# 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 then 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.

### 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 | | Definitions |
|---|---|---|---|---|---|---|---|
| **Product family** | BMR313 | | | | | | |
| **Mech. solution** | | 1 | | | | | 0 = Open frame<br>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 = 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 |
|---|---|---|---|
| BMR3131011/001 | 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 ($V_{in}$) continious 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 |

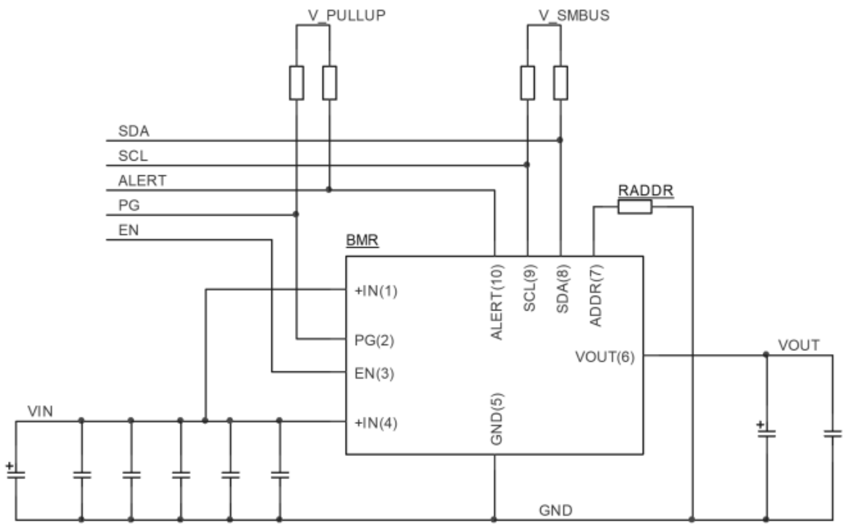
## Reliability

The failure rate (λ) and mean time between failures (MTBF= 1/λ) 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 µF + 2 x 2.2 µF ceramic, $C_{out}$ = 2 x 470 µF

| Characteristic | conditions | minimum | typical | maximum | unit |
|---|---|---|---|---|---|
| **Key features** | | | | | |
| Efficiency (η) | Peak | | 97.2 | | % |
| | 100 % of $P_{out\_TDP}$ | | 96.4 | | % |
| | 50 % of $P_{out\_TDP}$<br>$V_{in}$ = 48 V | | 97.1 | | % |
| | 100 % of $P_{out\_TDP}$<br>$V_{in}$ = 48 V | | 96.0 | | % |
| $P_{out\_TDP}$ thermal design power (TDP) | See Note 1 | | 1000 | | W |
| $P_{out\_MAX}$ peak power (t ≤ 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 | µF |
| **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 | | µF |
| Recommended external input capacitance | See Note 2 | 100 | 150 | | µF |

*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 µF + 5*10 µF*

## 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 µF + 2 x 2.2 µF ceramic, $C_{out}$ = 2 x 470 µF

| 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 kΩ 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 | $V_{out}$ = 0V | | | 140 | µF |
| **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 | µA |
| Sink current | EN pin | | | 90 | µA |

*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)<br>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 trigged 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 |
| $V_{IL}$- 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 |
| $C_{I\_PIN}$ - 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

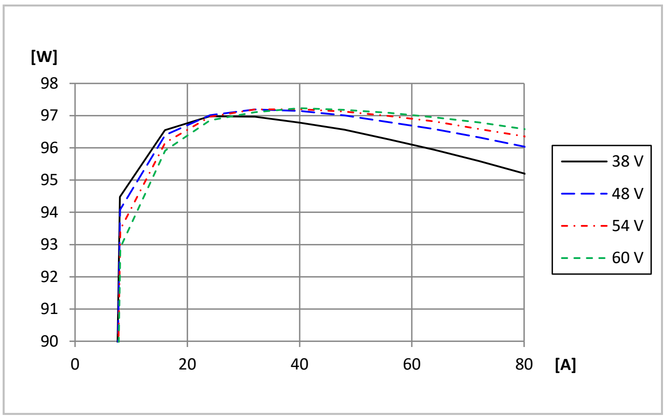
For more detailed information please refer to Technical Reference Document: PMBus commands. This product is supported by the Flex Power Designer tool.

| Command | Conditions | minimum | typical | maximum | Unit |
|---|---|---|---|---|---|
| **Monitoring accuracy** | | | | | |
| Input voltage<br>READ_VIN | | | ±1 | | % |
| Output voltage<br>READ_VOUT | | | ±2 | | % |
| Output current<br>READ_IOUT | $V_{in}$ = 54 V, $I_{out}$ = 80 A | | ±5 | | % |
| Temperature<br>READ_TEMPERATURE_1 | T ≥ 25 °C | | ±3 | | °C |

