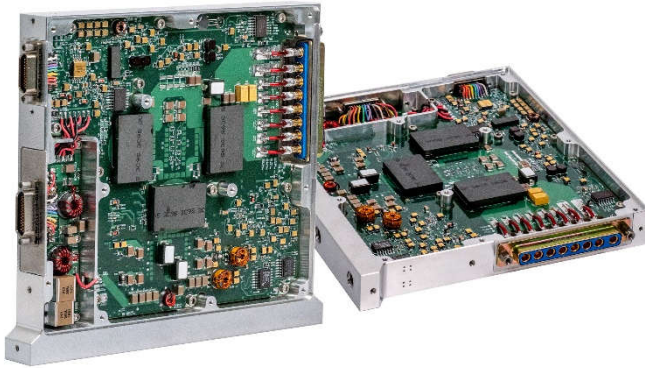




Power Your Critical Mission Today

SGRB12028S SERIES

SPACE QUALIFIED DC-DC CONVERTERS



Product Overview

Input: 98 V to 136 V continuous, 141 V transient

400 W, single output of 12 V to 28 V adjustable

Efficiency up to 95%

Modified versions available to meet customer-specific requirements

1.0 DESCRIPTION

The SGRB12028S is a space rated DC-DC converter specifically designed for the harsh radiation environments of the most demanding commercial, scientific and military space applications. Using advanced GaN technology, the SGRB is radiation-hardened and achieves very high efficiency. A fixed frequency reduced voltage switching topology results in very low input and output noise, making it suitable for use in a variety of high-power space payload or bus applications. VPT's history of proven space flight heritage ensures long term performance reliability.

1.1 FEATURES

- Up to 400 W output power
- Continuous operation over a temperature range of -35 °C to +85 °C with no power derating
- Very low output noise
- Undervoltage lockout
- Integrated EMI filter
- Parallel up to 5 units with current share - contact VPT for higher wattage requirements.
- High Efficiency up to 95% using GaN Technology
- 4 bit word voltage adjustment
- 141 V, 1 msec transient
- 80 V transient with reduced output power
- Overvoltage Protection
- Current limit protection / Short Circuit protection
- Power Supply Telemetry

1.2 SPACE LEVEL CHARACTERIZATIONS

- Guaranteed TID performance to 100 krad(Si) including ELDRS
- SEE performance to 85 MeV/mg/cm². Transients are fully analyzed for cross-section and magnitude
- Worst-Case Analysis & Thermal Analysis available for purchase
- Radiation, MTBF reliability reports available

