



Power Your Critical Mission Today

# SGRB10012HCS SERIES

## SPACE QUALIFIED HYBRID DC-DC CONVERTERS



SGRB10012HCS - Exact marking may differ from that shown

### Models Available

Input: 85 V to 113 V continuous, 120 V transient
Single output of 12 V to 16 V adjustable
Efficiency up to 94%
Modified versions available to meet customer-specific requirements

### 1.0 DESCRIPTION

The SGRB10012HCS 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

- Designed for High Capacitive Loads up to 7 mF
- Up to 24 A output current
- 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 94% using GaN Technology
- 4 bit word voltage adjustment
- 120 V, 1 sec transient
- Overvoltage Protection
- Current limit protection / Short Circuit protection
- 28 V Command on & Command off
- Power Supply Telemetry

### 1.2 SPACE LEVEL CHARACTERIZATIONS

- Guaranteed TID performance to 100 krad(Si) including ELDRS
- SEE performance to 85 MeV/mg/cm<sup>2</sup>. Transients are fully analyzed for cross-section and magnitude
- Worst-case analysis & Thermal Analysis available for purchase
- Radiation, MBTF reliability reports available

### 1.3 MANUFACTURING AND COMPLIANCE

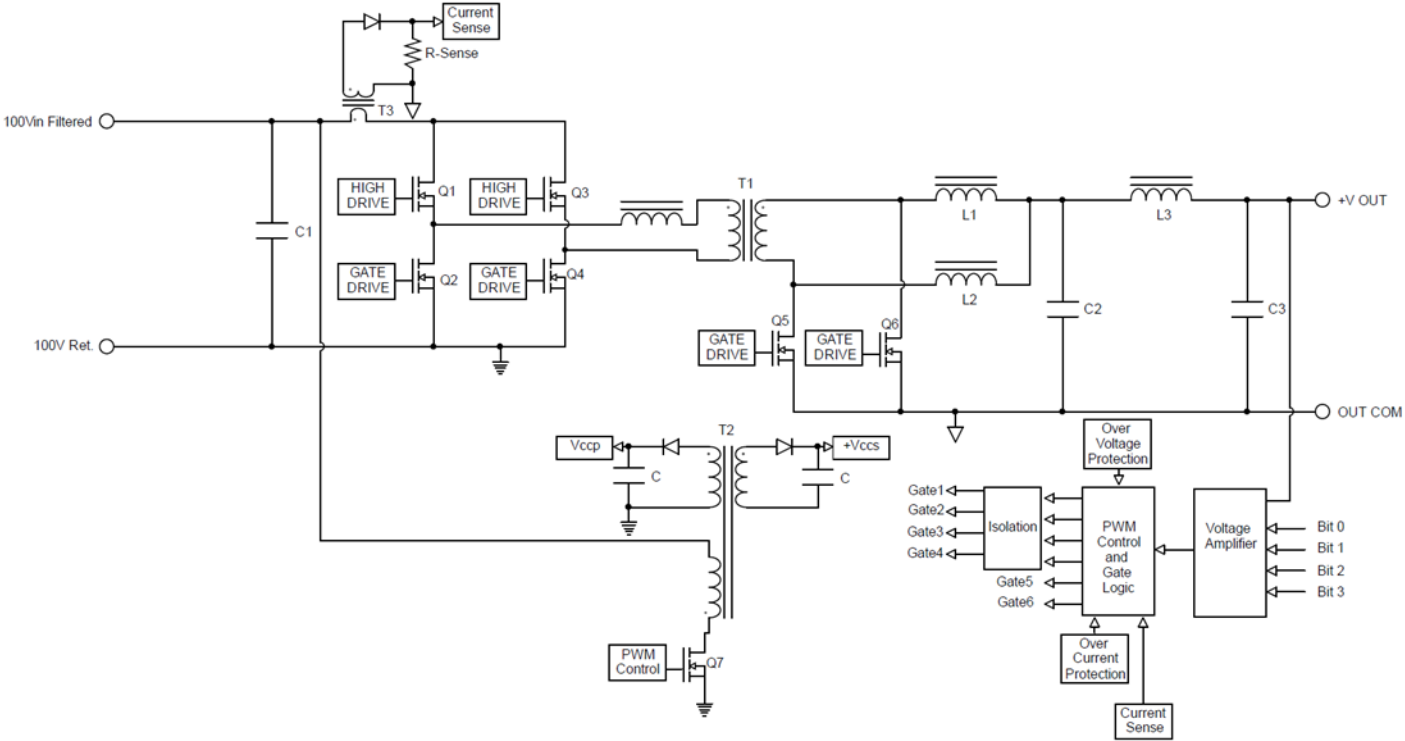
- Manufactured in a facility certified to ISO9001, J-STD-001 and IPC-A-610
- Designed in line with MIL-HNBK-1547 derating

