

## HIGH RELIABILITY HYBRID DC-DC CONVERTERS

### DESCRIPTION

The DVTR series of high reliability DC-DC converters is operable over the full military (-55 °C to +125 °C) temperature range with no power derating. Unique to the DVTR series are robust and effective input and output filters which provide dramatically reduced input and output noise performance when compared to other manufacturers competing devices. Operating at a nominal fixed frequency of 500 kHz, these regulated, isolated units utilize a high speed magnetic feedback design and well controlled undervoltage lockout circuitry to eliminate slow start-up problems.

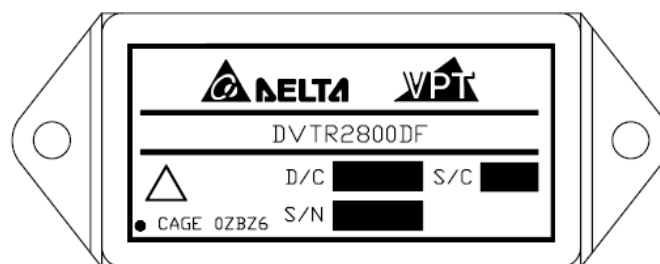
These converters are designed and manufactured in a facility qualified to ISO9001 and certified to MIL-PRF-38534 and MIL-STD-883.

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 or Solder Seal Hermetic Package
- High Power Density: > 40 W/in<sup>3</sup>
- Custom Versions Available
- Additional Environmental Screening Available
- Meets MIL-STD-461C and MIL-STD-461D EMC Requirements When Used With a DVMC28 EMI Filter
- Flanged and Non-flanged Versions Available.
- MIL-PRF-38534 Element Evaluated Components
- Space Applications should consider VPT's "S" Series of Radiation Tolerant Power Conversion Devices. Contact VPT for details.



**Figure 1 – DVTR2800D / DVTR2800DF DC-DC Converter**  
(Not To Scale)

SPECIFICATIONS ( $T_{CASE} = -55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ ,  $V_{IN} = +28\text{V} \pm 5\%$ , 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, $T_{CASE} = +125^{\circ}\text{C}$ )	13 Watts	Weight (Maximum) (Un-Flanged / Flanged)	(49 / 52) Grams

Parameter		Conditions	DVTR2805D			DVTR2812D			Units
			Min	Typ	Max	Min	Typ	Max	
STATIC									
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
Ripple Current		Full Load <sup>5</sup> , 20Hz to 10MHz	-	-	50	-	-	50	mA <sub>p-p</sub>
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	12.0	-	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>5,7</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>	73	-	-	78	-	-	%
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	450	550	400	450	550	kHz
SYNC FREQUENCY RANGE		V <sub>H</sub> – V <sub>L</sub> = 5V, DC = 20-80%	500	-	600	500	-	600	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 ( $T_{CASE} = -55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ ,  $V_{IN} = +28\text{V} \pm 5\%$ , Full Load<sup>5</sup>, 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 <sup>1</sup>	40 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, $T_{CASE} = +125^{\circ}\text{C}$ )	13 Watts	Weight (Maximum) (Un-Flanged / Flanged)	(49 / 52) Grams

Parameter		Conditions	DVTR2805D			DVTR2812D			Units
			Min	Typ	Max	Min	Typ	Max	
DYNAMIC									
Load Step Output Transient	±V <sub>OUT</sub>	Half Load to Full Load	-	-	400	-	-	450	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	-	300	600	-	500	900	mV <sub>PK</sub>
Line Step Recovery <sup>2, 4</sup>			-	300	500	-	300	500	μSec
Turn On Delay	±V <sub>OUT</sub>	V <sub>IN</sub> = 0V to 28V	-	-	20	-	-	20	mSec
Turn On Overshoot			-	-	25	-	-	50	mV <sub>PK</sub>

- 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  $135^{\circ}\text{C}$ .
  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  $-55^{\circ}\text{C}$ .