1.3 MANUFACTURING AND COMPLIANCE

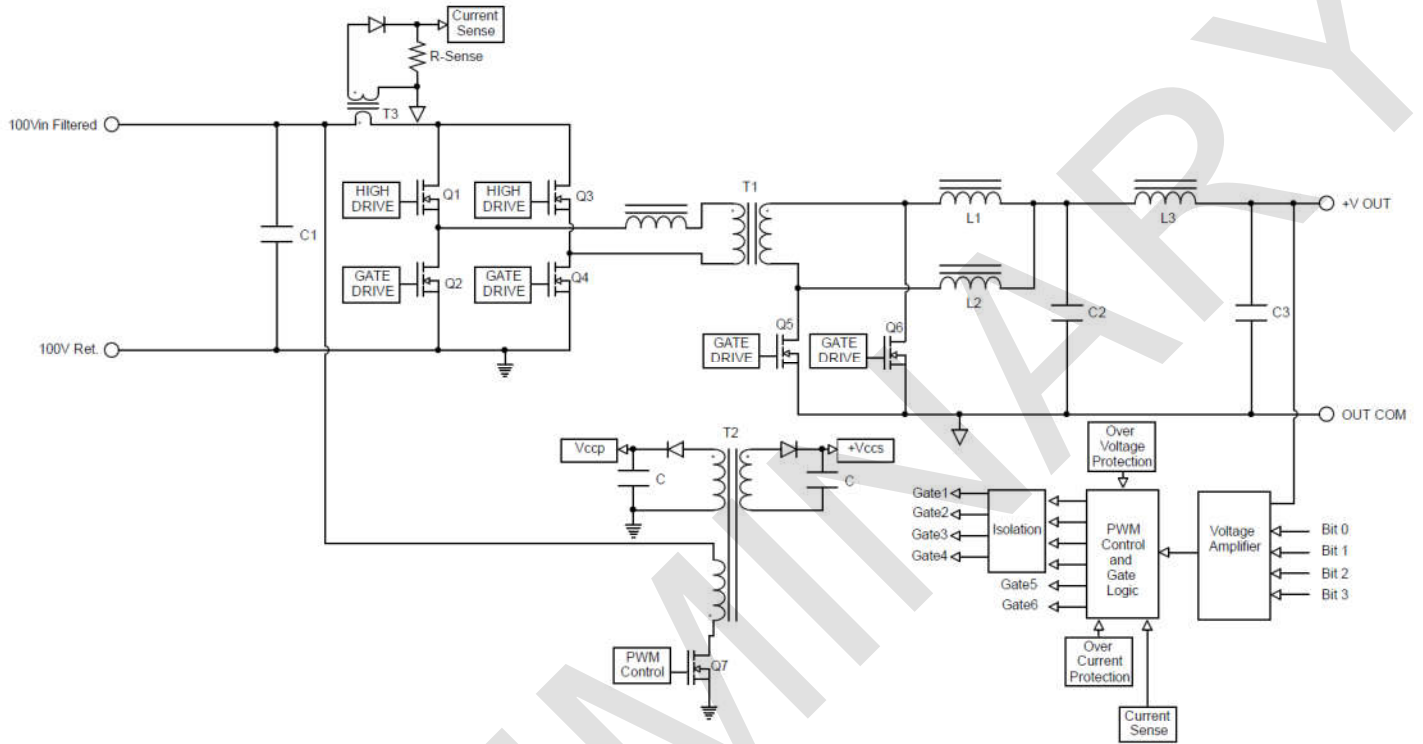
- Manufactured in a facility certified to ISO9001, J-STD-001 and IPC-A-610
- Designed in line with MIL-HNBK-1547 derating

1.4 PACKAGING

- Low-profile: 6.85" x 5.95" x 0.75"
- Max weight: 850 g
- Aluminum case and cover with nickel plating

2.0 DIAGRAMS

2.1 BLOCK DIAGRAM



3.0 SPECIFICATIONS

3.1 ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings			
Input Voltage (Continuous):	-0.5 V to 136 V	Operating Temperature (Full Load):	-35 °C to +85 °C
Input Voltage (Transient, 1 msec):	-0.5 V to 141 V	Storage Temperature:	-35 °C to +85 °C
Input Voltage (Transient, 10 µsec):	-0.5 V to 150 V		

3.2 PERFORMANCE SPECIFICATIONS

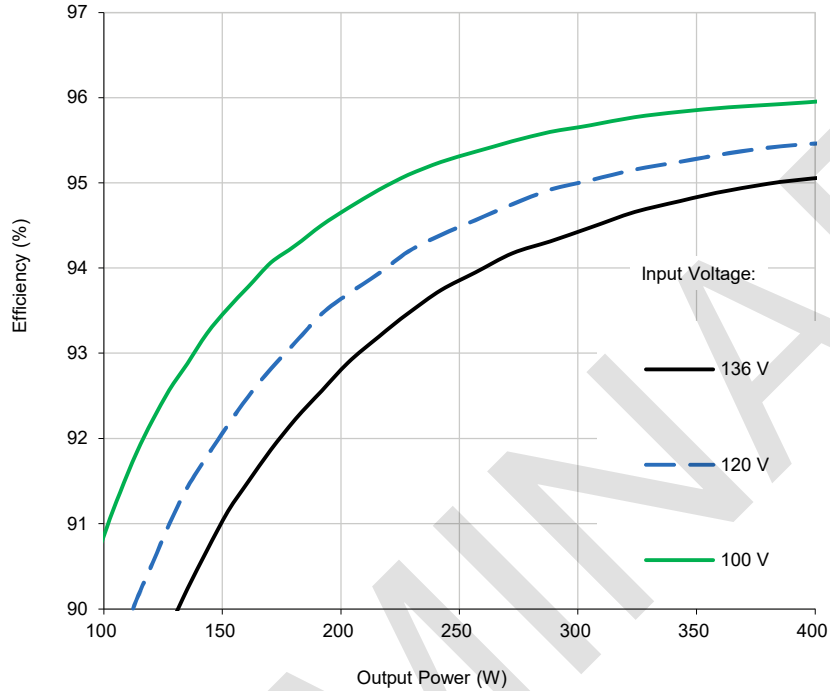
Tcase = -35 °C to +85 °C, Vin = +120 V ± 5%, Full Load, Unless Otherwise Specified

