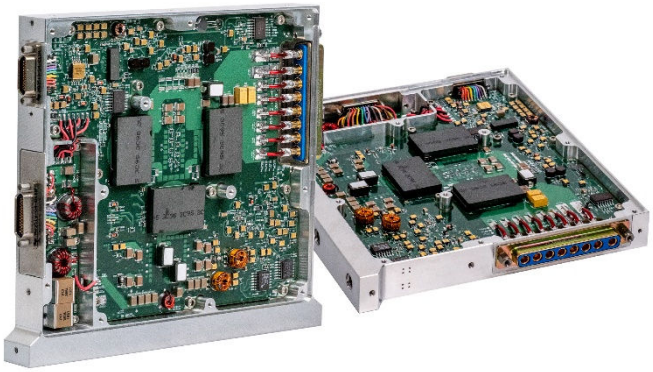
TECHNICAL PREVIEW

Power Your Critical Mission Today

# SGRB12000S SERIES

## SPACE QUALIFIED DC-DC CONVERTERS



| Models Available |
|---|
| Input: 95 V to 140 V continuous, 150 V transient |
| Single output: 15 V, 18 V, 28 V or 50 V |
| Wattage: 360 – 400 W |
| Efficiency up to 96% |

## 1.0 DESCRIPTION

The SGRB Series is a technology-leading solution for space-rated DC-DC power conversion. With its state-of-the-art GaN technology, VPT designed this converter to thrive in the most demanding commercial, scientific, and military space environments. Its radiation hardened design ensures long-term reliability, making it the perfect choice for space payload or primary spacecraft bus applications that require high efficiency and low noise. Standalone, the SGRB Series provides up to 400 watts of output power and can be paralleled to reach significantly higher power levels if needed.

Due to its advanced fixed frequency reduced voltage switching topology, the SGRB Series produces extremely low input and output noise. This award-winning power conversion solution can be used for a wide range of high-power space applications. With VPT's extensive history of space flight heritage and proven performance, the SGRB Series will deliver the dependable performance that your mission demands.

## 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

## 1.1 FEATURES (CONTINUED)

- High Efficiency up to 96% using GaN Technology
- Output voltage adjustment options
- ON/OFF Control options
- Overvoltage Protection
- Current limit protection / Short Circuit protection
- Power Supply Telemetry
- Parallel operation for higher power requirements using current share. See Section 6.2.4 Parallel Operation (SHARE) for more details.
- Modified versions available to meet customer-specific requirements.

## 1.2 SPACE LEVEL CHARACTERIZATIONS

- Guaranteed TID performance to 100 krad(Si) including ELDRS
- SEE performance to 85 MeV/mg/cm$^2$. 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

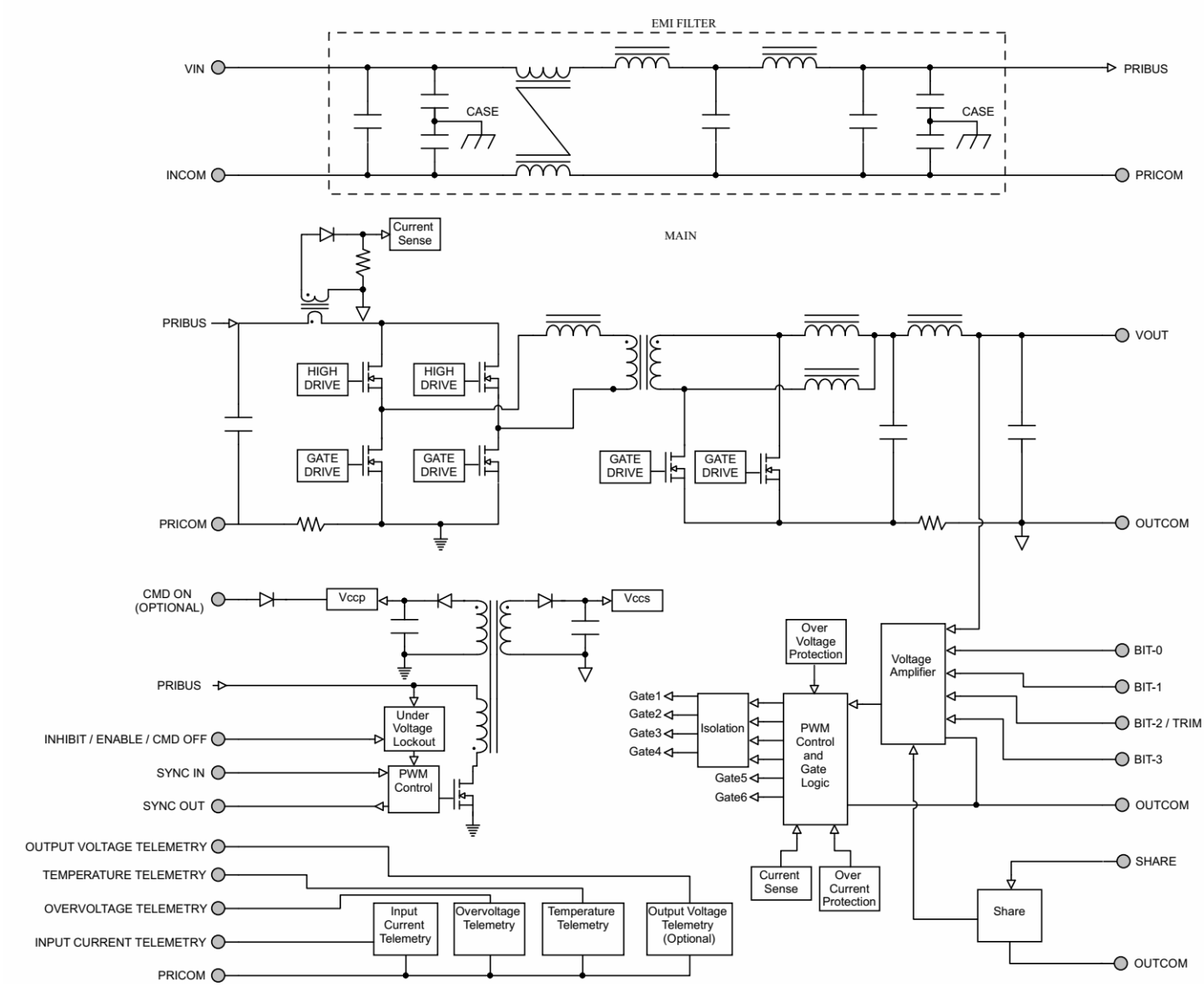
- Manufactured in a facility certified to SAE AS9100, J-STD-001 (Space Addendum) and IPC-A-610
- Designed in line with EEE-INST-002 derating

## 1.4 PACKAGING

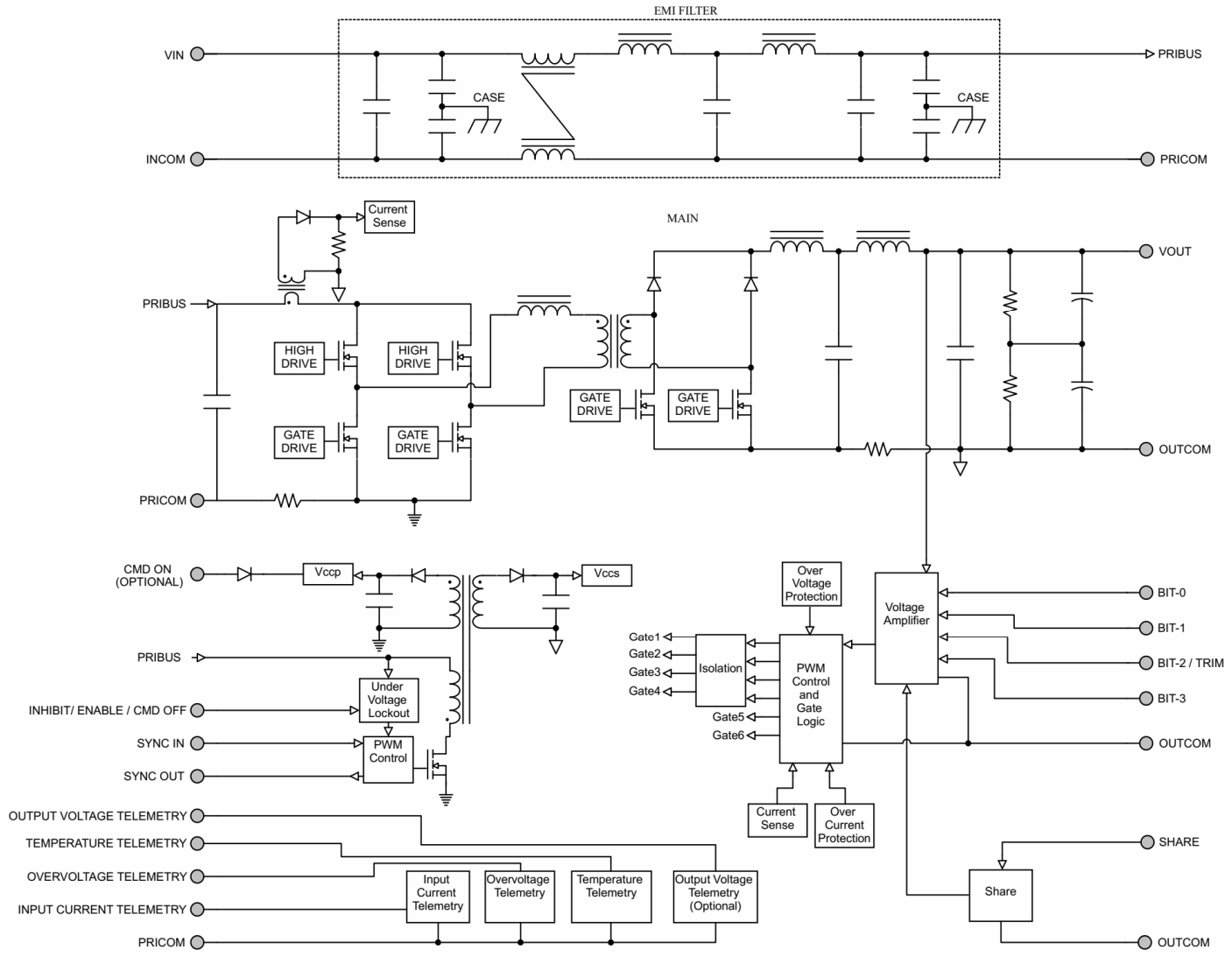
- Low-profile: 6.85” x 5.95” x 0.75”
- Max weight: 850 g
- Aluminum case and cover with nickel plating