SPECIFICATIONS ( $T_{CASE} = -55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ ,  $V_{IN} = +28\text{V} \pm 5\%$ , 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, $T_{CASE} = +125^{\circ}\text{C}$ )	13 Watts	Weight (Maximum) (Un-Flanged / Flanged)	(49 / 52) Grams

Parameter		Conditions	DVTR2815D			Units
			Min	Typ	Max	
STATIC						
INPUT Voltage <sup>4</sup>		Continuous	15	28	50	V
		Transient, 1 sec	-	-	80	V
Current		Inhibited	-	-	6	mA
		No Load	-	-	90	mA
Ripple Current		Full Load <sup>5</sup> , 20Hz to 10MHz	-	-	50	mA <sub>p-p</sub>
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>5,7</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>	79	-	-	%
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	450	550	kHz
SYNC FREQUENCY RANGE		V <sub>H</sub> – V <sub>L</sub> = 5V, DC = 20-80%	500	-	600	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 ( $T_{CASE} = -55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ ,  $V_{IN} = +28\text{V} \pm 5\%$ , Full Load<sup>5</sup>, 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 <sup>1</sup>	40 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, $T_{CASE} = +125^{\circ}\text{C}$ )	13 Watts	Weight (Maximum) (Un-Flanged / Flanged)	(49 / 52) Grams

Parameter		Conditions	DVTR2815D			Units
			Min	Typ	Max	
DYNAMIC						
Load Step Output Transient	±V <sub>OUT</sub>	Half Load to Full Load	-	-	500	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	-	500	900	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. 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.