SGRB12028S					
Parameter	Conditions	Min	Typ	Max	Units
INPUT					
Voltage	Continuous	98	120	136	V
	Transient, 1 msec ³	-	-	141	V
	Transient, 10 µsec ³	-	-	150	V
Current	INH < 0.5 V	-	5	-	mA
	No Load	-	20	50	mA
Undervoltage Lockout	Turn-On	-	-	95	V
	Turn-Off ^{3, 4, 5}	75	-	-	V
OUTPUT STATIC					
Voltage	+Vout, Tcase = -35 °C to +85 °C	-0.35	Vset	0.35	V
Power ²		0	-	400	W
Current ²		0	-	14.3	A
Ripple Voltage	20 Hz to 10 MHz	-	-	0.4%	mVpp
Line Regulation	VIN = 98 V to 136 V	-	10	100	mV
Load Regulation	No Load to Full Load	-	45	80	mV
Load Fault Power Dissipation	Overload ³	-	25	45	W
	Short Circuit ³	-	27	50	W
OUTPUT DYNAMIC					
Load Step, Half to Full Load	Vo=28 V	-	1150	1500	mVpk
	Recovery ¹	-	270	500	µs
Turn-On, Vin = 0 to 120 V	Delay	-	35	50	ms
	Overshoot	-	0	25	mVpk
FUNCTION					
INH Pin Input ³	Output Inhibited	0	-	0.5	V
INH Pin Open Circuit Voltage ³	Output Enabled	0	-	16	V
Voltage Trim Range		12		28	V
SHARE Pin Voltage ³		-	-	5	V
Current Share Accuracy ³		-	0.14	0.85	A
SYNC Frequency Range		500	-	550	kHz
Overvoltage Trip Point ³	Overvoltage signal = 5V	29.5	-	32	V
GENERAL					
Efficiency	Vo=28 V	93	95		%
Capacitive Load ³				100	µF
Switching Frequency		400	450	500	kHz
Isolation	100 V DC, Tcase = 25 °C	10	-	-	MΩ
Weight			810	850	g
MTBF (MIL-HDBK-217F)	SF @ Tcase = 55 °C		TBD		MHr

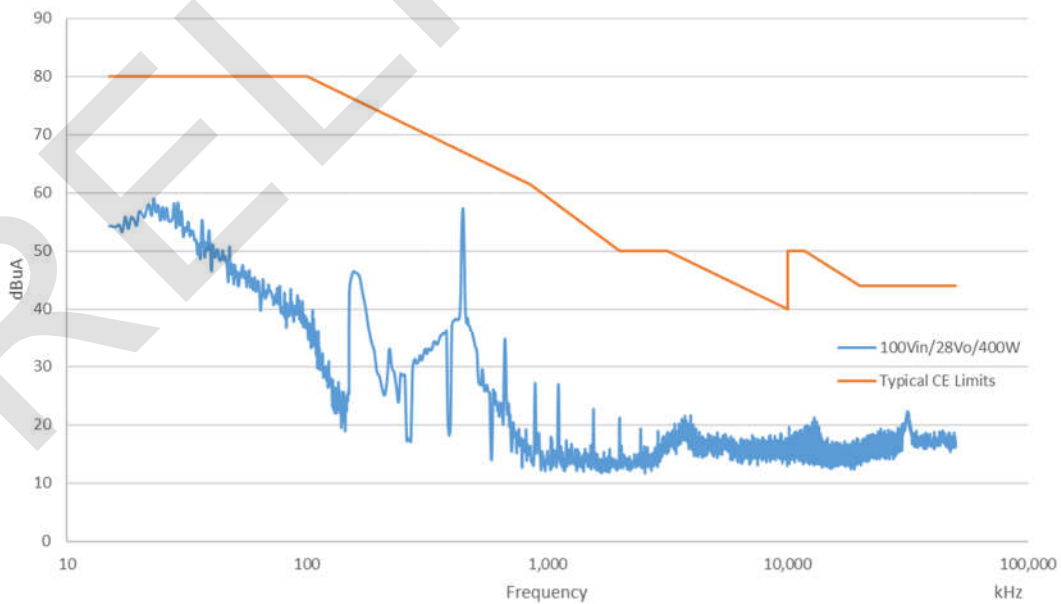
1. Time for output voltage to settle within 1% of steady-state value
2. Derate linearly to 0 at 95°C
3. Verified by initial electrical design. Post design verification, parameter shall be guaranteed to the limits specified.
4. VPT does not guarantee output voltage regulation with input voltage below 93.1 V.
5. Derate output power linearly for input voltage below 93.1 V, down to 75% power at 80 V. Derate to zero output power below input voltage of 80 V.

