



PRM[™] Regulator PRM2313S60E54H0T00

High-Efficiency Converter

Features & Benefits

- 48.0V input (38.0 60.0V), non-isolated ZVS buck-boost regulator
- 30.0 54.0V adjustable output range
- Single-ended remote sense
- 800W output power
- 97.7% typical efficiency at full load
- PRM2313 SM-ChiP package

Typical Applications

- DC Power Distribution
- High-Performance Computing Systems (HPC)

Product Ratings				
$V_{IN} = 38.0 - 60.0V$	$P_{OUT} = 800W$			
V _{OUT} = 48.0V (30.0 – 54.0V Trim)	I _{OUT} = 16.67A			

Product Description

The SM-ChiP[™] ZVS Buck-Boost Regulator is a high-efficiency regulator integrating control, power FETs, magnetics and support components within a high density SM-ChiP package. By utilizing a Zero-Voltage Switching (ZVS) topology, the regulator is able to provide a high efficiency over the line and load range for a large step-down voltage range.

Minimal external components are required for operation, making this product ideal for driving high-efficiency non-isolated NBMs to power low-voltage rails to run low-power regulators, LDOs, as well as loads that require precise regulation such as hard drives or bias rails.

The SM-ChiP package is compatible with standard pick-and-place and surface-mount assembly processes. In the application, it provides superior thermal management with simple cooling methods.

Note: Product images may not highlight current product markings and cosmetic features.

Package Information

- 22.8 x 13.8 x 7.4mm SM-ChiP™
- Weight: 9.0g



Typical Application



Typical application: 48V to 12V regulator







Terminal Descriptions

Terminal Number	Signal Name	Туре	Function
1	SGND	Signal	Signal Ground: reference for control signals; internally connected to PGND
2	TRIM	Signal	Trim: output voltage trim adjust
3	EAO	Signal	Error Amplifier Output: load-share connection; EAOs are interconnected for parallel operation
4	+VS	Signal	Voltage Sense: positive voltage sense; connect to the PRM output
5	+OUT	Power	Positive Output: power terminal
6	VDR	Signal	Bias Supply Output: see Application Description for important considerations
7	PGOOD	Signal	Power Good: Open drain with internal pull-up; high when regulator is operating and V_{OUT} is in regulation, otherwise pulls low
8	EN	Signal	Enable: when input asserted active or left floating, regulator is enabled
9	SCL	Signal	Factory use only
10	SDA	Signal	Factory use only
11	+IN	Power	Positive Input: power terminal
12	ITRIM	Signal	Current Trim: current limit adjust input
13 ^[c]	PGND	Power	Power Ground: power return for +IN and +OUT current

^[c] Terminal 13 represents the package top and bottom conductive plating. Refer to product outline for additional details.



Part Ordering Information

Part Number	Temperature Grade	Option	Tray Size
PRM2313S60E54H0 T 0 0	T = -40 to 125°C	0 = 48.0V nominal output	66 parts per tray

Storage and Handling Information

Note: For compressive loading refer to <u>Application Note AN:036</u>, "Recommendations for Maximum Compressive Force of Heat Sinks." For handling and assembly processing, and for rework considerations refer to <u>Application Note AN:701</u>, "SM-ChiP Reflow Soldering Recommendations."

Attribute	Comments	Specification
Storage Temperature Range		–40 to 125°C
Operating Internal Temperature Range (T _{INT})		–40 to 125°C
Weight		9.0g
Package Plating		ENiG: 100 – 300µin Ni, 2 – 5µin Au
MSL Rating		MSL 4, 245°C maximum reflow temperature
CCD Dating	Human Body Model ANSI/ESDA/JEDEC JS-001-2017	Class 1C (>1kV to 2kV) HBM
ESD raung	Charged Device Model ANSI/ESDA/JEDEC JS-002-2014	Class 1C (>200 to 500V) CDM

