SVTR2800D Series

HIGH RELIABILITY HYBRID RADIATION TOLERANT DC-DC CONVERTERS

DESCRIPTION

The SVTR series of high reliability DC-DC converters is operable over the full military temperature range (-55 °C to +125 °C) with no power derating. Paramount to the SVTR series is a magnetic feedback circuit that is radiation immune. Operating at a nominal fixed frequency of 500 kHz, these regulated, isolated units utilize well-controlled undervoltage lockout circuitry to eliminate slow start-up problems.

The SVTR series 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 SVTR 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. Characterization is performed at both the component level and at the SVTR series hybrid converter level.

These converters are designed and manufactured in a facility qualified to ISO9001 and certified to MIL-PRF-38534 Class H and Class K and MIL-STD-883.

This product may incorporate one or more of the following U.S. patents:

5,784,266 5,790,389 5,963,438 5,999,433
6,005,780 6,084,792 6,118,673

FEATURES

- Guaranteed TID Performance to 30 krad(Si) including ELDRS, per VPT's RHA plan specified per MIL-PRF-38534, Appendix G, Level P with 2X margin.
- Characterized to 44 MeV-cm^2/mg with minor transients only; no dropouts, shutdowns, latch up or burn out.
- High Reliability
- Very Low Output Noise
- Wide Input Voltage Range: 15 to 50 Volts per MIL-STD-704
- Up to 40 Watts Output Power
- Radiation Immune Magnetic Feedback Circuit
- NO Use of Optoisolators
- Undervoltage Lockout
- Current Limit and Short Circuit Protection
- High Input Transient Voltage: 80 Volts for 1 sec per MIL-STD-704A
- Precision Seam Seal Hermetic Package
- High Power Density: > 40 W/in^3
- Custom Modified Versions May Be Available
- Additional Environmental Screening Available
- Meets MIL-STD-461 Revisions C, D, E and F EMC Requirements When Used With VPT's EMI Filters
- Flanged and Non-flanged Versions Available.
- MIL-PRF-38534 Element Evaluated Components
- Worst Case analysis, Stress, Radiation, and Reliability reports available[1]

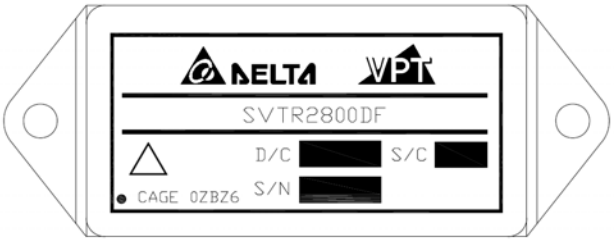

Figure 1 – SVTR2800D / SVTR2800DF DC-DC Converter (Exact marking may differ from that shown)

[1]Subject to all export restrictions and export regulations including but not limited to the Export Administration and Foreign Assets Control Regulations. Further restrictions may apply contact VPT for details.

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SPECIFICATIONS (T_{CASE} = -55°C to +125°C, V_{IN} = +28V ± 5%, Full Load[5], Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS

Input Voltage (Continuous)	50 V_{DC}	Junction Temperature Rise to Case	+15°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-65°C to +150°C
Output Power[1]	40 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +125°C)	13 Watts	Weight (Maximum) (Un-Flanged / Flanged)	(52 / 55) Grams
ESD Rating per MIL-PRF-38534	3A		

Parameter		Conditions[8]	SVTR2805D			SVTR2812D			Units
			Min	Typ	Max	Min	Typ	Max	
STATIC									
INPUT Voltage[4]		Continuous	15	28	50	15	28	50	V
		Transient, 1 sec	-	-	80	-	-	80	V
Current		Inhibited	-	4	6	-	4	6	mA
		No Load	-	60	90	-	60	90	mA
Ripple Current		Full Load[5], 20Hz to 10MHz	-	30	50	-	30	50	mA_{p-p}
		End-of-Life	-	-	70	-	-	70	mA_{p-p}
Inhibit Pin Input[4]			0	-	1.5	0	-	1.5	V
Inhibit Pin Open Circuit Voltage[4]			9.0	11.0	13.0	9.0	11.0	13.0	V
UVLO Turn On			12.0	-	14.8	12.0	-	14.8	V
UVLO Turn Off[4]			11.0	-	14.5	11.0	-	14.5	V
OUTPUT Voltage[5]	$+V_{OUT}$	T_{CASE} = 25°C	4.95	5.0	5.05	11.88	12.0	12.12	V
	$+V_{OUT}$	T_{CASE} = -55°C to +125°C	4.925	5.0	5.075	11.82	12.0	12.18	V
	$+V_{OUT}$	End-of-Life	4.89	-	5.10	11.66	-	12.30	V
	$-V_{OUT}$	T_{CASE} = 25°C	4.80	5.0	5.20	11.80	12.0	12.20	V
	$-V_{OUT}$	T_{CASE} = -55°C to +125°C	4.70	5.0	5.30	11.64	12.0	12.36	V
	$-V_{OUT}$	End-of-Life	4.665	-	5.325	11.48	-	12.48	V
Power[3,6]	Total		0	-	30	0	-	40	W
	$\pm V_{OUT}$	Either Output	0	-	21	0	-	28	W
Current[3,6]	$\pm V_{OUT}$	Either Output	0	-	4.2	0	-	2.33	A
Ripple Voltage	$\pm V_{OUT}$	Full Load[5], 20Hz to 10MHz	-	30	60	-	25	50	mV_{p-p}
Line Regulation	$+V_{OUT}$	V_{IN} = 16V to 40V	-	2	20	-	2	20	mV
	$-V_{OUT}$	V_{IN} = 16V to 40V	-	25	200	-	25	200	mV
Load Regulation	$+V_{OUT}$	No Load to Full Load[5]	-	5	50	-	2	50	mV
	$-V_{OUT}$	No Load to Full Load[5,7]	-	30	200	-	20	200	mV
Cross Regulation	$-V_{OUT}$	+Load 70%, -Load 30% +Load 30%, -Load 70%	-	360	650	-	430	650	mV
EFFICIENCY		Full Load[5]	73	79	-	78	84	-	%
LOAD FAULT POWER DISSIPATION		Overload[4]	-	-	16	-	-	14	W
		Short Circuit	-	-	16	-	-	14	W
CAPACITIVE LOAD[4]		Either Output	-	-	500	-	-	500	µF
SWITCHING FREQUENCY			400	500	550	400	500	550	kHz
SYNC FREQUENCY RANGE		$V_H - V_L$ = 5V, DC = 20-80%	500	-	600	500	-	600	kHz
ISOLATION		500 V_{DC}, T_{CASE} = 25°C	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)		SF @ T_C = 55°C	-	752	-	-	752	-	kHrs

See notes next page.

