DATA SHEET

Power Your Critical Mission Today

# SVGA0510S SERIES

## SPACE QUALIFIED POINT OF LOAD CONVERTERS




SVGA Series DC-DC Converter

| Models Available |
|---|
| Input: 5 V nominal |
| 33 W, 10 A output |
| Qualified to MIL-PRF-38534 Class H and Class K |

## 1.0 DESCRIPTION

The SVGA Series of space qualified point of load DC-DC converters is specifically designed for the harsh radiation environment of space applications. Performance is guaranteed through the use of hardened semiconductor components, radiation lot acceptance testing (RLAT) of non-hardened components, and analysis. The SVGA Series has been characterized for Total Ionizing Dose (TID) performance including Enhanced Low Dose Rate Sensitivity (ELDRS) and for Single Event Effects (SEE) according to VPT's DLA-approved Radiation Hardness Assurance (RHA) plan per MIL-PRF-38534, Appendix G, Level P. Characterization is performed at both the component level and at the SVGA Series hybrid converter level.

The SVGA Series of point of load DC-DC converters is radiation tolerant and suited for use in low Earth orbit (LEO), medium Earth orbit (MEO), geostationary orbit (GEO), deep space, and launch vehicle programs.

## 1.1 FEATURES

- Operates from 5 V input
- Adjustable Output from 0.8 V to 3.4 V
- Up to 10 Amps or 33 Watt Output
- High Efficiency, up to 94%
- High Power Density, >100 W/in$^3$
- Output Inhibit Control
- Low Output Noise
- No Use of Optoisolators
- Short Circuit Protection

## 1.2 SPACE LEVEL CHARACTERIZATIONS

- Guaranteed TID performance to 100 krad(Si) including ELDRS
- SEE performance to 85 MeV-cm$^2$/mg. Transients are fully characterized for cross section and magnitude
- Worst-case analysis, stress, radiation, reliability reports available

## 1.3 MANUFACTURING AND COMPLIANCE

- Qualified to MIL-PRF-38534 Class H and Class K, DLA SMD # 5962-12219
- MIL-PRF-38534 element evaluated components
- Manufactured in a MIL-PRF-38534 Class H and Class K facility
- MIL-STD-883
- ISO-9001

## 1.4 PACKAGING

- Low-profile: 1.075" x 1.075" x 0.270"
- Max weight: 16 g
- Precision projection-welded hermetic metal case

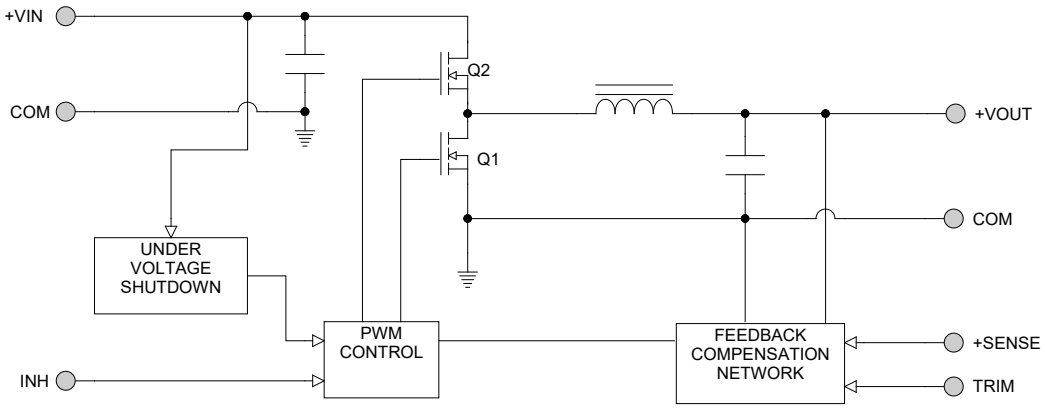
## 1.5 SIMILAR PRODUCTS AND ACCESSORIES

- SVGA0515S 50 W space qualified point of load DC-DC converter
- SVRGA0508S 20 W space qualified point of load DC-DC converter
- Custom versions available
- Space qualified isolated DC-DC converters, 15 - 100 W
- EMI filters

