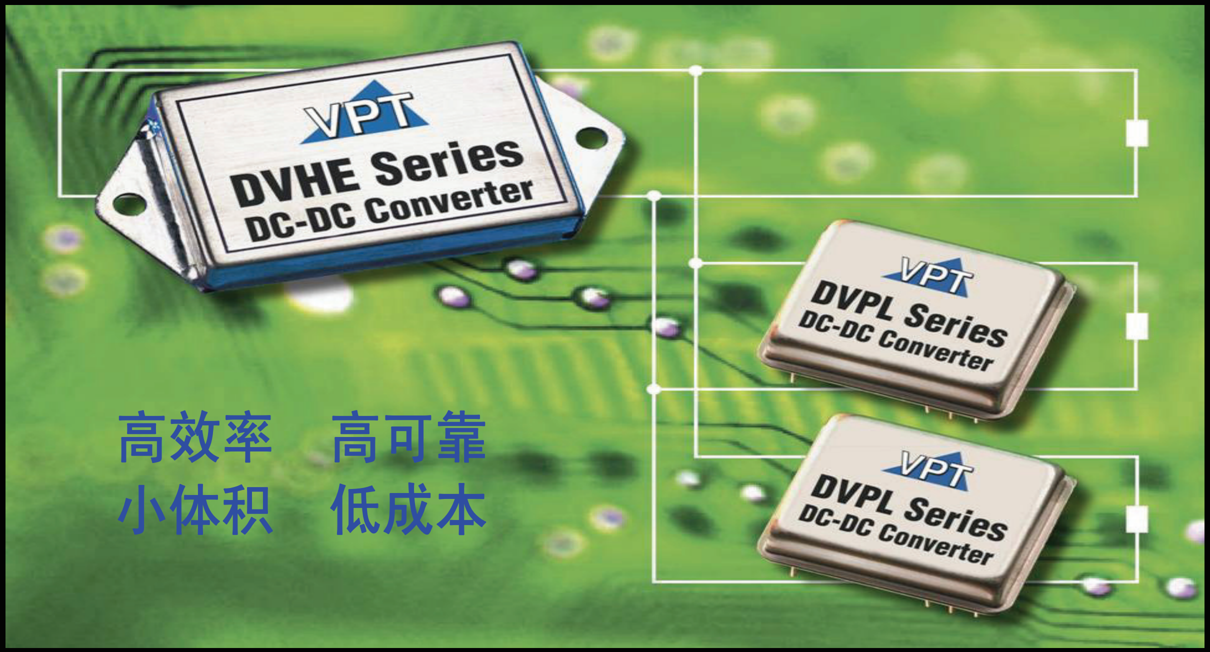
HERO 负载点供电系统



HERO 系统是专为低电压供电需求设计的高转换效率、高可靠性的电源系统，其由 DVHE 系列 DC-DC 电源模块和 DVPL 系列负载点非隔离 DC-DC 电源模块组成，其中 DVHE 系列及 DVPL 系列也可以分别单独使用。

DVHE 系列 DC-DC 电源模块是标准的密封金属封装模块，尺寸是上一代标准尺寸的 66%。使用 DVHE 电源模块给多个低电压器件供电可避免使用多个低压 DC-DC 转换器，可节省模板空间和降低成本。

- 单路输出电压：1.9V，2.5V，3.3V，5V
- 宽输入电压范围：16V-40V，瞬态 50V
- 高达 50W 的输出功率，效率超过了 90%
- 工作温度：-55℃- +125℃

DVPL 负载点模块是世界上第一款满足 MIL-PRF-38534 规范、采用厚膜工艺、全军温范围工作的密封金属封装低压差电源转换器。

- 输入电压：3.0-5.5V 和 4.5-5.5V 两款
- 效率典型值：95%
- 输出电流：5A 和 10A 两款
- 输出电压可调：0.8V-3.3V
- 工作温度：-55℃- +125℃

600V 浪涌、反向保护的 EMI 滤波器

VPTi10-28 滤波器内置有 EMI 滤波器、瞬态电压保护功能及反向电压保护功能，六面体全金属封装。

- 电压输入：-40V – +40V；
- 输出电压 0-40V，最大输出电流 10A；最大输出功率 200W；
- 真正的输入电压反接保护；
- 瞬态电压满足 MIL-STD-704 及 MIL-STD-1275 要求，最高可达 600V；
- 工作温度：-55° C – +100° C；

升压功能、6V～600V 浪涌的调理模块

VPTPCM-12 电压调理模块是为扩展 VPT 电源模块输入电压范围和提高瞬态电压能力的调理模块。

- 输入电压：9-40V
- 输出电压 17-40V，最大输出功率 120W；
- 瞬态电压：满足 MIL-STD-704 及 MIL-STD-1275 要求；最低 6V，最高可达 600V；
- 效率高达 99%
- 工作温度：-55° C – +100° C；

270V-28V 效率高达 91%的 DC-DC 总线转换模块

VPTHVM-270 是一款全金属封装的隔离调控的总线转换模块，能够将 DC270V 输入转为 DC28V 输出，继而为后面的 VPT 系列和 DV 系列的模块供电。最多可并联 5 片使用，功率最高可达 1000W；

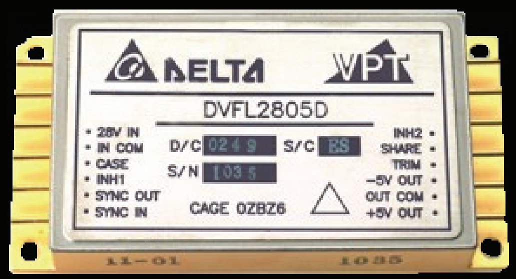
- 宽范围的输入电压，180V-350V；高瞬态：500V，1sec；低瞬态：160V，1sec；
- 磁反馈隔离，不使用光耦；
- 输出电压 DC28V，输出功率可达 200W；
- 工作温度：-55 ℃-100℃；

100W 功率，效率高达 91%的 DC-DC 电源模块

VPT100-2800系列是一款高可靠性、高效率、低成本的DC-DC电源模块，其采用同步整流设计，磁反馈，无光耦合。该模块可并联使用以获得更高的功率。

- 输入电压：16～40V
- 单路、双路输出，电压可调（+10%～-20%）
- 具有输入欠压锁止、输出限流和短路保护功能
- 六面全金属封装
- 工作温度：-55 ℃-100℃

DVFL2800 系列

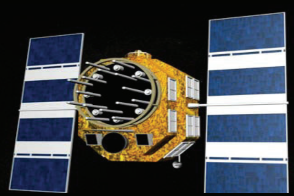


✧ 30W～120W 范围输出功率

✧ 具有较强抗辐照能力

✧ 可并联使用至 500W 输出功率

- 输入电压：16～40V
- 单路、双路输出，电压可调（+10%～-20%）
- 最大输出功率 120W
- 高功率密度：〉80 W/in3
- 精密焊接密封封装
- 具有输入欠压锁止，输出限流和短路保护功能，并可自行恢复



Catalogue
目　录

第一卷　军用 COTS 系列

表面贴装工艺、金属封装

Tcase＝ －55～＋100℃

适用范围：航空及各类军事领域；

注：其他应用说明请参见一鉴天公司网站

第二卷 混合厚模 DV 系列

厚膜工艺、全密闭充氮气金属封装
Tcase = －55～＋125℃
适用范围：航空、航天及各类军事领域；

注：其他应用说明请参见一鉴天公司网站

VPT 公司简介

- **关键时刻的创新电源产品**

VPT 公司为军事、航空和太空应用提供高密度、小体积、轻重量的 DC-DC 转换器，EMI（电磁干扰）滤波器和其他电源产品。通过与世界上最大的商业电源供应制造商 Delta 电子合作，VPT 以最好的质量认证、合理的价格，在最短的时间内为客户提供专利电源方案。

- **军事、航空和太空的认证电源方案**

不管在地面、空中、或太空，VPT 产品专为所需场合而设计。VPT 严格按照工业标准，在通过 MIL-PRF-38534 性能技术规范和 ISO9001 国际标准质量体系认证的设备中制造电源产品。

每天，包括 NASA（美国国家航空和宇宙航行局），Lockheed Martin, Boeing, Raytheon, the United States Air Force 在内的许多重要机构都依赖于 VPT 的高可靠性电源系统。

- **合理的价格，快速的交货**

VPT 标准产品通常是被提前生产好摆放在货架上，时刻准备着出货。高效的生产与货架成品相结合保证客户以可负担的价格快速收到所需产品。

- **先进的技术，产品和服务**

VPT 设计团队汇聚了本行业中最为推崇的电源供应创新者。在每个产品中，客户都能享受满足规格要求的尖端技术。

➢ **厚膜混合军事/航空转换器和滤波器**

在航行器、导弹系统、人造卫星以及更多的应用场合中，这种系列的 DC-DC 转换器和 EMI 滤波器随时都可用于飞行。执行关键任务时，每个创新产品都能保证压力环境下的可靠性和最优化性能。产品有多个筛选级供选择以确保应用的相配性，包括强辐射的太空环境。在最轻的密封包装下，VPT 先进的厚膜混合芯片以及线路技术传输可能的最大功率密度。

➢ **军事合格产品**

通过 VPT，在更短的时间内客户可以获得价格更便宜的合格军用产品。VPT 能够提供哥伦布国防供应中心(DSCC)合格制造商名单(MIL-PRF-38534,混合微型电路，FSC-5962）上的产品。这个名单将持续扩大。所以请联系 VPT 索取最新的标准军事制图资料。

➢ **军事/航空密封商用货架产品**

与其他大多数密封商用成品模块不同，VPT 的商用成品模块为满足独特的军事环境而专门设计，具有一些独特的特征，如扩大的温度范围,28V 和 270V 总线最优化，和一个全面的军事标准输入电压范围。VPT 商用密封货架产品可为耐震便携式电脑，导弹系统，非飞行用关键设备或基于地面的军事机动车提供在成品上可负担的电源

转换方案。

创新的技术•快速的货运•合理的方案•认证的质量

➢ **面向太空挑战的电源产品**

VPT 标准混合式转换器是经过在最终的太空环境中得以证实的可靠产品。通过与固有的抗辐射部件结合设计，所有的产品都能通过辐射测试，包括总剂量和单粒子翻转。对于额外的资格认证，产品可按照 MIL-PRF-38534H 级或特定需求，太空可靠性终端应用而定制。

➢ **来自研究太空电源应用专家的人造卫星电源系统**

VPT 可设计功率高达 650Watts 定制的人造卫星电源系统。具备了在辐射环境进行产品设计的丰富经验，VPT 可提供专业的技术指导和生产设备以帮助客户的太空任务快速飞离地面。

➢ **快速，经济的系统集成**

VPT 可提供具有完整外部控制电路及接口的电源子系统的专家集成。

附：采用 VPT 电源产品的部分项目名单

航空(Aircraft)

- Airbus A380
- ALR-56
- Apache Helicopter
- Blackhawk
- Boeing 737,757&777,7E7
- Canadair
- C-17
- CH-53
- CL289 DRONE
- F-15,F-16,F-18,F-22,F-35
- Falcon 900
- Fokker
- Gulfstream
- Harrier
- Hercules C-130
- Jaas-39 Grippen
- Lynx
- Mini-Armor
- NH-90
- Predator
- SAR
- Tomahawk
- Tornado
- WAH-64 HUMS

陆地机动车(Terrestrial Vehicles)

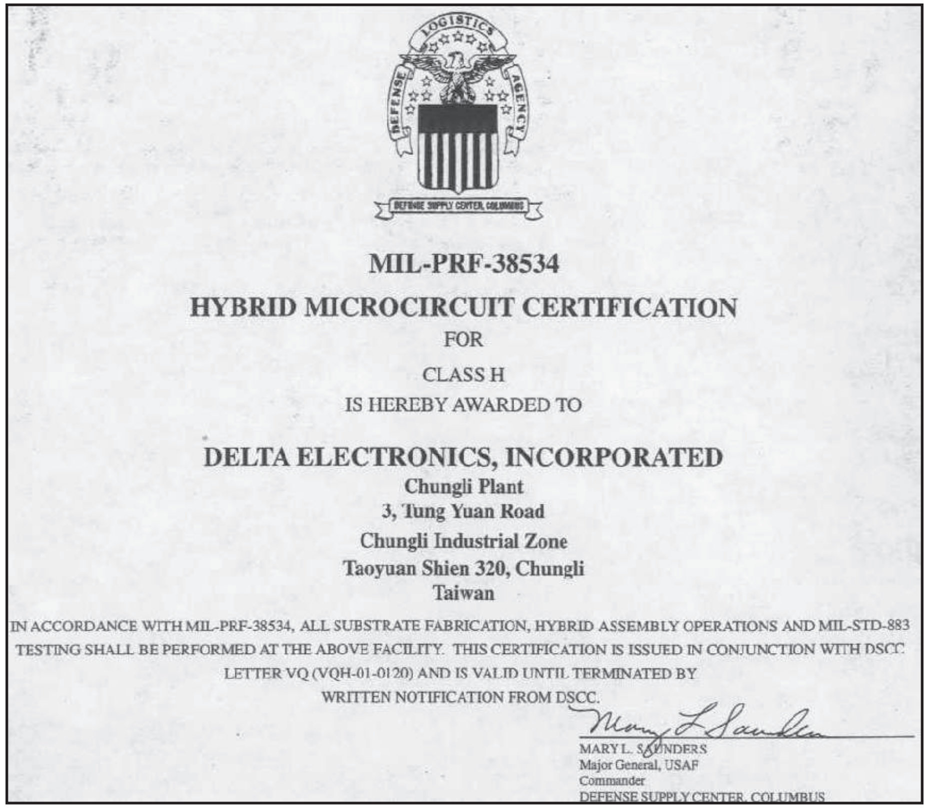
- Abrhanms Tank
- Crusader
- Lance
- Leopard
- Raven II
- Sealaunch
- Trojan
- US Army LAV
- Virginia Class Submarine
- SeaWolf Class Submarine
- Warrior

太空（Space）

- AISAT
- Alpha SAT
- Contour Satellite
- DAWGSTAR
- FY Series Meteorological SATS
- FAISAT
- ICU
- GPM
- GPS
- HokieSAT
- INSAT
- Triana（GORESAT）
- SCISAT
- SDO
- Space Shuttle Experiments
- Space Station
- Venus Express Satellite
- WFCA
- X-33 & X-37
- GPSIII
- GPSIIF
- GPS IIRM

导弹(Weapons)

- ACES
- Advanced Targeting Pod
- AMRAAM
- ATACMS 2000
- ATGM(Anti Tank Guided Missile)
- BMD(Ballistic Missile Defense System)
- IRIS T
- Meteor-W
- PAC-3
- Stinger Missile
- Tactical Tomahawk
- THAAD
- Tomahawk
- Tracer
- GPSIII



