BMR491 series DC-DC Converters Input 40-60 V, Output up to 55 A / 1300 W	28701-BMR491 12 Rev B April 2026
	© Flex

Key Features

- Industry standard low profile Quarter-brick
  58.4 x 36.8 x 14.5 mm (2.30 x 1.45 x 0.57 in)
- High efficiency, typ. 97.1 % at 54 Vin, half load
- Fully regulated
- Input to output 1500V isolated
- Baseplate to enhance thermal performance
- Active current sharing supported
- PMBus compliant
- Flex power designer supported
- Halogen free
- MTBF 7.7 Million hours

General Characteristics

- Input voltage range: 40-60 V
- Output voltage: 24 V
- Max output current: 55 A
- Max output power: 1300 W
- Monotonic start-up
- Output over voltage protection
- Over temperature protection
- Output short-circuit protection
- Remote control
- Highly automated manufacturing ensures quality
- ISO 9001/14001 certified supplier

Safety Approvals

Design for Environment

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

Contents

flex

Technical Specification

BMR491 series DC-DC Converters Input 40-60 V, Output up to 55 A / 1300 W	28701-BMR491 12 Rev B	April 2026
	© Flex	

Ordering Information

Product program	Vin	Output
BMR491 2512 / 872	40 - 60	24 V / 55 A, 1300 W, baseplate, 7-pin digital header, active current sharing

Product number and Packaging

BMR491	n_1	n_2	n_3	n_4	/	n_5	n_6	n_7	n_8
Mechanical option	x				/				
Baseplate		x			/				
Hardware option			x	x	/				
Configuration file					/	x	x	x	
Delivery package					/				x

Options	Description
n_1	0 = Standard pin length 5.33 mm(0.210 in.) 2 = Lead length 3.69 mm(0.145 in.) (cut) 3 = Lead length 4.57 mm(0.180 in.) (cut)
n_2	5 = Dual side integrated baseplate
n_3 n_4	12 = 24 Vout, 1300W, isolated, DOSA 7 pin digital interface, active current sharing
n_5 n_6 n_7	872 = CDA Configuration for 40-60 Vin, 24 Vout, 1300W isolated, DOSA 7 pin digital interface, active current sharing, n_3n_4 = 12 xxx = Application Specific Configuration
n_8	Blank = foam tray (default option) for wave soldering H = hard tray in dry pack for pin in paste

Example: a 24V/ 1300W power module operating at 40-60Vin, through-hole mounted, 3.69mm standard pin product with dual side integrated baseplate, with DOSA 7-pin digital interface, active current sharing capability, hard tray delivery package would be BMR4912512/872H

General Information

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 steady-state failure rate, λ	Std. deviation, σ
129 nFailures/h	8.4 nFailures/h

MTBF (mean value) for the BMR491 series = 7.74 Mh.
MTBF at 90% confidence level = 7.14 Mh

Compatibility with RoHS requirements

The products are compatible with the relevant clauses and requirements of the RoHS directive 2011/65/EU and 2015/863 and have a maximum concentration value of 0.1% by weight in homogeneous materials for lead, mercury, hexavalent chromium, PBB, PBDE, DEHP, BBP, DBP, DIBP and of 0.01% by weight in homogeneous materials for cadmium.

Exemptions in the RoHS directive utilized in Flex Power products are found in the Statement of Compliance document.

Flex Power fulfills and will continuously fulfill all its obligations under regulation (EC) No 1907/2006 concerning the registration, evaluation, authorization and restriction of chemicals (REACH) as they enter into force and is through product materials declarations preparing for the obligations to communicate information on substances in the products.

Quality Statement

The products are designed and manufactured in an industrial environment where quality systems and methods like ISO 9000, Six 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 the products.

Warranty

Warranty period and conditions are defined in Flex Power General Terms and Conditions of Sale.

Limitation of Liability

Flex Power does not make any other warranties, expressed or implied including any warranty of merchantability or fitness for a particular purpose (including, but not limited to, use in life support applications, where malfunctions of product can cause injury to a person's health or life).

Safety Specification

General information

Flex Power DC/DC converters and DC/DC regulators are designed in accordance with the safety standards IEC 62368-1, EN 62368-1 and UL 62368-1 *Audio/video, information and communication technology equipment - Part 1: Safety requirements*

IEC/EN/UL 62368-1 contains requirements to prevent injury or damage due to the following hazards:

- Electrical shock
- Electrically-caused fire
- Injury caused by hazardous substances
- Mechanically-caused injury
- Skin burn
- Radiation-caused injury

On-board DC/DC converters, Power interface modules 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 regulations for the final product.

Component power supplies for general use shall comply with the requirements in IEC/EN/UL 62368-1. Product related standards, e.g. IEEE 802.3af *Power over Ethernet*, and ETS-300132-2 *Power interface at the input to telecom equipment, operated by direct current (dc)* are based on IEC/EN/UL 60950-1 with regards to safety.

Flex Power DC/DC converters, Power interface modules and DC/DC regulators are UL 62368-1 recognized and certified in accordance with EN 62368-1. The flammability rating for all construction parts of the products meet requirements for V-0 class material according to IEC 60695-11-10, *Fire hazard testing, test flames* – 50 W horizontal and vertical flame test methods.

Isolated DC/DC converters

The product may provide basic or functional insulation between input and output according to IEC/EN/UL 62368-1 (see Safety Certificate), different conditions shall be met if the output of a basic or a functional insulated product shall be considered as ES1 energy source.

For basic insulated products (see Safety Certificate) the output is considered as ES1 energy source if one of the following conditions is met:

- The input source provides supplementary or double or reinforced insulation from the AC mains according to IEC/EN/UL 62368-1.
- The input source provides functional or basic insulation from the AC mains and the product’s output is reliably connected to protective earth according to IEC/EN/UL 62368-1.

For functional insulated products (see Safety Certificate) the output is considered as ES1 energy source if one of the following conditions is met:

- The input source provides double or reinforced insulation from the AC mains according to IEC/EN/UL 62368-1.
- The input source provides basic or supplementary insulation from the AC mains and the product’s output is reliably connected to protective earth according to IEC/EN/UL 62368-1.
- The input source is reliably connected to protective earth and provides basic or supplementary insulation according to IEC/EN/UL 62368-1 and the maximum input source voltage is 60 Vdc.

Galvanic isolation between input and output is verified in an electric strength test and the isolation voltage (V_{iso}) meets the voltage strength requirement for basic insulation according to IEC/EN/UL 62368-1.

It is recommended to use a slow blow fuse 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 that imposes a short circuit on the input source, this fuse will provide the following functions:

- Isolate the fault 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

flex

Technical Specification

BMR491 series DC-DC Converters Input 40-60 V, Output up to 55 A / 1300 W	28701-BMR491 12 Rev B April 2026

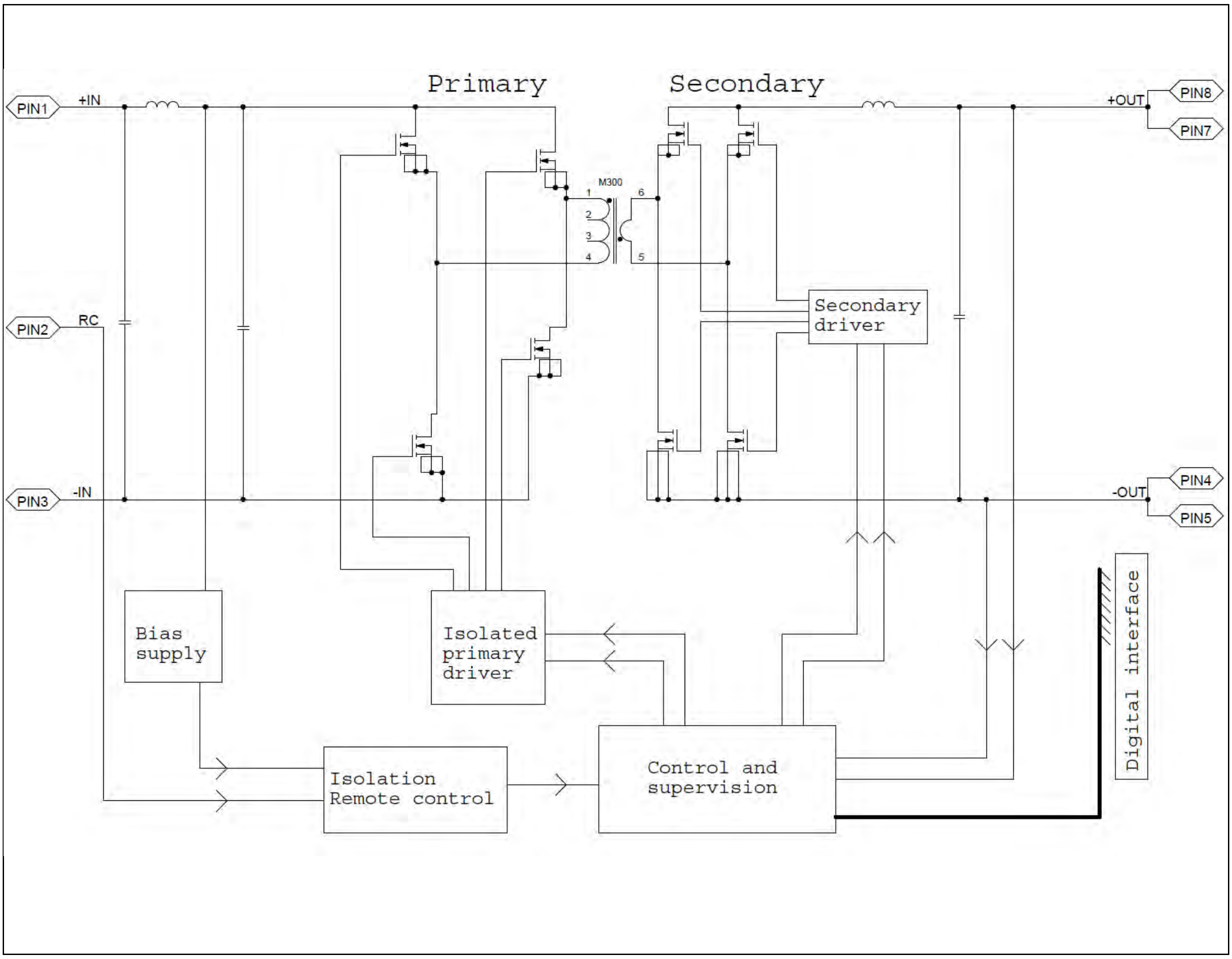
Absolute Maximum Ratings

Characteristics		min	typ	max	Unit
T_{P1}	Monitored point (see Thermal Consideration section)	-40		+110	°C
T_{P2}	Operating Temperature (see Thermal Consideration section)	-40		+125	°C
T_S	Storage temperature	-55		+125	°C
V_I	Input voltage	-0.5		+65	V
V_{iso}	Isolation voltage (input to output test voltage)			1500	Vdc
V_{iso}	Isolation voltage (input to baseplate test voltage)			1500	Vdc
V_{iso}	Isolation voltage (base plate to output test voltage), see Note 1			0	Vdc
V_{tr}	Input voltage transient (t_p 100 ms)			+80	V
V_{RC}	Remote Control pin voltage	-0.3		20	V

Note 1 : Baseplate is grounded to -OUT

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 in the Electrical Specification. If exposed to stress above these limits, function and performance may degrade in an unspecified manner.

Fundamental Circuit Diagram



BMR491 series DC-DC Converters Input 40-60 V, Output up to 55 A / 1300 W	28701-BMR491 12 Rev B April 2026
	© Flex

Common Electrical Specification

This section includes parameter specifications common to all product versions within the product series. Typically, these are parameters defined by the digital controller of the products. In the table below PMBus commands for configurable parameters are written in capital letters.