## 2.0 DIAGRAMS

### 2.1 BLOCK DIAGRAM




Block Diagram for models ≤ 28 V output.




Block Diagram for 50 V output model.

## 3.0 SPECIFICATIONS

## 3.1 ABSOLUTE MAXIMUM RATINGS

| Absolute Maximum Ratings | | | |
|---|---|---|---|
| Input Voltage (Continuous): | -0.5 V to 140 V | Operating Temperature (Full Load): | -35 °C to +85 °C |
| Input Voltage (Transient, 1 second): | -0.5 V to 150 V | Storage Temperature: | -35 °C to +110 °C |

## 3.2 PERFORMANCE SPECIFICATIONS

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

| | | SGRB12015S | | | SGRB12018S | | | |
|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Conditions** | **Min** | **Typ** | **Max** | **Min** | **Typ** | **Max** | **Units** |
| **INPUT** | | | | | | | | |
| Voltage | Continuous | 95 | 120 | 140 | 95 | 120 | 140 | V |
| | Transient, 1 sec | - | - | 150 | - | - | 150 | V |
| Current | INH < 1.5 V | - | 3.5 | 5 | - | 2.5 | 5 | mA |
| | No Load | - | 100 | 150 | - | 100 | 150 | mA |
| Undervoltage Lockout | Turn-On | - | - | 94.0 | - | - | 94.0 | V |
| | Turn-Off | 87.0 | - | - | 87.0 | - | - | V |
| **OUTPUT STATIC** | | | | | | | | |
| Voltage, Nominal[5] | Tcase = -35 °C to +85 °C | 14.74 | 15 | 15.26 | 17.69 | 18 | 18.32 | V |
| Voltage | Tcase = -35 °C to +85 °C | -1.75% | Vset | 1.75% | -1.75% | Vset | 1.75% | V |
| Power[2] | | 0 | - | 396 | 0 | - | 400 | W |
| Current[2] | | 0 | - | 24 | 0 | - | 22.2 | A |
| Ripple Voltage | 20 Hz to 10 MHz | - | - | 85 | - | - | 100 | mVpp |
| Line Regulation | $V_{IN}$ = 95 V to 140 V | - | 10 | 100 | - | 10 | 100 | mV |
| Load Regulation | No Load to Full Load | - | 45 | 80 | - | 45 | 80 | mV |
| Load Fault Power Dissipation | Overload | - | 30 | 40 | - | 25 | 35 | W |
| | Short Circuit | - | 25 | 35 | - | 22 | 30 | W |
| **OUTPUT DYNAMIC** | | | | | | | | |
| Load Step, Half to Full Load | | - | 720 | 1000 | - | 450 | 600 | mVpk |
| | Recovery[1] | - | 350 | 600 | - | 150 | 250 | µs |
| Turn-On, Vin = 0 to 120 V | Delay | - | 30 | 50 | - | 30 | 50 | ms |
| | Overshoot | - | 25 | 50 | - | 25 | 50 | mVpk |
| **FUNCTION** | | | | | | | | |
| INHIBIT Pin Input[3] | Output Inhibited | 0 | - | 1.5 | 0 | - | 1.5 | V |
| INHIBIT Pin Open Circuit Voltage[3] | Output Enabled | 10 | - | 16 | 10 | - | 16 | V |
| Voltage Trim Range | | 12 | | 16.5 | 16 | | 23.5 | V |
| SHARE Pin Voltage | | - | - | 10 | - | - | 10 | V |
| Current Share Accuracy[3] | | - | 0.24 | 1.44 | - | 0.22 | 1.3 | A |
| SYNC Frequency Range | | 500 | - | 550 | 500 | - | 550 | kHz |
| Overvoltage Trip Point | Overvoltage signal = 5 V | 18.5 | - | 21 | 27.3 | - | 29.4 | V |
| **GENERAL** | | | | | | | | |
| Efficiency | | 91.5 | 93.5 | - | 91.5 | 93.5 | - | % |
| Capacitive Load[3] | | 0 | - | 100 | 0 | - | 100 | µF |
| Switching Frequency | | 400 | 450 | 500 | 400 | 450 | 500 | kHz |
| Isolation[4] | 100 V DC, Tcase = 25 °C | 10 | - | - | 10 | - | - | MΩ |
| Weight | Vertical Package Option | - | 810 | 850 | - | 810 | 850 | g |
| | Horizontal Package Option | - | 725 | 765 | - | 725 | 765 | g |
| MTBF (MIL-HDBK-217F) | SF @ Tcase = 55 °C | | 1.99 | | | 1.95 | | 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. Isolation listed without output voltage telemetry.
5. See Section 6.2.2 for Output Voltage Adjust connections to achieve Nominal Output Voltage.

## 3.2 PERFORMANCE SPECIFICATIONS

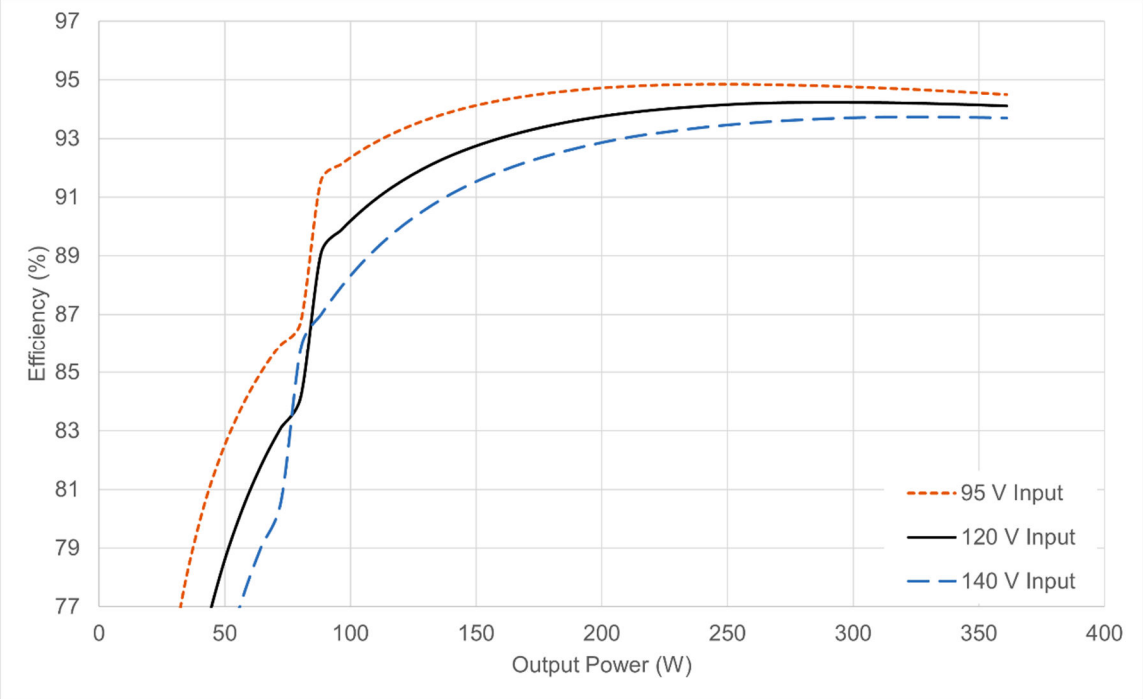
Tcase = -35 °C to +85 °C, Vin = +120 V ± 5%, Vo = Nominal[5], Full Load, Unless Otherwise Specified