Reliability and Agency Approvals

Attribute	Comments	Value	Unit		
	Telcordia Issue 2, Method I Case 3, Gound Benign, Controlled	15.9			
MTBF	MIL-HDBK-217Plus Parts Count - 25°C Ground Benign, Stationary, Indoors / Computer Profile	6.84	MHrs		
Agency Approvals/Standards	cTÜVus, UL 62368-1, CAN/CSA No. C22.2 62368-1, EN 62368-1				
	UKCA, electrical equipment (safety) regulations				
	CE Marked to the Low Voltage Directive and RoHS Recast Directive, as applicable				

Absolute Maximum Ratings

The ABSOLUTE MAXIMUM ratings below are stress ratings only. Operation at or beyond these maximum ratings can cause permanent damage to device. Electrical specifications do not apply when operating beyond rated operating conditions. Operating beyond rated operating conditions for an extended period of time may affect device reliability. Positive terminal currents represent current flowing out of the terminal.

Parameter	Comments	Min	Мах	Unit
+IN to PGND	Continuous, non-operating	-0.3	75	V
+OUT to PGND	Continuous, non-operating	-0.3	60	V
		-0.3	5.5	V
VDR to SGND			+150 / -0	mA
		-0.3	5.5	V
PGOOD to SGND			±20	mA
EN to SGND		-0.3	5.5	V
SCL to SGND		-0.3	5.5	V
SDA to SGND		-0.3	5.5	V
TRIM to SGND		-0.3	5.5	V
ITRIM to SGND		-0.3	5.5	V
EAO to SGND		-0.3	5.5	V
+VS to SGND		-0.3	60	V
SGND			±0.5	А
Output Current			40	А



VIC

Electrical Specifications

Specifications apply over all line and load conditions, and trim from 30.0 to 54.0V, unless otherwise noted. **Boldface** specifications apply over the temperature range of $-40^{\circ}C \le T_{INT} \le 125^{\circ}C$. All other specifications are at $T_{INT} = 25^{\circ}C$ unless otherwise noted.