T_{P1} = -30 to +95 °C, V_I = 40 to 60 V, unless otherwise specified under Conditions.
Typical values given at: T_{P1} = +25 °C, V_I = 54 V, max I_O, unless otherwise specified under Conditions:
BMR491XXXX/851

Characteristics		Conditions	min	typ	max	Unit
f_{SW} = $1/T_{SW}$	Switching Frequency			180		kHz
	Switching Frequency Range, Note 1	PMBus configurable FREQUENCY_SWITCH	150		200	kHz
	Switching Frequency Set-point Accuracy	T_{P1} = +25 °C	-2		2	%
	External Sync Pulse Width		150			ns
	Input Clock Frequency Drift Tolerance	External sync	-4		4	%

T_{INIT}	Initialization Time	From V_I > ~27 V to ready to be enabled		30		ms
T_{ONdel_tot}	Output voltage Total On Delay Time	Enable by input voltage		T_{INIT} + T_{ONdel}		
		Enable by RC or CTRL pin		T_{ONdel}		
T_{ONdel}	Output voltage On Delay Time	PMBus configurable Turn on delay duration		0		ms
		Range TON_DELAY	0		655	ms
		Accuracy (actual delay vs set value)		±1		%
T_{OFFdel}	Output voltage Off Delay Time	PMBus configurable Turn off delay duration, Note 2		5		ms
		Range TOFF_DELAY	0		655	ms
		Accuracy (actual delay vs set value), Note 3		±1		%
T_{ONrise} / $T_{OFFfall}$	Output voltage On/Off Ramp Time (0-100%-0 of V_O)	Turn on ramp duration		200		ms
		Turn off ramp duration	Disabled in standard configuration. Turn off immediately upon expiration of Turn off delay.			ms
		Range TON_RISE/TOFF_FALL	0		655	ms
		Ramp time accuracy for standalone operation (actual ramp time vs set value)		±1		%
V_{Ioff}	Input turn off range	States the level where the output voltage is disabled, PMBus configurable	30	35	60	V
V_{Ion}	Input turn on range	States the level where the output voltage is enabled, PMBus configurable.	30	37	60	V

flex

Characteristics		Conditions	min	typ	max	Unit
Power Good, PG	PG threshold	PMBus configurable Rising		8		V_O
		PMBus configurable Falling		5		V_O
	PG thresholds range	POWER_GOOD_ON VOUT_UV_FAULT_LIMIT	0		100	% V_O
	PG delay	From V_O reaching target to PG assertion		1		ms

Input Under Voltage Protection, IUVP	IUVP threshold	PMBus configurable		0		V
	IUVP threshold range	VIN_UV_FAULT_LIMIT		0-100		%V_{IN}
	IUVP hysteresis	PMBus configurable		0		V
	IUVP hysteresis range	VIN_UV_FAULT_LIMIT-VIN_UV_WARN_LIMIT		0		V
	Set point accuracy			1		%
	IUVP response delay			100		µs
	Fault response	PMBus configurable VIN_UV_FAULT_RESPONSE	Ignore fault			
Input Over Voltage Protection, IOVP	IOVP threshold	PMBus configurable		70		V
	IOVP threshold range	VIN_OV_FAULT_LIMIT		0-100		%V_{IN}
	IOVP hysteresis	PMBus configurable VIN_OV_FAULT_LIMIT-VIN_OV_WARN_LIMIT		0		V
	IOVP hysteresis range	VIN_OV_WARN_LIMIT		0-100		%V_{IN}
	Set point accuracy			±1		%
	IOVP response delay			100		µs
	Fault response	PMBus configurable VIN_OV_FAULT_RESPONSE	Disable until Fault Cleared			
Output Voltage Over/Under Voltage Protection, OVP/UVP	UVP threshold	PMBus configurable		0		V_O
	UVP threshold range	VOUT_UV_FAULT_LIMIT		0-100		%V_O
	OVP threshold	PMBus configurable		31.2		V_O
	OVP threshold range	VOUT_OV_FAULT_LIMIT		0-32		V_O
	UVP/OVP response time			100/50		µs
	Fault response	PMBus configurable VOUT_UV_FAULT_RESPONSE	Ignore fault			
		PMBus configurable VOUT_OV_FAULT_RESPONSE	Disable until fault cleared			
Over Current Protection, OCP Note 5	OCP threshold	PMBus configurable		70		A
	OCP threshold range	IOUT_OC_FAULT_LIMIT		0-128		A
	Protection delay	See Note 4		0		ms
	Fault response	PMBus configurable IOUT_OC_FAULT_RESPONSE -Stand alone, see Note 6 -ACS	Shutdown, 2 ms delay then shut down, no retry			
Over Temperature Protection, OTP, Note 7	OTP threshold	PMBus configurable		125		°C
	OTP threshold range	OT_FAULT_LIMIT	-50		+150	°C
	OTP hysteresis	PMBus configurable OT_FAULT_LIMIT- OT_WARN_LIMIT		35		°C
	Fault response	PMBus configurable OT_FAULT_RESPONSE	Shutdown, automatic restart when no fault exists, ~90°C @ the temperature sensor			

flex

Technical Specification

BMR491 series DC-DC Converters Input 40-60 V, Output up to 55 A / 1300 W	28701-BMR491 12 Rev B April 2026
	© Flex

Characteristics		Conditions	min	typ	max	Unit
Monitoring Accuracy	Input voltage READ_VIN			±125		mV
	Output voltage READ_VOUT			±10		mV
	Output current READ_IOUT	T_{P1} = 25 °C, V_O = 24.0 V		±0.25		A
		T_{P1} = -30 - 125 °C, V_O = 24.0 V		±2.5		A
	Duty cycle READ_DUTY_CYCLE		No tolerance, Read value is the actual value applied by PWM controller			
	Temperature READ_TEMPERATURE_1	Temperature sensor, -30 - 125 °C		±7		°C

Current difference between products in a current sharing group, Note 8	Steady state operation	Max 2 x READ_IOUT monitoring accuracy			
Supported number of products in a current sharing group				3	

		Conditions	min	typ	max	Unit
V_{OL}	Logic output low signal level	SCL, SDA, SYNC, GCB, SALERT, PG Sink / source current = 4 mA			0.25	V
V_{OH}	Logic output high signal level		2.7			V
I_{OL}	Logic output low sink current				4	mA
I_{OH}	Logic output high source current				4	mA
V_{IL}	Logic input low threshold	SCL, SDA, CTRL, SYNC			1.1	V
V_{IH}	Logic input high threshold		2.1			V
C_{I_PIN}	Logic pin input capacitance	SCL, SDA, CTRL, SYNC		10		pF
RC_{S_PU}	Secondary Remote-Control logic pin internal pull-up resistance	SCL, SDA, SALERT		No internal pull-up		
		CTRL to +3.3V Note 9		47		kΩ
f_{SMB}	Supported SMBus Operating frequency		100		400	kHz
T_{BUF}	SMBus Bus free time	STOP bit to START bit See section SMBus – Timing		1.3		μs
t_{set}	SMBus SDA setup time from SCL	See section SMBus – Timing		100		ns
t_{hold}	SMBus SDA hold time from SCL	See section SMBus – Timing		0		ns
	SMBus START/STOP condition setup/hold time from SCL			600		ns
T_{low}	SCL low period		1.3			μs
T_{high}	SCL high period			0.6	50	μs

Note 1. There are configuration changes to consider when changing the switching frequency, see section Switching Frequency.
Note 2. A default value of 0 ms forces the device to Immediate Off behavior with TOFF_FALL ramp-down setting being ignored.
Note 3. The specified accuracy applies for off delay times larger than 4 ms. When setting 0 ms the actual delay will be 0 ms.
Note 4. According to the combination of command MFR_RESPONSE_UNIT_CFG and delay time set in IOUT_OC_FAULT_RESPONSE, see Appendix – PMBus commands.
Note 5. Note that higher OCP threshold than specified may result in damage of the module at OC fault conditions.
Note 6. For current setting see Appendix – PMBus commands
Note 7. See section Over Temperature Protection (OTP).
Note 8. Only valid for Active Current Share (ACS).
Note 9. If configure the CTRL pin with internal Pull-up with command MFR_MULTI_PIN_CONFIG, see Appendix – PMBus commands.

flex

BMR 491 2512/872

Electrical Specification
24 V, 50 A / 1000 W

T_{P1} = -30 to +95ºC, V_I = 40 to 60 V, unless otherwise specified under Conditions, see Note 1
Typical values given at: T_{P1} = +25°C, V_I= 54V, max P_{OTDP}, unless otherwise specified under Conditions, see Note 1.
Additional C_{out} = 1 mF, C_{in} = 0.47 mF

Characteristics		Conditions	min	typ	max	Unit
V_I	Input voltage range		40		60	V
V_{Ioff}	Turn-off input voltage	Decreasing input voltage	34	35	36	V
V_{Ion}	Turn-on input voltage	Increasing input voltage	36	37	38	V
C_I	Internal input capacitance	V_I = 54 V		9.5		µF
P_{OMAX}	Output power maximum	See Note 1			1300	W
P_{OTDP}	Output power (Thermal Design Power)	See Note 1			1300	W
η	Efficiency	50% of P_{OMAX} (650 W)		97.1		%
		100% of P_{OMAX} (1300 W)		96.5		
		50% of P_{OMAX} (650 W), V_I = 48 V		96.8		
		100% of P_{OMAX} (1300 W), V_I = 48 V		96.6		
P_d	Power Dissipation	100% of P_{OMAX}, V_I = 54V		50.2	65	W
P_{li}	Input idling power	P_O = 0 W, V_I = 54 V		9.3		W
P_{RC}	Input standby power	V_I = 54 V (turned off with RC)		1.2		W
f_s	Switching frequency change to ripple freq	0-100 % of P_{OMAX} 0-100 % of max P_{OTDP}	175	180	184	kHz
V_{Oi}	Output voltage initial setting and accuracy	T_{P1} = +25°C, V_I = 54 V, P_O = 0 W	23.94	24	24.06	V
V_O	Output voltage tolerance band	0-100% of P_{OMAX} V_I = 40 – 60 V	23.42		24.48	V
	Output adjust range	0-100% of max P_{OMAX}, see Note 1	16		26.4	V
	Idling voltage	P_O = 0 W	23.8		24.2	V
	Line regulation	V_I = 40 - 60 V, 0-100% of P_{OMAX}		15		mV
	Load regulation	V_I = 54 V, 0-100% of P_{OMAX}			460	mV
V_{tr}	Load transient voltage deviation	V_I = 54 V, Load step 25-75-25% of P_{OMAX}, di/dt = 2 A/µs. See Note 2		±500		mV
t_{tr}	Load transient recovery time			180		µs
t_r	Ramp-up time (from 0−100% of V_{Oi})	V_I = 40-60 V, 0-100% of P_{OMAX} See Note 1		***200***		ms
t_s	Start-up time (from V_I connection to 90% of V_{Oi})			***230***		ms
t_{RC}	RC start-up time	100% of P_{OMAX}		***200***		ms
t_{trim}	Output					
RC	Sink current			0.13		mA
	Trigger level	RC-voltage		1.7		V
	Response time			1.5		mS
I_O	Output current	V_I = 40 - 60 V, see Note 1	0		55	A
I_{lim}	Current limit threshold	T_{P1} = +25°C		70		A
I_{sc}	Short circuit current	T_{P1} = +25ºC, Irms, see Note 3		15.8		A
C_{out}	Recommended Capacitive Load	T_{P1} = +25ºC	470	1000	6800	µF
V_{Oac}	Output ripple & noise	See ripple & noise section, 100% of P_{OMAX}		100		mVp-p
OVP	Output over voltage protection			31.2		V
	Input over voltage protection			70		V

Note 1: The maximum output current is limited to 55A. the maximum power (Maximum power = peak power) is ≤1300W the continuous power (TDP, Thermal Design Power) is ≤1300W, depending on thermal conditions.

Note 2: Cout = 3.56 mF (7x470 µF + 270 µF; 16SEPC, Panasonic, low ESR, POLYMER cap.)

