode) and resume normal operation automatically after removal of the over voltage condition.

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Over Current Protection (OCP)

The products 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 product 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 products are designed to operate in different thermal environments and sufficient cooling must be provided to ensure reliable operation.

For products mounted on a PCB without a heat sink attached, cooling is achieved mainly by conduction, from the pins to the host board, and convection, which is dependant on the airflow across the product. Increased airflow enhances the cooling of the product. 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 $V_I=53$ V.

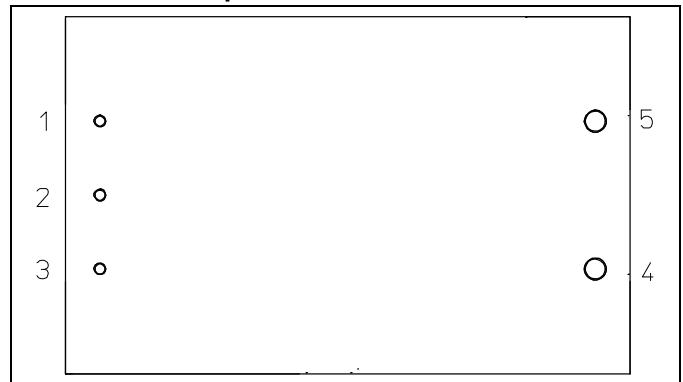
Proper cooling of the product can be verified by measuring the temperature at positions P1, P2, P3. The temperature at these positions should not exceed the max values provided in the table below. The number of points may vary with different thermal design and topology.

See Design Note 019 for further information.

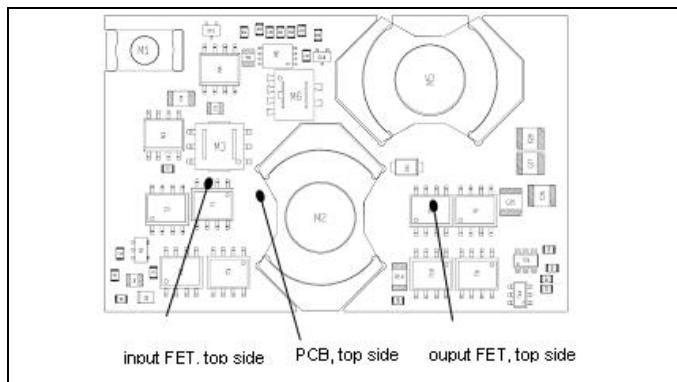
Position	Description	Temp. limit
P1	PCB	125° C
P2	Input Mosfet case	130° C
P3	Output Mosfet case	130° C

Definition of reference temperature T_{P1}

The reference temperature is used to monitor the temperature limits of the product. Temperatures above maximum T_{P1} , measured at the reference point 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 product.

Connections (top side)

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



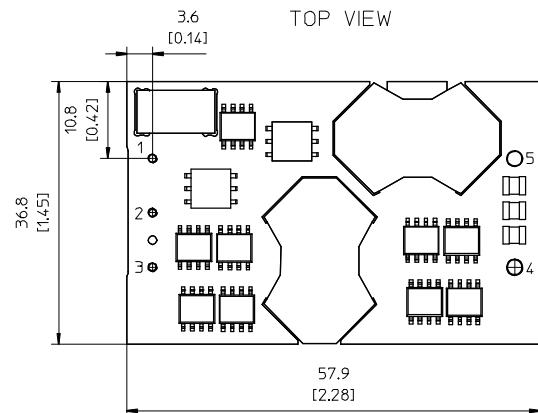
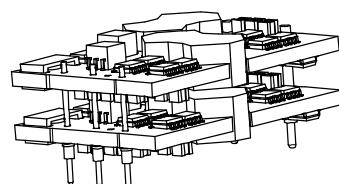
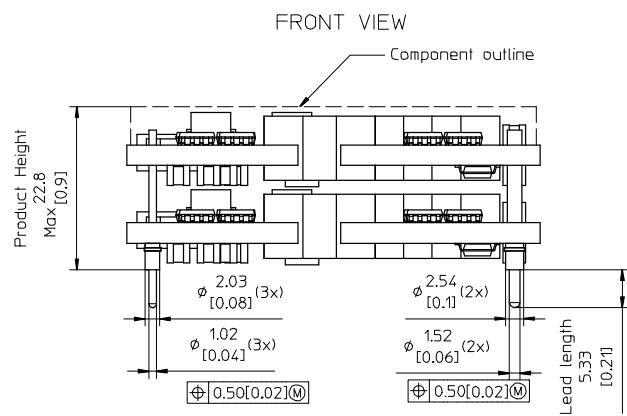
Open frame

