

## HIGH RELIABILITY HYBRID DC-DC CONVERTERS WITH INTEGRAL EMI FILTER

### DESCRIPTION

The DVETR series of high-reliability DC-DC converters provide decades of successful critical mission support. Operable over the full military (-55 °C to +125 °C) temperature range with no power derating, the DVETR series unique input, and output filters dramatically reduce input and output noise performance. While operating at a nominal fixed frequency of 450 kHz, these regulated, isolated units utilize a high-speed magnetic feedback design and well-controlled under-voltage lockout circuitry to eliminate slow start-up problems.

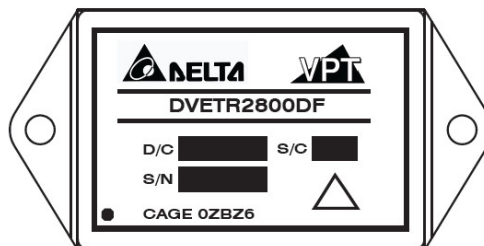
These converters are designed and manufactured in a facility qualified to ISO9001 and certified to MIL-PRF-38534 and MIL-STD-883.

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

- High Reliability
- Very Low Output Noise
- Wide Input Voltage Range: 15 to 50 Volts per MIL-STD-704
- Up to 40 Watts Output Power
- Fault Tolerant Magnetic Feedback Circuit
- NO Use of Optoisolators
- Undervoltage Lockout
- Indefinite Short Circuit Protection
- Current Limit Protection
- Industry Standard Pinout
- High Input Transient Voltage: 80 Volts for 1 sec per MIL-STD-704A
- Precision Seam Welded Hermetic Package
- High Power Density: > 30 W/in<sup>3</sup>
- Custom Versions Available
- Additional Environmental Screening Available
- No External EMI Filter Required
- Meets MIL-STD-461C and MIL-STD-461D EMC Requirements
- Protects Against Conducted Susceptibility Specified in MIL-STD-461C, CS01 and CS02
- Flanged and Non-flanged Versions Available
- MIL-PRF-38534 Element Evaluated Components



**Figure 1** – DVETR2800D / DVETR2800DF DC-DC Converter  
(Exact marking may differ from that shown)

## SPECIFICATIONS (T<sub>CASE</sub> = -55°C to +125°C, V<sub>IN</sub> = +28V ± 5%, Full Load<sup>5</sup>, Unless Otherwise Specified)

### ABSOLUTE MAXIMUM RATINGS

Input Voltage (Continuous)	50 V <sub>DC</sub>	Junction Temperature Rise to Case	+15°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-65°C to +150°C
Output Power <sup>1</sup>	40 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T <sub>CASE</sub> = +125°C)	14 Watts	Weight (Maximum) (Un-Flanged / Flanged)	(56 / 60) Grams

Parameter	Conditions	DVETR2805D			DVETR2812D			Units
		Min	Typ	Max	Min	Typ	Max	
<b>STATIC</b>								
INPUT Voltage <sup>4</sup>	Continuous	15	28	50	15	28	50	V
	Transient, 1 sec	-	-	80	-	-	80	V
Current	Inhibited	-	-	6	-	-	6	mA
	No Load	-	-	90	-	-	90	mA
Inhibit Pin Input <sup>4</sup>		0	-	1.5	0	-	1.5	V
Inhibit Pin Open Circuit Voltage <sup>4</sup>		9.0	11.0	13.0	9.0	11.0	13.0	V
UVLO Turn On		12.0	-	14.8	12	-	14.8	V
UVLO Turn Off <sup>4</sup>		11.0	-	14.5	11.0	-	14.5	V
OUTPUT Voltage <sup>5</sup>	+V <sub>OUT</sub> T <sub>CASE</sub> = 25°C	4.95	5.0	5.05	11.88	12.0	12.12	V
	+V <sub>OUT</sub> T <sub>CASE</sub> = -55°C to +125°C	4.925	5.0	5.075	11.82	12.0	12.18	V
	-V <sub>OUT</sub> T <sub>CASE</sub> = 25°C	4.80	5.0	5.20	11.80	12.0	12.20	V
	-V <sub>OUT</sub> T <sub>CASE</sub> = -55°C to +125°C	4.70	5.0	5.30	11.64	12.0	12.36	V
Power <sup>3,6</sup>	Total	0	-	30	0	-	40	W
	±V <sub>OUT</sub> Either Output	0	-	21	0	-	28	W
Current <sup>3,6</sup>	±V <sub>OUT</sub> Either Output	0	-	4.2	0	-	2.33	A
Ripple Voltage	±V <sub>OUT</sub> Full Load <sup>5</sup> , 20Hz to 10MHz	-	-	60	-	-	50	mV <sub>p-p</sub>
Line Regulation	+V <sub>OUT</sub> V <sub>IN</sub> = 16V to 40V	-	-	20	-	-	20	mV
	-V <sub>OUT</sub> V <sub>IN</sub> = 16V to 40V	-	-	200	-	-	200	mV
Load Regulation	+V <sub>OUT</sub> No Load to Full Load <sup>5</sup>	-	-	50	-	-	50	mV
	-V <sub>OUT</sub> No Load to Full Load <sup>5</sup>	-	-	200	-	-	200	mV
Cross Regulation	-V <sub>OUT</sub> +Load 70%, -Load 30% +Load 30%, -Load 70%	-	-	650	-	-	650	mV
EFFICIENCY	Full Load <sup>5</sup>	70	-	-	74	-	-	%
LOAD FAULT POWER DISSIPATION	Overload <sup>4</sup>	-	-	16	-	-	14	W
	Short Circuit	-	-	16	-	-	14	W
CAPACITIVE LOAD <sup>4</sup>	Either Output	-	-	500	-	-	500	μF
SWITCHING FREQUENCY		400	500	550	400	500	550	kHz
ISOLATION	500 V <sub>DC</sub> , T <sub>CASE</sub> = 25°C	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	AIF @ T <sub>c</sub> = 55°C	-	413	-	-	413	-	kHrs

See notes next page.