4.0 PERFORMANCE CURVES

4.1.1 Efficiency, $V_o = 28\text{ V}$ (Typical, $25\text{ }^\circ\text{C}$)

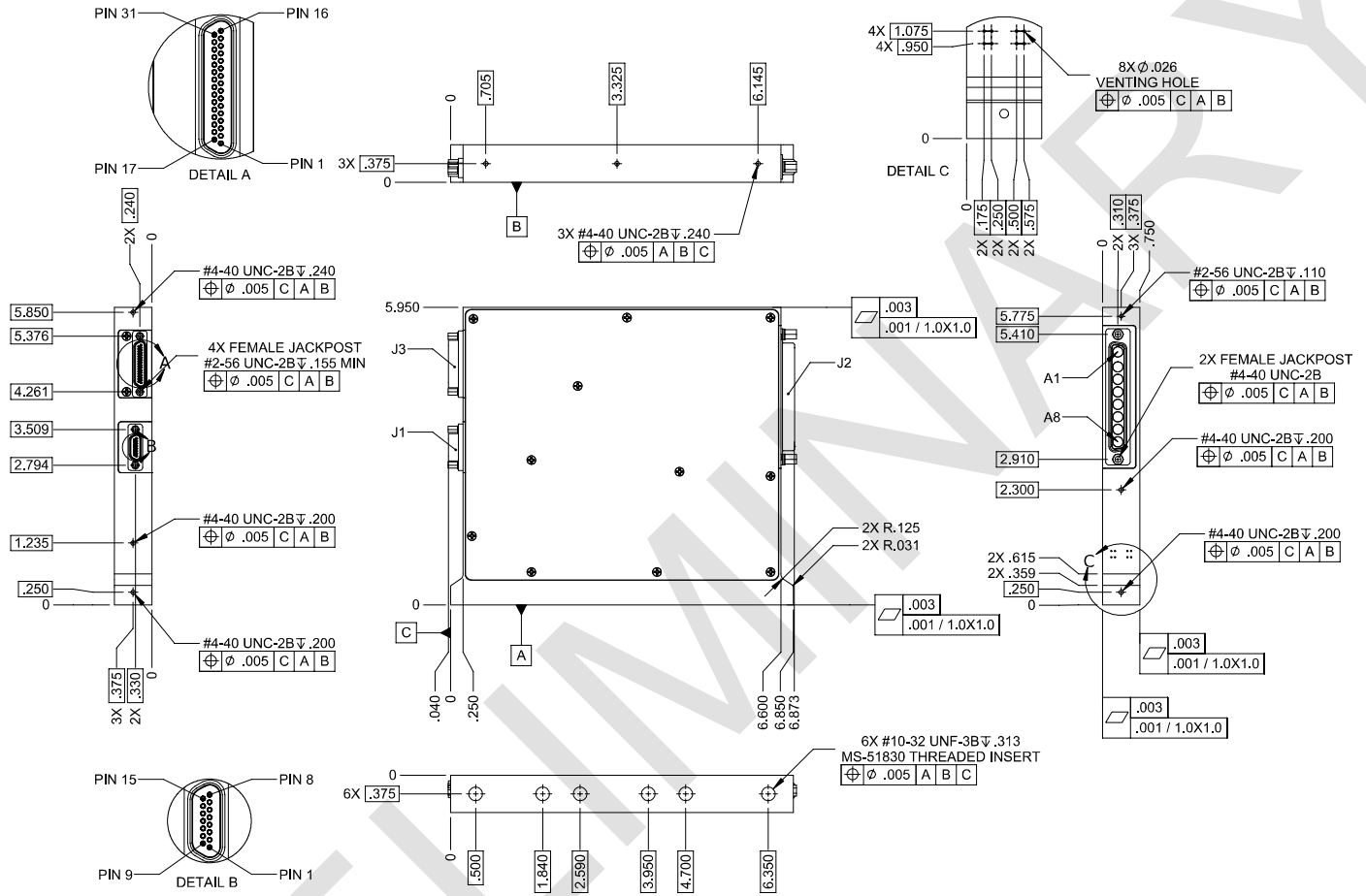


4.2.1 Conducted Emissions on V_{in} , $V_o = 28\text{ V}$ (Note: Curves from SGRB10028S unit with 100 V input. Shown for example.)



