



SVCL2800S SERIES

SPACE QUALIFIED HYBRID INRUSH CURRENT LIMITER



SVCL2800S – Exact marking may differ from that shown

Models Available

Input: 11 V to 50 V continuous, 80 V transient

100 W and 200 W versions

Qualified to MIL-PRF-38534 Class H and Class K; RHA level R

1.0 DESCRIPTION

The SVCL Series of space qualified Inrush Current Limiters are 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 SVCL 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 R. Characterization is performed at both the component level and at the SVCL Series hybrid converter level. The SVCL28 is designed to control the inrush current drawn by VPT's EMI filters and DC-DC converters during turn-on. The SVCL28 functions by limiting the rate of rise of its output voltage and will also control the inrush current of discrete input capacitors.

The SVCL28 Series of Inrush Current Limiters is radiation hardened 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

- High reliability
- Wide input voltage range: 11 V to 50 V plus 80 V transient
- Continuous operation over full military temperature range of -55 °C to +125 °C with no power derating
- Compatible with external capacitance
- Inhibit out
- No use of optoisolators
- Undervoltage lockout

Products and reports described in this datasheet are subject to all export license restrictions and regulations which may include but are not limited to ITAR (International Traffic in Arms Regulations) and the Export Administration and Foreign Assets Control Regulations. Further restrictions may apply. Contact VPT sales for details.

1.2 SPACE LEVEL CHARACTERIZATIONS

- Guaranteed TID performance to 100 krad(Si) including LDR
- SEE performance to 85 MeV/mg/cm². 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 # 5962-16216
- MIL-PRF-38534 element evaluated components
- MIL-STD-461 C/D/E/F when used with appropriate VPT EMI filter
- Manufactured in a MIL-PRF-38534 Class H and Class K facility
- MIL-STD-883
- ISO-9001

1.4 PACKAGING

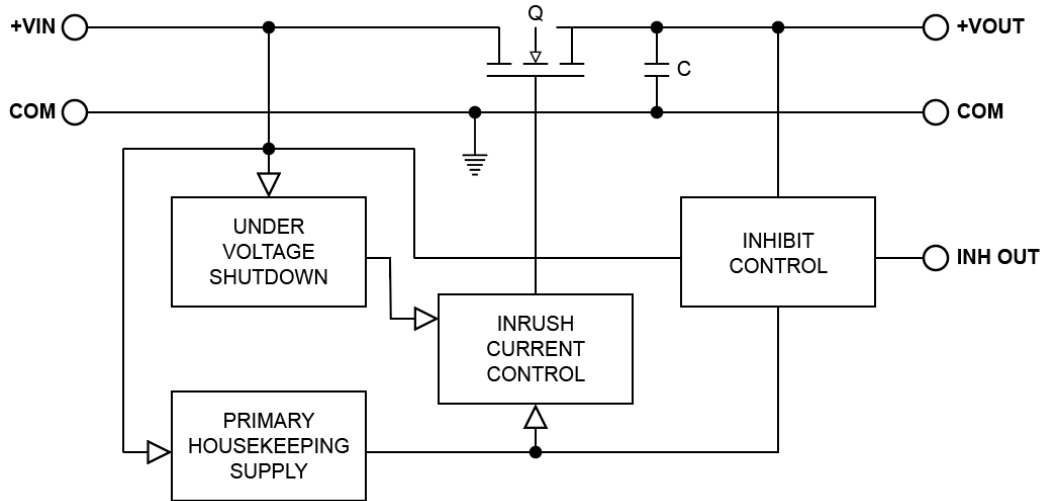
- Low-profile: 1.075" x 1.075" x 0.270"
- Max weight: 16 g
- Precision projection-welded hermetic metal case

