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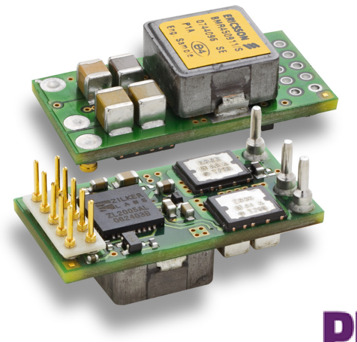
Technical Specification

BMR 450 DC/DC Regulators, Input 4.5-14 V, Output 20 A/100 W	EN/LZT 146 400 R1C November 2008

Key Features

- Small package
  25.65 x 12.9 x 8.2 mm (1.01 x 0.51 x 0.323 in.)
- 20 A output current
- 4.5 V - 14 V input voltage range
- 0.6 V - 5.5 V output voltage range
- High efficiency, typ. 96,8 % at half load, 5 Vin, 3.3 Vout
- 5 million hours MTBF
- Through hole and surface mount versions
- PMBus compliant



General Characteristics

- Voltage/current/temperature monitoring
- Precision delay and ramp-up
- Non-linear transient response
- Wide output voltage adjust function
- Start up into a pre-biased output safe
- Output short-circuit protection
- Over temperature protection
- On/Off inhibit control
- Output voltage sense
- ISO 9001/14001 certified supplier

Safety Approvals

c UL us

Pending

Design for Environment

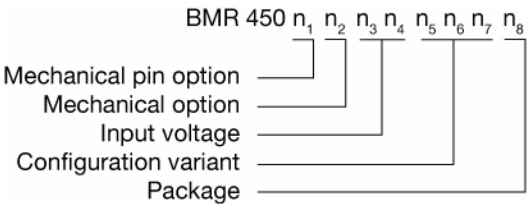
RoHS compatible

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

Contents

General Information

Ordering Information



Number	Description
BMR450	Default 20 A POL
n_1	0 = Through hole mount version 1 = Surface mount version
n_2	0 = Open frame (default)
n_3 n_4	02 = 4.5 – 14 Vin PMBus and analog voltage adjust
n_5 n_6 n_7	020 = Default configuration variant
n_8	0 = Tray

As an example a 20 A POL, surface mount, open frame, 4.5-14Vin product with default configuration variant 020 packed in trays would be BMR450 1002 020 0.

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:
- 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 AB's General Terms and Conditions of Sale. Ericsson AB does not make any other warranties, expressed or implied including any warranty of merchantability, effects of product configurations made by customers or fitness for a particular purpose.

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 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 Absolute maximum ratings).
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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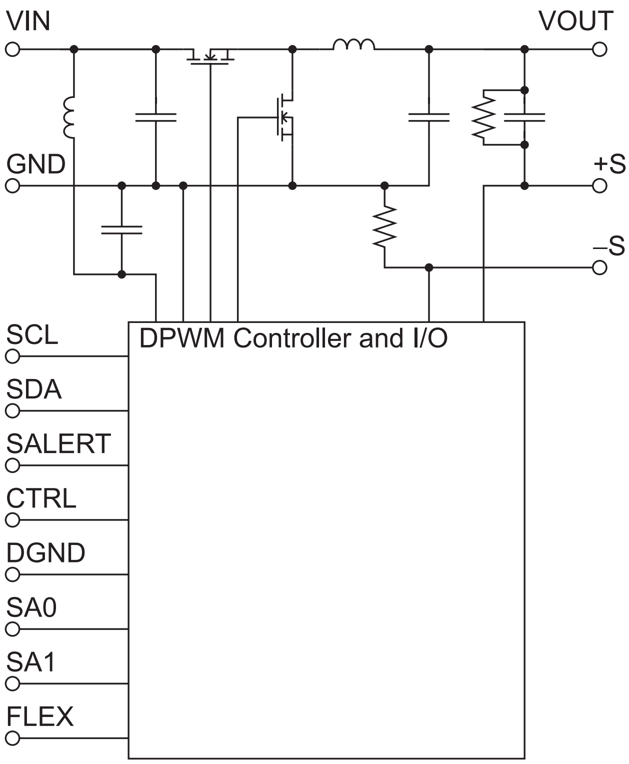
Absolute Maximum Ratings

Characteristics		min	typ	max	Unit
T_{P1}	Operating temperature (see Thermal Consideration section)	-40		120	°C
T_S	Storage temperature	-40		125	°C
V_I	Input voltage (See Operating Information Section for input and output voltage relations)	-0.3		16	V
V_O	Output voltage	0.6		5.5	V
P_O	Output power			100	W
Logic I/O voltage	CTRL, SA(0,1), SALERT, SCL, SDA, FLEX	-0.3		6.5	V
Ground voltage differential	DGND, -S, GND	-0.3		0.3	V
Analog pin voltage	VOUT, +S	-0.3		6.5	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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Functional Specification

T_{P1} = -40 to +85ºC, V_I = 4.5 to 14 V
Typical values given at: T_{P1} = +25°C, V_I = 12 V, max I_O, unless otherwise specified under Conditions
Configuration File: 190 10-CDA 102 899/020

Characteristics		Conditions	min	typ	max	Unit
General Electrical Characteristics						
f_s Switching frequency		Factory default		320		kHz
C_{ISMBus} Internal capacitance		SMBus signals, SDA, SCL		7		pF
C_I Internal input capacitance				70		µF
Fault Protection Characteristics						
Input Under Voltage Lockout, UVLO	UVLO Threshold		-	4.25	-	V
	Set point accuracy		-100	-	100	mV
	Hysteresis	Factory default	-	0.25	-	V
	Delay		-	-	2.5	µs
(Output voltage) Over/Under Voltage Protection, OVP/UVP	UVP threshold	Factory default	-	85	-	% V_{OUT}
	OVP threshold	Factory default	-	115	-	% V_{OUT}
	OVP/UVP fault response time	Factory default	-	25	-	µs
Over Current Protection, OCP	Set point accuracy	Io	-20		40	%
	OCP threshold	Factory default	-	30	-	A
	OCP protection delay	Factory default	-	45	-	µs
Over Temperature Protection, OTP at T_{P1}	OTP threshold	Factory default	-	120	-	°C
	OTP hysteresis	Factory default		15		
Logic Input/Output Characteristics						
Logic input low threshold (V_{IL})		CTRL, SCL, SDA, FLEX	-	-	0.8	V
Logic input high threshold (V_{IH})			2	-	-	V
Logic output low (V_{OL})		SALERT, SCL, SDA, FLEX I_{OL} ≤ 4 mA	-	-	0.4	V
Logic output high (V_{OH})		SALERT, SCL, SDA, FLEX I_{OL} ≥ -2 mA	2.25	-	-	V
Setup time, SMBus (t_{set})		See Note 1	300	-		ns
Hold time, SMBus (t_{hold})		See Note 1	250	-		ns

Note 1: See operation information section for I2C/SMBus Setup and Hold Times – Definitions

1.0V, 20A / 20W Electrical Specification — BMR 450 XX02020X

T_{P1} = -40 to +85ºC, V_I = 4.5 to 14 V. Configuration: CDA 102 899/020, R_{SET} = 19.6 kΩ.
Typical values given at: T_{P1} = +25°C, V_I = 12.0 V, max I_O, unless otherwise specified under Conditions.
Additional C_I = 470 µF. See Operating Information section for selection of capacitor types.
Sense pins are connected to the output pins.