Attribute	Symbol	Conditions / Notes	Min	Тур	Max	Unit
Power Input Specifications						
Input Voltage Range	V _{IN}	Continuous, operating	38.0	54.0	60.0	V
Input Voltage Slew Rate	dV _{IN} /dt	$0V \le V_{IN} \le 60.0V$	0.001		1000	V/ms
No-Load Power Dissipation	P _{NL}	Enabled, $V_{IN} = 54.0V$		0.24	0.400	W
Input Quiescent Current	I _{QC}	Disabled, $V_{IN} = 54.0V$		6.9	10	mA
Input Capacitance (Internal)	C _{IN_INT}	Effective value, $V_{IN} = 54.0V$		4.8		μF
Input Capacitance (Internal) ESR	R _{C-IN}	Effective value, $V_{IN} = 54.0V$		1.0		mΩ
		Power Output Specifications				
Output Voltage Set Point	V _{OUT_SET}	No load, no connection to TRIM	47.7	48.2	48.7	V
Output Voltage Trim Range	V _{OUT}		30.0	48.0	54.0	V
Output Voltage Load Regulation	V _{OUT-REG-LOAD}				0.3	%
Output Voltage Line Regulation	V _{OUT-REG-LINE}				0.1	%
Output Voltage Temperature Regulation	V _{OUT-REG}				2.1	%
Total Regulation Error	V _{OUT-REG-TOTAL}	(Line/Load/Temp regulation and set point accuracy)			2.5	%
Rated Output Power	P _{OUT}	$V_{OUT} \ge 48.0V$			800	W
Rated Output Current	I _{OUT}	$V_{OUT} \le 48.0V$			16.67	А
Rated Output Power, Peak	P _{OUT_PK}	$V_{OUT} ≥ 48.0V,$ ≤10ms pulse width, ≤10% duty cycle			900	W
Rated Output Current, Peak	I _{OUT_PK}	V_{OUT} ≤ 48.0V, ≤10ms pulse width, ≤10% duty cycle			18.75	А
Switching Frequency	Esw	$V_{IN} = 54.0V, V_{OUT} = 48.0V,$ $I_{OUT} = 16.67A, T_{INT} = 25^{\circ}C$	1.225	1.250	1.275	MHz
Switching Frequency	FSW	Over rated line, average load, trim and temperature, exclusive of burst mode	0.900		1.275	MHz
		From V_{IN} first crossing $V_{\text{IN-UVLO+}}$ to soft-start ramp		100		μs
Output Turn-On Delay	t _{on}	From EN release to soft-start ramp, V _{IN} pre-applied		100		μs
Output Voltage Rise Time	t _{RISE-VOUT}	From soft start begin to $V_{\mbox{\scriptsize OUT}}$ settled to within 5%	6.0	8.0	10.0	ms
Efficiency Ambient		$V_{IN} = 54.0V, V_{OUT} = 48.0V,$ $I_{OUT} = 16.67A, T_{CASE} = 25^{\circ}C$	97.5	98.0		%
Efficiency, Ambient	IAMB	V _{IN} = 54.0V, V _{OUT} = 48.0V, I _{OUT} = 8.3A, T _{CASE} = 25°C	97.2	97.6		%
		V _{IN} = 54.0V, V _{OUT} = 48.0 V, I _{OUT} = 16.67A, T _{CASE} = 100°C	97.5	97.9		%
Efficiency, Hot	η_{HOT}	$V_{IN} = 54.0V, V_{OUT} = 48.0 V,$ $I_{OUT} = 8.3A, T_{CASE} = 100^{\circ}C$	97.3	97.6		%
Output Discharge Current	I _{OD}	$V_{OUT} > 0.5V$, discharge current = CC; otherwise 500 Ω resistive	8	10	15	mA
Output Voltage Ripple	V _{OUT_PP}	$\begin{split} V_{\text{IN}} &= 54.0 \text{V}, \ V_{\text{OUT}} = 48.0 \text{V}, \\ I_{\text{OUT}} &= 16.67 \text{A}, \ C_{\text{OUT-EXT}} = 0 \mu \text{F}, \ 20 \text{MHz BW} \end{split}$		2.2		V _{P-P}
Output Inductance (Parasitic)	L _{OUT-PAR}	Frequency at 1MHz, simulated terminal model		2.5		nH

VIC

Electrical Specifications (Cont.)

Specifications apply over all line and load conditions, and trim from 30.0 to 54.0V, unless otherwise noted. **Boldface** specifications apply over the temperature range of $-40^{\circ}C \le T_{INT} \le 125^{\circ}C$. All other specifications are at $T_{INT} = 25^{\circ}C$ unless otherwise noted.