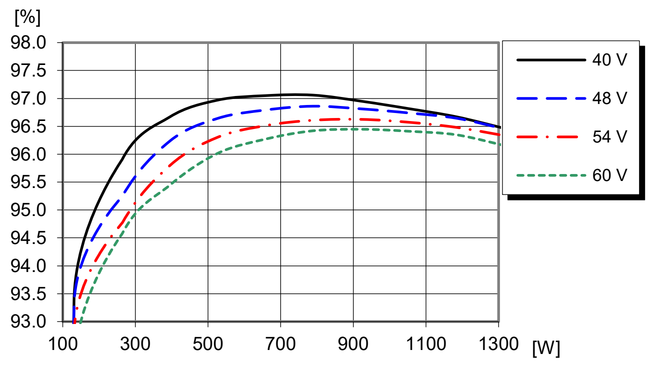
Note 3: Hiccup short circuit protection; RMS output current is the presented.

flex

Typical Characteristics
24 V, 55 A / 1300 W

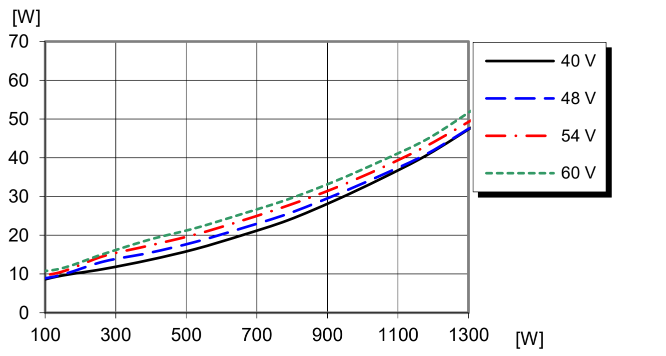
BMR 491 2512/872

Efficiency



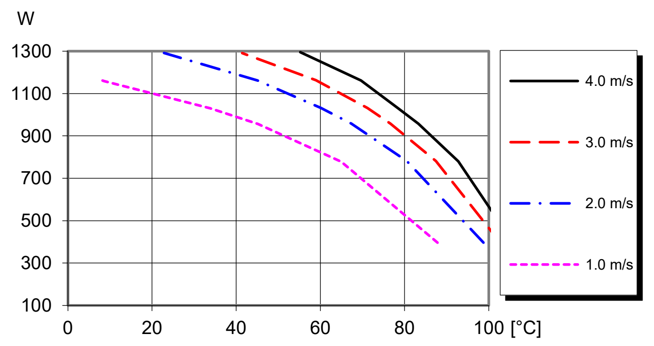
Efficiency vs. load current and input voltage at T_{P1} = +25°C

Power Dissipation



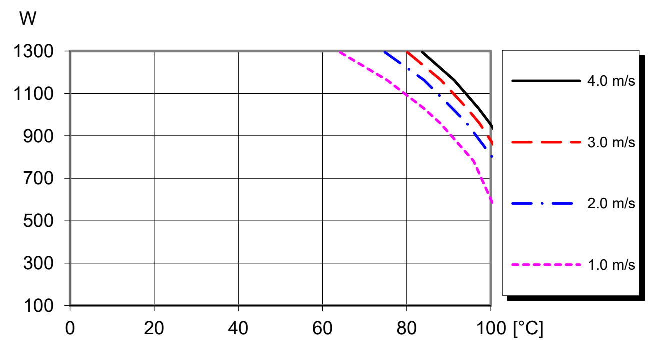
Dissipated power vs. load current and input voltage at T_{P1} = +25°C

Output Power Derating – Baseplate – 54Vin



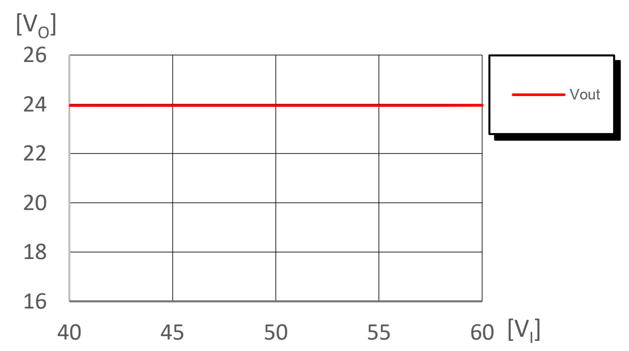
Available output power vs. ambient air temperature and airflow.
See Thermal Consideration section.

Output Power Derating – 1” Heat Sink – 54Vin



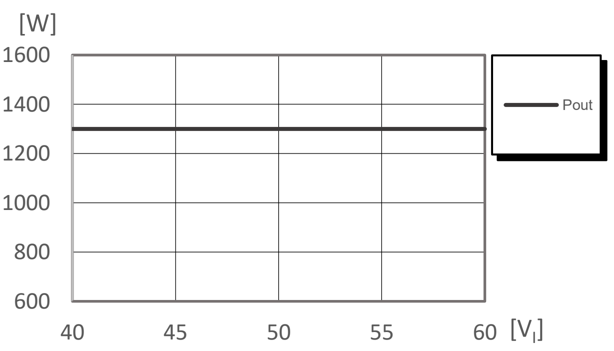
Available output power vs. ambient air temperature and airflow.
See Thermal Consideration section.

Line Characteristics – typical



Output voltage vs. input voltage at T_{P1} = +90°C

Available Power



Available output power vs. input voltage , T_{P1} = +90°C

flex

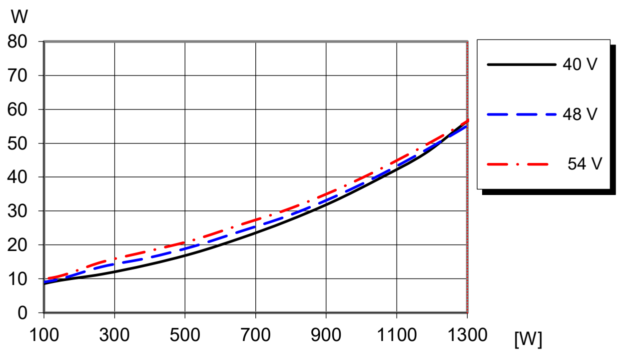
Technical Specification

BMR491 series DC-DC Converters Input 40-60 V, Output up to 55 A / 1300 W	28701-BMR491 12 Rev B April 2026
	© Flex

Typical Characteristics
24 V, 55 A / 1300 W

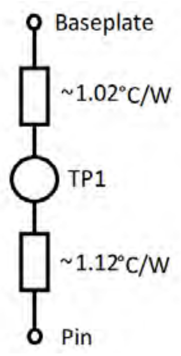
BMR 491 2512/872

Power loss @ elevated temperature



Efficiency vs. load current and input voltage at T_{P1} = +95°C

Simplified 2-resistor thermal model



Thermal model at T_{P1} = +125°C

flex

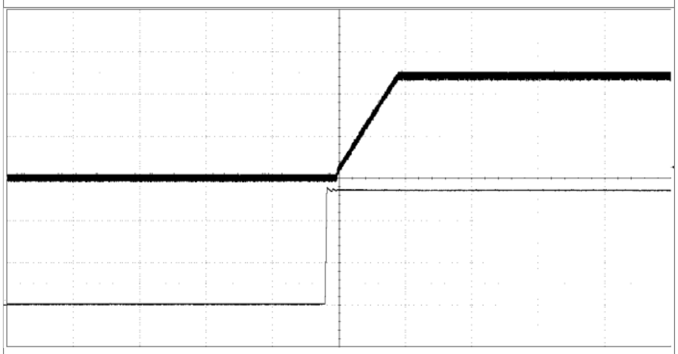
Technical Specification

BMR491 series DC-DC Converters Input 40-60 V, Output up to 55 A / 1300 W	28701-BMR491 12 Rev B April 2026
	© Flex

Typical Characteristics
24 V, 55 A / 1300 W

BMR 491 2512/872

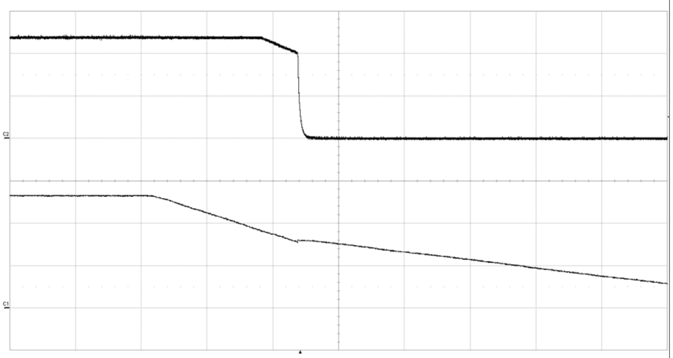
Start-up



Start-up enabled by connecting V_I at:
T_{P1} = +25°C, V_I = 54 V,
I_O = 55 A resistive load.

Top trace: output voltage 10 V/div.
Bottom trace: input voltage 20 V/div.
Time scale: 200 ms/div

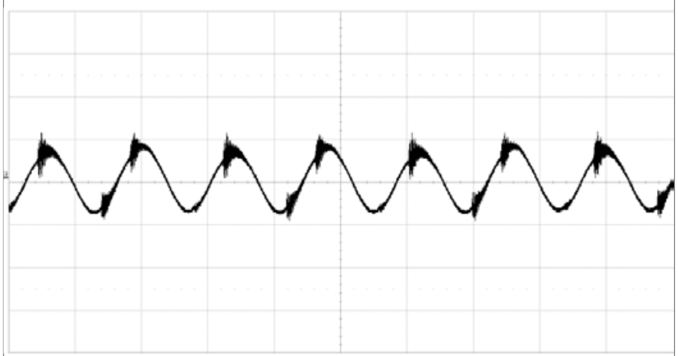
Shut-down



Shut-down enabled by disconnecting V_I at:
T_{P1}= +25°C, V_I = 54 V,
I_O = 55 A resistive load.

Top trace: output voltage 10 V/div.
Bottom trace: input voltage 20 V/div.
Time scale: 10 ms/div.

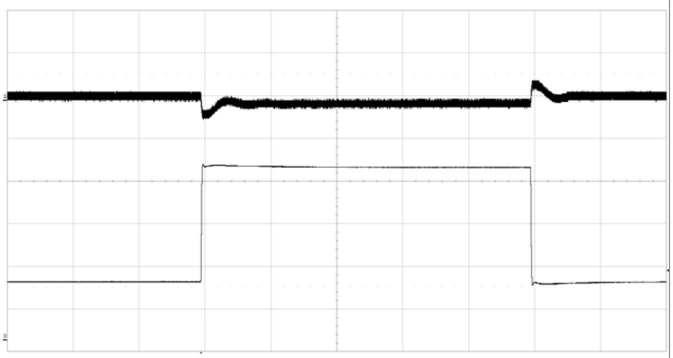
Output Ripple & Noise



Output voltage ripple at:
T_{P1}= +25°C, V_I = 54 V,
I_O = 55 A resistive load.

Trace: output voltage 50 mV/div.
Time scale: 2 μs/div.

Output Load Transient Response



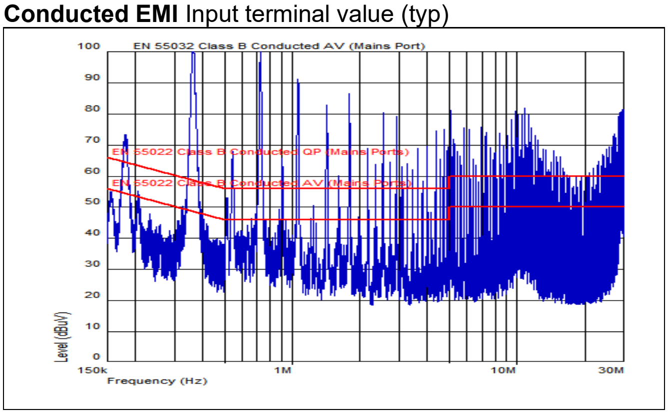
Output voltage response to load current step-change 13.75-41.25-13.75 A (2 A/μs) at:
T_{P1}=+25°C, V_I = 54 V.

Top trace: output voltage 1 V/div.
Bottom trace: load current 10 A/div.
Time scale: 1 ms/div.

EMC Specification

Conducted EMI measured according to EN55022 / EN55032, CISPR 22 / CISPR 32 and FCC part 15J (see test set-up). The fundamental switching frequency is 180 kHz for BMR491. The EMI characteristics below is measured at V_I = 54 V and max I_O.