## Electrical graphs for BMR3131011/001

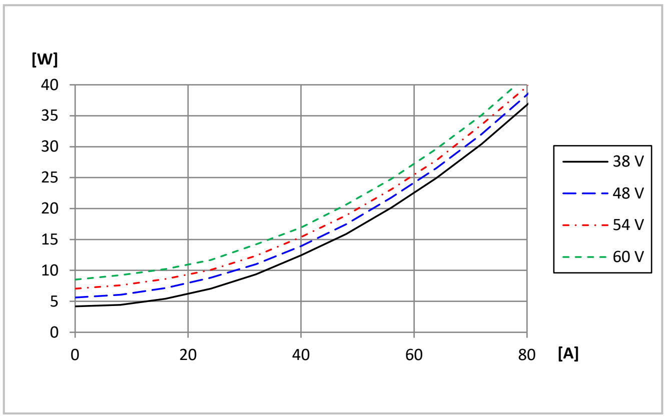
**13.5 V, 80 A (220 A peak) / 1000 W (3000 W peak)**

### Efficiency



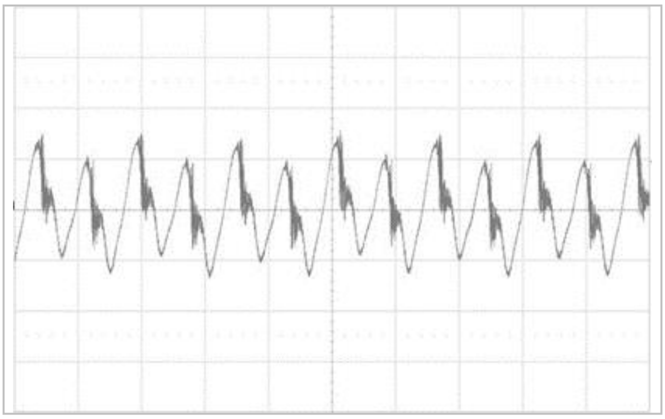

*Efficiency vs. output power and input voltage at $T_{P1}$ = +25 °C.*

### Power dissipation



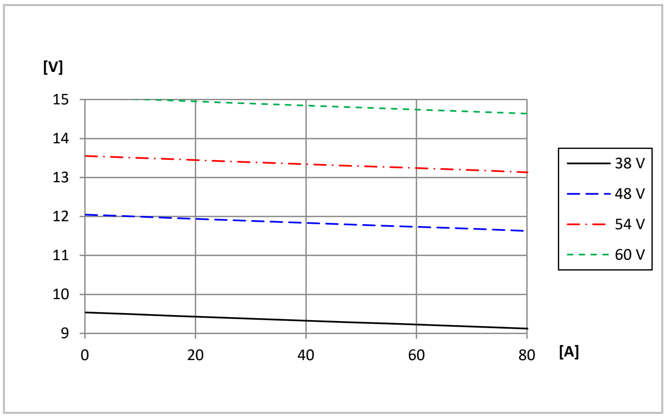

*Dissipated power vs. load power at $T_{P1}$ = +25 °C.*

### Output Ripple and Noise



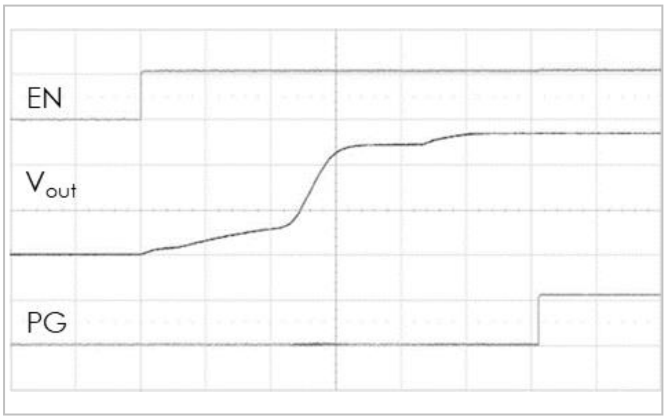
*$V_{in}$ = 54 V, $I_{out}$ = 80 A, 20 MHz BW. Scale 10 mV/div, 500 ns/div.*