Characteristics		Conditions	min	typ	max	Unit
V_I	Input voltage range		4.5		14	V
V_{Ioff}	Turn-off input voltage	Decreasing input voltage		4.25		V
V_{Ion}	Turn-on input voltage	Increasing input voltage		4.5		V
P_O	Output power		0		20	W
η	Efficiency	50 % of max I_O		88.1		%
		max I_O		85.4		
P_d	Power dissipation			3.4		W
P_{li}	Input idling power	I_O = 0.01 A		0.57		W
P_{RC}	Input standby power	Turned off with CTRL, see Note 3		120		mW
I_S	Static input current			2		A
V_{Oi}	Output voltage initial setting and accuracy		0.990	1.000	1.010	V
V_O	Output voltage tolerance band	0.05 - 100 % of max I_O	0.985		1.015	V
	Idling voltage	I_O = 0.01 A		1.000		V
	Line regulation			4		mV
	Load regulation	0.05 - 100 % of max I_O		4		mV
V_{tr1}	Load transient voltage deviation	Load step 25–75-25 % of max I_O, di/dt = 2.5 A/µs with default configuration and C_O = 5 mF		-50/+60		mV
t_{tr1}	Load transient recovery time			150		µs
C_O	Recommended capacitive load	See Note 1	470		100 000	µF
t_r	Ramp-up time (from 10 − 90 % of V_{Oi})	0.05 - 100 % of max I_O	-	10	-	ms
t_s	Start-up time (from V_I connection to 10 % of V_{Oi})		-	30	-	ms
t_f	V_I shut-down fall time. (From V_I off to 10 % of V_O)			250		µs
		I_O = 0.2 A		250		ms
t_{CTRL}	CTRL start-up time			20		ms
	CTRL shut-down fall time (From CTRL off to 10 % of V_O)			7		ms
		I_O = 0.2 A		7		ms
I_O	Output current		0.01		20	A
I_{lim}	Current limit threshold		24	30		A
I_{sc}	Short circuit current			40		A
V_{Oac}	Output ripple & noise	See Note 2		10		mVp-p

Note 1: See Operating Information section for selection of capacitor types.
Note 2: See Operating Information section for measurement set-up.
Note 3: The idling power can be reduced to typically 20 mW if monitoring is not needed. Please contact your local Ericsson Power Modules representative for custom configurations.

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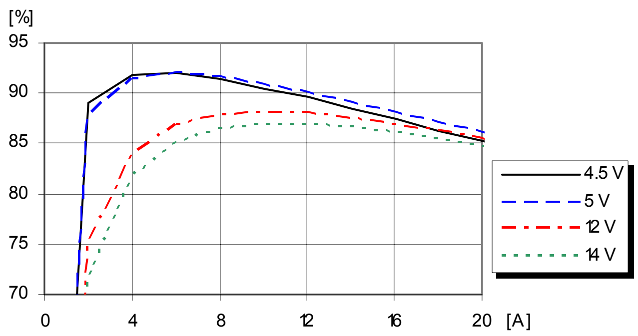
1.0V, 20A / 20W Typical Characteristics

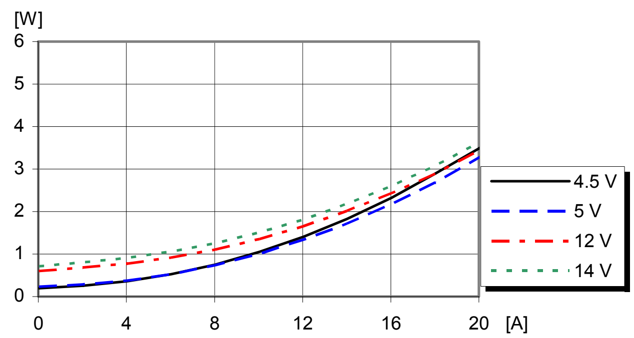
BMR 450 XX02020X

Efficiency



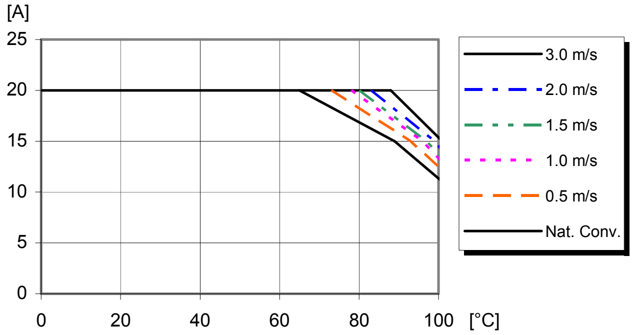
Efficiency vs. load current and input voltage at T_{P1} = +25°C.

Power Dissipation



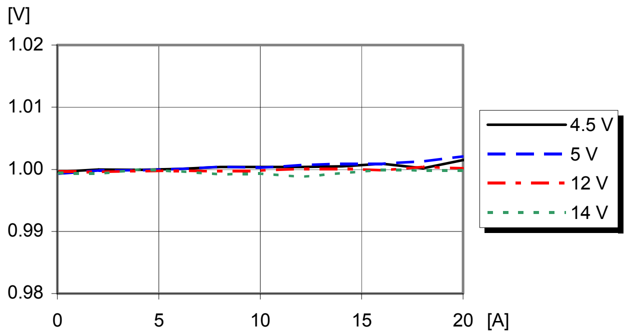
Dissipated power vs. load current and input voltage at T_{P1} = +25°C.

Output Current Derating



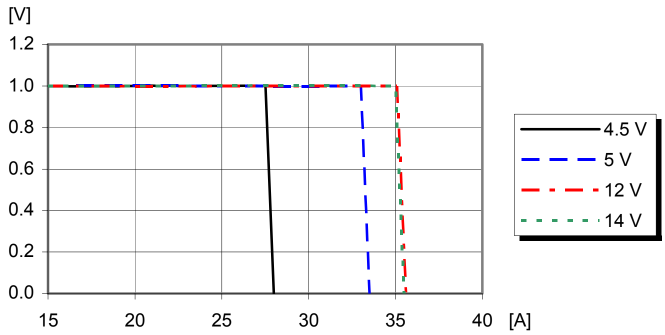
Available load current vs. ambient air temperature and airflow at V_I = 5 V. See Thermal Consideration section.

Output Characteristics



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

Current Limit Characteristics



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

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1.0V, 20A / 20W Typical Characteristics

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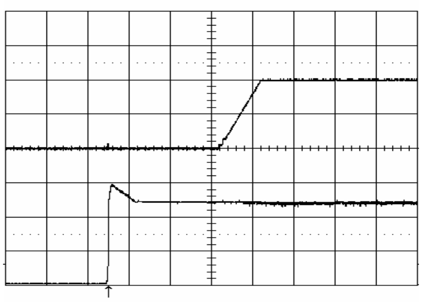
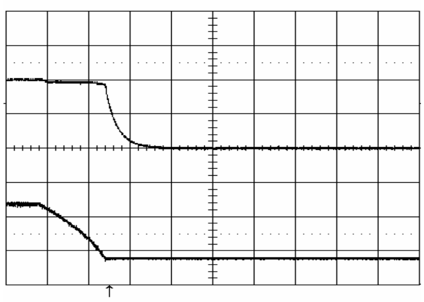
Start-up



Start-up enabled by connecting V_I at:
T_{P1} = +25°C, V_I = 12 V,
I_O = 20 A resistive load and 5 mF.

Top trace: output voltage (0.5 V/div.).
Bottom trace: input voltage (5 V/div.).
Time scale: (10 ms/div.).

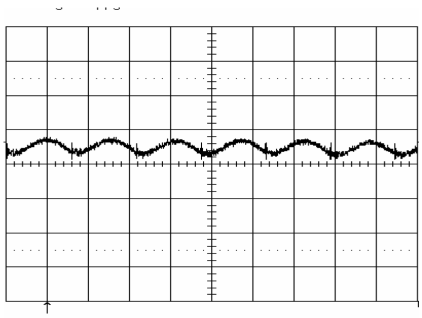
Shut-down



Shut-down enabled by disconnecting V_I at:
T_{P1} = +25°C, V_I = 12 V,
I_O = 20 A resistive load.

