SVFL2800S Series

HIGH RELIABILITY HYBRID RADIATION TOLERANT DC-DC CONVERTERS

DESCRIPTION

The SVFL 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 SVFL series is a magnetic feedback circuit that is radiation immune. Operating at a nominal fixed frequency of 525 kHz, these regulated, isolated units utilize well controlled undervoltage lockout circuitry to eliminate slow start-up problems. The current sharing function allows a maximum of five units to be connected in parallel to boost the total output power to 5 times.

The SVFL 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 SVFL 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 SVFL 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
- Parallel Up to 5 Units With Current Sharing
- Output Voltage Trim Up +10% or Down –20%
- Wide Input Voltage Range: 16 to 40 Volts per MIL-STD-704
- Up to 120 Watts Output Power
- Radiation Immune Magnetic Feedback Circuit
- NO Use of Optoisolators
- Undervoltage Lockout
- Current Limit and Short Circuit Protection
- High Input Transient Voltage: 50 Volts for 1 sec per MIL-STD-704A
- Precision Seam Welded Hermetic Package
- High Power Density: > 80 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
- MIL-PRF-38534 Element Evaluated Components Utilized

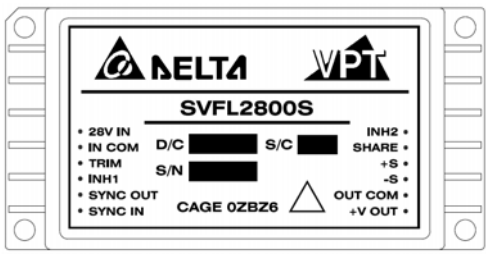

Figure 1 – SVFL2800S DC-DC Converter (Exact marking may differ from that shown)

[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, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	40 V_{DC}	Junction Temperature Rise to Case	+15°C
Input Voltage (Transient, 1 second)	50 Volts	Storage Temperature	-65°C to +150°C
Output Power[1]	120 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +125°C)	41 Watts	Weight (Maximum)	86 Grams

Parameter	Conditions[5]	SVFL283R3S			SVFL2805S			Units
		Min	Typ	Max	Min	Typ	Max	
STATIC								
INPUT Voltage[4]	Continuous	16	28	40	16	28	40	V
	Transient, 1 sec	-	-	50	-	-	50	V
Current	Inhibited 1	-	1	6	-	1	6	mA
	Inhibited 2	-	40	70	-	40	70	mA
	No Load	-	60	120	-	65	120	mA
Ripple Current	Full Load, 20Hz to 10MHz	-	25	80	-	35	80	mA_{p-p}
	End-of-Life	-	-	140	-	-	140	mA_{p-p}
INH1 Pin Input[4]		0	-	1.5	0	-	1.5	V
INH2 Pin Input[4]		0	-	1	0	-	1	V
INH1 Pin Open Circuit Voltage[4]		10.5	-	15	10.5	-	15	V
INH2 Pin Open Circuit Voltage[4]		4	-	12	4	-	12	V
UVLO Turn On		14.5	-	16	14.5	-	16	V
UVLO Turn Off[4]		13.5	-	15.5	13.5	-	15.5	V
OUTPUT Voltage V_{OUT}	T_{CASE} = 25°C	3.267	3.30	3.333	4.95	5.00	5.05	V
OUTPUT Voltage V_{OUT}	T_{CASE} = -55°C to +125°C	3.25	3.30	3.35	4.925	5.00	5.075	V
OUTPUT Voltage V_{OUT}	End-of-Life	3.24	-	3.35	4.89	-	5.10	V
Power		0	-	66	0	-	100	W
Current V_{OUT}		-	-	20	-	-	20	A
Ripple Voltage V_{OUT}	Full Load, 20Hz to 10MHz	-	15	80	-	15	80	mV_{p-p}
Line Regulation V_{OUT}	V_{IN} = 16V to 40V	-	2	20	-	2	20	mV
Load Regulation V_{OUT}	No Load to Full Load	-	2	80	-	2	100	mV
Voltage Trim[4] V_{OUT}	Full Load	-10	-	10	-20	-	10	%
Share Pin Voltage[4]		2	-	4	2	-	4	V
EFFICIENCY		67	72	-	72	77	-	%
LOAD FAULT POWER DISSIPATION	Overload[4]	-	-	50	-	-	50	W
	Short Circuit	-	-	50	-	-	50	W
CAPACITIVE LOAD[4]		-	-	1000	-	-	1000	µF
SWITCHING FREQUENCY		425	525	600	425	525	600	kHz
SYNC FREQUENCY RANGE	$V_H - V_L$ = 5V Duty Cycle = 20% - 80%	500	-	600	500	-	600	kHz
ISOLATION	500 V_{DC}	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	SF @ T_C = 55°C	-	727	-	-	727	-	kHrs

See notes next page.

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

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	40 V_{DC}	Junction Temperature Rise to Case	+15°C
Input Voltage (Transient, 1 second)	50 Volts	Storage Temperature	-65°C to +150°C
Output Power[1]	120 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +125°C)	41 Watts	Weight (Maximum)	86 Grams

Parameter		Conditions[5]	SVFL283R3S			SVFL2805S			Units
			Min	Typ	Max	Min	Typ	Max	
DYNAMIC									
Load Step Output Transient	V_{OUT}	Half Load to Full Load	-	140	400	-	160	400	mV_{PK}
Load Step Recovery[2]			-	260	500	-	260	500	µSec
Line Step Output Transient[4]	V_{OUT}	V_{IN} = 16V to 40V	-	300	600	-	300	600	mV_{PK}
Line Step Recovery[2, 4]			-	300	500	-	300	500	µSec
Turn On Delay	V_{OUT}	V_{IN} = 0V to 28V	-	5	20	-	5	20	mSec
Turn On Overshoot			-	0	15	-	0	25	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. 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, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	40 V_{DC}	Junction Temperature Rise to Case	+15°C
Input Voltage (Transient, 1 second)	50 Volts	Storage Temperature	-65°C to +150°C
Output Power[1]	120 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +125°C)	41 Watts	Weight (Maximum)	86 Grams