DEFENSE LOGISTICS AGENCY

DEFENSE SUPPLY CENTER, COLUMBUS

MIL-PRF-38534

HYBRID MICROCIRCUIT CERTIFICATION

FOR

CLASS H

IS HEREBY AWARDED TO

DELTA ELECTRONICS, INCORPORATED

Chungli Plant

3, Tung Yuan Road

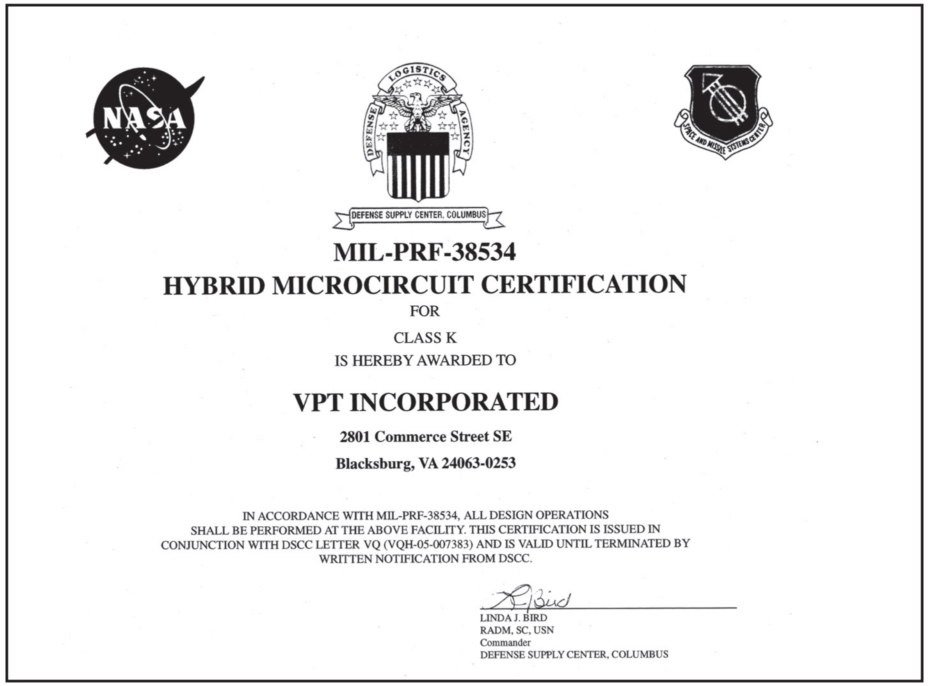
Chungli Industrial Zone

Taoyuan Shien 320, Chungli

Taiwan

IN ACCORDANCE WITH MIL-PRF-38534, ALL SUBSTRATE FABRICATION, HYBRID ASSEMBLY OPERATIONS AND MIL-STD-883 TESTING SHALL BE PERFORMED AT THE ABOVE FACILITY. THIS CERTIFICATION IS ISSUED IN CONJUNCTION WITH DSCC LETTER VQ (VQH-01-0120) AND IS VALID UNTIL TERMINATED BY WRITTEN NOTIFICATION FROM DSCC.

MARY L. SAUNDERS
Major General, USAF
Commander
DEFENSE SUPPLY CENTER, COLUMBUS



NASA

DEFENSE LOGISTICS AGENCY

DEFENSE SUPPLY CENTER, COLUMBUS

MIL-PRF-38534

HYBRID MICROCIRCUIT CERTIFICATION

FOR

CLASS K

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VPT INCORPORATED

2801 Commerce Street SE

Blacksburg, VA 24063-0253

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LINDA J. BIRD
RADM, SC, USN
Commander
DEFENSE SUPPLY CENTER, COLUMBUS

军用 COTS 系列产品简介

具有挑战性的商务货架产品

军方及其他高可靠性系统的设计师们都始终面临着降低成本和压缩调试时间的压力，根据美国国防部的《商务货架产品指示》，有效解决其问题的主要方法之一就是在军事标准及规范之前，用更好的切实可用的商务程序、标准、器件及部件来等替代。COTS 或者商务货架产品能提供最新技术，最短开发周期以及更低成本的产品。它是在不牺牲系统操作性与可靠性前提下，为避免系统缺陷的最有效办法。

VPT 系列的商务货架（COTS） DC-DC 转换器与 EMI 滤波器提供了一个无需降低性能及可靠性要求的低成本电源需求的解决方案。从高可靠性应用的设计角度出发，通过使用低成本的器件和坚固的集成封装技术，VPT 系列产品在设计上融合被实际应用证实的特性和性能。

被验证过的设计封装

在不降低系统可靠性以及总成本增加的基础上，降低设计封装成本的支出是很有必要的。VPT 系列正是通过大量高可靠性验证设计成功，从而使性能与可靠性达到最优组合的系列产品。基于 MIL-PRF-38534 这一标准的产品线，所生产的产品应用于太空、航空宇宙、卫星地面等众多领域，而 VPT 系列的电源设计不仅基于可靠性，更提供众多类似的产品功能及内在回路设计。

最初的 VPT 系列 DC-DC 产品包含的输出功率为 5，15，30，100W，输出电压 3.3，5，12，15，±5，±12，±15，28V 标准输入电压。另外还提供 EMI 滤波器，输入瞬间保护并且扩大了输入电压范围。

像 MIL-STD-704 和 MIL-STD-1275 这些普通军品级功率标准要求一个较宽的输入电压范围，通常包含瞬时电压。低端工作电压和高端瞬时电压要求优于 18 到 36V 商务 DC-DC 模块的性能。VPT 系列主要使用反馈技术及最优的布局结构，这些产品使用简单、性能可靠，已被用户广泛使用，而且这些产品能提供一个宽的输入电压范围，见表 1。工作电压从 15 或 16V 到 40 或 50V，并且瞬态输入电压达到 50 或 80V，这就意味着 DC-DC 转换器可以适合很多的输入功率需求。配件 VPT 系列前置模块，在工作电压下降到 6V、高达 100V 的长持续时间的瞬态电压及达到 600V 的尖峰脉冲电压情况下同样可以适用。

表 1，DC-DC 转换器拓扑结构

Table 1. DC-DC Converter Topologies

Series	Topology	Input Voltage Range	Input Voltage Transient
VPT5	Flyback	15 to 50V	80V
VPT15	Flyback	15 to 50V	80V
VPT30	Flyback	15 to 50V	80V
VPT100	Forward	16 to 40V	50V

VPT 系列也可以简化 EMC（电磁兼容性）的要求。使用内部 L-C 滤波器固定频率的设计提供了更低的输入电流纹波和更低的输出电压纹波噪声。所有的 VPT 系列装置应用标准六边形金属封装，减少了辐射发射和辐射敏感度，并且 VPT 系列 EMI 滤波器模块为传导发射和传导敏感度符合 MIL-STD-461C/D/E 标

准做好了准备。滤波器参数见表 2，这些滤波器具有最小的额定电流。不同的转换器组合，只要滤波器的额定电流没有超出范围，输出功率和输入电压都是可以允许的。一个单独的滤波器可以驱动成倍增加的转换器。

Table 2. Filter Recommendations

System output power (Watts)	Recommended Filter	Rated Current (Amps)
15	VPTF1-28	1.0
45	VPTF3-28	3.0
For higher power levels consult the factory.		

标准化特性使得 VPT 的 DC-DC 转换器可以很容易地综合到任何一个系统中，包括：使用抑制开关控制器提供可靠的功率。在输入电压范围内的闭锁输出输入，软启动消除了模块在关闭和开启条件下的电流尖峰，提供了一个没有过压输出的控制良好的启动顺序。输出电压的修整能力允许输出被调节到各种非标准的电压；调节范围一般为-20%到+10%。为了高输出功率模块的补偿，遥测管脚、线路或者连接器压降并改善输出。过流和短路保护将在发生错误时保护转换器和相邻的部分、线路。固定频率设计减少和 PF 系统的兼容性问题的机会。一个在一些模块上的频率同步输入允许在一个外置精确控制纹波频率。

更低成本以及坚固耐用的组装

低成本与坚固的封装技术所达到的高性能和高可靠性恰恰反应了 VPT 产品系列的独特性。VPT 产品装配是采用表面安装的高度自动化技术，在一个多层印刷板上集成了使用平面磁性元件的电源和控制电路，如图 1，其使用的元器件为商业或工业级，包括片状元器件及塑封半导体器件。

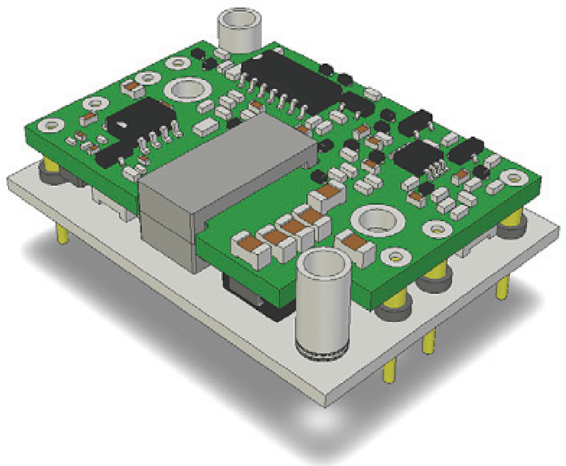


Figure 1.Single board construction integrates power and control circuitry with planar magnetics

图一：集成了使用平面功率磁性元件的电源和控制线路的单块基板

单块基板结构减少了装配步骤、降低了材料成本及电路相互间连接，它与多层基板设计相比增加了低功率模块的可靠性。完整的平面磁性元件减少了线路的复杂性、连接终端和焊接点，消除了飞线，同时保持了一个较低的轮廓，降低了漏电感与关联损耗，提高了线路效率。

线路板和元器件被涂上一层氨基甲酸聚合树脂，从而保护模板免受湿气，解决了塑料微电路长期失效的问题。线路板安装在采用高导热性和低绝缘系数的合成橡胶基板上，线路板的热量首先传递到基板上，其次在传递到基板上的安装支架，使热量远离半导体。通过这种结构设计使底板有效冷却，从而达到在没有通风的情况下温度高至 100℃时仍能满功率运行，同时使模板的工作温度保持在允许的范围内。

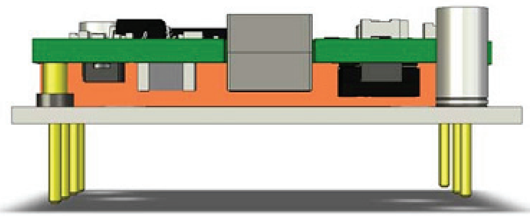


Figure 2. A filled elastomer provides a thermal path to the baseplate.

该 VPT 系列产品具有较宽的工作温度范围，可适用于很多高可靠性的应用。满额定功率下的连续工作温度为-55℃到 100℃。这个工作温度是以模块底板温度为准测量的。盖子几乎不提供热交换，加上散热器效果也很小。热系统设计应使热量通过模块外壳底部传到印制线路板、散热器或其他散热结构。温度下降到-55℃时，从设计上完全保证正常的启动和工作

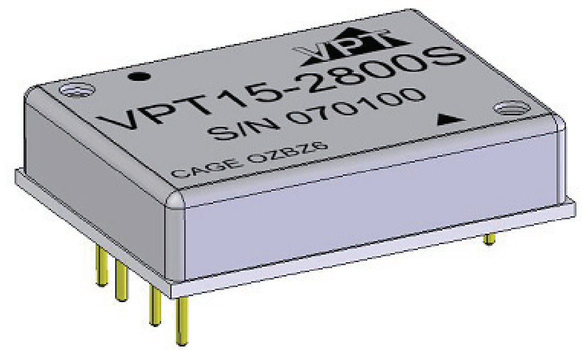


Figure 3. All metal package simplifies EMI compliance.

一个六面的金属封装提供了耐用、有效的 EMI 保护。金属外壳的上盖和底板是通过机械和电气的方式彼此连接，并用同样的方式与内部的 PCB 板连接。内部共模电容模块为辐射和共模噪声、降低辐射发射和辐射敏感度提供了一个回路，并很大地减少 EMI 兼容。然而开放式结构、塑料或者微型环氧电源模块可以产生干扰，并且通常需要增加屏蔽，VPT 系列提供了一个解决方案

品质和可靠性

对于 VPT 系列产品，在设计阶段已开始可靠性设计，不是后期再加入。每一个内部器件的电气和机械性能都是在完整的环境条件下（包括温度，湿度，震动和振动）仔细评估后被选用的。光绝缘体（包括光敏感器件的耦合装置）、电解电容和其它有限寿命的、高故障率或者有温度限制的部件都禁止在 VPT 产品上使用。依照 MIL-HDBK-217 标准来完成可靠性计算，根据最好的商业规范，特别是 J-STD-00、IPC-A-610 （3 级）和 ISO-9001 来装配完成的。已经被验证含铅焊接材料使用在高可靠性应用领域。对于系统设计者提到的长期使用纯锡焊剂的可靠性利害关系，VPT 产品没有参照 ROHS 并努力去减轻缓解这些利害关系。VPT 生产的高品质产品并不完全参照 MIL 标准。

当其部件和模块要满足最好的商业规范，环境筛选及指标要求应接近军档级别，特别是 MIL-STD-810 和 MIL-STD-883。VPT 系列产品提供一个筛选级别，这个级别包含稳定的烘烤，高低温试验和 96 小时高温老化。每个部件都经过 100％的环境筛选和电性能测试。一个严格的标准程序包括大范围的温度循环、寿命老化（交变湿热）测试和功率循环寿命测试。机械冲击和随机振动是用于高级别典型的恶劣军事环境中。

通过使用低成本商业可用器件和规范，加上精细的器件和材料的挑选及产品性能指标和筛选，每一个单品都保持低的成本，并且提高了可靠性。

不要冒设计风险

在成本和时间的压力下，他们不顾风险，冒然使用最低的成本，最易使用的部件。一个“便宜的” 普通商用或电信 DC-DC 转换器可能得到工程师的认可并能符合产品成本的要求，但今后很可能被证实是一个不良的实现方案。它可能在以后的设计过程、性能测试或者野外使用不符合要求，这就需要更多的时间和金钱成本来替换它。普通商用级或通讯部件的主要缺点是：限制输入电压和瞬时电压范围，限制温度范围，并且限制承受恶劣环境条件的能力，比如：高低温周期性变化、冲击和振动，高加速应力寿命实验（HALT）和高加速应力筛选（HASS）。最坏的情况是最在后的野外使用出现问题。当有等级的商用产品用于最终产品设计时，他们很可立刻解决问题。典型的高可靠性工序从最初的设计到完成产品生产可能需要很多年，然后能够工作 10 到 20 年甚至更多。典型的普通商用或通信 DC-DC 转换器可能仅仅有 2 到 5 年寿命或更少。用有等级的商业 DC-DC 转换器设计一个系统，预期重新设计到产品仅需 3 年。