Attribute	Symbol	Conditions / Notes	Min	Тур	Max	Unit	
	Power Output Specifications (Cont.)						
Output Capacitance (Internal)	C _{OUT-INT}	Effective value, $V_{OUT} = 48.0V$		4.8		μF	
Output Capacitance (Internal) ESR	R _{COUT}	Effective value, $V_{OUT} = 48.0V$		1		mΩ	
PRM Load Capacitance (PRM Output)	C _{LOAD-PRM}	At PRM output; excludes reflected capacitance from NBM [™] output	0		63	μF	
PRM Load Capacitance (Total Effective)	C _{LOAD} -TOTAL_EFF	Total effective value at PRM output, including reflected capacitance from NBM output			130	μF	
12V Load Capacitance (NBM Output)	C _{LOAD-NBM}	At K = ¼ NBM out	0		1000	μF	
Load Transient Voltage Deviation	V _{TRANS}	10% <-> 100% load step, 10A/μs, 0μF C _{OUT-EXT} , deviation from initial set point		1.6	3.0	V	
Load Transient Recovery Time	t _{TRANS}	10% <-> 100% load step, 10A/ μ s, 0 μ F C _{OUT-EXT} , deviation from initial set point		200		μs	
		Array Operation					
Maximum Array Size		Maximum number of parallel devices			3	PRMs	
Array De-Rating	% _{IOUT_ARRAY}	Percentage derating from rated current when operated in array as specified	10			%	
Current Sharing Difference	%IOUT_SHARE	maximum array size, equal input, outptut and EAO voltages at full load; less than 10°C case temperature difference		10	13	%	
		Powertrain Faults					
Input Undervoltage Turn-ON	V _{IN_UVLO+}	Powertrain recovery	34.0	35.8	37.6	V	
Input Undervoltage Hysteresis	V _{IN_UVLO_HYST}	$(V_{IN_UVLO+}) - (V_{IN_UVLO-})$	1.5	1.8	2.1	V	
Input Overvoltage Turn-ON	V _{IN_OVLO-}	Powertrain recovery	62.8	66.1	69.4	V	
Input Overvoltage Hysteresis	V _{IN_OVLO_HYST}	$(V_{IN_OVLO+}) - (V_{IN_OVLO-})$		1.3		V	
Output Overvoltage Turn-OFF Threshold	V _{OUT_OVT}	Rising threshold, powertrain shut down	56.8	57.9	60.0	V	
Output Overvoltage Hysteresis	V _{OUT_OVH}			1.2		V	
Minimum Current-Limited Output Voltage	V _{OUT_UVP}				8	V	
Output Overcurrent Shut Down (Slow)	I _{OUT_SCL}	10µs time constant	20.6			А	
Controller Programmed Temperature Shut Down ^[a]	T _{CSD}	Detected at control IC	125			°C	
EAO Overload Limit	V _{EAO_OL}		3.18	3.30	3.43	V	
EAO Overload Timeout	t _{oL}	EAO continuously above EAO_LIMIT	900	1024	1100	μs	
Trim Voltage Overvoltage Threshold	V _{TRIM_OV}	$V_{TRIM} > V_{TRIM_OV}$	1.94	2.04	2.14	V	
Output Voltage Negative Fault Threshold	V _{OUT_NEG}		-0.45	-0.25	-0.15	V	
Fault Response Time	t _{PROT}	OVLO, UVLO, ENABLE, OTP, TRIM_OV		2.0		μs	
Fault Recovery Time	t _{PROT-RECOVERY}	OVLO, UVLO, OTP		30		ms	

^[a] Programmed temperature shutdown does not protect the device, and exceeding the maximum Internal Operating Temperature can lead to failure. Users should utilize the thermal tools provided in the datasheet to maintain maximum internal temperature within the Operating Temperature range.

VI

Electrical Specifications (Cont.)

Specifications apply over all line and load conditions, and trim from 30.0 to 54.0V, unless otherwise noted. **Boldface** specifications apply over the temperature range of $-40^{\circ}C \le T_{INT} \le 125^{\circ}C$. All other specifications are at $T_{INT} = 25^{\circ}C$ unless otherwise noted.