Parameter	Conditions[5]	SVFL2812S			SVFL2815S			Units
		Min	Typ	Max	Min	Typ	Max	
STATIC								
INPUT Voltage[4]	Continuous	16	28	40	16	28	40	V
	Transient, 1 sec	-	-	50	-	-	50	V
Current	Inhibited 1	-	1	6	-	1	6	mA
	Inhibited 2	-	40	70	-	40	70	mA
	No Load	-	80	120	-	85	120	mA
Ripple Current	Full Load, 20Hz to 10MHz	-	30	80	-	30	80	mA_{p-p}
	End-of-Life	-	-	140	-	-	140	mA_{p-p}
INH1 Pin Input[4]		0	-	1.5	0	-	1.5	V
INH2 Pin Input[4]		0	-	1	0	-	1	V
INH1 Pin Open Circuit Voltage[4]		10.5	-	15	10.5	-	15	V
INH2 Pin Open Circuit Voltage[4]		4	-	12	4	-	12	V
UVLO Turn On		14.5	-	16	14.5	-	16	V
UVLO Turn Off[4]		13.5	-	15.5	13.5	-	15.5	V
OUTPUT Voltage V_{OUT}	T_{CASE} = 25°C	11.88	12.00	12.12	14.85	15.00	15.15	V
OUTPUT Voltage V_{OUT}	T_{CASE} = -55°C to +125°C	11.82	12.00	12.18	14.775	15.00	15.225	V
OUTPUT Voltage V_{OUT}	End-of-Life	11.66	-	12.28	14.565	-	15.355	V
Power		-	-	110	-	-	120	W
Current V_{OUT}		-	-	9.2	-	-	8.0	A
Ripple Voltage V_{OUT}	Full Load, 20Hz to 10MHz	-	25	80	-	25	80	mV_{p-p}
Line Regulation V_{OUT}	V_{IN} = 16V to 40V	-	2	20	-	2	20	mV
Load Regulation V_{OUT}	No Load to Full Load	-	2	120	-	2	120	mV
Voltage Trim[4] V_{OUT}	Full Load	-20	-	10	-20	-	10	%
Share Pin Voltage[4]		2	-	4	2	-	4	V
EFFICIENCY		79	85	-	80	85	-	%
LOAD FAULT POWER DISSIPATION	Overload[4]	-	-	50	-	-	50	W
	Short Circuit	-	-	50	-	-	50	W
CAPACITIVE LOAD[4]		-	-	500	-	-	500	µF
SWITCHING FREQUENCY		425	525	600	425	525	600	kHz
SYNC FREQUENCY RANGE	$V_H - V_L$ = 5V Duty Cycle = 20% - 80%	500	-	600	500	-	600	kHz
ISOLATION	500 V_{DC}	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	SF @ T_C = 55°C	-	727	-	-	727	-	kHrs

See notes next page.

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

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	40 V_{DC}	Junction Temperature Rise to Case	+15°C
Input Voltage (Transient, 1 second)	50 Volts	Storage Temperature	-65°C to +150°C
Output Power[1]	120 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +125°C)	41 Watts	Weight (Maximum)	86 Grams

Parameter		Conditions[5]	SVFL2812S			SVFL2815S			Units
			Min	Typ	Max	Min	Typ	Max	
DYNAMIC									
Load Step Output Transient	V_{OUT}	Half Load to Full Load	-	570	1000	-	640	1000	mV_{PK}
Load Step Recovery[2]			-	290	500	-	260	500	µSec
Line Step Output Transient[4]	V_{OUT}	V_{IN} = 16V to 40V	-	600	1200	-	600	1200	mV_{PK}
Line Step Recovery[2, 4]			-	300	500	-	300	500	µSec
Turn On Delay	V_{OUT}	V_{IN} = 0V to 28V	-	5	20	-	5	20	mSec
Turn On Overshoot			-	0	50	-	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. End-of-Life performance includes aging and radiation degradation and is within standard limits except where noted.