| | | SGRB12028S | | | SGRB12050S | | | |
|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Conditions** | **Min** | **Typ** | **Max** | **Min** | **Typ** | **Max** | **Units** |
| **INPUT** | | | | | | | | |
| Voltage | Continuous | 95 | 120 | 140 | 95 | 120 | 140 | V |
| | Transient, 1 sec | - | - | 150 | - | - | 150 | V |
| Current | INH < 1.5 V | - | 2.5 | 5 | - | 2.5 | 5 | mA |
| | No Load | - | 100 | 150 | - | 100 | 150 | mA |
| Undervoltage Lockout | Turn-On | - | - | 94.0 | - | - | 94.0 | V |
| | Turn-Off | 87.0 | - | - | 87.0 | - | - | V |
| **OUTPUT STATIC** | | | | | | | | |
| Voltage, Nominal[5] | Tcase = -35 °C to +85 °C | 27.51 | 28 | 28.49 | 49.12 | 50 | 50.88 | V |
| Voltage | Tcase = -35 °C to +85 °C | -1.75% | Vset | 1.75% | -1.75% | Vset | 1.75% | V |
| Power[2] | | 0 | - | 400 | 0 | - | 400 | W |
| Current[2] | | 0 | - | 14.3 | 0 | - | 9 | A |
| Ripple Voltage | 20 Hz to 10 MHz | - | - | 100 | - | - | 200 | mVpp |
| Line Regulation | $V_{IN}$ = 95 V to 140 V | - | 10 | 100 | - | 10 | 100 | mV |
| Load Regulation | No Load to Full Load | - | 45 | 80 | - | 45 | 80 | mV |
| Load Fault Power Dissipation | Overload | - | 23 | 30 | - | 30 | 40 | W |
| | Short Circuit | - | 18 | 25 | - | 25 | 35 | W |
| **OUTPUT DYNAMIC** | | | | | | | | |
| Load Step, Half to Full Load | | - | 1150 | 1500 | - | 1150 | 1500 | mVpk |
| | Recovery[1] | - | 270 | 500 | - | 270 | 500 | µs |
| Turn-On, Vin = 0 to 120 V | Delay | - | 30 | 50 | - | 30 | 50 | ms |
| | Overshoot | - | 25 | 50 | - | 25 | 50 | mVpk |
| **FUNCTION** | | | | | | | | |
| INHIBIT Pin Input[3] | Output Inhibited | 0 | - | 1.5 | 0 | - | 1.5 | V |
| INHIBIT Pin Open Circuit Voltage[3] | Output Enabled | 0 | - | 16 | 10 | - | 16 | V |
| Voltage Trim Range | | 12 | | 28 | 40 | | 55 | V |
| SHARE Pin Voltage | | - | - | 10 | - | - | 10 | V |
| Current Share Accuracy[3] | | - | 0.14 | 0.85 | - | 0.1 | 0.6 | A |
| SYNC Frequency Range | | 500 | - | 550 | 500 | - | 550 | kHz |
| Overvoltage Trip Point | Overvoltage signal = 5 V | 32.5 | - | 35 | 64 | - | 68 | V |
| **GENERAL** | | | | | | | | |
| Efficiency | | 93 | 95 | - | 92 | 95 | - | % |
| Capacitive Load[3] | | 0 | - | 100 | 0 | - | 100 | µF |
| Switching Frequency | | 400 | 450 | 500 | 400 | 450 | 500 | kHz |
| Isolation[4] | 100 V DC, Tcase = 25 °C | 10 | - | - | 10 | - | - | MΩ |
| Weight | Vertical Package Option | - | 810 | 850 | - | 810 | 850 | g |
| | Horizontal Package Option | - | 725 | 765 | - | 725 | 765 | g |
| MTBF (MIL-HDBK-217F) | SF @ Tcase = 55 °C | | 1.95 | | | TBD | | MHr |

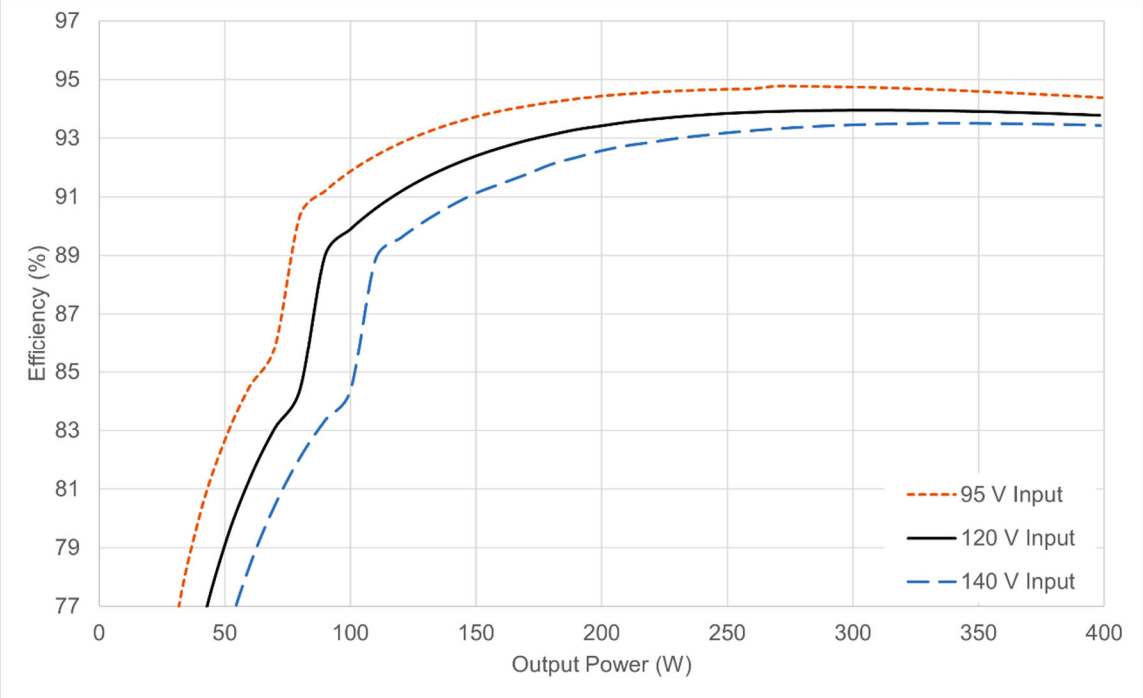
1. Time for output voltage to settle within 1% of steady-state value
2. Derate linearly to 0 at 95°C
3. Verified by initial electrical design. Post design verification, parameter shall be guaranteed to the limits specified.
4. Isolation listed without output voltage telemetry.
5. See Section 6.2.2 for Output Voltage Adjust connections to achieve Nominal Output Voltage.

## 4.0 PERFORMANCE CURVES

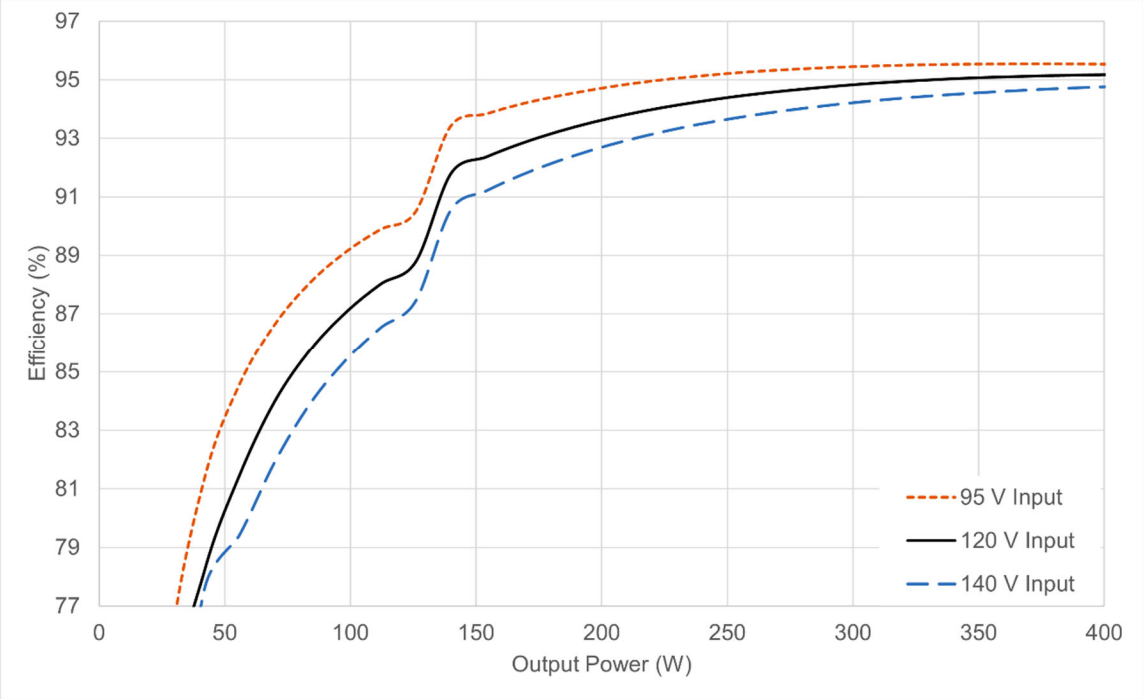
### 4.1.1 SGRB12015S Efficiency Vo = 15 V (Typical, 25 °C)