SPECIFICATIONS (T_{CASE} = -55°C to +125°C, V_{IN} = +28V ± 5%, Full Load[5], Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Junction Temperature Rise to Case	+15°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-65°C to +150°C
Output Power[1]	40 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +125°C)	13 Watts	Weight (Maximum) (Un-Flanged / Flanged)	(52 / 55) Grams
ESD Rating per MIL-PRF-38534	3A		

Parameter		Conditions[8]	SVTR2805D			SVTR2812D			Units
			Min	Typ	Max	Min	Typ	Max	
DYNAMIC									
Load Step Output Transient	$\pm V_{OUT}$	Half Load to Full Load	-	100	400	-	300	450	mV_{PK}
Load Step Recovery[2]			-	100	350	-	120	400	µSec
Line Step Output Transient[4]	$\pm V_{OUT}$	V_{IN} = 16V to 40V	-	300	600	-	500	900	mV_{PK}
Line Step Recovery[2, 4]			-	300	500	-	300	500	µSec
Turn On Delay	$\pm V_{OUT}$	V_{IN} = 0V to 28V	-	10	20	-	10	20	mSec
Turn On Overshoot			-	0	25	-	0	50	mV_{PK}

Notes:
1. Dependant on output voltage.
2. Time for output voltage to settle within 1% of its nominal value.
3. Derate linearly to 0 at 135°C.
4. Verified by qualification testing.
5. Half load at $+V_{OUT}$ and half load at $-V_{OUT}$.
6. Up to 70% of the total power or current can be drawn from any one of the two outputs.
7. 5% Load to Full Load at -55°C.
8. End-of-Life performance includes aging and radiation degradation and is within standard limits except where noted.

SPECIFICATIONS (T_{CASE} = -55°C to +125°C, V_{IN} = +28V ± 5%, Full Load[5], Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS

Input Voltage (Continuous)	50 V_{DC}	Junction Temperature Rise to Case	+15°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-65°C to +150°C
Output Power[1]	40 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +125°C)	13 Watts	Weight (Maximum) (Un-Flanged / Flanged)	(52 / 55) Grams
ESD Rating per MIL-PRF-38534	3A		

Parameter		Conditions[8]	SVTR2815D			Units
			Min	Typ	Max	
STATIC						
INPUT Voltage[4]		Continuous	15	28	50	V
		Transient, 1 sec	-	-	80	V
Current		Inhibited	-	4	6	mA
		No Load	-	60	90	mA
Ripple Current		Full Load[5], 20Hz to 10MHz	-	25	50	mA_{p-p}
		End-of-Life	-	-	70	mA_{p-p}
Inhibit Pin Input[4]			0	-	1.5	V
Inhibit Pin Open Circuit Voltage[4]			9.0	11.0	13.0	V
UVLO Turn On			12.0	-	14.8	V
UVLO Turn Off[4]			11.0	-	14.5	V
OUTPUT Voltage[5]	$+V_{OUT}$	T_{CASE} = 25°C	14.85	15.0	15.15	V
	$+V_{OUT}$	T_{CASE} = -55°C to +125°C	14.70	15.0	15.30	V
	$+V_{OUT}$	End-of-Life	14.565	-	15.4	V
	$-V_{OUT}$	T_{CASE} = 25°C	14.70	15.0	15.30	V
	$-V_{OUT}$	T_{CASE} = -55°C to +125°C	14.55	15.0	15.45	V
	$-V_{OUT}$	End-of-Life	14.415	-	15.55	V
Power[3,6]	Total		-	-	40	W
	$\pm V_{OUT}$	Either Output	-	-	28	W
Current[3,6]	$\pm V_{OUT}$	Either Output	-	-	1.87	A
Ripple Voltage	$\pm V_{OUT}$	Full Load[5], 20Hz to 10MHz	-	25	50	mV_{p-p}
Line Regulation	$+V_{OUT}$	V_{IN} = 16V to 40V	-	2	20	mV
	$-V_{OUT}$	V_{IN} = 16V to 40V	-	65	200	mV
Load Regulation	$+V_{OUT}$	No Load to Full Load[5]	-	2	50	mV
	$-V_{OUT}$	No Load to Full Load[5,7]	-	35	200	mV
Cross Regulation	$-V_{OUT}$	+Load 70%, -Load 30% +Load 30%, -Load 70%	-	420	650	mV
EFFICIENCY		Full Load[5]	78	84	-	%
LOAD FAULT POWER DISSIPATION		Overload[4]	-	-	14	W
		Short Circuit	-	-	14	W
CAPACITIVE LOAD[4]		Either Output	-	-	500	µF
SWITCHING FREQUENCY			400	500	550	kHz
SYNC FREQUENCY RANGE		$V_H - V_L$ = 5V, DC = 20-80%	500	-	600	kHz
ISOLATION		500 V_{DC}, T_{CASE} = 25°C	100	-	-	MΩ
MTBF (MIL-HDBK-217F)		SF @ T_C = 55°C	-	752	-	kHrs

See notes next page.

SPECIFICATIONS (T_{CASE} = -55°C to +125°C, V_{IN} = +28V ± 5%, Full Load[5], Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Junction Temperature Rise to Case	+15°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-65°C to +150°C
Output Power[1]	40 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +125°C)	13 Watts	Weight (Maximum) (Un-Flanged / Flanged)	(52 / 55) Grams
ESD Rating per MIL-PRF-38534	3A		

Parameter		Conditions[8]	SVTR2815D			Units
			Min	Typ	Max	
DYNAMIC						
Load Step Output Transient	±V_{OUT}	Half Load to Full Load	-	280	500	mV_{PK}
Load Step Recovery[2]			-	100	300	µSec
Line Step Output Transient[4]	±V_{OUT}	V_{IN} = 16V to 40V	-	500	900	mV_{PK}
Line Step Recovery[2, 4]			-	300	500	µSec
Turn On Delay	±V_{OUT}	V_{IN} = 0V to 28V	-	10	20	mSec
Turn On Overshoot			-	0	50	mV_{PK}

Notes:
1. Dependant on output voltage.
2. Time for output voltage to settle within 1% of its nominal value.
3. Derate linearly to 0 at 135°C.
4. Verified by qualification testing.
5. Half load at +V_{OUT} and half load at –V_{OUT}.
6. Up to 70% of the total power or current can be drawn from any one of the two outputs.
7. 5% Load to Full Load at -55°C.
8. End-of-Life performance includes aging and radiation degradation and is within standard limits except where noted.

