BMR316

4:1 Intermediate Bus Converter (1000W)

The BMR316 is a powerful and compact digital non-isolated, unregulated DC/DC converter designed to support Datacom and AI 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 2800 W.

This converter can deliver a power density up to 900 W/cm³ (15 kW/in³) when delivering peak power to the load.

BMR316 IBC, is a part of a portfolio with multiple options of VRM and PoL solutions to further convert the intermediate bus to downstream core voltages.

This product is supported by the Flex Power Designer tool.

Key features

- Horizontal mounting non-isolated DC/DC converter
- High power density IBC up to 900 W/cm³
- Ratio conversion 4:1, 1 kW continuously, 2.8 kW peak power
- Peak efficiency 97.7 %
- LGA industry standard footprint and pinout
- Optimized thermal design for cold wall mounting
- MTBF 7.43 million hours
- DMTBF of 2 million hours
- Meets safety requirements per IEC/EN/UL 62368-1
- PMBus configuration

Key electrical information

Parameter	Values
Input Voltage range	38-60 V
Output Voltage range	9.5-15 V
Output current	80 A
Output power	1000 W
Peak power	2800 W

Mechanical

23.4 x 17.8 x 7.65 mm

Soldering methods

- Pb free SMD reflow

Application areas

- Designed for Datacom and AI applications

Product options

The table below describes the different product options.

Example:	BMR316	1	01	1	/021	Definitions
Product family	BMR316					
Mech. solution		1				1 = Baseplate, LGA
Sequence number			01			01 = Internal Power Good Pull up 02 = External Power Good Pull up 03 = Internal Power Good Pull up & no Zener Diodes on EN, PG and Alert pin
Function				1		1 = Stacked module
Configuration code					/021	021 = PMBus base address 0x6n, Table 1 022 = PMBus base address 0x1n, Table 2 023 = PMBus base address 0x1n, Table 1 *Note, see resistor tables in PMBus addressing section of the Design & Application Guidelines.*
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
BMR3161011/021	38-60 V	9.5-15 V / 80 A / 1000 W	Baseplate / Internal Power Good Pull up / PMBus base address 0x6n, Table 1
BMR3161021/021	38-60 V	9.5-15 V / 80 A / 1000 W	Baseplate / External Power Good Pull up / PMBus base address 0x6n, Table 1
BMR3161011/022	38-60 V	9.5-15 V / 80 A / 1000 W	Baseplate / Internal Power Good Pull up / PMBus base address 0x1n, Table 2
BMR3161011/023	38-60 V	9.5-15 V / 80 A / 1000 W	Baseplate / Internal Power Good Pull up / PMBus base address 0x1n, Table 1
BMR3161031/023	38-60 V	9.5-15 V / 80 A / 1000 W	Baseplate / Internal Power Good Pull up & no Zener Diodes on EN, PG and Alert pin / PMBus base address 0x1n, Table 1

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	110	°C
Storage temperature	-40	125	°C
Input voltage (V_{in}) continious operation	-0.3	65	V
Input voltage transient	-0.3	64	V
C_{out}	0.1	6	mF
Signal I/O voltage (EN, PG, ALERT/SYNC, ADDR)	-0.3	3.7	V
SCL, SDA	-0.3	5.5	V

Reliability

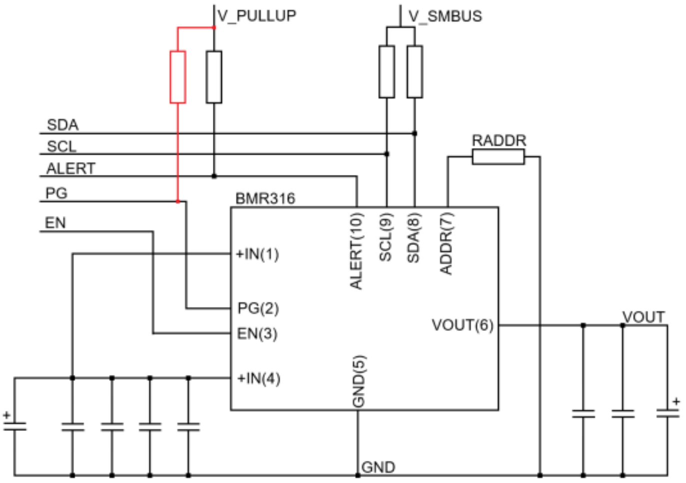
The failure rate (λ) and mean time between failures (MTBF= 1/λ) is calculated at max output power and an operating ambient temperature (T_A) of +40 °C. Flex Power Modules uses Telcordia SR-332 Issue 4 Method 1 to calculate the mean steady-state failure rate and standard deviation (σ). Telcordia SR-332 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)	127	156	nfailures/h
Standard deviation (σ)	22.1		nfailures/h
MTBF	7.85	6.42	MHr

The BMR316 module has demonstrated a MTBF of 2x10^6 hours at 64A, 3 m/s airflow (1 inch heat sink) and 25°C ambient reference temperature with 90% confidence level.

Typical application diagram

Optional Pull-up resistor for PG is showed in red.
See product options.
Capacitor values are defined in the Electrical Specification tables. The EMI filter is defined in the EMC Part 2.



Electrical specifications for BMR316

13.5 V, 80 A (210 A peak) / 1000 W (2800 W peak)

Min and max values are valid for: T_{P1} = -20 to +110°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} = 2 x100 µF + 5 x 2.2 µF ceramic, C_{out} = 2 x 470 µF + 10 x 10 µF ceramic

Characteristic	conditions	minimum	typical	maximum	unit
Key features					
Efficiency (η)	Peak @ 40% P_{out_TDP}		97.7		%
	100 % of P_{out_TDP}		96.7		%
	50 % of P_{out_TDP}		97.6		%
P_{out_TDP} thermal design power (TDP)			1000		W
P_{out_MAX} peak power			2800		W
Power dissipation	40% of P_{out_TDP}		10.2		W
	100 % of P_{out_TDP}		36.6		W
	50 % of P_{out_TDP}		13.1		W
Switching frequency (f_s)	0-100 % of P_{out_TDP}		1000		kHz
Recommended capacitive load	Note 2	220	1000	6000	µF
Input characteristics					
Input voltage range (V_{in})		38		60	V
Input idling power	Vin=54V, Iout=0A, EN on		5.5		W
Input standby power	Vin=54V, Iout=0A, EN off		520		mW
Input OVP				65	V
Internal input capacitance	Nominal capacitance		18.8		µF
Recommended external input capacitance		100	470		µF

Note 1: Max peak power is ≤ 2800 W and continuous power (thermal design power TDP) is ≤ 1000 W depending on thermal conditions.