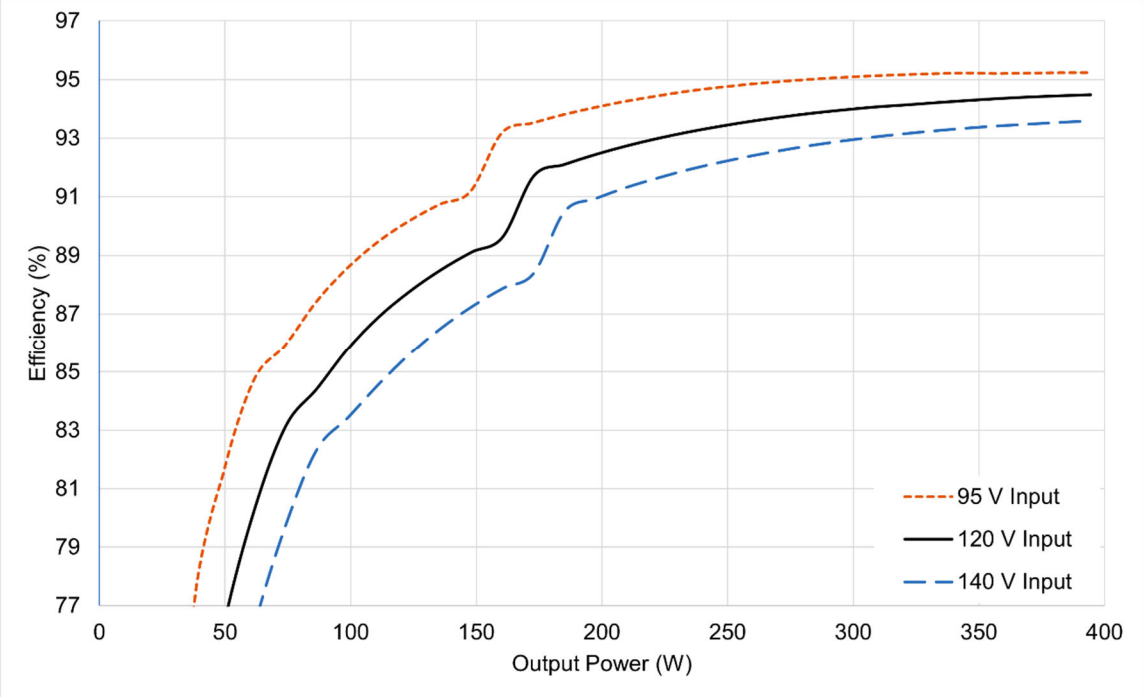

### 4.1.2 SGRB12018S Efficiency Vo = 18 V (Typical, 25 °C)



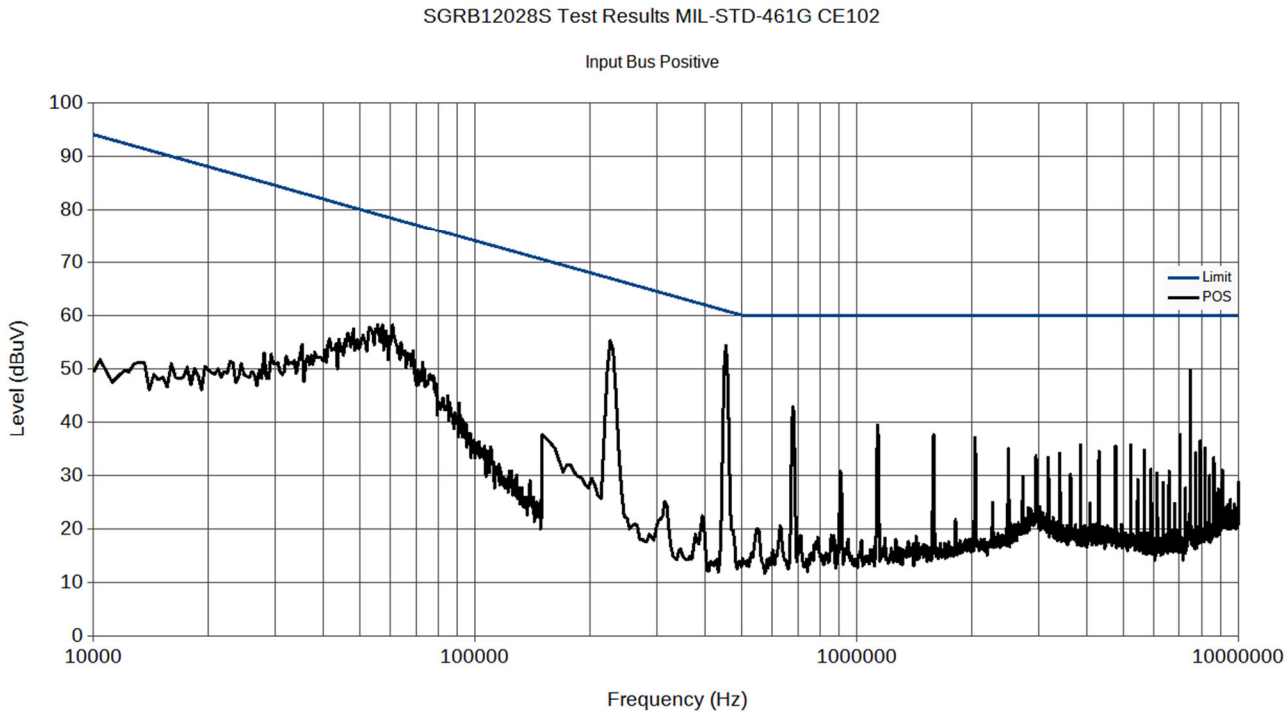
### 4.1.3 SGRB12028S Efficiency Vo = 28 V (Typical, 25 °C)