BLOCK DIAGRAM

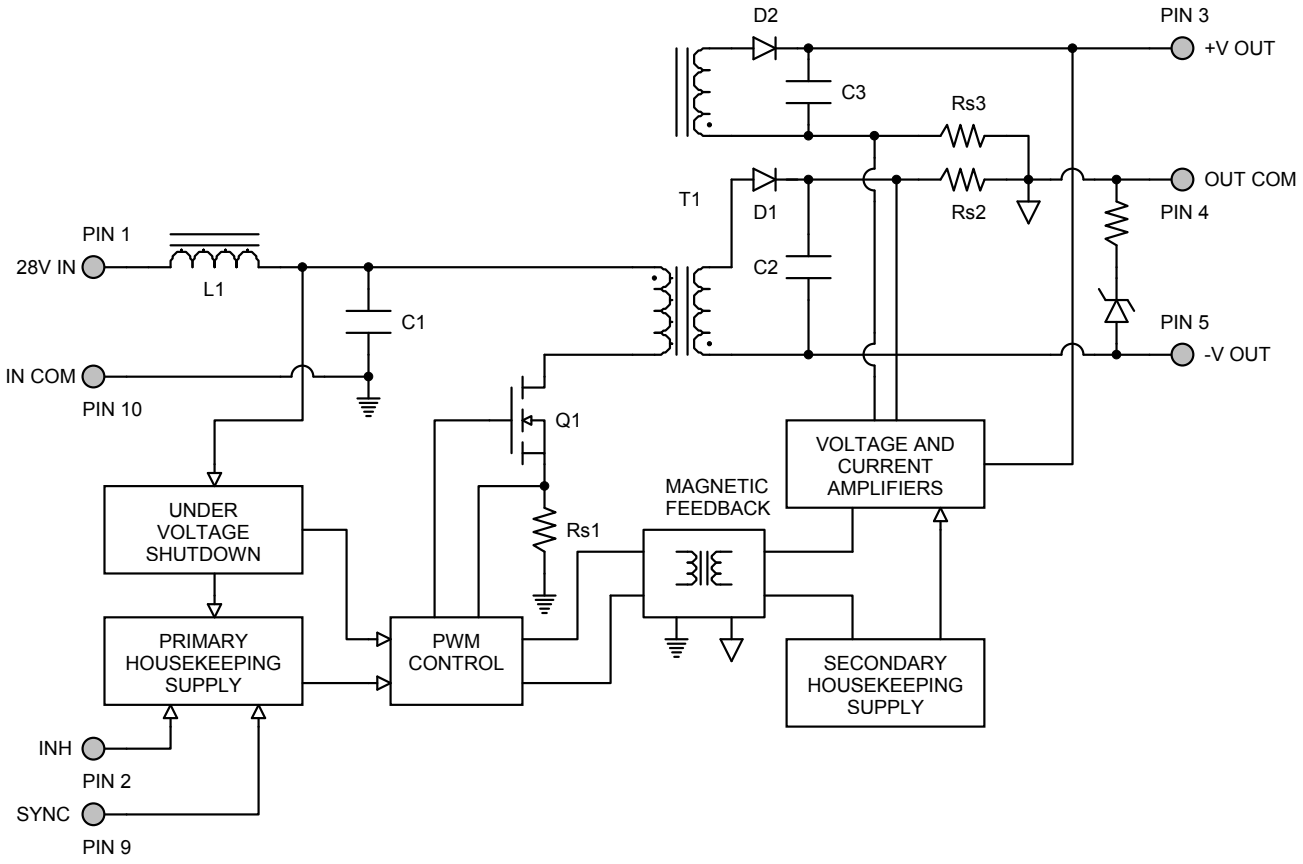


Figure 2

CONNECTION DIAGRAM

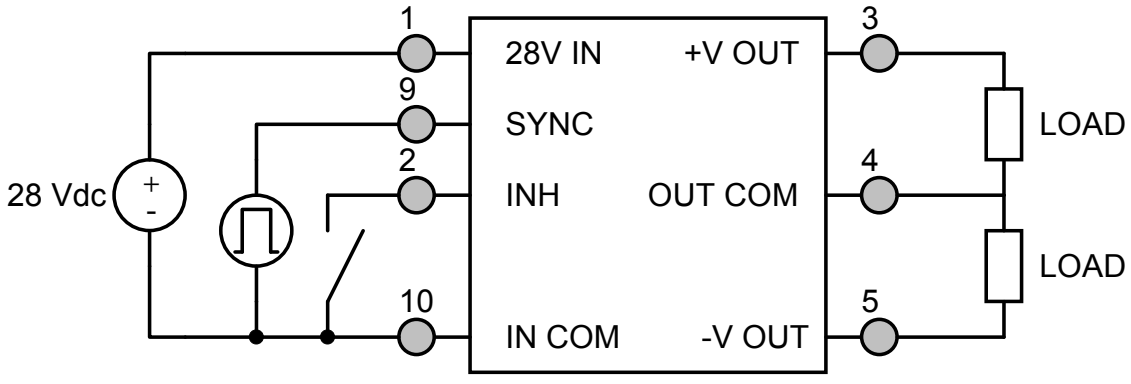


Figure 3

INHIBIT DRIVE CONNECTION DIAGRAMS

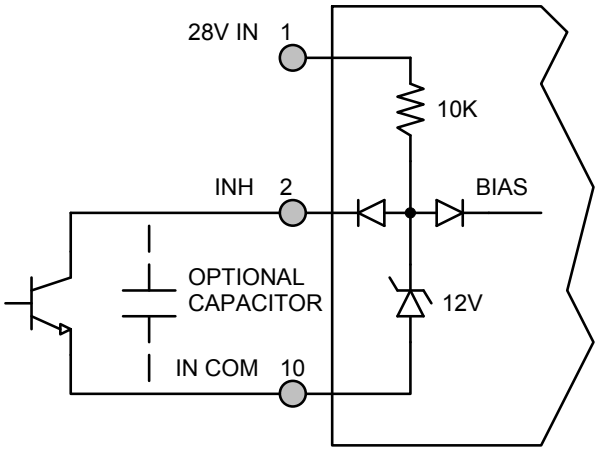


Figure 4 – Internal Inhibit Circuit and Recommended Drive
(Shown with optional capacitor for turn-on delay)