5.0 MECHANICAL OUTLINES AND PINOUT

5.1 Vertical Package Option:



1. Tolerances are ± 0.005 " unless otherwise stated
2. Material: Case (Aluminum 6061, electroless nickel plated 100-300 microinches thick, per ASTM B733, Type V class 4)
3. J1 is Glenair P/N M83513/04-B11N
4. J2 is Positronics P/N SCBM8W8S0000G
5. J3 is Glenair P/N M83513/04-E11N
6. Temperature is specified at the baseplate, side A as shown above.

5.0 MECHANICAL OUTLINES AND PINOUT (CONTINUED)

J1		J2		J3	
Pin	Function	Pin	Function	Pin	Function
1	VIN	A1	VOUT	1	TEMPERATURE TELEMETRY
2	VIN	A2	OUTCOM	2	INHIBIT
3	VIN	A3	VOUT	3	OVERVOLTAGE TELEMETRY
4	NO CONNECT	A4	OUTCOM	4	INPUT CURRENT TELEMETRY
5	INCOM	A5	VOUT	5	NO CONNECT
6	INCOM	A6	OUTCOM	6	SYNC INPUT
7	INCOM	A7	VOUT	7	SYNC-OUT
8	NO CONNECT	A8	OUTCOM	8	TELEMETRY RETURN
9	VIN			9	TELEMETRY RETURN
10	VIN			10	OUTCOM
11	NO CONNECT			11	OUTCOM
12	NO CONNECT			12	CURRENT SHARE
13	INCOM			13	BIT-0
14	INCOM			14	BIT-1
15	NO CONNECT			15	BIT-2
				16	BIT-3
				17	TEMPERATURE TELEMETRY
				18	INHIBIT
				19	OVERVOLTAGE TELEMETRY
				20	INPUT CURRENT TELEMETRY
				21	NO CONNECT
				22	SYNC INPUT
				23	SYNC-OUT
				24	TELEMETRY RETURN
				25	OUTCOM
				26	OUTCOM
				27	CURRENT SHARE
				28	BIT-0
				29	BIT-1
				30	BIT-2
				31	BIT-3

6.0 TECHNICAL NOTES

Please note that many of these functions are also demonstrated in detail on the VPT website in the form of [technical video labs](#).



6.1 GENERAL INFORMATION

6.1.1 Topology Description

The SGRB12028S uses a reduced voltage phase shifted full bridge topology. The reduced voltage switching topology reduces high frequency noise on both the input and output. Utilizing advanced GaN, radiation hardened switching components optimize efficiency and reduce overall size and weight.

6.1.2 External Components

The SGRB12028S is designed to operate stand-alone in most applications. It does not require any external components for proper operation or to meet the datasheet specifications. Input and output L-C filters are provided internally for low ripple and noise. To further reduce output ripple and noise, a small ceramic capacitor, 1 μ F to 10 μ F, can be added at the output. Most application specific ripple requirements can be met with the addition of output capacitors alone. External output capacitance can be added up to the maximum listed in Section 3.2.

6.2 FUNCTION DESCRIPTIONS

6.2.1 On/Off Control (Inhibit)

The INH (Inhibit) pin is a primary-side control pin referenced to TELEMETRY RETURN. The INH pin must be driven using an open collector or open drain configuration. Pulling the INH pin low disables the converter output, removes bias voltage from internal control circuitry, and puts the converter in a state of minimum input current draw. Leaving INH open enables the output, allowing the converter to operate normally. The pin must be pulled below 0.5 V to disable the output. An optional capacitor from INH to TELEMETRY RETURN may be used to delay turn-on. The INH pin should be left open if not used.