### Output voltage droop



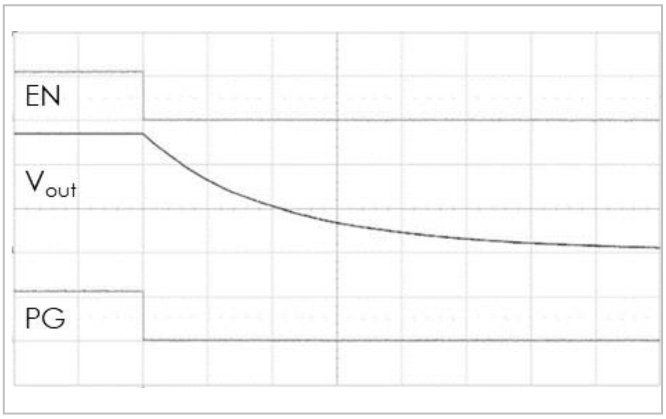

*Output voltage vs output current.*

### Startup




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

### Shutdown

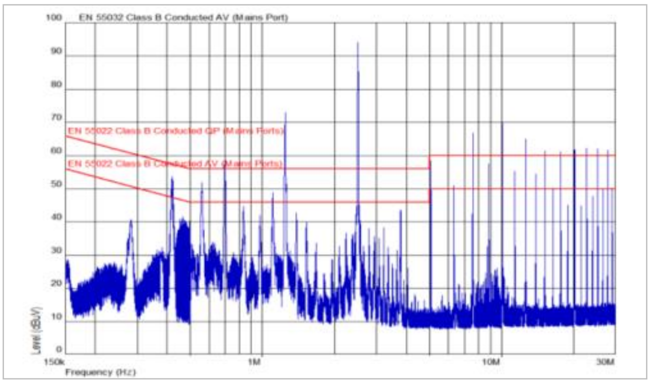



*Output disabled by EN pin. $V_{in}$ = 54 V, $I_{out}$ = 1 A*
*Scale from top: 2, 5, 2 V/div, 5 ms/div.*

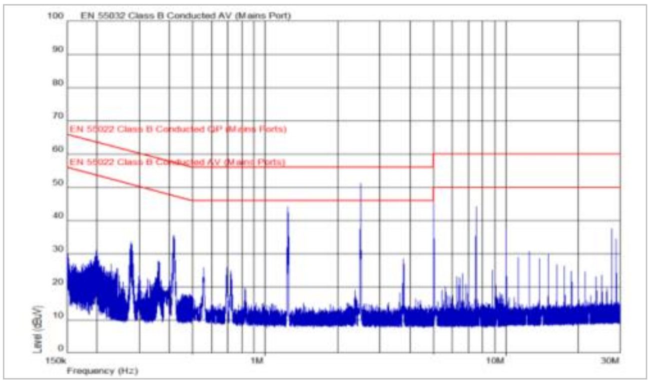
# Part 2: EMC

## 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 V and max $I_{out}$.



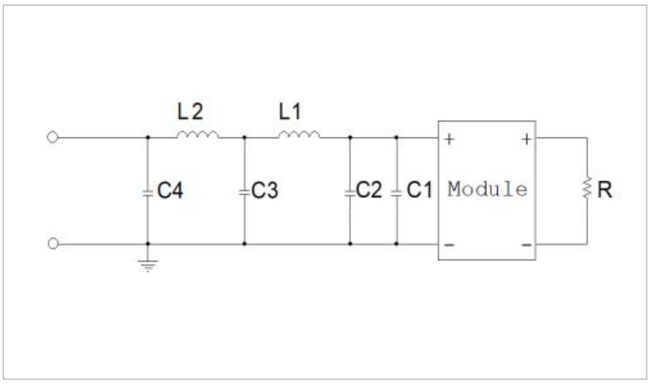

*EMI without filter. (Blue graph = QP values)*




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

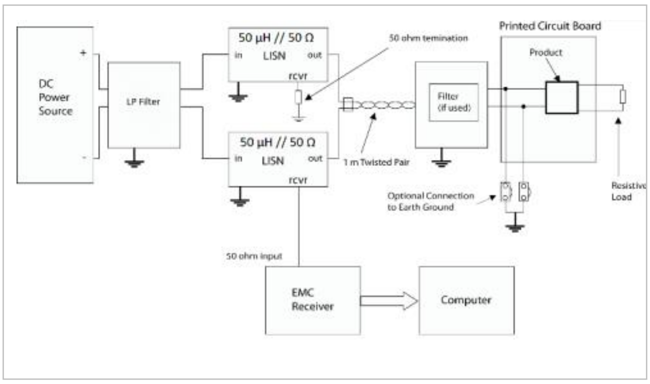
## Optional external filter for Class B

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 x 2.2 µF + 100 µF (Oscon)*
*C2 = 5 x 10 µF*
*C3 = 5 x 10 µF L1 = 100 nH*