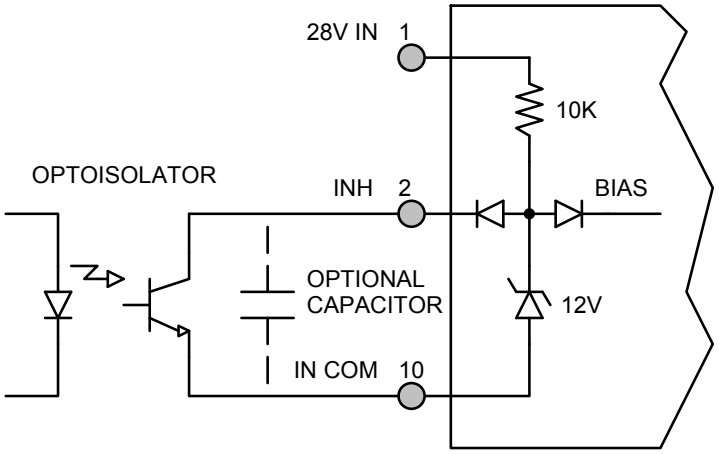


Figure 5 – Isolated Inhibit Drive
(Shown with optional capacitor for turn-on delay)

EMI FILTER HOOKUP DIAGRAM

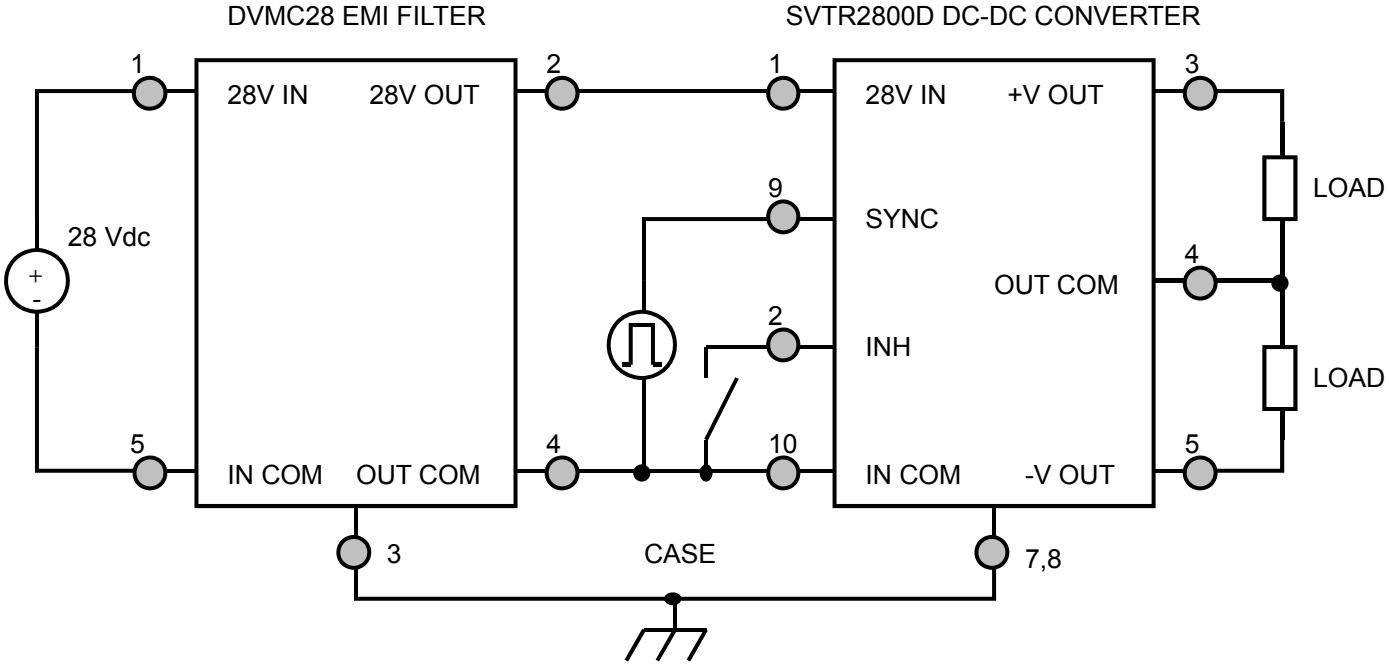


Figure 6 – Converter with EMI Filter

EFFICIENCY PERFORMANCE CURVES (T_{CASE} = 25°C, Full Load, Unless Otherwise Specified)

------- V_{IN} = 16V	——— V_{IN} = 28V	– – – – – V_{IN} = 40V

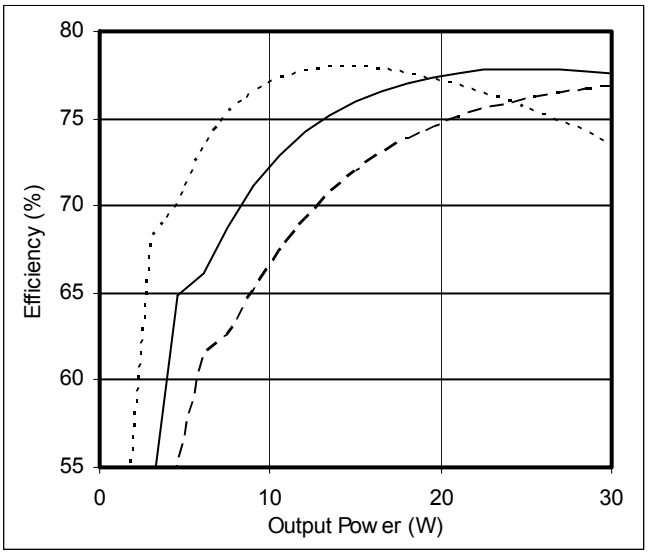


Figure 7 – SVTR2805D
Efficiency (%) vs. Output Power (W)

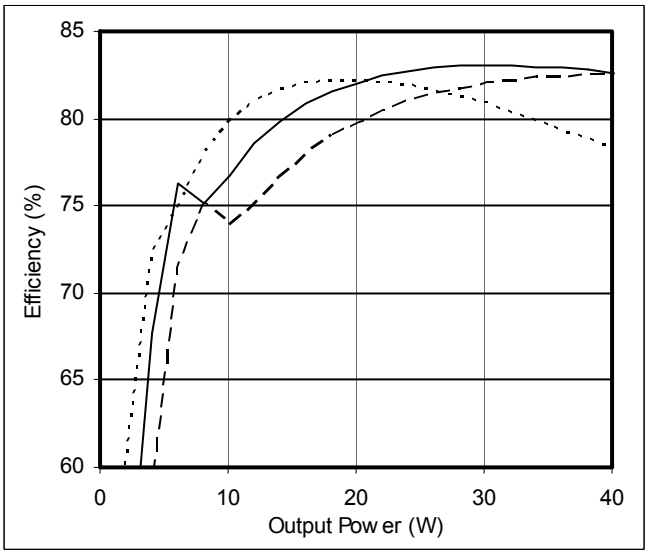


Figure 8 – SVTR2812D
Efficiency (%) vs. Output Power (W)