您的正确选择

VPT 公司拥有广泛的军事、太空、航空电子设备以及其他高可靠性设备的应用经验。其产品部件被广泛地应用到各种领域，如美国空军最关键的卫星、军用（加固型）电脑、航空飞行器系统、无人航空飞行器系统、武器、汽车、地面积便携式仪器等成千上万的设备中。VPT 公司产品已获得 MIL-PRF-38534 标准中 K 级鉴定，这是美国国防部供应中心（DSCC）颁发的最高质量认证。VPT 公司是唯一一家同时提供 MIL-SPEC 和商务货架 DC-DC 转换器解决方法的厂家，

VPT 公司凭借高可靠性的 MIL-PRF-38534 技术，在考虑了设备成本的同时，为您提供了 VPT 系列产品。其系列产品不同于盲目设计或二次包装的商业设计，而是在清楚掌握军事和航空电子设备市场的需求后，以高可靠性为原则及严格环境条件下设计出来的。VPT 公司不仅提供长期产品支持与技术服务，并接受低量订单以满足客户要求。对于那些高要求和重要关键的应用，可从 VPT 的 MIL-PRF-38534 混合 DC-DC 转换器系列产品种选择：密闭全封装、完全满足 MIL=PRF-38534 和 MIL-STD-883 标准、标准微电路设计。

产品型号命名说明

零件编号定义

COTS Potted DC-DC 转换器（DC-DC　Converter）

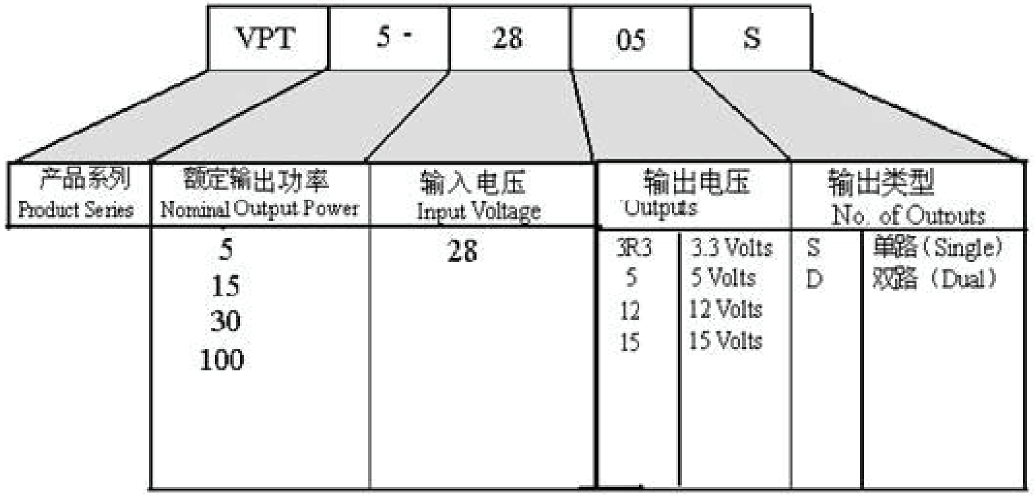
DV	200-	28	05	D	

产品系列 Product Series	额定输出功率 Nominal Output Power		输入电压 Input Voltage		输出电压 Outputs		输出类型 No. of Outputs		筛选编码 Screening Code	
	200	200 W	28	28 V	1R5	1.5 Volts	S	单路（Single）	None	标 准 级 (Standard)
					3R3	3.3 Volts	D	双路（Dual）	/MIL	军 事 级 （MIL）
					05	5 Volts				
					6R2	6.2 Volts				
					12	12 Volts				
					15	15 Volts				

EMI 滤波器（EMI Filter）

VPTF	3	28

产品系列 Product Series	额定输入电流 Nominal Output Current	输入电压 Input Voltage
	1	28
	3	



产品选型指南

COTS series

VPT Series	Input DC Voltage/V	Max Output Power/W	output DC Voltage/V	Output Trim	SYNC	INHIBIT	Page
COTS DC-DC Converters							
VPT5-2800S							
VPT5-283R3S	15-50	4	3.3			yes	37-46
VPT5-2805S	15-50	5	5			yes	37-46
VPT5-2812S	15-50	5	12			yes	37-46
VPT5-2815S	15-50	5	15			yes	37-46
VPT15-2800S/D							
VPT15-283R3S	15-50	10	3.3	yes		yes	47-68
VPT15-2805S	15-50	15	5	yes		yes	47-68
VPT15-2812S	15-50	15	12	yes		yes	47-68
VPT15-2815S	15-50	15	15	yes		yes	47-68
VPT15-2805D	15-50	15	±5			yes	47-68
VPT15-2812D	15-50	15	±12			yes	47-68
VPT15-2815D	15-50	15	±15			yes	47-68
VPT30-2800S/D							
VPT30-283R3S	15-50	25	3.3	yes	yes	yes	69-89
VPT30-2805S	15-50	30	5	yes	yes	yes	69-89
VPT30-2812S	15-50	30	12	yes	yes	yes	69-89
VPT30-2815S	15-50	30	15	yes	yes	yes	69-89
VPT30-2805D	15-50	30	±5		yes	yes	69-89
VPT30-2812D	15-50	30	±12		yes	yes	69-89
VPT30-2815D	15-50	30	±15		yes	yes	69-89
VPT100-2800S/D-VPT100+可并联使用							
VPT100-283R3S	16-40	66	3.3	yes	yes	yes	90-111
VPT100-2805S	16-40	100	5	yes	yes	yes	90-111

VPT Series	Input DC Voltage/V	Max Output Power/W	output DC Voltage/V	Output Trim	SYNC	INHIBIT	Page
VPT100-2812S	16-40	100	12	yes	yes	yes	90-111
VPT100-2815S	16-40	100	15	yes	yes	yes	90-111
VPT100-2812D	16-40	100	±12	yes	yes	yes	90-111
VPT100-2815D	16-40	100	±15	yes	yes	yes	90-111
Potted COTS DC-DC Converters							
DVST2800T							
DVST281R83R35T	15-50	22.5	1.8;3.3;5			yes	112-123
DVST281R83R312T	15-50	22.5	1.8;3.3;12			yes	112-123
DVST281R83R315T	15-50	22.5	1.8;3.3;15			yes	112-123
DVST281R855T	15-50	23.5	1.8;5;5			yes	112-123
DVST281R8512T	15-50	23.5	1.8;5;12			yes	112-123
DVST281R8515T	15-50	23.5	1.8;5;15			yes	112-123
DVST281R8125T	15-50	23.5	1.8;12;5			yes	112-123
DVST281R81212T	15-50	23.5	1.8;12;12			yes	112-123
DVST281R81215T	15-50	23.5	1.8;12;15			yes	112-123
DVST281R8155T	15-50	23.5	1.8;15;5			yes	112-123
DVST281R81512T	15-50	23.5	1.8;15;12			yes	112-123
DVST281R81515T	15-50	23.5	1.8;15;15			yes	112-123
DVST283R33R35T	15-50	24	3.3;3.3;5			yes	112-123
DVST283R33R312T	15-50	24	3.3;3.3;12			yes	112-123
DVST283R33R315T	15-50	24	3.3;3.3;15			yes	112-123
DVST283R355T	15-50	25	3.3;5;5			yes	112-123
DVST283R3512T	15-50	25	3.3;5;12			yes	112-123
DVST283R3515T	15-50	25	3.3;5;15			yes	112-123
DVST283R3125T	15-50	25	3.3;12;5			yes	112-123
DVST283R31212T	15-50	25	3.3;12;12			yes	112-123
DVST283R31215T	15-50	25	3.3;12;15			yes	112-123
DVST283R3155T	15-50	25	3.3;15;5			yes	112-123
DVST283R31512T	15-50	25	3.3;15;12			yes	112-123

VPT Series	Input DC Voltage/V	Max Output Power/W	output DC Voltage/V	Output Trim	SYNC	INHIBIT	Page
DVST283R31515T	15-50	25	3.3;15;15			yes	112-123
DVST2853R35T	15-50	29	5;3.3;5			yes	112-123
DVST2853R312T	15-50	29	5;3.3;12			yes	112-123
DVST2853R315T	15-50	29	5;3.3;15			yes	112-123
DVST28555T	15-50	30	5;5;5			yes	112-123
DVST285512T	15-50	30	5;5;12			yes	112-123
DVST285515T	15-50	30	5;5;15			yes	112-123
DVST285125T	15-50	30	5;12;5			yes	112-123
DVST2851212T	15-50	30	5;12;12			yes	112-123
DVST2851215T	15-50	30	5;12;15			yes	112-123
DVST285155T	15-50	30	5;15;5			yes	112-123
DVST2851512T	15-50	30	5;15;12			yes	112-123
DVST2851515T	15-50	30	5;15;15			yes	112-123
DVST286R253R35T	15-50	29	6.25;3.3;5			yes	112-123
DVST286R253R312T	15-50	29	6.25;3.3;12			yes	112-123
DVST286R253R315T	15-50	29	6.25;3.3;15			yes	112-123
DVST286R2555T	15-50	30	6.25;5;5			yes	112-123
DVST286R25512T	15-50	30	6.25;5;12			yes	112-123
DVST286R25515T	15-50	30	6.25;5;15			yes	112-123
DVST286R25125T	15-50	30	6.25;12;5			yes	112-123
DVST286R251212T	15-50	30	6.25;12;12			yes	112-123
DVST286R251215T	15-50	30	6.25;12;15			yes	112-123
DVST286R25155T	15-50	30	6.25;15;5			yes	112-123
DVST286R251512T	15-50	30	6.25;15;12			yes	112-123
DVST286R251515T	15-50	30	6.25;15;15			yes	112-123
DVST28123R35T	15-50	29	12;3.3;5			yes	112-123
DVST28123R312T	15-50	29	12;3.3;12			yes	112-123
DVST28123R315T	15-50	29	12;3.3;15			yes	112-123
DVST281255T	15-50	30	12;5;5			yes	112-123
DVST2812512T	15-50	30	12;5;12			yes	112-123

VPT Series	Input DC Voltage/V	Max Output Power/W	output DC Voltage/V	Output Trim	SYNC	INHIBIT	Page
DVST2812515T	15-50	30	12;5;15			yes	112-123
DVST2812125T	15-50	30	12;12;5			yes	112-123
DVST28121212T	15-50	30	12;12;12			yes	112-123
DVST28121215T	15-50	30	12;12;15			yes	112-123
DVST2812155T	15-50	30	12;15;5			yes	112-123
DVST28121512T	15-50	30	12;15;12			yes	112-123
DVST28121515T	15-50	30	12;15;15			yes	112-123
DV200-28S/D—单路输出可并联使用							
DV200-283R3S	16-50	100	3.3	yes	yes	yes	17-36
DV200-2805S	16-50	150	5	yes	yes	yes	17-36
DV200-2812S	16-50	175	12	yes	yes	yes	17-36
DV200-2815S	16-50	200	15	yes	yes	yes	17-36
DV200-2805D	16-50	150	±5	yes	yes	yes	17-36
DV200-2812D	16-50	175	±12	yes	yes	yes	17-36
DV200-2815D	16-50	200	±15	yes	yes	yes	17-36
Pre-Conditioning Modules—前端调理模块							
VPTPCM-12（升压功能、**6V-600V** 浪涌的前端调理模块）							
VPTPCM-12	9-40	120	17-40			yes	160-168
VPTi10-28（**600V** 浪涌、反向保护的 **EMI** 滤波器）							
VPTi10-28	-40-40	200	0-40			yes	169-177
Bus COTS DC-DC Converters							
VPTHVM-270（270V-28V、效率 91%、总线转换模块、可并联使用）							
VPTHVM-270	180-350	270	28		yes	yes	178-186

EMI FILTERS

VPT Series	Input DC Voltage/V	Max Output Current/A	Max output Power/W	Page
VPTF1-28	0-50	1.0	15	132-138
VPTF3-28	0-50	3.0	45	139-145
VPTF10-28	0-50	10.0	200	146-152
VPTF20-28	0-50	20.0	400	153-159
To suppress transient voltages poted EMI filters—抗 600V 浪涌的 EMI 灌胶封装滤波器				
DVMN28	16-50	14.0	250	124-131

Poted COTS(灌胶)电源模块和滤波器环境筛选

筛选 (Screening)	MIL-STD-883	标准级 (Standard-No Suffix)	军 事 级 (**Military**)
封装前检查 (Pre-cap Inspection)	IPC-A-610 Class III	■	■
温度循环 (Temperature Cycling)	Method 1010, Condition B		■
老化 (Burn-In)	96 hours at +100℃ 12 hours at +100℃	■ (12 hours)	■ (96 hours)
最终电气测试 (Final Electrical)	100% at -55℃，+25℃，100℃* 100% at +25℃	■ (100% at +25℃)	■ (100% at -55℃，+25℃，100℃*)
最终检查 (Final Visual)	Method 2009	■	■

注意： *装运过程中包括-55℃，+25℃和 100℃时 100% R&R 测试的所有的数据

COTS 电源模块和滤波器环境筛选

筛选 (Screening)	MIL-STD-883	军 事 级 (**Military**)
内部检测 (Internal Visual)	IPC-A-610	■
稳定烘焙 (stabilization Bake)	Method 1008, Condition B，125℃，24 hours	■
温度循环 (Temperature Cycling)	Method 1010, Condition B, -55℃ to +125℃, 10 Cycles	■
老化 (Burn-In)	Method 1015，96 hours at +100℃	■
最终电气测试 (Final Electrical)	100% at +25℃	■
外部检查 (External Visual)	Method 2009	■

DV200-2800S Series

HIGH RELIABILITY DC-DC CONVERTERS

DESCRIPTION

The DV200 series of high reliability, isolated DC-DC converters is operable over a wide (-55 °C to +100 °C) temperature range with no power derating. Unique to the DV200 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 current sharing function allows a maximum of five units to be connected in parallel to boost the total output power to 5 times. The output voltage is trimmable up to +10% or down –20%.