## BLOCK DIAGRAM

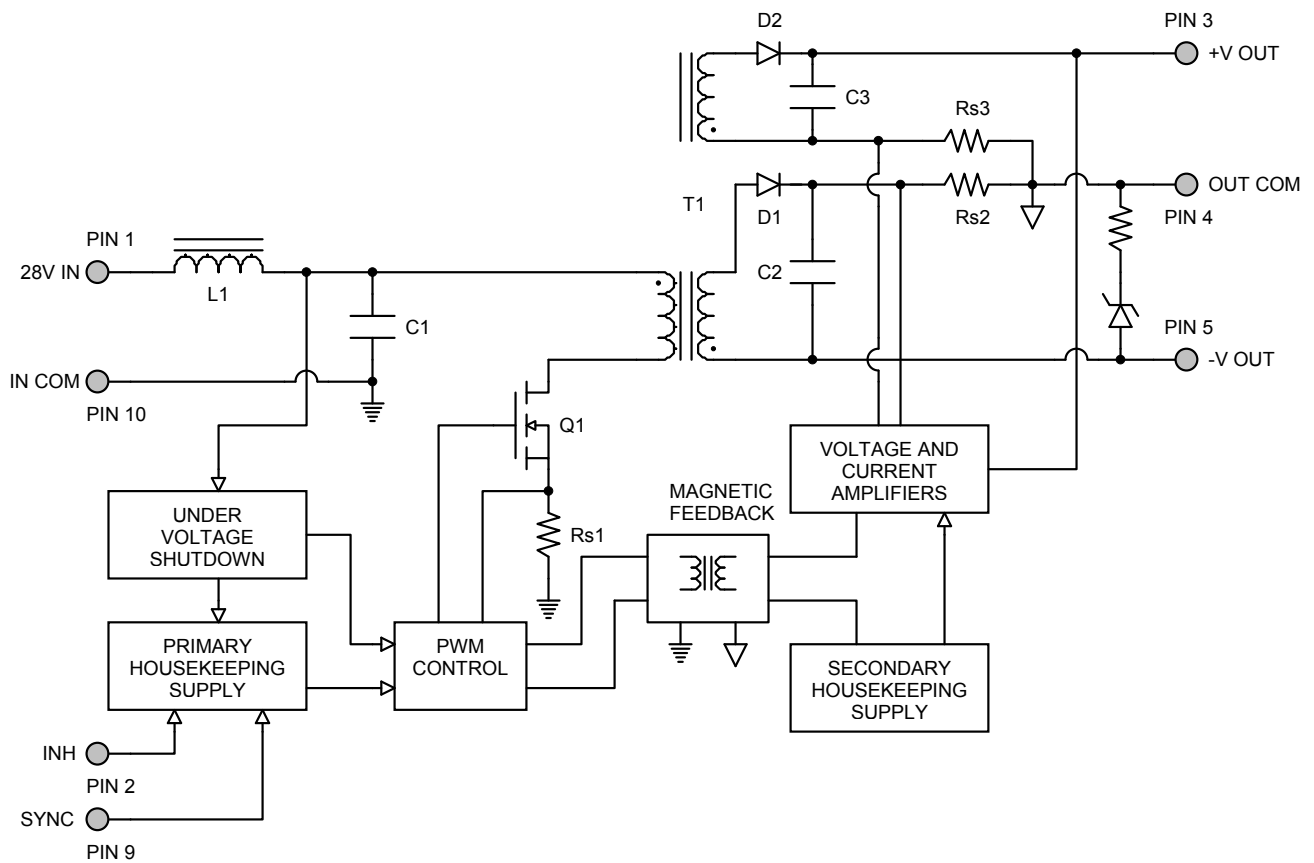


Figure 2

## CONNECTION DIAGRAM

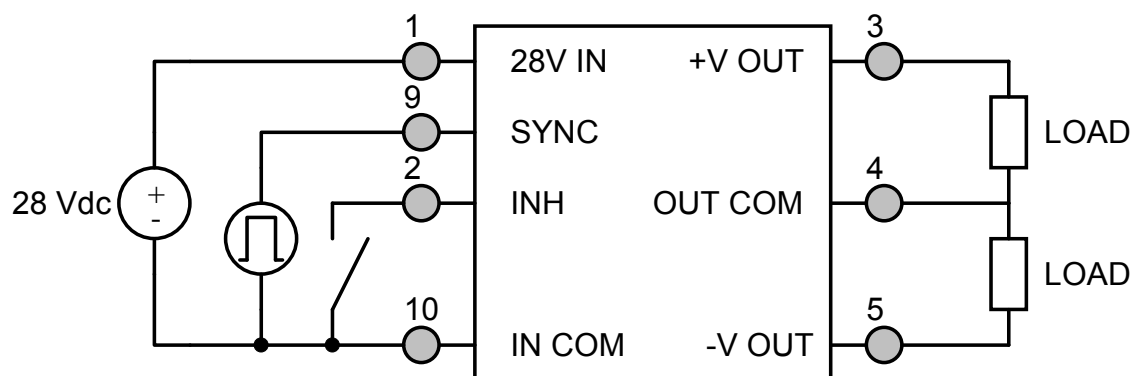


Figure 3

28V IN 1

10K

INH 2

BIAS

OPTIONAL CAPACITOR

IN COM 10

12V

28V IN 1

10K

INH 2

BIAS

OPTIONAL CAPACITOR

12V

IN COM 10

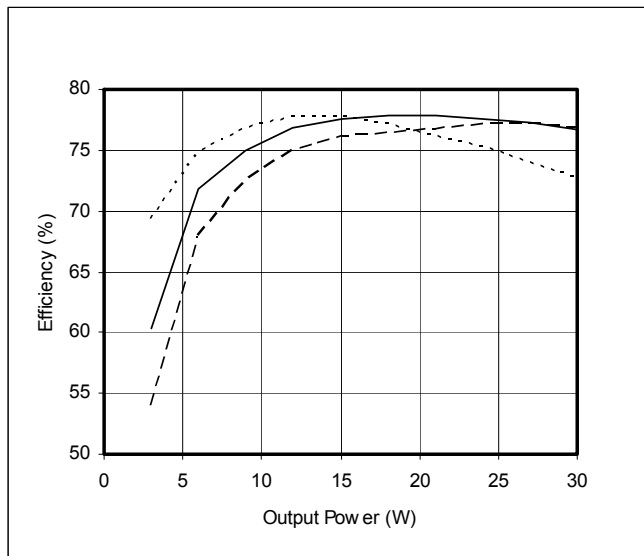
OPTOISOLATOR

[illegible]

