

BMR313

Ultra-small Intermediate Bus Converter

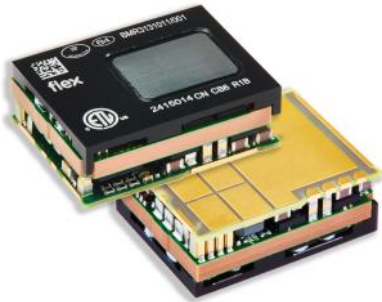
The BMR313 is a powerful and compact digital non-isolated, unregulated DC/DC converter designed to support Artificial Intelligence applications.

It can also be used for other high-power IBC requirements which have limited boardspace available.

The converter has a ratio conversion of 4:1 and provides 1000 W continuous power and has peak power capabilities of up to 3000 W.

This converter can deliver a power density of more than 900 W/cm³ or 15 kW/in³ when delivering peak power to the load.

This 48 to 12 V IBC solution also complements our VRM and PoL solutions used to further convert the 12 V intermediate bus to downstream core voltages.



Intertek

Key features

- Horizontal mounting non-isolated DC/DC converter
- High power density IBC up to 0.9 kW/cm³
- Ratio conversion 4:1, 1 kW continuously, 3 kW peak power
- Peak efficiency 97.2 %
- LGA industry standard footprint and pinout
- Optimized thermal design for cold wall mounting
- MTBF 7.43 million hours
- Meets safety requirements per IEC/EN/UL 62368-1
- PMBus configuration

Soldering methods

- Pb free SMD reflow

Key electrical information

Parameter	Values
Input range	38-60 V
Output voltage	9.5-15 V
Output current	80 A
Output power	1000 W
Peak power	3000 W

Mechanical

23.4 x 17.8 x 7.65 mm

Application areas

- Designed for AI applications

Product options

The table below describes the different product options.

Example: BMR313 1 01 1 /001 C							Definitions
Product family	BMR313						
Mech. solution		1					0 = Open frame 1 = Baseplate, LGA
Sequence number			01				01 = Input 38-60 V, Output 9.5-15 V, 1 kW continuously, 3 kW peak
Function				1			1 = Stacked module
Configuration code					/001		001 = Default config for Input 38-60 V, Output 9.5-15 V, 1 kW continuously, 3 kW peak
Packaging options						C	C = Antistatic tape and reel package

For more information, please refer to Part 3 [Mechanical information](#).

If you do not find the variant you are looking for, please contact us at [Flex Power Modules](#).

Order number examples

Part number	V _{in}	Output	Configuration
BMR3131011/001C	38-60 V	9.5-15 V / 80 A / 1000 W	Baseplate / stacked module / antistatic tape and reel package

Part 1: Electrical specifications

Absolute maximum ratings

Stress in excess of our defined *absolute maximum ratings* may cause permanent damage to the converter. Absolute maximum ratings, also referred to as *non-destructive limits*, are normally tested with one parameter at a time exceeding the limits in the electrical specification.

Characteristics	min	max	Unit
Operating temperature (T_{P1})	-20	125	°C
Storage temperature	-40	125	°C
Input voltage (V_{in}) continuous operation	-0.3	60	V
Input voltage transient	-0.3	68	V
C_{out}	0.1	6	mF
Signal I/O voltage (EN, PG, ALERT, ADDR, SCL, SDA)	-0.3	7	V

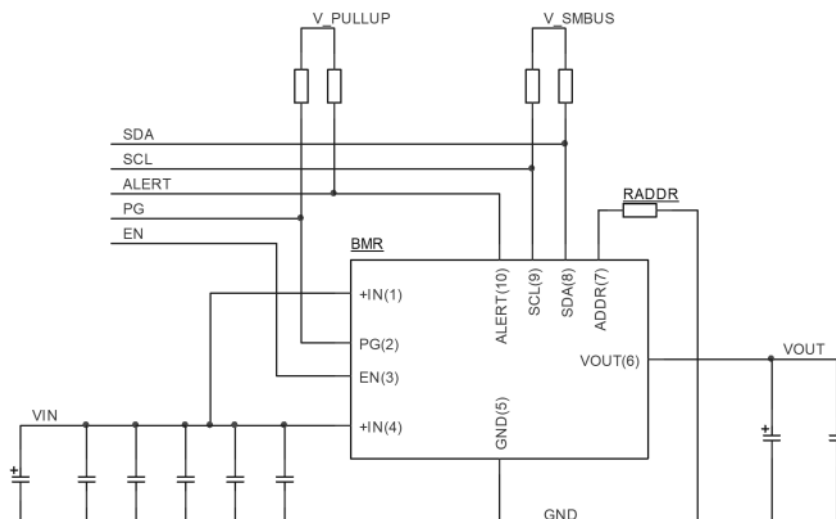
Reliability

The failure rate (λ) and mean time between failures (MTBF= $1/\lambda$) is calculated at max output power and an operating ambient temperature (T_A) of +40 °C. Flex Power Modules uses Telcordia SR-332 Issue 4 Method 1 to calculate the mean steady-state failure rate and standard deviation (σ). Telcordia SR-332 Issue 4 also provides techniques to estimate the upper confidence levels of failure rates based on the mean and standard deviation.

	Mean	90% confidence level	Unit
Steady-state failure rate (λ)	135	169	nfailures/h
Standard deviation (σ)	27.2		nfailures/h
MTBF	7.4	5.9	MHr

Typical application diagram

Capacitor values are defined in the Electrical Specification tables. The EMI filter is defined in the [EMC Part 2](#).