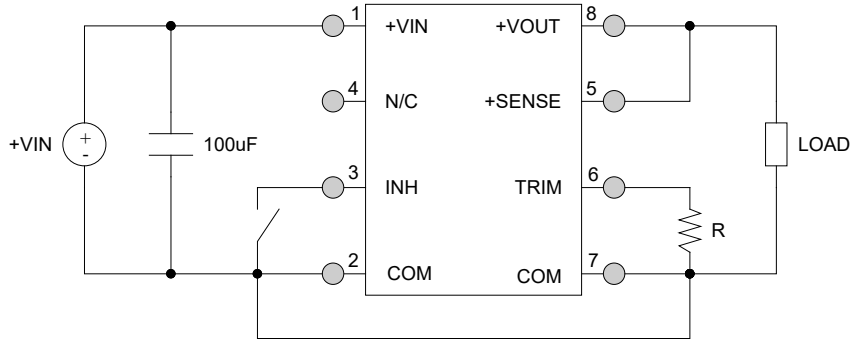
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## 2.0 DIAGRAMS

### 2.1 BLOCK DIAGRAM




### 2.2 CONNECTION DIAGRAM




## 3.0 SPECIFICATIONS

### 3.1 ABSOLUTE MAXIMUM RATINGS

| Absolute Maximum Ratings | | | |
|---|---|---|---|
| Input Voltage (Continuous): | -0.3 V to 7 V | Operating Temperature (Full Load): | -55 °C to +125 °C |
| Input Voltage (Transient, 1 second): | -0.3 V to 7.5 V | Storage Temperature: | -65 °C to +150 °C |
| ESD Rating per MIL-PRF-38534: | 3B | Lead Solder Temperature (10 seconds): | 270 °C |

## 3.2 PERFORMANCE SPECIFICATIONS[1]

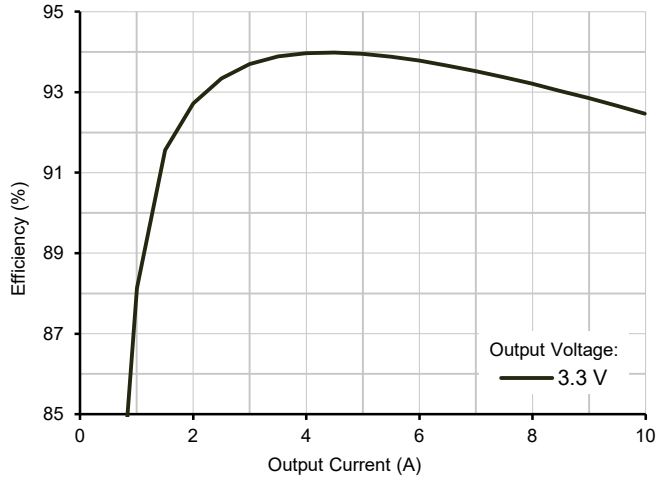
Tcase = -55 °C to +125 °C, Vin = +5 V ± 1%, Full Load, Unless Otherwise Specified