### 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 113 V	Operating Temperature (Full Load):	-35 °C to +85 °C
Input Voltage (Transient, 1 second):	-0.5 V to 120 V	Storage Temperature:	-35 °C to +85 °C
ESD Rating:	TBD		

## 3.2 PERFORMANCE SPECIFICATIONS

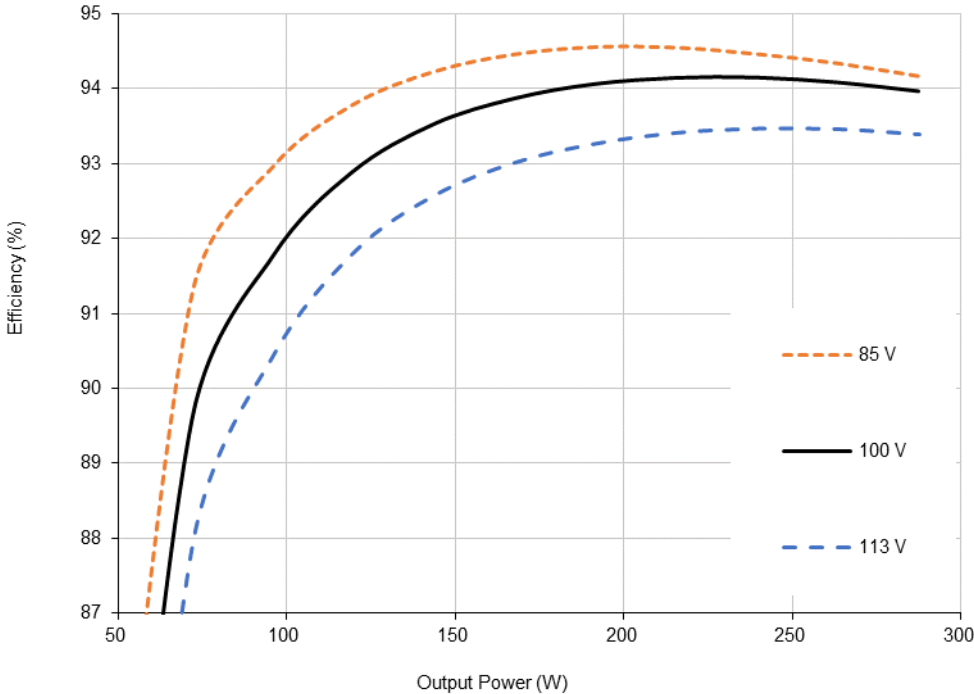
T<sub>case</sub> = -35 °C to +85 °C, V<sub>in</sub> = +28 V ± 5%, Full Load, Unless Otherwise Specified