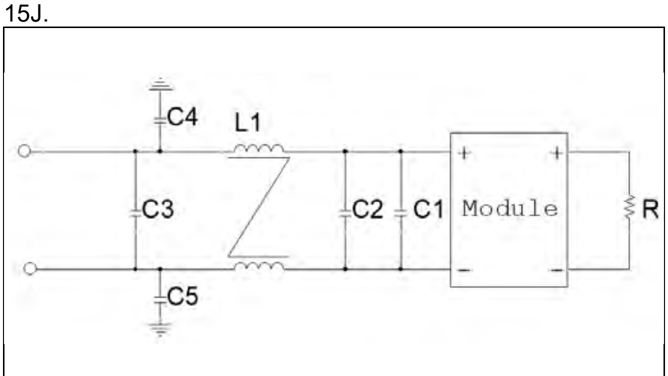
Conducted EMI Input terminal value (typ)



EMI without filter. EN55032 Test method and limits are the same as EN55022. 470 uF 100V input capacitor and 2x 470 uF 16 V OS-CON output capacitor used.

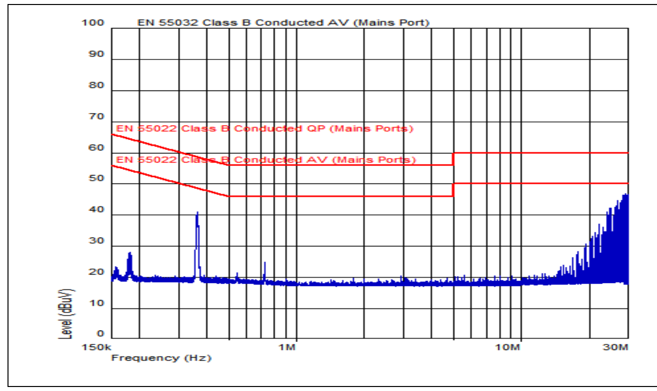
Optional external filter for class B

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

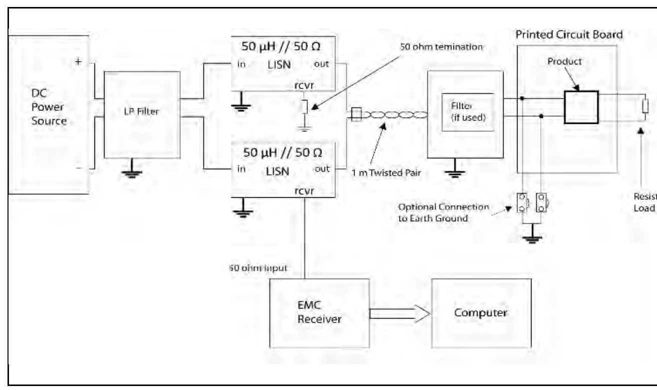


Filter components:

C1 = 470 µF (e-lyt)	L1 = 1.3 mH
C2 = 4 x 10 µF (MLCC)	C4, C5 = 4.7 nF (MLCC)
C3 = 4 x 4.7 µF (MLCC)	



EMI with filter, EN55022 Test method and limits are the same as EN55032.



Test set-up.

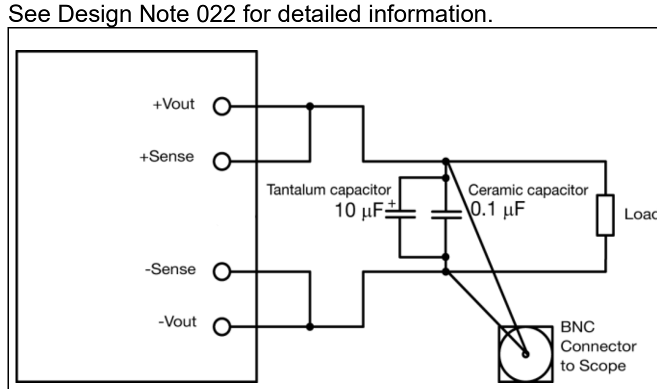
Layout recommendations

The radiated EMI performance of the product will depend on the PWB 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 PWB and improve the high frequency EMC performance.

Output ripple and noise

Output ripple and noise measured according to figure below. See Design Note 022 for detailed information.



Output ripple and noise test setup

Power Management Overview

This product is equipped with a PMBus interface. The product incorporates a wide range of readable and configurable 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, duty cycle and internal temperature.

The product is delivered with a default configuration suitable for a wide range operation in terms of input voltage, output voltage, and load. The configuration is stored in an internal Non-Volatile Memory (NVM). All power management functions can be reconfigured using the PMBus interface

Throughout this document, different PMBus commands are referenced. A detailed description of each command is provided in the appendix at the end of this specification.

The Flex Power Designer software suite can be used to configure and monitor this product via the PMBus interface. For more information please contact your local Flex sales representative.

SMBus Interface

This product provides a PMBus digital interface that enables the user to configure many aspects of the device operation as well as to monitor the input and output voltages, output current and device temperature. The product can be used with any standard two-wire I²C (master must allow for clock stretching) or SMBus host device. In addition, the product is compatible with PMBus version 1.3 and includes an SALERT line to help mitigate bandwidth limitations related to continuous fault monitoring. The product supports 100 kHz and 400 kHz bus clock frequency only. The PMBus signals, SCL, SDA and SALERT require passive pull-up resistors as stated in the SMBus Specification. Pull-up resistors are required to guarantee the rise time as follows:

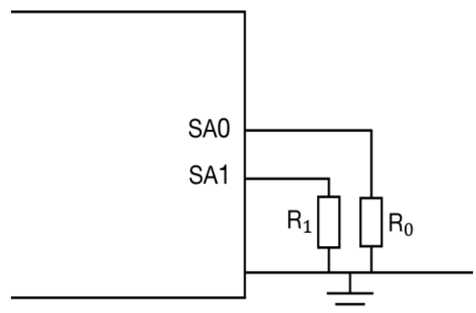
Eq. 7 $\tau = R_p C_p \le 1us$

where R_p is the pull-up resistor value and C_p is the bus load. The maximum allowed bus load is 400 pF. The pull-up resistor should be tied to an external supply between 2.7 to 3.8 V, which should be present prior to or during power-up. If the proper power supply is not available, voltage dividers may be applied. Note that in this case, the resistance in the equation above corresponds to parallel connection of the resistors forming the voltage divider.

It is recommended to always use PEC (Packet Error Check) when communicating via PMBus. There is an optional setting that makes PEC required which further increase communication robustness. This can be configured by setting bit 7 in command MFR_SPECIAL_OPTIONS (0xE0).

PMBus Addressing

The following figure and table show recommended resistor values with min and max voltage range for hard-wiring PMBus addresses (series E96, 1% tolerance resistors suggested):



Schematic of connection of address resistors, (SA0 is optional).

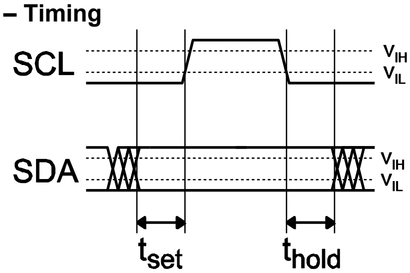
SA1 Index	R_{SA1} [kΩ]	Resulting address with MFR_OFFSET_ADDRESS = 96d
0	10	96d (0x60)
1	15	97d (0x61)
2	21	98d (0x62)
3	28	99d (0x63)
4	35.7	100d (0x64)
5	45.3	101d (0x65)
6	56.2	102d (0x66)
7	69.8	103d (0x67)
8	88.7	104d (0x68)
9	107	105d (0x69)
10	130	106d (0x6A)
11	158	107d (0x6B)
12	191	108d (0x6C)
13	232	109d (0x6D)

The SA1 pin can be configured with a resistor to DGND or -Out according to the following equation:

PMBus Address(decimal) = SA1 index + MFR_OFFSET_ADDRESS

If the calculated PMBus address is 0, 11 or 12, PMBus address 127 is assigned instead. From a system point of view, the user shall also be aware of further limitations of the addresses as stated in the PMBus Specification. It is not recommended to keep the SA1 pin left open. See section MFR_OFFSET_ADDRESS (0xEE) how to set the command to utilize single address pin option. Specific variants may already have a default non-zero value set for MFR_OFFSET_ADDRESS.

I²C/SMBus – Timing



Setup and hold times timing diagram

The setup time, t_{set}, is the time data, SDA, must be stable before the rising edge of the clock signal, SCL. The hold time t_{hold}, is the time data, SDA, must be stable after the rising edge of the clock signal, SCL. If these times are violated incorrect data may be captured or meta-stability may occur and the bus communication may fail. All standard SMBus protocols must be followed, including clock stretching. This product supports the BUSY flag in the status commands to indicate product being too busy for SMBus response. A bus-free time delay between every SMBus transmission (between every stop & start condition) must occur. Refer to the SMBus specification, for SMBus electrical and timing requirements. Note that an additional delay of 5 ms has to be inserted in case of storing the RAM content into the internal non-volatile memory.

Monitoring via PMBus

It is possible to continuously monitor a wide variety of parameters through the PMBus interface. These include, but are not limited to, the parameters listed in the table below.

Parameter	PMBus Command
Input voltage	READ_VIN
Output voltage	READ_VOUT
Output current	READ_IOUT
Temperature *	READ_TEMPERATURE_1
Switching Frequency	READ_FREQUENCY
Duty cycle	READ_DUTY_CYCLE

*Reports the temperature from temperature sensor set in command 0xDC, internal (controller IC)/external (temp sensor).

Monitoring Faults

Fault conditions can be detected using the SALERT pin, which will be asserted low when any number of pre-configured fault or warning conditions occurs. The SALERT pin will be held low until faults and/or warnings are cleared by the CLEAR_FAULTS command, or until the output voltage has been re-enabled. It is possible to mask which fault conditions should not assert the SALERT pin by the command SMBALERT_MASK. In response to the SALERT signal, the user may read a number of status commands to find out what fault or warning condition occurred, see table below.

Fault & Warning Status	PMBus Command
Overview, Power Good	STATUS_BYTE STAUS_WORD
Output voltage level	STATUS_VOUT
Output current level	STATUS _IOUT
Input voltage level	STATUS_INPUT
Temperature level	STATUS_TEMPERATURE
PMBus communication	STATUS_CML
Miscellaneous	STATUS_MFR_SPECIFIC

Black Box/ Event Recorder

Overview

A black box, or history event recorder, is provided to capture brick data at the time of fault occurrence. The intent is to assist in fault diagnosis.

- 48 life cycle & fault & events, first in - first out
  - status flags according to PMBus spec part II rev 1.3
  - life cycle events such as
    - boot
    - fault event recorder erased
    - VinOff/VinOn
    - Vin drop out
- 24 event slots are dedicated for faults
  - Fault events are defined by setting SMBALERT_MASK
  - The default configuration defines following faults:
    - VOUT UV Fault
    - VOUT OV Fault
    - VIN UV Fault
    - VIN OV Fault
    - IOUT UC Fault
    - IOUT OC Fault
    - UT Fault
    - OT Fault
- First in - first out (in case the event recorder was not erased the oldest event gets discarded as new events are recorded)
- When memory is full, the oldest 4 events are erased. A "full" event recorder therefore contains a minimum of 20 fault events and 20 life cycle events.
- Reading the event recorder involves setting the index (PMBus write byte) and reading the indexed event (PMBus read block)
- Ability to clear the section of the event recorder that are dedicated for faults

An event contains following information:

- EventID# < 2^16
- Time stamp 100 ms resolution < 13.6 years
- Status Word, non sticky bits
- Status bytes for all PMBus status registers, non-sticky bits
- Telemetry for Vin, Vout, Iout and temperature (resolution below)

BMR491 series DC-DC Converters Input 40-60 V, Output up to 55 A / 1300 W	28701-BMR491 12 Rev B April 2026
	© Flex

Black Box/ Event Recorder resolution for telemetry
Following resolutions are valid

- Vin: 0.5 V
- Vout: 2^(VoutMode+8) V
  - o e.g. if VoutMode = -11, Vout resolution is 2^(-11+8) = 2^-3 = 125 mV
- Iout: Resolution depends on IOUT_OC_FAULT_LIMIT
  - o e.g. if IOUT_OC_FAULT_LIMIT < 85 A, Iout resolution is 0.5 A)
- Temperature: 1 °C

Unit off status codes
Applies only to the life cycle section of the event recorder

When the Status Word in an event is 0x0040 (Unit off) the StatusMfr byte indicates if the unit was turned on or off and with what source.