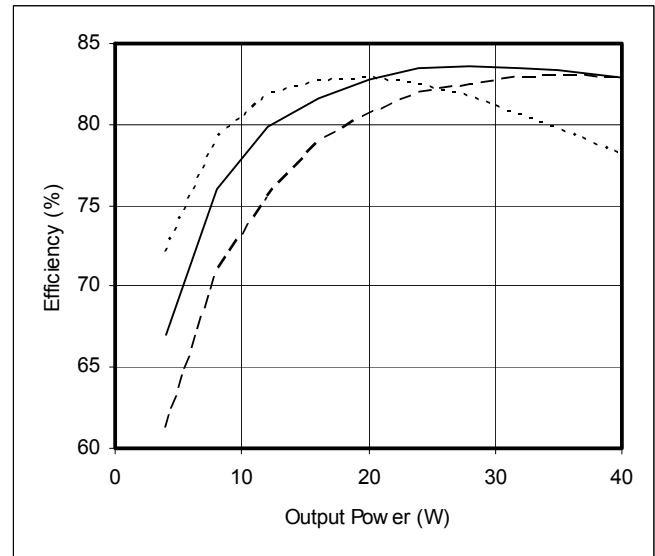
7

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

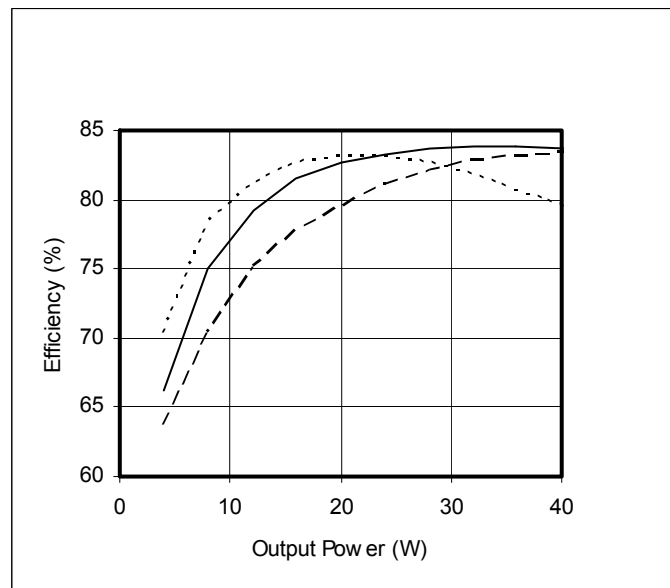
----- $V_{IN} = 16V$	———— $V_{IN} = 28V$	----- $V_{IN} = 40V$
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**Figure 7 – DVTR2805D**  
Efficiency (%) vs. Output Power (W)