Note 2: Paralleling reduced max cap

Electrical specifications for BMR316

13.5 V, 80 A (210 A peak) / 1000 W (2800 W peak)

Min and max values are valid for: T_{P1} = -20 to +110 degC, 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} = 2 x 100 µF + 5 x 2.2 µF ceramic, C_{out} = 2 x 470 µF + 10 x 10 µF ceramic

Characteristic	conditions	minimum	typical	maximum	unit
Output characteristics					
Output voltage	P_{out} = 0 W		13.5		V
Output voltage	Disabled, no load		0.5		V
Output voltage	Disabled, 1 kΩ load		0		V
Output current (I_{out})	V_{in} = 38 - 60 V, PG asserted			80	A
Output voltage droop	I_{out} step from 0 to 80 A		460		mV
Output ripple & noise	20 MHz BW		120		mV_{p-p}
Internal output capacitance	V_{out} = 0V			160	µF
On/off control					
Turn-off input voltage	Decreasing input voltage		32		V
Turn-on input voltage	Increasing input voltage		37		V
Ramp-up time	From 10% to 90% of V_{out}, I_{out} = 0 A		4.3		ms
Start-up time	from V_{in} connection to 90% of V_{out}		20		ms
Enable start-up time	From EN asserted to 100% of Vout, I_{out} = 0 A		4		ms
Logic high: trigger level	EN pin	1.7			V
Logic low: trigger level	EN pin			1.55	V
Source current	EN pin (Internal pull up), see Note 2			5	mA
Sink current	EN pin			4	mA

Note 1: Max. output current is rated at 210 A. Max power is ≤ 2800 W and continuous power (thermal design power (TDP) is ≤ 1000 W depending on thermal conditions).

*Note 2: A protection Zener diode is connected to GND, which would influence the need for external source current on EN pin. Modules with PN: BMR316XX**3**X/XXX is not equipped with Zener diode and the pull-up resistor value is higher, thus significantly less source current is needed on BMR316XX**3**X/XXX. Internal pull-up is default, so no additional pull up is needed for modules with or without the protective Zener diode.*

Electrical specifications for BMR316

13.5 V, 80 A (210 A peak) / 1000 W (2800 W peak)

Characteristic	conditions	minimum	typical	maximum	unit
Protection features					
Input Over Voltage fault limit (IOVP)	Latch (0x80)		65		V
Input Over Voltage warning limit			62		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)		16.25		V
Output overvoltage warning limit			15.5		V
Over temperature fault limit (OTP)	Latch (0x80)		125		°C
Over temperature warning limit (OTW)			110		°C
Over Current Protection (OCP) Note 1	Average OCP Limit		100		A
	IOUT_OC_FAULT_LIMIT (Normal OCP)		210		A
	IOUT_OC_FAST_FAULT_LIMIT (Fast OCP)		220		A
Protection Response Time	IOVP		2		µs
	OVP		0.04		µs
	UVP		0.16		µs
	OTP		2		µs
	Average OCP @ base current=60A to overcurrent 120A Note 2		42		ms
	OCP		70		µs
	FAST OCP		5		µs

Note 1: The module can run less than 80us at fast OC level (IOUT_OC_FAST_FAULT_LIMIT), and between 80us to 50ms at the normal OC level (IOUT_OC_FAULT_LIMIT), and above 50ms the average OC level. Note the time module can run before the average OCP depends on the IOUT telemetry reading, base current level, peak current level and peak current length. The average OCP defines the over current level at which the module can run continuously, without thermally stressing the module. The detailed explanation can be found on the technical reference document.

Note 2: The time specified is based on the calculation at base current 60A and overcurrent 120A for 50ms. The detailed explanation can be found on the technical reference document.

Electrical specifications for BMR316

13.5 V, 80 A (210 A peak) / 1000 W (2800 W peak)

Characteristic	conditions	minimum	typical	maximum	unit
Monitoring & Control					
$UVLO_{VI}$ - Under Voltage Lock-Out	V_{in} rising threshold		37		V
	Hysteresis		5.4		V
Power Good Delay Time	From V_{out} = 100 % to PG asserted		15		ms
Power Good Threshold	Low to high transition		9.3		V_{out}
	High to low transition, Note 1		9.1		V_{out}
V_{IL} - Logic input low	SDA, SCL, ALERT			1.0	V
V_{IL}- Logic input high	SDA, SCL, ALERT	2.3			V
V_{OL} - Logic output low	SDA, SCL, ALERT			400	mV
I_{OL} - Logic output low sink current	SDA, SCL, ALERT			20	mA
I_{LEAK} - Logic leakage current	SDA, SCL, ALERT	-5		5	µA
C_{I_PIN} - Logic input capacitance	SDA, SCL, ALERT		7		pF
f_{SMB} - SMBus Operating frequency		100		400	kHz
EN - Enable	See page 5 "On/Off control"				

Note 1: Power Good is deasserted when any protection and warning is triggered, regardless of the output voltage level.