Top trace: output voltage (0.5 V/div).
Bottom trace: input voltage (5 V/div.).
Time scale: (10 ms/div.).

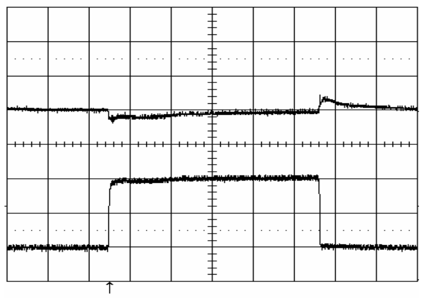
Output Ripple & Noise



Output voltage ripple at:
T_{P1} = +25°C, V_I = 12 V,
I_O = 20 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 (5-15-5 A) at:
T_{P1} = +25°C, V_I = 12 V, C_O = 5 mF.

Top trace: output voltage (200 mV/div.).
Bottom trace: load current (10 A/div.).
Time scale: (0.2 ms/div.).

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BMR 450 DC/DC Regulators, Input 4.5-14 V, Output 20 A/100 W	EN/LZT 146 400 R1C November 2008 © Ericsson AB

3.3V, 20A / 66W Electrical Specification

BMR 450 XX02020X

T_{P1} = -40 to +85°C, V_I = 4.5 to 14 V. Configuration: CDA 102 899/020, R_{SET} = 1.21 kΩ.
Typical values given at: T_{P1} = +25°C, V_I = 12 V, max I_O, unless otherwise specified under Conditions.
Additional C_I = 470 µF. See Operating Information section for selection of capacitor types.
Sense pins are connected to the output pins.

Characteristics		Conditions	min	typ	max	Unit
V_I	Input voltage range		4.5		14	V
V_{Ioff}	Turn-off input voltage	Decreasing input voltage		4.25		V
V_{Ion}	Turn-on input voltage	Increasing input voltage		4.5		V
P_O	Output power		0		66	W
η	Efficiency	50 % of max I_O		94.7		%
		max I_O		93.5		
P_d	Power dissipation			4.4		W
P_{li}	Input idling power	I_O = 0.01 A		1.0		W
P_{RC}	Input standby power	Turned off with CTRL, see Note 3		120		mW
I_S	Static input current			6		A
V_{Oi}	Output voltage initial setting and accuracy		3.285	3.300	3.315	V
V_O	Output voltage tolerance band	0.05 - 100 % of max I_O	3.250		3.350	V
	Idling voltage	I_O = 0.01 A		3.300		V
	Line regulation			4		mV
	Load regulation	0.05 - 100 % of max I_O		4		mV
V_{tr1}	Load transient voltage deviation	Load step 25-75-25 % of max I_O, di/dt = 2.5 A/µs with default configuration and C_O = 2 mF		-140/+170		mV
t_{tr1}	Load transient recovery time			150		µs
C_O	Recommended capacitive load	See Note 1	470		100 000	µF
t_r	Ramp-up time (from 10 − 90 % of V_{Oi})	0.05 - 100 % of max I_O		10		ms
t_s	Start-up time (from V_I connection to 10 % of V_{Oi})			30		ms
t_f	V_I shut-down fall time. (From V_I off to 10 % of V_O)			250		µs
		I_O = 0.2 A		250		s
t_{CTRL}	CTRL start-up time			20		ms
	CTRL shut-down fall time (From RC off to 10 % of V_O)			7		ms
		I_O = 0.2 A		7		ms
I_O	Output current		0.01		20	A
I_{lim}	Current limit threshold		24	30		A
I_{sc}	Short circuit current			40		A
V_{Oac}	Output ripple & noise	See Note 2		45		mVp-p

Note 1: See Operating Information section for selection of capacitor types.
Note 2: See Operating Information section for measurement set-up.
Note 3: The idling power can be reduced to typically 20 mW if monitoring is not needed. Please contact your local Ericsson Power Modules representative for custom configurations.

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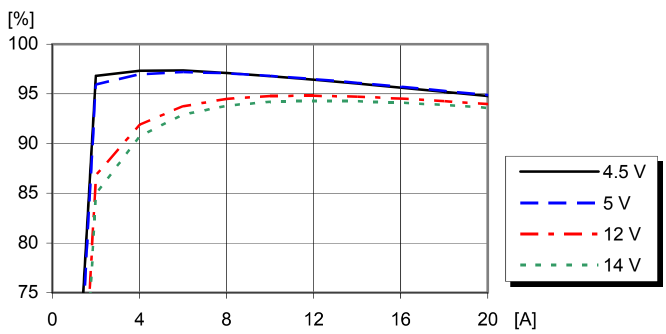
3.3V, 20A / 66W Typical Characteristics

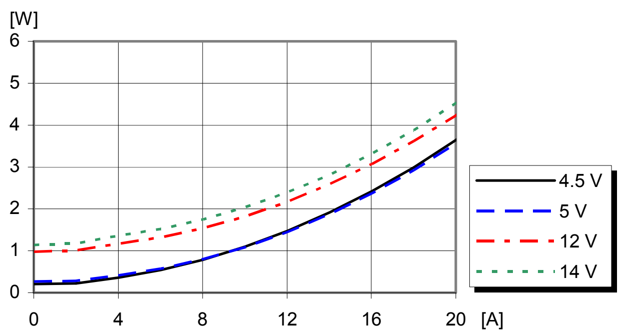
BMR 450 XX02020X

Efficiency



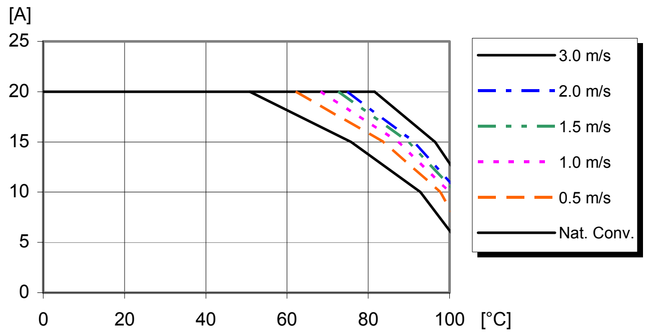
Efficiency vs. load current and input voltage at T_{P1} = +25°C.

Power Dissipation



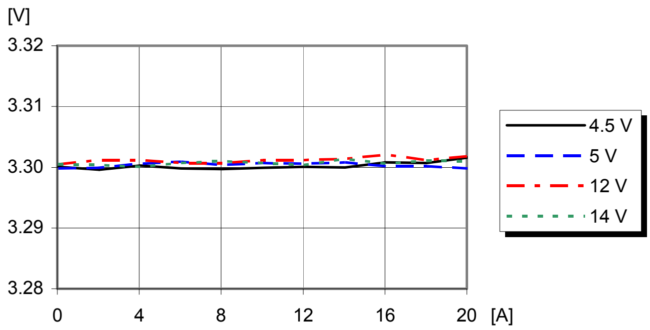
Dissipated power vs. load current and input voltage at T_{P1} = +25°C.

Output Current Derating



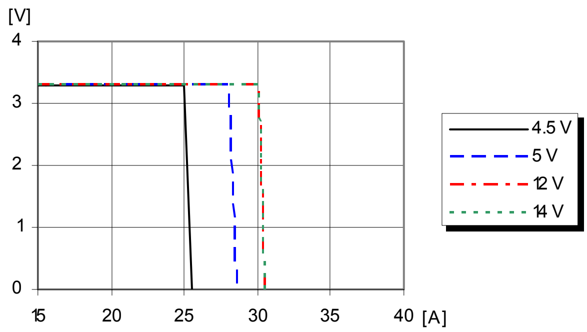
Available load current vs. ambient air temperature and airflow at V_I = 12 V. See Thermal Consideration section.