BLOCK DIAGRAM

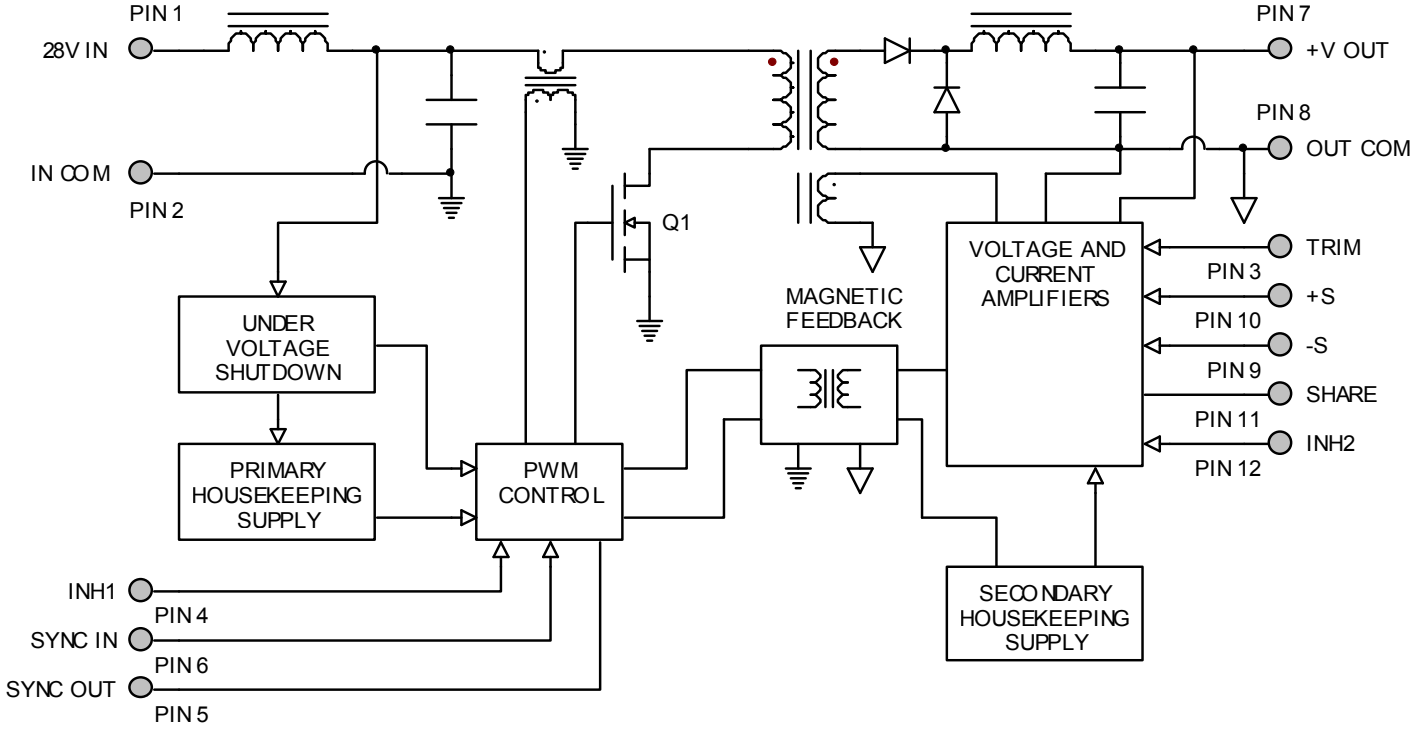


Figure 2

CONNECTION DIAGRAM

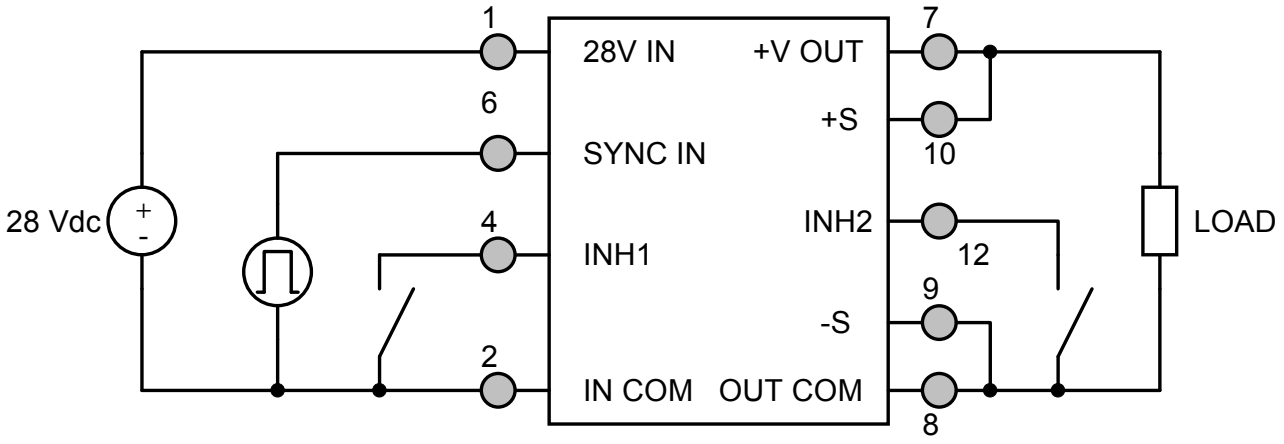


Figure 3

INHIBIT DRIVE CONNECTION DIAGRAM

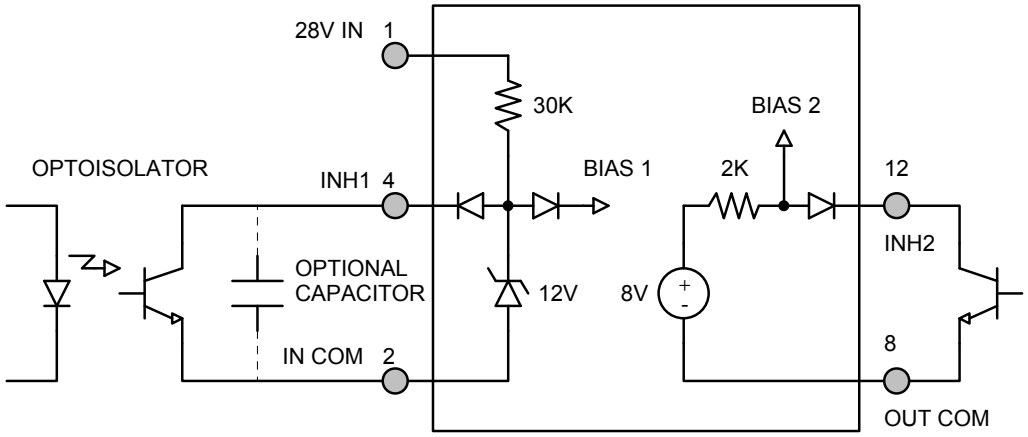


Figure 4 – Isolated Inhibit Drive and Internal Equivalent Circuit

(Shown with optional capacitor for turn-on delay)