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

T_{P1} = -20 to + 110°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

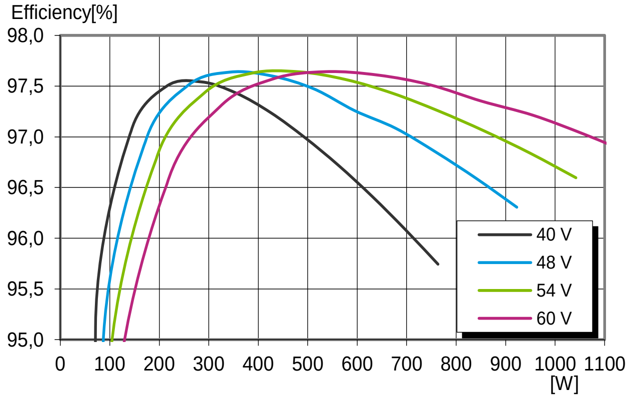
For more detailed information please refer to Technical Reference Document: PMBus commands. This product is supported by the Flex Power Designer tool.

Command	Conditions	minimum	typical	maximum	Unit
Monitoring accuracy					
Input voltage READ_VIN			±1		%
Output voltage READ_VOUT			±0.1		%
Output current READ_IOUT	V_{in} = 54 V, I_{out} = 50-80 A		±5		%
Output current READ_IOUT	V_{in} = 54 V, I_{out} = 0-50 A		±10		A
Temperature READ_TEMPERATURE_1	T ≥ 25 °C		±1		°C

Electrical graphs for BMR316

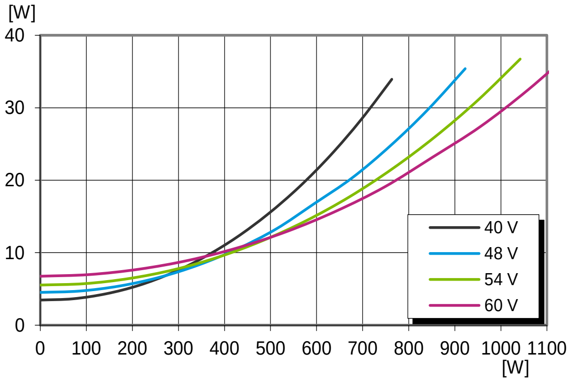
13.5 V, 80 A (210 A peak) / 1000 W (2800 W peak)

Efficiency



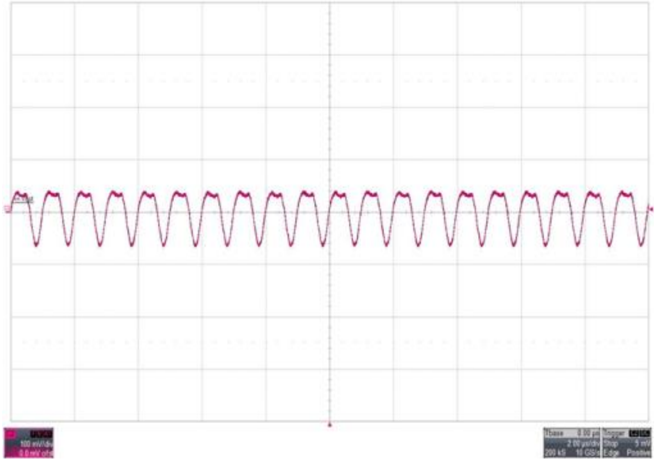
Efficiency vs. output power and input voltage at T_{P1} = +25 °C.

Power dissipation



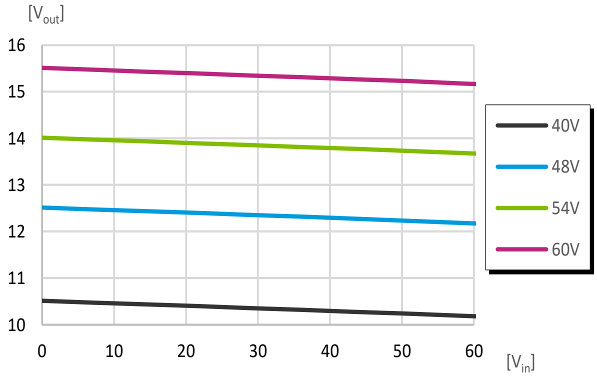
Dissipated power vs. load power at T_{P1} = +25 °C.

Output Ripple and Noise



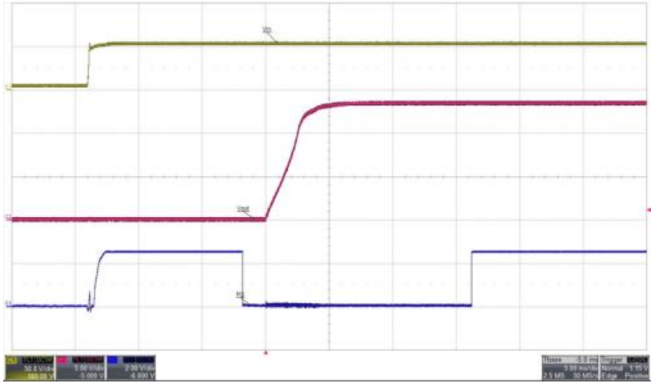
V_{in} = 54 V, I_{out} = 80 A, 20 MHz BW. Scale 100 mV/div, 2 us/div.

Output voltage droop



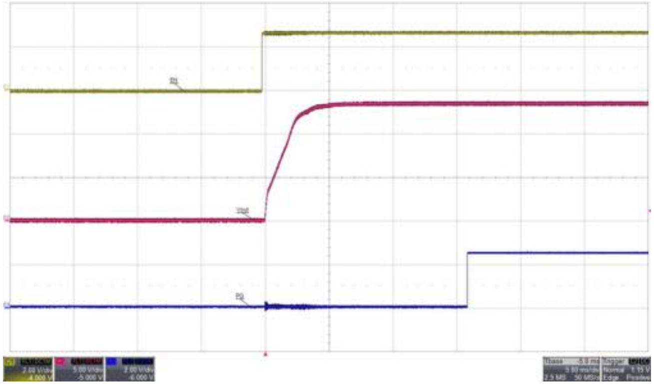
Output voltage vs output current.

Startup, Vin



Output enabled by EN pin. V_{in} = 54 V, I_{out} = 2 A
Scale from top: 50, 5, 2 V/div, 5 ms/div.