Output Characteristics



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

Current Limit Characteristics

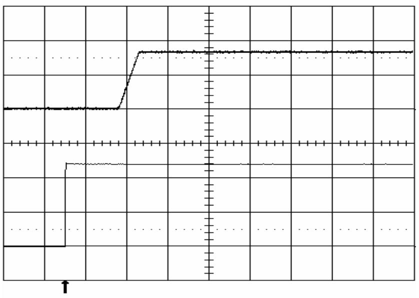


Output voltage vs. load current at T_{P1} = +25°C.

3.3V, 20A / 66W Typical Characteristics

BMR 450 XX02020X

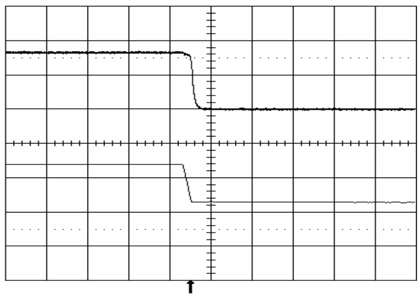
Start-up



Start-up enabled by connecting V_I at:
T_{P1} = +25°C, V_I = 12 V,
I_O = 20 A resistive load and 2 mF.

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

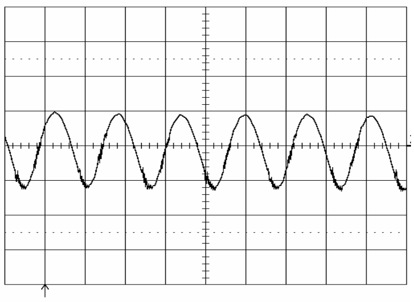
Shut-down



Shut-down enabled by disconnecting V_I at:
T_{P1} = +25°C, V_I = 12 V,
I_O = 20 A resistive load.

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

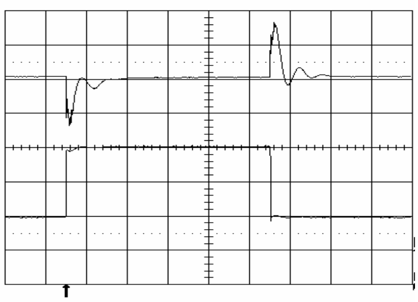
Output Ripple & Noise



Output voltage ripple at:
T_{P1} = +25°C, V_I = 12 V,
I_O = 20 A resistive load.

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

Output Load Transient Response



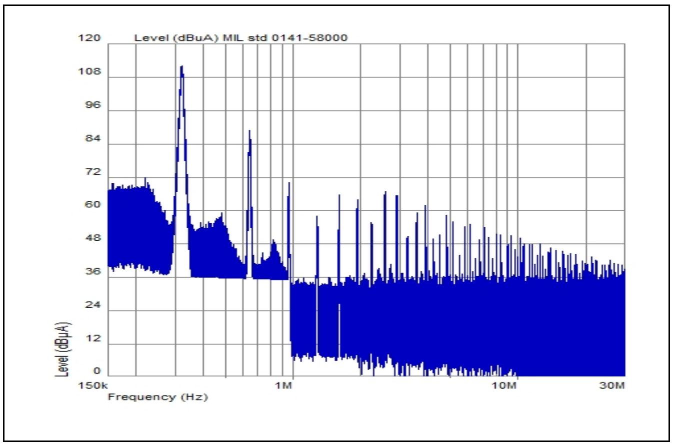
Output voltage response to load current step-change (5-15-5 A) at:
T_{P1} = +25°C, V_I = 12 V, C_O = 2 mF.

Top trace: output voltage (100 mV/div.).
Bottom trace: load current (5 A/div.).
Time scale: (0.5 ms/div.).

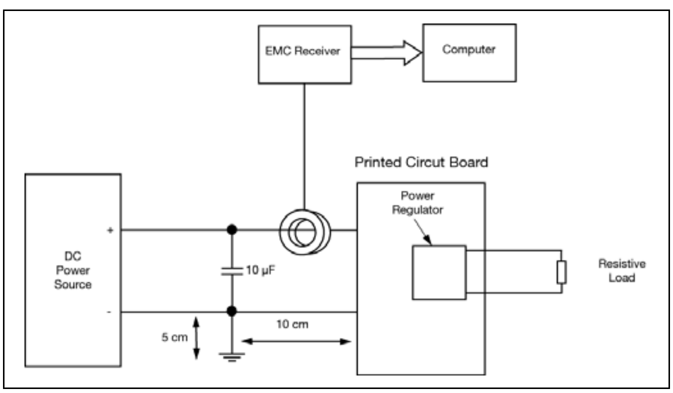
EMC Specification

Conducted EMI measured according to test set-up and standard MIL std 0141 - 58000.
The fundamental switching frequency is 320 kHz for BMR 450.

Conducted EMI Input terminal value (typ)



EMI without filter



Test set-up

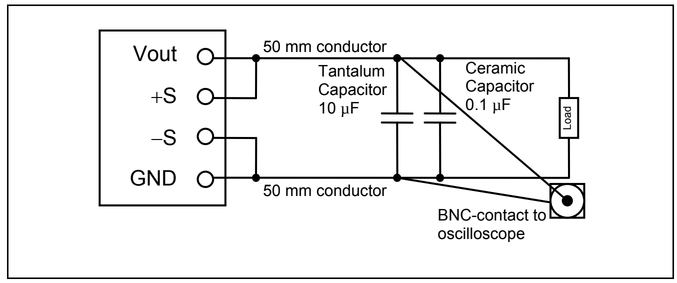
Layout recommendations

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 is measured with the filter according to figure below. A 50 mm conductor works as a small inductor forming together with the two capacitances a damped filter.



Output ripple and noise test set-up.

Operating information

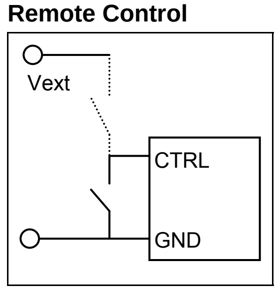
Input Voltage

The input voltage range, 4.5 - 14 V, makes the products easy to use in intermediate bus applications when powered by a non-regulated bus converter or a regulated bus converter. See Ordering Information for input voltage range.

Turn-off Input Voltage Range

The product monitors the input voltage and will turn-on and turn-off at configured levels. The default turn-on input voltage level setting is 4.5 V, whereas the corresponding turn-off input voltage level is 4.25 V. Hence, the default hysteresis between turn-on and turn-off input voltage is 0.25 V.

Remote Control



The product is equipped with a remote control function, i.e., the CTRL pin. The remote control can be referenced to either the primary negative input connection (GND) or to an external voltage (Vext), which is a 3 - 5 V positive supply voltage in accordance with the SMBus Specification version 2.0. The CTRL function allows the product to be turned on/off by an external device like a semiconductor or mechanical switch. By default the product will turn on with the CTRL pin is left open and turn off when the CTRL pin is applied to GND. The CTRL pin has an internal pull-up resistor. The maximum required sink current is 0.5 mA. When the CTRL pin is left open, the voltage generated on the CTRL pin is max 6 V.

Please contact your local Ericsson Power Modules representative for custom configurations.

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 Capacitors. If the input voltage source contains significant inductance, the addition of a 470 µF capacitor with low ESR at the input of the product will ensure stable operation.

External Decoupling Capacitors

Input capacitors:
The recommended input capacitor has a minimum capacitance of 470 µF and a low ESR. The ripple current rating of the capacitor must be at least 4 A rms. For high-performance/transient applications or wherever the input source performance is degraded, additional low ESR ceramic type capacitors at the input is recommended. The additional input low ESR capacitance above the minimum level insures an optimized performance.