## SPECIFICATIONS (T<sub>CASE</sub> = -55°C to +125°C, V<sub>IN</sub> = +28V ± 5%, Full Load<sup>5</sup>, Unless Otherwise Specified)

### ABSOLUTE MAXIMUM RATINGS

Input Voltage (Continuous)	50 V <sub>DC</sub>	Junction Temperature Rise to Case	+15°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-65°C to +150°C
Output Power <sup>1</sup>	40 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T <sub>CASE</sub> = +125°C)	14 Watts	Weight (Maximum) (Un-Flanged / Flanged)	(56 / 60) Grams

Parameter	Conditions	DVETR2805D			DVETR2812D			Units	
		Min	Typ	Max	Min	Typ	Max		
<b>DYNAMIC</b>									
Load Step Output Transient	±V <sub>OUT</sub>	Half Load to Full Load	-	-	500	-	-	600	mV <sub>PK</sub>
Load Step Recovery <sup>2</sup>			-	-	350	-	-	400	μSec
Line Step Output Transient <sup>4</sup>	±V <sub>OUT</sub>	V <sub>IN</sub> = 16V to 40V	-	150	600	-	850	1200	mV <sub>PK</sub>
Line Step Recovery <sup>2, 4</sup>			-	150	500	-	300	500	μSec
Turn On Delay	±V <sub>OUT</sub>	V <sub>IN</sub> = 0V to 28V	-	-	20	-	-	20	mSec
Turn On Overshoot			-	-	50	-	-	50	mV <sub>PK</sub>

#### Notes:

1. Dependent 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 initial electrical design verification. Post design verification, parameter shall be guaranteed to the limits specified.
5. Half load at +V<sub>OUT</sub> and half load at -V<sub>OUT</sub>.
6. Up to 70% of the total power or current can be drawn from any one of the two outputs.

## SPECIFICATIONS (T<sub>CASE</sub> = -55°C to +125°C, V<sub>IN</sub> = +28V ± 5%, Full Load<sup>5</sup>, Unless Otherwise Specified)

### ABSOLUTE MAXIMUM RATINGS

Input Voltage (Continuous)	50 V <sub>DC</sub>	Junction Temperature Rise to Case	+15°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-65°C to +150°C
Output Power <sup>1</sup>	40 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T <sub>CASE</sub> = +125°C)	14 Watts	Weight (Maximum) (Un-Flanged / Flanged)	(56 / 60) Grams

Parameter	Conditions	DVETR2815D			Units
		Min	Typ	Max	
<b>STATIC</b>					
INPUT Voltage <sup>4</sup>	Continuous	15	28	50	V
	Transient, 1 sec	-	-	80	V
Current	Inhibited	-	-	6	mA
	No Load	-	-	90	mA
Inhibit Pin Input <sup>4</sup>		0	-	1.5	V
Inhibit Pin Open Circuit Voltage <sup>4</sup>		9.0	11.0	13.0	V
UVLO Turn On		12.0	-	14.8	V
UVLO Turn Off <sup>4</sup>		11.0	-	14.5	V
OUTPUT Voltage <sup>5</sup>	+V <sub>OUT</sub> T <sub>CASE</sub> = 25°C	14.85	15.0	15.15	V
	+V <sub>OUT</sub> T <sub>CASE</sub> = -55°C to +125°C	14.70	15.0	15.30	V
	-V <sub>OUT</sub> T <sub>CASE</sub> = 25°C	14.70	15.0	15.30	V
	-V <sub>OUT</sub> T <sub>CASE</sub> = -55°C to +125°C	14.55	15.0	15.45	V
Power <sup>3,6</sup>	Total	-	-	40	W
	±V <sub>OUT</sub> Either Output	-	-	28	W
Current <sup>3,6</sup>	±V <sub>OUT</sub> Either Output	-	-	1.87	A
Ripple Voltage	±V <sub>OUT</sub> Full Load <sup>5</sup> , 20Hz to 10MHz	-	-	50	mV <sub>p-p</sub>
Line Regulation	+V <sub>OUT</sub> V <sub>IN</sub> = 16V to 40V	-	-	20	mV
	-V <sub>OUT</sub> V <sub>IN</sub> = 16V to 40V	-	-	200	mV
Load Regulation	+V <sub>OUT</sub> No Load to Full Load <sup>5</sup>	-	-	50	mV
	-V <sub>OUT</sub> No Load to Full Load <sup>5</sup>	-	-	200	mV
Cross Regulation	-V <sub>OUT</sub> +Load 70%, -Load 30% +Load 30%, -Load 70%	-	-	650	mV
EFFICIENCY	Full Load <sup>5</sup>	75	-	-	%
LOAD FAULT POWER DISSIPATION	Overload <sup>4</sup>	-	-	14	W
	Short Circuit	-	-	14	W
CAPACITIVE LOAD <sup>4</sup>	Either Output	-	-	500	μF
SWITCHING FREQUENCY		400	500	550	kHz
ISOLATION	500 V <sub>DC</sub> , T <sub>CASE</sub> = 25°C	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	AIF @ T <sub>c</sub> = 55°C	-	413	-	kHrs

See notes next page.