Startup, EN

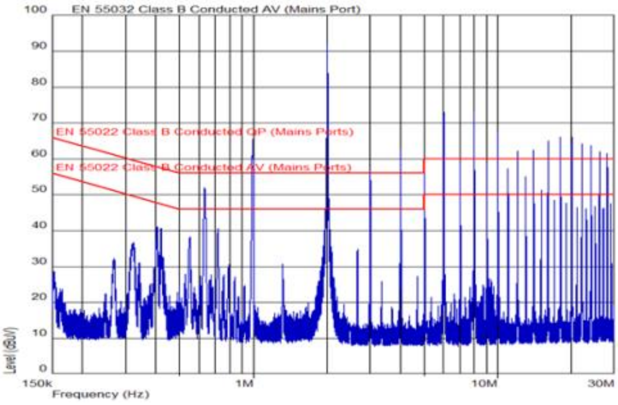


Output disabled by EN pin. V_{in} = 54 V, I_{out} = 80 A
Scale from top: 2, 5, 2 V/div, 5 ms/div.

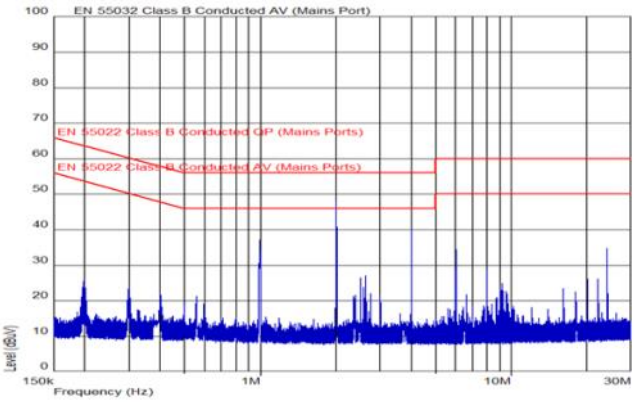
Part 2: EMC

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 1MHz for BMR316. The EMI characteristics below is measured at V_{in} = 54 V and max I_{out}. Note the provided filter ensures the module is below average limit, but not below quasi-peak limit.



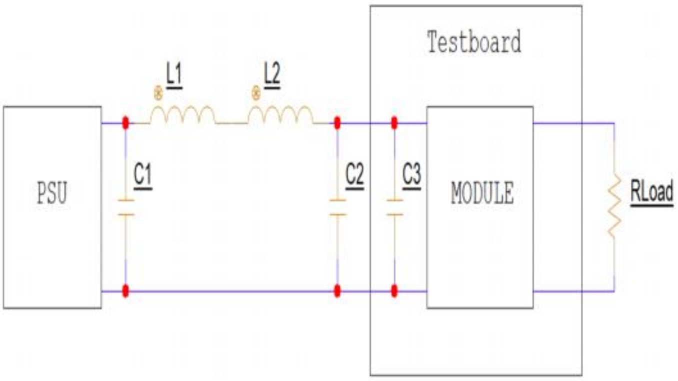
EMI without filter. (graph = average values)



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

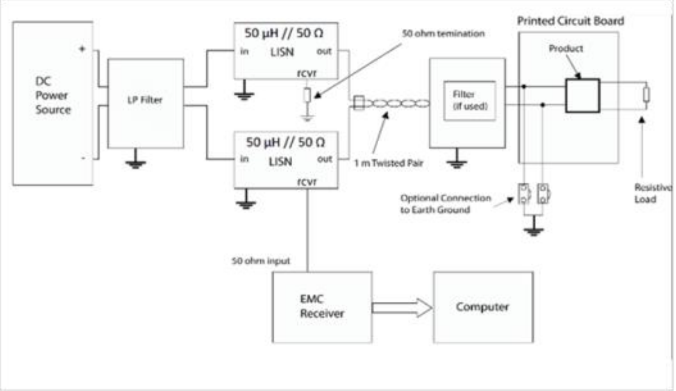
Optional external filter for Class B

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:
L1 and L2 = 100 nH
C1 = 5 x 10 µF
C2 = 5 x 10 µF +2 x 2.2µF
C3 = 100 µF

Filter components:
100 nH : IHLP5050FDERR10M01
10 µF : GRM32ER71J106KA12L
2.2µF: GRF32ER72A225KA11L



Test set-up

**paird 1m cable out from LISN*

Layout recommendations

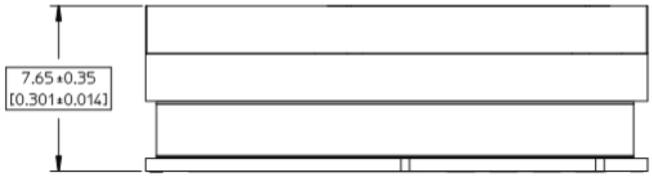
The radiated EMI performance of the product will depend on the customer PCB layout and ground layer design. It is also important to consider the stand-off of the product. If a ground layer is used, it should be connected to the output of the product and the equipment ground or chassis. A ground layer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