Electrical specifications for BMR3131011/001**13.5 V, 80 A (220 A peak) / 1000 W (3000 W peak)**

Min and max values are valid for: $T_{P1} = -20$ to $+95$ °C, $V_{in} = 38$ to 60 V, $I_{out} = 80$ A, unless otherwise specified under conditions. Typical values given at: $T_{P1} = +25$ °C, $V_{in} = 54$ V, max P_{out_TDP} , unless otherwise specified under conditions, see *Note 1*.

Additional external $C_{in} = 470$ μ F + 2 x 2.2 μ F ceramic, $C_{out} = 2$ x 470 μ F

Characteristic	conditions	minimum	typical	maximum	unit
Key features					
Efficiency (η)	Peak		97.2		%
	100 % of P_{out_TDP}		96.4		%
	50 % of P_{out_TDP} $V_{in} = 48$ V		97.1		%
	100 % of P_{out_TDP} $V_{in} = 48$ V		96.0		%
P_{out_TDP} thermal design power (TDP)	See Note 1		1000		W
P_{out_MAX} peak power ($t \leq 0.25$ s)	See Note 1		3000		W
Power dissipation	100 % of P_{out_TDP}		39.7		W
Switching frequency (f_s)	0-100 % of P_{out_TDP}		1250		kHz
Recommended capacitive load		40	470	6000	μ F
Input characteristics					
Input voltage range (V_{in})		38		60	V
Input idling power	$P_{out} = 0$ W		7.1		W
Input standby power	(turned off with EN)		580		mW
Input OVP				68	V
Internal input capacitance			14.4		μ F
Recommended external input capacitance	See Note 2	100	150		μ F

Note 1: Max. output current is rated at 220 A. Max power is ≤ 3000 W and continuous power (thermal design power TDP) is ≤ 1000 W depending on thermal conditions.

*Note 2: Typical value (recommended) is 100 μ F + 5*10 μ F*

Electrical specifications for BMR3131011/001**13.5 V, 80 A (220 A peak) / 1000 W (3000 W peak)**

Min and max values are valid for: $T_{P1} = -20$ to $+95$ °C, $V_{in} = 38$ to 60 V, $I_{out} = 80$ A, unless otherwise specified under conditions. Typical values given at: $T_{P1} = +25$ °C, $V_{in} = 54$ V, max P_{out_TDP} , unless otherwise specified under conditions, see *Note 1*.

Additional external $C_{in} = 470$ μ F + 2 x 2.2 μ F ceramic, $C_{out} = 2$ x 470 μ F

Characteristic	conditions	minimum	typical	maximum	unit
Output characteristics					
Output voltage	$P_{out} = 0$ W		13.55		V
Output voltage	Disabled, no load		2.7		V
Output voltage	Disabled, 1 k Ω load		0.15		V
Output current (I_{out})	$V_{in} = 38 - 60$ V, PG asserted		80	220	A
Output current (I_{out})	Before PG, $V_{in} = 54$ V, $C_{out} = 1.0$ mF, Note 2			30	A
Output current (I_{out})	Before PG, $V_{in} = 38$ V, $C_{out} = 6$ mF, Note 2			10	A
Output voltage droop	I_{out} step from 0 to 80 A		420		mV
Output ripple & noise	20 MHz BW, see Note 3		26		mV _{p-p}
Internal output capacitance	$V_{out} = 0$ V			140	μ F
On/off control					
Initialization Time	From $V_{in} > 8.5$ V to ready to be enabled		31		ms
Turn-off input voltage	Decreasing input voltage		32		V
Turn-on input voltage	Increasing input voltage		37		V
On Delay Time	From EN asserted to ramp start		0		ms
Ramp-up time	From 10% to 90% of V_{out} , $I_{out} = 0$ A		2.5		ms
Start-up time	from V_{in} connection to 90% of V_{out}		36		ms
Enable start-up time	From EN asserted to 100% of V_{out} , $I_{out} = 0$ A		5.2		ms
Logic high: trigger level	EN pin	0.7			V
Logic low: trigger level	EN pin			0.6	V
Source current	EN pin (Internal pull up)			0	μ A
Sink current	EN pin			90	μ A

Note 1: Max. output current is rated at 220 A. Max power is ≤ 3000 W and continuous power (thermal design power (TDP)) is ≤ 1000 W depending on thermal conditions).

Note 2: Resistive load. The output current value is evaluated after PG. For example, max resistive load before PG at $V_{in} = 38$ V, $C_{out} = 6$ mF is a load that gives 10 A current at $V_{out} = V_{in} / 4 = 9.5$ V

Note 3: See Technical Reference: Application and design considerations.

Electrical specifications for BMR3131011/001**13.5 V, 80 A (220 A peak) / 1000 W (3000 W peak)**

Characteristic	conditions	minimum	typical	maximum	unit
Protection features					
Input Under Voltage fault limit (IUVP)	Latch (0x80)		32		V
Input Over Voltage fault limit (IOVP)	Latch (0x80)		68		V
Output undervoltage fault limit (UVP)	Latch (0x80)		7.5		V
Output undervoltage warning limit			8.5		V
Output overvoltage fault limit (OVP)	Latch (0x80)		17		V
Output overvoltage warning limit			15.5		V
Over temperature fault limit (OTP)	Latch (0x80)		130		°C
Over temperature warning limit			120		°C
Over Current Protection (OCP) See Note 1	Comparator OCP threshold	250	300		A
	Comparator OCP response time			1	µs
	Average OCP, IOUT_OC_FAULT_LIMIT	190	240		A
	Timed OCP, IOUT_OC_WARN_LIMIT	120	150		A
	Timed OCP response time		88		ms
	Timed OCP response time set point accuracy		0.55		ms
Short circuit output current	T _{P1} = 25 °C, start against short			6.5	A
Protection response time (IUVP, IOVP, UVP, OVP, OTP, Average OCP)	See Note 2	0.75		1	ms

Note 1: Response time = transient duration required to trig an OCP fault. See section Over Current Protection in "Technical Reference: Application and design considerations" for a detailed description of the OCP functionality.