NS_UNIT_IS_OFF (cfg)	0
NS_UNIT_IS_OFF (priRC)	1
NS_UNIT_IS_OFF (secRC)	2
NS_UNIT_IS_OFF (PMBus)	3
NS_UNIT_IS_ON (cfg)	4
NS_UNIT_IS_ON (priRC)	5
NS_UNIT_IS_ON (secRC)	6
NS_UNIT_IS_ON (PMBus)	7

Power Good status codes
Applies only to the life cycle section of the event recorder
When the Status Word in an event is 0x0800 (Power Good) the StatusMfr byte indicates if PG was asserted or de-asserted. 0 means power is not good, 1 means power is good

Manufacturer status codes (StatusMfr)
When status word is 0x0001 a system event is reported in the StatusMfr byte:

- 0x01 BOOT_EVENT
- 0x02 INPUT_LOW_ EVENT
- 0x04 CANCEL_EVENT
- 0x08 ERASE_EVENT
- 0x10 CLR_EVENT
- 0x20 ERASE_OVFL_EVENT

All codes apply to the life cycle section of the event recorder. Only INPUT_LOW_DETECT, CANCEL_EVENT and ERASE_OVFL_EVENT apply to the fault section of the event recorder.

- The BOOT_EVENT records time data when needed
- An INPUT_LOW_ EVENT might be recorded at shut down. The purpose of this event is to store time data at shutdown unless it has already been stored
- The maximum time between two events is 2.1 years. A time out will be recorded as a CANCEL_EVENT
- An ERASE_EVENT is recorded in the life cycle section when the fault section is cleared
- A CLR_EVENT is recorded in the life cycle section when a CLEAR_FAULTS command is sent to the unit
- An ERASE_OVFL_EVENT indicates that the event recorder was overloaded while erasing old records but did recover

Reading the event recorder
EVENT_INDEX
Writing to this command sets current index to read by the READ_EVENT command. It also provides means to clear the fault section of the event recorder and finding the newest event (equal to number of events stored in the event recorder)

Write byte	Read after write
0 – 47	same value as written.
254	Index of newest record in the life cycle section of the event recorder.
255	Index of newest record in the fault section of the event recorder.
0xAA	0xAA. The fault section of the event recorder is cleared.

For all the above; READ_EVENT is prepared for reading the index that was written.
Index 0-23 refers to the fault section of the event recorder
Index 24-47 refers to the life cycle section of the event recorder

READ_EVENT
One event, prepared by writing to EVENT_INDEX, are read as a 23 byte block.

Notes

- When clearing the fault section of the event recorder, the event id number is reset but time stamp data is kept
- Clearing the fault section of the event recorder takes typically 121 ms. During this time fault handling is disabled and a PMBus host must not access the unit.
- Reading an empty event will return 0xFF in all bytes.
- Setting up the event record (after indexing with the EVENT_INDEX command) takes typically 30 us. Reading within this time frame will return unpredictable result.

PMBUS command details
EVENT_INDEX (read/write byte 0xDB)
Offset value 0-47. 0 is always the oldest event in the fault section of the event recorder. 24 is the oldest event in the life cycle section. For other options see above.

Start	Device Address & R/*W*	Command byte 0xDB	*Index value (byte)*	PEC	Stop

READ_EVENT (read block 0xD7)

<table>
<tr><td>Start</td><td>Device Address & W</td><td>Command Code 0xD7</td><td>Repeated start</td><td>Device Address & R</td><td>Block count = 23</td></tr>
<tr><td colspan="2">EventID# (high byte)</td><td>EventID# (low byte)</td><td>TimeStamp (byte3)</td><td>TimeStamp (byte2)</td><td></td></tr>
<tr><td colspan="2">TimeStamp (byte1)</td><td>TimeStamp (byte0)</td><td>StatusWord (high byte)</td><td>StatusWord (low byte)</td><td></td></tr>
<tr><td colspan="2">StatusVout</td><td>StatusIout</td><td>StatusInput</td><td>StatusTemperature</td><td></td></tr>
<tr><td colspan="2">StatusCML</td><td>StatusOther</td><td>StatusMfr</td><td>VinValue (high byte)</td><td></td></tr>
<tr><td colspan="2">VinValue (low byte)</td><td>VoutValue (high byte)</td><td>VoutValue (low byte)</td><td>IoutValue (high byte)</td><td></td></tr>
<tr><td colspan="2">IoutValue (low byte)</td><td>TemperatureValue (high byte)</td><td>TemperatureValue (low byte)</td><td>PEC</td><td>Stop</td></tr>
</table>

Non-Volatile Memory (NVM)
The product incorporates two Non-Volatile Memory areas for storage of the PMBus command values; the Default NVM and the User NVM. The Default NVM is pre-loaded with Flex factory default values. The Default NVM is write-protected and can be used to restore the Flex factory default values through the command RESTORE_DEFAULT_ALL (0x12).
The User NVM is pre-loaded with Flex factory default values. The User NVM is writable and open for customization. The values in NVM are loaded during initialization according to section Initialization Procedure, where after commands can be changed through the PMBus Interface. The STORE_USER_ALL (0x15) command will store the changed parameters to the User NVM.

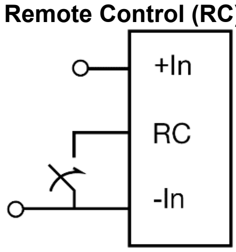
Operating Information

Input Voltage
The input voltage range 40 to 60 Vdc meets the requirements for normal input voltage range in –48 Vdc systems, -40.5 to -57.0 V. At input voltages exceeding 60 V, the power loss will be higher than at normal input voltage and T_{P1} must be limited to absolute max +125°C. The absolute maximum continuous input voltage is 65 Vdc.

Short duration transient disturbances can occur on the DC distribution and input of the product when a short circuit fault occurs on the equipment side of a protective device (fuse or circuit breaker). The voltage level, duration and energy of the disturbance are dependent on the particular DC distribution network characteristics and can be sufficient to damage the product unless measures are taken to suppress or absorb this energy. The transient voltage can be limited by capacitors and other energy absorbing devices like zener diodes connected across the positive and negative input conductors at a number of strategic points in the distribution network. The end-user must secure that the transient voltage will not exceed the value stated in the Absolute maximum ratings. ETSI TR 100 283 examines the parameters of DC distribution networks and provides guidelines for controlling the transient and reduce its harmful effect.

Turn-on and -off Input Voltage
The product monitors the input voltage and will turn on and turn off at configured thresholds (see Electrical Specification). The turn-on input voltage voltage threshold is set higher than the corresponding turn-off threshold. Hence, there is a hysteresis between turn-on and turn-off input voltage levels.

Remote Control (RC)



The products are fitted with a remote control function referenced to the primary negative input connection (-In), with negative and positive logic options available. The RC function allows the product to be turned on/off by an external device like a semiconductor or mechanical switch. The RC pin has an internal pull up resistor.

The external device must provide a minimum required sink current >0.5 mA to guarantee a voltage not higher than maximum voltage on the RC pin (see Electrical characteristics table). When the RC pin is left open, the voltage generated on the RC pin is max 5 V. The standard product is provided with "negative logic" RC and will be off until the RC pin is connected to the –In. To turn off the product the RC pin should be left open. In situations where it is desired to have the product to power up automatically without the need for control signals or a switch, the RC pin shall be wired directly to –In.

Remote Control (secondary side)
The CTRL-pin can be configured as remote control via the PMBus interface. In the default configuration the CTRL-pin is disabled and floating. The output can be configured to internal pull-up to 3.3 V using the MFR_MULTI_PIN_CONFIG (0xF9) command. The logic options for the secondary remote control can be positive or negative logic. The logic option for the secondary remote control is easily configured via ON_OFF_CONFIG (0x02) using Flex Power Designer software command, see also MFR_MULTI_PIN_CONFIG section. When not used it is recommended to connect the CTRL pin to DGND.

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. Minimum recommended external input capacitance is 470 µF. The electrolytic capacitors will be degraded in low temperature. The needed input capacitance in low temperature should be equivalent to 470 µF at 20°C. The performance in some applications can be enhanced by addition of external capacitance as described under External Decoupling Capacitors. If the input voltage source contains significant inductance, the addition of a low ESR ceramic capacitor of 22 – 100 µF capacitor across the input of the product will ensure stable operation. The minimum required capacitance value depends on the output power and the input voltage. The higher output power the higher input capacitance is needed. A minor leakage current in standby mode might over time build up a few volts if not taken care of with external load.

External Decoupling Capacitors
When powering loads with significant dynamic current requirements, the voltage regulation at the point of load can be improved by addition of decoupling capacitors at the load. The most effective technique is to locate low ESR ceramic and electrolytic capacitors as close to the load as possible, using several parallel capacitors to lower the effective ESR. The ceramic capacitors will handle high-frequency dynamic load changes while the electrolytic capacitors are used to handle low frequency dynamic load changes. It is equally important to use low resistance and low inductance PWB layouts and cabling.

BMR491 series DC-DC Converters Input 40-60 V, Output up to 55 A / 1300 W	28701-BMR491 12 Rev B April 2026
	© Flex

External decoupling capacitors will become part of the product's control loop. The control loop is optimized for a wide range of external capacitance and the maximum recommended value that could be used without any additional analysis is found in the Electrical specification.
The ESR of the capacitors is a very important parameter. Stable operation is guaranteed with a verified ESR value of >1 mΩ across the output connections.
For further information please contact your local Flex Power Modules representative.

Remote Sense

The products have 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 PWB ground layer to reduce noise susceptibility. The remote sense circuitry will compensate a voltage drop between output pins and the point of load that is as high as 10% of the output voltage.

If the remote sense is not needed +Sense should be connected to +Out and –Sense should be connected to –Out. To be able to use remote sense the converter must be equipped with a digital header.

The product provides a PMBus digital interface that enables the user to configure many aspects of the device operation as well as monitor the input and output parameters.
The Flex Power Designer software suite can be used to configure and monitor this product via the PMBus interface. For more information, please contact your local Flex sales representative.

Output Voltage Adjust using PMBus

The output voltage of the product can be reconfigured via PMBus command VOUT_COMMAND (0x21) or VOUT_TRIM (0x22). This can be used when adjusting the output voltage above or below output voltage initial setting up to a certain level, see Electrical specification for adjustment range.

Output voltage setting must be kept below the threshold of the over voltage protection, (OVP) to prevent the product from shutting down. At increased output voltages the maximum power rating of the product remains the same, and the max output current must be decreased correspondingly.

Margin Up/Down Controls

These controls allow the output voltage to be momentarily adjusted, either up or down, by a nominal 10%. The margin high and margin low shall be limited to max and min output voltage, if the nominal output voltage is changed. This provides a convenient method for dynamically testing the operation of the load circuit over its supply margin or range. It can also be used to verify the function of supply voltage supervisors.
The margin up and down levels of the product can easily be re-configured using Flex Power Designer software.

Soft-start Power Up

The default rise time for a single product is 10 ms. When starting by applying input voltage the control circuit boot-up time adds an additional 25 ms delay. The soft-start and soft-stop control functionality allows the output voltage to ramp-up and ramp-down with defined timing with respect to the control of the output. This can be used to control inrush current and manage supply sequencing of multiple controllers.
The rise time is the time taken for the output to ramp to its target voltage, while the fall time is the time taken for the output to ramp down from its regulation voltage to 0 V. The TON_DELAY (0x60) time sets a delay from when the output is enabled until the output voltage starts to ramp up. The TOFF_DELAY (0x64) delay time sets a delay from when the output is disabled until the output voltage starts to ramp down.