*C4, L2 not populated.*




*Test set-up*

## Layout recommendations

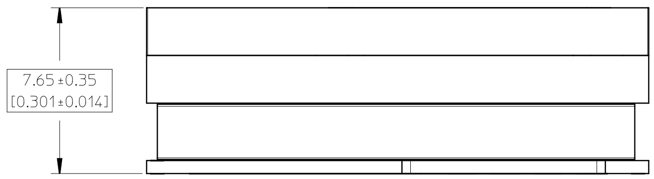
The radiated EMI performance of the product will depend on the PCB layout and ground layer design. It is also important to consider the stand-off of the product. If a ground layer is used, it should be connected to the output of the product and the equipment ground or chassis. A ground layer will increase the stray capacitance in the PCB and improve the high frequency EMC performance.

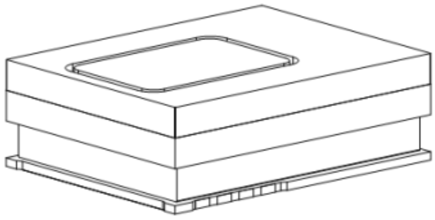
# Part 3: Mechanical information

## BMR3131011/001: SMD mounted, baseplate version

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

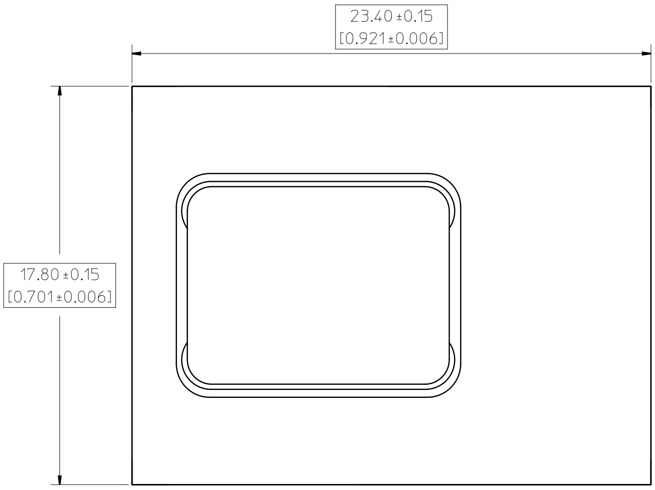
### Side view



### Top view

Product overall X/Y dimension including both top and bottom boards.




Weight: typical 10.1 g

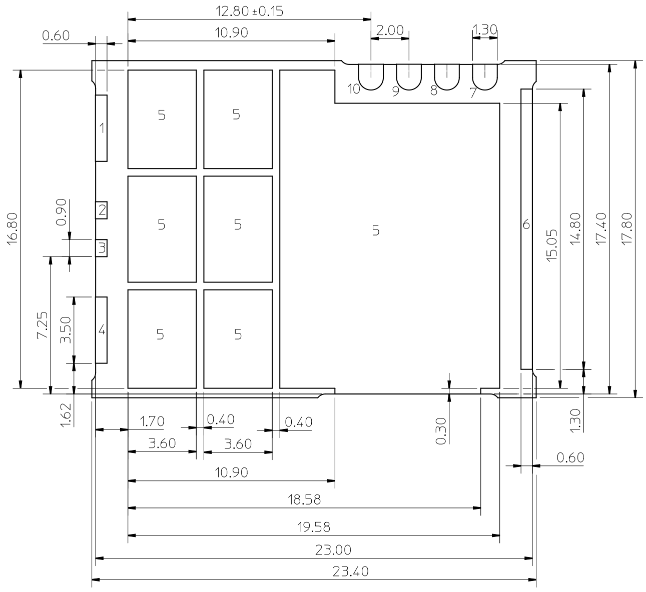
All dimensions in mm [inches]

Tolerances unless specified:

x.x ±0.5 mm [0.02 inch]

x.xx ±0.25 mm [0.01 inch]

(not applied on footprint or typical values)