Output capacitors:
The recommended output capacitor has a minimum capacitance of 470 µF and a low ESR. 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 capacitors in parallel 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 high frequency noise at the load.
It is equally important to use low resistance and low inductance PCB layouts and cabling.
External decoupling capacitors are a part of the control loop of the product and may affect the stability margins. The ESR of the capacitors is a very important parameter. Stable operation is guaranteed for an ESR value of >5 mΩ and a total capacitance in the range defined in the electrical specification. For a total capacitance outside this range or with lower ESR a re-configuration will be necessary for robust dynamic operation and stability. Please contact your local Ericsson Power Modules representative for custom configurations.

Control Loop Compensation

The product is configured with a robust control loop compensation which allows for a wide range operation of input and output voltages and capacitive loads as defined in the electrical specification. Please contact your local Ericsson Power Modules representative for custom configurations.

Load Transient Response Optimization

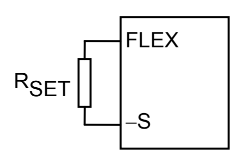
The product incorporates a Non-Linear transient Response, NLR, loop that decreases the response time and the output voltage deviation during a load transient. The NLR results in a higher equivalent loop bandwidth than is possible using a traditional linear control loop. The product is pre-configured with appropriate NLR settings for robust and stable operation for a wide range of input voltage and a capacitive load range as defined in the electrical specification. For a specific input voltage, and capacitive load, the NLR and control loop compensation configuration can be optimized for a robust and stable operation and with an improved load transient response. Please contact your local Ericsson Power Modules representative for custom configurations.

Remote Sense

The product has 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 +S should be connected to VOUT and −S should be connected to GND.

Output Voltage Adjust Range

With Analog Output Voltage Adjust the output voltage can be set by an external resistor, R_{SET}, which is applied between the FLEX pin and the −S pin.



Analog output voltage adjust with external resistor.

The following table shows recommended resistor values for R_{SET} (1% tolerance resistors suggested).

Index	V_{OUT} [V]	R_{set}[kΩ]	Index	V_{OUT} [V]	R_{set}[kΩ]
0	0.7	Open	14	0.991	21.5
1	0.752	110	15	1.00	19.6
2	0.758	100	16	1.10	16.2
3	0.765	90.9	17	1.158	13.3
4	0.772	82.5	18	1.20	12.1
5	0.79	75.0	19	1.25	9.09
6	0.80	56.2	20	1.50	7.50
7	0.821	51.1	21	1.669	5.62
8	0.834	46.4	22	1.80	4.64
9	0.848	42.2	23	2.295	2.87
10	0.88	34.8	24	2.506	2.37
11	0.899	31.6	25	3.30	1.21
12	0.919	28.7	26	5.00	Shorted
13	0.965	23.7			

Output Voltage Adjust using PMBus

Please contact your local Ericsson Power Modules representative for custom configurations.

Synchronization

Not available in the current version.
Please contact your local Ericsson Power Modules representative for custom configurations.

Interleaving

Not available in the current version.
Please contact your local Ericsson Power Modules representative for custom configurations.

Parallel Operation

Parallel operation is not recommended.

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 120°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 >15°C below the temperature threshold. Please contact your local Ericsson Power Modules representative for custom configurations.

Over Current Protection (OCP)

The product includes current limiting circuitry for protection at continuous overload. The product will shut down immediately for output currents in excess of the current limit, I_{lim}. The product will try to restart every 70 ms, i.e., hiccup mode, and resume normal operation after removal of the overload. The load distribution should be designed for the maximum output short circuit current specified. Please contact your local Ericsson Power Modules representative for custom configurations.

Soft-start Power Up

The soft-start control introduces a time-delay (default setting 10 ms) before allowing the output voltage to rise. The default rise time of the ramp up is 10 ms. Power-up is hence completed within 20 ms in default configuration using remote control.
When starting by applying input voltage the control circuit boot-up time adds an additional 10 ms delay. Please contact your local Ericsson Power Modules representative for custom configurations

Margin Up/Down Controls

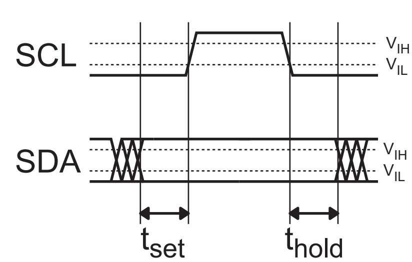
Not available in the current version.
Please contact your local Ericsson Power Modules representative for custom configurations.

Pre-Bias Startup Capability

Pre-bias startup often occurs in complex digital systems when current from another power source is fed back through a dual-supply logic component, such as FPGA or ASIC.
The BMR 450 product family incorporates synchronous rectifiers, but will not sink current during startup, or turn off, or whenever a fault shuts down the product in a pre-bias condition. Please contact your local Ericsson Power Modules representative for custom configurations.

I^2C/SMBus Setup and Hold Times – Definitions

The setup time, t_{set}, is the time the data, SDA, must be stable before the rising edge of the clock signal, SCL. The hold time t_{hold}, is the time the data must be stable after the rising edge of the clock signal, SCL. If these times are violated incorrect data can be captured or meta-stability can occur and the bus communication fails.



SMBus timing diagram

Thermal Consideration

General

The regulators 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 regulator. Increased airflow enhances the cooling of the regulator.

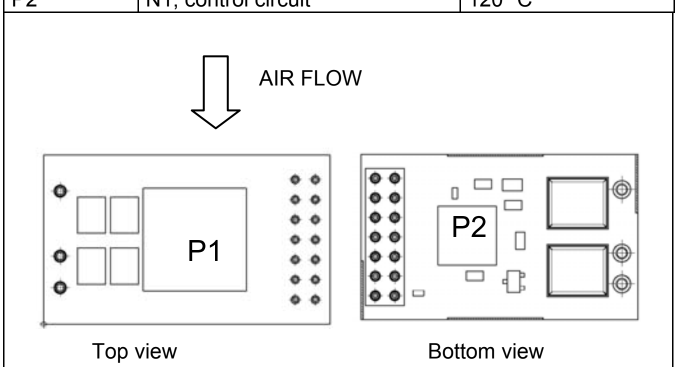
The Output Current Derating graph found in the Output section for each model provides the available output current vs. ambient air temperature and air velocity at specified V_I.

The product is tested on a 254 x 254 mm, 35 µm (1 oz), 8-layer test board mounted vertically in a wind tunnel with a cross-section of 608 x 203 mm.

Proper cooling of the product can be verified by measuring the temperature at positions P1 and P2. The temperature at these positions should not exceed the max values provided in the table below.

See Design Note 019 for further information.

Position	Device	max value
P1	Reference point, L1, inductor	120° C
P2	N1, control circuit	120° C



Temperature positions and air flow direction.

Definition of reference temperature T_{P1}

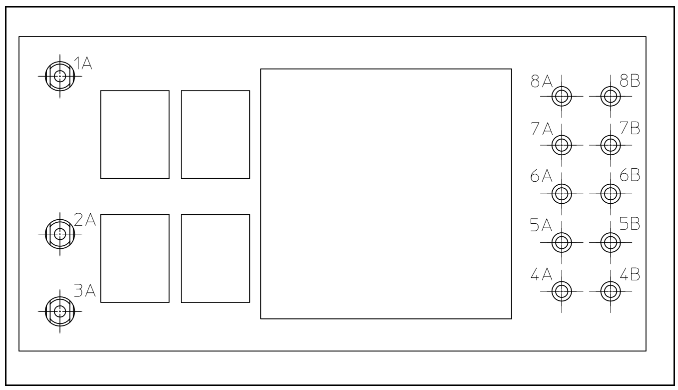
The reference temperature is used to monitor the temperature limits of the product. Temperature above maximum T_{P1}, meassured at the reference point P1 are not allowed and may cause degradation or permanent damage to the product. T_{P1} is also used to define the temperature range for normal operating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

Power Management Overview

The product incorporates a wide range of monitorable power management features that are simple to implement with a minimum of external components. Additionally, the product includes protection features that continuously safeguard the load from damage due to unexpected system faults. A fault is also shown as an alert on the SALERT pin. The following product parameters can continuously be monitored by a host: Input voltage, output voltage/current, and internal temperature.