**Figure 8 – DVTR2812D**  
Efficiency (%) vs. Output Power (W)



**Figure 9 – DVTR2815D**  
Efficiency (%) vs. Output Power (W)



## EMI PERFORMANCE CURVES

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

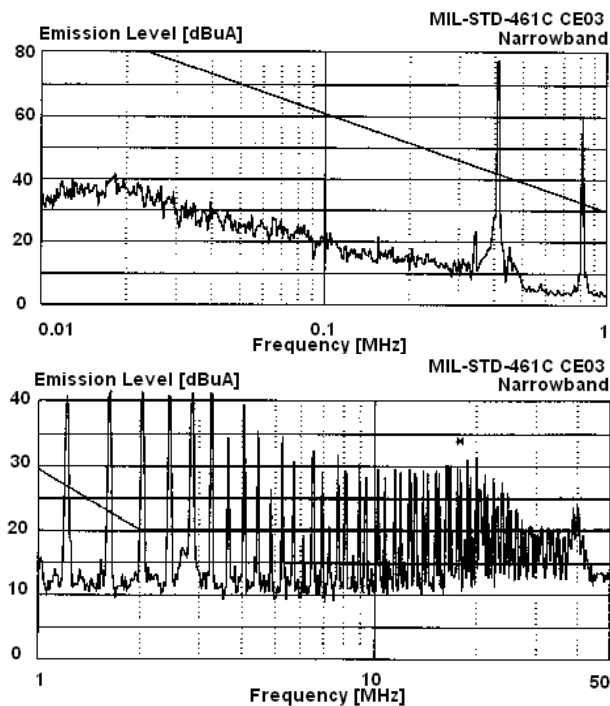


Figure 10 – DVTR2800D without EMI Filter

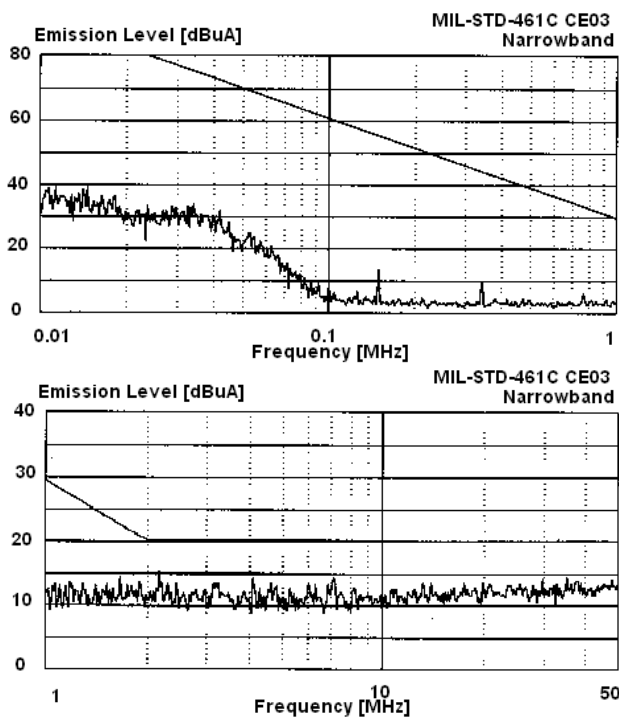
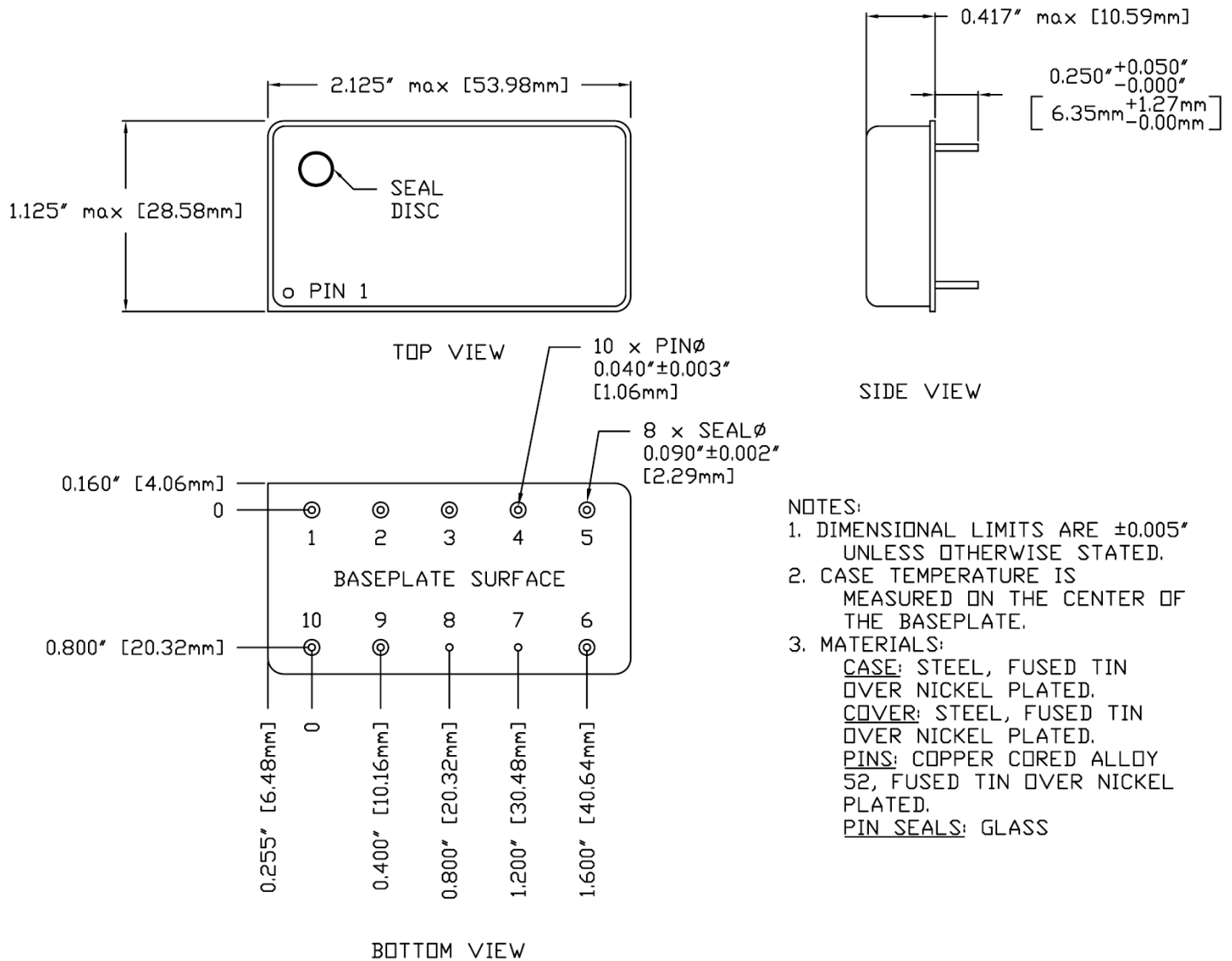