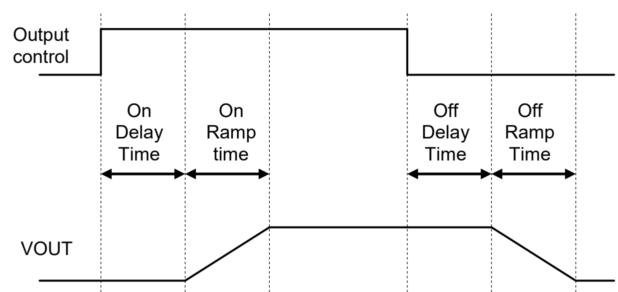


Illustration of Soft-Start and Soft-Stop.

By default, soft-stop is disabled, and the regulation of output voltage stops immediately when the output is disabled. Soft-stop can be enabled through the PMBus command ON_OFF_CONFIG (0x02). The delay and ramp times can be reconfigured using the PMBus commands TON_DELAY (0x60), TON_RISE (0x61), TOFF_DELAY (0x64) and TOFF_FALL (0x65).
Before module initiates startup sequence it checks for any parameters exceeding fault levels that could affect startup.

Pre-bias Start-up

The product has a Pre-bias start up functionality and will not sink current during start up if a pre-bias source is present at the output terminals. If the Pre-bias voltage is lower than the target value set in VOUT_COMMAND (0x21), the product will ramp up to the target value. If the Pre-bias voltage is higher than the target value set in VOUT_COMMAND (0x21), the product will ramp down to the target value and in this case sink current for a time interval set by the command TOFF_MAX_WARN_LIMIT (0x66).

Parallel Operation ACS (Active Current Share)

Better current share performance can be achieved on the variants with ACS feature enabled. The advantages of the ACS compared with normal DLS: It utilizes a dedicate current share bus to balance the load between the paralleled modules. Each module in the bus will trim its regulated output up and down continuously to be able to output the same current seen from the current share bus. This feature will cancel out the current share error caused by the modules output voltage deviation, temperature deviation and layout

flex

Technical Specification

BMR491 series DC-DC Converters Input 40-60 V, Output up to 55 A / 1300 W	28701-BMR491 12 Rev B April 2026
	© Flex

asymmetry. The max load of the paralleled modules equals to (max load of single module-2.5A) * number of paralleled modules. The 2.5A is the maximum error of the output current monitor and current accuracy between products in a current sharing group is 2 x 2.5A. The ACS also provides less droop compared with the DLS, thus push the max power even higher. The modules are adjusting their output continuously according to the ACS algorithm, the output voltage at idle will vary maximum ±100mV due to limitations in idle current measurements. The ACS feature is not activated during start up so the maximum load during ramp up will still be limited to number of modules x max load of single module x 90% (nmodules x Ioutmax x 0.9).

How to setup the ACS: All the precautions mentioned in the DLS section are still valid when use the ACS. All the CTRL (Pin 9) pins of the paralleled modules need to be tied together and close to each module a ceramic capacitor shall be connected between CTRL (Pin 9) and DGND.

Over/Under Temperature Protection (OTP, UTP)
The products are protected from thermal overload by an internal over temperature sensor.
The product will make continuous attempts to start up (non-latching mode) and resume normal operation automatically when the temperature has dropped below the temperature threshold set in command OT_WARN_LIMIT (0x51).
In the temperature readout (0x8D) range between OT_WARN_LIMIT (0x51) and OT_FAULT_LIMIT (0x4F) the module will not start-up.
If for any reason the module needs to start or restart, it will wait until the temperature readout value is below the value of OT_WARN_LIMIT.
This includes restarts initiated by OCP, input and output OVP or any other protection as well as Vin and remote control.

OTP and hysteresis of the product can be re-configured using the PMBus interface. The product has also an under-temperature protection. The OTP and UTP fault limit and fault response can be configured via the PMBus. Note: using the fault response “continue without interruption” may cause permanent damage to the product

Input Over/Under Voltage Protection
The product can be protected from high input voltage and low input voltage by a pre-configured value with a response time of 100us. The over/under-voltage fault level and fault response is easily configured using Flex Power Designer software, see also Appendix – PMBus commands.

Output Over Voltage Protection (OVP)
The product includes over voltage limiting circuitry for protection of the load. The default OVP limit is 30% above the nominal output voltage. If the output voltage exceeds the OVP limit, the product can respond in different ways.
The default response from an over voltage fault is to immediately shut down. The device will continuously check for the presence of the fault condition, and when the fault condition no longer exists the device will be re-enabled.
The OVP fault level and fault response can be configured via the PMBus interface, see Appendix – PMBus commands.

Over Current Protection (OCP)
The products include current limiting circuitry for protection at continuous overload. For standard configuration the output voltage will decrease towards 0.3×Vout, set in command IOUT_OC_LV_FAULT_LIMIT (0x48), then shutdown and automatic restart for output currents in excess of max output current (max I_O). The product will resume normal operation after removal of the overload. The load distribution should be designed for the maximum output short circuit current specified.
The over current protection of the product can be configured via the PMBus interface, see Appendix – PMBus commands.

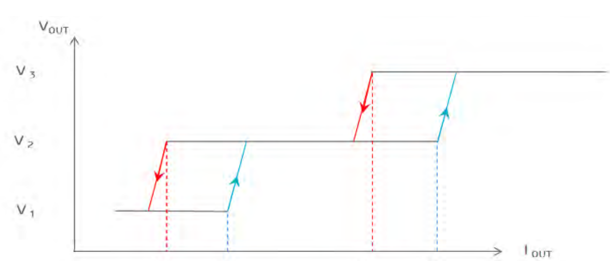
Switching frequency
The switching frequency is set to 180kHz as default but this can be reconfigured via the PMBus interface. The product is optimized at this frequency, but can run at lower and higher frequency (150kHz-200kHz). The electrical performance can be affected if the switching frequency is changed.

DBV (Dynamic Bus Voltage)
The MFR_DBV_CONFIG (0xEF) command can be used when the output voltage shall change depending on the output current load, which can improve the energy consumption. In MFR_DBV_CONFIG there are 4 current thresholds, low to mid (I1H), mid to low (I1L), mid to high (I2H) and high to mid (I2L) and 2 voltage levels that can be set, V1 and V2, V3 is the default setting in VOUT_COMMAND (0x21).

The Vout rise time is configured via VOUT_TRANSITION_RATE (0x27), consider that the max output current or power can’t be exceeded when entering different Vout levels.

The MFR_DBV_CONFIG is easily configured using Flex Power Designer software, see also Appendix – PMBus commands.

It is not recommended to use DBV when operating units in parallel.



ART (Adaptive Ramp-up Time)

Technical Specification

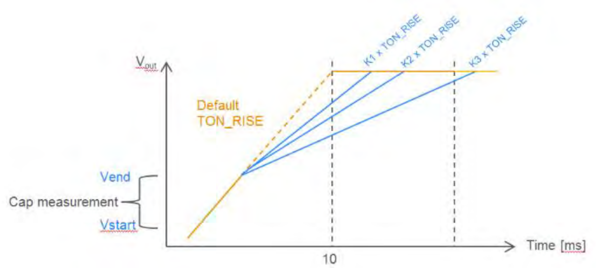
BMR491 series DC-DC Converters Input 40-60 V, Output up to 55 A / 1300 W	28701-BMR491 12 Rev B	April 2026
	© Flex	

MFR_DLC_CONFIG (0xF7) command combines ART and DLC functions. This section describes the ART function. It can be useful when adaptive rise time is requested, referenced to the output capacitive load.

From start of ramp-up, TON_RISE (0x61) is used. V_{end} and V_{start} state the levels on the ramp where the output capacitance is measured. The values K1, K2 and K3 set the ramp factor multiplied to the default TON_RISE value. The ramp factor is referenced to Limit1, Limit2 and Limit3 stated in MFR_DLC_CONFIG.

The MFR_DLC_CONFIG is easily configured using Flex Power Designer software, see also Appendix – PMBus commands.

It is not recommended to use ART when operating units in parallel.



DLC (Dynamic Load Compensation)
MFR_DLC_CONFIG (0xF7) command combines ART and DLC functions. This section describes the DLC function. The DLC function is useful when optimized parameters for the control loop is requested, referenced to the output capacitive load. Only if the output capacitance is larger than Limit3 the control loop will be changed.

V_{end} and V_{start} state the levels on the ramp where the output capacitance is measured. At the end of this measurement the control loop can possibly change depending on the configuration.

The MFR_DLC_CONFIG is easily configured using Flex Power Designer, see also Appendix – PMBus commands.

It is not recommended to use DLC when operating units in parallel.

Multi pin configuration
The MFR_MULTI_PIN_CONFIG (0xF9) command can be re-configured using the PMBus interface to enable or disable different functions and set the pin configuration of the digital header (pin 6-15), see Appendix – PMBus commands. The MULTI_PIN_CONFIG is easily configured using Flex Power Designer, see also Appendix – PMBus commands. Active current share is hardware configured, meaning if this is setting is active it cannot be reconfigured.

Address Offset
The command MFR_OFFSET_ADDRESS (0xEE) is used to configure an address offset. The PMBus-address offset's value increments the address value following the formula in the PMBus Addressing section of documentation. This increases flexibility when the part is used in single-pin and no-pin addressing scenarios, such as when the SA1 is used instead for Sync. See Appendix – PMBus commands.

Thermal Consideration

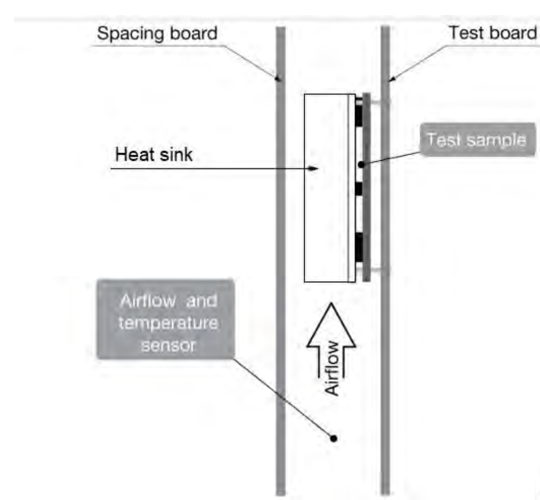
General

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

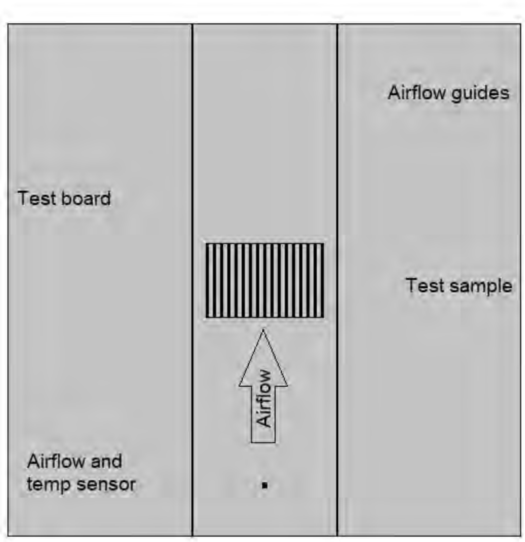
These high output power modules require external cooling such as heat sink or cold wall.
Wind speed and temperature are measured in a point upstream the device. Output Current Derating graph found in the Output section for each model provides the available output current vs. ambient air temperature and air velocity at V_I = 54 V.

For products using any form of heat sink structure a top spacing board and side airflow guides are used to ensure airflow hitting the module and not diverted away.
Distance between the tested device and the top space board and the side airflow guides are 6.35mm ± 1mm.

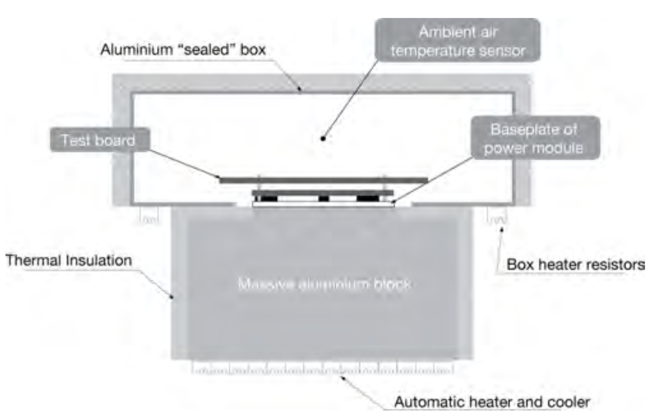
Product is tested on a 254 x 254 mm, 35 µm (1 oz), 16-layer test board mounted vertically in a wind tunnel.