1.5 SIMILAR PRODUCTS AND ACCESSORIES

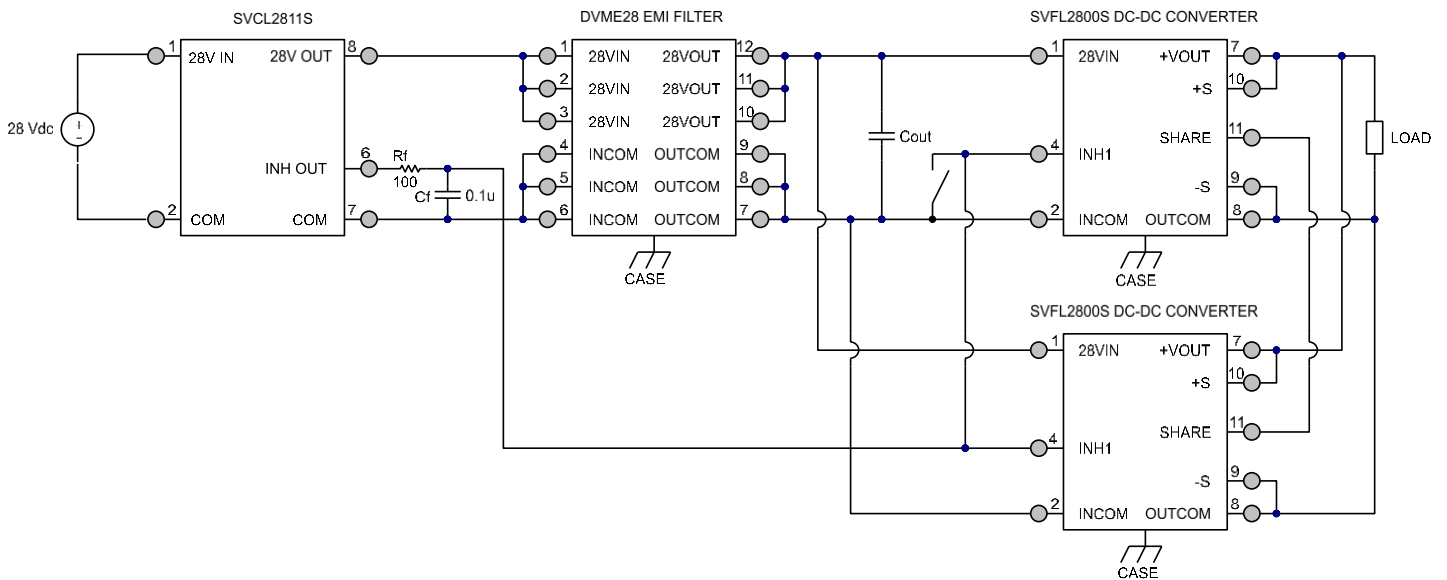
- [SVFL](#) 120 W space qualified single output DC-DC converter
- [SVFL](#) 120W space qualified dual output DC-DC converter
- [DVCL](#) INRUSH current limiter
- Custom versions available
- [EMI filters](#)

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)	50 V	Operating Temperature (Full Load):	-55 °C to +125 °C
Input Voltage (Transient, 1 second)	80 V	Storage Temperature	-65 °C to +150 °C
INH OUT Pin Voltage	30 V DC	Lead Solder Temperature (10 seconds)	270 °C
ESD Rating per MIL-PRF-38534	3B		

3.2 PERFORMANCE SPECIFICATIONS

Tcase = -55 °C to +125 °C, VIN = +28 V ± 5%, Full Load, Cout = 100µF Unless Otherwise Specified

SVCL285R5S					
Parameter	Conditions	Min	Typ	Max	Units
INPUT					
Voltage	Continuous	11	28	50	V
	Transient, 1 sec ²	-	-	80	V
Inrush Current	Peak, Cout = 100 µF	-	-	1.7	Apk
	Peak, Cout = 250 µF ²	-	-	4.3	Apk
Current	No Load	-	10	14	mA
Undervoltage Lockout	Turn-On	-	8.5	11	V
OUTPUT STATIC					
Voltage		Vout = Vin – (Iin x RDC)			V
Current ¹		0	-	5.5	A
Power ¹		0	-	100	W
OUTPUT DYNAMIC					
Output Voltage Slope, Vin=0 V to 28 V		-	4	11	V/ms
Turn-On, Vin = 0 V to 28 V	Delay	-	8.7	15	mSec
	Overshoot	-	-	50	mVpk
GENERAL					
DC Resistance		-	35	80	mΩ
Capacitive Load ²		-	-	250	µF
Power Dissipation ²		-	-	2.42	W
Isolation	500 V DC, Tcase = 25 °C	100	-	-	MΩ
Capacitance	Pin to Case	2400	3300	4200	pF
MTBF (MIL-HDBK-217F)	SF @ Tcase = 55 °C	-	7.867	-	MHrs
Weight		-	-	16	g

1. Derate linearly to 0 at 135 °C.

2. Verified by initial electrical design verification. Post design verification, parameter shall be guaranteed to the limits specified.