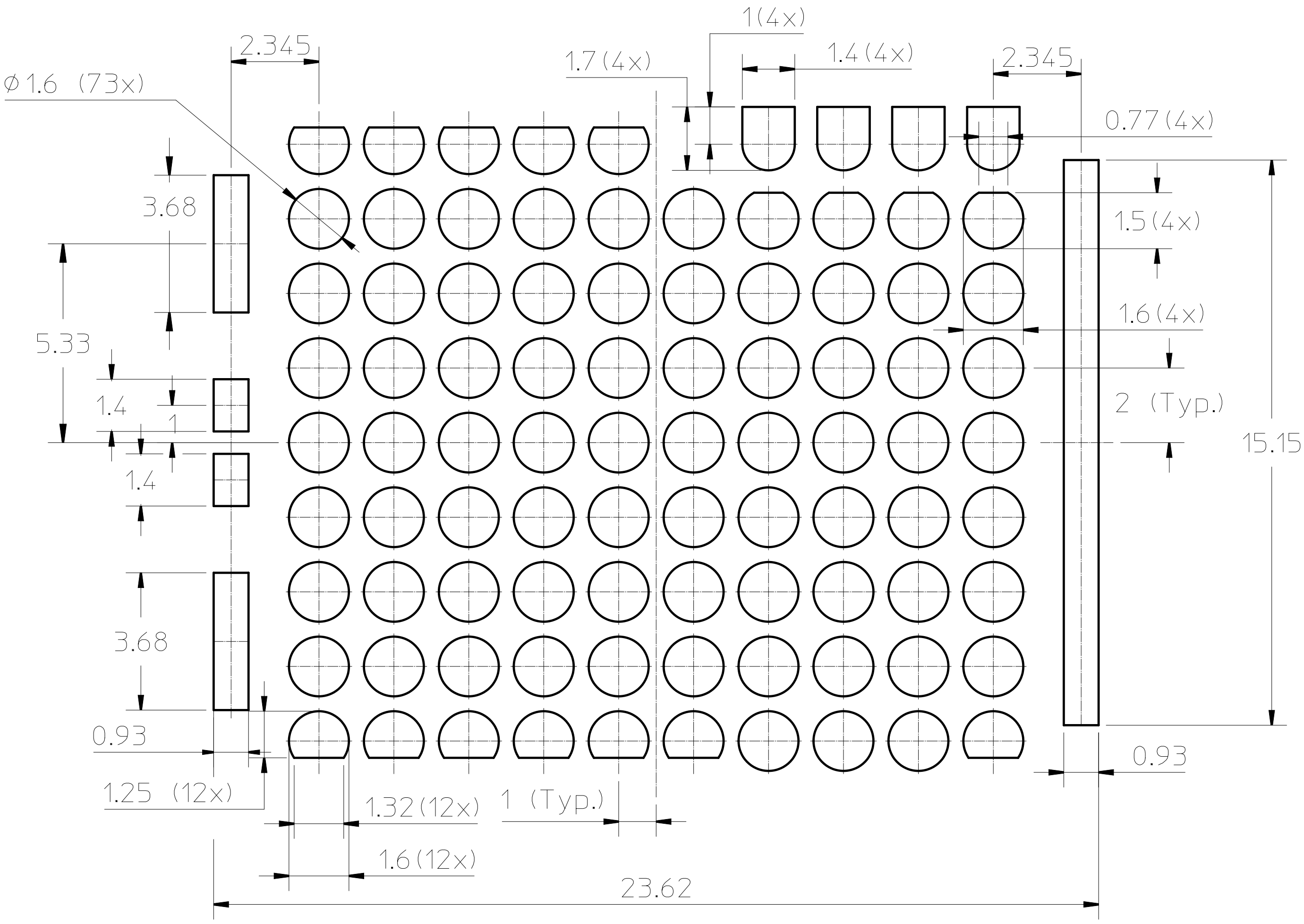



All component placements – whether shown as physical components or symbolical outline – are for reference only and are subject to change throughout the product's life cycle, unless explicitly described and dimensioned in this drawing.