| | | SVGA0510S | | | |
|---|---|---|---|---|---|
| **Parameter** | **Conditions** | **Min** | **Typ** | **Max** | **Units** |
| **INPUT** | | | | | |
| Voltage[4] | Vout = 0.8 V to 2.5 V | 3.5 | - | 7.0 | V |
| | Vout = 2.6 V to 3.3 V | 4.1 | - | 7.0 | V |
| Current | INH < 1.5 V | - | 30 | 35 | mA |
| | No Load | - | 100 | 150 | mA |
| Undervoltage Lockout[4,5] | Turn-On | - | 3.0 | - | V |
| | Turn-Off | - | 2.7 | - | V |
| **OUTPUT STATIC** | | | | | |
| Voltage | Tcase = 25 °C | -1.0 | - | +1.0 | %Vout |
| | Tcase = -55 °C to +125 °C | -1.5 | - | +1.5 | %Vout |
| Power[2] | | 0 | - | 33 | W |
| Current | | 0 | - | 10 | A |
| Ripple Voltage | 20 Hz to 10 MHz | - | 60 | 100 | mVpp |
| Load Regulation | No Load to Full Load | - | 10 | 25 | mV |
| Load Fault Power Dissipation | Vout = 3.3 V | - | 1.5 | 3 | W |
| **OUTPUT DYNAMIC** | | | | | |
| Load Step, Half to Full Load, Vout = 3.3 V | Output Transient | - | 75 | 120 | mV |
| | Recovery[3] | - | 25 | 60 | µs |
| Turn-On, Vin = 0 to 5 V | Delay | - | 5 | 10 | ms |
| | Overshoot | - | 2 | 10 | mVpk |
| **FUNCTION** | | | | | |
| INH Pin Input[4] | Output Inhibited | 0 | - | 1.5 | V |
| INH Pin Open Circuit Voltage[4] | Output Enabled | - | 4.7 | Vin | V |
| **GENERAL** | | | | | |
| Efficiency | Vout = 3.3 V | 88 | 93 | - | % |
| Capacitive Load[4] | | - | - | 5000 | µF |
| Switching Frequency | | 200 | 250 | 315 | kHz |
| Weight | Standard package option | - | - | 16 | g |
| MTBF (MIL-HDBK-217F) | SF @ Tcase = 55 °C | - | 6.9 | - | MHr |
| **POST-RAD END-OF-LIFE LIMITS[6]** | | | | | |
| OUTPUT Voltage | Tcase = -55 °C to +125 °C | -3.0 | - | +3.0 | %Vout |
| Switching Frequency | Tcase = -55 °C to +125 °C, Vin = 5 V | 190 | - | 325 | kHz |
| | Tcase = -55 °C to +125 °C, Vin = 3.6 V to 7 V | 185 | - | 350 | kHz |

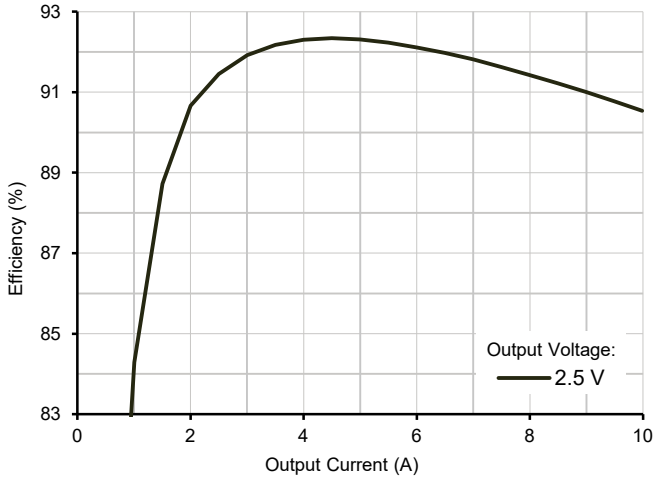
1. Performance specifications are met with 100 µF from VIN to COM
2. Dependent on output voltage
3. Time for output voltage to settle within 1% of steady-state value
4. Verified by qualification testing
5. Output voltage not necessarily in regulation
6. End-of-Life performance includes aging and radiation degradation and is within standard limits except where noted