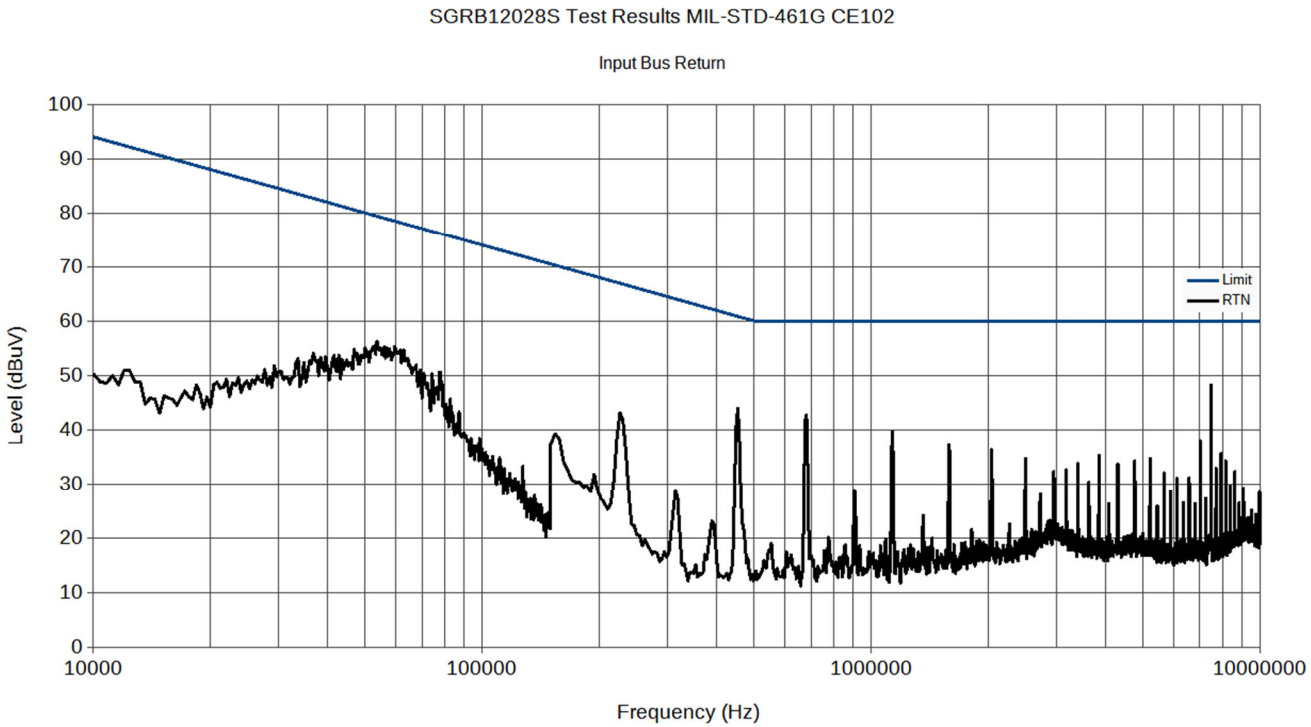



### 4.1.4 SGRB12050S Efficiency Vo = 50 V (Typical, 25 °C)



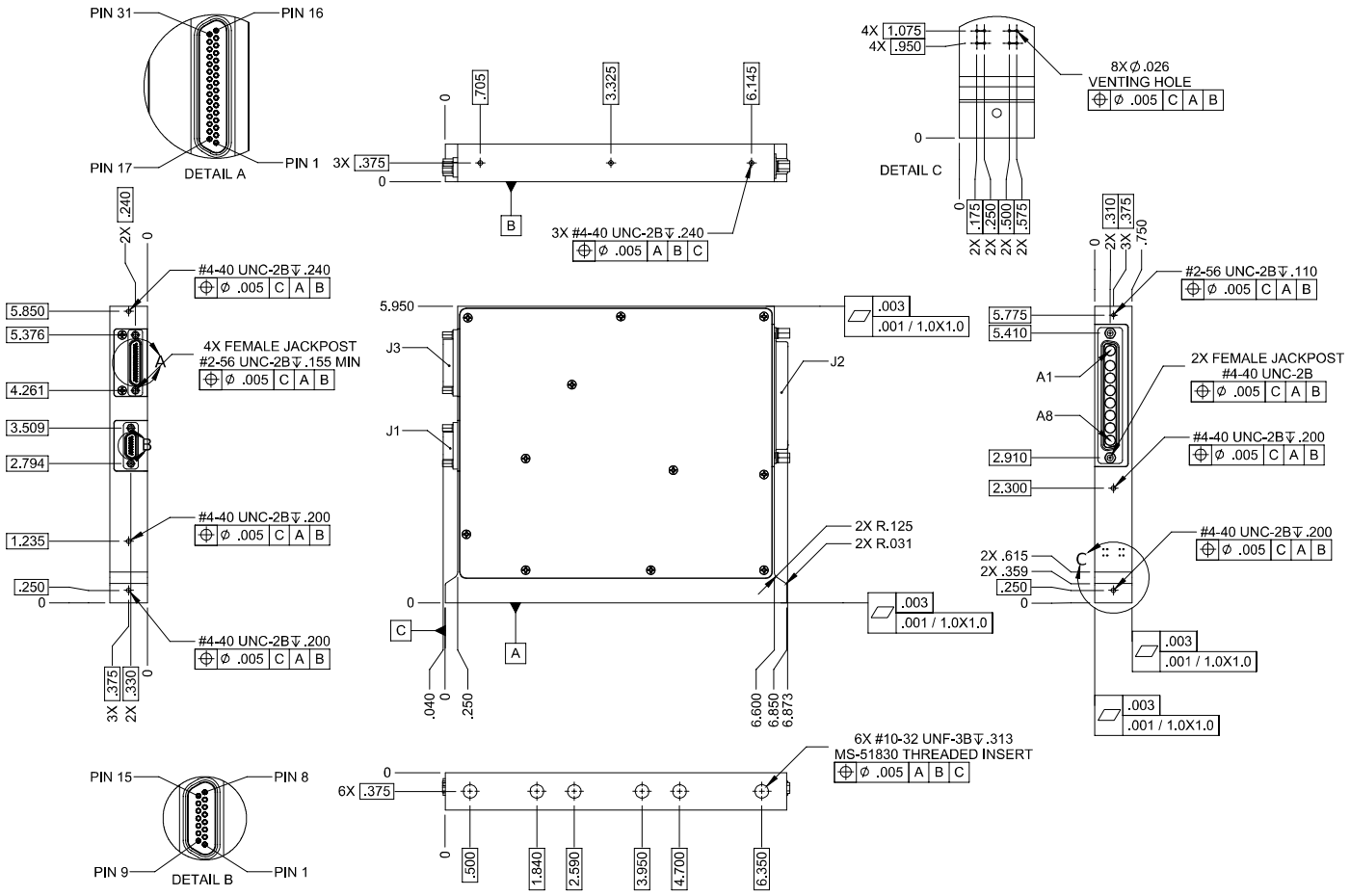
### 4.2.1 Conducted Emissions SGRB12028S, Vin = 120 V, Vo = 28V (Typical, 25 °C)



## 5.0 MECHANICAL OUTLINES AND PINOUT

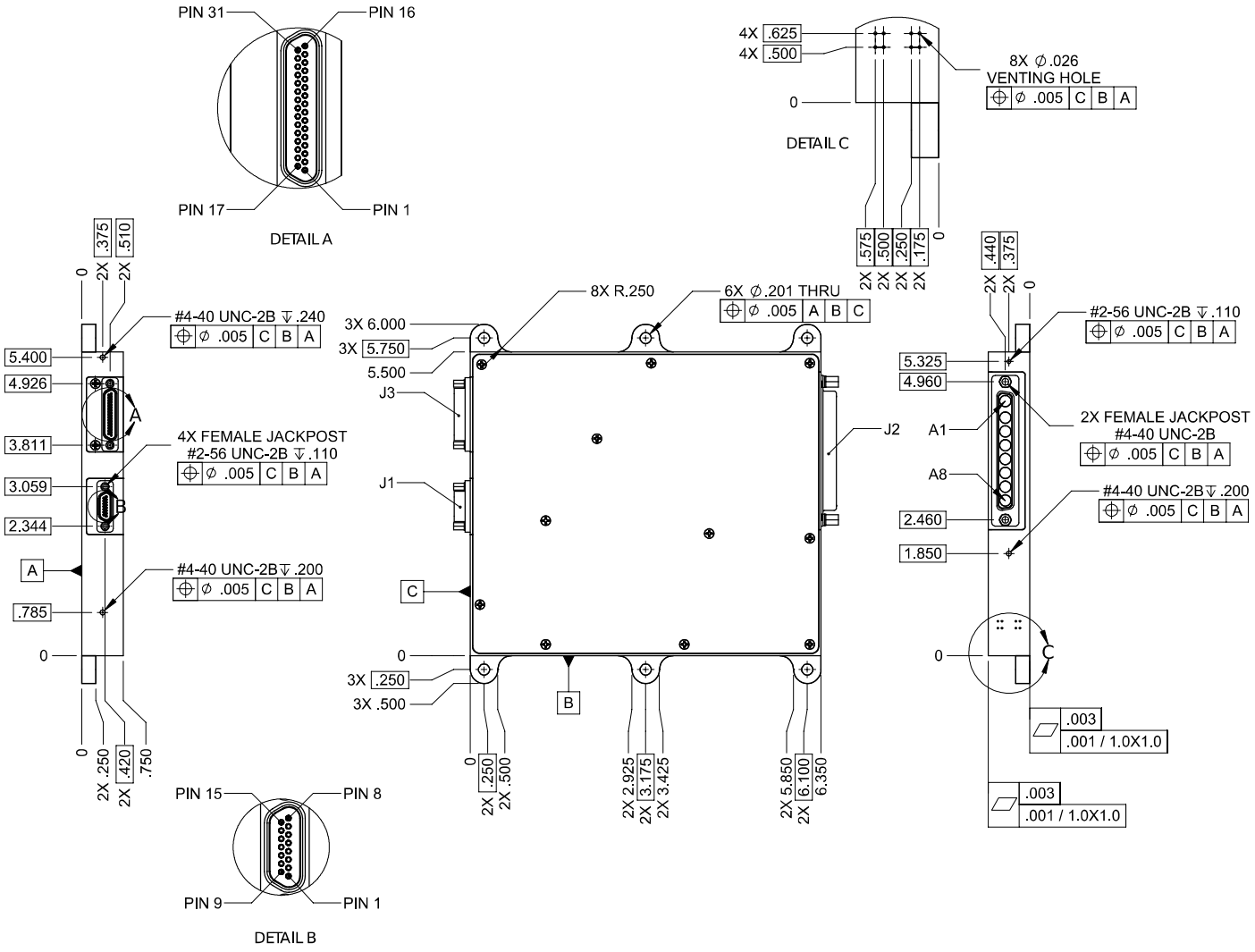
### 5.1 Vertical Package Option:




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 M83513/04-B11N
4. J2 is Positronics P/N SCBM8W8S0000G
5. J3 is M83513/04-E11N
6. Temperature is specified at the baseplate, side A as shown above.

## 5.0 MECHANICAL OUTLINES AND PINOUT (CONTINUED)

### 5.2 Horizontal 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 M83513/04-B11N
4. J2 is Positronics P/N SCBM8W8S0000G
5. J3 is 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 / ENABLE / CMD OFF |
| 3 | VIN | A3 | VOUT | 3 | OVERVOLTAGE TELEMETRY |
| 4 | VIN | A4 | OUTCOM | 4 | INPUT CURRENT TELEMETRY |
| 5 | INCOM | A5 | VOUT | 5 | VOUT TELEMETRY / PRICOM |
| 6 | INCOM | A6 | OUTCOM | 6 | SYNC IN |
| 7 | INCOM | A7 | VOUT | 7 | SYNC OUT |
| 8 | INCOM | A8 | OUTCOM | 8 | PRICOM |
| 9 | VIN | | | 9 | PRICOM |
| 10 | VIN | | | 10 | OUTCOM / CMD ON |
| 11 | VIN | | | 11 | OUTCOM |
| 12 | INCOM | | | 12 | CURRENT SHARE |
| 13 | INCOM | | | 13 | BIT-0 / OUTCOM |
| 14 | INCOM | | | 14 | BIT-1 / OUTCOM |
| 15 | INCOM | | | 15 | BIT-2 / TRIM |
| | | | | 16 | BIT-3 / OUTCOM |
| | | | | 17 | TEMPERATURE TELEMETRY |
| | | | | 18 | INHIBIT / ENABLE / CMD OFF |
| | | | | 19 | OVERVOLTAGE TELEMETRY |
| | | | | 20 | INPUT CURRENT TELEMETRY |
| | | | | 21 | VOUT TELEMETRY / PRICOM |
| | | | | 22 | SYNC IN |
| | | | | 23 | SYNC OUT |
| | | | | 24 | PRICOM |
| | | | | 25 | OUTCOM / CMD ON |
| | | | | 26 | OUTCOM |
| | | | | 27 | CURRENT SHARE |
| | | | | 28 | BIT-0 / OUTCOM |
| | | | | 29 | BIT-1 / OUTCOM |
| | | | | 30 | BIT-2 / TRIM |
| | | | | 31 | BIT-3 / 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 SGRB12000S Series uses a reduced voltage switching phase shifted full bridge topology. By reducing the voltage during switching, losses and high frequency noise are reduced on both the input and output. The design utilizes GaN radiation hardened switching devices to both optimize efficiency and reduce overall size and weight.