EMI FILTER HOOKUP DIAGRAM

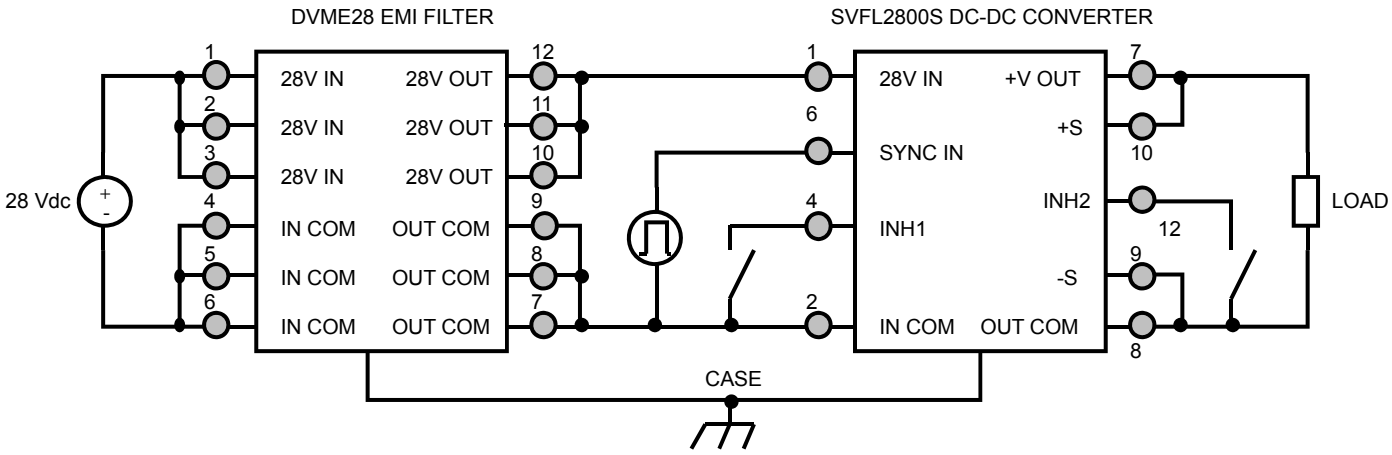


Figure 5 – Converter with EMI Filter

PARALLEL CONNECTION DIAGRAMS

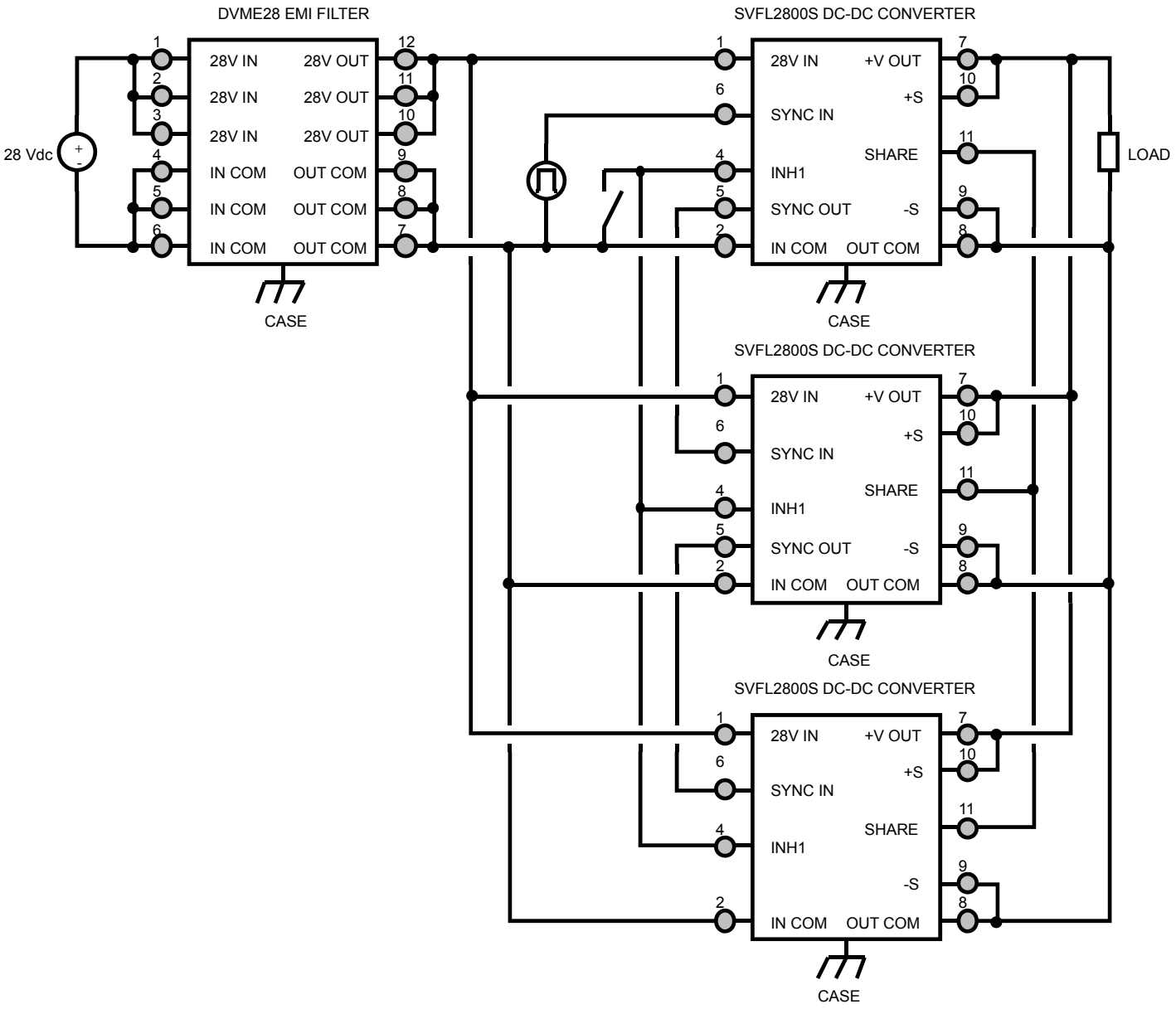
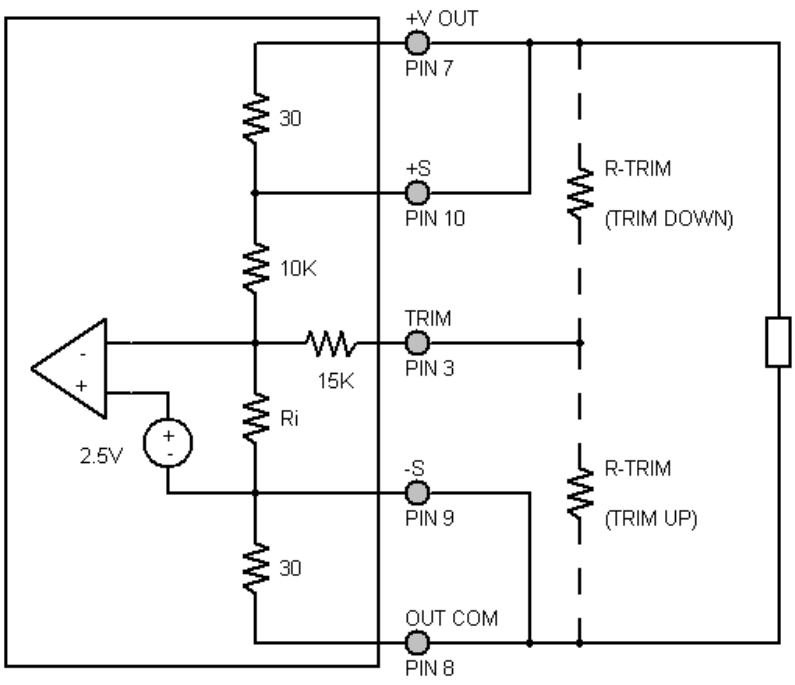