6.2.2 Adjusting the Output Voltage (BIT)

The output voltage can be adjusted from 12 V to 28 V with the use of 4 bits that are high impedance inputs. Pulling each bit low results in a change in the output voltage according to the table below. BIT pins are referenced to OUTCOM. Each bit that is left open will be pulled up internally to 12 V through a 40 k Ω resistor and will result in a high function.

Bit-3	Bit-2	Bit-1	Bit-0	28 V Output Voltage
0	0	0	0	12
0	0	0	1	13.07
0	0	1	0	14.13
0	0	1	1	15.2
0	1	0	0	16.27
0	1	0	1	17.33
0	1	1	0	18.4
0	1	1	1	19.47
1	0	0	0	20.53
1	0	0	1	21.6
1	0	1	0	22.67
1	0	1	1	23.73
1	1	0	0	24.8
1	1	0	1	25.87
1	1	1	0	26.93
1	1	1	1	28

6.2.3 Frequency Synchronization (SYNCIN, SYNCOUT)

The SGRB12028S Series will free run at a switching frequency of approximately 450 kHz, which has been set for optimum converter performance. Frequency synchronization is not necessary unless required by system constraints. The SGRB12028S Series provides a frequency synchronization input (SYNCIN) and output (SYNCOUT), both referenced to INCOM. The SYNCIN pin can be driven by an external clock or by the SYNCOUT pin of another SGRB converter. The internal clock and internal power train will operate at the frequency applied to the SYNCIN pin. The SYNCIN pin should be driven with a TTL type 5 V square wave signal. The duty cycle of the square wave should be between 40% and 60%. The SYNCIN pin is internally capacitively coupled, and the internal load is equivalent to 220 pF. Proper layout and circuit techniques are necessary to prevent noise from being injected into this pin. Synchronized converters should be located physically close together and share a low impedance TELEMETRY RETURN connection. The SYNCIN pin can be left open or connected to TELEMETRY RETURN if not used.

6.2.4 Parallel Operation (SHARE)

The SGRB12028S Series provides a SHARE function for active current-sharing among paralleled modules. To enable load sharing, connect a single wire between the SHARE pins of all parallel modules. The SHARE pin can be noise sensitive. Paralleled converters should be located physically close to one another and share a low impedance OUTCOM connection. A symmetrical layout of the output traces will improve share accuracy. Frequency synchronization is not required for parallel operation. The SHARE pin should be left open if not used.

6.3 PROTECTION FEATURES

6.3.1 Input Undervoltage Lockout

The SGRB12028 provides input undervoltage lockout protection. For input voltages below the turn-on voltage, the converter will remain off, drawing minimal current from the source. When the input voltage exceeds the turn-on voltage, the converter will start. The lockout circuit is designed to tolerate slow ramping input voltage waveforms. The undervoltage lockout will immediately turn off the output voltage when V_{in} is below 75 V. When V_{in} is below 95 V and above 75 V the unit will operate but may not meet performance detailed in the electrical performance table in section 3.2. See table notes for more detail.

6.3.2 Output Soft Start

The SGRB12028S utilizes an output soft-start function to ramp the output in a controlled manner, eliminating output voltage overshoot and limiting inrush current at turn on. A voltage-mode soft-start ensures the output waveform remains consistent regardless of changes in the load current. The output rise time is approximately 20 ms. Under normal conditions, current drawn from the source during turn-on will not exceed the full-load input current. The turn-on delay time is specified from the application of input voltage (or release of the inhibit pin) until the output reaches 90% of its final value.

6.3.3 Output Overcurrent Protection

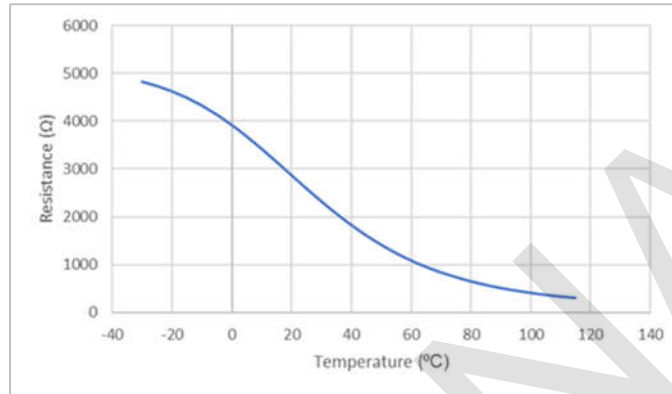
The SGRB12028S provides output overcurrent and output short circuit protection. During a load fault condition, a constant output current control circuit reduces the converter duty cycle to limit the output current to approximately 125% its rated value. The converter will continue to provide constant current into any overload or short circuit condition. This feature allows the converter to start into any capacitive load. Recovery is automatic and immediate upon removal of the fault condition. Sustained short circuit or overload operation can cause excessive power dissipation. Care should be taken to control the operating temperature of the converter in this condition.