## SPECIFICATIONS (T<sub>CASE</sub> = -55°C to +125°C, V<sub>IN</sub> = +28V ± 5%, Full Load<sup>5</sup>, Unless Otherwise Specified)

### ABSOLUTE MAXIMUM RATINGS

Input Voltage (Continuous)	50 V <sub>DC</sub>	Junction Temperature Rise to Case	+15°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-65°C to +150°C
Output Power <sup>1</sup>	40 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T <sub>CASE</sub> = +125°C)	14 Watts	Weight (Maximum) (Un-Flanged / Flanged)	(56 / 60) Grams

Parameter	Conditions	DVETR2815D			Units	
		Min	Typ	Max		
<b>DYNAMIC</b>						
Load Step Output Transient	±V <sub>OUT</sub>	Half Load to Full Load	-	-	600	mV <sub>PK</sub>
Load Step Recovery <sup>2</sup>			-	-	300	μSec
Line Step Output Transient <sup>4</sup>	±V <sub>OUT</sub>	V <sub>IN</sub> = 16V to 40V	-	850	1200	mV <sub>PK</sub>
Line Step Recovery <sup>2, 4</sup>			-	300	500	μSec
Turn On Delay	±V <sub>OUT</sub>	V <sub>IN</sub> = 0V to 28V	-	-	20	mSec
Turn On Overshoot			-	-	50	mV <sub>PK</sub>

#### Notes:

1. Dependent 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 initial electrical design verification. Post design verification, parameter shall be guaranteed to the limits specified.
5. Half load at +V<sub>OUT</sub> and half load at -V<sub>OUT</sub>.
6. Up to 70% of the total power or current can be drawn from any one of the two outputs.