### 6.1.2 External Components

The SGRB12000S Series 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, except for the resistor for output Resistor Trim if that option is present. 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 µF to 10 µF, 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. For applications requiring additional capacitance please contact VPT for assistance.

### 6.1.3 References

Referring to Section 2.1, the block diagram, input power is connected to the EMI filter section from VIN to INCOM. As power is filtered and moves through to the main converter both VIN and INCOM pass through a common mode choke. After passing through the EMI filter VIN becomes PRIBUS and INCOM becomes PRICOM. Both are further filtered by capacitors that bypass common mode noise to the chassis. The nodes INCOM and PRICOM are nearly identical at DC but impedance between them increases with frequency. There can be a noise level difference between these two nodes made up of switching harmonics and other high frequency components.

As shown in the block diagram, PRICOM is used as the reference for the following signals:

- INHIBIT – Converter inhibit
- SYNC – Clock used to synchronize operation of the main converter
- INPUT CURRENT TELEMETRY – Scaled representation of the input current
- OVERVOLTAGE TELEMETRY – Signal indicating converter has shut down due to an overvoltage detection on the output
- TEMPERATURE TELEMETRY – Thermistor coupled to the main converter circuit board for external monitoring
- OUTPUT VOLTAGE TELEMETRY – Scaled representation of the output voltage

The output is isolated from the input by up to 100 V (unless the output voltage telemetry circuit is present) and thus VOUT is referenced to a secondary side return, OUTCOM. There is capacitance from PRICOM to OUTCOM to ensure high frequency noises are bypassed. SHARE is used for running multiple converters in parallel and is also referenced to OUTCOM.

## 6.2 FUNCTION DESCRIPTIONS

### 6.2.1 On/Off Control

**INHIBIT**

The INHIBIT pin is a primary-side control pin referenced to PRICOM. The INHIBIT pin must be driven using an open collector or open drain configuration. Pulling INHIBIT 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 INHIBIT open enables the output, allowing the converter to operate normally. The pin must be pulled below 1.5 V to disable the output; it will source less than 1 mA in this state. The INHIBIT pin should be left open if not used.

**Enable (Optional)**

As an alternative to INHIBIT, the ENABLE pin is a primary-side control pin referenced to PRICOM. The ENABLE pin must be driven using an open collector or open drain configuration. Leaving ENABLE open disables the converter output, removes bias voltage from internal control circuitry, and puts the converter in a state of minimum input current draw. Pulling the ENABLE pin low enables the

output, allowing the converter to operate normally. The pin must be pulled below 0.75 V to enable the output. The ENABLE pin should be shorted to PRICOM if not used.

**Command On & Off (Optional)**
As an alternative to INHIBIT, the converter can be configured to use Command On and Command Off circuits instead. Command On is a nominal 28 V input signal used to turn on the output. 400 mA of sourcing current is required to start the internal circuitry of the SGRB12000S Series converter. This signal must be applied for a minimum of 40 ms and input voltage must be in the nominal range specified in table 3.2 for the converter to turn on.

Command Off is a nominal 28 V signal that is used to turn off the output. This signal is required to be a minimum of 40 ms to ensure the output is off. Once commanded off, a Command On signal must be reapplied to turn the output back on.

It is not possible to configure the converter to use multiple on/off control options; only one option may be selected.

### 6.2.2 Adjusting the Output Voltage

**Bits**
The output voltage set point of the converter can be adjusted in one of two ways. If the converter is configured to use bits, then the 4 high- impedance bit inputs can be pulled low to 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 10 V through a 40kΩ resistor and will result in setting that bit high. The BIT pin settings can be changed while the SGRB's output is enabled.

| Option 1: Bits | | | | | | | |
|---|---|---|---|---|---|---|---|
| Bit-3 | Bit-2 | Bit-1 | Bit-0 | SGRB12015S Vout (V) | SGRB12018S Vout (V) | SGRB12028S Vout (V) | SGRB12050S Vout (V) |
| 0 | 0 | 0 | 0 | 12 | 16 | 12 | 40 |
| 0 | 0 | 0 | 1 | 12.3 | 16.5 | 13.07 | 41 |
| 0 | 0 | 1 | 0 | 12.6 | 17 | 14.13 | 42 |
| 0 | 0 | 1 | 1 | 12.9 | 17.5 | 15.2 | 43 |
| 0 | 1 | 0 | 0 | 13.2 | 18 | 16.27 | 44 |
| 0 | 1 | 0 | 1 | 13.5 | 18.5 | 17.33 | 45 |
| 0 | 1 | 1 | 0 | 13.8 | 19 | 18.4 | 46 |
| 0 | 1 | 1 | 1 | 14.1 | 19.5 | 19.47 | 47 |
| 1 | 0 | 0 | 0 | 14.4 | 20 | 20.53 | 48 |
| 1 | 0 | 0 | 1 | 14.7 | 20.5 | 21.6 | 49 |
| 1 | 0 | 1 | 0 | 15 | 21 | 22.67 | 50 |
| 1 | 0 | 1 | 1 | 15.3 | 21.5 | 23.73 | 51 |
| 1 | 1 | 0 | 0 | 15.6 | 22 | 24.8 | 52 |
| 1 | 1 | 0 | 1 | 15.9 | 22.5 | 25.87 | 53 |
| 1 | 1 | 1 | 0 | 16.2 | 23 | 26.93 | 54 |
| 1 | 1 | 1 | 1 | 16.5 | 23.5 | 28 | 55 |

**Resistor TRIM**
If the converter is configured to use resistor trim, then a resistor can be connected from TRIM to OUTCOM to adjust the output voltage according to the table below. To meet the performance specified in Section 3.2, 0.1% resistors should be used. Because the TRIM pin can be sensitive to external noise, the trim resistor should be physically located close to the converter with short interconnects. The TRIM pin should be left open if not used.

It is not possible to configure the converter to use both bits and resistor trim; only one option may be selected.

| Option 2: Resistor Trim | | | | | | | |
|---|---|---|---|---|---|---|---|
| SGRB12015S | | SGRB12018S | | SGRB12028S | | SGRB12050S | |
| Rtrim (Ω) | Vout (V) | Rtrim (Ω) | Vout (V) | Rtrim (Ω) | Vout (V) | Rtrim (Ω) | Vout (V) |
| - | 12 | - | 16 | - | 12 | - | 40 |
| 144k | 12.3 | 117k | 16.5 | 45.5k | 13.07 | 111k | 41 |
| 70.2k | 12.6 | 49.4k | 17 | 21.1k | 14.13 | 46.1k | 42 |
| 44.1k | 12.9 | 29.6k | 17.5 | 13.0k | 15.2 | 27.4k | 43 |
| 30.7k | 13.2 | 20.1k | 18 | 8.99k | 16.27 | 18.6k | 44 |
| 22.5k | 13.5 | 14.6k | 18.5 | 6.60k | 17.33 | 13.4k | 45 |
| 17.0k | 13.8 | 11.0k | 19 | 4.99k | 18.4 | 10.1k | 46 |
| 13.1k | 14.1 | 8.42k | 19.5 | 3.84k | 19.47 | 7.68k | 47 |
| 10.1k | 14.4 | 6.51k | 20 | 2.98k | 20.53 | 5.90k | 48 |
| 7.79k | 14.7 | 5.04k | 20.5 | 2.31k | 21.6 | 4.53k | 49 |
| 5.92k | 15 | 3.86k | 21 | 1.78k | 22.67 | 3.43k | 50 |
| 4.40k | 15.3 | 2.91k | 21.5 | 1.35k | 23.73 | 2.54k | 51 |
| 3.13k | 15.6 | 2.11k | 22 | 981 | 24.8 | 1.80k | 52 |
| 2.05k | 15.9 | 1.44k | 22.5 | 673 | 25.87 | 1.18k | 53 |
| 1.13k | 16.2 | 865 | 23 | 411 | 26.93 | 646 | 54 |
| 323 | 16.5 | 370 | 23.5 | 182 | 28 | 184 | 55 |

**Configuring Nominal Output Voltage**

The SGRB12000S Series requires specific Bit or Resistor Trim connections to achieve the Nominal Output Voltage defined in Section 3.2.

| Nominal Vout Configuration | | Option 1: Bits | | | | Option 2: Resistor Trim |
|---|---|---|---|---|---|---|
| Model | Vout (V) | Bit-3 | Bit-2 | Bit-1 | Bit-0 | Rtrim (Ω) |
| SGRB12015S | 15 | 1 | 0 | 1 | 0 | 5.92k |
| SGRB12018S | 18 | 0 | 1 | 0 | 0 | 20.1k |
| SGRB12028S | 28 | 1 | 1 | 1 | 1 | 182 |
| SGRB12050S | 50 | 1 | 0 | 1 | 0 | 3.43k |

### 6.2.3 Frequency Synchronization (SYNC IN, SYNC OUT)

The SGRB12000S 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 SGRB12000S Series provides a frequency synchronization input (SYNC IN) and output (SYNC OUT), both referenced to PRICOM. The SYNC IN pin can be driven by an external clock or by the SYNC OUT pin of another SGRB converter. The internal clock and internal power train will operate at the frequency applied to the SYNC IN pin. The SYNC IN 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 SYNC IN 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 PRICOM connection. The SYNC IN pin can be left open or connected to PRICOM if not used.