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

FEATURES

- High Reliability
- Parallel Up to 5 Units With Current Sharing
- Output Voltage Trim Up +10% or Down –20%
- Wide Input Voltage Range: 16 to 50 Volts
- Up to 200 Watts Output Power
- Radiation Immune Magnetic Feedback Circuit
- NO Use of Optoisolators
- Undervoltage Lockout
- Short Circuit Protection
- Current Limit Protection
- Input Transient Voltage: 55 Volts for 1 second
- High Power Density: ≈ 80 W/in^3
- Custom Versions Available
- Additional Environmental Screening Available
- Meets MIL-STD-461C and MIL-STD-461D EMC Requirements When Used With a DVMN28 EMI Filter

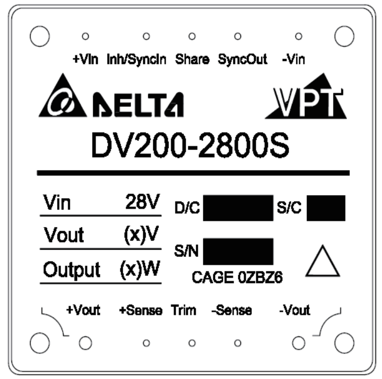


Figure 1 – DV200-2800S DC-DC Converter
(Not To Scale)

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West, Suite 206
Everett, WA 98204
http://www.vpt-inc.com

Sales Information:
Phone: (425) 353-3010
Fax: (425) 353-4030
E-mail: sales@vpt-inc.com

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Junction Temperature Rise to Case	+25°C
Input Voltage (Transient, 1 second)	55 Volts	Storage Temperature	-65°C to +135°C
Output Power[1,3]	200 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	44 Watts	Weight (Maximum)	115 Grams

Parameter	Conditions	DV200-283R3S			DV200-2805S			Units
		Min	Typ	Max	Min	Typ	Max	
STATIC								
INPUT Voltage[5]	Continuous	16	28	50	16	28	50	V
	Transient, 1 sec	-	-	55	-	-	55	V
Current	Inhibited	-	6	10	-	6	10	mA
	No Load	-	20	50	-	20	50	mA
Ripple Current	Full Load, 20Hz to 10MHz	-	-	100	-	-	100	mA_{p-p}
Inhibit Pin Input[4]	To Disable Output	0	-	1.5	0	-	1.5	V
Inhibit Pin Open Circuit Voltage[4]		8	9.5	11	8	9.5	11	V
UVLO Turn On		13.5	15	15.8	13.5	15	15.8	V
UVLO Turn Off[4]		10.0	12.0	14.0	10.5	12.0	14.0	V
OUTPUT Voltage V_{OUT}	T_{CASE} = 25°C	3.267	3.30	3.333	4.95	5.00	5.05	V
V_{OUT}	T_{CASE} = -55°C to +100°C	3.25	3.30	3.35	4.925	5.00	5.075	V
Power[3]	V_{IN} = 18V to 50V	0	-	100	0	-	150	W
	V_{IN} = 16V to 18V	0	-	60	0	-	90	W
Current[3] I_{OUT}	V_{IN} = 18V to 50V	0	-	30	0	-	30	A
	V_{IN} = 16V to 18V	0	-	18	0	-	18	A
Ripple Voltage V_{OUT}	Full Load, 10kHz to 10MHz	-	50	150	-	50	150	mV_{p-p}
V_{OUT}	Full Load, 10kHz to 2MHz	-	10	50	-	10	50	mV_{p-p}
Line Regulation V_{OUT}	V_{IN} = 18V to 50V	-	10	80	-	10	80	mV
Load Regulation V_{OUT}	No Load to Full Load	-	10	100	-	10	100	mV
Voltage Trim V_{OUT}	Full Load	-20	0	10	-20	-	10	%
EFFICIENCY	Full Load	74	80	-	79	83	-	%
LOAD FAULT POWER DISSIPATION	Overload[4]	-	45	-	-	45	-	W
	Short Circuit[4]	-	45	-	-	45	-	W
CAPACITIVE LOAD[4]		-	-	2000	-	-	2000	µF
SWITCHING FREQUENCY		450	500	550	450	500	550	kHz
SYNC FREQUENCY RANGE	$V_H – V_L$ = 5V Duty Cycle = 20% - 80%	450	500	550	450	500	550	kHz
ISOLATION	500 V_{DC}	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	GB @ T_C = 55°C	-	955	-	-	955	-	kHrs
DYNAMIC								
Load Step Output Transient V_{OUT}	Half Load to Full Load	-	200	450	-	300	550	mV_{PK}
Load Step Recovery[2]		-	200	650	-	200	600	µSec
Line Step Output Transient[4] V_{OUT}	V_{IN} = 18V to 40V	-	150	300	-	150	300	mV_{PK}
Line Step Recovery[2, 4]		-	50	150	-	50	150	µSec
Turn On Delay V_{OUT}	V_{IN} = 0V to 28V	-	20	30	-	20	30	mSec
Turn On Overshoot		-	0	30	-	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 110°C.
4. Verified by qualification testing. 5. 100% output power available for V_{IN} = 18V to 50V and only 60% output power available for V_{IN} = 16V to 18V.

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Junction Temperature Rise to Case	+25°C
Input Voltage (Transient, 1 second)	55 Volts	Storage Temperature	-65°C to +135°C
Output Power[1,3]	200 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	44 Watts	Weight (Maximum)	115 Grams

Parameter	Conditions	DV200-2812S			DV200-2815S			Units
		Min	Typ	Max	Min	Typ	Max	
STATIC								
INPUT Voltage[5]	Continuous	16	28	50	16	28	50	V
	Transient, 1 sec	-	-	55	-	-	55	V
Current	Inhibited	-	6	10	-	6	10	mA
	No Load	-	20	50	-	20	50	mA
Ripple Current	Full Load, 20Hz to 10MHz	-	-	150	-	-	150	mA_{p-p}
Inhibit Pin Input[4]	To Disable Output	0	-	1.5	0	-	1.5	V
Inhibit Pin Open Circuit Voltage[4]		8	9.5	11	8	9.5	11	V
UVLO Turn On		13.5	15	15.8	13.5	15	15.8	V
UVLO Turn Off[4]		10.0	12.0	14.0	10.0	12.0	14.0	V
OUTPUT Voltage V_{OUT}	T_{CASE} = 25°C	11.88	12.0	12.12	14.85	15.0	15.15	V
V_{OUT}	T_{CASE} = -55°C to +100°C	11.82	12.0	12.18	14.775	15.0	15.225	V
Power[3]	V_{IN} = 18V to 50V	0	-	175	0	-	200	W
	V_{IN} = 16V to 18V	0	-	105	0	-	120	W
Current[3] I_{OUT}	V_{IN} = 18V to 50V	0	-	14.6	0	-	13.3	A
	V_{IN} = 16V to 18V	0	-	8.76	0	-	7.98	A
Ripple Voltage V_{OUT}	Full Load, 10kHz to 10MHz	-	100	200	-	100	200	mV_{p-p}
V_{OUT}	Full Load, 10kHz to 2MHz	-	5	30	-	5	30	mV_{p-p}
Line Regulation V_{OUT}	V_{IN} = 18V to 50V	-	10	100	-	10	100	mV
Load Regulation V_{OUT}	No Load to Full Load	-	10	120	-	10	120	mV
Voltage Trim V_{OUT}	Full Load	-20	-	10	-20	-	10	%
EFFICIENCY	Full Load	82	84	-	82	86	-	%
LOAD FAULT POWER DISSIPATION	Overload[4]	-	45	-	-	45	-	W
	Short Circuit[4]	-	45	-	-	45	-	W
CAPACITIVE LOAD[4]		-	-	1000	-	-	1000	µF
SWITCHING FREQUENCY		450	500	550	450	500	550	kHz
SYNC FREQUENCY RANGE	$V_H – V_L$ = 5V Duty Cycle = 20% - 80%	450	500	550	450	500	550	kHz
ISOLATION	500 V_{DC}	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	GB @ T_C = 55°C	-	955	-	-	955	-	kHrs
DYNAMIC								
Load Step Output Transient V_{OUT}	Half Load to Full Load	-	550	1000	-	1000	1350	mV_{PK}
Load Step Recovery[2]		-	200	400	-	200	500	µSec
Line Step Output Transient[4] V_{OUT}	V_{IN} = 18V to 40V	-	1000	1200	-	1000	1200	mV_{PK}
Line Step Recovery[2, 4]		-	50	200	-	50	200	µSec
Turn On Delay V_{OUT}	V_{IN} = 0V to 28V	-	20	30	-	20	30	mSec
Turn On Overshoot		-	-	50	-	-	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 110°C.
4. Verified by qualification testing. 5. 100% output power available for V_{IN} = 18V to 50V and only 60% output power available for V_{IN} = 16V to 18V.

BLOCK DIAGRAM

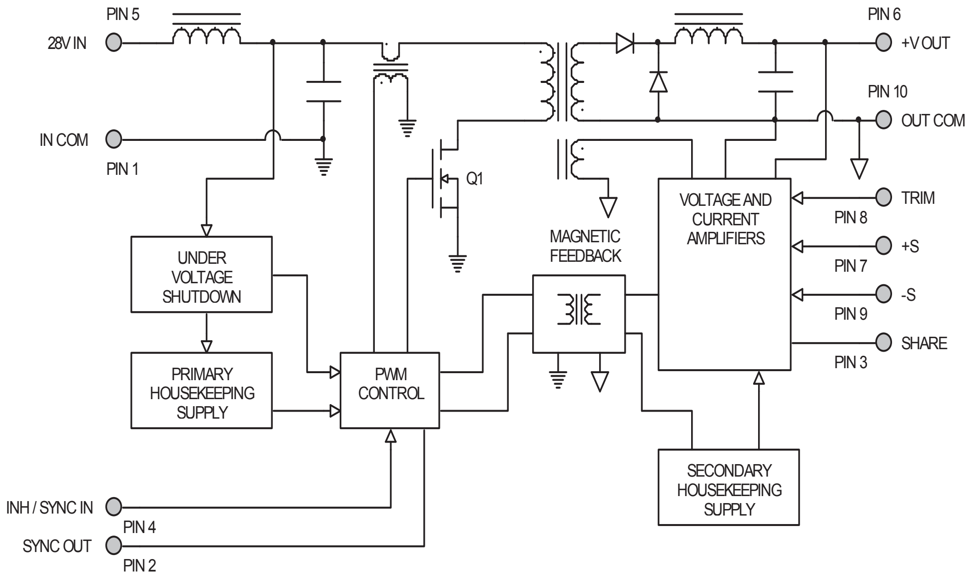


Figure 2

CONNECTION DIAGRAM

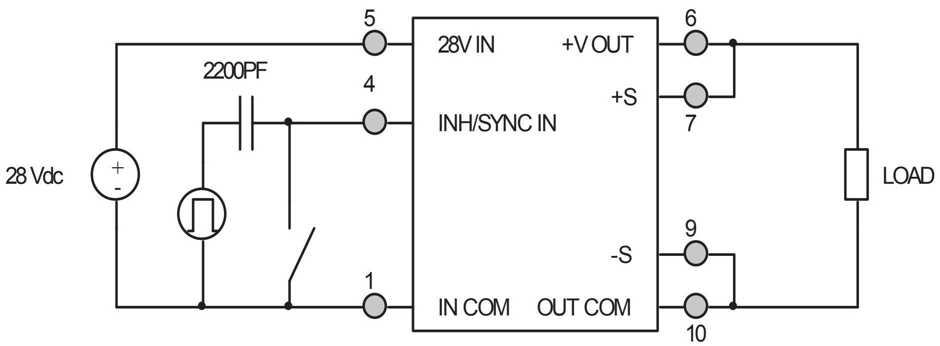


Figure 3

INHIBIT DRIVE CONNECTION DIAGRAMS

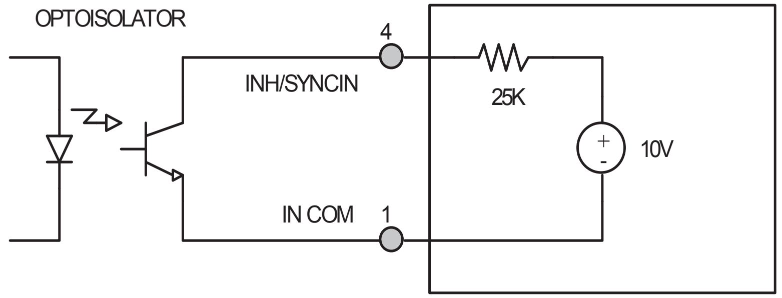


Figure 4 – Isolated Inhibit Drive and Internal Equivalent Circuit

PARALLEL CONNECTION DIAGRAM

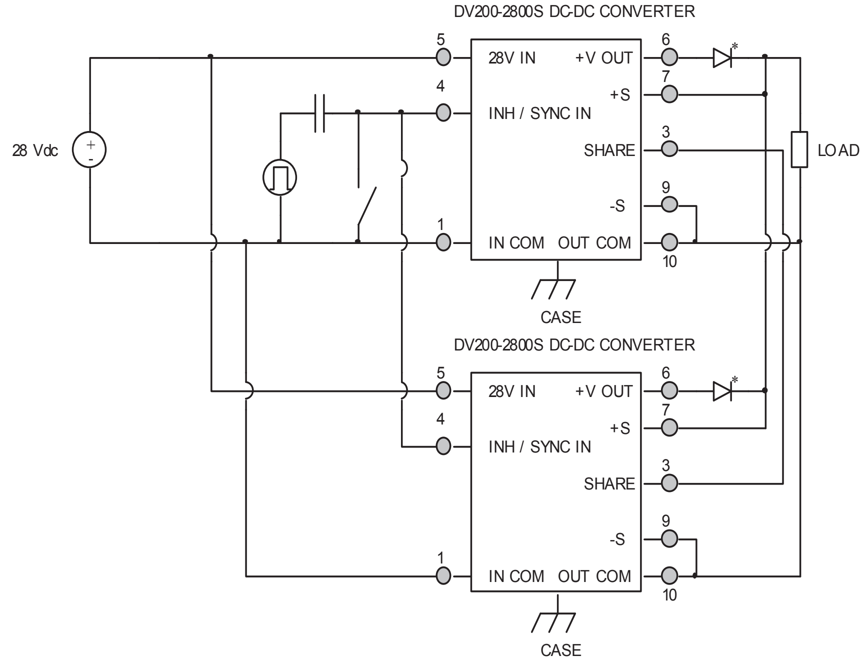
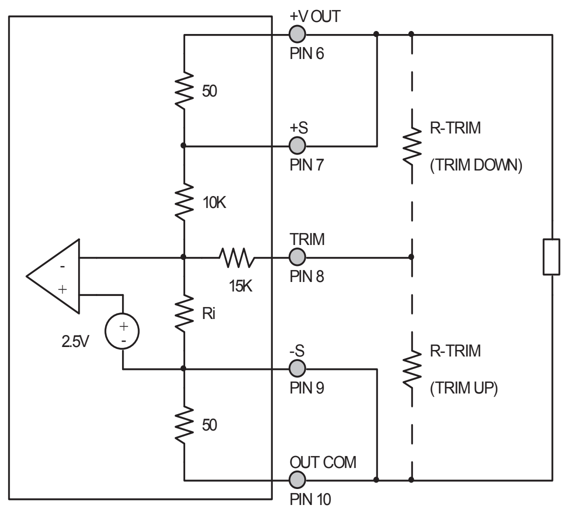


Figure 5 – Parallel Connection with Current Sharing
(*Shown with optional "OR" ing diode)

OUTPUT VOLTAGE TRIM

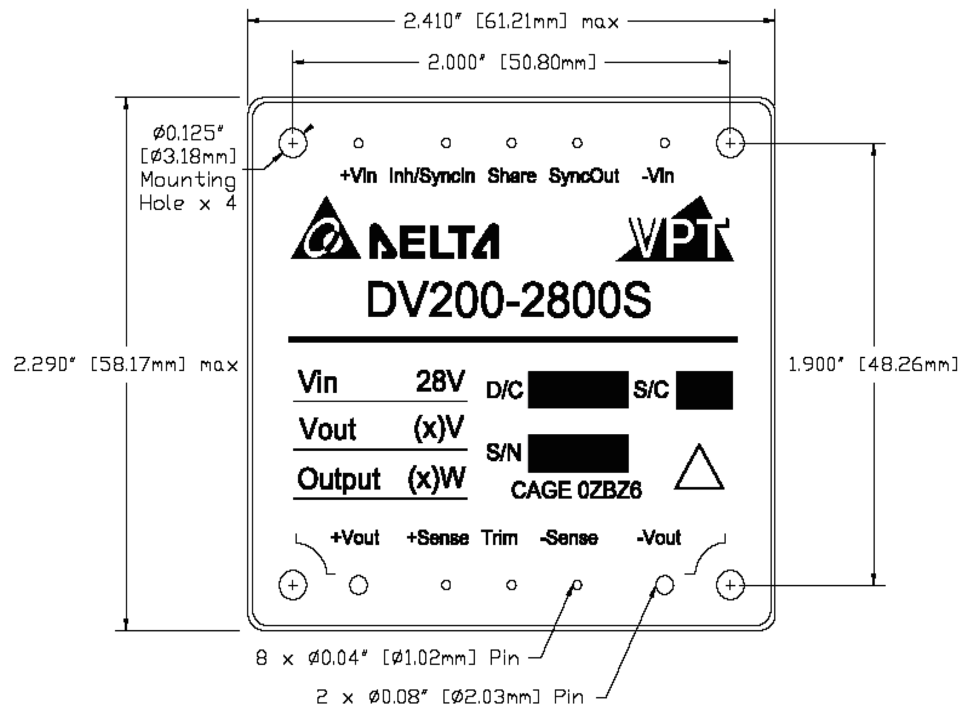


The output voltage can be trimmed down by connecting a resistor between the TRIM pin (PIN 8) and the +V OUT pin (PIN 6), or can be trimmed up by connecting a resistor between the TRIM pin (PIN 8) and the OUT COM pin (PIN 10). The maximum trim range is +10% up and –20% down. The appropriate resistor values versus the output voltage are given in the trim table below.