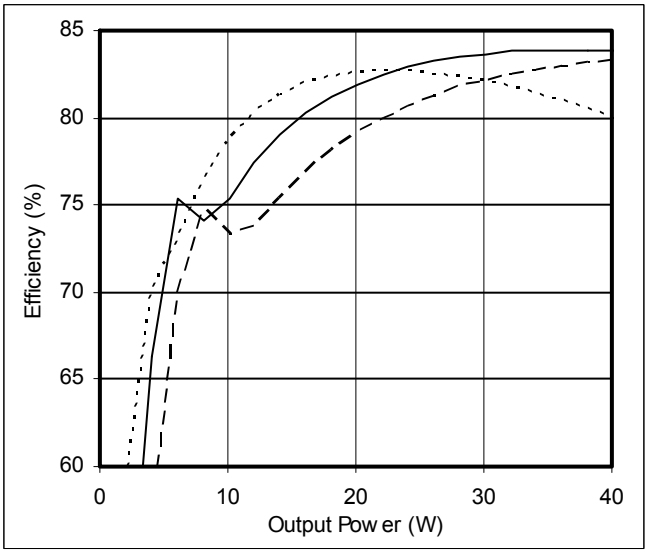


Figure 9 – SVTR2815D
Efficiency (%) vs. Output Power (W)

CROSS REGULATION CURVES (T_{CASE} = 25°C, Full Load, Unless Otherwise Specified)

+Io = 10%	+Io = 30%	+Io = 50%	+Io = 70%

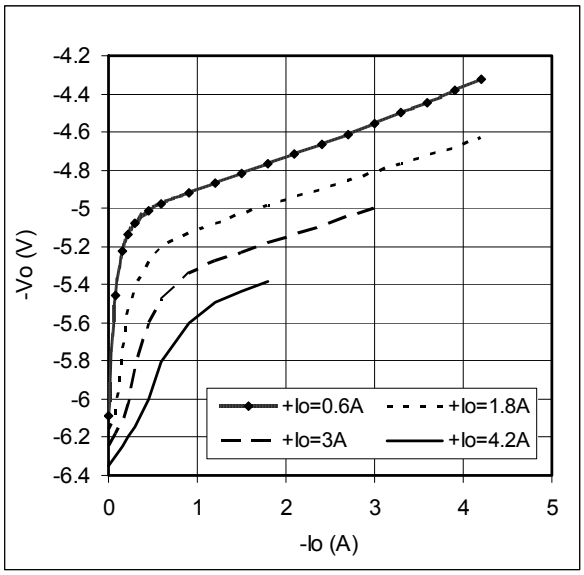


Figure 10 – SVTR2805D
-Vout (V) vs. -Iout (A)

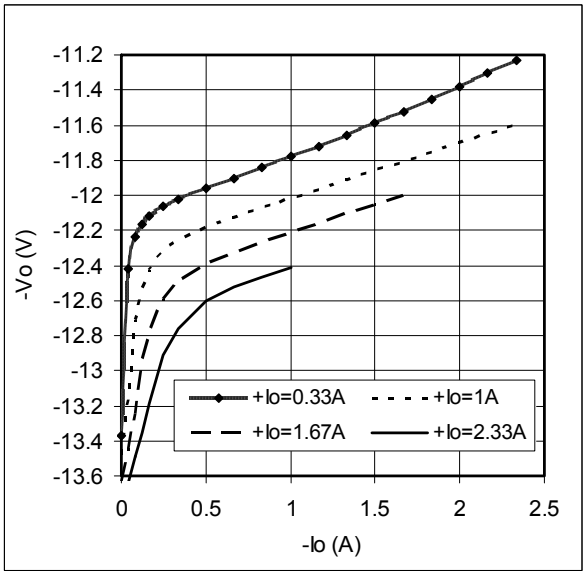


Figure 11 – SVTR2812D
-Vout (V) vs. -Iout (A)

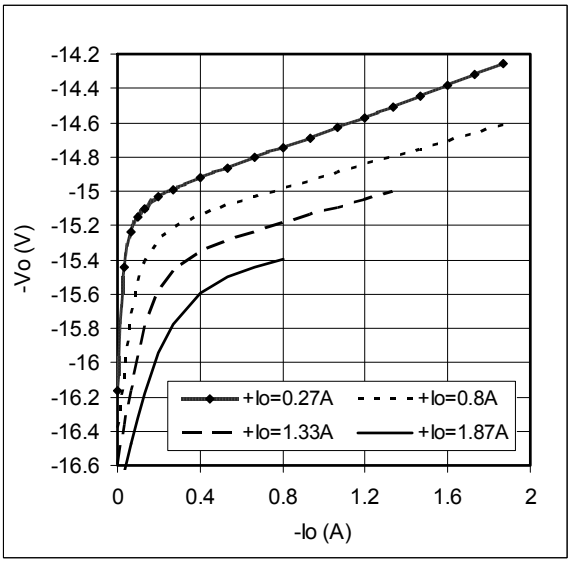


Figure 12 – SVTR2815D
-Vout (V) vs. -Iout (A)

EMI PERFORMANCE CURVES (T_{CASE} = 25°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