### 6.2.4 Parallel Operation (SHARE)

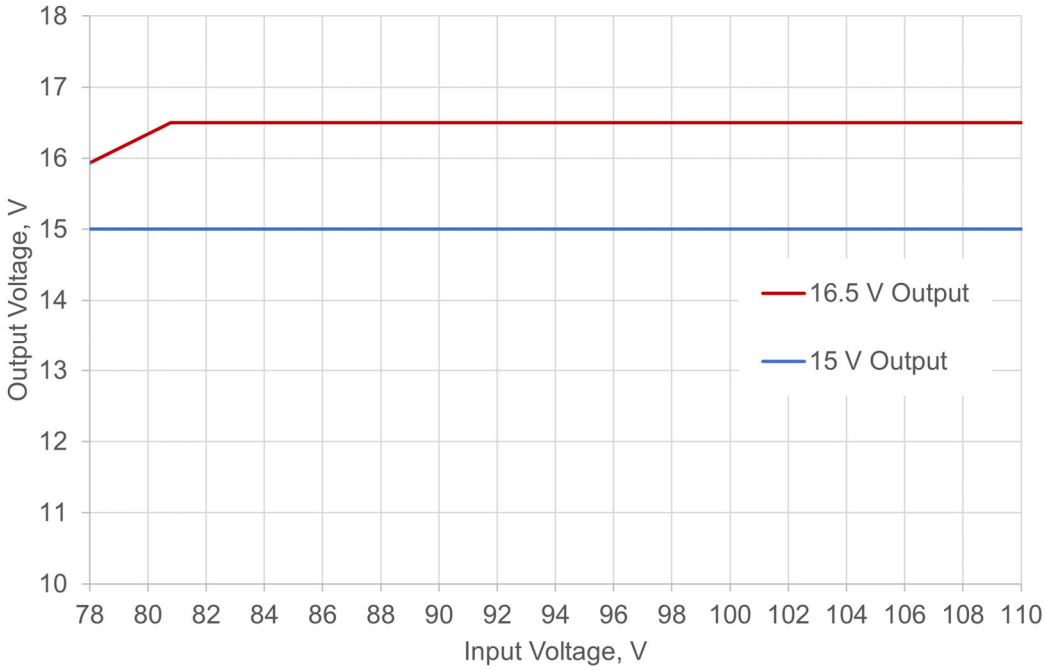
The SGRB12000S Series provides a SHARE function for active current-sharing among paralleled modules. To enable load sharing, connect a single wire between the SHARE pins of all parallel modules. The SHARE pin can be noise sensitive. Paralleled converters should be located physically close to one another 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

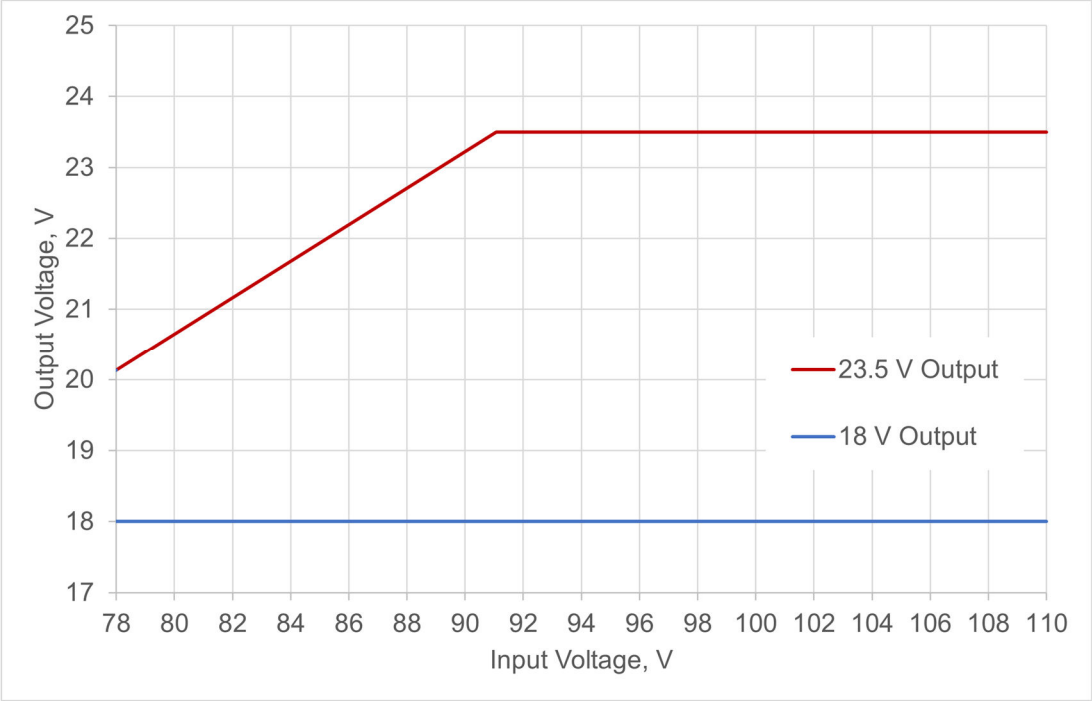
### 6.3.1 Input Undervoltage Lockout

The SGRB12000S Series 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 Vin is below the threshold specified in Section 3.2. When Vin is below 94 V and above the UVLO turn-off threshold the unit will operate but may not meet performance detailed in the electrical performance table in section 3.2. See curves 6.3.1.1 – 6.3.1.4 for more detail.

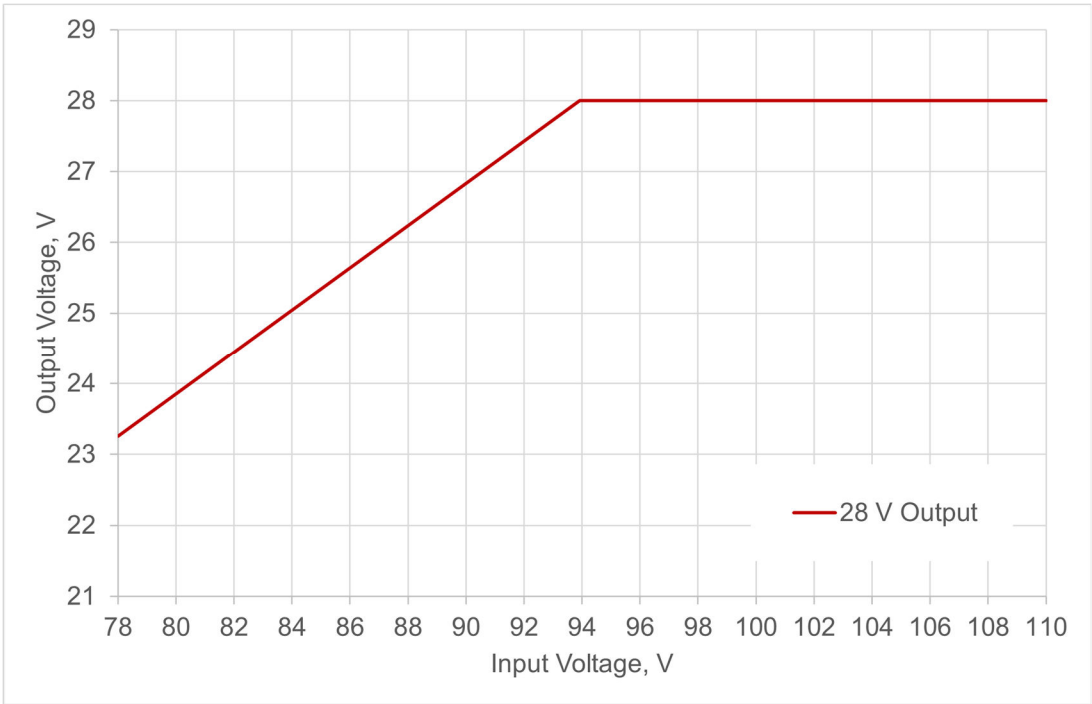
#### 6.3.1.1 Output Voltage versus Input Voltage, SGRB12015S (Worst Case)