SGRB10012HCS					
Parameter	Conditions	Min	Typ	Max	Units
<b>INPUT</b>					
Voltage	Continuous	85	100	113	V
	Transient, 1 sec <sup>3</sup>	-	-	120	V
Current	CMD Off	-	1	5	mA
	No Load	-	100	250	mA
Undervoltage Lockout	Turn-On	-	-	84.9	V
	Turn-Off <sup>3</sup>	80	-	-	V
<b>OUTPUT STATIC</b>					
Voltage	+V <sub>out</sub> , T <sub>case</sub> = -35 °C to +85 °C	-0.240	12	0.240	V
Current <sup>2</sup>		0	-	24	A
Ripple Voltage	20 Hz to 10 MHz	-	-	0.4%	mVpp
Line Regulation	V <sub>IN</sub> = 94.5 V to 105 V	-	5	20	mV
Load Regulation	No Load to Full Load	-	45	80	mV
Load Fault Power Dissipation	Overload <sup>3</sup>	-	30	40	W
	Short Circuit <sup>3</sup>	-	30	40	W
<b>OUTPUT DYNAMIC</b>					
Load Step, Half to Full Load	V <sub>o</sub> = 16 V	-	1300	1700	mVpk
	Recovery <sup>1</sup>	-	6	8	ms
Turn-On, V <sub>in</sub> = 100 V, CMD On	Delay	-	35	50	ms
	Overshoot	-	100	250	mVpk
<b>FUNCTION</b>					
Command On	Output Enabled	24	28	34	V
Command Off	Output Off	24	28	34	V
Command Pulse	On or Off	36	40	44	ms
Voltage Trim Range		12		16	V
SHARE Pin Voltage <sup>3</sup>		-	-	5	V
Current Share Accuracy <sup>3</sup>		-	1	6	%
SYNC Frequency Range		500	-	550	kHz
Overvoltage Trip Point <sup>3</sup>	Overvoltage signal = 5 V	16.5	-	22	V
<b>GENERAL</b>					
Efficiency	V <sub>o</sub> = 12 V	91	93		%
Capacitive Load <sup>3</sup>		0.35	-	7	mF
Switching Frequency		400	450	500	kHz
Isolation	10 V DC, T <sub>case</sub> = 25 °C	10	-	-	kΩ
Weight			810	850	g
MTBF (MIL-HDBK-217F)	SF @ T <sub>case</sub> = 55 °C		TBD		kHr

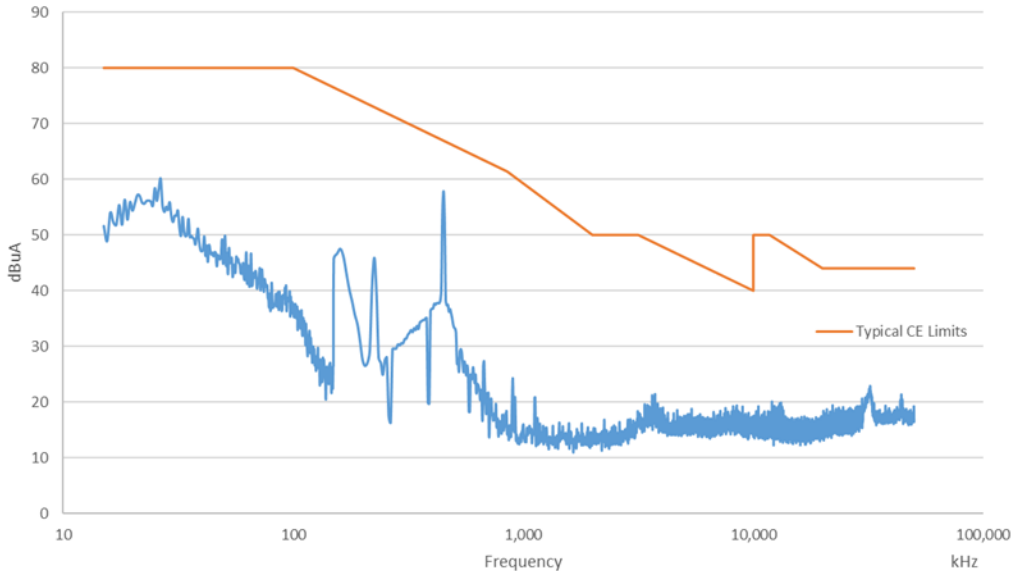
1. Time for output voltage to settle within 1% of steady-state value.
2. Derate linearly to 0 at 95°C.
3. Verified by initial electrical design. Post design verification, parameter shall be guaranteed to the limits specified.