Figure 11 – DVTR2800D with EMI Filter

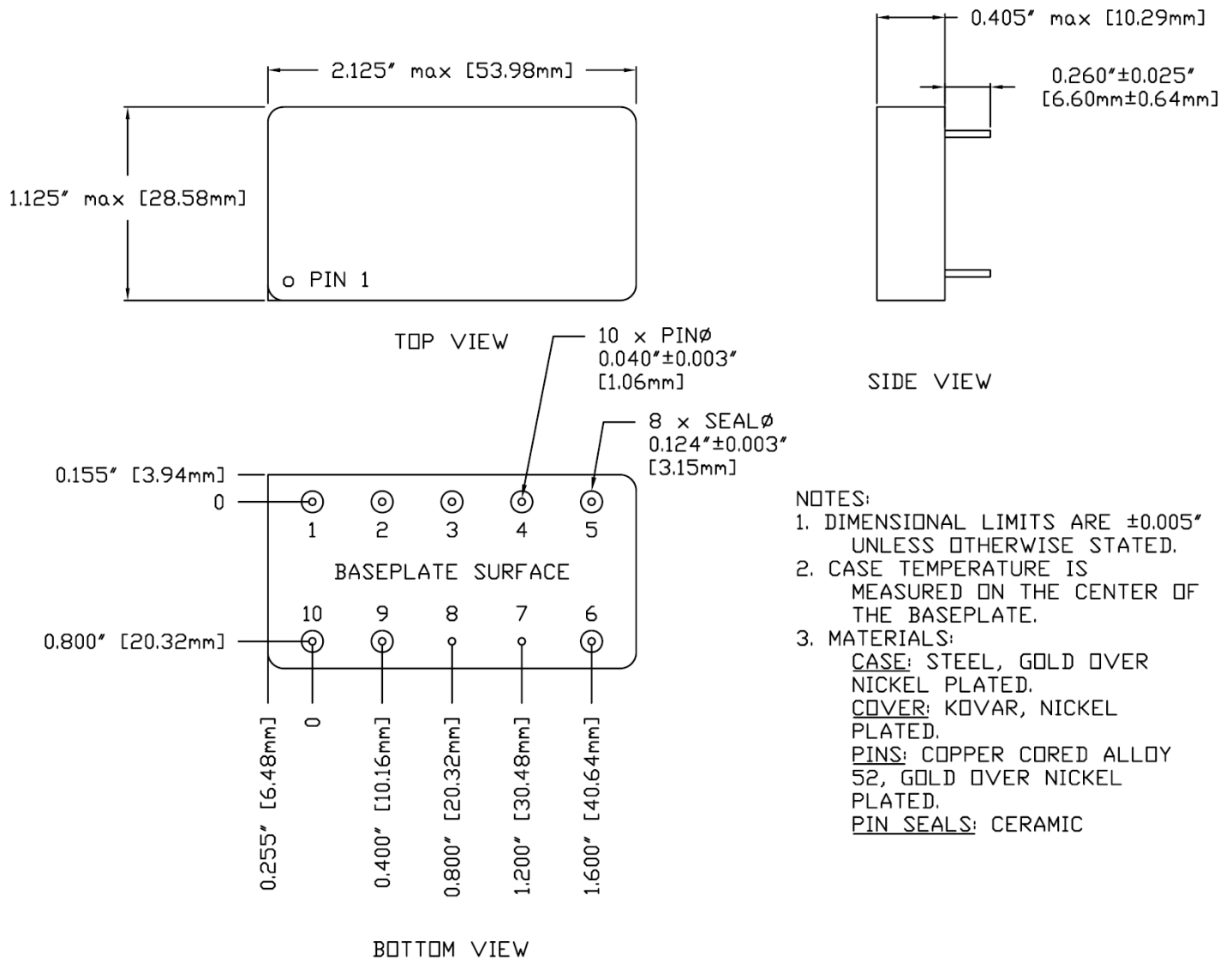
## PACKAGE SPECIFICATIONS (NON-FLANGED, SOLDER SEAL)



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 12** – Non-Flanged, Solder Seal Package and Pinout (Not Used for /HB or Higher Screened Products)