Note 2: The threshold is compared against a moving average value of four samples with 0.25 ms sampling interval. In addition, up to 0.3 ms may pass after a fault is triggered before switching stops.

Electrical specifications for BMR3131011/001**13.5 V, 80 A (220 A peak) / 1000 W (3000 W peak)**

Characteristic	conditions	minimum	typical	maximum	unit
Monitoring & Control					
UVLO _{VI} - Under Voltage Lock-Out	V _{in} rising threshold		8.5		V
	Hysteresis		2.5		V
Power Good Delay Time	From V _{out} = 100 % to PG asserted		0.8		ms
Power Good Threshold	Low to high transition		100		% V _{out}
	High to low transition, Note 1				
V _{IL} - Logic input low	SCL, SDA			0.8	V
V _{IH} - Logic input high	SCL, SDA	1.35			V
V _{OL} - Logic output low	SDA, ALERT, PG			65	mV
I _{OL} - Logic output low sink current	SDA, ALERT, PG			5	mA
I _{LEAK} - Logic leakage current	SDA, SCL, ALERT, PG			10	µA
C _{L_PIN} - Logic input capacitance	SDA, SCL, EN		10		pF
f _{SMB} - SMBus Operating frequency		10		400	kHz
EN - Enable	See page 5 "On/Off control"				

Note 1: Power Good is deasserted when the output voltage is disabled, regardless of the output voltage level.

In the table below all PMBus commands are written in capital letters.

T_{P1} = -20 to + 95 °C, V_{in} = 38 to 60 V, unless otherwise specified under conditions.

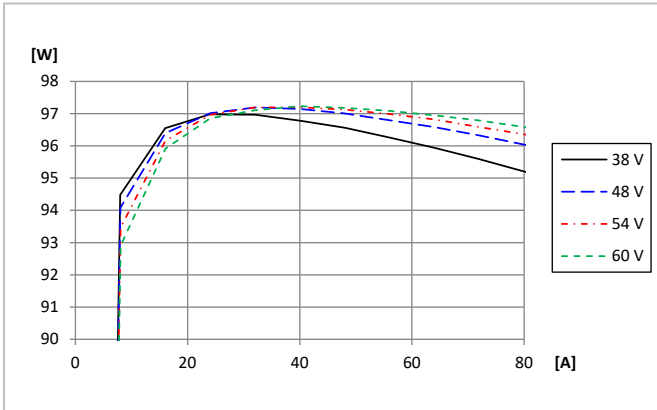
Typical values given at: T_{P1} = +25 °C, V_{in} = 54 V, max P_{out_TDP}, unless otherwise specified under conditions

For more detailed information please refer to Technical Reference Document: PMBus commands. This product is supported by the [Flex Power Designer tool](#).

Command	Conditions	minimum	typical	maximum	Unit
Monitoring accuracy					
Input voltage READ_VIN			±1		%
Output voltage READ_VOUT			±2		%
Output current READ_IOUT	V _{in} = 54 V, I _{out} = 80 A		±5		%
Temperature READ_TEMPERATURE_1	T ≥ 25 °C		±3		°C

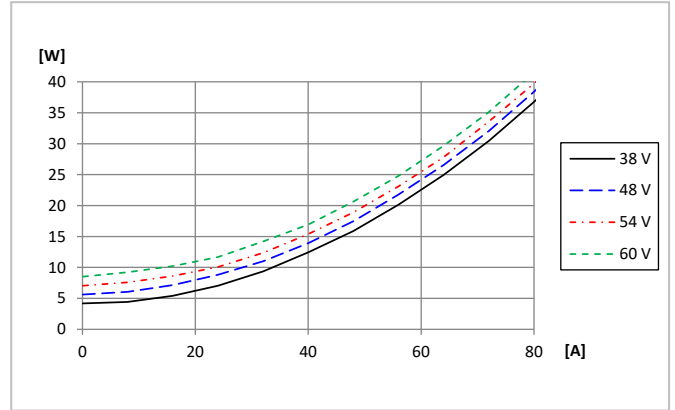
Electrical graphs for BMR3131011/001
13.5 V, 80 A (220 A peak) / 1000 W (3000 W peak)

Efficiency



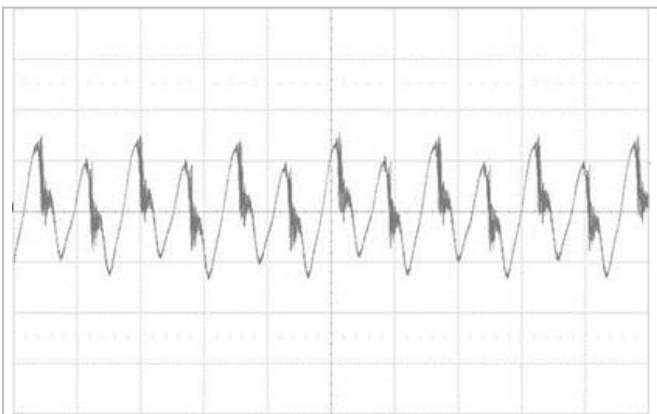
Efficiency vs. output power and input voltage at $T_{PI} = +25\text{ }^{\circ}\text{C}$.