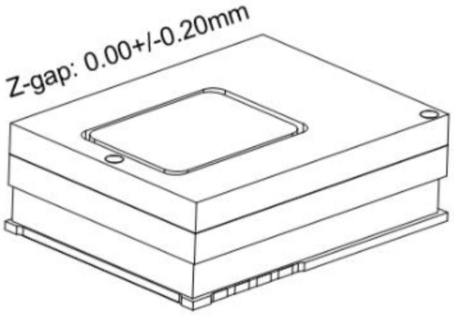
Part 3: Mechanical information

BMR316: SMD mounted, baseplate version

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

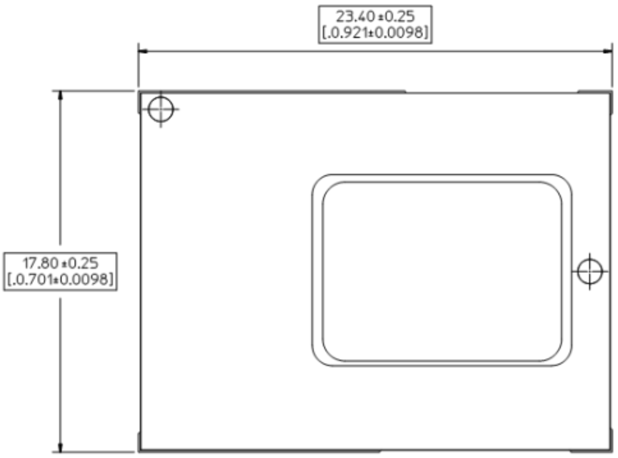
Side view

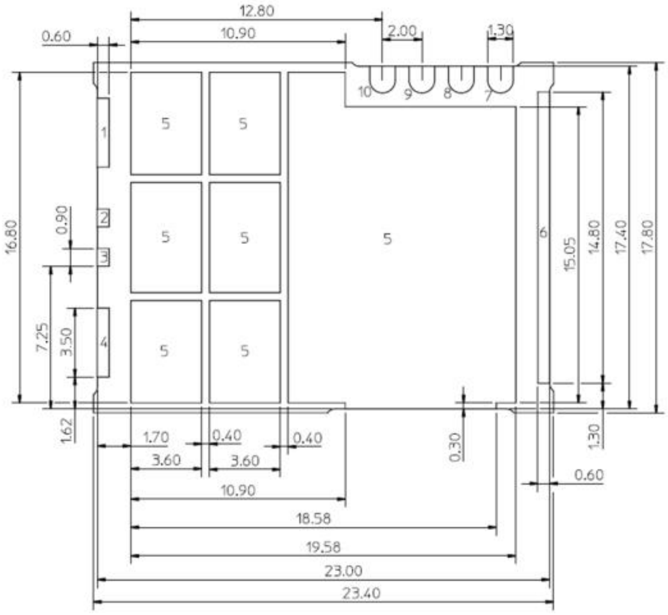




Top view

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





BASEPLATE INTERFACE

Material: Aluminium (anodized, black)

PAD SPECIFICATION

Material: Copper alloy

Plating: ENIG

(Electroless nickel/immersion gold plating)

WEIGHT

Typical 10.1g

All dimensions in mm [inches]

Tolerances unless specified:

x.x ±0.5 mm [0.02 inch]

x.xx ±0.25 mm [0.01 inch]

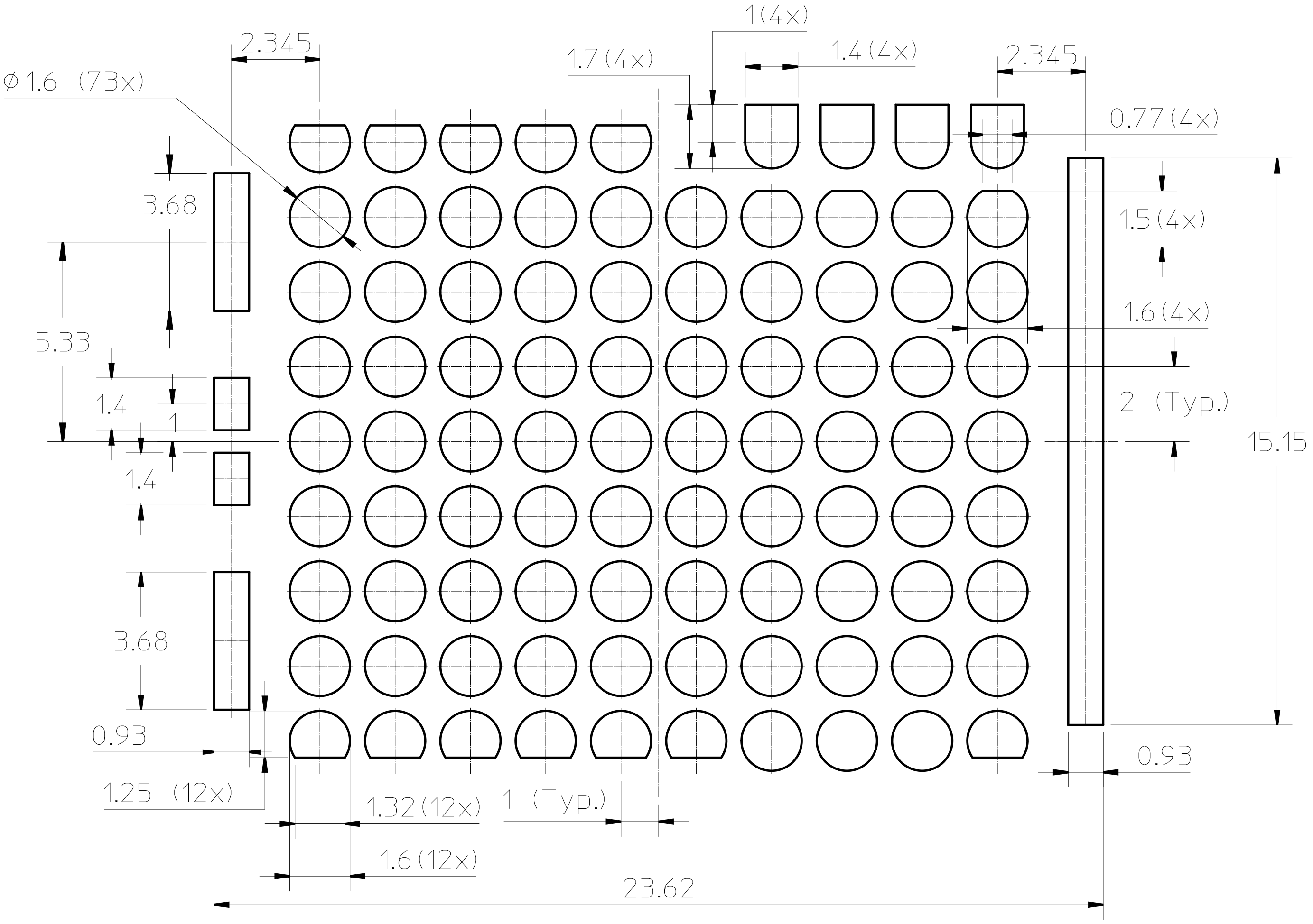
(not applied on footprint or typical values)

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.