6.4 TELEMETRY FEATURES

All telemetry signals are referenced to TELEMETRY RETURN.

6.4.1 Temperature Telemetry

The temperature telemetry uses a thermistor that has the properties below. A current source will need to be applied and a voltage read to determine the temperature of the circuit board. The current into the temperature telemetry pin should be limited to 1 mA.



6.4.2 Over Voltage Telemetry

If an internal failure causes the output voltage to exceed the overvoltage trip point the unit will latch itself off. If an overvoltage condition occurs the overvoltage telemetry signal will go to 5V. The overvoltage latch can be reset two ways. 1) Pull the inhibit pin low for at least 40 ms and then release it or 2) cycle the input voltage below the UVLO turn-off threshold.

6.4.3 Input Current Telemetry

The input current telemetry signal is a 0-5 V analog signal based on the input current of the unit. The accuracy of the current telemetry signal is +/- 5 %.

6.5 THERMAL CONSIDERATIONS

The SGRB12028S is rated for full power operation at 85 °C. Operation above 85 °C is allowed at reduced power. Specifically, the output power should be derated linearly from full power at 85 °C to half power at 90 °C and to zero power at 95 °C. The operating temperature of the converter is specified on the baseplate of the converter. The converter is designed to be conduction-cooled, with the baseplate mounted to a heat sink, chassis, heat pipe or other thermal surface.

The DC-DC converter contains many semiconductor components. The maximum temperature rise from junction to case is **TBD** °C at full load.

6.6 RADIATION HARDNESS ASSURANCE

VPT takes a conservative approach to radiation testing to ensure product performance in a space environment. VPT's DLA-approved Radiation Hardness Assurance (RHA) plan documents VPT's processes and procedures for guaranteeing the performance of VPT products under various environmental conditions in space, including Total Ionizing Dose (TID) and Single-Event Effects (SEE). Additionally, Enhanced Low Dose-Rate Sensitivity (ELDRS) effects are considered for all bipolar ICs used in the SGRB. Hardness is guaranteed by a combination of both converter-level analysis and Radiation Lot Acceptance Testing (RLAT) of all sensitive semiconductor piece-parts used within the converter.

6.6.1 Radiation Test and Performance Levels

Radiation Environment		Piece Part RLAT	Converter-Level Analysis
Total Ionizing Dose (TID)	High Dose Rate (HDR)	100 krad(Si)	100 krad(Si)
	Low Dose Rate (LDR)	100 krad(Si) ¹	100 krad(Si)
Single-Event Effects (SEE)	Destructive (SEB, SEGR, SEL)	Not applicable	≥ 85 MeV/mg/cm ²
	Non-Destructive (SET, SEU, SEFI) ²	Not applicable	≥ 85 MeV/mg/cm ²

1. Piece-part LDR screening performed only on potentially ELDRS parts (bipolar ICs).
2. The PWM IC used in this part is susceptible to a non-destructive SEFI/SEL event with threshold LET ≥ 42 MeV/mg/cm². The SEFI manifests as a shutdown for up to 1 second, followed by a controlled soft-start of the converter. The non-destructive SEL manifests itself as a shutdown requiring user intervention to recover by cycling either the input power or the inhibit function. At the worst-case 125 °C and 85 MeV/mg/cm², the cross-section of these events is 3.18 x 10⁻⁶ cm². Full details available in the Radiation Test Report.