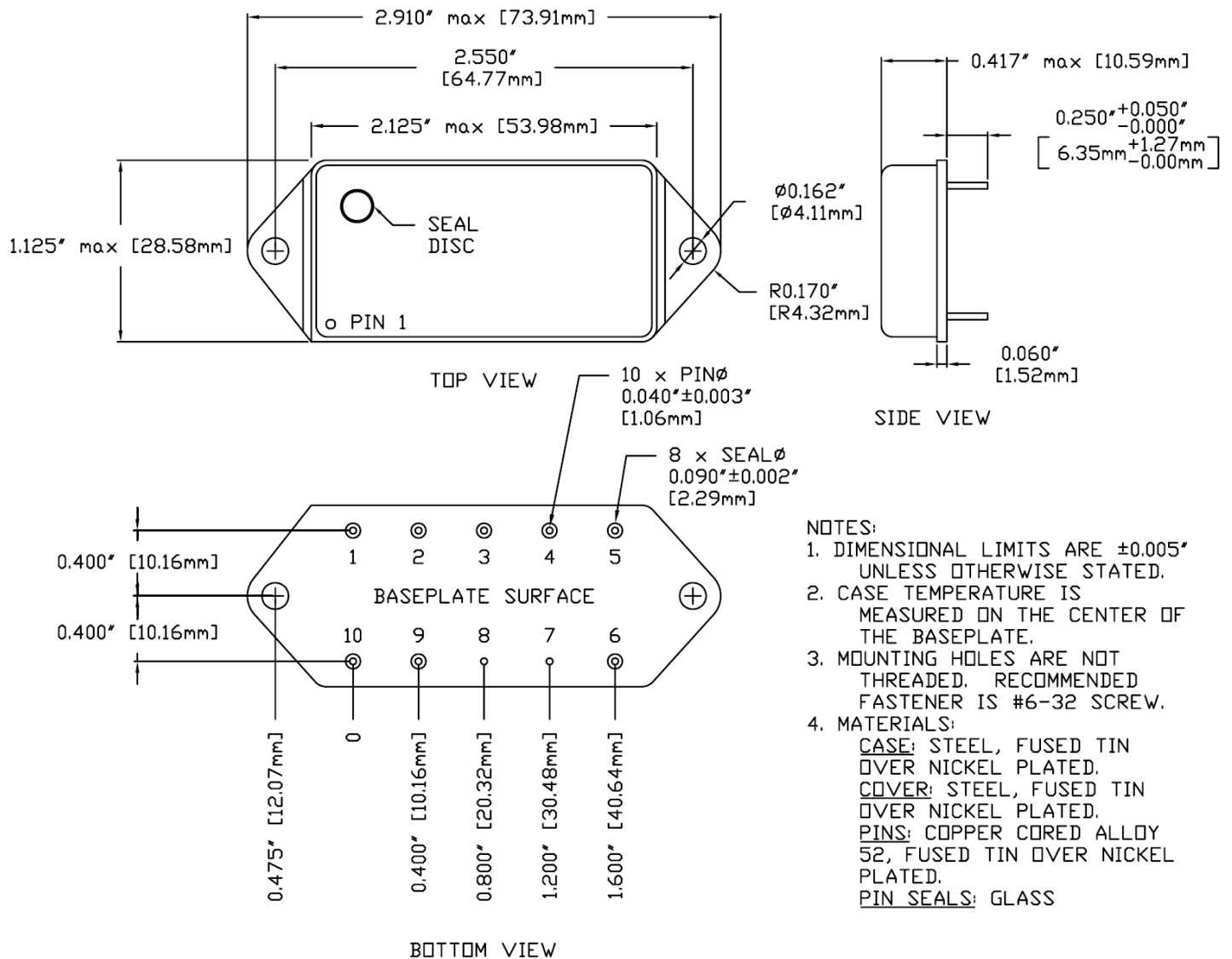
## PACKAGE SPECIFICATIONS (NON-FLANGED, SEAM SEAL)



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 13** – Non-Flanged, Seam Seal Package and Pinout