## 4.0 PERFORMANCE CURVES

### 4.1.1 Efficiency, $V_o=12\text{ V}$

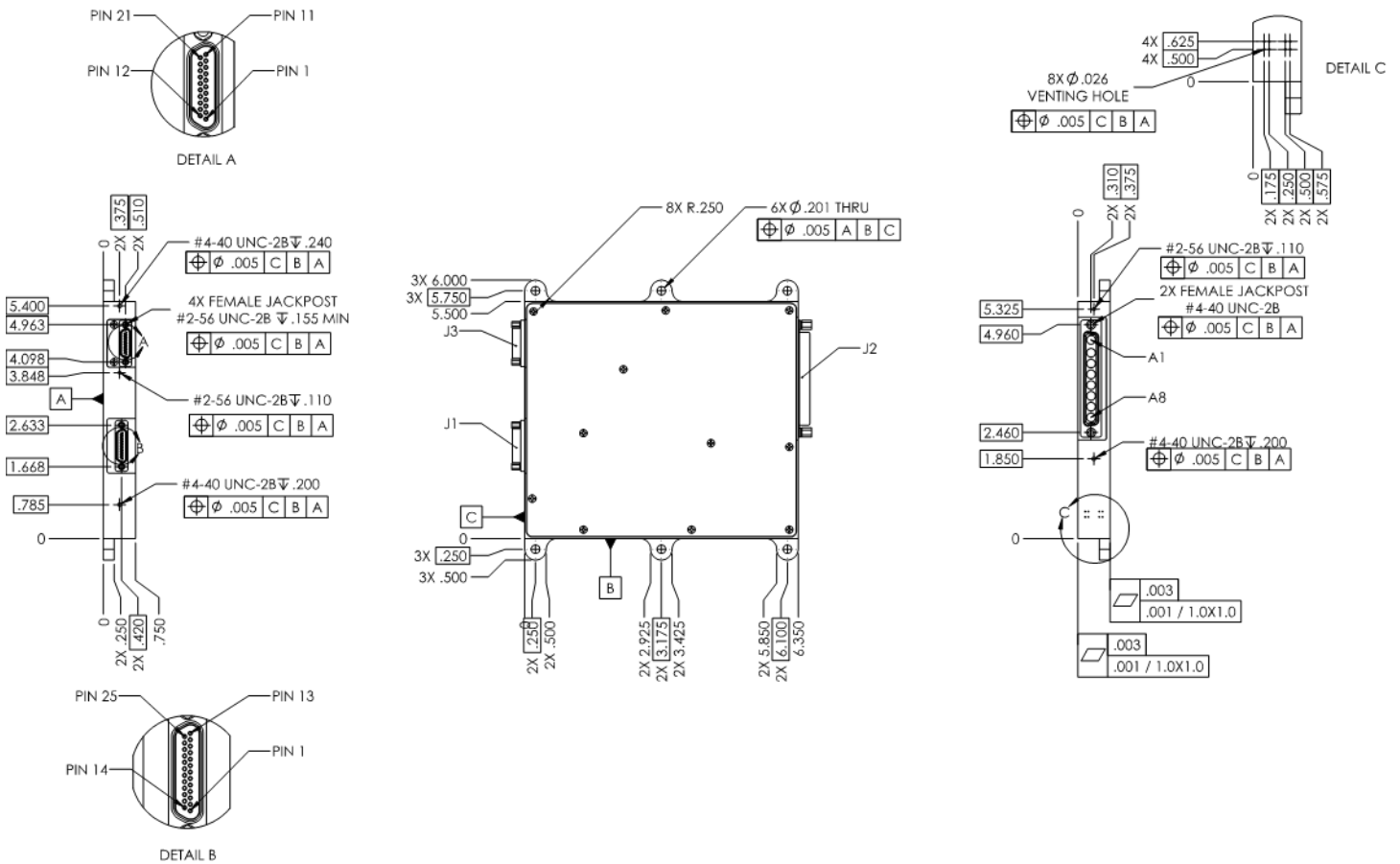


### 4.1.2 Conducted Emissions on $V_{in}$ , $V_o = 12\text{ V}$



## 5.0 MECHANICAL OUTLINES AND PINOUT

### Standard Package Option:



1. Tolerances are  $\pm 0.005$ " 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-D11N.
4. J2 is Positronics P/N SCBM8W8S0000G.
5. J3 is Glenair P/N M83513/04-C11N.
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	NO CONNECT	A1	VOUT	1	CURRENT SHARE
2	COMMAND OFF	A2	OUTCOM	2	OUTCOM
3	COMMAND ON	A3	VOUT	3	BIT-1
4	VOUT TELEMTRY	A4	OUTCOM	4	BIT-3
5	OVERVOLTAGE TELEMTRY	A5	VOUT	5	NO CONNECT
6	INPUT CURRENT TELEMTRY	A6	OUTCOM	6	SYNC-OUT
7	INCOM	A7	VOUT	7	NO CONNECT
8	NO CONNECT	A8	OUTCOM	8	BIT-0
9	INCOM			9	BIT-2
10	INCOM			10	OUTCOM
11	NO CONNECT			11	CURRENT SHARE
12	VIN			12	NO CONNECT
13	VIN			13	BIT-0
14	NO CONNECT			14	BIT-2
15	COMMAND OFF			15	OUTCOM
16	COMMAND ON			16	SYNC INPUT
17	VOUT TELEMTRY			17	NO CONNECT
18	OVERVOLTAGE TELEMTRY			18	OUTCOM
19	INPUT CURRENT TELEMTRY			19	BIT-1
20	NO CONNECT			20	BIT-3
21	TEMPERATURE TELEMTRY			21	NO CONNECT
22	INCOM				
23	NO CONNECT				
24	VIN				
25	VIN				

1. No Connect Pins on J1 should be shorted to INCOM.
2. No Connect Pins on J3 should be shorted to OUTCOM.

## 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 SGRB10012HCS 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, optimizes efficiency and reducing overall size and weight. The SGRB10012HCS internally connects the input common to the chassis.

### 6.1.2 External Components

The SGRB10012HCS is designed to operate with a nominal 2 mF of capacitance. Not having the minimum capacitance listed in section 3.2 could result in control loop instability and possibly damage to the part.