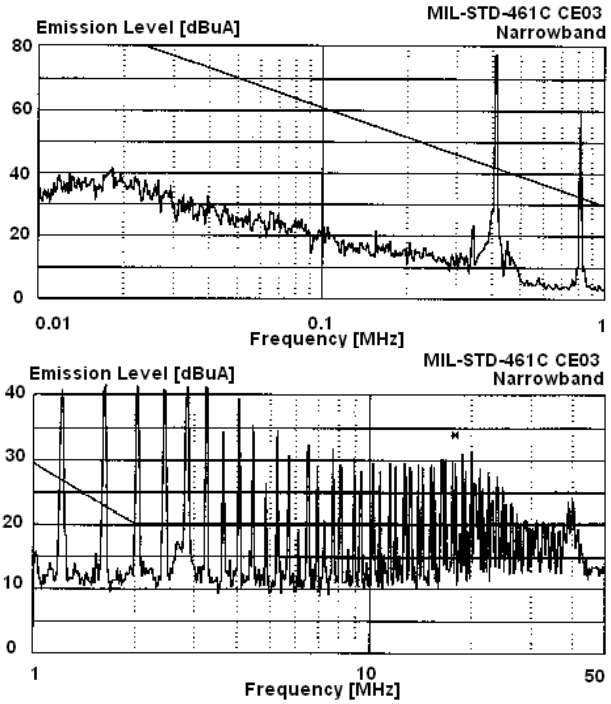


Figure 13 – SVTR2800D without EMI Filter

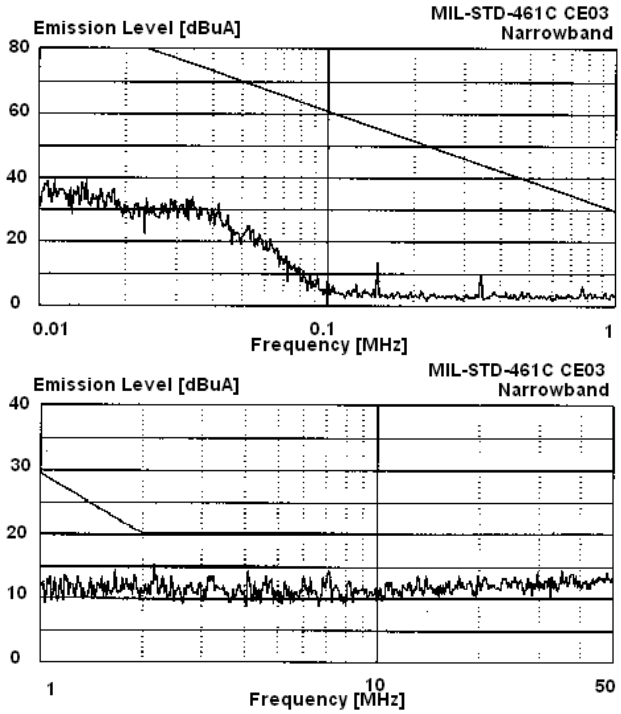


Figure 14 – SVTR2800D with EMI Filter

RADIATION HARDNESS ASSURANCE (RHA)

The SVTR series radiation performance is guaranteed through the use of hardened semiconductor components, radiation lot acceptance testing (RLAT) of non-hardened components, and characterization of the completed hybrid according to VPT's Radiation Hardness Assurance (RHA) plan per MIL-PRF-38534, Appendix G. Post radiation end of life performance limits are determined by worst case analysis.

As part of qualification, one representative model of the hybrid converter family is characterized for total ionizing dose (TID). TID is tested to 60 krad(Si). Subsequent performance is guaranteed to 30 krad(Si) by 2 times margin. Characterization is performed at high dose rate (HDR) in accordance with condition C (minimum dose rate of 30 rad(Si)/s) of method 1019 of MIL-STD-883, and at low dose rate (LDR) in accordance with condition D of method 1019 of MIL-STD-883. A minimum of 1 biased sample and 1 unbiased sample is tested. After radiation exposure, converter testing is performed at 25 °C per standard datasheet limits. The radiation exposure test circuit is given in Figure 15.

Also as part of qualification, one representative model of the hybrid converter family is characterized for Single Event Effects (SEE). The specific test LET is specified on the first page of the datasheet and is tested to a minimum fluence of $1x10^6$ particles/cm^2. The characterization is performed at nominal input voltage at 25 °C in air. The radiation exposure test circuit is specified in Figure 16.

RADIATION HARDNESS ASSURANCE (continued)

Continued compliance is guaranteed by component testing and analysis. Critical semiconductor components, unless procured with manufacturer radiation guarantees, are subjected to RLAT at HDR in accordance with condition C of method 1019 of MIL-STD-883. Semiconductors which have been shown to exhibit ELDRS are subject to RLAT at LDR in accordance with condition D of method 1019 of MIL-STD-883. RLAT is not performed on inherently radiation hard semiconductor component technologies including zeners, diodes, and small signal BJTs.

RHA TEST CIRCUIT DIAGRAMS

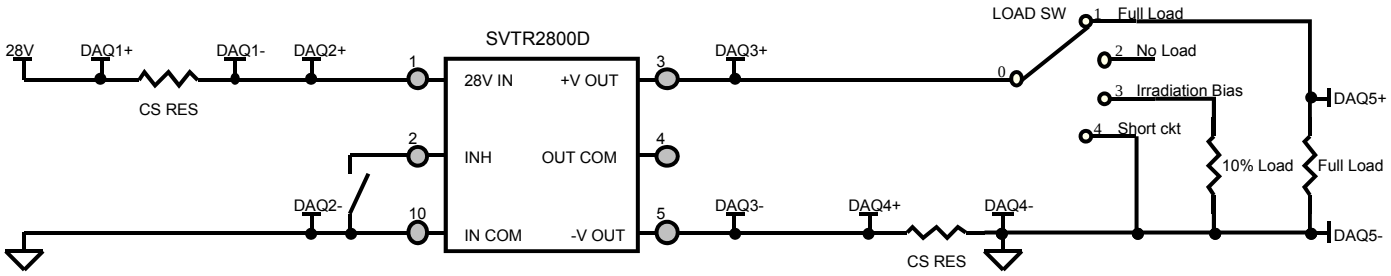


Figure 15 – Radiation exposure circuit (TID)