Monitoring parameters can be configured to provide alerts for specific conditions. Please contact your local Ericsson Power Modules representative for custom configurations.

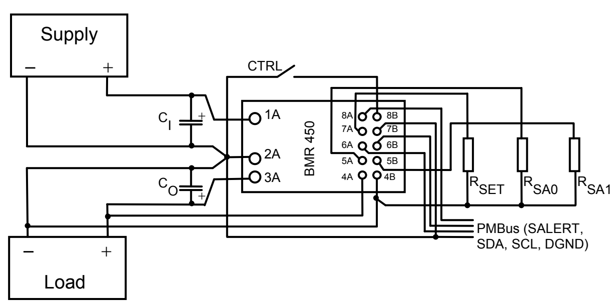
Connections



Pin layout, top view.

Pin	Designation	Function
1A	VIN	Input Voltage
2A	GND	Power Ground
3A	VOUT	Output Voltage
4A	+S	Plus sense
4B	−S	Minus sense
5A	SA0	Address pin 0
5B	SA1	Address pin 1
6A	SCL	PMBus Clock
6B	SDA	PMBus Data
7A	FLEX	Analog voltage adjust
7B	DGND	PMBus Ground
8A	SALERT	PMBus Alert
8B	CTRL	PMBus Control (Remote Control)

Typical Application Circuit



The resistors, R_{SA0} and R_{SA1}, are used for adressing, described in section Adressing.

PMBus Interface

The DC/DC regulators provide a PMBus digital interface that enables the user to monitor the input and output parameters. The products can be used with any standard 2-wire I^2C or SMBus host device. In addition, the device is compatible with PMBus version 1.1 and includes an SALERT line to help mitigate bandwidth limitations related to continuous fault monitoring.

Monitoring via PMBus

A system controller can monitor a wide variety of different parameters through the PMBus interface. The controller can monitor for fault condition by monitoring the SALERT pin, which will be asserted when any number of pre-configured fault or warning conditions occur. The system controller can also continuously monitor for any number of power conversion parameters including but not limited to the following:

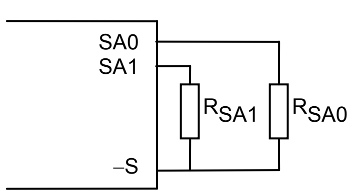
- Input voltage
- Output voltage
- Output current
- Internal junction temperature
- Switching frequency
- Duty cycle

Evaluation software

For the DC/DC regulators Ericsson provides an evaluation software, called CMM.
For more information please contact your local Ericsson sales representative.

Addressing

The PMBus address should be configured with resistors connected between SA0 and SA1 pin to the –S pin, as shown in the figure. Recommended resistor values for hard-wiring PMBus addresses (series E96, 1% tolerance resistors suggested) are shown in the table.



Schematic of connection of address resistors.

SA0/SA1 Index	R_{SA0}/R_{SA1} [kΩ]	SA0/SA1 Index	R_{SA0}/R_{SA1} [kΩ]
0	10	13	34.8
1	11	14	38.3
2	12.1	15	42.2
3	13.3	16	46.4
4	14.7	17	51.1
5	16.2	18	56.2
6	17.8	19	61.9
7	19.6	20	68.1
8	21.5	21	75
9	23.7	22	82.5
10	26.1	23	90.9
11	28.7	24	100
12	31.6		

The PMBus address follows the equation below:

PMBus Address = 25 x (SA1 index) + (SA0 index)

The user can theoretically configure up to 625 unique PMBus addresses, however the PMBus address range is inherently limited to 128. Therefore, the user should use index values 0 - 4 on the SA1 pin and the full range of index values on the SA0 pin, which will provide 125 device address combinations. The user shall also be aware of further limitations of the address space as stated in the SMBus Specification.

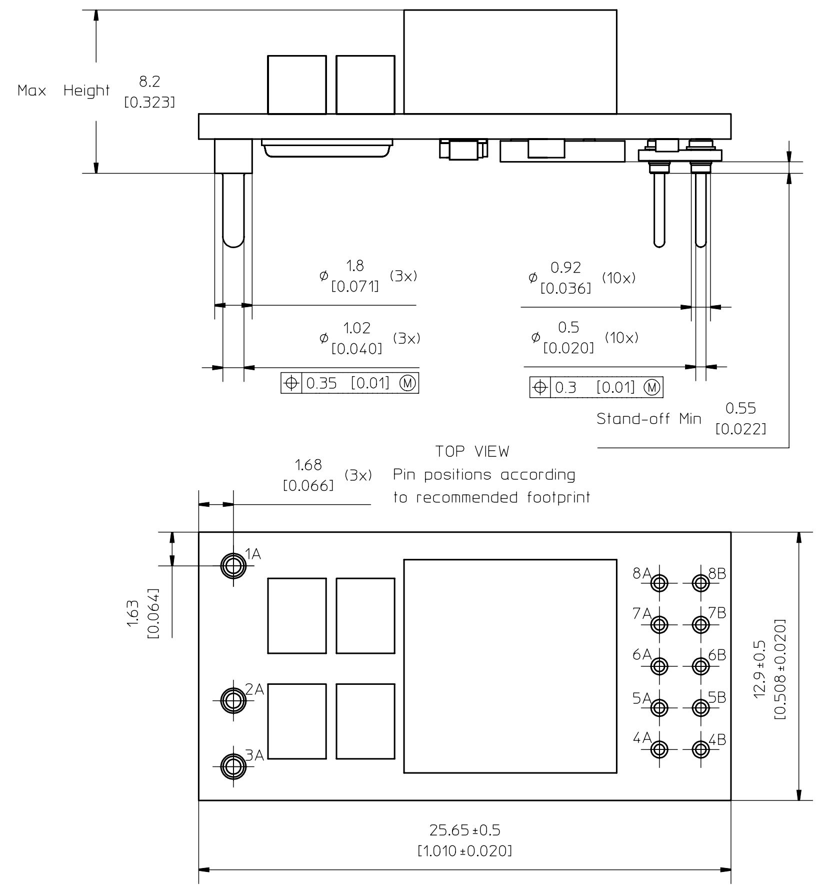
PMBus Read Commands

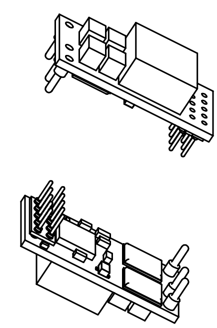
The DC/DC regulators are PMBus compliant. The following table lists the implemented read PMBus commands. For more detailed information see PMBus Power System Management Protocol Specification; Part I – General Requirements, Transport and Electrical Interface and PMBus Power System Management Protocol; Part II – Command Language.

Designation	Cmd	Impl
Standard PMBus Commands		
Status Commands		
CLEAR_FAULTS	03h	Yes
STATUS_BYTES	78h	Yes
STATUS_WORD	79h	Yes
STATUS_VOUT	7Ah	Yes
STATUS_IOUT	7Bh	Yes
STATUS_INPUT	7Ch	Yes
STATUS_TEMPERATURE	7Dh	Yes
Monitor Commands		
READ_VIN	88h	Yes
READ_VOUT	8Bh	Yes
READ_IOUT	8Ch	Yes
READ_TEMPERATURE_1	8Dh	Yes
READ_TEMPERATURE_2	8Eh	No
READ_FAN_SPEED_1	90h	No
READ_DUTY_CYCLE	94h	Yes
Identification Commands		
PMBUS_REVISION	98h	Yes
MFR_ID	99h	Yes
MFR_MODEL	9Ah	Yes
MFR_REVISION	9Bh	Yes
MFR_LOCATION	9Ch	Yes
MFR_DATE	9Dh	Yes
MFR_SERIAL	9Eh	Yes
Supervisory Commands		
RESTORE_DEFAULT_ALL	12h	No
RESTORE_USER_ALL	16h	No

Notes:
Cmd is short for Command.
Impl is short for Implemented.