3.2 PERFORMANCE SPECIFICATIONS (CONTINUED)

Tcase = -55 °C to +125 °C, VIN = +28 V ± 5%, Full Load, Cout = 100µF Unless Otherwise Specified

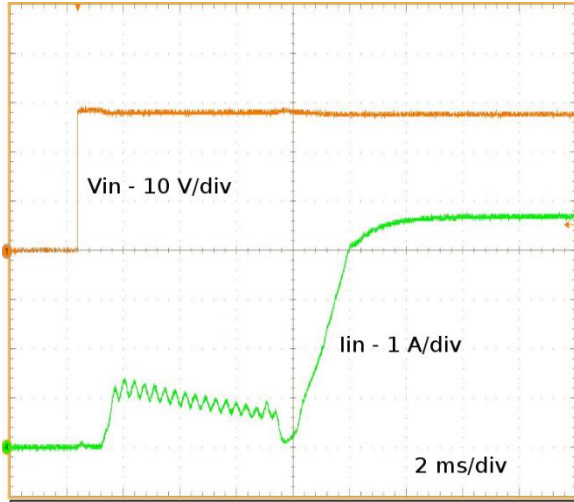
SVCL2811S					
Parameter	Conditions	Min	Typ	Max	Units
INPUT					
Voltage	Continuous	11	28	50	V
	Transient, 1 sec ²	-	-	80	V
Inrush Current	Peak, Cout = 100µF	-	-	1.7	Apk
	Peak, Cout = 500µF ²	-	-	8.5	Apk
Current	No Load	-	10	14	mA
Undervoltage Lockout	Turn-On	-	8.5	11	V
OUTPUT STATIC					
Voltage		Vout = Vin – (lin x Rdc)			V
Current ¹		0	-	11	A
Power ¹		0	-	200	W
OUTPUT DYNAMIC					
Output Voltage Slope, Vin=0 V to 28 V	-	-	4	11	V/ms
Turn-On, Vin = 0 V to 28 V	Delay	-	8.7	15	mSec
	Overshoot	-	-	50	mVpk
GENERAL					
DC Resistance		-	30	70	mΩ
Capacitive Load ²		-	-	500	µF
Power Dissipation ²		-	-	8.5	W
Isolation	500 V DC, Tcase = 25 °C	100	-	-	MΩ
Capacitance	Pin to Case	2400	3300	4200	pF
MTBF (MIL-HDBK-217F)	SF @ Tcase = 55 °C	-	4.984	-	MHrs
Weight		-	-	16	g

1. Derate linearly to 0 at 135 °C.

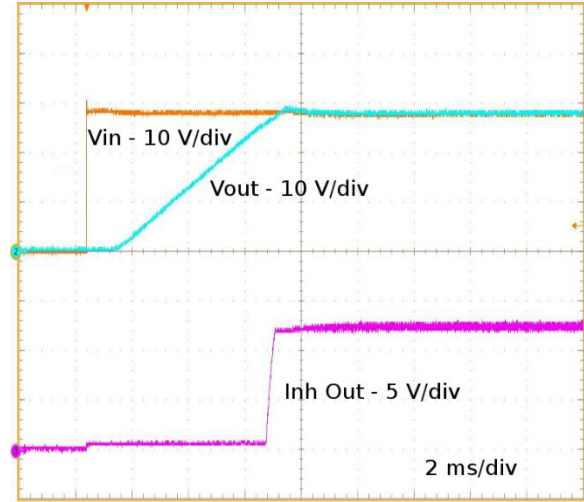
2. Verified by initial electrical design verification. Post design verification, parameter shall be guaranteed to the limits specified.