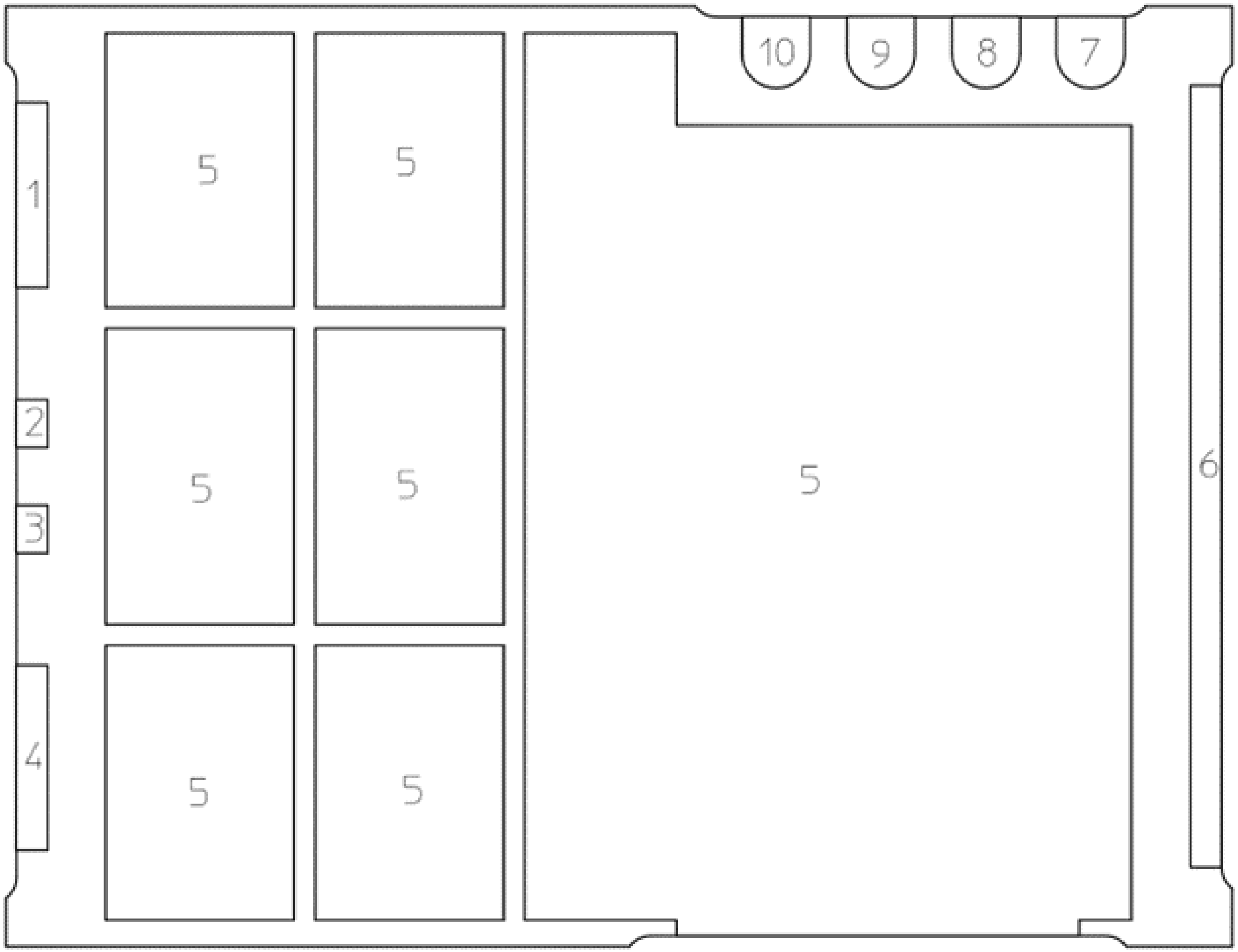
## BMR3131011/001: SMD mounted, baseplate version

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 | VOUT | 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

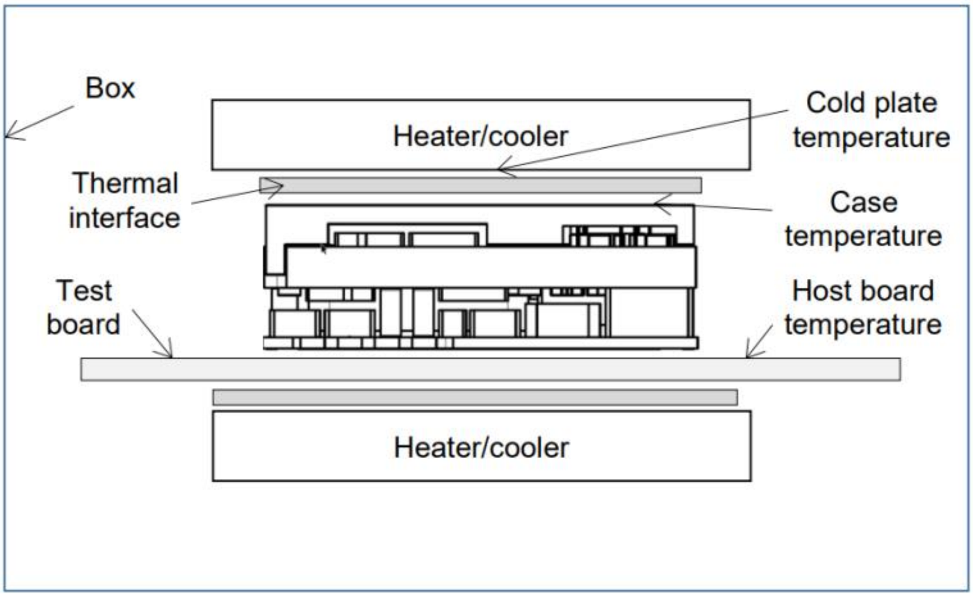
### General

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/coolers; 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.