Power dissipation



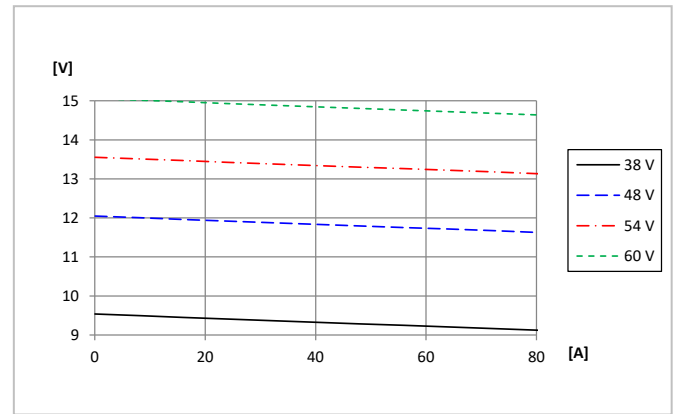
Dissipated power vs. load power at $T_{PI} = +25\text{ }^{\circ}\text{C}$.

Output Ripple and Noise



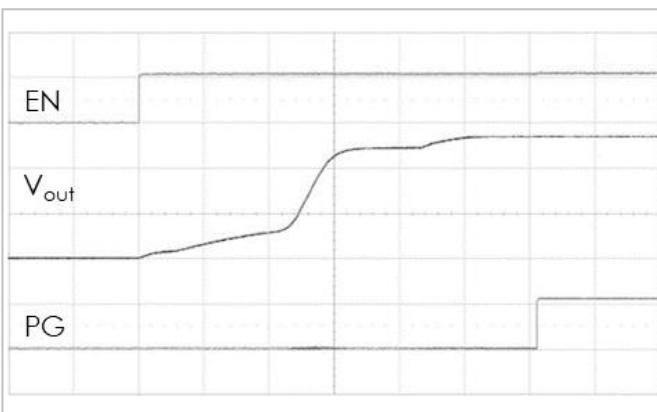
$V_{in} = 54\text{ V}$, $I_{out} = 80\text{ A}$, 20 MHz BW. Scale 10 mV/div, 500 ns/div.

Output voltage droop



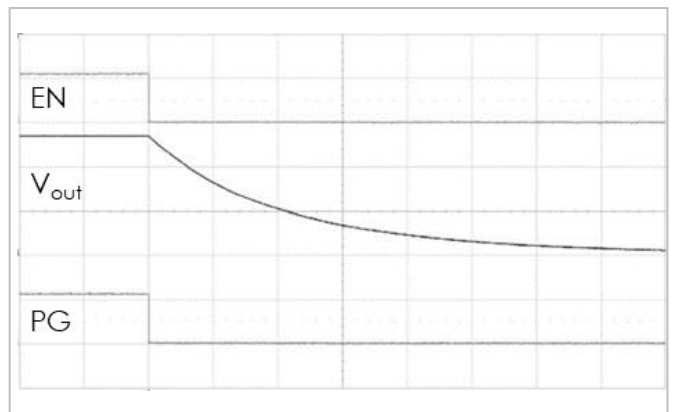
Output voltage vs output current.

Startup



Output enabled by EN pin. $V_{in} = 54\text{ V}$, $I_{out} = 1\text{ A}$
Scale from top: 2, 5, 2 V/div, 1 ms/div.

Shutdown

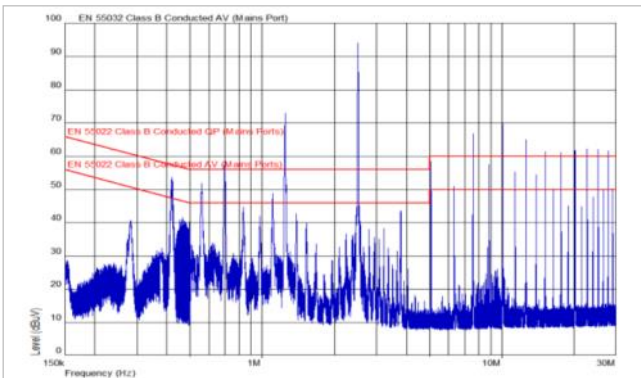


Output disabled by EN pin. $V_{in} = 54\text{ V}$, $I_{out} = 1\text{ A}$
Scale from top: 2, 5, 2 V/div, 5 ms/div.

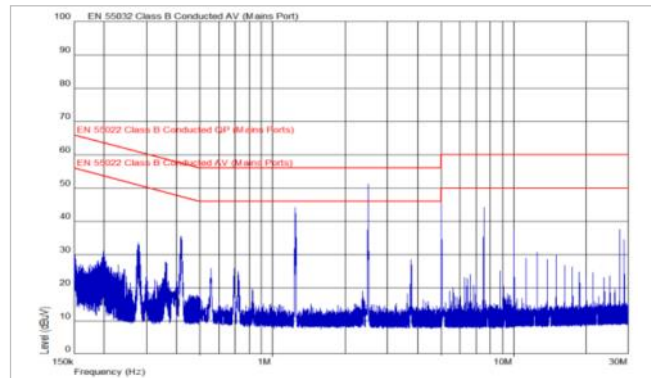
Part 2: EMC

EMC specifications

Conducted EMI measured according to EN55022 / EN55032, CISPR 22 / CISPR 32 and FCC part 15J (see test set-up below). The fundamental switching frequency is 1.25 MHz for BMR313. The EMI characteristics below is measured at $V_{in} = 54\text{ V}$ and max I_{out} .