6.6.2 RHA Plan Summary

Test	RHA Plan for SGRB Series Isolated DC-DC Converters
Total Ionizing Dose (TID):	Sensitive semiconductor components undergo RLAT to 100 krad(Si) per MIL-STD-883 Method 1019. Converters are analyzed to 100 krad(Si).
Enhanced Low Dose Rate Sensitivity (ELDRS):	All bipolar linear ICs are characterized for ELDRS and tested in accordance with MIL-STD-883 test method 1019 section 3.13
Single Event Effects (SEE):	Converters are analyzed to LET ≥ 85 MeV/mg/cm ² for both catastrophic events (SEL, SEB, SEGR) and functional interrupts (SEFI) under heavy ion exposure. Converters are also analyzed for cross-section and magnitude of output transients (SET) for at least 3 different LET levels.
Radiation Lot Acceptance Testing (RLAT):	All production lots of sensitive semiconductor components undergo RLAT for TID at HDR and/or LDR as appropriate per part type.

6.6.3 Supporting Documentation Available (Contact Sales)

Report	Description
Radiation Hardness Assurance Plan:	DLA-approved RHA plan covering TID, SEE, and ELDRS
Worst-Case Analysis Report for purchase:	Detailed worst-case analysis including electrical stress/derating limits and guaranteed circuit performance post-radiation and end of life
Radiation Test Summary Report:	Overview of piece-part RLAT and hybrid characterization for all guaranteed environments. Also includes SEE cross-section data.
Reliability Report:	MTBF report based on MIL-HDBK-217 reliability calculations.
Thermal Analysis Report for purchase:	Component temperature rise analysis and measurement results.

7.0 ENVIRONMENTAL SCREENING

Test	Test Method and/or Condition	Flight	/EM (Engineering Model) ²
Internal Visual	IPC-A-610, Class 3 J-STD-001	•	•
Random Vibration	7.4 Grms XYZ Axis Duration: 60 seconds	•	
Temperature Cycling	Temp: -35 °C to 85 °C Cycles: 10 Dwell: 30 minutes Ramp: 5 °C/min.	•	
Final Electrical ¹	100% at -35 °C, 25 °C, and 85 °C	•	
	100% at 25 °C		•
External Visual	Internal Procedure	•	•

1. 100% R&R testing with all test data included in product shipment.
2. Engineering models utilize only the screening specified and are not considered compliant for flight use.

8.0 ORDERING INFORMATION

SGRB	120	28	B	I	S	V	/EM	-	xxx
1	2	3	4	5	6	7	8		9

(1) Product Series	(2) Nominal Input Voltage	(3) Output Voltage	(4) Trim	(5) Turn ON/OFF Control	(6) Number of Outputs	(7) Package Options	(8) Screening Code ¹	(9) Additional Screening Code
SGRB	120 120 Volts	28 Adjustable 12 V-28 V	B Bits	I Inhibit	S Single	V Vertical H Horizontal	None /EM Flight Engineering Model	Contact Sales

1. Engineering models utilize only the standard screening specified and are not considered compliant for flight use. These models are intended for low volume engineering characterization only and have no guarantee regarding operation in a radiation environment. The customer must place the following statement on each line item of their purchase order(s) for /EM units when ordering engineering models:

“(Customer Name) acknowledges that the /EM unit(s) listed in this line item is not permitted for flight use and will be used for Engineering characterization only.”

Please contact your sales representative or VPT Inc. Sales Department for more information concerning additional environmental screening and testing, different input voltage, output voltage, power requirements, source inspection, and/or special element evaluation for space or other higher-quality applications.

9.0 CONTACT INFORMATION

To request a quotation or place orders, please contact your sales representative or the VPT, Inc. Sales Department at:

Phone: (425) 353-3010
Fax: (425) 353-4030
E-mail: vptsales@vptpower.com

All information contained in this datasheet is believed to be accurate; however, no responsibility is assumed for possible errors or omissions. The products or specifications contained herein are subject to change without notice.

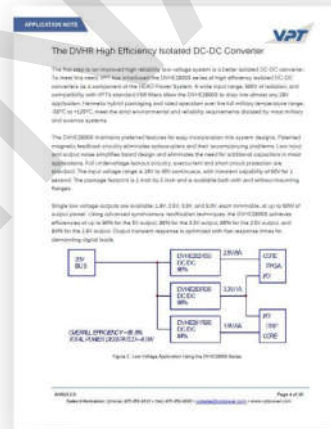
10.0 ADDITIONAL INFORMATION

Visit the VPT website for additional technical resources, including:

[Product Catalogs](#)



[Application Notes and White Papers](#)



[Technical Video Labs](#)



Additional Products For [Avionics/Military](#), [Hi-Rel COTS](#), and [Space Applications](#)