Figure 6 – Current Sharing Parallel Connection for Multiple Converters

OUTPUT VOLTAGE TRIM



The output voltage can be trimmed down by connecting a resistor between the TRIM pin (PIN 3) and the +V OUT pin (PIN 7), or can be trimmed up by connecting a resistor between the TRIM pin (PIN 3) and the OUT COM pin (PIN 8). The maximum trim range is +10% up and –20% down. The appropriate resistor values versus the output voltage are given in the trim table below.

Figure 7 – Output Voltage Trim

SVFL283R3S		SVFL2805S		SVFL2812S		SVFL2815S	
$+V_{OUT}$ (V)	R_{TRIM} (Ω)	$+V_{OUT}$ (V)	R_{TRIM} (Ω)	$+V_{OUT}$ (V)	R_{TRIM} (Ω)	$+V_{OUT}$ (V)	R_{TRIM} (Ω)
3.60	68.3k	5.5	35k	13.2	5.8k	16.50	1.7k
3.55	85k	5.4	47.5k	13.0	10k	16.25	5k
3.50	110k	5.3	68.3k	12.8	16.2k	16.00	10k
3.45	151.7k	5.2	110k	12.6	26.6k	15.75	18.3k
3.40	235k	5.1	235k	12.4	47.3k	15.50	35k
3.35	485k	5.0	-	12.2	109k	15.25	85k
3.30	-	4.9	225k	12.0	-	15.00	-
3.25	135k	4.8	100k	11.8	454k	14.75	475k
3.20	55k	4.7	58.3k	11.6	213k	14.50	225k
3.15	28.3k	4.6	37.5k	11.4	134k	14.25	142k
3.10	15k	4.5	25k	11.2	94k	14.00	100k
3.05	7k	4.4	16.7k	11.0	70.1k	13.75	75k
3.00	1.7k	4.3	10.7k	10.8	54.3k	13.50	58.3k
		4.2	6.3k	10.6	42.9k	13.25	46.4k
		4.1	2.8k	10.4	34.4k	13.00	37.5k
		4.0	0	10.2	27.8k	12.75	30.6k
				10.0	22.5k	12.50	25k
				9.8	18.2k	12.25	20.5k
				9.6	14.6k	12.00	16.7k

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

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

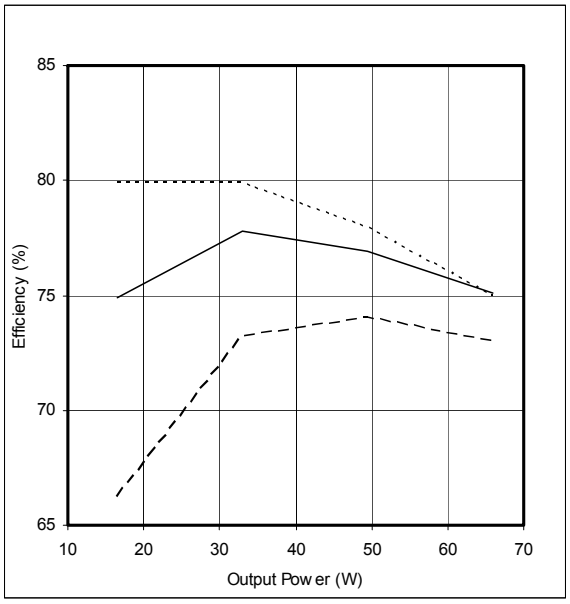


Figure 8 – SVFL283R3S
Efficiency (%) vs. Output Power (W)