Attribute	Symbol	Conditions / Notes	Min	Тур	Max	Unit
		VDR				
VDR Voltage	V _{VDR}	Internally Generated	4.84	5.1	5.36	V
VDR Input Undervoltage Turn-On	VIN_VDR_UVLO+		6.6	6.9	7.2	V
VDR Turn-On Hysteresis	VIN_VDR_UVLO_HYST			0.5		V
VDR Turn-On Delay	t _{on_vdr}	V_{IN} start from < 1V, $V_{\text{IN}} > V_{\text{IN}_{\text{VDR}_{\text{UVLO}_{\text{+}}}}}$ to VDR high		5.8		ms
VDR Start-Up Current	I _{VDR_STDBY}	Available source current during start up, VDR low			10	mA
VDR Source Current	I _{VDR_ON}	Available source current, VDR high, after t_{ON_VDR}			80	mA
		Enable: EN				
Enable Internal Pull-Up Voltage		Floating, no external pull up		2		V
Enable Bias Current	I _{EN}			50		μA
Enable High Threshold	EN _{IH}				1.1	V
Enable Low Threshold	EN _{IL}		0.7			V
Enable Threshold Hysteresis	EN _{HYS}		100	200	300	mV
		Power Good: PGOOD				
PGOOD High Leakage	PGOOD _{ILH}	$V_{PGOOD} = V_{VDR}$			10	μA
PGOOD Output Low	PGOOD _{OL}	$I_{PGOOD} = 4mA$			0.4	V
PGOOD TRIM Low Rise		TRIM threshold for PGOOD High	1.41	1.45	1.48	V
PGOOD TRIM Low Fall		TRIM threshold for PGOOD Low	1.36	1.41	1.46	V
PGOOD TRIM Threshold Hysteresis	5			35		mV
		Transconductance Error Amplifier				
Voltage at V _{TRIM} (Reference Voltage)	V _{TRIM}	Voltage reference, $V_{TRIM} = V_{EAO}$	1.67	1.70	1.73	V
Maximum EAO Output Voltage	V _{EAO_MAX}		3.5	3.6	4.0	V
Minimum EAO Output Voltage	V _{EAO_MIN}			0.05	0.15	V
V _{EAO} Pulse Skip Threshold	V _{EAO_PST}	Powertrain stops switching		0.6		V
Transconductance	gm _{EAO}	Factory set		2.3		mS
EAO Current Sourcing	I _{EAO_OUT}			370		μΑ
EAO Current Sinking	I _{EAO_SINK}			330		μA
		Current Limit: ITRIM				
ITRIM Threshold Voltage	V _{ITRIM_SET}	No connection to ITRIM	1.05	1.075	1.100	V
Output Current Limit Set Point	I _{LIMIT_CC}	Constant current limit, no connection to ITRIM; see applications section for important information on using ITRIM	29	30.5	32.0	А
Effective Internal Current Sense Gain	G _{ISENSE}	Current llmit active, V _{ITRIM} / I _{OUT} , I _{OUT} > 40% rated load	31.5	35	38.5	mV / A
I _{LIMIT} Range	I _{LIMIT_RANGE}	Permitted current limit set range	4		16.67	А
Output Current Limit Response Time	t _{ILIMIT_CC}	Detection to recovery to within 1% of current limit set point		12		ms



Specified Operating Area

The following figures present performance data in a typical application environment.



Figure 1 — Specified operating area vs. output voltage



Thermal Operating Area

The following figures present performance data in a typical application environment.







Figure 4 — Thermal specified operating area at $V_{OUT} = 48V$: max system I_{OUT} vs. temperature at bottom and leads







Figure 3 — Thermal specified operating area at $V_{OUT} = 30V$: max system I_{OUT} vs. temperature, at top, bottom and leads



Figure 5 — Thermal specified operating area at $V_{OUT} = 48V$: max system I_{OUT} vs. temperature, at top, bottom and leads







Typical Performance Characteristics

The following figures present performance data in a typical application environment.















Figure 9 — Power dissipation at 25°C case temperature, $V_{OUT} = 30.0V$



Figure 11 — Power dissipation at 25°C case temperature, $V_{OUT} = 48.0V$





Typical Performance Characteristics (Cont.)

The following figures present performance data in a typical application environment.















Figure 15 — Power dissipation at -40° C case temperature, $V_{OUT} = 30.0V$



Figure 17 — Power dissipation at -40° C case temperature, $V_{OUT} = 48.0V$





Typical Performance Characteristics (Cont.)

The following figures present performance data in a typical application environment.















Figure 21 — Power dissipation at 100°C case temperature, $V_{OUT} = 30.0V$



Figure 23 — Power dissipation at 100°C case temperature, $V_{OUT} = 48.0V$





Typical Performance Characteristics (Cont.)

The following figures present performance data in a typical application environment.