## 4.0 PERFORMANCE CURVES

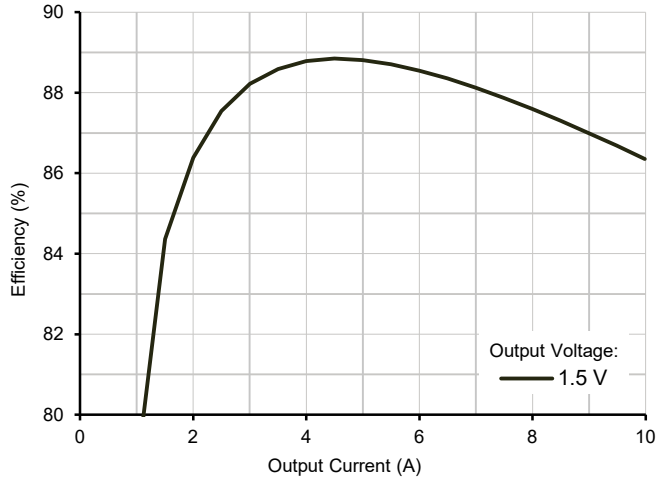
### 4.1.1 SVGA0510S Efficiency (Typical, 25 °C)



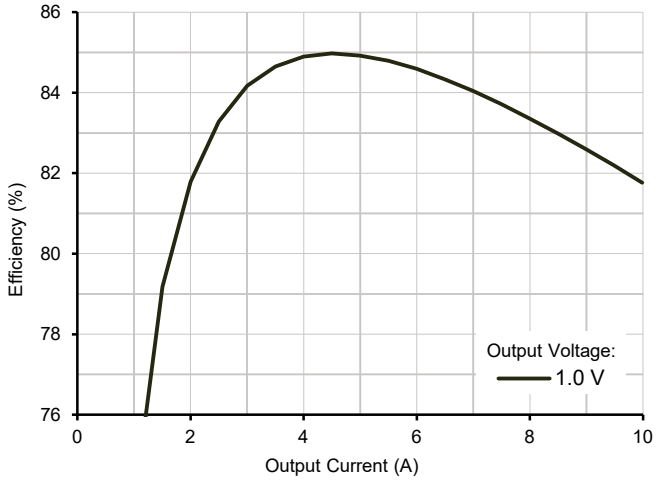

### 4.1.2 SVGA0510S Efficiency (Typical, 25 °C)



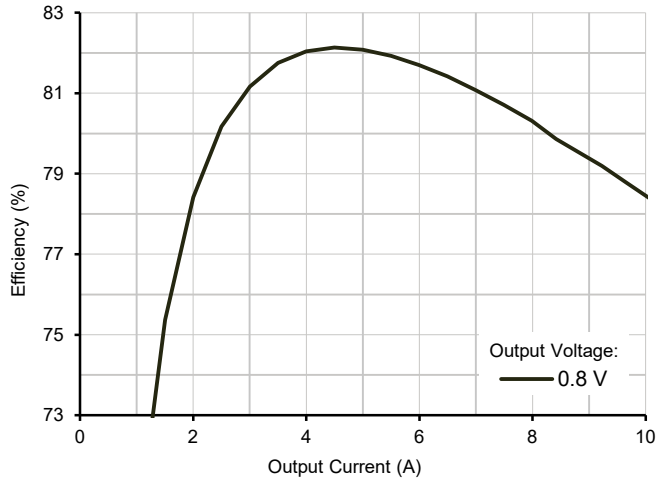

### 4.1.3 SVGA0510S Efficiency (Typical, 25 °C)




### 4.1.4 SVGA0510S Efficiency (Typical, 25 °C)

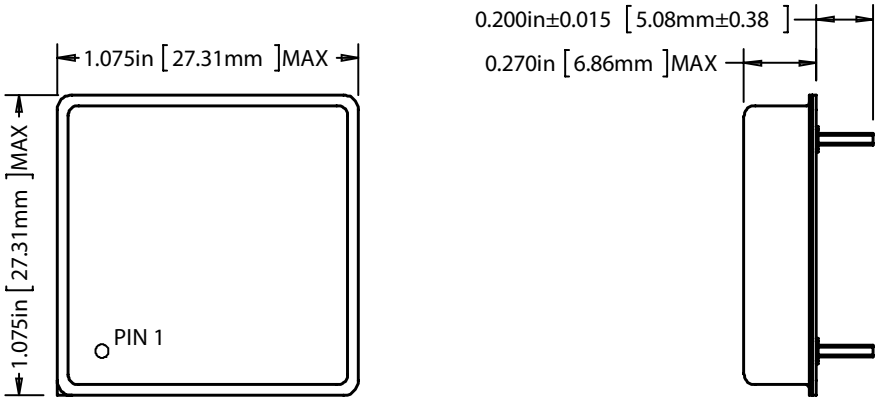


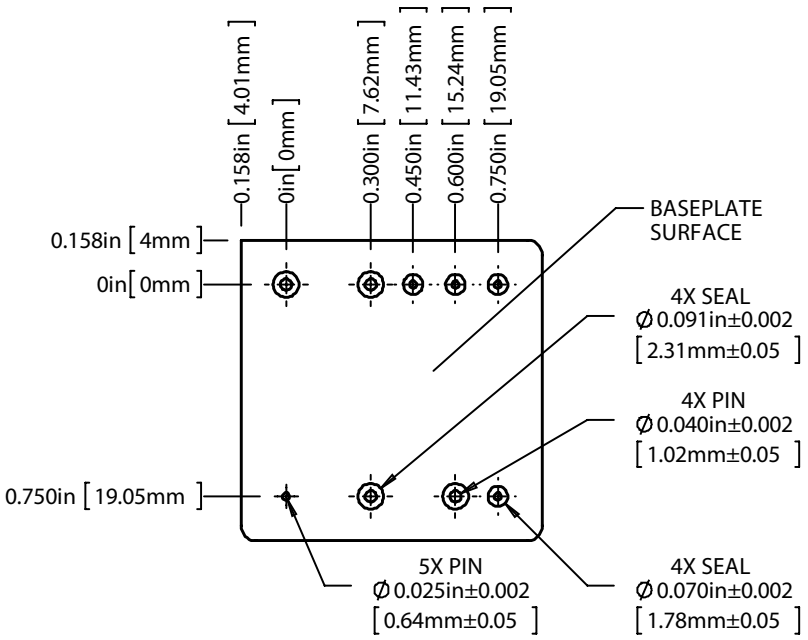

### 4.1.5 SVGA0510S Efficiency (Typical, 25 °C)



## 5.0 MECHANICAL OUTLINES AND PINOUT

**Standard Package Option:**




1. Tolerances are +0.005" unless otherwise stated
2. Case temperature is measured on the center of the baseplate surface
3. Materials: Case (Steel, gold over nickel plated); Cover (Steel, nickel plated); Pin (Copper-cored alloy 52, gold over nickel plated); Pin Seals (Glass)

| Pin | Function | Pin | Function | Pin | Function |
|---|---|---|---|---|---|
| 1 | +VIN | 4 | N/C | 7 | COM |
| 2 | COM | 5 | +SENSE | 8 | +VOUT |
| 3 | INH | 6 | TRIM | 9 | CASE |