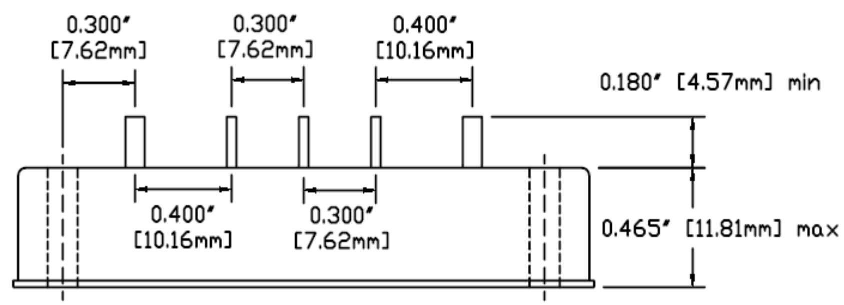
Figure 6 – Output Voltage Trim

DV200-283R3S		DV200-2805S		DV200-2812S		DV200-2815S	
$+V_{OUT}$ (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

PACKAGE SPECIFICATIONS



TOP VIEW



PIN	FUNCTION
1	IN COM
2	SYNC OUT
3	SHARE
4	INH / SYNC IN
5	28V IN
6	+V OUT
7	+S
8	TRIM
9	-S
10	OUT COM

SIDE VIEW

Figure 7 – Package and Pinout
(Dimensional Limits are ±0.005" Unless Otherwise Stated)

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	IN COM	Input Common Connection
2	SYNC OUT	Output Synchronization Signal
3	SHARE	Current Share
4	INH / SYNC IN	Logic Low = Disabled Output. Unconnected or open collector TTL or Square-wave Synchronization Signal = Enabled Output.
5	28V IN	Positive Input Voltage Connection
6	+V OUT	Positive Output Voltage Connection
7	+S	Positive Sense
8	TRIM	Trim Output Voltage to +10%, -20% of Nominal Value
9	-S	Return Sense
10	OUT COM	Output Common Connection

ENVIRONMENTAL SCREENING

Screening	MIL-STD-883	Standard (No Suffix)	Military /ML
Pre-Cap Inspection	IPC-A-610 Class II	•	•
Temperature Cycling	-55°C, 100°C, 10 Cycles		•
Burn-In	96 hours at +100°C 12 hours at +100°C	 •	•
Final Electrical	100% at -55°C, 25°C, 100°C[1] 100% at 25°C	 •	•
Final Inspection	Method 2009	•	•

Note: 1. 100% R&R testing at –55°C, +25°C, and +100°C with all test data included in product shipment.

ORDERING INFORMATION

DV200-	28	05	S	/ML	-	XXX
1	2	3	4	5		6

(1) Product Series	(2) Nominal Input Voltage		(3) Output Voltage	
DV200-	**28**	28 Volts	**3R3** **05** **12** **15**	3.3 Volts 5 Volts 12 Volts 15 Volts

(4) Number of Outputs		(5) Screening Code		(6) Additional Screening Code
S	Single	**None** **/ML**	Standard Military	Contact Sales

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.

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: sales@vpt-inc.com

DV200-2800D Series

HIGH RELIABILITY
DC-DC CONVERTERS

DESCRIPTION

The DV200 series of high reliability, isolated DC-DC converters is operable over a wide (-55 °C to +100 °C) temperature range with no power derating. Unique to the DV200 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 current sharing function allows a maximum of five units to be connected in parallel to boost the total output power to 5 times. The output voltage is trimmable up to +10% or down –20%.

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

FEATURES

- High Reliability
- Output Voltage Trim Up +10% or Down –20%
- Wide Input Voltage Range: 16 to 50 Volts
- Up to 200 Watts Output Power
- Up to 70% of Rated Output Power is Available for Each Output
- Radiation Immune Magnetic Feedback Circuit
- NO Use of Optoisolators
- Undervoltage Lockout
- Short Circuit Protection
- Current Limit Protection
- Input Transient Voltage: 55 Volts for 1 second
- High Power Density: ≈ 80 W/in^3
- Custom Versions Available
- Additional Environmental Screening Available
- Meets MIL-STD-461C and MIL-STD-461D EMC Requirements When Used With a DVMN28 EMI Filter

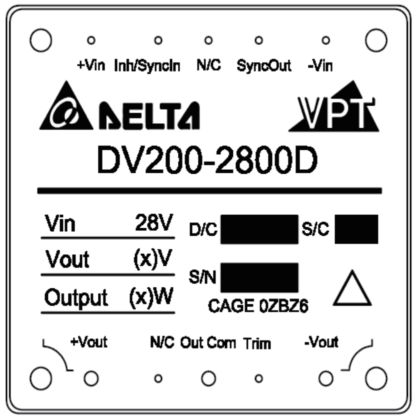


Figure 1 – DV200-2800D DC-DC Converter
(Not To Scale)

11314 4th Avenue
West, Suite 206
Everett, WA 98204
http://www.vpt-inc.com

Sales Information:
Phone: (425) 353-3010
Fax: (425) 353-4030
E-mail: sales@vpt-inc.com

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Junction Temperature Rise to Case	+25°C
Input Voltage (Transient, 1 second)	55 Volts	Storage Temperature	-65°C to +135°C
Output Power[1,3]	200 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	44 Watts	Weight (Maximum)	115 grams

Parameter		Conditions	DV200-2805D			DV200-2812D			Units
			Min	Typ	Max	Min	Typ	Max	
STATIC									
INPUT Voltage[7]		Continuous	16	28	50	16	28	50	V
		Transient, 1 sec	-	-	55	-	-	55	V
Current		Inhibited	-	6	10	-	6	10	mA
		No Load	-	20	80	-	20	80	mA
Ripple Current		Full Load[5], 20Hz to 10MHz	-	-	100	-	-	100	mA_{p-p}
Inhibit Pin Input[4]			0	-	1.5	0	-	1.5	V
Inhibit Pin Open Circuit Voltage[4]			8	9.5	11	8	9.5	11	V
UVLO Turn On			13.5	14	15.8	13.5	14	15.8	V
UVLO Turn Off[4]			10	12	14	10	12	14	V
OUTPUT Voltage	$+V_{OUT}$	T_{CASE} = 25°C	4.95	5.00	5.05	11.88	12.00	12.12	V
	$+V_{OUT}$	T_{CASE} = -55°C to +100°C	4.925	5.00	5.075	11.82	12.00	12.18	V
	$-V_{OUT}$	T_{CASE} = 25°C	4.80	5.00	5.20	11.76	12.00	12.24	V
	$-V_{OUT}$	T_{CASE} = -55°C to +100°C	4.85	5.00	5.25	11.52	12.00	12.48	V
Power[3,6,7]	Total	V_{IN} = 18V to 50V	-	-	150	-	-	175	W
		V_{IN} = 16V to 18V	-	-	90	-	-	105	W
	$\pm V_{OUT}$	V_{IN} = 18V to 50V Either Output	-	-	105	-	-	122.5	W
		V_{IN} = 16V to 18V Either Output	-	-	63	-	-	73.5	W
Current[3,6,7]	$\pm V_{OUT}$	V_{IN} = 18V to 50V Either Output	-	-	21	-	-	10.2	A
		V_{IN} = 16V to 18V Either Output	-	-	12.6	-	-	6.1	A
Ripple Voltage	$\pm V_{OUT}$	Full Load[5], 20Hz to 10MHz	-	50	150	-	50	200	mV_{p-p}
Line Regulation	$+V_{OUT}$	V_{IN} = 18V to 40V	-	10	80	-	10	80	mV
	$-V_{OUT}$	V_{IN} = 18V to 40V	-	10	200	-	10	200	mV
Load Regulation	$+V_{OUT}$	No Load to Full Load[5]	-	10	80	-	10	80	mV
	$-V_{OUT}$	No Load to Full Load[5]	-	10	200	-	10	200	mV
Cross Regulation	$-V_{OUT}$	V1+ Load 30% - Load 70% V2+ Load 70% - Load 30%	-	-	550	-	-	550	mV
Voltage Trim		Full Load	-20	-	10	-20	-	10	%
EFFICIENCY		Full Load[5]	79	82	-	80	84	-	%
LOAD FAULT POWER DISSIPATION		Overload[4]	-	-	80	-	-	80	W
		Short Circuit	-	-	80	-	-	80	W
CAPACITIVE LOAD[4]		Either Output	-	-	1000	-	-	1000	µF
SWITCHING FREQUENCY			450	500	550	450	500	550	kHz
SYNC FREQUENCY RANGE		$V_H – V_L$ = 5V Duty Cycle = 20% - 80%	450	-	550	450	-	550	kHz
ISOLATION		500 V_{DC}, T_{CASE} = 25°C	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)		GB @ T_C = 55°C	-	955	-	-	955	-	kHrs

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Junction Temperature Rise to Case	+25°C
Input Voltage (Transient, 1 second)	55 Volts	Storage Temperature	-65°C to +135°C
Output Power[1,3]	200 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	44 Watts	Weight (Maximum)	115 grams

Parameter		Conditions	DV200-2805D			DV200-2812D			Units
			Min	Typ	Max	Min	Typ	Max	
DYNAMIC									
Load Step Output Transient	$\pm V_{OUT}$	Half Load to Full Load	-	-	500	-	-	600	mV$_{PK}$
Load Step Recovery[2]		Half Load to Full Load	-	-	500	-	-	500	µSec
Line Step Output Transient[4]	$\pm V_{OUT}$	V_{IN} = 18V to 40V	-	300	600	-	600	1200	mV$_{PK}$
Line Step Recovery[2, 4]		V_{IN} = 18V to 40V	-	300	500	-	300	500	µSec
Turn On Delay	$\pm V_{OUT}$	V_{IN} = 0V to 28V	-	20	30	-	20	30	mSec
Turn On Overshoot		V_{IN} = 0V to 28V	-	-	50	-	-	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 110°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. 100% output power available for V_{IN} = 18V to 50V and only 60% output power available for V_{IN} = 16V to 18V.

DV200-2800D Series

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Junction Temperature Rise to Case	+25°C
Input Voltage (Transient, 1 second)	55 Volts	Storage Temperature	-65°C to +135°C
Output Power[1,3]	200 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	44 Watts	Weight (Maximum)	115 grams

Parameter		Conditions	DV200-2815D			Units
			Min	Typ	Max	
STATIC						
INPUT Voltage[7]		Continuous	16	28	50	V
		Transient, 1 sec	-	-	55	V
Current		Inhibited	-	6	10	mA
		No Load	-	20	80	mA
Ripple Current		Full Load[5], 20Hz to 10MHz	-	-	100	mA$_{P-P}$
Inhibit Pin Input[4]			0	-	1.5	V
Inhibit Pin Open Circuit Voltage[4]			8	9.5	11	V
UVLO Turn On			13.5	14	15.8	V
UVLO Turn Off[4]			10	12	14	V
OUTPUT Voltage	$+V_{OUT}$	T_{CASE} = 25°C	14.85	15.00	15.15	V
	$+V_{OUT}$	T_{CASE} = -55°C to +100°C	14.775	15.00	15.225	V
	$-V_{OUT}$	T_{CASE} = 25°C	14.70	15.00	15.30	V
	$-V_{OUT}$	T_{CASE} = -55°C to +100°C	14.40	15.00	15.60	V
Power[3,6,7]	Total	V_{IN} = 18V to 50V	-	-	200	W
	Total	V_{IN} = 16V to 18V	-	-	120	W
	$\pm V_{OUT}$	V_{IN} = 18V to 50V Either Output	-	-	140	W
	$\pm V_{OUT}$	V_{IN} = 16V to 18V Either Output	-	-	84	W
Current[3,6,7]	$\pm V_{OUT}$	V_{IN} = 18V to 50V Either Output	-	-	9.3	A
	$\pm V_{OUT}$	V_{IN} = 16V to 18V Either Output	-	-	5.6	A
Ripple Voltage	$\pm V_{OUT}$	Full Load[5], 20Hz to 10MHz	-	50	200	mV$_{P-P}$
Line Regulation	$+V_{OUT}$	V_{IN} = 18V to 40V	-	10	80	mV
	$-V_{OUT}$	V_{IN} = 18V to 40V	-	10	200	mV
Load Regulation	$+V_{OUT}$	No Load to Full Load[5]	-	10	80	mV
	$-V_{OUT}$	No Load to Full Load[5]	-	10	200	mV
Cross Regulation	$-V_{OUT}$	V1+ Load 30% - Load 70% V2+ Load 70% - Load 30%	-	-	550	mV
Voltage Trim		Full Load	-20	-	10	%
EFFICIENCY		Full Load[5]	81	85	-	%
LOAD FAULT POWER DISSIPATION		Overload[4]	-	-	80	W
		Short Circuit	-	-	80	W
CAPACITIVE LOAD[4]		Either Output	-	-	1000	µF
SWITCHING FREQUENCY			450	500	550	kHz
SYNC FREQUENCY RANGE		$V_H - V_L$ = 5V Duty Cycle = 20% - 80%	450	-	550	kHz
ISOLATION		500 V_{DC}, T_{CASE} = 25°C	100	-	-	MΩ
MTBF (MIL-HDBK-217F)		GB @ T_C = 55°C	-	955	-	kHrs

SPECIFICATIONS (T_{CASE} = -55°C to +100°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	+25°C
Input Voltage (Transient, 1 second)	55 Volts	Storage Temperature	-65°C to +135°C
Output Power[1,3]	200 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	44 Watts	Weight (Maximum)	115 grams

Parameter		Conditions	DV200-2815D			Units
			Min	Typ	Max	
DYNAMIC						
Load Step Output Transient	$\pm V_{OUT}$	Half Load to Full Load	-	-	600	mV_{PK}
Load Step Recovery[2]			-	-	500	µSec
Line Step Output Transient[4]	$\pm V_{OUT}$	V_{IN} = 18V to 40V	-	600	1200	mV_{PK}
Line Step Recovery[2, 4]			-	300	500	µSec
Turn On Delay	$\pm V_{OUT}$	V_{IN} = 0V to 28V	-	20	30	mSec
Turn On Overshoot			-	-	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 110°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. 100% output power available for V_{IN} = 18V to 50V and only 60% output power available for V_{IN} = 16V to 18V.