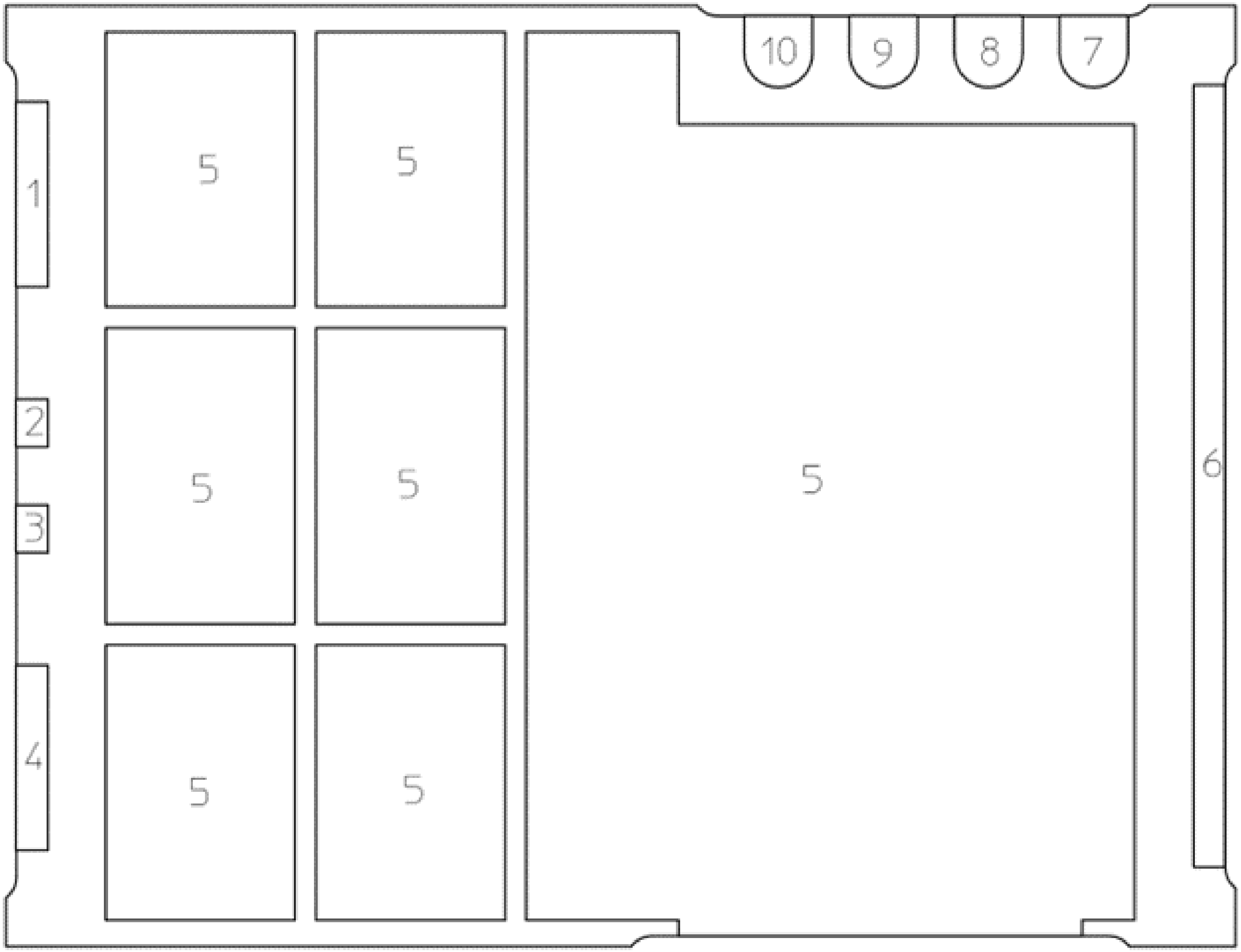
BMR316: SMD mounted, baseplate version

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/SYNC	Open Drain	See technical reference description.

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 liquid cooled 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.

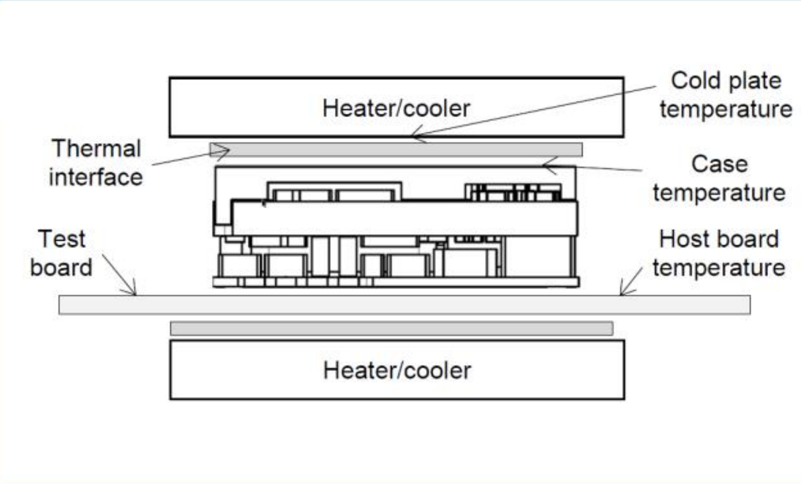
The windspeed and temperature are measured in a point upstream the device. The output current derating graph provides the derated power vs ambient temperature and air velocity at Vin = 54V.

For products using any form of heat sink structure a top spacing board and side airflow guides are used to ensure airflow hitting the device and not divert away.