Figure 26 — Output current vs. EAO voltage at 25°C case temperature, V_{OUT} = 30.0V



Figure 27 — Output current vs. EAO voltage at 25°C case temperature, $V_{OUT} = 48.0V$



Figure 28 — Output current vs. EAO voltage at 25°C case temperature, $V_{OUT} = 54.0V$



Terminal Descriptions

VDR Bias Regulator

The VDR internal bias regulator is an internally-generated 5V supply, which is intended primarily to power the internal controller and driver circuitry. VDR can be loaded up to I_{VDR_ON} once the device has completed start up. During start up the load on VDR must be limited to I_{VDR_STDBY} .

+IN – Input Power

The +IN terminal is the power rail input to the PRM. External filtering and decoupling techniques are application-specific. Low-ESR ceramic capacitors are recommended at the input terminal to power ground.

EAO – Modulator

EAO is the error amplifier output and is used for current sharing when parts are operated in an array.

The error amplifier is a wide-bandwidth Transconductance Amplifier (TCA). Here it is important to note that the compensation components are pre-programmed by the factory and are internal to the device.

EN – Enable

The EN terminal of the regulator is referenced to SGND and permits the user to turn the regulator on or off. The EN polarity is a positive logic assertion.

If the EN terminal is left floating or asserted high, the regulator output is enabled. When EN is asserted low, the regulator will complete the current switching cycle and enter a low-power state until EN is released.

PGOOD – Power Good

The PGOOD terminal functions as a power-good indicator. PGOOD is high when the regulator is operating and V_{OUT} is within regulation; otherwise it pulls low.

ITRIM – Current Trim

ITRIM sets the constant current limit set point.

By default constant current limit is set outside of the device ratings and a resistor must be placed from ITRIM to SGND to bring the current limit set point within the permitted current limit range. The current limit set point must be set below the rated current of the device and above the pulse-skip threshold current if used.

+VS – Positive Voltage Sense

+VS is the positive voltage sense and connects the internal voltage sense divider to the desired voltage sense location. +VS is not internally connected and a connection must be made to the PRM output.

TRIM

TRIM is the internal error amplifier inverting terminal. The output voltage is set by internal resistors, but can be adjusted by external resistors connected to TRIM.

SCL, SDA

For factory use only.

SGND – Signal Ground

SGND provides an internal Kelvin connection to PGND. SGND must be used as the reference for all signal and control terminals.

PGND

PGND is the common power return.



Thermal Design

Thermal management of PRM internal power dissipation is critical to reliable operation, and ample cooling is preferred since efficiency and reliability are better at lower internal temperatures. Figure 29 shows a thermal impedance model that can estimate the maximum temperature of the highest temperature component for a given electrical and thermal operating condition. The circuit model assumes each of those areas identified as thermal boundaries are isothermal although not necessarily the same temperature as the other boundary areas. Use of non-conductive TIM (Thermal Interface Material) is required to prevent shorting conductive surfaces on case.



Figure 29 — Thermal model

Symbol	Thermal Impedance (°C / W)	Definition of Estimated Thermal Resistance
$\theta_{\text{PGND_TOP}}$	3.6	from the hottest component inside the PRM to the top PGND terminal
θ_{+N}	57	from the hottest component inside the PRM to the circuit board it is mounted on at the +IN terminal
$\theta_{+\text{OUT}}$	61	from the hottest component inside the PRM to the circuit board it is mounted on at the +OUT terminal
$\theta_{SIGNALS}$	23	from the hottest component inside the PRM to the circuit board it is mounted on at the SIGNAL terminals
$\theta_{\text{PGND}_\text{BOTTOM}}$	3.9	from the hottest component inside the PRM to the circuit board it is mounted on at the PGND THERMAL AND ELECRICAL PAD
$\theta_{\text{PGND_TOP_BOTTOM}}$	17	between the top PGND terminal and the PGND THERMAL AND ELECTRICAL PAD

Table 1 — Thermal impedances



Figure 30 — Thermal model boundary conditions; area defined as shaded



VIC

Outline Drawing Top & Side View



Outline Drawing Bottom View





BOTTOM VIEW



Recommended Land Pattern (Component Side)