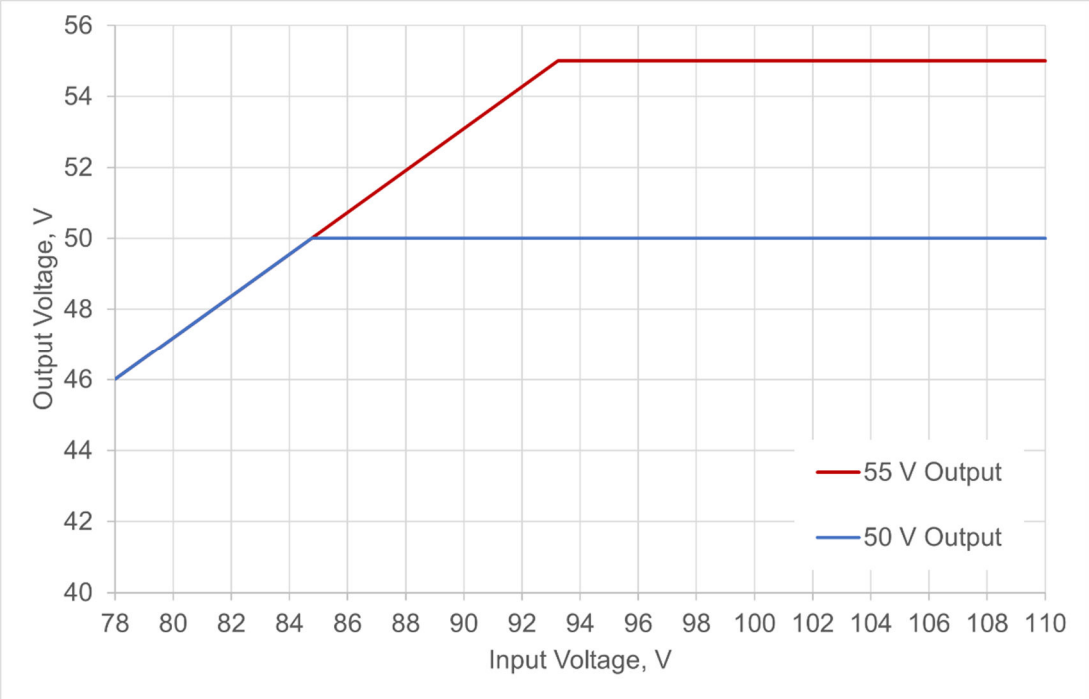
#### 6.3.1.2 Output Voltage versus Input Voltage, SGRB12018S (Worst Case)




#### 6.3.1.3 Output Voltage versus Input Voltage, SGRB12028S (Worst Case)



#### 6.3.1.4 Output Voltage versus Input Voltage, SGRB12050S (Worst Case)




### 6.3.2 Output Soft Start

The SGRB12000S Series 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 30 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 the rising edge of INHIBIT, or the falling edge of ENABLE, or the rising edge of Command On) until the output reaches 90% of its final value.

### 6.3.3 Output Overcurrent Protection

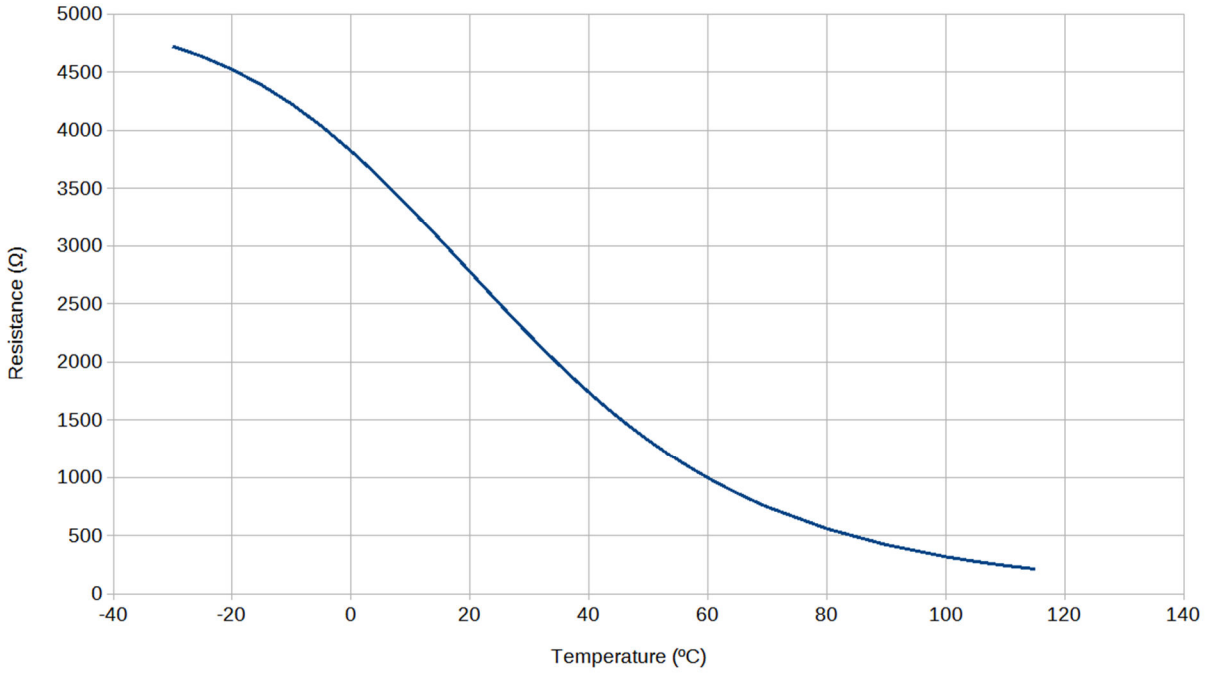
The SGRB12000S Series provides output overcurrent and output short circuit protection. During a load fault condition, a constant output current control circuit reduces the converter duty cycle to limit the output current to approximately 125% of its rated value. The converter will continue to provide 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 c ondition.

## 6.4 TELEMETRY FEATURES

All telemetry signals are referenced to PRICOM.

### 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 Output Voltage Telemetry (Optional)

The output voltage telemetry signal is a 0-5V analog signal that is a representation of the output voltage.

| SGRB Model | Output Voltage Telemetry Equation |
|---|---|
| SGRB12015S | $V_{tel}$ = 0.200*Vo |
| SGRB12018S | $V_{tel}$ = 0.182*Vo |
| SGRB12028S | $V_{tel}$ = 0.150*Vo |
| SGRB12050S | $V_{tel}$ = 0.091*Vo |

If this circuit is present in the converter, then the isolation voltage rating will decrease to 10 V at 25 ºC and minimum of 10 kΩ of resistance.

### 6.4.3 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 four ways. 1) Pull the INHIBIT pin low (below 1.5 V) for at least 40 ms and then release it to re-enable the output or 2) open the ENBALE pin (if present) for at least 40 ms and then pull low again to re-enable the output or 3) Use the Command On and Command Off pins (if present) to turn the converter off, then on again or 4) Cycle the input voltage below the UVLO turn-off threshold.

### 6.4.4 Input Current Telemetry

The output 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 SGRB12000S Series 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.

## 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$^2$[2] |
| | Non-Destructive (SET, SEU, SEFI)[2] | Not applicable | ≥ 85 MeV/mg/cm$^2$[2] |
| Displacement Damage (DD) | | $5x10^{11}$ n/cm$^2$ | $5x10^{11}$ n/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/cm$^2$. 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 (or by cycling enable or commanding the unit off and back on, if either of these options are present). At the worst-case 125 °C and 85 MeV/mg/cm$^2$, the cross-section of these events is 6.36 x $10^{-6}$ cm$^2$. 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 worst-case 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<br>J-STD-001 (Space Addendum) | • | • |
| Random Vibration | 7.4 Grms<br>XYZ Axis<br>Duration: 60 seconds | • | |
| Temperature Cycling | Temp: -35 °C to 85 °C<br>Cycles: 10<br>Dwell: 30 minutes<br>Ramp: 5 °C/min. | • | |
| Final Electrical[1] | 100% at -35 °C, 25 °C, and 85 °C | • | |
| | 100% at 25 ºC | | • |
| 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 | 50 | S | V | - | R | N | H | /EM | - | XXX |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | | 6 | 7 | 8 | 9 | | |

| (1) Product Series | (2) Nominal Input Voltage | (3) Output Voltage (Adjustable Range) | (4) Number of Outputs | (5) Package Options |
|---|---|---|---|---|
| **SGRB** | **120** 120 Volts | **50** 40 V - 55 V<br>**28** 12 V - 28 V<br>**18** 16 V – 23.5 V<br>**15** 12 V – 16.5 V | **S** Single | **V** Vertical<br>**H** Horizontal |

| (6) Output Adjust | (7) On/Off Control | (8) Isolation Voltage[2] | (9) Screening Code[1] | (10) Additional Screening Code |
|---|---|---|---|---|
| **R** Resistor Trim<br>**B** BITs | **N** Inhibit<br>**E** Enable<br>**C** Command On & Off | **H** 100 V<br>**L** 10 V | **None** Flight<br>**/EM** 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."

2. If 100 V Isolation (option H) is selected, the output voltage telemetry feature is unavailable and will be removed from converter.

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

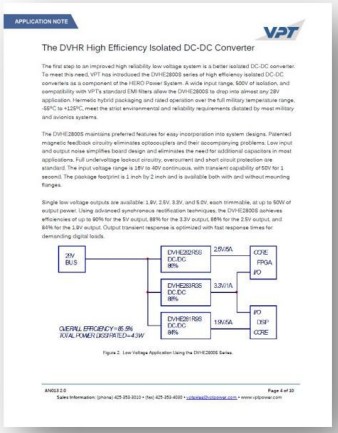
All information contained in this technical preview is believed to be accurate; however, no responsibility is assumed for possible errors or omissions. The products or specifications contained herein are subject to change without notice.

## 10.0 ADDITIONAL INFORMATION

Visit the VPT website for additional technical resources, including:

**Product Catalogs**


**Application Notes and White Papers**

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