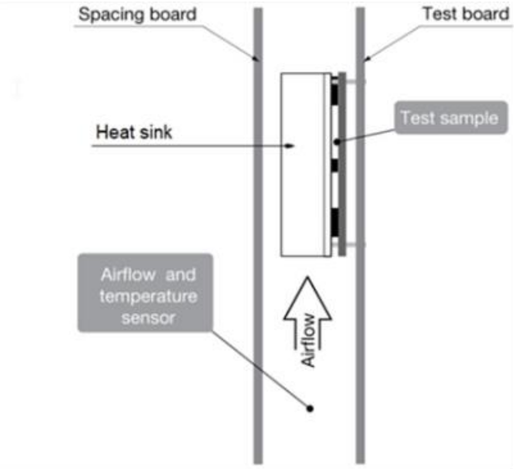
Distance between the tested device and top space and side air guides are 6.35mm ± 1mm.

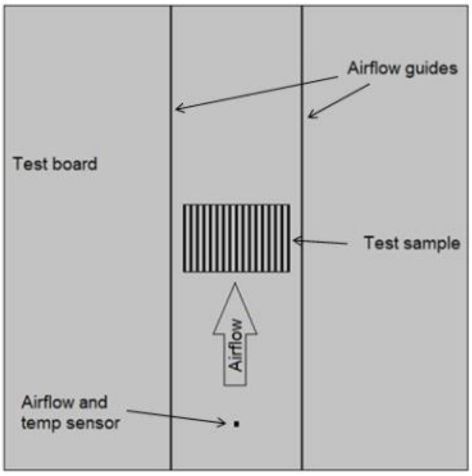
The device is tested on a 185*185mm. 105uM (3 os) 6 layer test-board mounted vertical in a wind tunnel.

Test Setup – Liquid cooling



Test Setup – Wind tunnel cooling





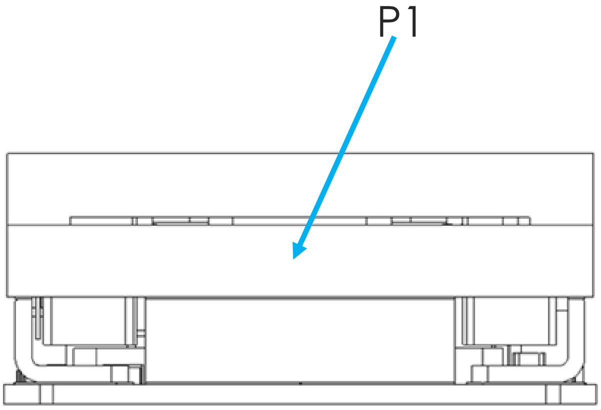
Definition of product operating temperature

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 position P1. The temperature at these position (T_{P1}) 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.

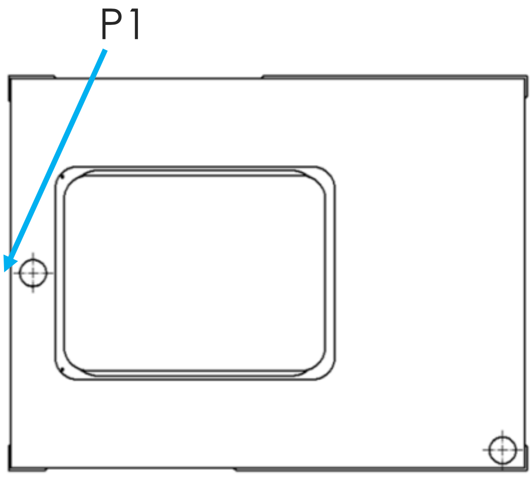
Position	Description	Max. Temp.
P1	Board edge on the output voltage side.	T_{P1} = 110 °C *

*This is the measurement spot that shall correspond with hot spot reaching up to OTP level,, which is 125*C.

Side view

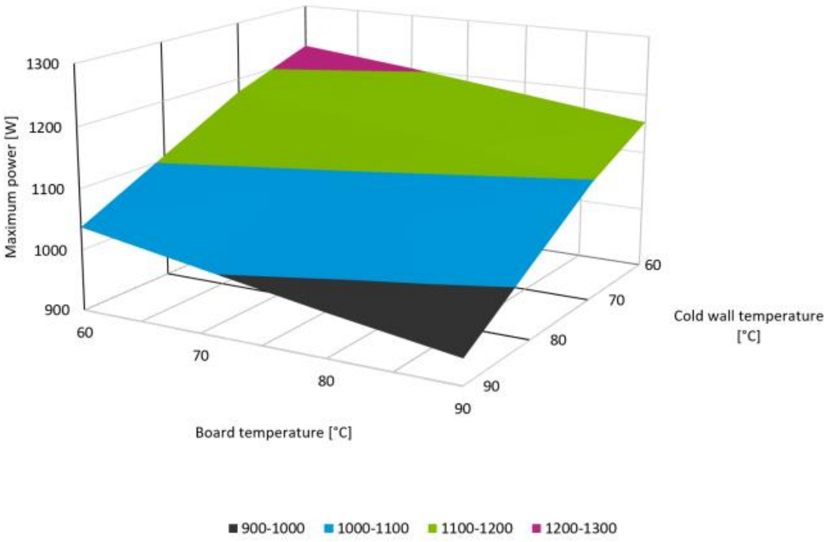


Top view

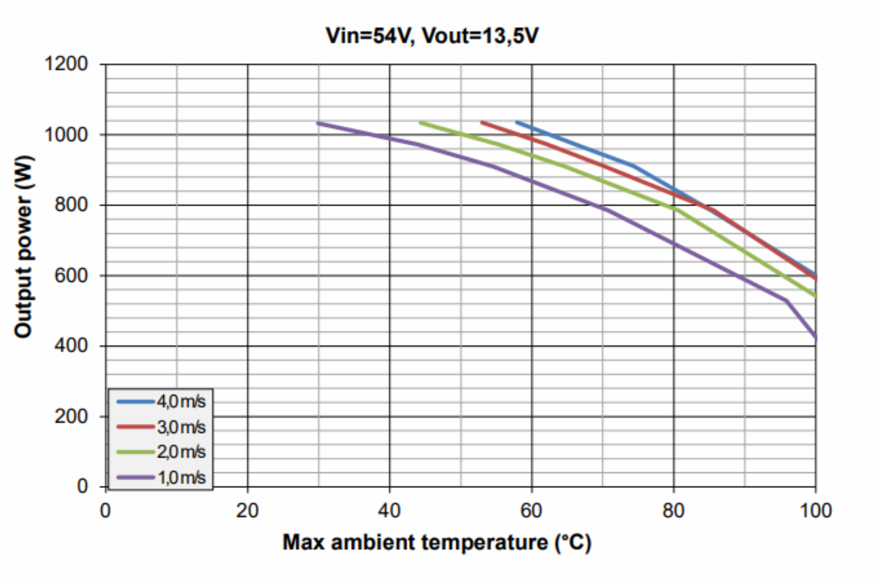


Thermal graphs

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.