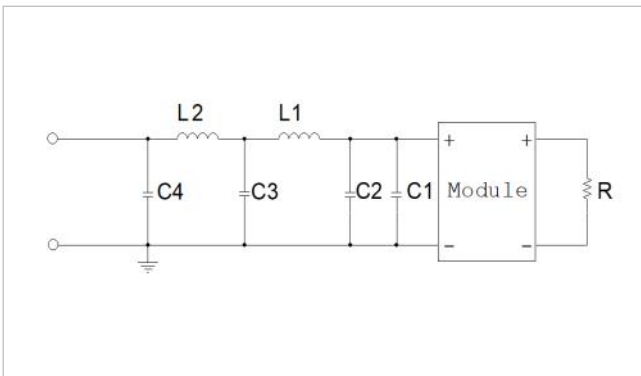
EMI without filter. (Blue graph = QP values)



EMI with an optional external filter, EN55032. Test method and limits are the same as EN55022. (Blue graph = QP values)

Optional external filter for Class B

Suggested external input filter in order to meet Class B in EN 55022 / EN 55032, CISPR 22 / CISPR 32 and FCC part 15J.



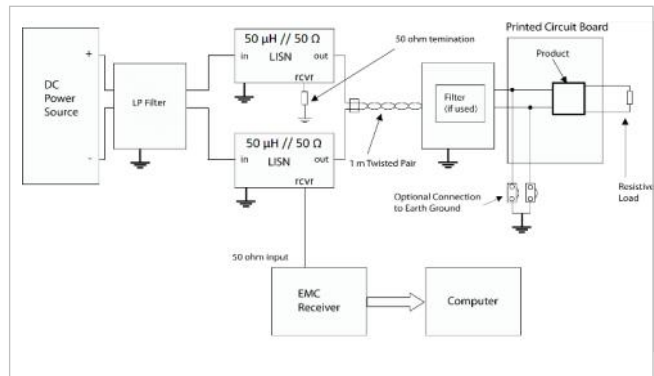
Filter components:

$C1 = 2 \times 2.2\ \mu\text{F} + 100\ \mu\text{F}$ (Oscon)

$C2 = 5 \times 10\ \mu\text{F}$

$C3 = 5 \times 10\ \mu\text{F}$ $L1 = 100\ \text{nH}$

$C4, L2$ not populated.



Test set-up

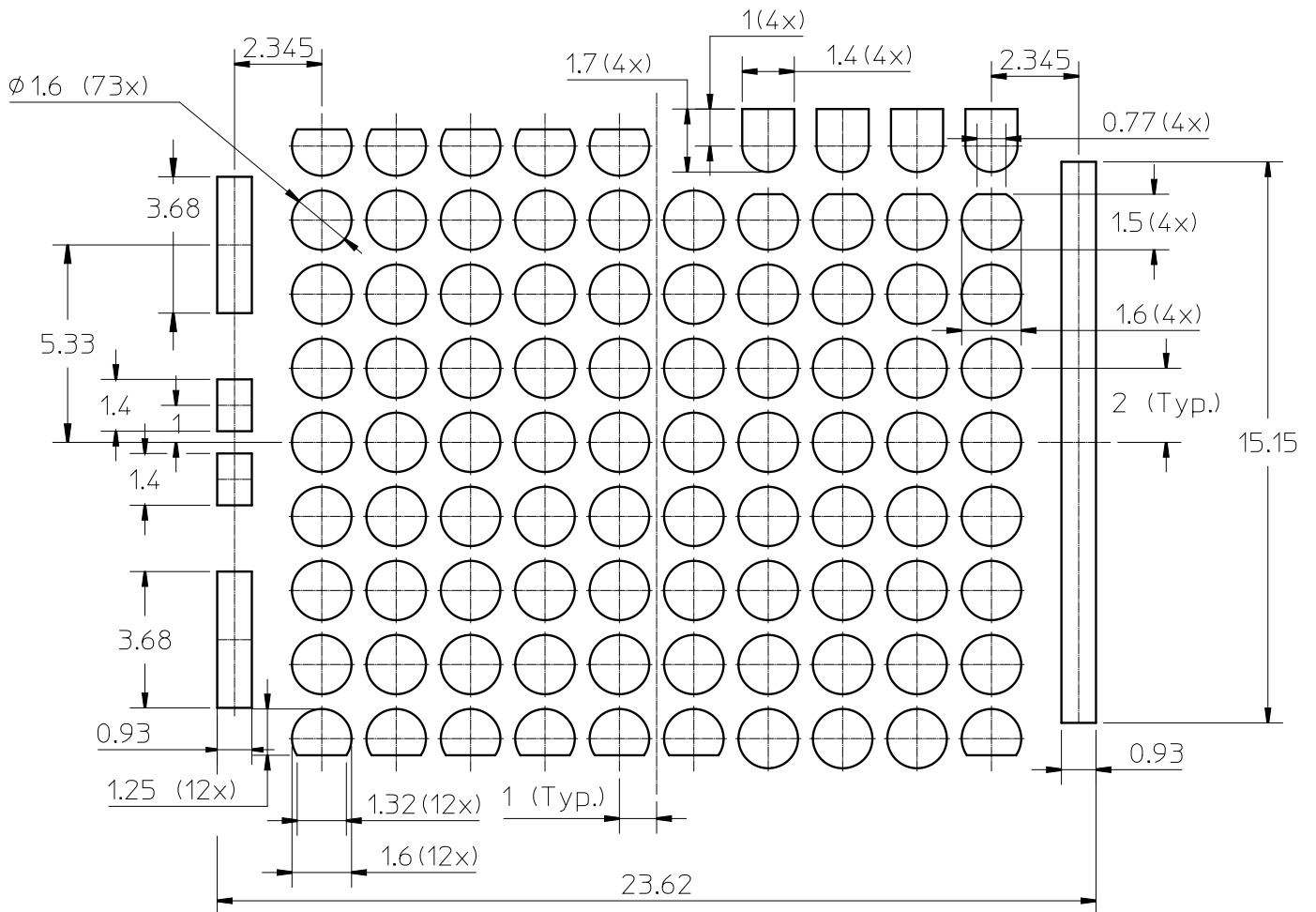
Layout recommendations

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.