**BLOCK DIAGRAM**

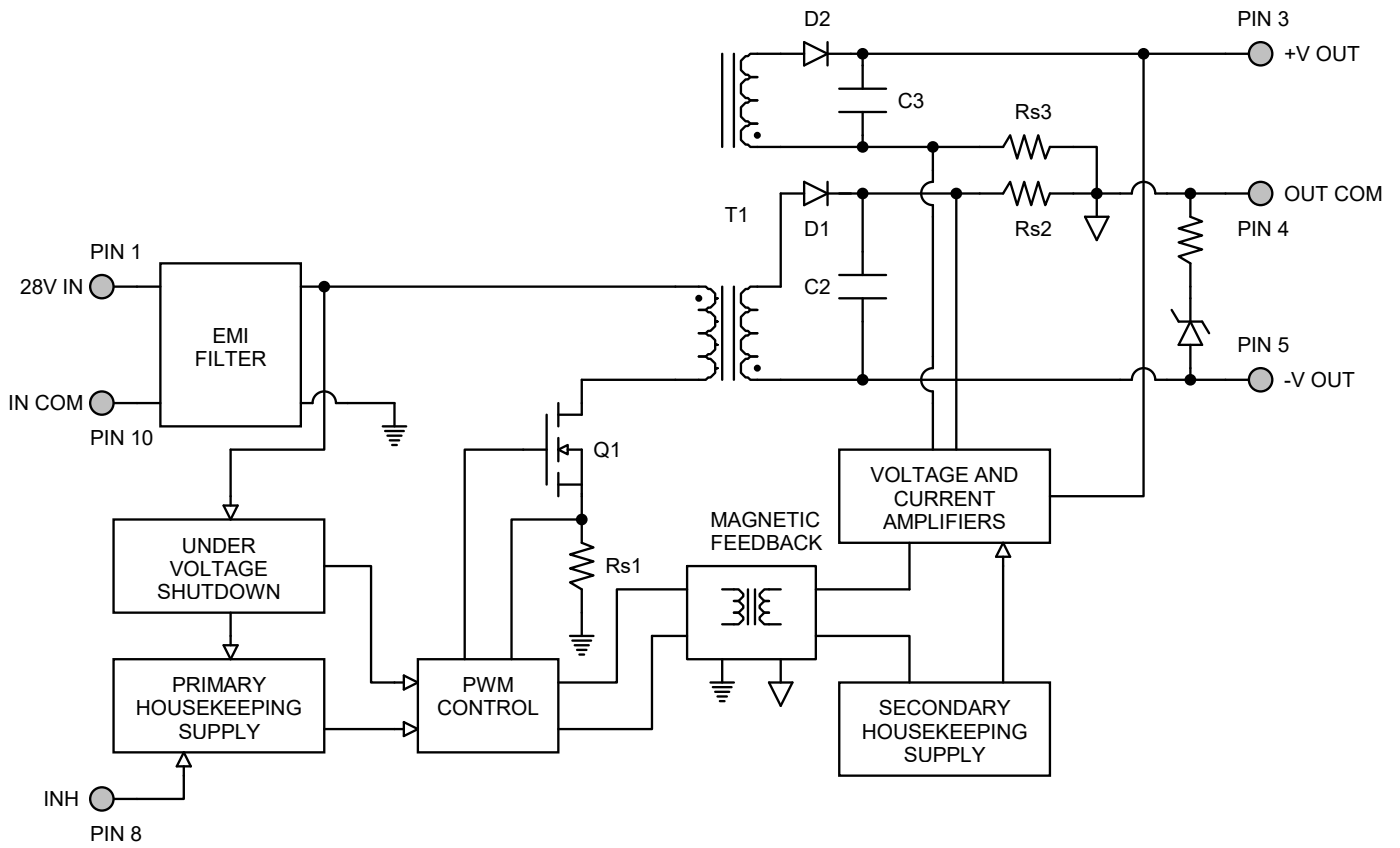


Figure 2

**CONNECTION DIAGRAM**

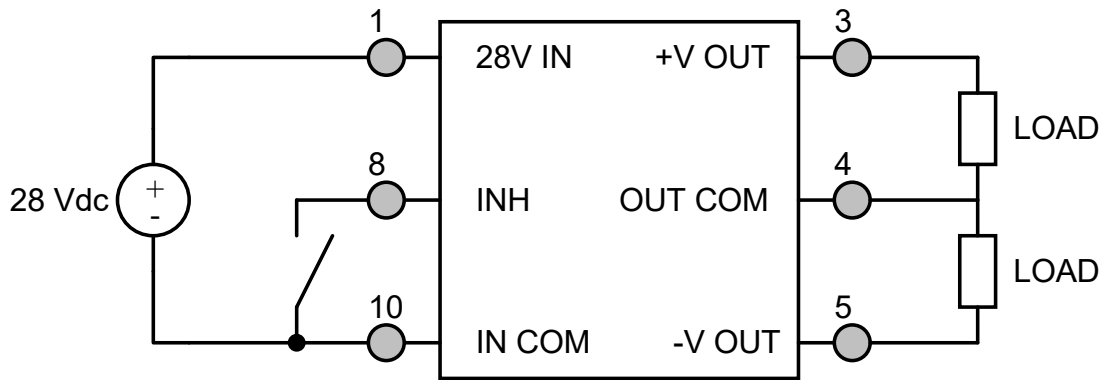


Figure 3

**INHIBIT DRIVE CONNECTION DIAGRAMS**

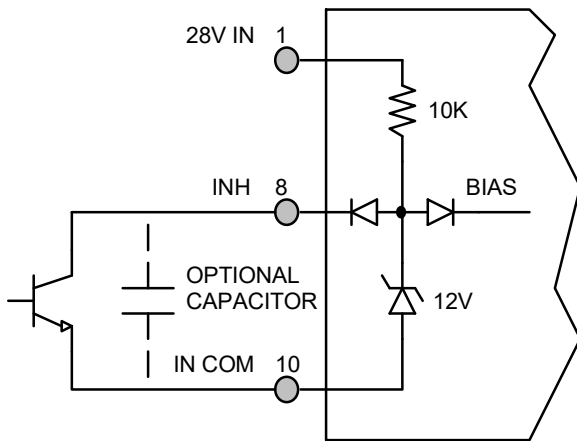


Figure 4 – Internal Inhibit Circuit and Recommended Drive  
(Shown with optional capacitor for turn-on delay)

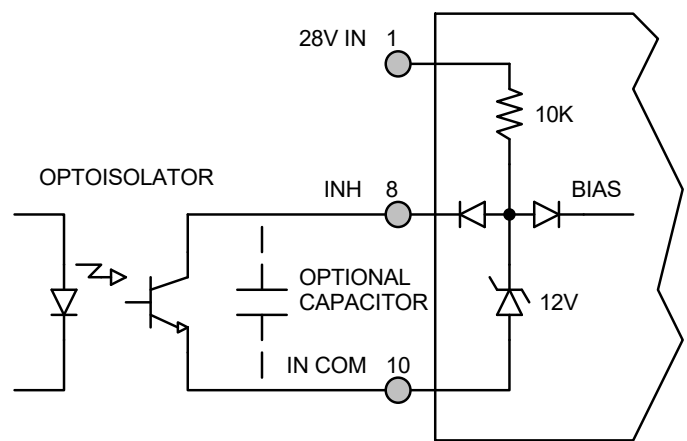
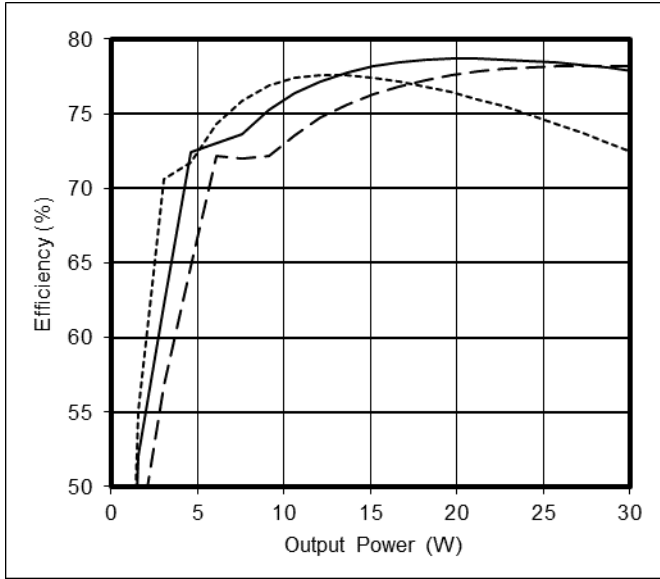
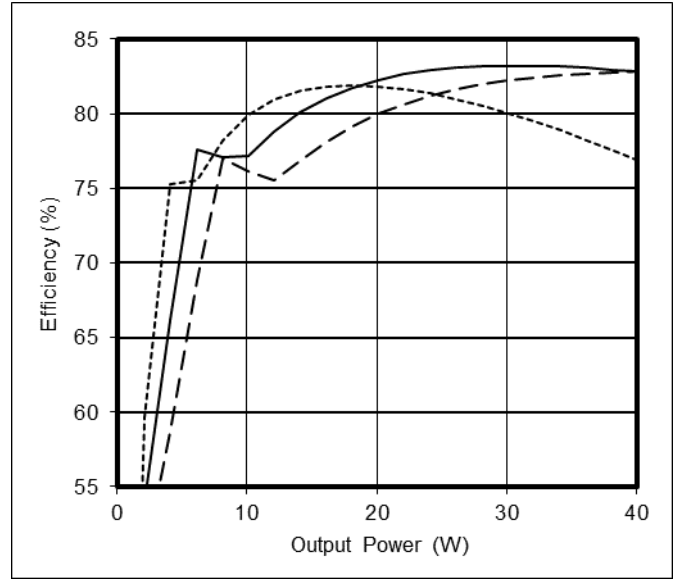