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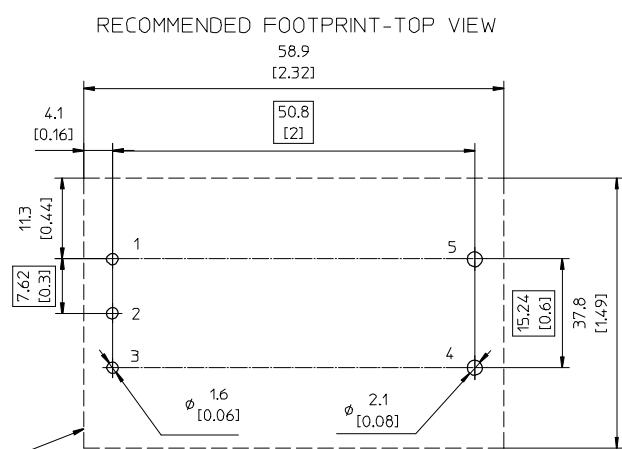
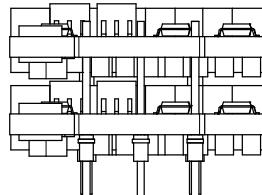
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Mechanical Information



RIGHT VIEW



Recommended keep away area for user components.

The standoff 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.

Pins:

Material: Copper alloy

Plating: 0.1 μ m Gold over 2 μ m Nickel

Notes:

- 1- Stand off to none conductive components
min 0.7 [0.027]
- Stand off to conductive components
min 0.95 [0.037]

Weight: typical 100 g

All dimensions in mm [inch]

Tolerances unless specified

x.x mm ± 0.50 mm [0.02]x.xx mm ± 0.25 mm [0.01]

(not applied on footprint or typical values)



BMR 653 series Intermediate Bus Converters Input 36-75 V, Output up to 60 A / 675 W	
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Soldering Information - Hole Mounting

The hole mounted product is intended for plated through hole mounting by wave or manual soldering. The pin temperature is specified to maximum to 270°C for maximum 10 seconds.

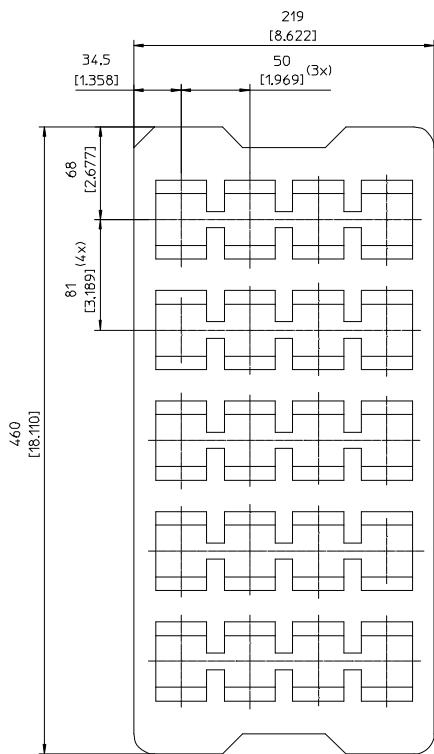
A maximum preheat rate of 4°C/s and maximum preheat temperature of 150°C is suggested. When soldering by hand, care should be taken to avoid direct contact between the hot soldering iron tip and the pins for more than a few seconds in order to prevent overheating.

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

The products are delivered in antistatic trays.

Tray Specifications	
Material	PE foam
Surface resistance	$10^5 < \text{Ohm/square} < 10^{12}$
Tray thickness	38 mm [1.50 inch]
Box capacity	20 products (1 full trays/box)
Tray weight	2100 g full tray (typical)



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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
Immersion in cleaning solvents	IEC 60068-2-45 XA, method 2	Water Glycol ether Isopropyl alcohol	55°C 35°C 35°C
Mechanical shock	IEC 60068-2-27 Ea	Peak acceleration Duration	30 m/s ² 11 ms
Operational life test	MIL-STD-202G, method 108A	Duration	1000 h
Resistance to soldering heat	IEC 60068-2-20 Tb, method 1A	Solder temperature Duration	270°C 10-13 s
Robustness of terminations	IEC 60068-2-21 Test Ua1	Tensile	All leads
Solderability	IEC 60068-2-20 test Ta	Preconditioning Temperature, SnPb Eutectic Temperature, Pb-free	Steam ageing 1 h ± 5 min 235°C 260°C
Vibration, broad band random	IEC 60068-2-64 Fh, method 1	Frequency Spectral density Duration	5 to 200 Hz 1 m ² /s ³ 10 min in each direction
Sinusoidal vibration	IEC 60068-2-6 Fc	Frequency Acceleration Sweep cycles	5 to 200 Hz 2 m/s ² 3 * 5
Bump	IEC 60068-2-29 Eb	Acceleration Duration Direction of bumps	180 m/s ² 6 ms 6 (100 in each direction)

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