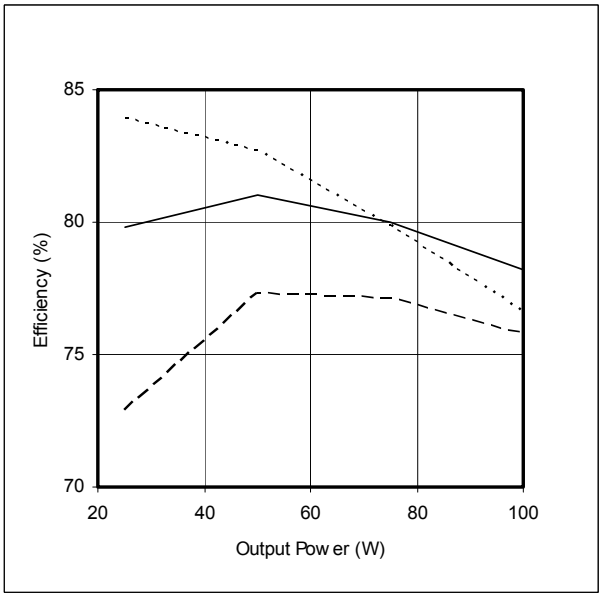


Figure 9 – SVFL2805S
Efficiency (%) vs. Output Power (W)

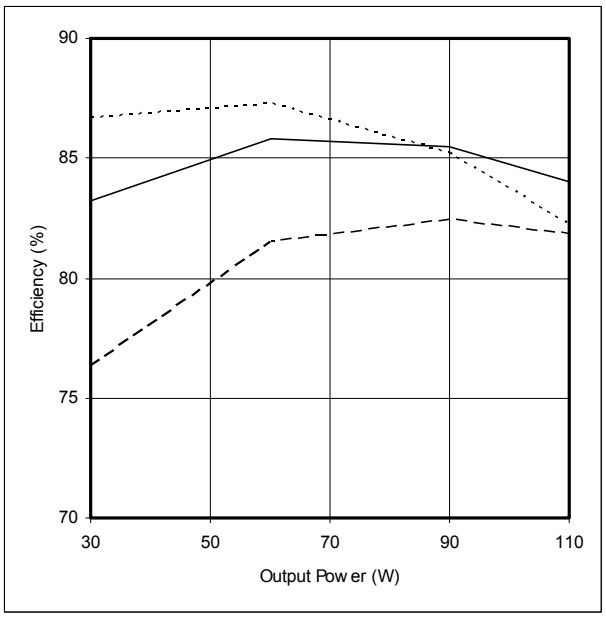


Figure 10 – SVFL2812S
Efficiency (%) vs. Output Power (W)

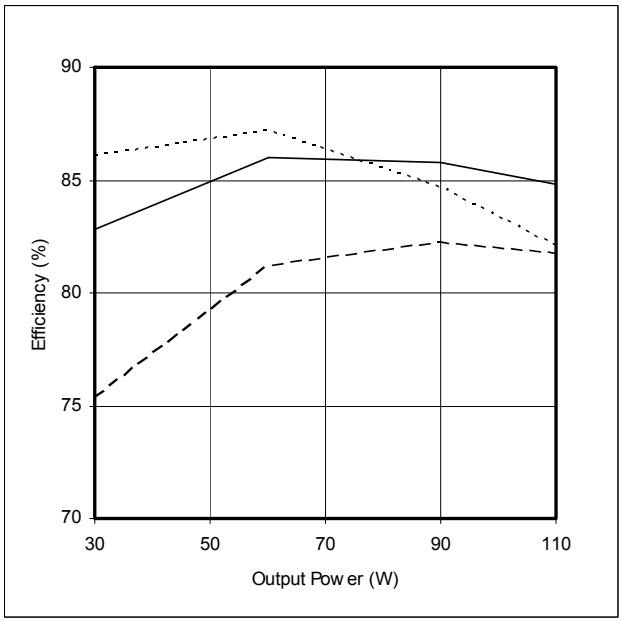


Figure 11 – SVFL2815S
Efficiency (%) vs. Output Power (W)