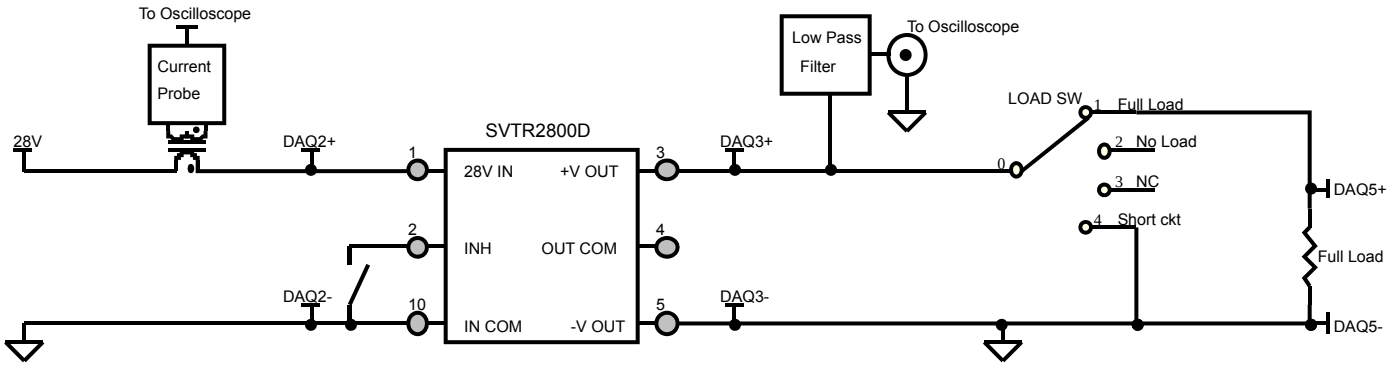
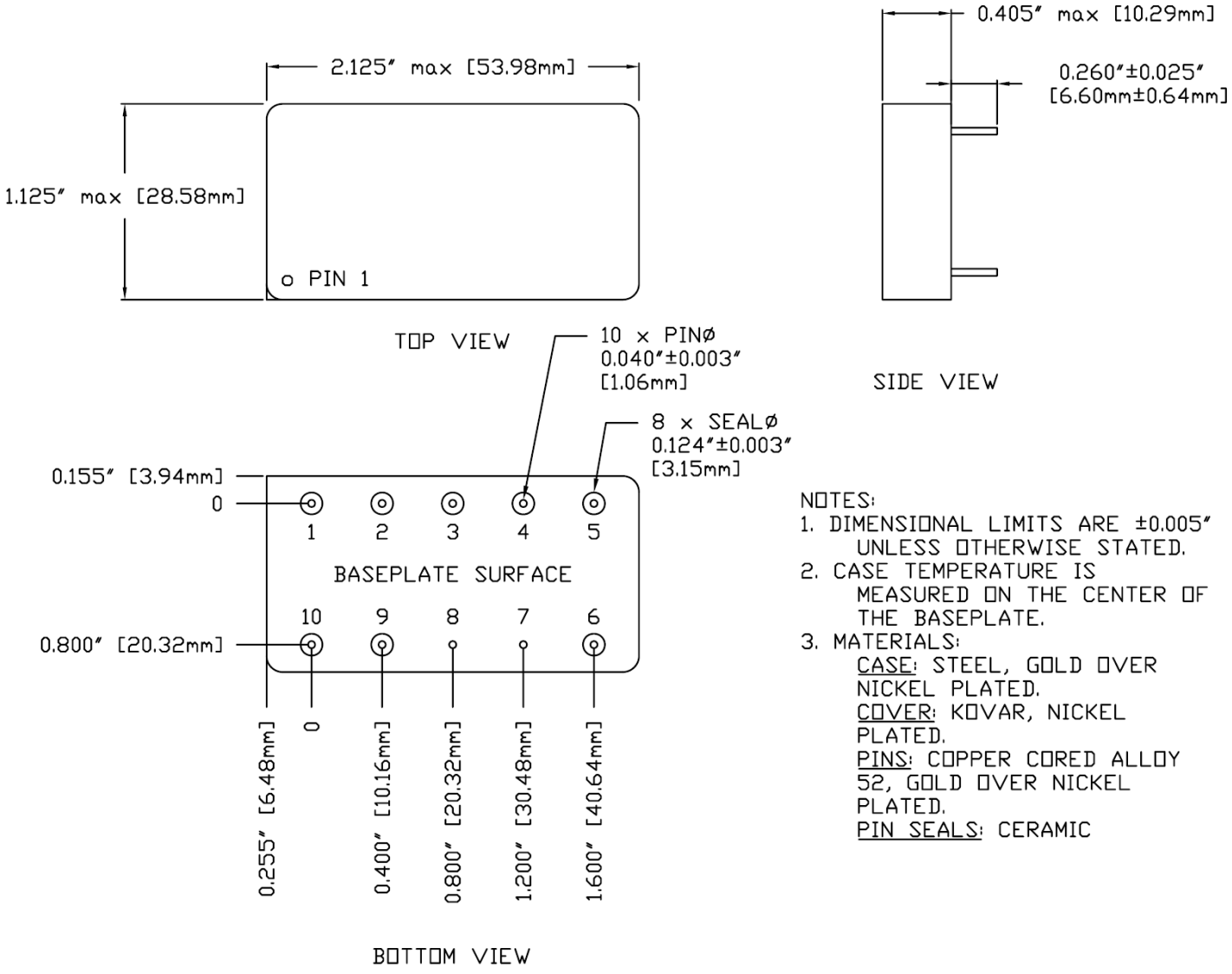


Figure 16 – Radiation exposure circuit (SEE)