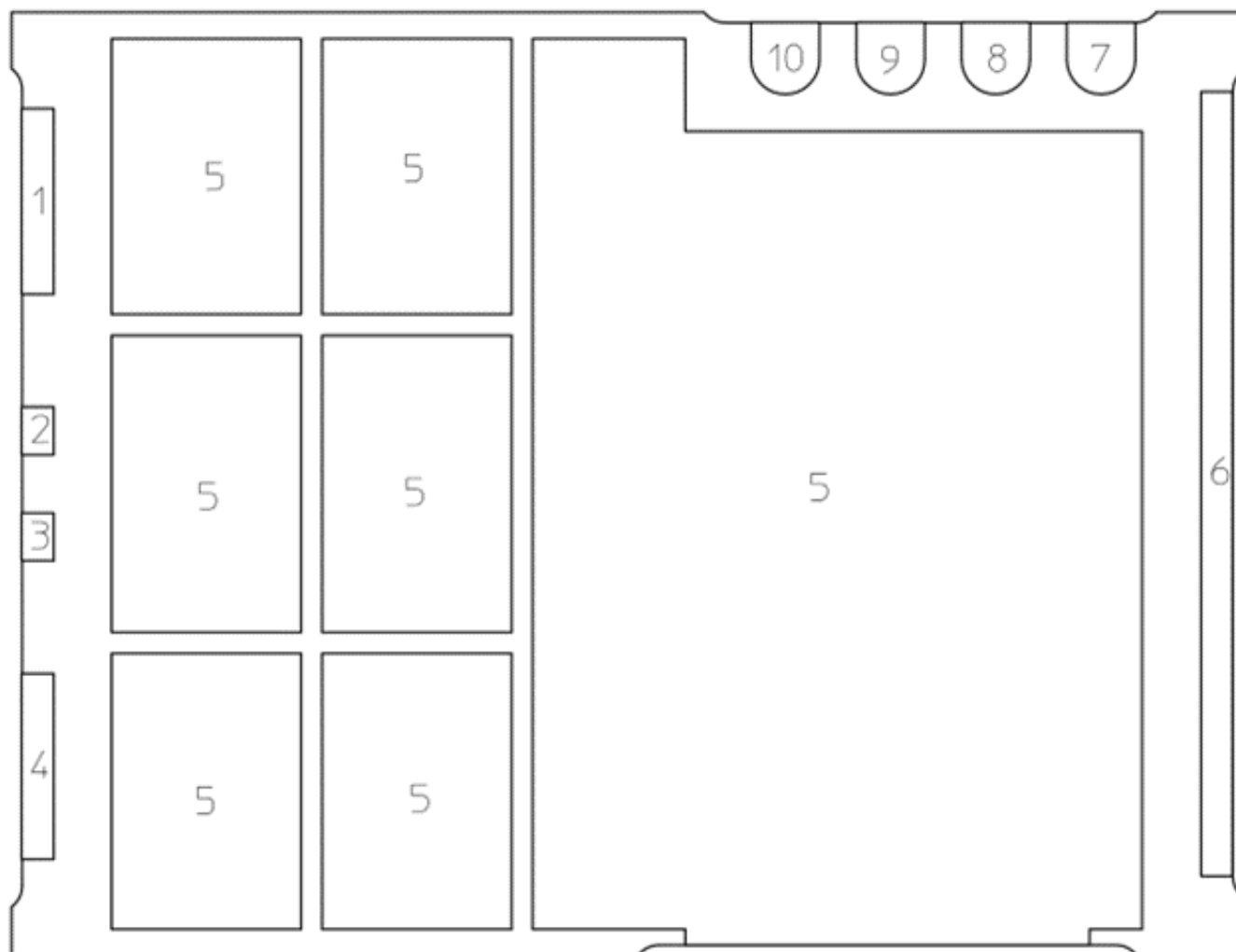
BMR3131011/001: SMD mounted, baseplate version

The mechanical information is based on a module which is SMD mounted and has a baseplate.

Recommended footprint top view through the product



TOP VIEW - Pin-out description and pin positions



Pin	Designation	Type	Function
1	+IN	Power	Input voltage
2	PG	Open Drain	Power good, active high
3	EN	Input	Enable, active high
4	+IN	Power	Input voltage
5	GND	Power	Power ground
6	VOOUT	Power	Output voltage
7	ADDR	Input	PMBus address pin strap
8	SDA	Input/Output	PMBus data
9	SCL	Input	PMBus clock
10	ALERT	Open Drain	Alert signal, active low. Asserted when an over current warning condition or an over temperature warning condition occurs. Can be connected to GND if unused.