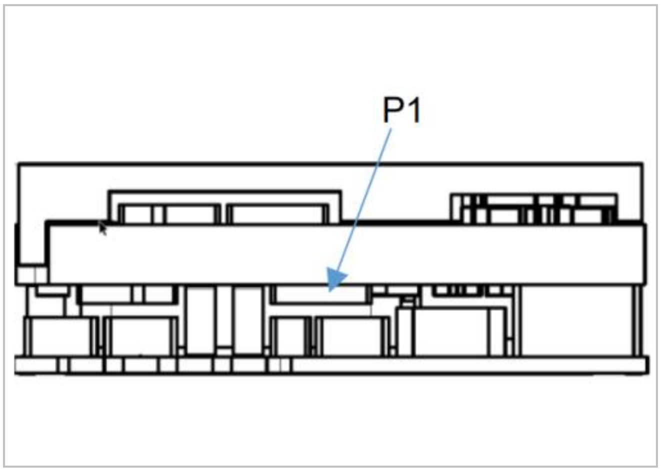

*Test set-up: Cold plate*

## Definition of product operating temperature

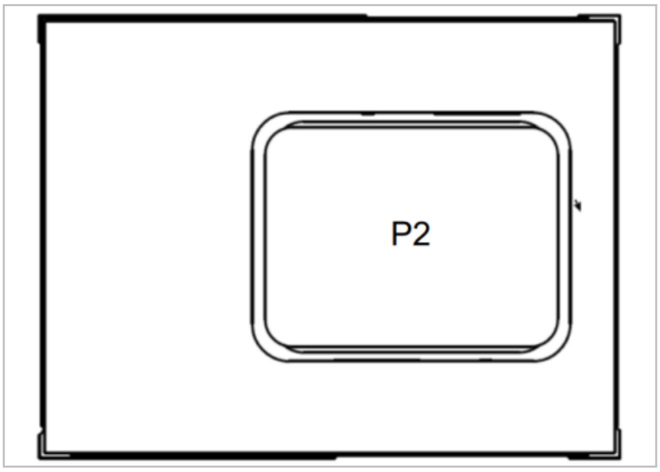
The product operating temperatures are used to monitor the temperature of the product, and proper thermal conditions can be verified by measuring the temperature at positions P1, P2. The temperature at these positions ($T_{P1}$, $T_{P2}$) should not exceed the maximum temperatures in the table below. 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 °C |
| P2 | Magnetic core | $T_{P2}$ = 125 °C |