## 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 SVGA0510S Series is a non-isolated, fixed-frequency, radiation-hardened, synchronous buck converter. It operates from a 5 V input and provides a stepped-down, precisely regulated, programmable output voltage at very-high efficiency. The SVGA0510S is optimized for low voltage point of load applications.

### 6.1.2 External Components

The SVGA0510S Series has internal input and output capacitors. For best performance under transient conditions, a minimum additional 100 µF tantalum input decoupling capacitor is recommended. The SVGA0510S is stable with no load capacitance. Additional output capacitance is allowed up to the maximum listed in Section 3.2.

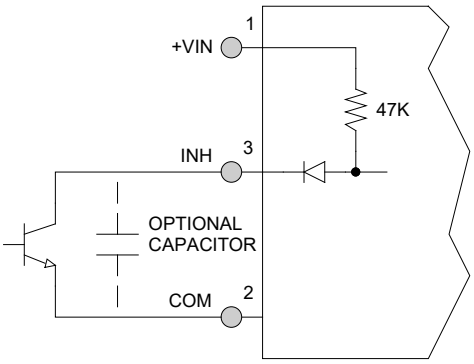
### 6.1.3 Source Impedance

The impedance of the 5 V input source can interact with the point of load converter and can affect performance. High source impedance is often caused by a long input cable or other components added in series with the input. In some cases, additional input capacitance will be needed to stabilize the system.