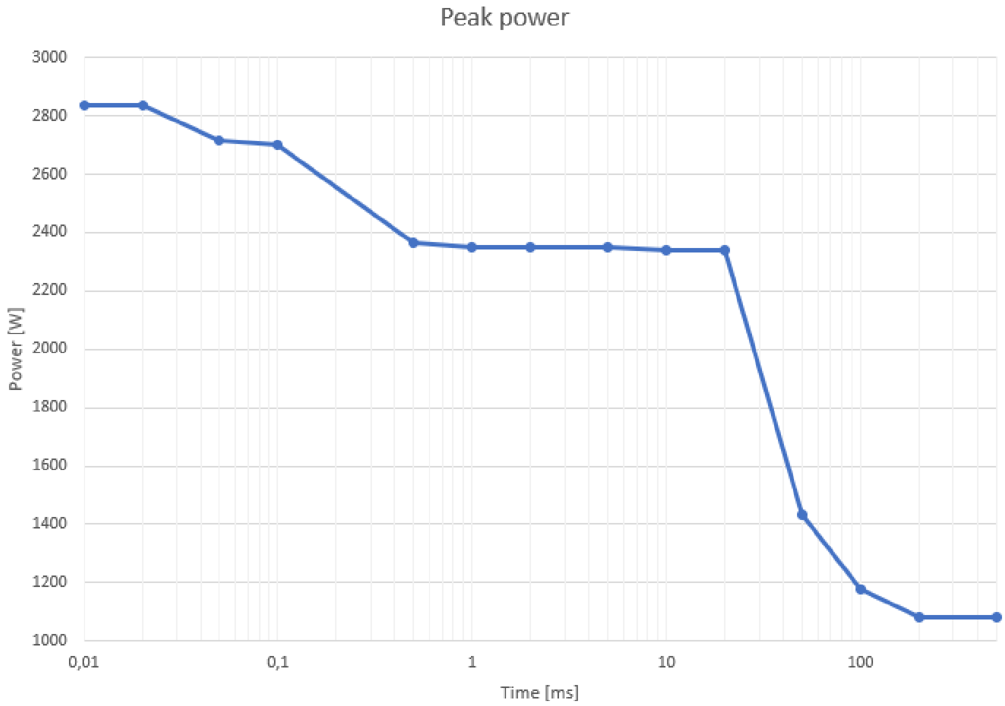


Max avreage output power vs. ambient temperature
Thermal interface gap pad to heat sink is 1.0 mm, 8 W/mK.

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

Peak Power

Peak current capability



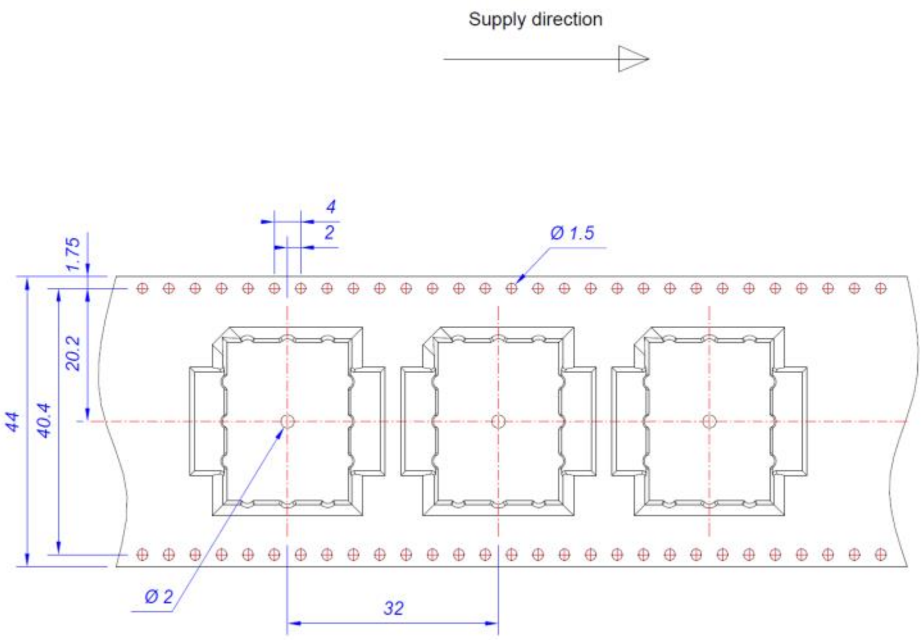
Max peak output current vs pulse duration and PMBus monitored temperature when pulse starts. Input voltage 54V and initial Iout = 60 A.

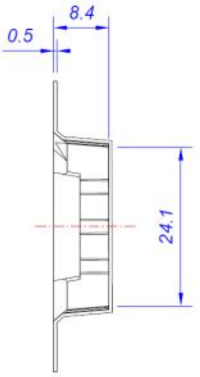
Part 5: Packaging

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	Release	2025-03-05	Team 4
Rev. B	Added variant without Zener diode. See page 2. Start up descriptions updated on page 8. Note 2 on page 5 is updated. Tp1 description on page 14 is improved. Mechancial drawing description updated and correction of typo on the inch measure on page 10. Iout reading accuracy on page 7 is improved to describe low, medium and high load.	2025-05-16	karjnils
Rev. C	Updated Iout reading range on page 7.	2025-05-20	Karjnils
Rev. D	Ordernumber example updated with all options.	2025-06-25	Karjnils

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.