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

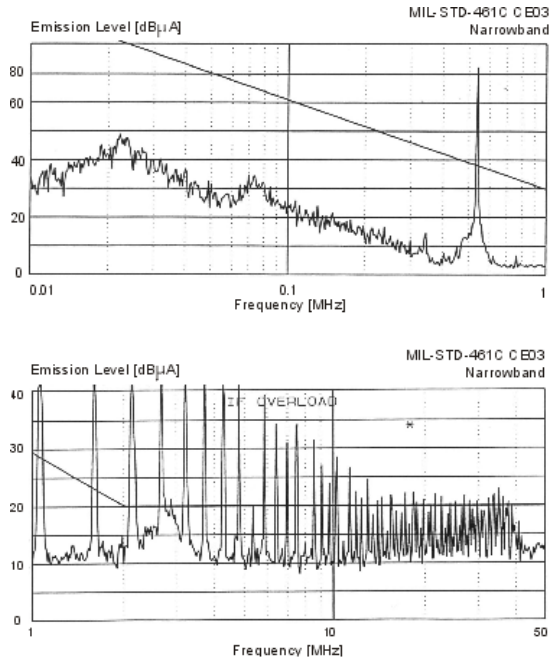


Figure 12 – SVFL2800S without EMI Filter

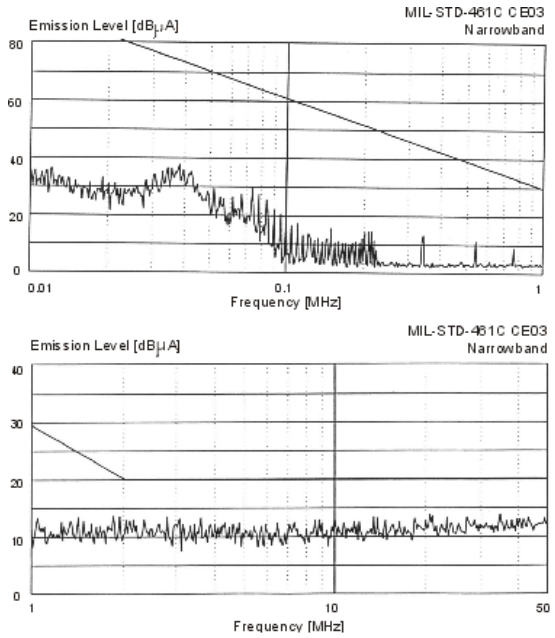


Figure 13 – SVFL2800S with EMI Filter

RADIATION HARDNESS ASSURANCE (RHA)

The SVFL 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 14.

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 15.

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

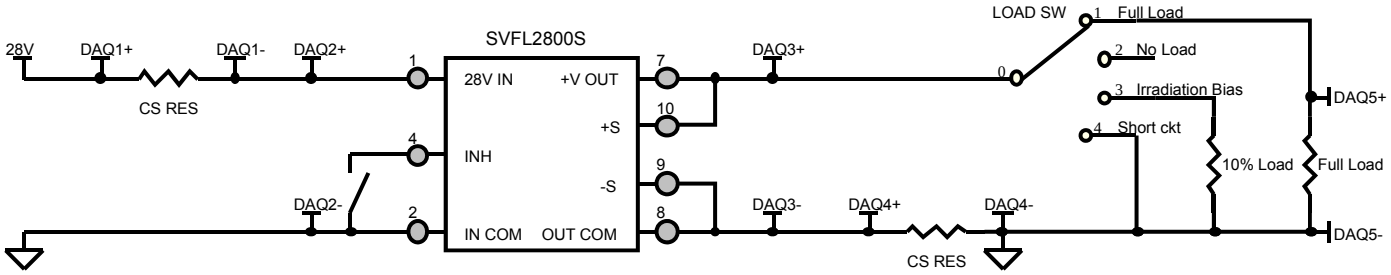


Figure 14 – Radiation exposure circuit (TID)

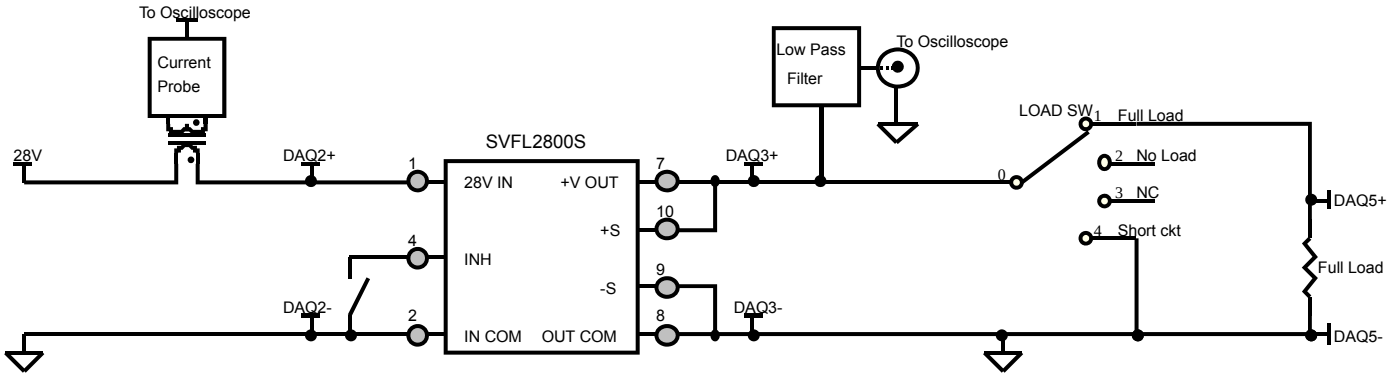
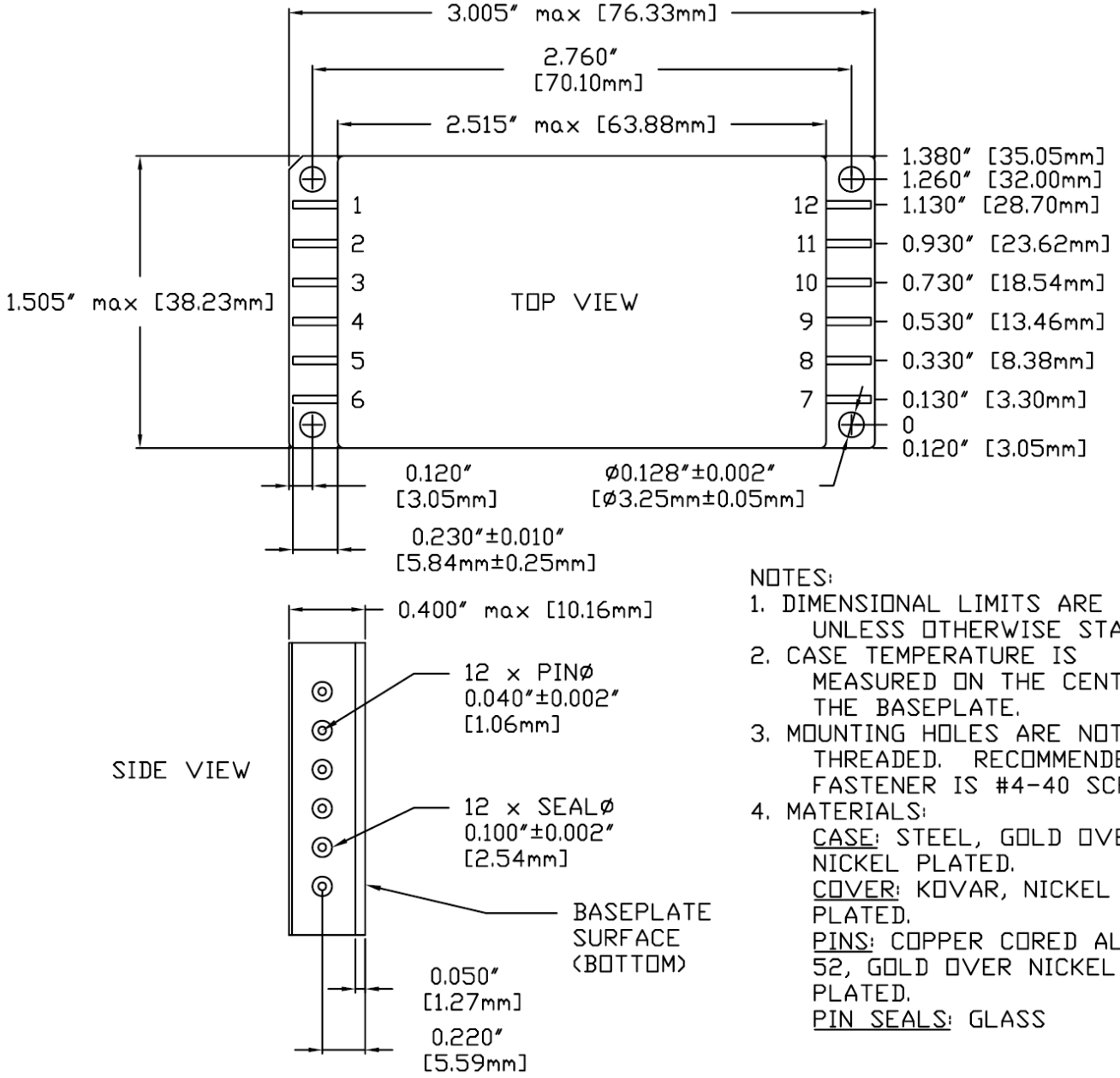