4.0 PERFORMANCE CURVES

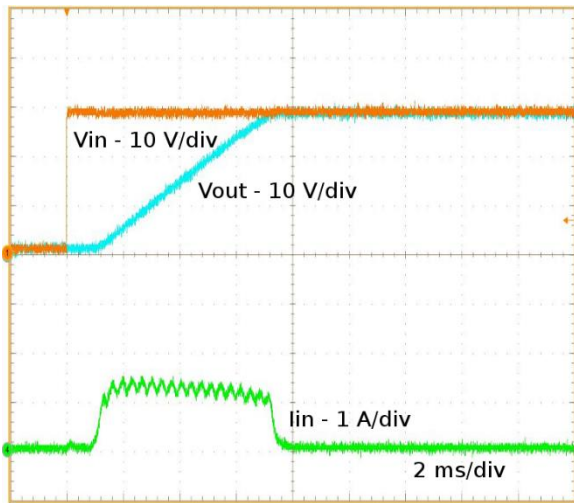
4.1.1 SVCL285R5S Vin, lin during turn-on at 28V with DVME28, Cout=100µF and 1x SVFL2800S at full load



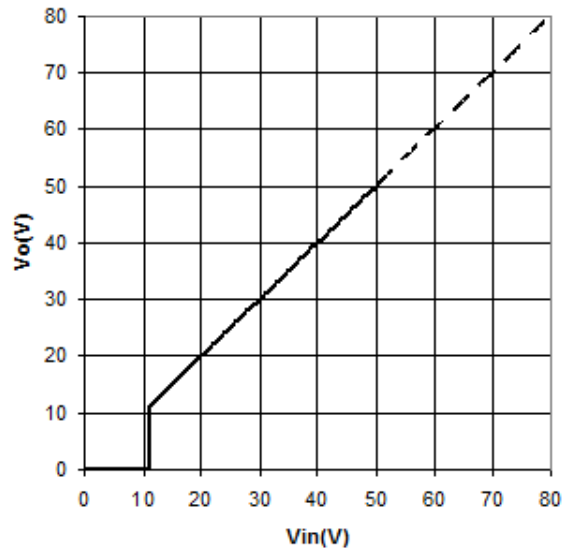
4.1.2 SVCL285R5S Vin, Vout, Inhibit Out during turn-on at 28V