BMR491 series DC-DC Converters Input 40-60 V, Output up to 55 A / 1300 W	28701-BMR491 12 Rev B April 2026
	© Flex



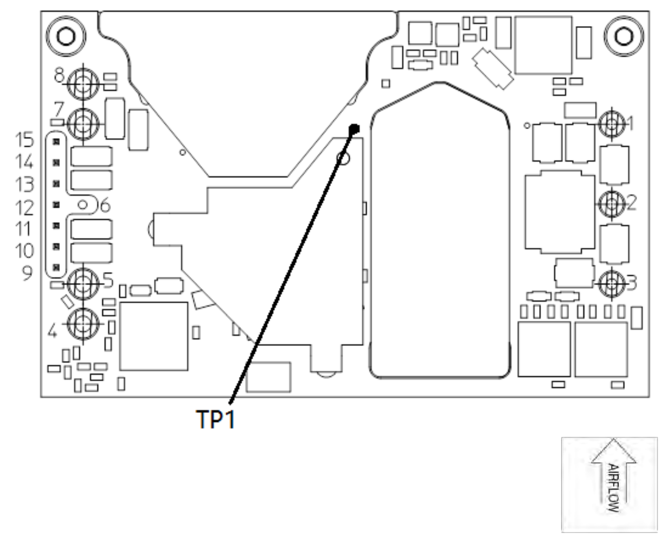
For products with base plate used in a sealed box/cold wall application, cooling is achieved mainly by conduction through the cold wall. The Output Current Derating graphs are found in the Output section for each model. The product is tested in a sealed box test set up with ambient temperatures 85°C. See Design Note 028 for further details.



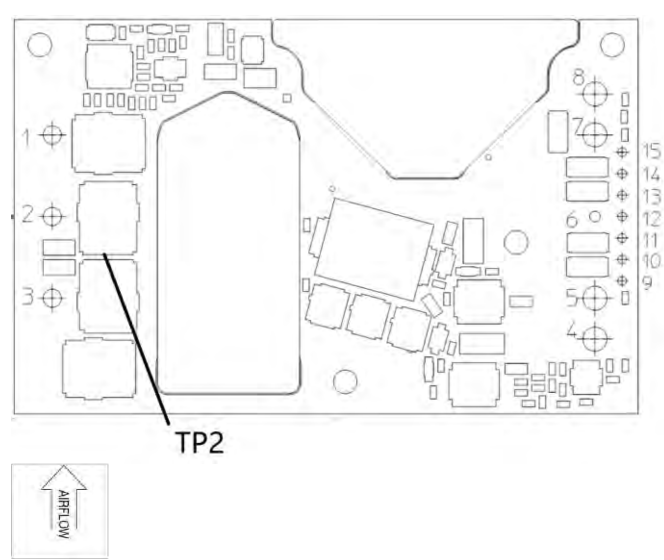
Definition of product operating temperature

The product operating temperatures is used to monitor the temperature of the product, and proper thermal conditions can be verified by measuring the temperature at positions P1 and 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 T_{P1}, measured at the reference point P1 are not allowed and may cause permanent damage.

Position	Description	Max Temp.
P1	PWB reference point	T_{P1}=110º C
P2	MOSFET pin solder point	T_{P1}=125º C



Base plate (Bottom view)



Open frame (Top view)

BMR491 series DC-DC Converters Input 40-60 V, Output up to 55 A / 1300 W	28701-BMR491 12 Rev B April 2026
	© Flex

Ambient Temperature Calculation
For products with base plate the maximum allowed ambient temperature can be calculated by using the thermal resistance.

1. The power loss is calculated by using the formula ((1/η) - 1) × output power = power losses (Pd).
η = efficiency of product. E.g. 96% = 0.96

2. Find the thermal resistance (Rth) in the Thermal Resistance graph found in the Output section for each model. ***Note that the thermal resistance can be reduced if a heat sink is mounted on the top of the base plate.***

Calculate the temperature increase (ΔT).
ΔT = Rth x Pd

3. Max allowed ambient temperature is:
Max T_{P1} - ΔT.

E.g. BMR 491 2510 at 4.0m/s:

1. $\left(\frac{1}{0.964}\right) - 1) \times 1300\ W = 49\ W$

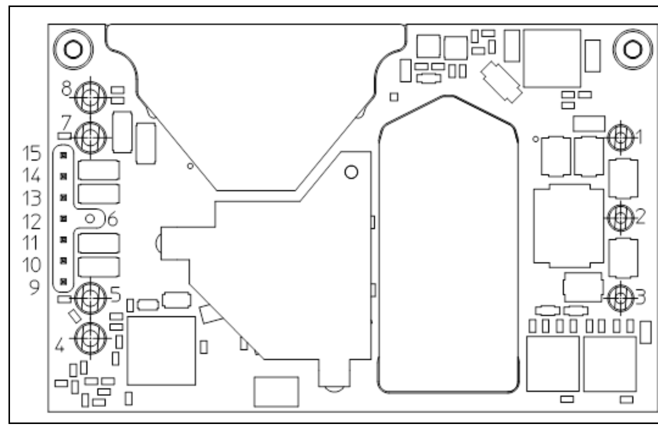
2. 49 W × 1.02°C/W = 50°C

3. 125 °C - 50°C = max ambient temperature is 75°C

4. The thermal performance can be improved by mounting a heat sink on top of the base plate.

The actual temperature will be dependent on several factors such as the PWB size, number of layers and direction of airflow.

Connections (Bottom view)



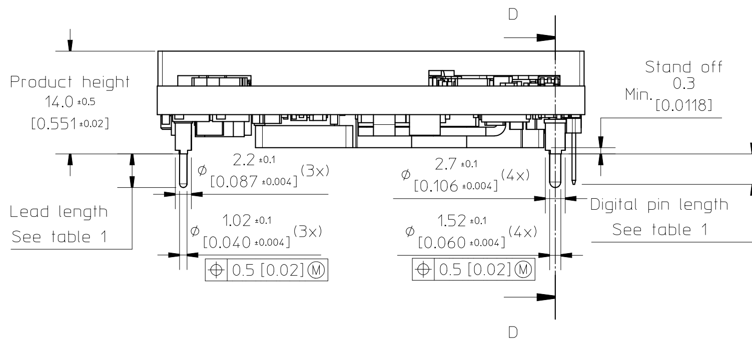
Pin	Designation	Possible Function
1	+In	Positive Input
2	RC	Remote Control
3	-In	Negative Input
4	-Out	Negative Output
5	-Out	Negative Output
6	*SYNC*	*SYNC input/output*
7	+Out	Positive Output
8	+Out	Positive Output
9	*ACS*	*Current Share*
10	-SENSE	Negative Remote Sense
11	SDA	PMBus Data
12	SALERT	PMBus alert signal
13	SCL	PMBus Clock
14	SA1	PMBus Address 1
15	*+SENSE*	*Positive Remote Sense*

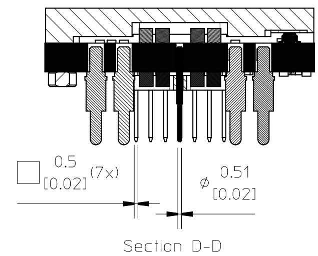
flex

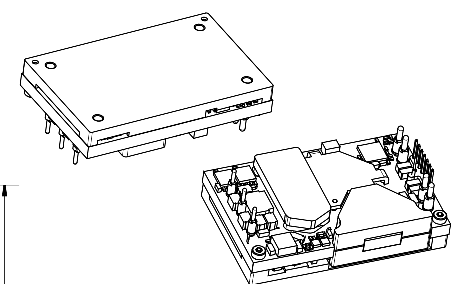
Technical Specification

BMR491 series DC-DC Converters Input 40-60 V, Output up to 55 A / 1300 W	28701-BMR491 12 Rev B	April 2026
	© Flex	

BMR 491 x5xx /xxx - Hole mounted, Baseplate version







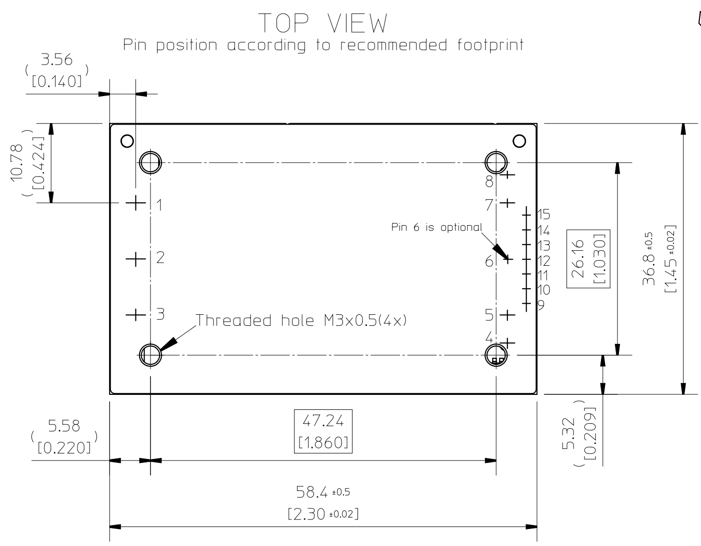


Table 1

	Lead length (Except: Pin6)	Digital pin & Pin6 insert length
Standard	5.33 [0.210]	4.83 [0.190]
LA	3.69 [0.145]	3.33 [0.131]
LB	4.57 [0.180]	4.15 [0.163]

NOTES:

BASEPLATE INTERFACE:

Material: Aluminium

For screw attachment apply mounting torque of max 0.44 Nm [3.9 lbf in.]

M3 screw must not protrude more than 3.0mm [0.118 in.] into the baseplate.

Pins:

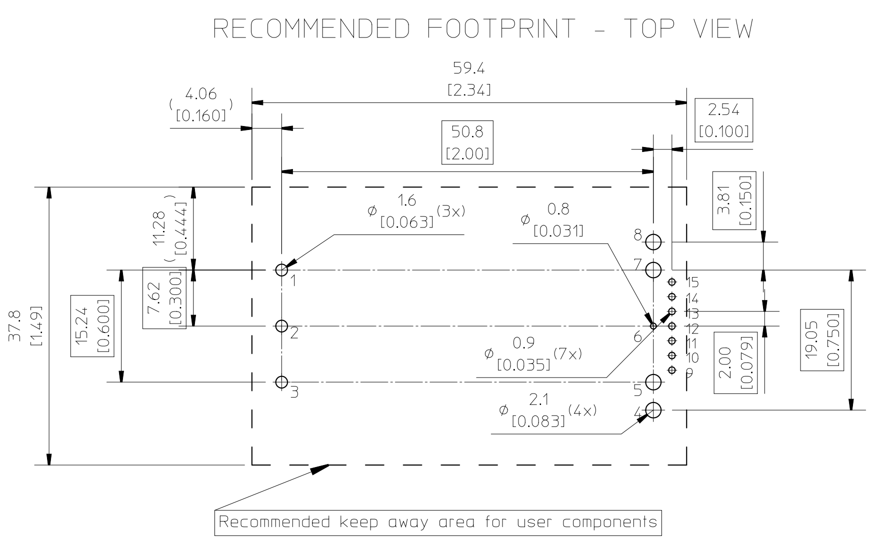
Pins material: Copper alloy

Plating: Min 0.1µm Au over 1-3µm Ni

WEIGHT

Typical: 88 g

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.