Part 4: Thermal considerations

Thermal considerations

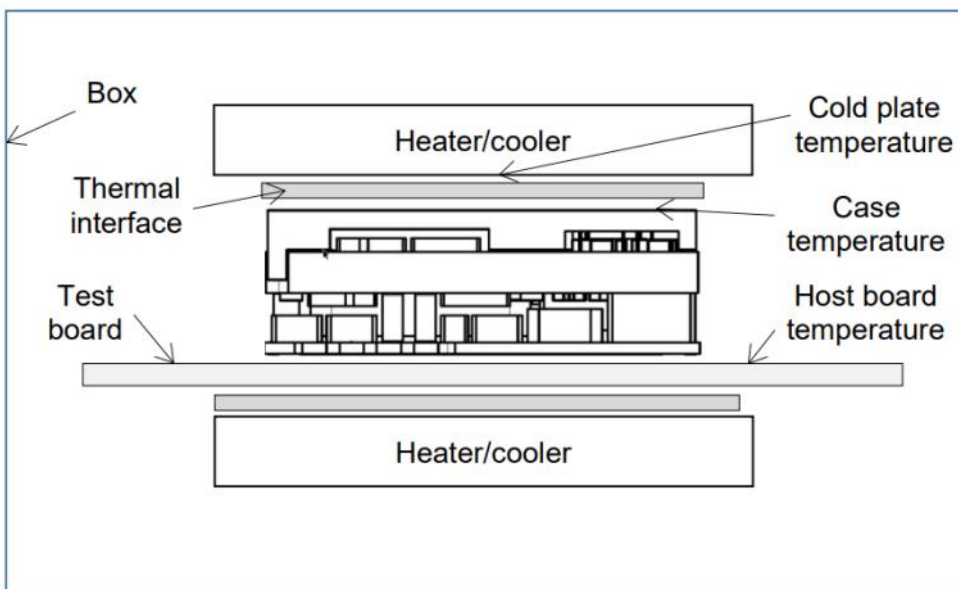
General

The product is designed with power switches on top to operate with top side cooling towards a heat sink or a cold plate. This is required to handle operation with high load. Cooling is also achieved by conduction to the host board and surrounding air. Sufficient cooling must be provided to ensure reliable operation.

The Output Current Derating graph found in the Electrical Specification section provides the available output current versus case temperature and host board temperature.

Test Setup – Cold Plate

The product is tested in a box with two heater/cooler; one as a cold plate to control the temperature at the top of the product, another on the bottom side of the test board to control the host board temperature. The test board used is 130 x 160 mm in size with 1.6 mm thickness and 6 layers of 3 oz.



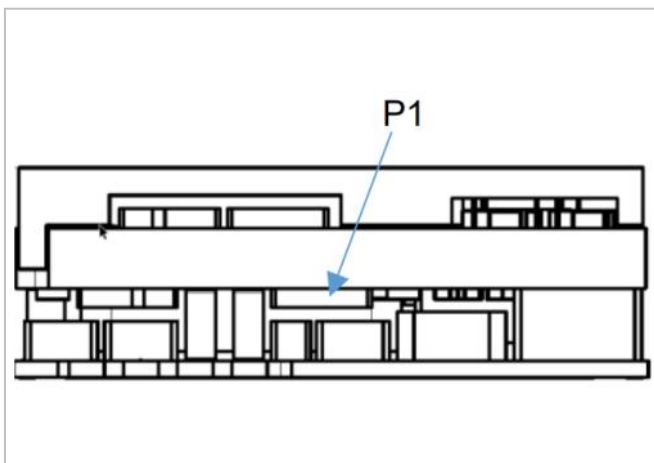
Test set-up: Cold plate

Definition of product operating temperature

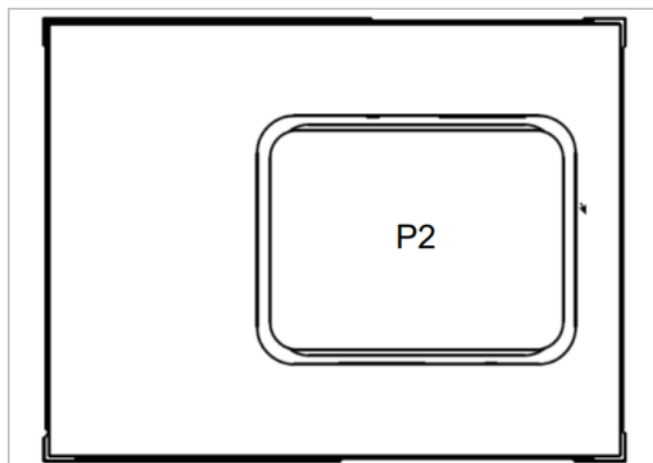
The product operating temperatures are used to monitor the temperature of the product, and proper thermal conditions can be verified by measuring the temperature at positions P1, P2. The temperature at these positions (T_{P1} , T_{P2}) should not exceed the maximum temperatures in the table below. The number of measurement points may vary with different thermal design and topology. Temperatures above maximum are not allowed and may cause permanent damage.

Position	Description	Max. Temp.
P1	MOSFET case	$T_{P1} = 125\text{ °C}$
P2	Magnetic core	$T_{P2} = 125\text{ °C}$