4.1.3 SVCL285R5S Vin, Vout, lin during turn-on at 28V, Cout=250µF max

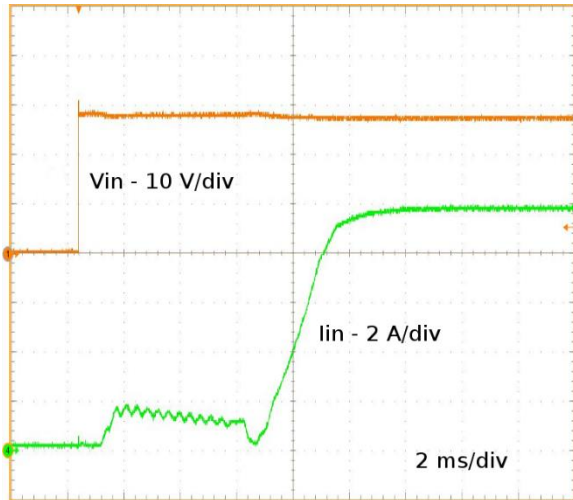


4.1.4 Output Voltage vs. Input Voltage

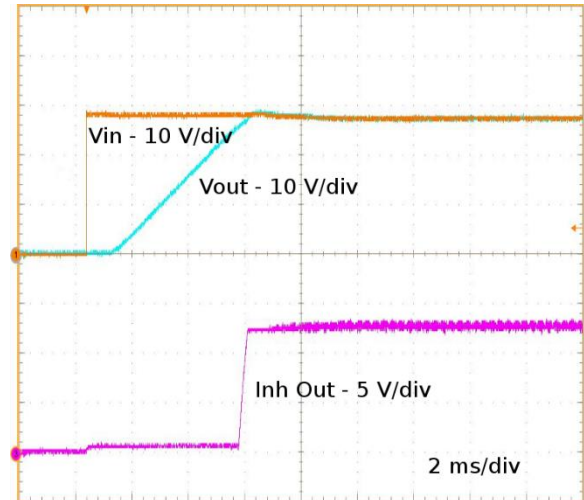


4.0 PERFORMANCE CURVES (CONTINUED)

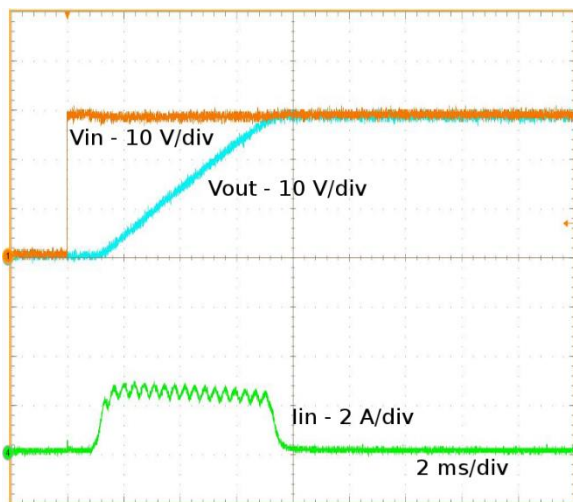
4.2.1 SVCL2811S Vin, lin during turn-on at 28V with DVME28, Cout=100 μ F and 2x SVFL2800S at full load



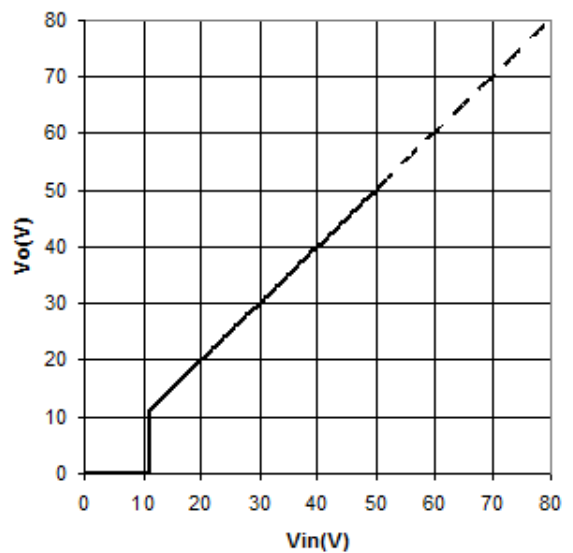
4.2.2 SVCL2811S Vin, Vout, Inhibit Out during turn-on at 28V