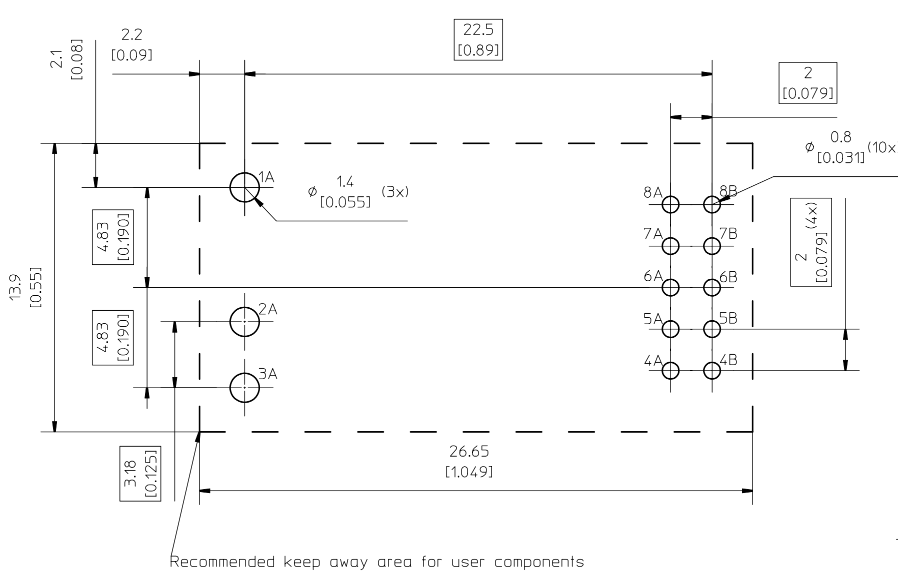
Mechanical Information – Hole Mount, Open Frame Version





PIN SPECIFICATIONS
Pin 1A-3A Material: Copper alloy
Plating: Min Matte tin 8-13 µm over 2.5-5 µm Ni.
Pin 4A-8B Material: Brass
Plating: Min Au 0.1 µm over 2 µm Ni.

RECOMMENDED FOOTPRINT - TOP VIEW



Weight: Typical 5.5g
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)

BMR 450 DC/DC Regulators, Input 4.5-14 V, Output 20 A/100 W	EN/LZT 146 400 R1C November 2008
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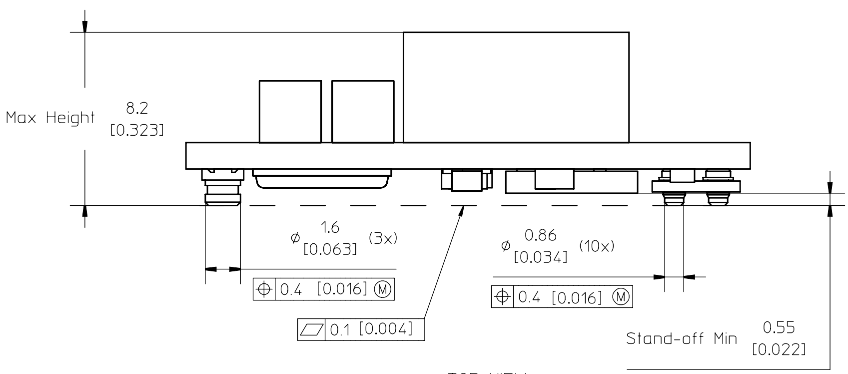
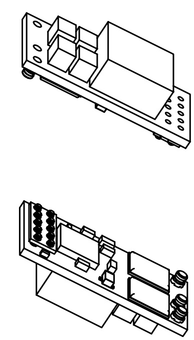
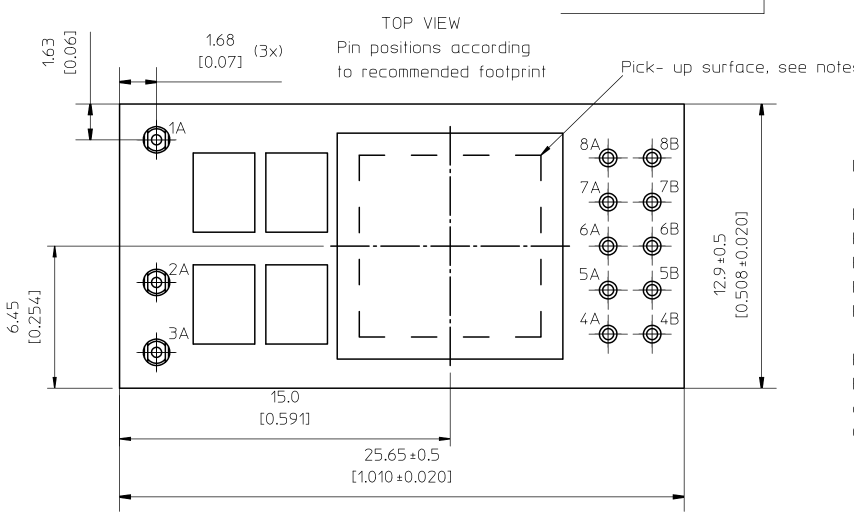
Mechanical Information – Surface Mount Version



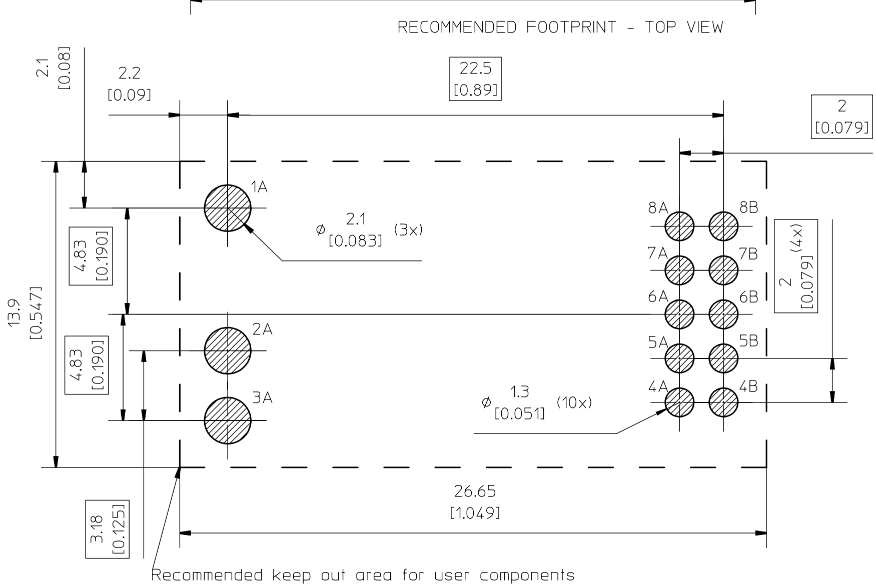




NOTES

PIN SPECIFICATIONS
Pin 1A-3A Material: Copper alloy
Plating: Au 0.1 µm over 1-3 µm Ni.
Pin 4A-8B Material: Brass
Plating: Au 0.1 µm over 2 µm Ni.

PICK-UP SURFACE
Recommended pick-up nozzle size for assigned pick-up area is maximum Ø8 [0.315].



Weight: Typical 5.5g
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)

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Soldering Information – Surface Mounting

The surface mount product is intended for forced convection or vapor phase reflow soldering in SnPb and Pb-free processes.

The reflow profile should be optimised to avoid excessive heating of the product. It is recommended to have a sufficiently extended preheat time to ensure an even temperature across the host PCB and it is also recommended to minimize the time in reflow.