Figure 5 – Isolated Inhibit Drive  
(Shown with optional capacitor for turn-on delay)

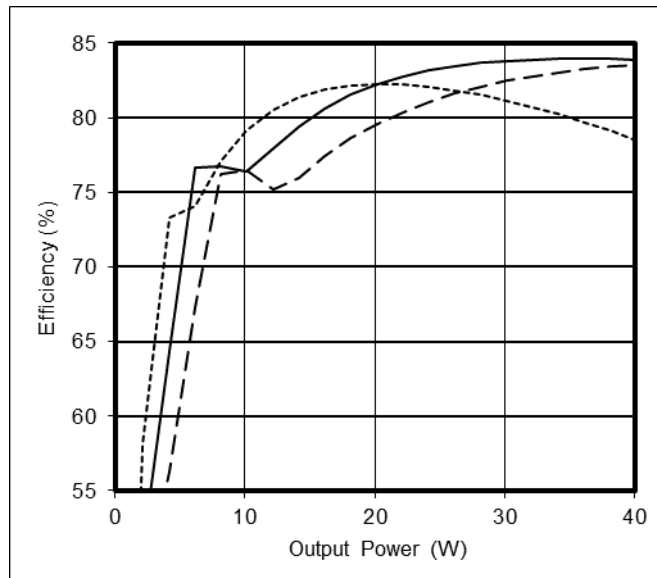
**EFFICIENCY PERFORMANCE CURVES** ( $T_{CASE} = 25^{\circ}C$ , Full Load, Unless Otherwise Specified)



**Figure 6 – DVETR2805D**  
Efficiency (%) vs. Output Power (W)



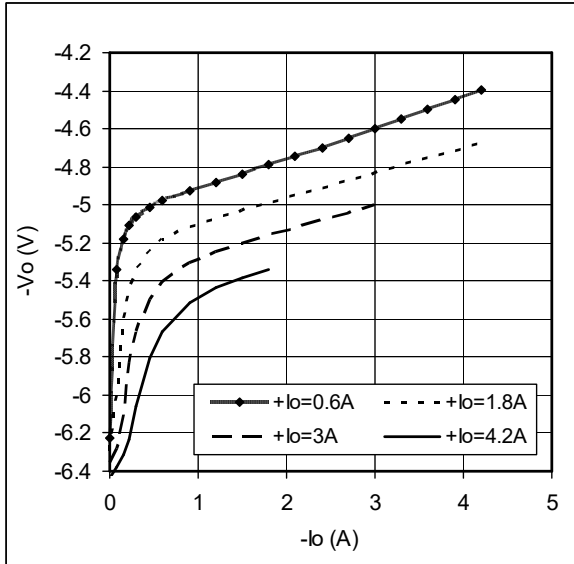
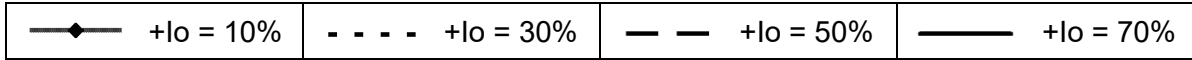
**Figure 7 – DVETR2812D**  
Efficiency (%) vs. Output Power (W)



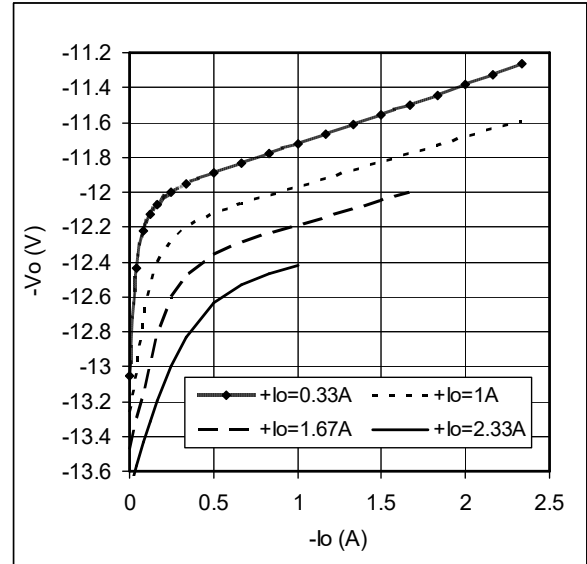
**Figure 8 – DVETR2815D**  
Efficiency (%) vs. Output Power (W)



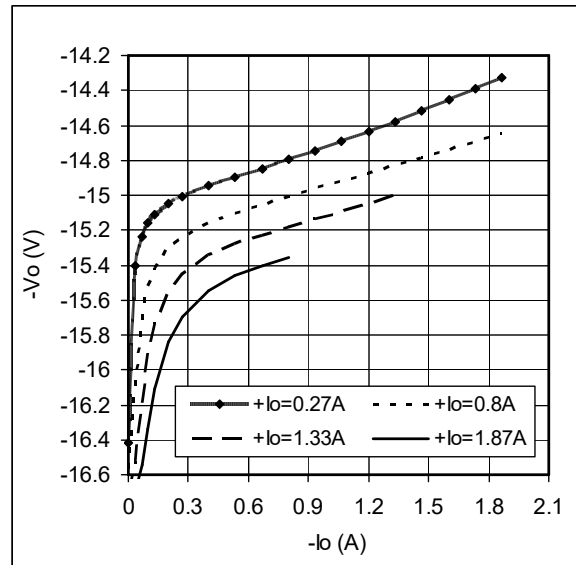
**CROSS REGULATION CURVES** ( $T_{CASE} = 25^{\circ}C$ , Full Load, Unless Otherwise Specified)