Figure 15 – Radiation exposure circuit (SEE)

PACKAGE SPECIFICATIONS



NOTES:
1. DIMENSIONAL LIMITS ARE ±0.005" UNLESS OTHERWISE STATED.
2. CASE TEMPERATURE IS MEASURED ON THE CENTER OF THE BASEPLATE.
3. MOUNTING HOLES ARE NOT THREADED. RECOMMENDED FASTENER IS #4-40 SCREW.
4. MATERIALS:
   CASE: STEEL, GOLD OVER NICKEL PLATED.
   COVER: KOVAR, NICKEL PLATED.
   PINS: COPPER CORED ALLOY 52, GOLD OVER NICKEL PLATED.
   PIN SEALS: GLASS

PIN	FUNCTION	PIN	FUNCTION	PIN	FUNCTION	PIN	FUNCTION
1	28V IN	4	INH1	7	+V OUT	10	+S
2	IN COM	5	SYNC OUT	8	OUT COM	11	SHARE
3	TRIM	6	SYNC IN	9	-S	12	INH2

Figure 16 – Package and Pinout

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	28V IN	Positive Input Voltage Connection
2	IN COM	Input Common Connection
3	TRIM	Trim Output Voltage to +10%, -20% of Nominal Value
4	INH1	Logic Low = Disabled Output. Connecting the inhibit(1) pin to input common causes converter shutdown. Logic High = Enabled Output. Unconnected or open collector TTL.
5	SYNC OUT	Output Synchronization Signal
6	SYNC IN	Input Synchronization Signal
7	+V OUT	Positive Output Voltage Connection
8	OUT COM	Output Common Connection
9	-S	Return Sense
10	+S	Positive Sense
11	SHARE	Current Share
12	INH2	Logic Low = Disabled Output. Connecting the inhibit(2) pin to output common causes converter shutdown. Logic High = Enabled Output. Unconnected or open collector TTL.

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. This is an additional screening test not required per MIL-PRF-38534, Class H.
3. Non-Destructive bond pull per Method 2023 performed. This is an additional screening test not required per MIL-PRF-38534, Class H.
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

SVFL	28	05	S	/H+	-	XXX
1	2	3	4	5		6

(1)	(2)		(3)		(4)	
Product Series	**Nominal Input Voltage**		**Output Voltage**		**Number of Outputs**	
SVFL	**28**	28 Volts	**3R3** **05** **12** **15**	3.3 Volts 5 Volts 12 Volts 15 Volts	**S**	Single

(5)		(6)
Screening Code		**Additional Screening Code**
/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)	SVFL2800S Series Similar Part Number
5962P1121701HXC 5962P1121701KXC	SVFL283R3S/H+ SVFL283R3S/K
5962P1121702HXC 5962P1121702KXC	SVFL2805S/H+ SVFL2805S/K
5962P1121703HXC 5962P1121703KXC	SVFL2812S/H+ SVFL2812S/K
5962P1121704HXC 5962P1121704KXC	SVFL2815S/H+ SVFL2815S/K

Do not use the SVFL2800S 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