2313 PRM TC2_3

(Reference DWG # 47574 Rev 4)

 \mathbf{V}



PRM2313S60E54H0T00

Revision History

Revision	Date	Description	Page Number(s)
1.0	01/07/19	Initial release	n/a
1.1	02/20/20	Corrected absolute maximum ratings for +OUT to PGND, +VS to SGND Added output overvoltage turn off specification	4 6
1.2	03/17/20	Corrected FLT terminal name to PGOOD Added PGOOD electrical specifications and description Updated thermal operating area bottom+leads charts	2, 3, 4, 19 7, 15 9
1.3	12/01/21	Updated and revised format of storage & handling, reliability and agency approvals Updated absolute max rating for +IN Updated orientation of terminal configuration, thermal boundaries, outline drawing	1, 4 4 3, 15, 16, 17, 18
1.4	12/20/24	Updated agency approvals Updated power and current rating notes/conditions	1, 4 5

Note: page removed in revision 1.3.



Vicor's comprehensive line of power solutions includes high density AC-DC and DC-DC modules and accessory components, fully configurable AC-DC and DC-DC power supplies, and complete custom power systems.

Information furnished by Vicor is believed to be accurate and reliable. However, no responsibility is assumed by Vicor for its use. Vicor makes no representations or warranties with respect to the accuracy or completeness of the contents of this publication. Vicor reserves the right to make changes to any products, specifications, and product descriptions at any time without notice. Information published by Vicor has been checked and is believed to be accurate at the time it was printed; however, Vicor assumes no responsibility for inaccuracies. Testing and other quality controls are used to the extent Vicor deems necessary to support Vicor's product warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

Specifications are subject to change without notice.

Visit https://www.vicorpower.com/dc-dc/isolated-regulated/buck-boost-current-multipliers for the latest product information.

Vicor's Standard Terms and Conditions and Product Warranty

All sales are subject to Vicor's Standard Terms and Conditions of Sale, and Product Warranty which are available on Vicor's webpage (https://www.vicorpower.com/termsconditionswarranty) or upon request.

Life Support Policy

VICOR'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS PRIOR WRITTEN APPROVAL OF THE CHIEF EXECUTIVE OFFICER AND GENERAL COUNSEL OF VICOR CORPORATION. As used herein, life support devices or systems are devices which (a) are intended for surgical implant into the body, or (b) support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in a significant injury to the user. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system or to affect its safety or effectiveness. Per Vicor Terms and Conditions of Sale, the user of Vicor products and components in life support applications assumes all risks of such use and indemnifies Vicor against all liability and damages.

Intellectual Property Notice

Vicor and its subsidiaries own Intellectual Property (including issued U.S. and Foreign Patents and pending patent applications) relating to the products described in this data sheet. No license, whether express, implied, or arising by estoppel or otherwise, to any intellectual property rights is granted by this document. Interested parties should contact Vicor's Intellectual Property Department.

The products described on this data sheet are protected by the following U.S. Patents Numbers: 5,945,130; 6,403,009; 6,710,257; 6,911,848; 6,930,893; 6,934,166; 6,940,013; 6,969,909; 7,038,917; 7,145,786; 7,166,898; 7,187,263; 7,202,646; 7,361,844; 9,516,761; D496,906; D505,114; D506,438; D509,472; and for use under 6,975,098 and 6,984,965.

Contact Us: https://www.vicorpower.com/contact-us

Vicor Corporation 25 Frontage Road Andover, MA, USA 01810 Tel: 800-735-6200 Fax: 978-475-6715

www.vicorpower.com

email

Customer Service: <u>custserv@vicorpower.com</u> Technical Support: <u>apps@vicorpower.com</u>

©2019 – 2024 Vicor Corporation. All rights reserved. The Vicor name is a registered trademark of Vicor Corporation. All other trademarks, product names, logos and brands are property of their respective owners.

Rev 1.4 12/2024