All dimensions in mm

Tolerances unless specified:

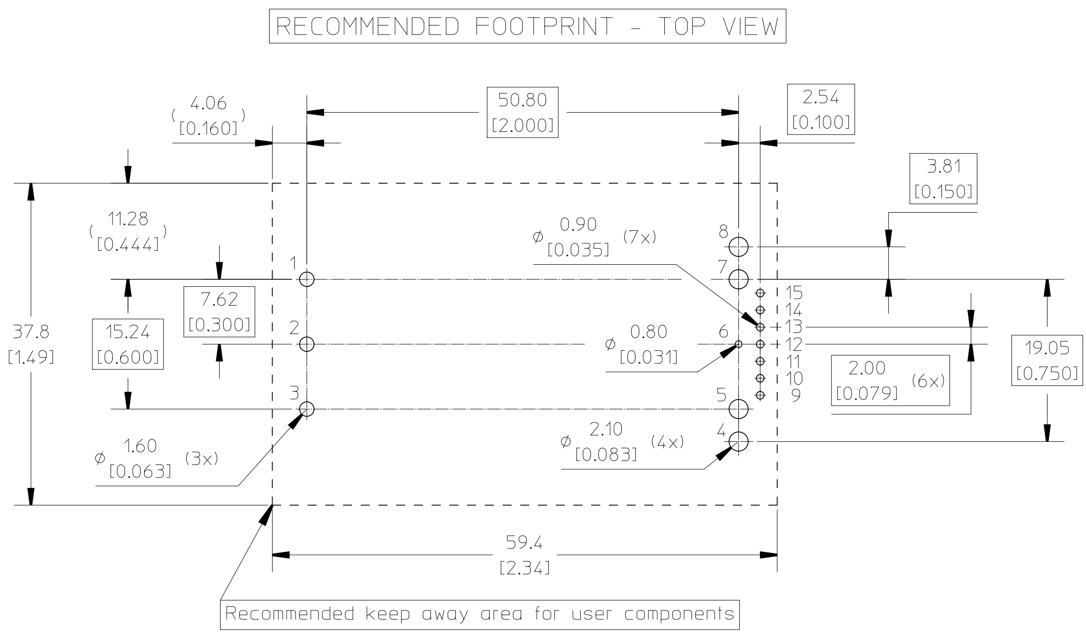
x.x ±0.5, x.xx±0.25

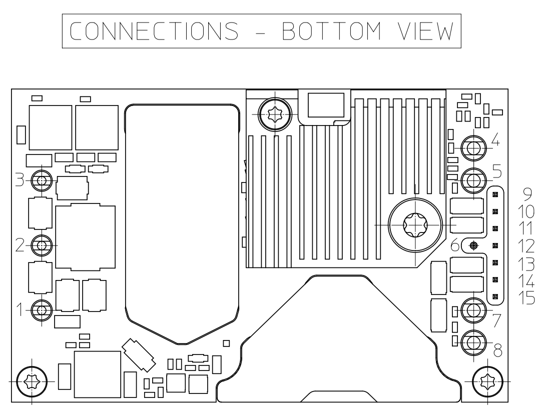
All component placements – whether shown as physical components or symbolical outline – are for reference only and are subject to change throughout the product's life cycle, unless explicitly described and dimensioned in this drawing.

Technical Specification

BMR491 series DC-DC Converters Input 40-60 V, Output up to 55 A / 1300 W	28701-BMR491 12 Rev B April 2026
	© Flex

Footprint and Pin positions valid for all versions





PIN SPECIFICATIONS:

Pin 1-5, 7-8 Material: Copper alloy
Plating: Min Au 0.1 µm over Ni 1-3 µm

Pin 6, 9-15 Material: Brass
Plating: Min Au 0.1 µm over Ni 1-3 µm

Technical Specification

BMR491 series DC-DC Converters Input 40-60 V, Output up to 55 A / 1300 W	28701-BMR491 12 Rev B April 2026
	© Flex

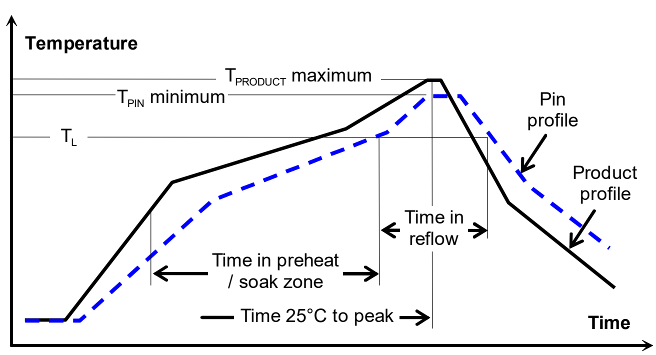
Soldering Information – Hole Mount through Pin in Paste Assembly

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

Reflow soldering is not preferred for through-hole mounted power modules due to challenges resulting in reduced reliability. High temperature reflow soldering causing IMC layer thickness increase resulting in shorten solder joint lifetime. To avoid component or solder failure a module peak temperature higher than 245 degrees and above 217 degrees more than 90 seconds is not recommended. To prevent re-melt of module internal solder joints shielding cap is required during reflow process.

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.

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	T_{PIN}	60 s	60 s
Minimum pin temperature	T_{PIN}	210°C	235°C
Peak product temperature	$T_{PRODUCT}$	225°C	245°C
Average ramp-down ($T_{PRODUCT}$)		6°C/s max	6°C/s max
Maximum time 25°C to peak		6 minutes	8 minutes



Thermocoupler Attachment

$T_{PRODUCT}$ is measured on the base plate top side, since this will likely be the warmest part of the product during the reflow process.
T_{PIN} temperature is measured on the power module pins solder joints at customer board.

Product reflow classification

The product has been tested for the following

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

Product reflow processes

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 60 seconds and a peak temperature of 220°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.

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 60 seconds and a peak temperature of 245°C on all solder joints is recommended to ensure a reliable solder joint.

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, floor life according to MSL 3, the modules must be baked according to J-STD-033.

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

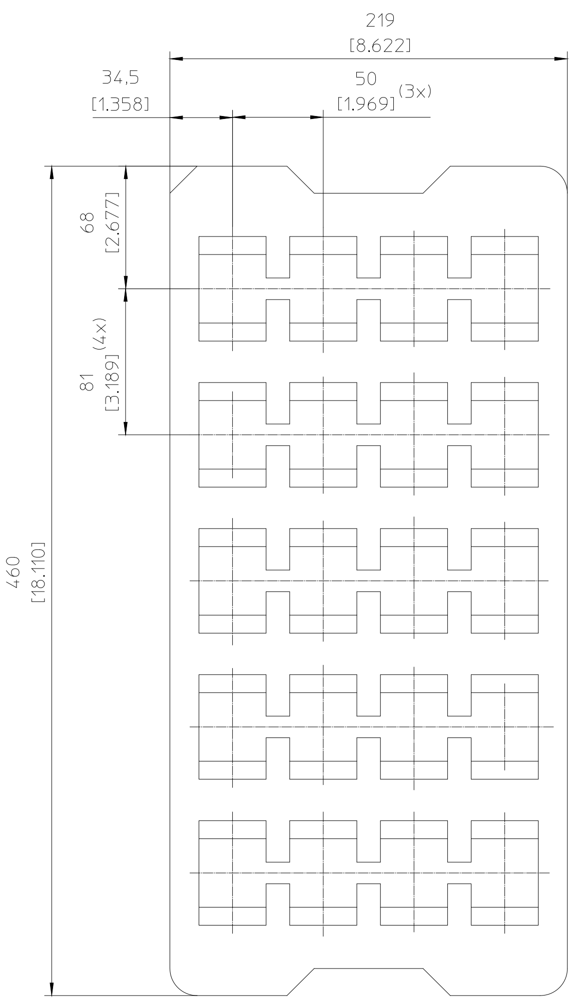
The products are delivered in antistatic Foam trays and in antistatic PPE trays (H option in PN, hard tray).

flex

Technical Specification

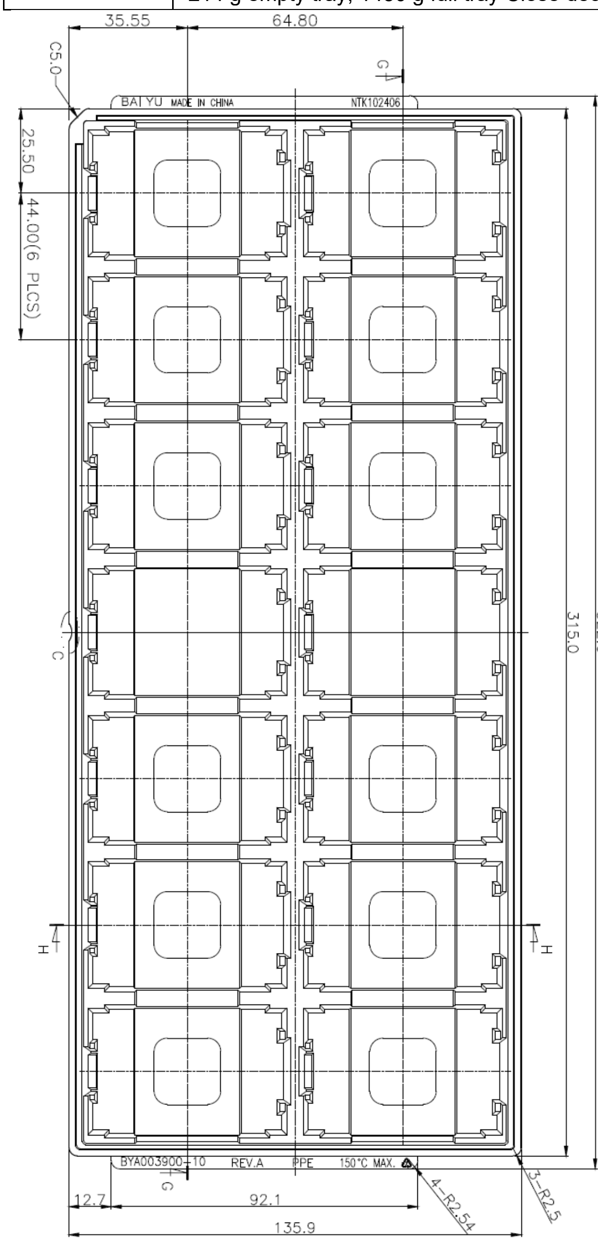
BMR491 series DC-DC Converters Input 40-60 V, Output up to 55 A / 1300 W	28701-BMR491 12 Rev B April 2026
	© Flex

Tray Specifications – Through hole version, BP versions and Integrated Heat sink without dry pack	
Material	PE Foam
Surface resistance	10^5 < Ohm/square < 10^{11}
Bakeability	The trays are not bakeable
Tray capacity	20 converters/tray
Box capacity	60 Base Plate products (3 full trays/box) 40 Integrated Heat Sink products (2 full trays/box)
Weight	48 g empty tray, 1790 g full tray Open deck BP 48 g empty tray, 2077 g full tray Int Heat sink 48 g empty tray, 1754 g full tray Thin BP 48 g empty tray, 1810 g full tray Close deck BP



Example PE Foam tray

Tray Specifications –base plate version (dry pack, pick & place) ("H" option)	
Material	Antistatic PPE
Surface resistance	10^5 < Ohm/square < 10^{11}
Bakeability	The trays can be baked at maximum 125°C for 48 hours
Tray capacity	14 converters/tray
Box capacity	42 products (3 full trays/box)
Weight	214 g empty tray, 1432 g full tray Open deck BP 214 g empty tray, 1408 g full tray Thin BP 214 g empty tray, 1450 g full tray Close deck BP



Hard tray (14 pcs)

flex

Product Qualification Specification

Characteristics			
External visual inspection	IPC-A-610		
Temperature shock test (Temperature cycling)	IEC 60068-2-14 Na	Temperature range Number of cycles Dwell/transfer time	-40 to 125°C 700 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	55°C
Mechanical shock	IEC 60068-2-27 Ea	Peak acceleration Duration	100 g 6 ms
Moisture reflow sensitivity [1]	J-STD-020E	Level 1 (SnPb-eutectic) Level 3 (Pb Free)	225°C 245°C
Operational Life test Rapid Temp.	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 60068-2-20 test Ta	Preconditioning Temperature, Pb-free	Steam ageing 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 & pin-in paste[3] products)
[2] Only for products intended for wave soldering (plated through hole products)