**Figure 9 – DVETR2805D**  
-Vout (V) vs. -Iout (A)



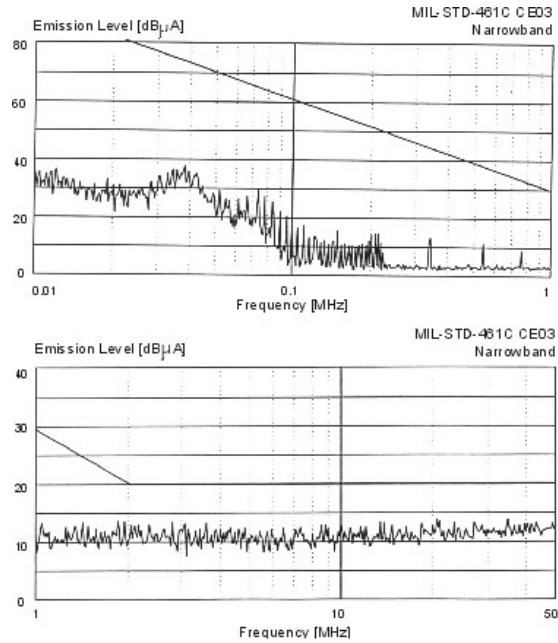
**Figure 10 – DVETR2812D**  
-Vout (V) vs. -Iout (A)



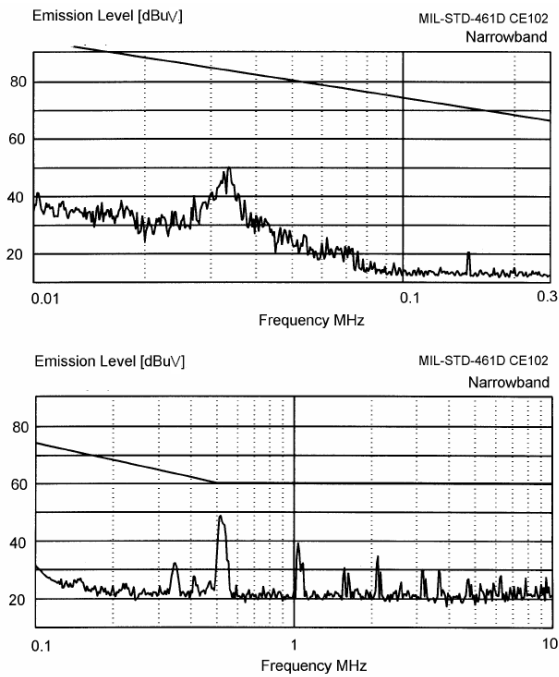
**Figure 11 – DVETR2815D**  
-Vout (V) vs. -Iout (A)

**EMI PERFORMANCE CURVES**

( $T_{CASE} = 25^{\circ}C$ ,  $V_{IN} = +28V \pm 5\%$ , Full Load, Unless Otherwise Specified)