## 6.2 FUNCTION DESCRIPTIONS

### 6.2.1 Command On

Command On is a nominal 28V input signal to turn the output on. 400mA of sourcing current is required to start the internal circuitry of the SGRB10012HCS. This signal must be applied for a minimum of 36ms, and input voltage must be in the nominal range specified in table 3.2 for the converter to turn on.

### 6.2.2 Command Off

Command Off is a nominal 28V signal that is used to turn the output off. 4mA of sourcing current is required to shutdown the internal circuitry of the SGRB10012HCS. This signal is required to be a minimum of 36ms to ensure the output is off. Once commanded off, a command on signal must be reapplied to turn the output back on.

### 6.2.3 Adjusting the output Voltage (TRIM)

The output voltage can be adjusted from 12 V to 16 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. Each bit that is left open will be pulled up internally to 10V through a 40kΩ resistor and will result in a high function.

Bit-3	Bit-2	Bit-1	Bit-0	Output Voltage
0	0	0	0	12.0
0	0	0	1	12.3
0	0	1	0	12.5
0	0	1	1	12.8
0	1	0	0	13.1
0	1	0	1	13.3
0	1	1	0	13.6
0	1	1	1	13.9
1	0	0	0	14.1
1	0	0	1	14.4
1	0	1	0	14.7
1	0	1	1	14.9
1	1	0	0	15.2
1	1	0	1	15.5
1	1	1	0	15.7
1	1	1	1	16.0

### 6.2.4 Frequency Synchronization (SYNCIN, SYNCOUT)

The SGRB10012HCS 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 SGRB10012HCS 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 INCOM connection. The SYNCIN pin can be left open or connected to INCOM if not used.

### 6.2.5 Parallel Operation (SHARE)

The SGRB10012HCS 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 SGRB10012HCS 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 after the command on pulse is received. The lockout circuit is designed to tolerate slow ramping input voltage waveforms.

### 6.3.2 Output Soft Start

The SGRB10012HCS 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 command on pulse until the output reaches 90% of its final value.