BLOCK DIAGRAM

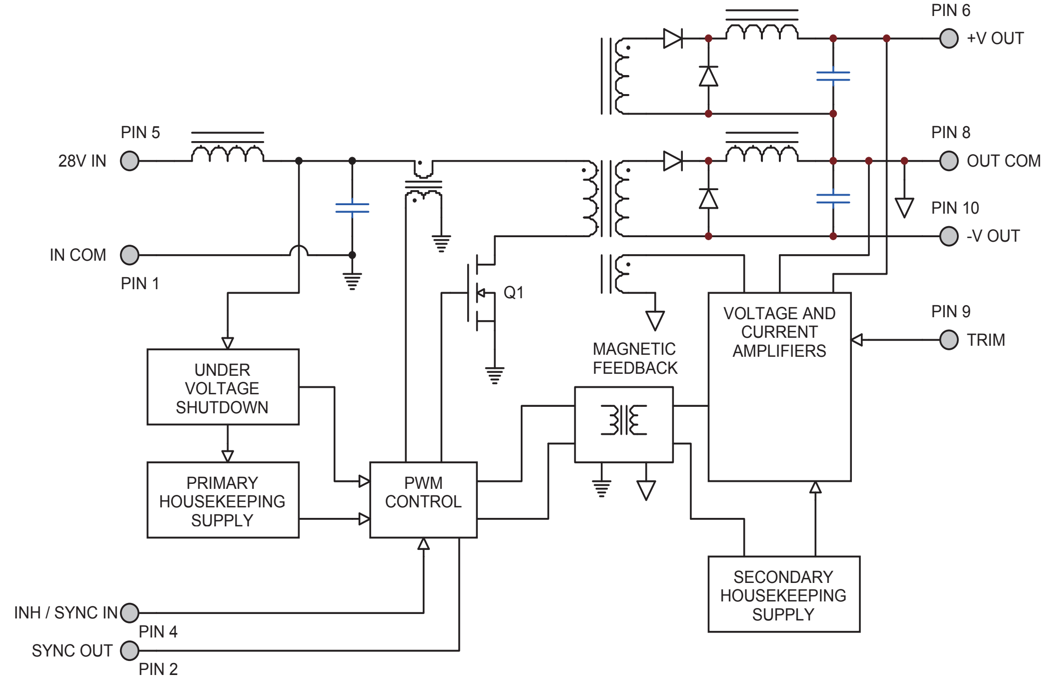


Figure 2

CONNECTION DIAGRAM

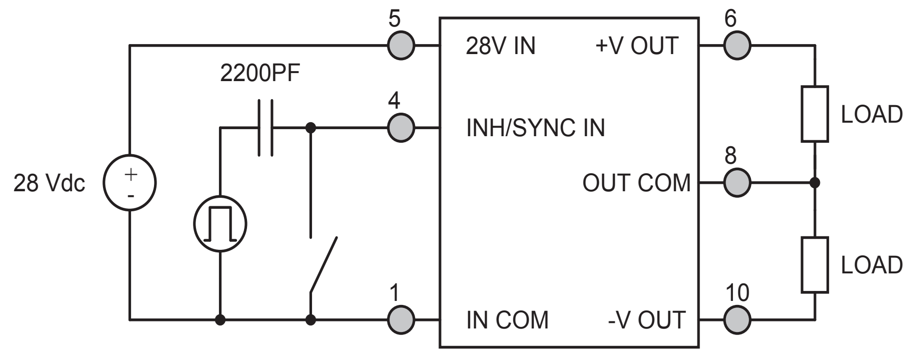


Figure 3

INHIBIT DRIVE CONNECTION DIAGRAMS

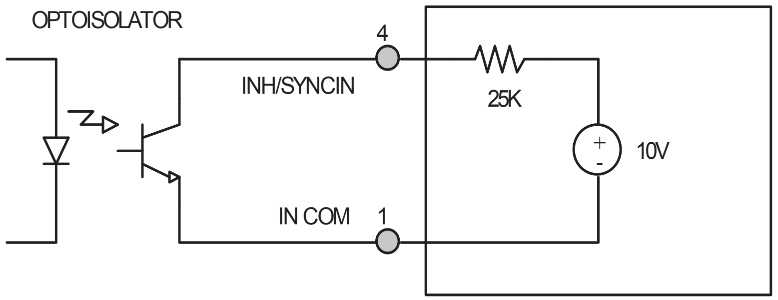
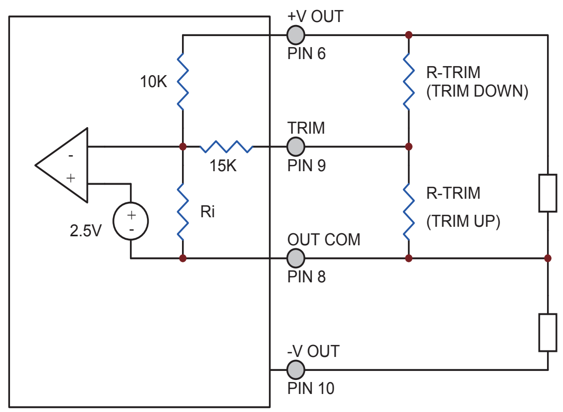


Figure 4 – Isolated Inhibit Drive and Internal Equivalent Circuit

OUTPUT VOLTAGE TRIM

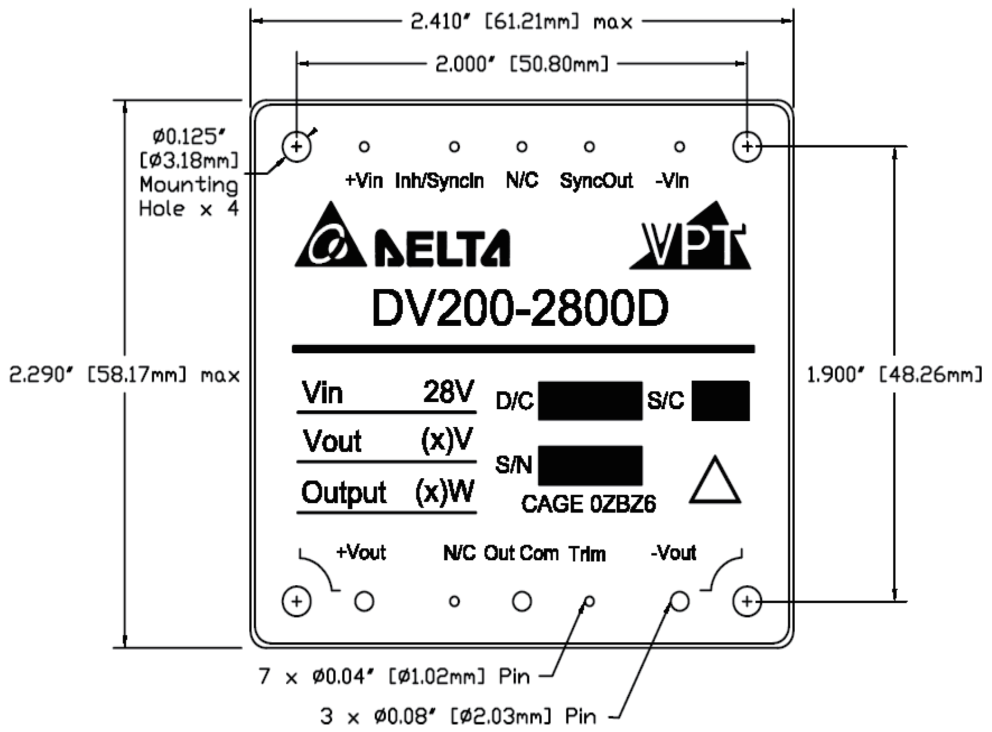


The output voltage can be trimmed down by connecting a resistor between the TRIM pin (PIN 9) and the +V OUT pin (PIN 6), or can be trimmed up by connecting a resistor between the TRIM pin (PIN 9) and the OUT COM pin (PIN 8). The maximum trim range is +10% up and –20% down. The appropriate resistor values versus the output voltage are given in the trim table below.

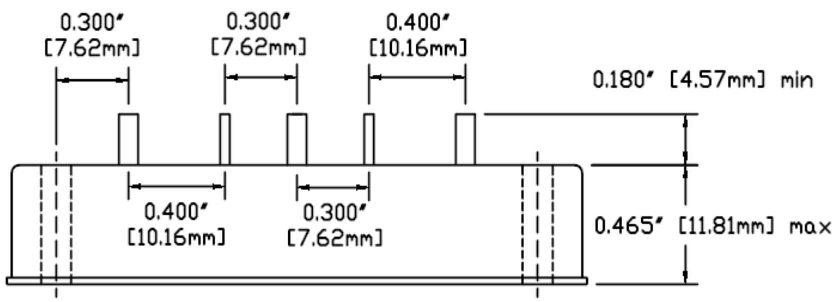
Figure 5 – Output Voltage Trim

DV200-2805D		DV200-2812D		DV200-2815D	
±V_{OUT} (V)	R_{TRIM} (Ω)	±V_{OUT} (V)	R_{TRIM} (Ω)	±V_{OUT} (V)	R_{TRIM} (Ω)
5.5	35k	13.2	5.8k	16.50	1.7k
5.4	47.5k	13.0	10k	16.25	5k
5.3	68.3k	12.8	16.2k	16.00	10k
5.2	110k	12.6	26.6k	15.75	18.3k
5.1	235k	12.4	47.3k	15.50	35k
5.0	-	12.2	109k	15.25	85k
4.9	225k	12.0	-	15.00	-
4.8	100k	11.8	454k	14.75	475k
4.7	58.3k	11.6	213k	14.50	225k
4.6	37.5k	11.4	134k	14.25	142k
4.5	25k	11.2	94k	14.00	100k
4.4	16.7k	11.0	70.1k	13.75	75k
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

PACKAGE SPECIFICATIONS



TOP VIEW



PIN	FUNCTION
1	IN COM
2	SYNC OUT
3	N/C
4	INH / SYNC IN
5	28V IN
6	+V OUT
7	N/C
8	OUT COM
9	TRIM
10	-V OUT

SIDE VIEW

Figure 6 – Package and Pinout
(Dimensional Limits are ±0.005" Unless Otherwise Stated)

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	IN COM	Input Common Connection
2	SYNC OUT	Output Synchronization Signal
3	N/C	No Connection
4	INH / SYNC IN	Logic Low = Disabled Output. Unconnected or open collector TTL or Square-wave Synchronization Signal = Enabled Output.
5	28V IN	Positive Input Voltage Connection
6	+V OUT	Positive Output Voltage Connection
7	N/C	No Connection
8	OUT COM	Output Common Connection
9	TRIM	Trim Output Voltage to +10%, -20% of Nominal Value
10	-V OUT	Negative Output Voltage Connection

ENVIRONMENTAL SCREENING

Screening	MIL-STD-883	Standard (No Suffix)	Military /ML
Pre-Cap Inspection	IPC-A-610 Class II	•	•
Temperature Cycling	-55°C, 100°C, 10 cycles		•
Burn-In	96 hours at +100°C 12 hours at +100°C	•	•
Final Electrical	100% at -55°C, 25°C, 100°C[1] 100% at 25°C	•	•
Final Inspection	Method 2009	•	•

Note: 1. 100% R&R testing at –55°C, +25°C, and +100°C with all test data included in product shipment.

ORDERING INFORMATION

DV200-	28	05	D	/ML	-	XXX
1	2	3	4	5		6

(1) Product Series	(2) Nominal Input Voltage		(3) Output Voltage	
DV200-	**28**	28 Volts	**05** **12** **15**	±5 Volts ±12 Volts ±15 Volts

(4) Number of Outputs		(5) Screening Code		(6) Additional Screening Code
D	Dual	**None** **/ML**	Standard Military	Contact Sales

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.

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: sales@vpt-inc.com

VPT5-2800S Series

HIGH RELIABILITY COTS DC-DC CONVERTERS

DESCRIPTION

The VPT5 series of isolated COTS DC-DC converters is a cost effective solution for many demanding high reliability applications. A wide input voltage range accommodates nominal 28V inputs including avionics, mobile, ground systems, and other applications. Low input and output ripple, fixed operating frequency, and companion EMI filters simplify system design and compliance. A proven design heritage, no optoisolators and a rugged all metal package ensure long term reliability.

The VPT5 series is intended for harsh environments including severe vibration, shock and temperature cycling. Testing is to JESD22, MIL-STD-810, and MIL-STD-883.

These converters are designed and manufactured in the USA in a facility certified to ISO9001, J-STD-001 and IPC-A-610.