**Side view**

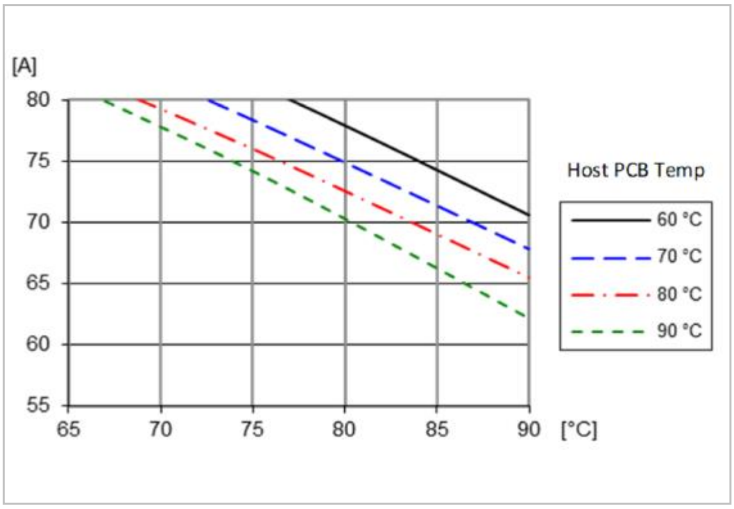



**Bottom view**



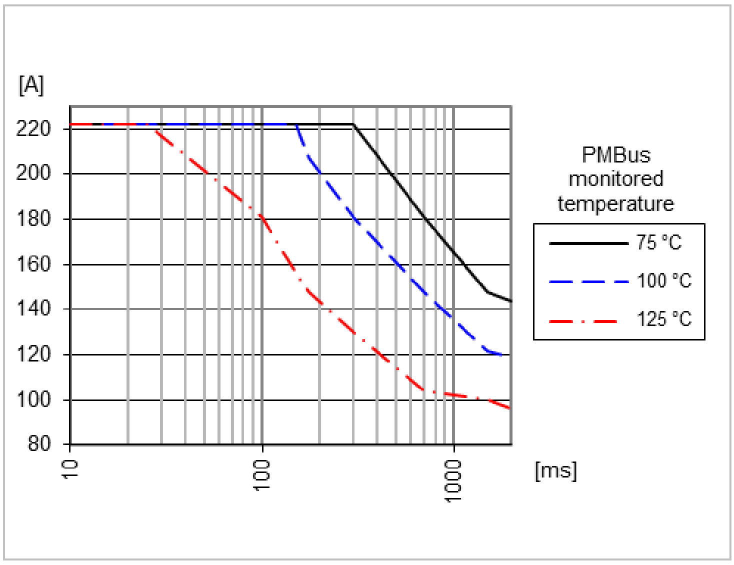
## Thermal graphs

### 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 Iout = 80 A. Limit given by max internal junction temperature (150 °C) of hotspot component.*

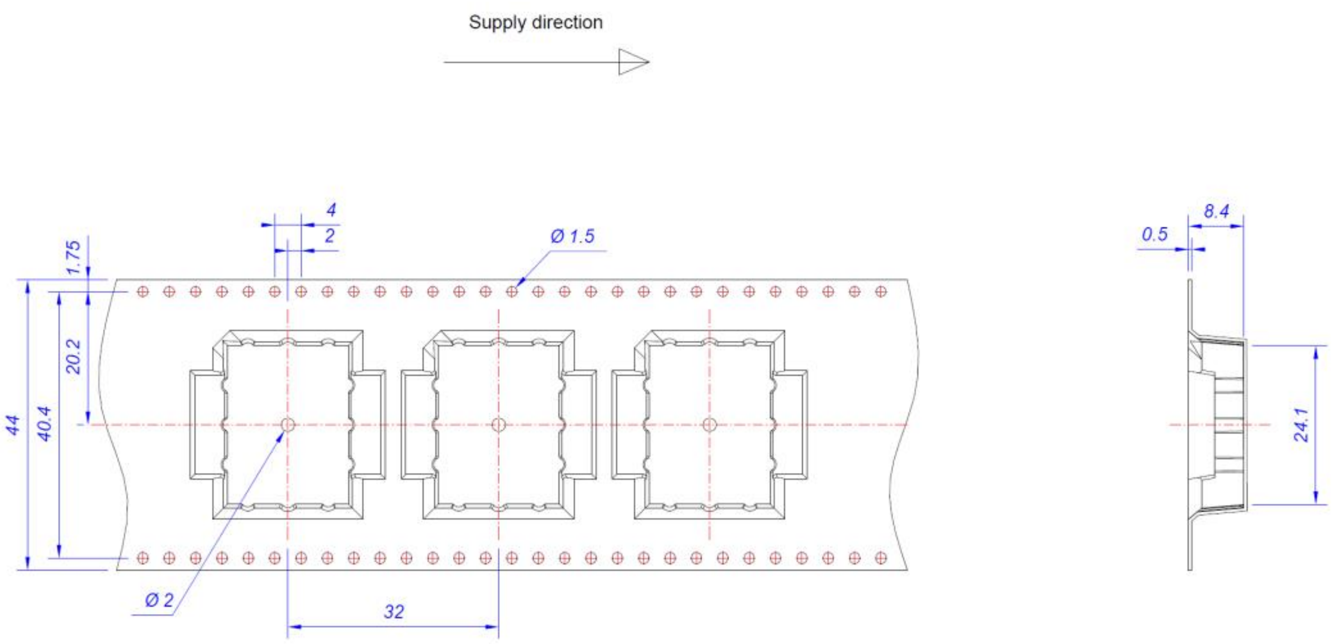
For more information, please refer to our thermal models on the website.

# Part 5: Packaging

## Packaging information

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

| Carrier Tape Specifications | |
|---|---|
| **Material** | PS, Antistatic |
| **Surface resistance** | < $10^7$ Ω/square |
| **Bakabilty** | 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<br>Footprint drawing updated | 2024-02-21 | KARFWAHL |
| Rev. D | Update of image page 1 | 2024-07-02 | KARTWAER |
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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.