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, since cleaning residues may affect long time reliability and isolation voltage.

Minimum Pin Temperature Recommendations

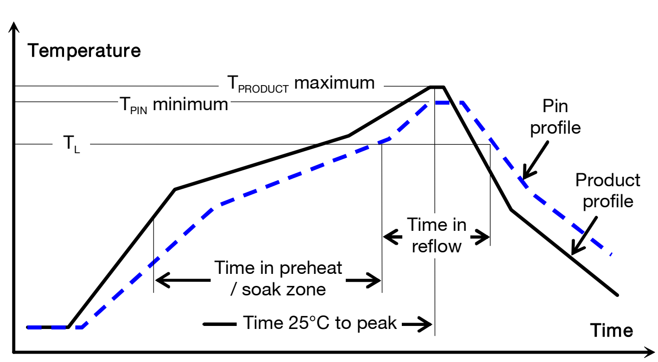
Pin number 2A is chosen as reference location for the minimum pin temperature recommendation since this will likely be the coolest solder joint during the reflow process.

SnPb solder processes

For SnPb solder processes, a pin temperature (T_{PIN}) in excess of the solder melting temperature, (T_L, 183°C for Sn63Pb37) for more than 30 seconds and a peak temperature of 210°C is recommended to ensure a reliable solder joint.

For dry packed products only: depending on the type of solder paste and flux system used on the host board, up to a recommended maximum temperature of 245°C could be used, if the products are kept in a controlled environment (dry pack handling and storage) prior to assembly.

General reflow process specifications		SnPb eutectic	Pb-free
Average ramp-up ($T_{PRODUCT}$)		3°C/s max	3°C/s max
Typical solder melting (liquidus) temperature	T_L	183°C	221°C
Minimum reflow time above T_L		30 s	30 s
Minimum pin temperature	T_{PIN}	210°C	235°C
Peak product temperature	$T_{PRODUCT}$	225°C	260°C
Average ramp-down ($T_{PRODUCT}$)		6°C/s max	6°C/s max
Maximum time 25°C to peak		6 minutes	8 minutes



Lead-free (Pb-free) solder processes

For Pb-free solder processes, a pin temperature (T_{PIN}) in excess of the solder melting temperature (T_L, 217 to 221°C for SnAgCu solder alloys) for more than 30 seconds and a peak temperature of 235°C on all solder joints is recommended to ensure a reliable solder joint.

Maximum Product Temperature Requirements

Top of the product PCB near pin 8B is chosen as reference location for the maximum (peak) allowed product temperature ($T_{PRODUCT}$) since this will likely be the warmest part of the product during the reflow process.

SnPb solder processes

For SnPb solder processes, the product is qualified for MSL 1 according to IPC/JEDEC standard J-STD-020C.

During reflow $T_{PRODUCT}$ must not exceed 225 °C at any time.

Pb-free solder processes

For Pb-free solder processes, the product is qualified for MSL 3 according to IPC/JEDEC standard J-STD-020C.

During reflow $T_{PRODUCT}$ must not exceed 260 °C at any time.

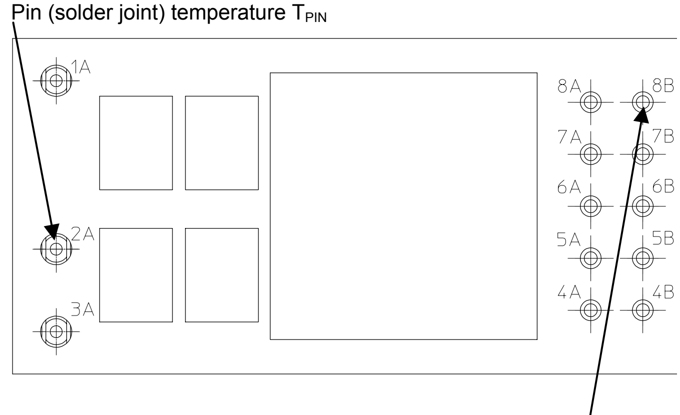
Dry Pack Information

Products intended for Pb-free reflow soldering processes are delivered in standard moisture barrier bags according to IPC/JEDEC standard J-STD-033 (Handling, packing, shipping and use of moisture/reflow sensitivity surface mount devices).

Using products in high temperature Pb-free soldering processes requires dry pack storage and handling. In case the products have been stored in an uncontrolled environment and no longer can be considered dry, the modules must be baked according to J-STD-033.

Thermocoupler Attachment

Pin 2A for measurement of minimum Pin (solder joint) temperature T_{PIN}



Pin 8B for measurement of maximum product temperature $T_{PRODUCT}$

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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.

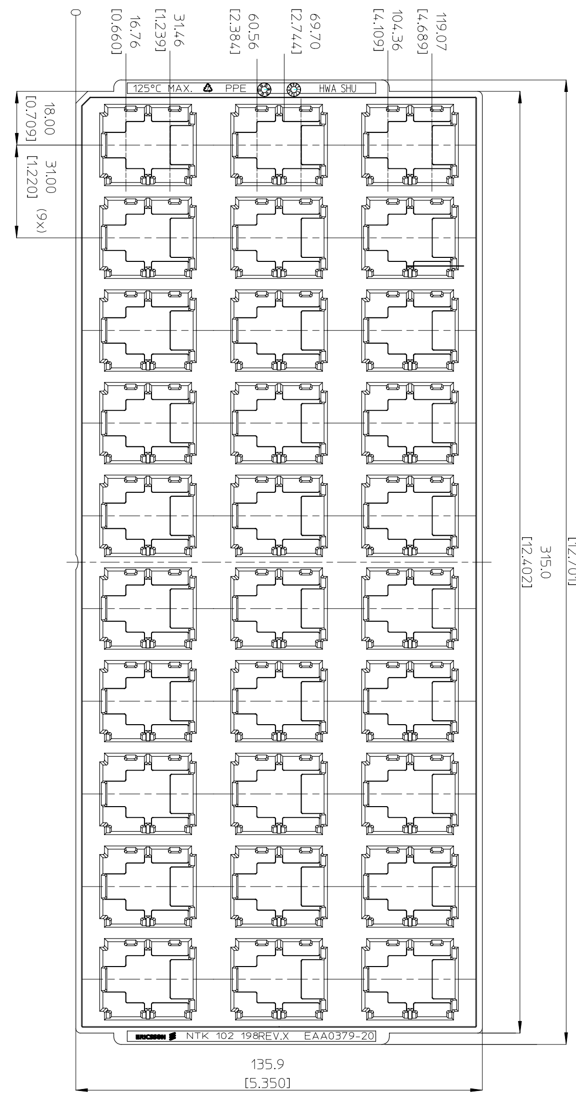
A maximum preheat rate of 4°C/s and maximum preheat temperature of 150°C is suggested. When soldering by hand, care should be taken to avoid direct contact between the hot soldering iron tip and the pins for more than a few seconds in order to prevent overheating.

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 injection molded trays (Jedec design guide 4.10D standard).

Tray Specifications	
Material	Antistatic PPE
Surface resistance	10^5 < Ohm/square < 10^{12}
Bakability	The trays can be baked at maximum 125°C for 48 hours
Tray thickness	14.50 mm 0.571 [inch]
Box capacity	300 products (5 full trays/box)
Tray weight	160 g empty, 490 g full tray



JEDEC standard tray for 6x10 = 60 products.
All dimensions in mm [inch]
Tolerances: X.x ±0.26 [0.01], X.xx ±0.13 [0.005]

Note: pick up positions refer to center of pocket.
See mechanical drawing for exact location on product.

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 Isopropyl alcohol	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 direction

Notes
[1] Only for products intended for reflow soldering (surface mount products)
[2] Only for products intended for wave soldering (plated through hole products)