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 at Low Cost
- 5 Watts Output Power
- Wide Input Voltage Range: 15 to 50 Volts per MIL-STD-704 and MIL-STD-1275
- High Input Transient Voltage: 80 Volts for 1 sec per MIL-STD-704A
- Input Undervoltage Lockout
- Fixed Frequency
- Output Soft Start
- Current Limit Protection
- Short Circuit Protection
- Magnetic Feedback, no Optoisolators
- Wide Temperature Range, -55°C to 100°C
- Fully Encapsulated
- Six Sided Metal Rugged Enclosure
- Meets MIL-STD-461C/D/E Conducted Emissions Requirements When Used With a VPTF series EMI Filter

Figure 1 – VPT5-2800S DC-DC Converter
(Not To Scale)

11314 4th Avenue
West, Suite 206
Everett, WA 98204
http://www.vpt-inc.com

Sales Information:
Phone: (425) 353-3010
Fax: (425) 353-4030
E-mail: vptsales@vpt-inc.com

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Junction Temperature Rise to Case	+10°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-55°C to +125°C
Output Power[1]	5 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	2.5 Watts	Weight (Maximum)	20 Grams

Parameter	Conditions	VPT5-283R3S			VPT5-2805S			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	-	-	6	-	-	6	mA
	No Load	-	-	60	-	-	60	mA
Ripple Current	Full Load, 20Hz to 10MHz	-	-	50	-	-	50	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 V_{OUT}	T_{CASE} = 25°C	3.25	3.30	3.35	4.92	5.00	5.08	V
V_{OUT}	T_{CASE} = -55°C to +100°C	3.21	3.30	3.38	4.87	5.00	5.13	V
Power[3]		0	-	5	0	-	5	W
Current[3] I_{OUT}		0	-	1.52	0	-	1.0	A
Ripple Voltage V_{OUT}	Full Load, 20Hz to 10MHz	-	-	60	-	-	40	mV_{p-p}
Line Regulation V_{OUT}	V_{IN} = 15V to 50V	-	-	10	-	-	10	mV
Load Regulation V_{OUT}	No Load to Full Load	-	-	10	-	-	10	mV
EFFICIENCY		62	66	-	70	74	-	%
LOAD FAULT POWER DISSIPATION	Overload[4]	-	-	3.7	-	-	3.3	W
	Short Circuit	-	-	3	-	-	3	W
CAPACITIVE LOAD[4]		-	-	1000	-	-	1000	µF
SWITCHING FREQUENCY		425	500	550	425	500	550	kHz
ISOLATION	500 V_{DC}	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	GM @ T_C = 55°C	-	468	-	-	468	-	kHrs
DYNAMIC								
Load Step Output Transient V_{OUT}	Half Load to Full Load	-	150	250	-	100	300	mV_{PK}
Load Step Recovery[2]		-	400	600	-	300	500	µSec
Line Step Output Transient[4] V_{OUT}	V_{IN} = 16V to 40V	-	200	400	-	200	500	mV_{PK}
Line Step Recovery[2, 4]		-	400	600	-	400	600	µSec
Turn On Delay V_{OUT}	V_{IN} = 0V to 28V	-	10	20	-	10	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 110°C. 4. Verified by qualification testing.

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Junction Temperature Rise to Case	+10°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-55°C to +125°C
Output Power[1]	5 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	2.5 Watts	Weight (Maximum)	20 Grams

Parameter	Conditions	VPT5-2812S			VPT5-2815S			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	-	-	6	-	-	6	mA
	No Load	-	-	60	-	-	60	mA
Ripple Current	Full Load, 20Hz to 10MHz	-	-	50	-	-	50	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 V_{OUT}	T_{CASE} = 25°C	11.82	12.0	12.18	14.77	15.0	15.23	V
V_{OUT}	T_{CASE} = -55°C to +100°C	11.70	12.0	12.30	14.62	15.0	15.38	V
Power[3]		0	-	5	0	-	5	W
Current[3] I_{OUT}		0	-	0.42	0	-	0.33	A
Ripple Voltage V_{OUT}	Full Load, 20Hz to 10MHz	-	-	30	-	-	30	mV_{p-p}
Line Regulation V_{OUT}	V_{IN} = 15V to 50V	-	-	10	-	-	10	mV
Load Regulation V_{OUT}	No Load to Full Load	-	-	10	-	-	10	mV
EFFICIENCY		71	75	-	71	76	-	%
LOAD FAULT POWER DISSIPATION	Overload[4]	-	-	3	-	-	3	W
	Short Circuit	-	-	3	-	-	3	W
CAPACITIVE LOAD[4]		-	-	500	-	-	500	µF
SWITCHING FREQUENCY		425	500	550	425	500	550	kHz
ISOLATION	500 V_{DC}	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	GM @ T_C = 55°C	-	468	-	-	468	-	kHrs
DYNAMIC								
Load Step Output Transient V_{OUT}	Half Load to Full Load	-	200	400	-	200	400	mV_{PK}
Load Step Recovery[2]		-	200	400	-	200	400	µSec
Line Step Output Transient[4] V_{OUT}	V_{IN} = 16V to 40V	-	450	700	-	450	700	mV_{PK}
Line Step Recovery[2, 4]		-	300	500	-	300	500	µSec
Turn On Delay V_{OUT}	V_{IN} = 0V to 28V	-	10	20	-	10	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 110°C. 4. Verified by qualification testing.

BLOCK DIAGRAM

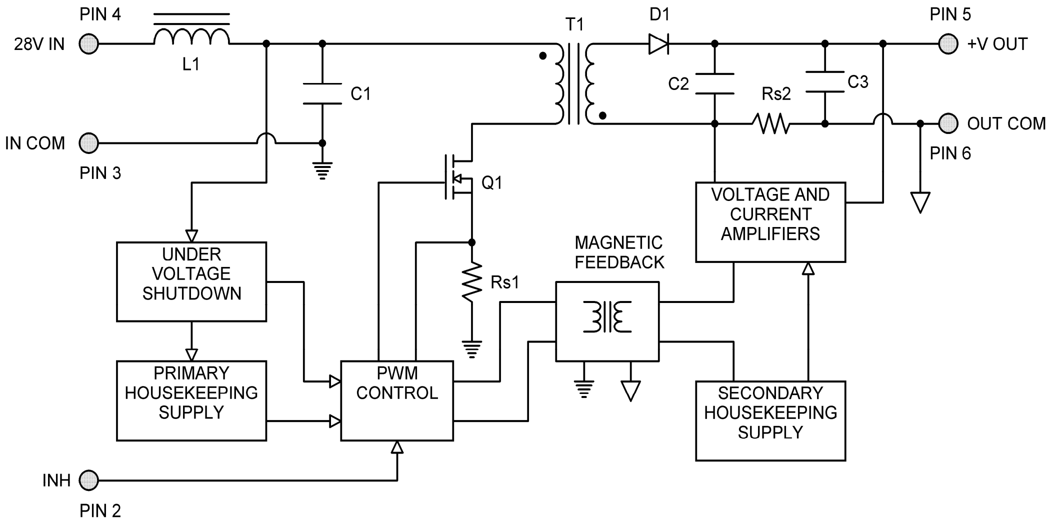


Figure 2

CONNECTION DIAGRAM

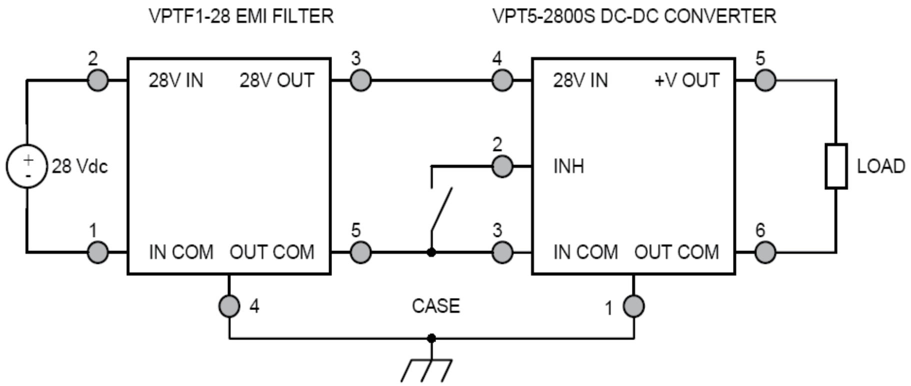


Figure 3
(Shown with optional EMI filter)

INHIBIT DRIVE CONNECTION DIAGRAMS

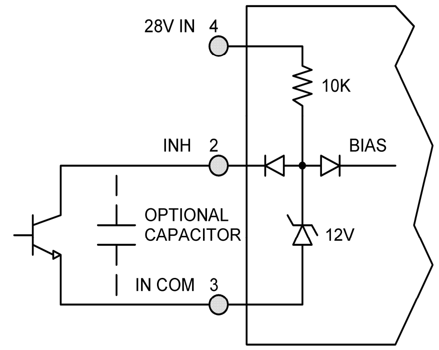


Figure 4 – Inhibit Circuit

(Shown with optional capacitor for turn-on delay)

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

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

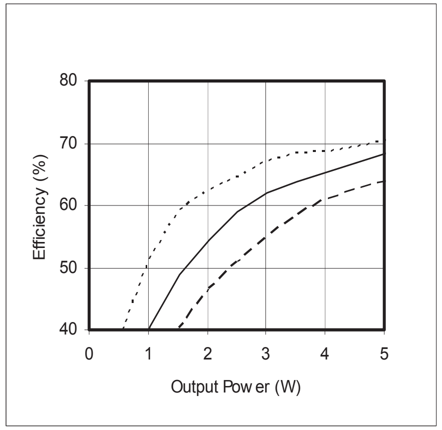


Figure 5 – VPT5-283R3S
Efficiency (%) vs. Output Power (W)

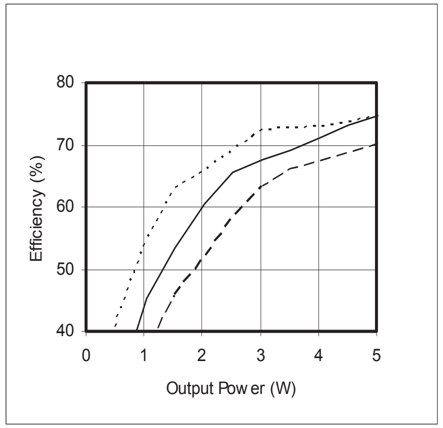


Figure 6 – VPT5-2805S
Efficiency (%) vs. Output Power (W)

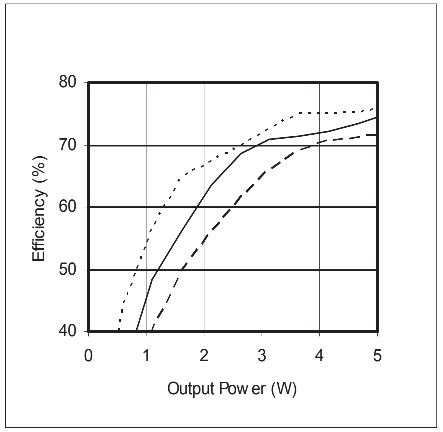


Figure 7 – VPT5-2812S
Efficiency (%) vs. Output Power (W)

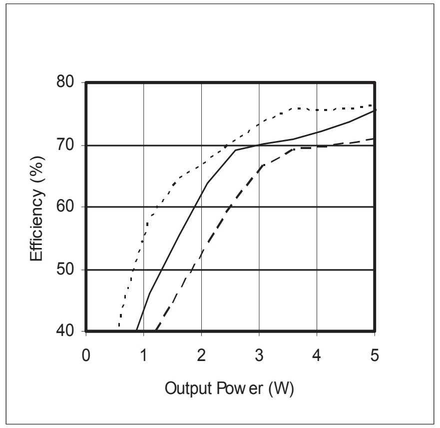


Figure 8 – VPT5-2815S
Efficiency (%) vs. Output Power (W)

VPT5-2800S Series

EMI PERFORMANCE CURVES

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

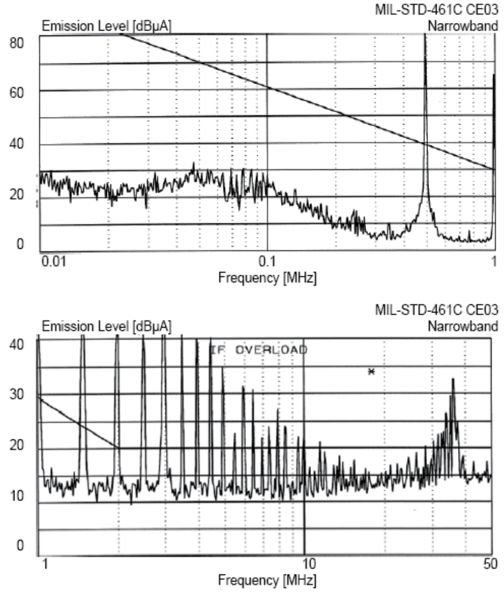


Figure 9 –VPT5-2800S without EMI Filter

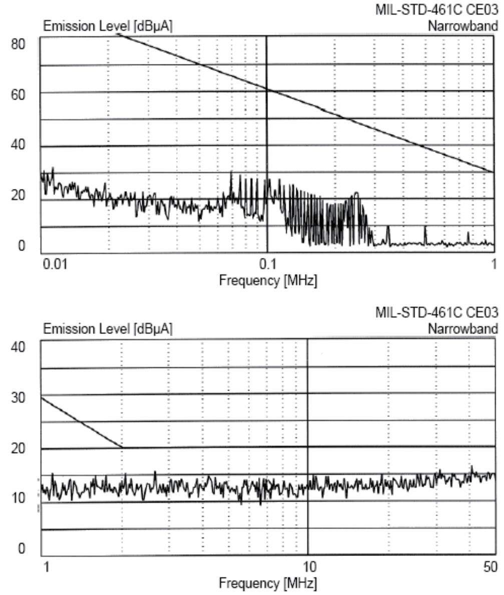


Figure 10 – VPT5-2800S with VPTF Series EMI Filter

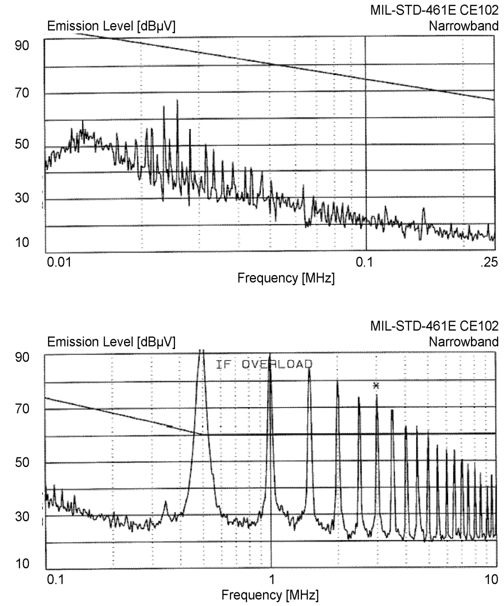


Figure 11 –VPT5-2800S without EMI Filter

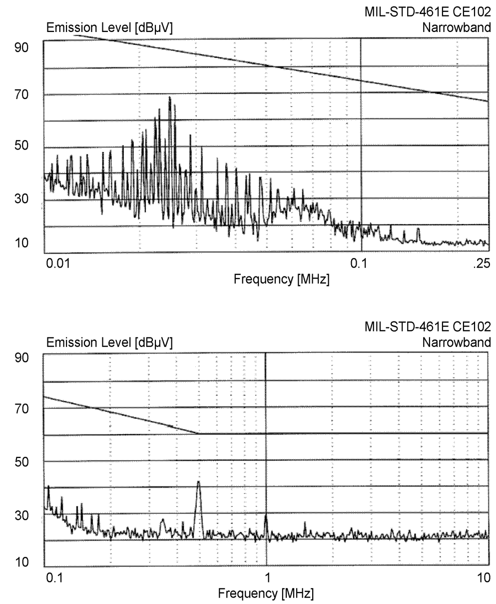
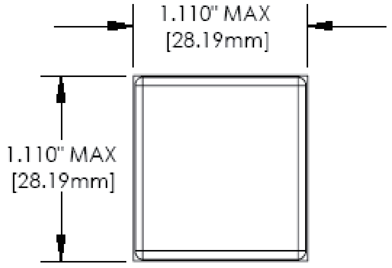
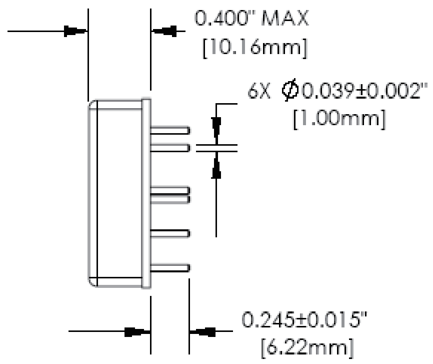


Figure 12 –VPT5-2800S with VPTF Series EMI Filter

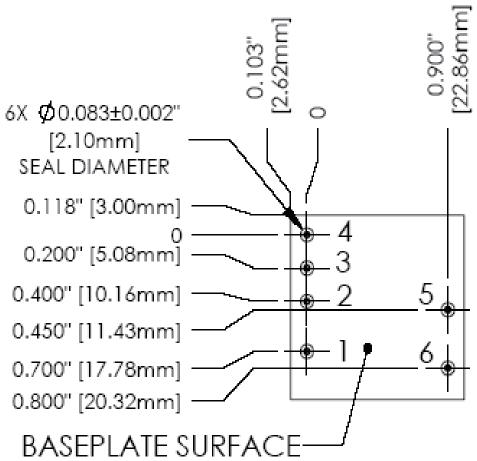
PACKAGE SPECIFICATIONS



TOP VIEW



SIDE VIEW



BOTTOM VIEW

PIN	FUNCTION
1	CASE
2	INHIBIT
3	IN COM
4	28V IN
5	+V OUT
6	OUT COM

Figure 13 – Package and Pinout
(Dimensional Limits are ±0.005" Unless Otherwise Stated)

Package Notes:
1. Case temperature is measured on the center of the baseplate surface.
2. Materials: Baseplate – aluminum, chromate conversion coating.
Cover – cold rolled steel, nickel plated.
Pins – copper, gold over nickel plating.