## 6.2 FUNCTION DESCRIPTIONS

### 6.2.1 On/Off Control (Inhibit)

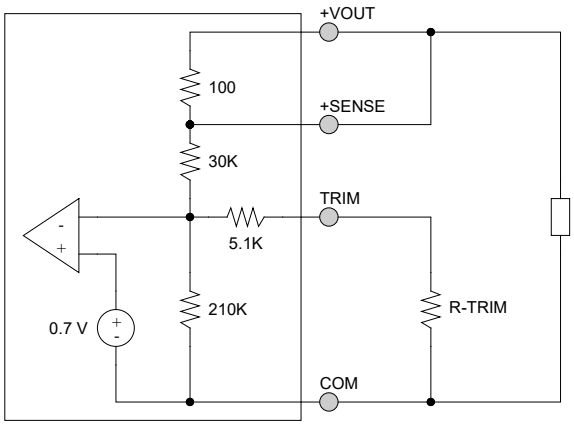
The INH (Inhibit) pin is a control pin referenced to COM. The INH pin must be driven using an open-collector or open-drain configuration. Pulling the INH pin low disables the converter output. Leaving INH open enables the output, allowing the converter to operate normally. The pin must be pulled below 1.5 V to disable the output. An optional capacitor from INH to COM may be used to delay turn-on. The INH pin should be left open if not used.



### 6.2.2 Adjusting the Output Voltage (TRIM)

The output voltage of the converter is set with an external resistor connected from the TRIM pin to the COM pin. This resistor must have a tolerance of 1% or better to achieve an accurate output voltage. The default output voltage with the TRIM pin left open is 0.8 V.

| SVGA0510S | |
|---|---|
| +Vout (V) | Rtrim (Ω) |
| 0.8 | None |
| 0.9 | 205k |
| 1.0 | 99.9k |
| 1.2 | 47.4k |
| 1.5 | 24.9k |
| 1.8 | 15.9k |
| 1.9 | 13.9k |
| 2.0 | 12.4k |
| 2.5 | 7.25k |
| 2.8 | 5.4k |
| 3.0 | 4.44k |
| 3.3 | 3.30k |
| 3.4 | 2.98k |




## 6.3 PROTECTION FEATURES

### 6.3.1 Input Undervoltage Lockout

The SVGA0510S Series provides input undervoltage lockout protection. For input voltages below the turn-on voltage, the converter will remain off. When the input voltage exceeds the turn-on voltage, the converter will start. For input voltages below the operating range of the converter but above the UVLO turn-off voltage, the converter may reach its maximum duty cycle and the output may drop out of regulation.

### 6.3.2 Output Soft-Start

The SVGA0510S 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 3 ms. The soft-start function is active whether the module is turned on with an application of input voltage or from release of the INH pin. The turn-on delay time is specified from the application of input voltage (or release of INH pin) until the output reaches 90% of its final value.

### 6.3.3 Output Short Circuit Protection

The SVGA0510S Series provides output short circuit protection. When a sustained high peak current is detected, the converter will shut down and enter a hiccup mode. After a delay, the converter will attempt a soft-start. This sequence will continue until the fault is removed, allowing the converter to soft-start and resume normal operation.

## 6.4 THERMAL CONSIDERATIONS

The SVGA0510S is rated for full power operation at 125 °C. Operation above 125 °C is allowed at reduced power. Specifically, the output power should be derated linearly from full power at 125 °C to half power at 130 °C and to zero power at 135 °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, PCB or other thermal surface. The internal power dissipating components are mounted to the baseplate of the converter and all heat flow is through the baseplate. The lid of the converter does not provide a good thermal path.

The hybrid DC-DC converter contains many semiconductor components. The maximum temperature rise from junction to case is 11 °C at full load.