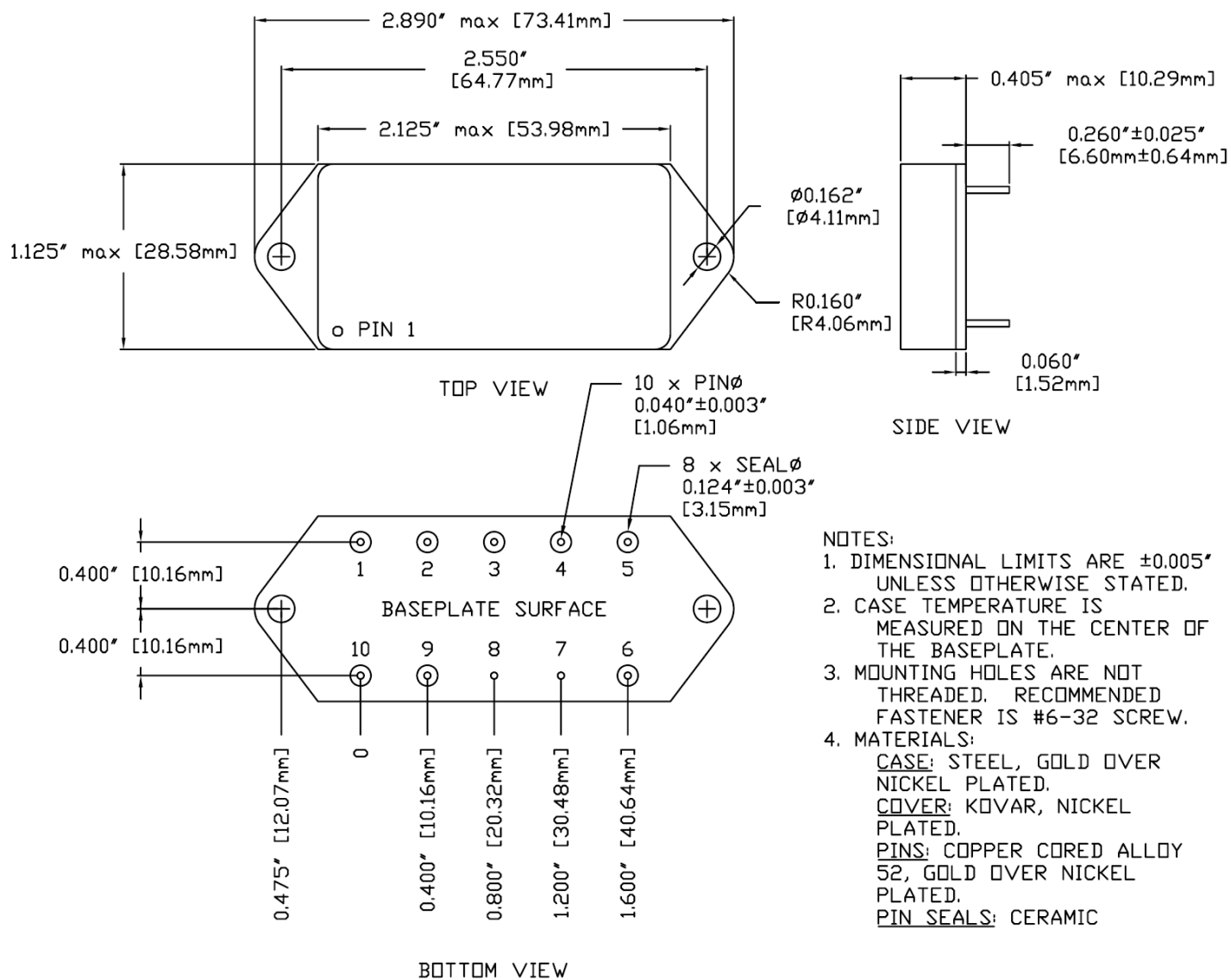
## PACKAGE SPECIFICATIONS (FLANGED, SOLDER SEAL)



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 14** – Flanged, Solder Seal Package and Pinout (Not Used for /HB or Higher Screened Products)

## PACKAGE SPECIFICATIONS (FLANGED, SEAM SEAL)



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 15** – Flanged, Seam Seal 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	Standard (No Suffix)	Extended /ES	HB /HB	Class H /H	Class K /K
Non-Destructive Bond Pull	Method 2023	•	•	•	•	•
Internal Visual	Method 2017, 2032 Internal Procedure	•	•	•	•	•
Temperature Cycling	Method 1010, Condition C Method 1010, -55°C to 125°C		•	•	•	•
Constant Acceleration	Method 2001, 3000g, Y1 Direction Method 2001, 500g, Y1 Direction		•	•	•	•
PIND	Method 2020, Condition A <sup>2</sup>					•
Pre Burn-In Electrical	100% at 25°C					•
Burn-In	Method 1015, 320 hours at +125°C Method 1015, 160 hours at +125°C 96 hours at +125°C 24 hours at +125°C	•	•	•	•	•
Final Electrical	MIL-PRF-38534, Group A <sup>1</sup> 100% at 25°C	•	•	•	•	•
Hermeticity	Method 1014, Fine Leak, Condition A Method 1014, Gross Leak, Condition C Dip (1 x 10 <sup>-3</sup> )	•	• •	• •	• •	• •
Radiography	Method 2012 <sup>3</sup>					•
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. Radiographic test Certificate of Compliance and film(s) included in product shipment.

## ORDERING INFORMATION

<b>DVTR</b>	<b>28</b>	<b>05</b>	<b>D</b>	<b>F</b>	<b>/HB</b>	-	<b>XXX</b>
1	2	3	4	5	6		7

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

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

- Notes:
1. Contact the VPT Inc. 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.

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**

<b>Standard Microcircuit Drawing (SMD)</b>	<b>DVTR2800D Series Similar Part Number</b>
*T.B.D.	DVTR2805D/H DVTR2805DF/H
*T.B.D.	DVTR2812D/H DVTR2812DF/H
*T.B.D.	DVTR2815D/H DVTR2815DF/H

Do not use the DVTR2800D 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 DSCC website at <http://www.dscclia.mil/programs/smcr/>. 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.

**CONTACT INFORMATION**

To request a quotation or place an order 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](mailto:vptsales@vpt-inc.com)

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