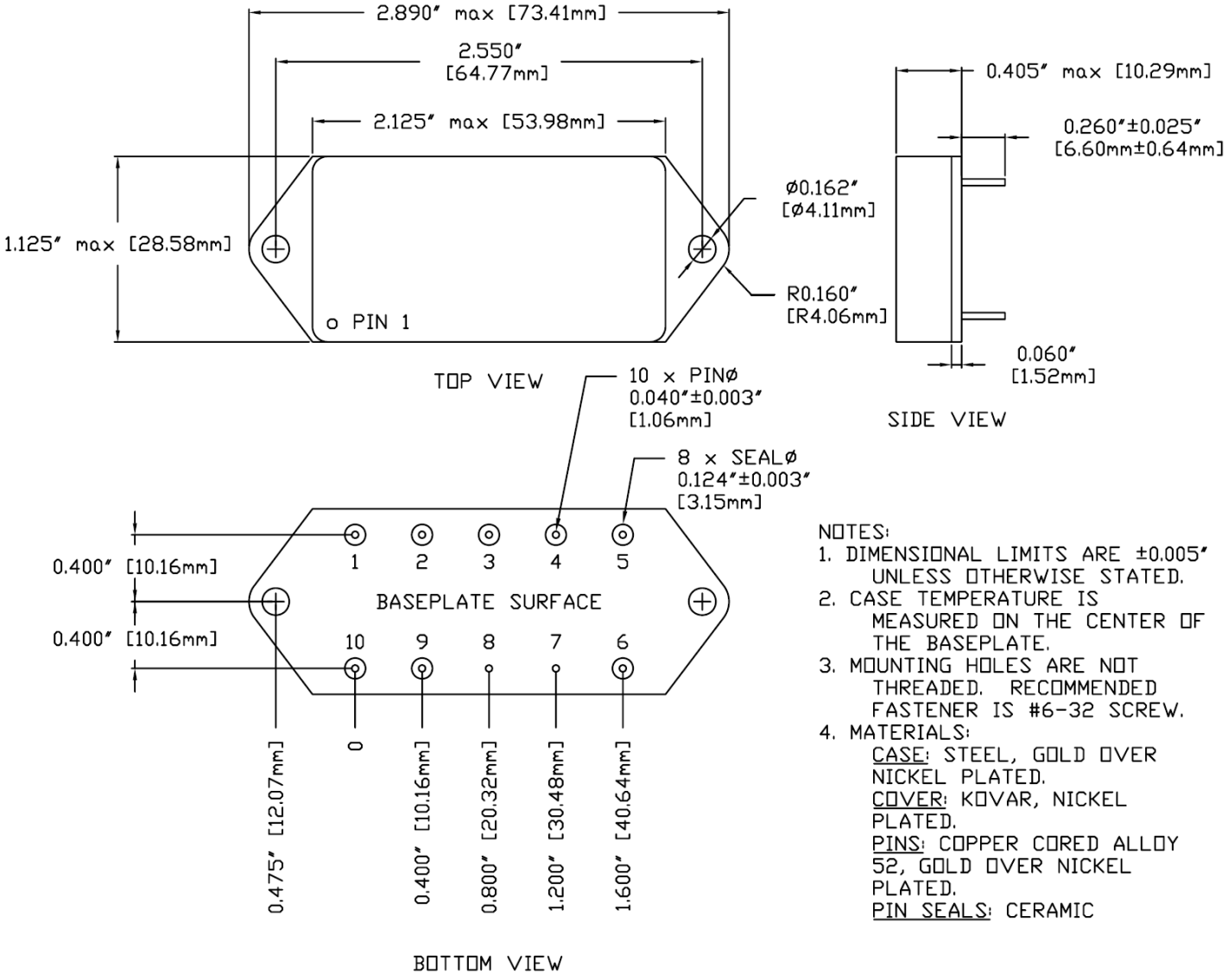
PACKAGE SPECIFICATIONS (NON-FLANGED)



PIN	FUNCTION	PIN	FUNCTION
1	28V IN	6	CASE
2	INHIBIT	7	CASE
3	+V OUT	8	CASE
4	OUT COM	9	SYNC
5	-V OUT	10	IN COM

Figure 17 – Non-Flanged Package and Pinout

PACKAGE SPECIFICATIONS (FLANGED)



PIN	FUNCTION	PIN	FUNCTION
1	28V IN	6	CASE
2	INHIBIT	7	CASE
3	+V OUT	8	CASE
4	OUT COM	9	SYNC
5	-V OUT	10	IN COM

Figure 18 – Flanged Package and Pinout

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	28V IN	Positive Input Voltage Connection
2	INHIBIT	Logic Low = Disabled Output. Connecting the inhibit pin to input common causes converter shutdown. Logic High = Enabled Output. Unconnected or open collector TTL.
3	+V OUT	Positive Output Voltage Connection
4	OUT COM	Output Common Connection
5	-V OUT	Negative Output Voltage Connection
6	CASE	Case Connection
7	CASE	Case Connection
8	CASE	Case Connection
9	SYNC	Synchronization Signal
10	IN COM	Input Common Connection

ENVIRONMENTAL SCREENING (100% Tested Per MIL-STD-883 as referenced to MIL-PRF-38534)

Screening	MIL-STD-883	Class H+ /H+	Class K /K	Engineering Model[5] /EM
Non-Destructive Bond Pull	Method 2023[3]	•	•	•
Internal Visual	Method 2017, 2032 Internal Procedure	•	•	•
Temperature Cycling	Method 1010, Condition C	•	•	
Constant Acceleration	Method 2001, 3000g, Y1 Direction	•	•	
PIND	Method 2020, Condition A[2]	•	•	
Pre Burn-In Electrical	100% at 25°C		•	
Burn-In	Method 1015, 320 hours at +125°C Method 1015, 160 hours at +125°C 24 Hours at +125°C	•	•	•
Final Electrical	MIL-PRF-38534, Group A[1] 100% at 25°C	•	•	•
Hermeticity	Method 1014, Fine Leak, Condition A Method 1014, Gross Leak, Condition C Dip (1 x 10^{-3})	• •	• •	•
Radiography	Method 2012[6]		•	
External Visual	Method 2009	•	•	•

Notes:
1. 100% R&R testing at –55°C, +25°C, and +125°C with all test data included in product shipment.
2. PIND test Certificate of Compliance included in product shipment.
3. Non-Destructive bond pull per Method 2023 performed.
4. Please contact your sales representative or the VPT Inc. Sales Department for more information concerning additional environmental screening and testing options desired.
5. Engineering models utilize only the standard screening specified and are not considered compliant for flight use.
6. Radiographic test Certificate of Compliance and film(s) included in product shipment.

ORDERING INFORMATION

SVTR	28	05	D	F	/HB+	-	XXX
1	2	3	4	5	6		7

(1)	(2)		(3)		(4)	
Product Series	**Nominal Input Voltage**		**Output Voltage**		**Number of Outputs**	
SVTR	**28**	28 Volts	**05** **12** **15**	± 5 Volts ± 12 Volts ± 15 Volts	**D**	Dual

(5)		(6)		(7)
Package Option		**Screening Code**		**Additional Screening Code**
None **F**	Non-Flanged Flanged	**/EM** **/H+** **/K**	Engineering Model Class H+ Class K	Contact Sales

Note: 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. 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 requirement, source inspection, and/or special element evaluation for space or other higher quality applications.

SMD (STANDARD MICROCIRCUIT DRAWING) NUMBERS

Standard Microcircuit Drawing (SMD)	SVTR2800D Series Similar Part Number
5962P1122301HXC 5962P1122301HYC 5962P1122301KXC 5962P1122301KYC	SVTR2805D/H+ SVTR2805DF/H+ SVTR2805D/K SVTR2805DF/K
5962P1122302HXC 5962P1122302HYC 5962P1122302KXC 5962P1122302KYC	SVTR2812D/H+ SVTR2812DF/H+ SVTR2812D/K SVTR2812DF/K
5962P1122303HXC 5962P1122303HYC 5962P1122303KXC 5962P1122303KYC	SVTR2815D/H+ SVTR2815DF/H+ SVTR2815D/K SVTR2815DF/K

Do not use the SVTR2800D 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 http://www.dscc.dla.mil/programs/smcr/. The SMD number listed above is for standard gold-plated lead finish and “P” RHA (Radiation Hardness Assurance) level. 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.

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@vpt-inc.com