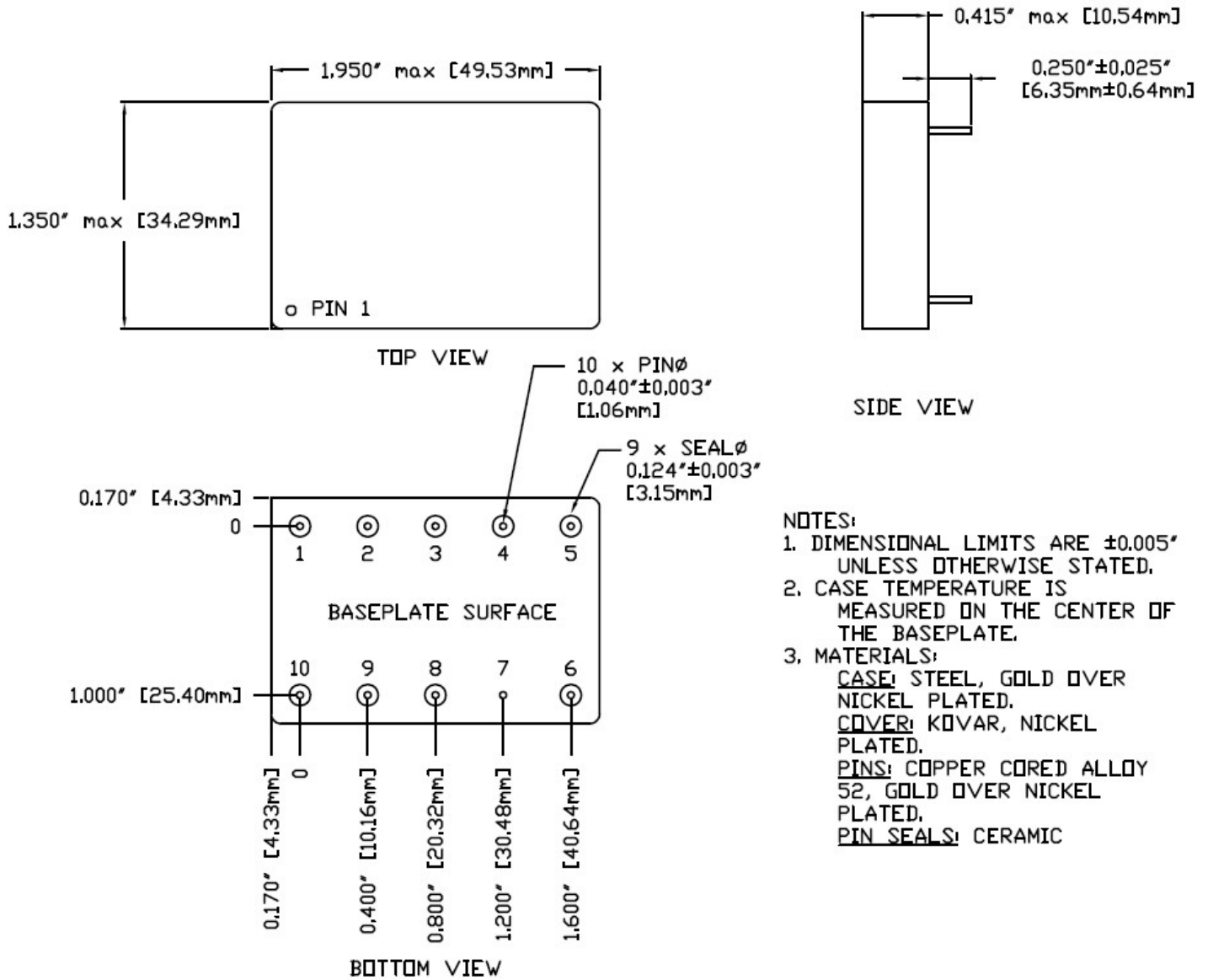


**Figure 12 – MIL-STD-461C  
DVETR2800D**



**Figure 13 – MIL-STD-461D  
DVETR2800D**

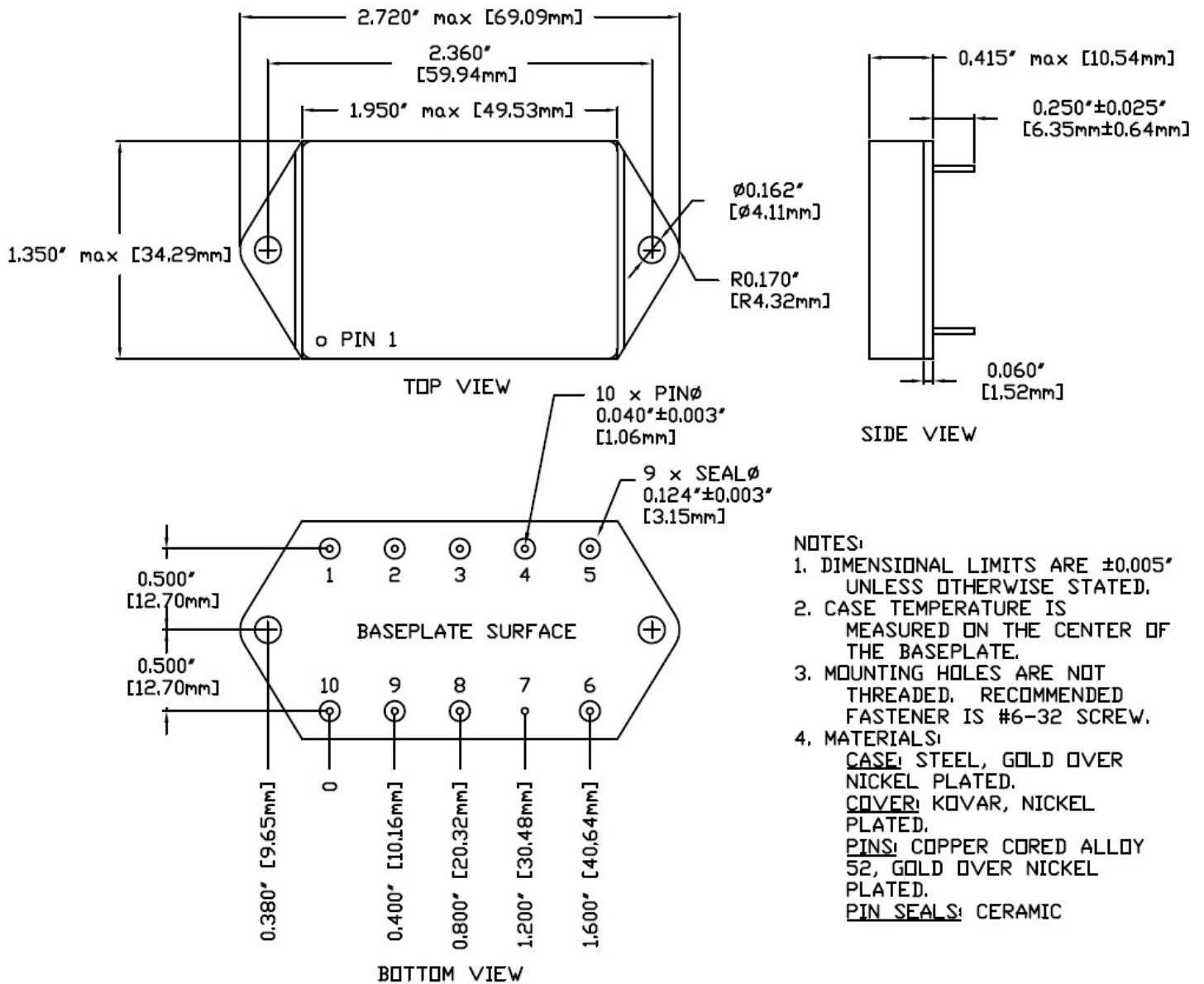
**PACKAGE SPECIFICATIONS (NON-FLANGED, SEAM SEAL)**



Pin	Function	Pin	Function
1	28V IN	6	N/C
2	N/C	7	CASE
3	+V OUT	8	INHIBIT
4	OUT COM	9	N/C
5	-V OUT	10	IN COM