Side view

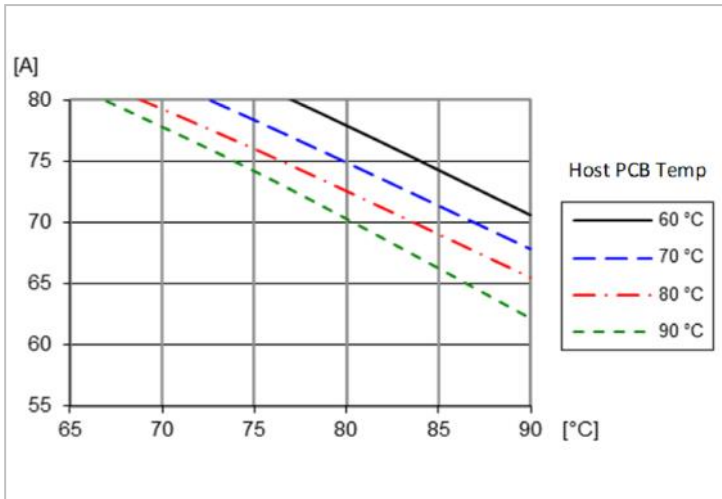


Bottom view



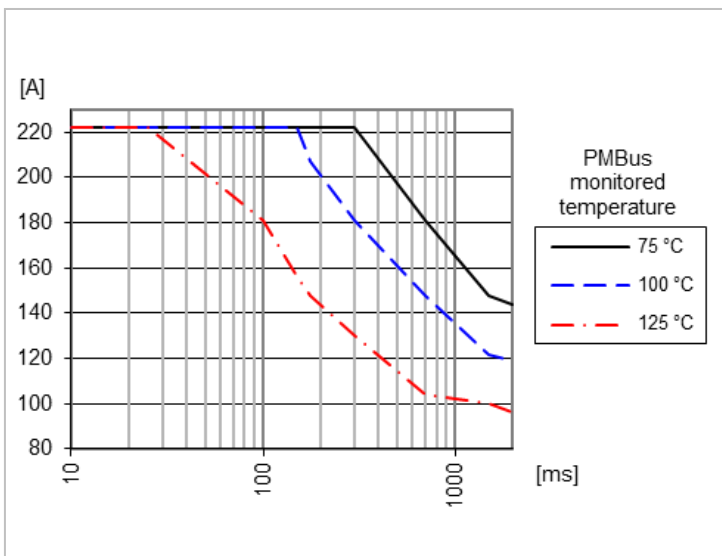
Thermal graphs

Output current derating



Max average output current vs. cold plate temperature (x-axis) and host board temperature. Thermal interface gap pad 1.0 mm, 8 W/mK.

Peak current capability



Max peak output current vs pulse duration and PMBus monitored temperature when pulse starts. Initial $I_{out} = 80$ A. Limit given by max internal junction temperature (150 °C) of hotspot component.

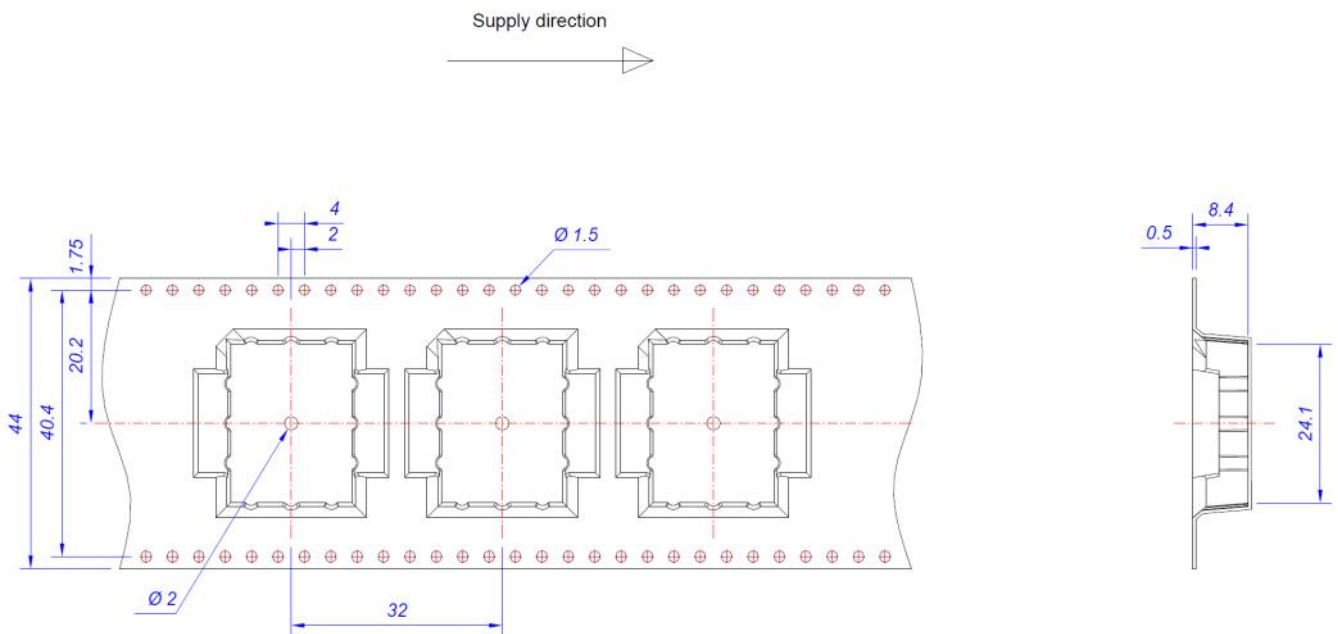
For more information, please refer to our [thermal models](#) on the website.

Part 5: Packaging

Packaging information

The products are delivered in antistatic carrier tape (EIA 481 standard).

Carrier Tape Specifications	
Material	PS, Antistatic
Surface resistance	$< 10^7 \Omega/\text{square}$
Bakability	The tape is not bakeable
Tape width, W	44 mm [1.73 inch]
Pocket pitch, P1	32 mm [1.26 inch]
Pocket depth, K0	8.4 mm [0.33 inch]
Reel diameter	330 mm [13.0 inch]
Reel capacity	180 products /reel
Reel weight	2400 g/full reel



Part 6: Revision history**Revision table**

Revision number	revision change	date	revisor
Rev. A	New document	2023-12-21	KARFWAHL
Rev. B	Mechanical drawing Top View Bottom board updated	2024-02-14	KARFWAHL
Rev. C	Clarified Output current derating diagram text Footprint drawing updated	2024-02-21	KARFWAHL
Rev. D	Update of image page 1	2024-07-02	KARTWAER
Rev. E	Corrected typos in Product options and Order number	2024-10-08	JIDGEZOU

© Flex Power Modules 2024

The information and specifications in this document is believed to be correct at the time of publication. However, no liability is accepted for inaccuracies, printing errors or for any consequences thereof. Flex reserves the right to change the contents of this document at any time without prior notice.

flex[®]

Flex Power Modules, a business line of Flex, is a leading manufacturer and solution provider of scalable DC/DC converter primarily serving the data processing, communications, industrial and transportation markets. Offering a wide range of both isolated and non-isolated solutions, its digitally-enabled DC/DC converters include PMBus compatibility supported by the powerful [Flex Power Designer](#).