## 6.5 VPT RHA PLAN AND APPROACH

VPT takes a conservative approach to radiation testing to ensure product performance during space travel. 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 TID, SEE, and ELDRS.

| Documents Available | Details |
|---|---|
| DLA approved Radiation Hardness Assurance (RHA) Plan Summary | The radiation environments covered by this overview include: total ionizing dose (TID), which includes enhanced low dose rate sensitivity (ELDRS); displacement damage (DD); and single event effects (SEE). |
| Worst-Case Analysis Report | Detailed worst-case analysis guarantees circuit performance post radiation and end of life. |
| Stress Report | Individual component stress analysis and deratings are included as part of the WCA report. |
| Radiation Test Summary Report | An overview report on the component level RLAT and characterization testing for TID and DD as well as the hybrid level characterizations for TID and SEE response. |
| Reliability Report | MTBF report based on MIL-HDBK-217 reliability calculations. |
| Thermal Analysis Report | Component temperature rise analysis and measurement results. |

| Test Definition | VPT's Approach |
|---|---|
| Total Ionizing Dose (TID). A measure of the energy absorbed in the semiconductor components from the naturally occurring sources of radiation (protons, electrons, photons). This results in the slow degradation of semiconductor performance specifications. TID is tested by exposing components to gamma radiation from a Cobalt-60 source. | SVGA Series: Designed for 100 krad(Si). Sensitive semiconductor components undergo RLAT to 100 krad(Si) per MIL-STD-883 Method 1019. Converters are characterized to 100 krad(Si). |
| Enhanced Low Dose Rate Sensitivity (ELDRS): Many linear-bipolar integrated circuits show enhanced parameter degradation when exposed at low dose rates close to those seen in a space environment as compared to the high dose rates (50-300 rad(Si)/s) that components were traditionally tested at for TID degradation. MIL-STD-883 Method 1019 gives guidance for characterizing components for ELDRS. Components that exhibit ELDRS are tested for TID at a rate below 0.01 rad(Si)/s. | SVGA Series: All bipolar linear ICs are characterized for ELDRS sensitivity and tested in accordance with MIL-STD-883 test method 1019 section 3.13 |
| Single Event Effects (SEE). Single high energy protons and heavy ions can deposit sufficient energy in a semiconductor component, causing a range of effects. SEEs include single event latchups (SELs), single event gate ruptures (SEGRs), single event transients (SETs), single event functional interrupts (SEFIs) and single event burnouts (SEBs). | SVGA Series: Converters are characterized for catastrophic events (SEL, SEB, SEGR) as well as functional interrupts (SEFI) under heavy ion exposure to LET = 85 MeV-cm$^2$/mg. Converters are also characterized for cross section and magnitude of output transients (SET) for at least 3 different LET levels. |
| Radiation Lot Acceptance Testing (RLAT): Semiconductor wafer lots are exposed to TID on a sample basis. If the parameter degradation for the tested samples is within the predetermined acceptance limits, then the lot can be used in radiation hardened converters. | SVGA Series: Sensitive semiconductor components undergo RLAT for TID. |

## 7.0 ENVIRONMENTAL SCREENING

100% tested per MIL-STD-883 as referenced to MIL-PRF-38534.

Contact sales for more information concerning additional environmental screening and testing options. VPT Inc. reserves the right to ship higher screened or SMD products to meet orders for lower screening levels at our sole discretion unless specifically forbidden by customer contract.