Figure 14 – Non-Flanged, Seam Seal Package and Pinout

**PACKAGE SPECIFICATIONS (FLANGED, SEAM SEAL)**



- NOTES:**
1. DIMENSIONAL LIMITS ARE  $\pm 0.005"$  UNLESS OTHERWISE STATED.
  2. CASE TEMPERATURE IS MEASURED ON THE CENTER OF THE BASEPLATE.
  3. MOUNTING HOLES ARE NOT THREADED. RECOMMENDED FASTENER IS #6-32 SCREW.
  4. MATERIALS:  
CASE: STEEL, GOLD OVER NICKEL PLATED.  
COVER: KOVAR, NICKEL PLATED.  
PINS: COPPER CORED ALLOY 52, GOLD OVER NICKEL PLATED.  
PIN SEALS: CERAMIC

Pin	Function	Pin	Function
1	28V IN	6	N/C
2	N/C	7	CASE
3	+V OUT	8	INHIBIT
4	OUT COM	9	N/C
5	-V OUT	10	IN COM

**Figure 15 – Flanged, Seam Seal Package and Pinout**

## PACKAGE PIN DESCRIPTION

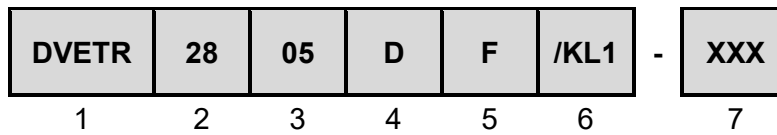
Pin	Function	Description
1	28V IN	Positive Input Voltage Connection
2	N/C	No Connection
3	+V OUT	Positive Output Voltage Connection
4	OUT COM	Output Common Connection
5	-V OUT	Negative Output Voltage Connection
6	N/C	No Connection
7	CASE	Case Connection
8	INHIBIT	Logic Low = Disabled Output. Connecting the inhibit pin to input common causes converter shutdown. Logic High = Enabled Output. Unconnected or open collector TTL.
9	N/C	No Connection
10	IN COM	Input Common Connection

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

Test	MIL-STD-883 Test Method, Condition	No Suffix (Standard) Non-QML <sup>5</sup>	/ES (Extended) Non-QML <sup>5</sup>	/H (Class H)	/KL1 Non-QML <sup>5,9</sup>
Non-Destructive Bond Pull	TM2023	• <sup>4</sup>	• <sup>4</sup>	• <sup>4</sup>	•
Internal Visual	TM2010, TM2017, TM2032 (MIL-STD-750, TM2072, TM2073)	•	•	•	•
Temperature Cycling	TM1010, Condition C -65°C to 150°C, Ambient			•	•
	TM1010, Condition B -55°C to 125°C, Ambient		•		
Constant Acceleration	TM2001, 3000g, Y1 Direction			•	•
	TM2001, 500g, Y1 Direction		•		
PIND <sup>7</sup>	TM2020, Condition A				•
Pre Burn-In Electrical	25°C				•
Burn-In	TM1015, 320 hrs, 125°C, Case Typ				•
	TM1015, 160 hrs, 125°C, Case Typ			•	
	96 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 <sup>3</sup>			•	•
	MIL-PRF-38534, Group A Subgroups 1 and 4 25°C	•	•		
Hermeticity (Seal)	TM1014, Fine Leak, Condition A2 or B1		•	•	•
	TM1014, Gross Leak, Condition C1 or B2		•	•	•
	Gross Leak, Dip (No Bomb), Visual Verification	•			
Radiography <sup>8</sup>	TM2012				•
External Visual	TM2009	•	•	•	•

- Notes:
- Contact Sales for more information concerning additional environmental screening and testing options desired.
  - 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.
  - 100% R&R testing with all test data included in product shipment.
  - Not required per MIL-PRF-38534. Test is performed for additional product quality assurance.
  - Non-QML products may not meet all requirements of MIL-PRF-38534.
  - Note intentionally not used.
  - PIND test Certificate of Compliance included in product shipment.
  - Radiographic test Certificate of Compliance and film(s) or data CD included in product shipment.
  - 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.

## ORDERING INFORMATION



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

(5) Package Option		(6) Screening Code <sup>1, 2, 3</sup>		(7) Additional Screening Code
None F	Non-Flanged Flanged	None /ES /H /KL1	Standard Extended Class H Class KL1	Contact Sales

- Notes:
1. Contact the VPT Inc. Sales Department for availability of Class H (/H) and KL1 (/KL1) 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. -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 requirement, source inspection, and/or special element evaluation for space or other higher quality applications.

## SMD (STANDARD MICROCIRCUIT DRAWING) NUMBERS

Standard Microcircuit Drawing (SMD)	DVETR2800D Series Similar Part Number
5962-1520901HXC	DVETR2805D/H
5962-1520901HXA	DVETR2805D/H-E
5962-1520901HYC	DVETR2805DF/H
5962-1520901HYA	DVETR2805DF/H-E
5962-1520902HXC	DVETR2812D/H
5962-1520902HXA	DVETR2812D/H-E
5962-1520902HYC	DVETR2812DF/H
5962-1520902HYA	DVETR2812DF/H-E
5962-1520903HXC	DVETR2815D/H
5962-1520903HXA	DVETR2815D/H-E
5962-1520903HYC	DVETR2815DF/H
5962-1520903HYA	DVETR2815DF/H-E

Do not use the DVETR2800D 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. SMD's 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 is for MIL-PRF-38534 Class H screening, standard gold plated lead finish, and no 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:

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**E-mail:** [vptsales@vptpower.com](mailto:vptsales@vptpower.com)

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