4.2.3 SVCL2811S Vin, Vout, lin during turn-on at 28V, Cout=500 μ F

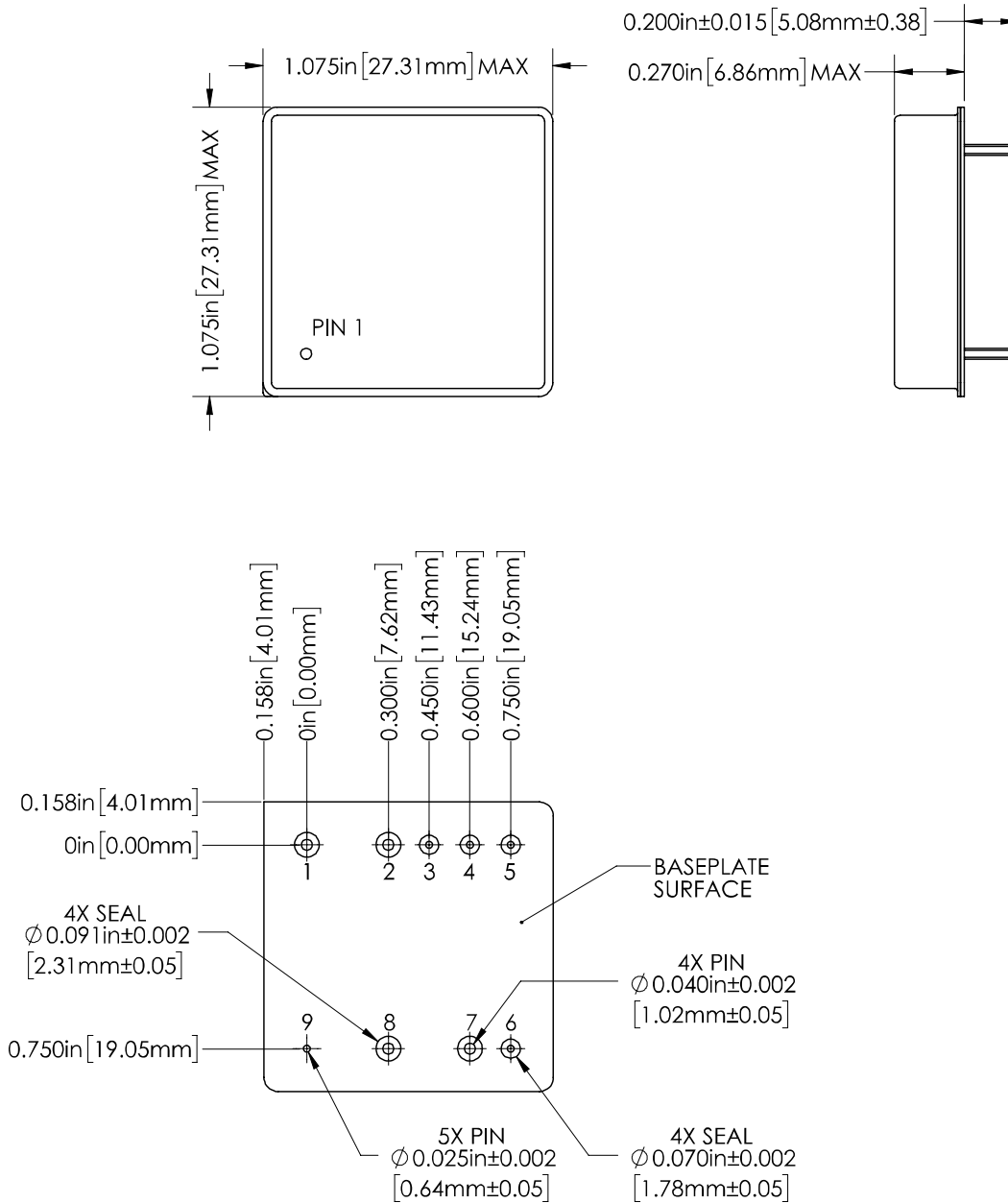


4.2.4 Output Voltage vs. Input Voltage



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	NC	7	COM
2	COM	5	NC	8	+VOUT
3	NC	6	INH OUT	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](#).



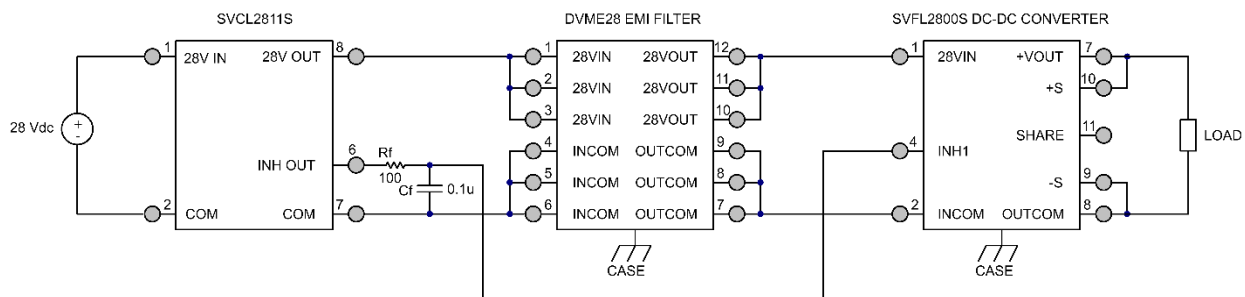
6.1 GENERAL INFORMATION

6.1.1 Topology Description

The SVCL2800S Series utilizes series MOSFETs between the +Vin and +Vout pins of the device. The internal circuitry controls the MOSFET gates to limit the ramp rate of the SVCL output voltage. This controlled ramp rate limits the peak current that is drawn from the system power bus while charging capacitors in downstream EMI filters, DC-DC converter input filters and any other capacitance located downstream of the SVCL. After the output voltage ramp is complete, the series MOSFETs are fully enhanced, providing a low steady-state on-resistance and power loss.