| Test | MIL-STD-883 Test Method, Condition | /H+ (Class H + PIND) | /K (Class K) | /EM (Engineering Model) Non-QML[1,6] |
|---|---|---|---|---|
| Non-Destructive Bond Pull | TM2023 | •[2] | • | •[2] |
| Internal Visual | TM2010, TM2017, TM2032 (MIL-STD-750, TM2072, TM2073) | • | • | • |
| Temperature Cycling | TM1010, Condition C -65 °C to 150 °C, Ambient | • | • | |
| Constant Acceleration | TM2001, 3000g, Y1 Direction | • | • | |
| PIND[3] | TM2020, Condition A | •[2] | • | |
| Pre Burn-In Electrical | 25 °C | | • | |
| Burn-In | TM1015, 320 hrs., 125 °C, Case Typ | | • | |
| | TM1015, 160 hrs., 125 °C, Case Typ | • | | |
| | 24 hrs., 125 °C, Case Typ | | | • |
| Final Electrical | MIL-PRF-38534, Group A Subgroups 1-6 -55 °C, 25 °C, 125 °C[4] | • | • | |
| | MIL-PRF-38534, Group A Subgroups 1 and 4 25 °C | | | • |
| Hermeticity (Seal) | TM1014, Fine Leak, Condition A2 or B1 | • | • | |
| | TM1014, Gross Leak, Condition C or B2 | • | • | |
| | Gross Leak, Dip ($1x10^{-3}$) | | | • |
| Radiography[5] | TM2012 | | • | |
| External Visual | TM2009 | • | • | • |

1. Non-QML products may not meet all requirements of MIL-PRF-38534
2. Not required per MIL-PRF-38534. Test performed for additional product quality assurance
3. PIND test Certificate of Compliance included in product shipment
4. 100% R&R testing with all test data included in product shipment
5. Radiographic test Certificate of Compliance and film(s) or data CD included in product shipment
6. Engineering models utilize only the screening specified and are not considered compliant for flight use

## 8.0 STANDARD MICROCIRCUIT DRAWING (SMD) NUMBERS

| Standard Microcircuit Drawing Number | SVGA0510S Series Similar Part Number |
|---|---|
| 5962R1221901HXC | SVGA0510S/H+ |
| 5962R1221901HXA | SVGA0510S/H+-E |
| 5962R1221901KXC | SVGA0510S/K |
| 5962R1221901KXA | SVGA0510S/K-E |

Do not use the SVGA0510S Series similar part number for SMD product acquisition. It is listed for reference only. For exact specifications for the SMD product, refer to the SMD drawing. SMDs can be downloaded from the DLA Land and Maritime (Previously known as DSCC) website at https://landandmaritimeapps.dla.mil/programs/defaultapps.asp. The SMD number listed above represents the Federal Stock Class, Device Type, Device Class Designator, Case Outline, Lead Finish and RHA Designator (where applicable). Please reference the SMD for other screening levels, lead finishes, and radiation levels. All SMD products are marked with a "Q" on the cover as specified by the QML certification mark requirement of MIL-PRF-38534.

## 9.0 ORDERING INFORMATION

| SVGA | 05 | 10 | S | /K | - | XXX |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | | 6 |

| (1) Product Series | (2) Nominal Input Voltage | (3) Output Current | (4) Number of Outputs | (5) Screening Code[1,2,3] | (6) Additional Screening Code |
|---|---|---|---|---|---|
| **SVGA** | **05** 5 Volts | **10** 10 Amps | **S** Single | **/EM** Engineering Model<br>**/H+** Class H + PIND<br>**/K** Class K | Contact Sales |

1 Contact the VPT Sales Department for availability of Class H (/H) or Class K (/K) qualified products
2 VPT Inc. reserves the right to ship higher screened or SMD products to meet lower screened orders at our sole discretion unless specifically forbidden by customer contract
3 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 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

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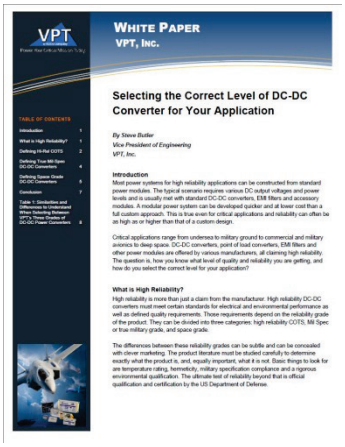
## 11.0 ADDITIONAL INFORMATION

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**