### 6.3.3 Output Overcurrent Protection

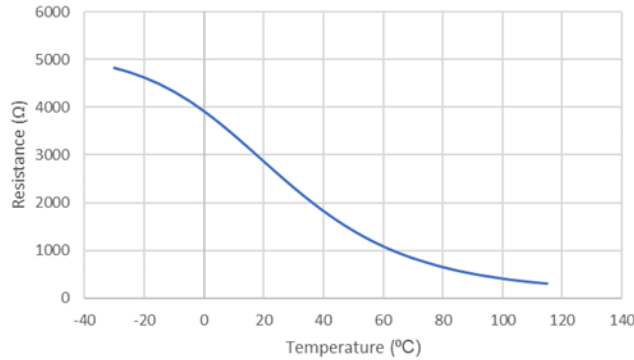
The SGRB10012HCS provides output overcurrent and output short circuit protection. During a load fault condition, a constant output current control circuit reduces the converter duty cycle to limit the output current to approximately 100% of its rated value. The converter will continue to provide constant 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

### 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.



### 6.4.2 Output Voltage Telemetry

The output voltage telemetry signal is a 0-5V analog signal that is a representation of the output voltage.  $V_{tel}=0.182 \cdot V_o$ .

### 6.4.3 Over Voltage Telemetry

If an internal failure that would cause the output voltage to exceed its commanded regulation point, the unit will latch itself off. If an overvoltage condition occurs, the overvoltage output signal will go 5 V. To reset the overvoltage latch, a command-off pulse needs to be applied before the unit can be commanded back on.

### 6.4.4 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 SGRB10012HCS 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 29 °C at full load.

## 6.6 ISOLATION CONSIDERATIONS

The DC isolation is typically specified at 10 V at 25°C and 10kΩ of resistance. The low level of isolation is a result of the output voltage telemetry. This signal crosses the isolation boundary from the secondary to the primary with an analog isolation amplifier. If an analog output voltage telemetry is not required, the isolation could increase to 100 V and 10 MΩ.

## 6.7 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.

### 6.7.1 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) <sup>1</sup>	100 krad(Si)
Single-Event Effects (SEE)	Destructive (SEB, SEGR, SEL)	Not applicable	≥ 85 MeV/mg/cm <sup>2</sup>
	Non-Destructive (SET, SEU, SEFI) <sup>2</sup>	Not applicable	≥ 85 MeV/mg/cm <sup>2</sup>

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/cm<sup>2</sup>. 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/cm<sup>2</sup>, the cross-section of these events is 3.18 x 10<sup>-6</sup> cm<sup>2</sup>. Full details available in the Radiation Test Report.

### 6.7.2 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 <sup>2</sup> 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.

### 6.7.3 Supporting Documentation Available (Contact Sales)

Report	Description
Radiation Hardness Assurance Plan:	DLA-approved RHA plan covering TID, SEE, and ELDRS
Worst-Case Analysis Report:	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:	Component temperature rise analysis and measurement results.

## 7.0 ENVIRONMENTAL SCREENING

Test	Test Method and/or Condition	Flight	/EM (Engineering Model) <sup>2</sup>
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 <sup>1</sup>	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

<b>SGRB</b>	<b>100</b>	<b>12</b>	<b>HCS</b>	<b>/EM</b>	<b>-</b>	<b>xxx</b>
1	2	3	4	5		6

(1) Product Series	(2) Nominal Input Voltage	(3) Output Voltage	(4) Number of Outputs	(5) Screening Code <sup>1</sup>	(6) Additional Screening Code
<b>SGRB</b>	<b>100</b> 100 Volts	<b>12</b> Adjustable 12V-16V	<b>HCS</b> High Capacitive Load Single Output	<b>None /EM</b> 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 the 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.

## 10.0 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](mailto: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.

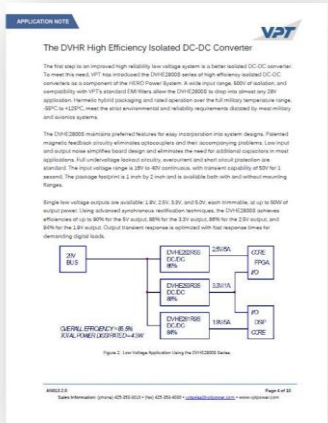
## 11.0 ADDITIONAL INFORMATION

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](#)