6.1.2 External Components

The SVCL2800S 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. It is recommended to add the filter components R_f (100 Ω) and C_f (0.1 μF) shown in the figure below when operated in an environment exposed to heavy ions. This will prevent potential single event transients (SET) on the Inhibit Out pin from interfering with the operation of any DC-DC converters connected to this pin.



6.1.3 Using Inh Out Pin for Source Impedance Control

The performance of a DC-DC converter can be negatively impacted by a high source impedance. If any downstream DC-DC converters are enabled while the SVCL28 is ramping up the output voltage, the inrush-limiting MOSFETs inside the SVCL28 will present a very high source impedance to the downstream DC-DC converter. To mitigate potential performance issues, it is recommended to use the INH OUT function of the SVCL28 to drive the INH pins of downstream DC-DC converters. This will keep the downstream DC-DC converters turned off through the duration of the SVCL28 startup and release Inhibit only after the controlled inrush transient has completed and the MOSFETs have been fully enhanced.

6.1.4 Output Capacitance Limitations

Since the current limiter operates by slowly turning on the series MOSFETs, these devices are operated in the linear region during the output ramp-up time. For this reason, it is important to limit the total capacitance that the device must charge to the Max Load Capacitance specification located in section 3.2, to avoid violating the series MOSFET Safe Operating Area (SOA). This total includes the capacitances in the down-stream EMI filters, DC-DC converter input filters and any discrete capacitors on the bus between the SVCL28 and the downstream DC-DC converters. Note that any capacitors on the output of down-stream VPT DC-DC converters do not need to be included in the total. The converters do not start until after the current limiter has ramped up the output voltage and the INH OUT pin goes to a high impedance state. In addition, all VPT DC-DC converters have a well-controlled soft start feature that limits the rate of rise of the converter output voltage, limiting the charging current to the output capacitors.

6.2 FUNCTION DESCRIPTIONS

6.2.1 INH OUT Control Pin

The INH OUT (inhibit output) pin is designed to drive the inhibit (INH) pins of VPT DC-DC converters. When connected to the INH pins of all downstream DC-DC converters, the SVCL28 will hold the converters in the inhibited condition while the current limiter output voltage ramps up. An internal, open collector bipolar junction transistor pulls down the inhibit input pins during the current limiter ramp up time, releasing them once the ramp up is complete. This eliminates the need for external inhibit circuitry and prevents the converters from exhibiting abnormal startup behavior.

6.3 PROTECTION FEATURES

6.3.1 Input Undervoltage Lockout

The SVCL2800S Series provides input undervoltage lockout protection. For input voltages below the turn-on voltage, the current limiter will remain off with the +VOOUT disconnected from the +Vin by the series MOSFETs, drawing minimal current from the source. When the input voltage exceeds the turn-on voltage, the current limiter will begin to ramp up the output voltage.

6.4 THERMAL CONSIDERATIONS

The SVCL2800S Series 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 zero power at 135 °C. The operating temperature of the current limiter is specified on the baseplate of the converter. The current limiter 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 and mounting flanges. The lid of the converter does not provide a good thermal path.

The hybrid current limiter contains many semiconductor components. The maximum temperature rise from junction to case is 4 °C at full rated output power.

6.5 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 hybrid. Hardness is guaranteed by a combination of both hybrid-level characterization and Radiation Lot Acceptance Testing (RLAT) of all sensitive semiconductor piece-parts used within the hybrid.

6.5.1 Radiation Test and Performance Levels

Radiation Environment		Piece Part RLAT	Hybrid-Level Characterization
Total Ionizing Dose (TID)	High Dose Rate (HDR)	100 krad(Si)	100 krad(Si)
	Low Dose Rate (LDR)	¹ 100 krad(Si)	100 krad(Si)
Single-Event Effects (SEE)	Destructive (SEB, SEGR, SEL)	Not applicable	≥ 85 MeV/mg/cm ²
	Non-Destructive (SET, SEU)	Not applicable	≥ 85 MeV/mg/cm ²
Displacement Damage (DD)		1x10 ¹² n/cm ²	Not applicable

1. Piece-part LDR screening performed only on potentially ELDRS parts (bipolar ICs).

6.5.2 RHA Plan Summary

Test	RHA Plan for SV Series Isolated DC-DC Converters
Total Ionizing Dose (TID):	Sensitive semiconductor components undergo RLAT to 60 krad(Si) per MIL-STD-883 Method 1019. Converters are characterized to 60 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 characterized to LET ≥ 44 MeV/mg/cm ² for both catastrophic events (SEL, SEB, SEGR) and functional interrupts (SEFI) under heavy ion exposure. 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):	All production lots of sensitive semiconductor components undergo RLAT for TID at HDR and/or LDR as appropriate per part type.
Displacement Damage (DD):	Sensitive semiconductor components undergo RLAT to 1x10 ¹² n/cm ² per MIL-STD-883 Method 1017.

6.5.3 RHA Designators available on SMD

The SVCL2800S series converters are available on SMD with RHA level R. See section 8.0 for full SMD number information.

6.5.4 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

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 Screening + PIND)	/K and /KL ^{1,7} (Class K Screening)	/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	•		
Final Electrical	24 hrs., 125 °C, Case Typ			•
	MIL-PRF-38534, Group A Subgroups 1-6 -55 °C, 25 °C, 125 °C ⁴	•	•	
Hermeticity (Seal)	MIL-PRF-38534, Group A Subgroups 1 and 4 25 °C			•
	TM1014, Fine Leak, Condition A2 or B1	•	•	
Radiography ⁵	TM1014, Gross Leak, Condition C1 or B2	•	•	
	Gross Leak, Dip (1x10 ⁻³)			•
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.
7. -KL1 products are identical in every way with Class K products in compliance with MIL-PRF-38534 revision L and later revisions except they contain elements evaluated to the requirements of MIL-PRF-38534 revision K and previous revisions. These devices are not marked with an SMD number or MIL-PRF-38534 certification mark and are marked with -KL1 screening code in place of -K.

8.0 STANDARD MICROCIRCUIT DRAWING (SMD) NUMBERS

Standard Microcircuit Drawing Number	SVCL2800S Series Similar Part Number
5962R1621601HXC	SVCL285R5S/H+
5962R1621601HXA	SVCL285R5S/H+-E
5962R1621601KXC	SVCL285R5S/K
5962R1621601KXA	SVCL285R5S/K-E
5962R1621602HXC	SVCL2811S/H+
5962R1621602HXA	SVCL2811S/H+-E
5962R1621602KXC	SVCL2811S/K
5962R1621602KXA	SVCL2811S/K-E

Do not use the SVCL2800S 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

SVCL	28	11	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
SVCL	28 28 Volts	5R5 5.5 Amps 11 11 Amps	S Single	/EM Engineering Model /H+ Class H + PIND /K Class K /KL1 Class K (KL1)	Contact Sales

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

"(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"

- KL1 products are identical in every way with Class K products in compliance with MIL-PRF-38534 revision L and later revisions except they contain elements evaluated to the requirements of MIL-PRF-38534 revision K and previous revisions. These devices are not marked with an SMD number or MIL-PRF-38534 certification mark and are marked with -KL1 screening code in place of -K.

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

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.

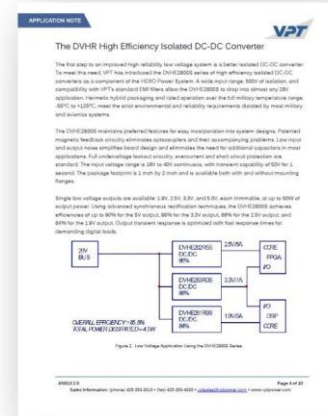
11.0 ADDITIONAL INFORMATION

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](#)