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	CASE	Case Connection
2	INHIBIT	This is an open collector input. Logic Low = Disabled Output. Connect the inhibit pin to input common to disable the output. Unconnected, open collector or open drain = Enabled Output.
3	IN COM	Input Return Connection
4	28V IN	Positive Input Voltage Connection
5	+V OUT	Positive Output Voltage Connection
6	OUT COM	Output Return Connection

100% ENVIRONMENTAL SCREENING

Screening	Condition
Internal Visual	IPC-A-610
Stabilization Bake	MIL-STD-883, Method 1008, Condition B, 125°C, 24 hours
Temperature Cycling	MIL-STD-883, Method 1010, Condition B, -55°C to +125°C, 10 Cycles
Burn-In	MIL-STD-883, Method 1015, 96 hours at +100°C
Final Electrical	100% at 25°C
External Visual	MIL-STD-883, Method 2009

ORDERING INFORMATION

VPT5-	28	05	S
1	2	3	4

(1)	(2)		(3)		(4)	
Product Series	**Nominal Input Voltage**		**Output Voltage**		**Number of Outputs**	
VPT5-	**28**	28 Volts	**3R3** **05** **12** **15**	3.3 Volts 5 Volts 12 Volts 15 Volts	**S**	Single

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

VPT15-2800S Series

HIGH RELIABILITY COTS DC-DC CONVERTERS

DESCRIPTION

The VPT15 series of isolated COTS DC-DC converters is a cost effective solution for many demanding high reliability applications. A wide input voltage range accommodates nominal 28V inputs including avionics, mobile, ground systems, and other applications. Low input and output ripple, fixed operating frequency, and companion EMI filters simplify system design and compliance. A proven design heritage, no optoisolators and a rugged all metal package ensure long term reliability.

The VPT15 series is intended for harsh environments including severe vibration, shock and temperature cycling. Testing is to JESD22, MIL-STD-810, and MIL-STD-883.

These converters are designed and manufactured in the USA in a facility certified to ISO9001, J-STD-001 and IPC-A-610.

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 at Low Cost
- Up to 15 Watts Maximum Output Power
- Wide Input Voltage Range: 15 to 50 Volts per MIL-STD-704 and MIL-STD-1275
- High Input Transient Voltage: 80 Volts for 1 sec per MIL-STD-704A
- Input Undervoltage Lockout
- Fixed Frequency
- Output Voltage Trim (+10% / -20%)
- Output Soft Start
- Current Limit Protection
- Short Circuit Protection
- Magnetic Feedback, no Optoisolators
- Wide Temperature Range, -55°C to 100°C
- Fully Encapsulated
- Six Sided Metal Rugged Enclosure
- Meets MIL-STD-461C/D/E Conducted Emissions Requirements When Used With a VPTF series EMI Filter

Figure 1 – VPT15-2800S Converter
(Not To Scale)

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Everett, WA 98204
http://www.vpt-inc.com

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SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, 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	-55°C to +125°C
Output Power[1]	15 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	6 Watts	Weight (Maximum)	33 Grams

Parameter		Conditions	VPT15-283R3S			VPT15-2805S			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	-	-	6	-	-	6	mA
		No Load	-	40	65	-	40	65	mA
Ripple Current		Full Load, 20Hz to 10MHz	-	-	80	-	-	80	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	V_{OUT}	T_{CASE} = 25°C	3.25	3.30	3.35	4.92	5.00	5.08	V
	V_{OUT}	T_{CASE} = -55°C to +100°C	3.21	3.30	3.38	4.87	5.00	5.13	V
Power[3]			0	-	10	0	-	15	W
Current[3]	V_{OUT}		0	-	3.0	0	-	3.0	A
Ripple Voltage	V_{OUT}	Full Load, 20Hz to 10MHz	-	-	40	-	-	40	mV_{p-p}
Line Regulation	V_{OUT}	V_{IN} = 15V to 50V	-	-	10	-	-	10	mV
Load Regulation	V_{OUT}	No Load to Full Load	-	-	10	-	-	10	mV
EFFICIENCY			65	68	-	72	75	-	%
LOAD FAULT POWER DISSIPATION		Overload[4]	-	-	8	-	-	8	W
		Short Circuit	-	-	8	-	-	8	W
CAPACITIVE LOAD[4]			-	-	1000	-	-	1000	µF
SWITCHING FREQUENCY			400	500	550	400	500	550	kHz
ISOLATION		500 V_{DC}	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)		GM @ T_C = 55°C	-	445	-	-	445	-	kHrs
DYNAMIC									
Load Step Output Transient	V_{OUT}	Half Load to Full Load	-	170	250	-	170	250	mV_{PK}
Load Step Recovery[2]			-	300	450	-	300	450	µSec
Line Step Output Transient[4]	V_{OUT}	V_{IN} = 16V to 40V	-	300	450	-	300	450	mV_{PK}
Line Step Recovery[2, 4]			-	400	550	-	400	550	µSec
Turn On Delay	V_{OUT}	V_{IN} = 0V to 28V	-	10	20	-	10	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 110°C. 4. Verified by qualification testing.

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, 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	-55°C to +125°C
Output Power[1]	15 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	6 Watts	Weight (Maximum)	33 Grams

Parameter		Conditions	VPT15-2812S			VPT15-2815S			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	-	-	6	-	-	6	mA
		No Load	-	40	65	-	40	65	mA
Ripple Current		Full Load, 20Hz to 10MHz	-	-	80	-	-	80	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	V_{OUT}	T_{CASE} = 25°C	11.82	12.0	12.18	14.77	15.0	15.23	V
	V_{OUT}	T_{CASE} = -55°C to +100°C	11.70	12.0	12.30	14.62	15.0	15.38	V
Power[3]			0	-	15	0	-	15	W
Current[3]	V_{OUT}		0	-	1.25	0	-	1.0	A
Ripple Voltage	V_{OUT}	Full Load, 20Hz to 10MHz	-	-	30	-	-	30	mV_{p-p}
Line Regulation	V_{OUT}	V_{IN} = 15V to 50V	-	-	10	-	-	10	mV
Load Regulation	V_{OUT}	No Load to Full Load	-	-	10	-	-	10	mV
EFFICIENCY			77	80	-	77	80	-	%
LOAD FAULT POWER DISSIPATION		Overload[4]	-	-	8	-	-	8	W
		Short Circuit	-	-	8	-	-	8	W
CAPACITIVE LOAD[4]			-	-	500	-	-	500	µF
SWITCHING FREQUENCY			400	500	550	400	500	550	kHz
ISOLATION		500 V_{DC}	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)		GM @ T_C = 55°C	-	445	-	-	445	-	kHrs
DYNAMIC									
Load Step Output Transient	V_{OUT}	Half Load to Full Load	-	250	350	-	250	350	mV_{PK}
Load Step Recovery[2]			-	150	250	-	150	250	µSec
Line Step Output Transient[4]	V_{OUT}	V_{IN} = 16V to 40V	-	450	700	-	450	700	mV_{PK}
Line Step Recovery[2, 4]			-	400	550	-	400	550	µSec
Turn On Delay	V_{OUT}	V_{IN} = 0V to 28V	-	10	20	-	10	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 110°C. 4. Verified by qualification testing.

BLOCK DIAGRAM

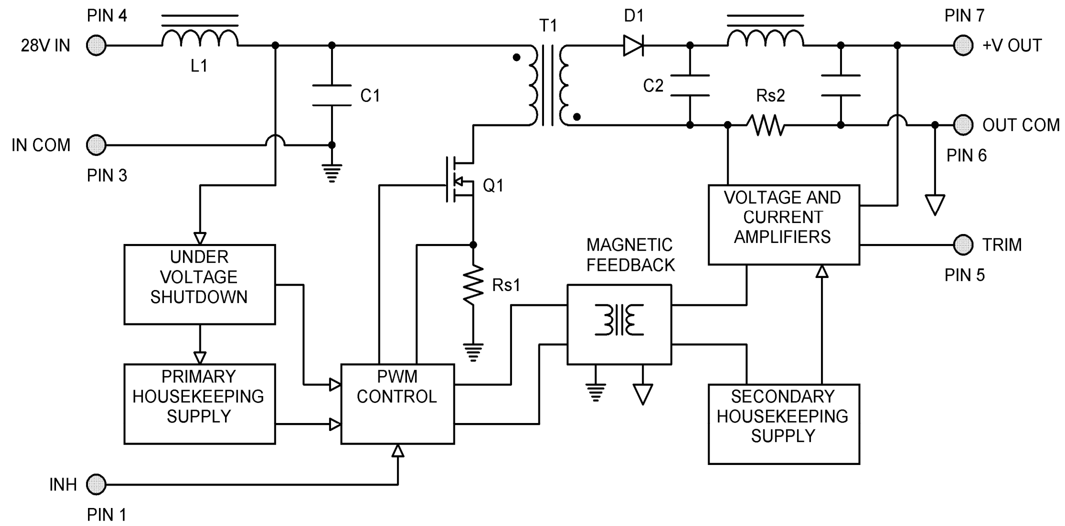


Figure 2

CONNECTION DIAGRAM

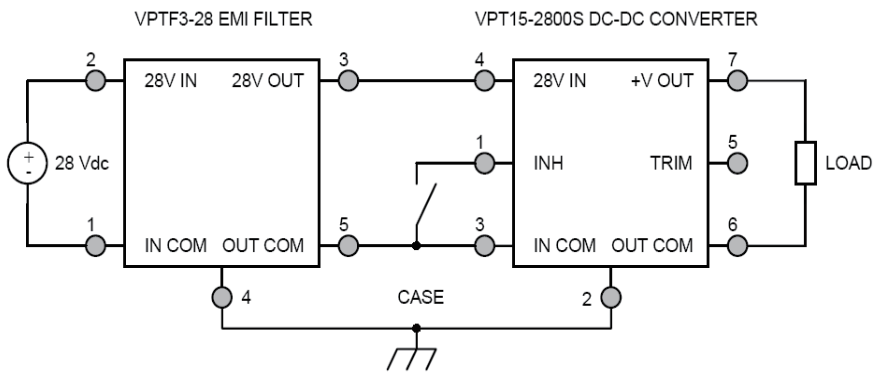


Figure 3
(Shown with optional EMI filter)

CONNECTION DIAGRAMS

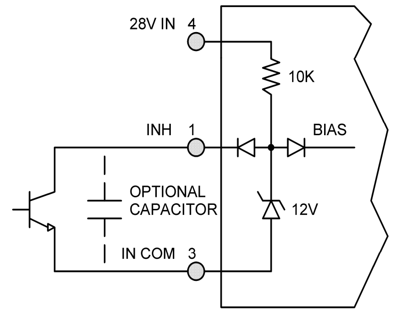


Figure 4 –Inhibit Circuit

(Shown with optional capacitor for turn-on delay)

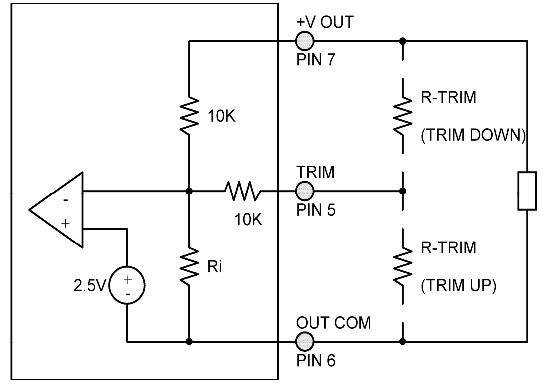


Figure 5 – Output Voltage Trim Circuit

OUTPUT VOLTAGE TRIM

The output voltage can be trimmed down by connecting a resistor between the TRIM pin and the +V OUT pin, or can be trimmed up by connecting a resistor between the TRIM pin and the OUT COM pin as shown in Figure 5. 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.

VPT15-283R3S		VPT15-2805S		VPT15-2812S		VPT15-2815S	
$+V_{OUT}$ (V)	R_{TRIM} (Ω)	$+V_{OUT}$ (V)	R_{TRIM} (Ω)	$+V_{OUT}$ (V)	R_{TRIM} (Ω)	$+V_{OUT}$ (V)	R_{TRIM} (Ω)
3.60	7.27k	5.5	39.6k	13.2	10.7k	16.50	6.5k
3.55	89.2k	5.4	52k	13.0	14.8k	16.25	9.8k
3.50	114k	5.3	72.6k	12.8	21k	16.00	14.8k
3.45	155k	5.2	113.9k	12.6	31.3k	15.75	23k
3.40	238k	5.1	237k	12.4	51.9k	15.50	39.6k
3.35	487k	5.0	--	12.2	114k	15.25	89k
3.30	--	4.9	232.5k	12.0	--	15.00	--
3.25	144k	4.8	106.1k	11.8	457k	14.75	482k
3.20	61.9k	4.7	64k	11.6	218k	14.50	231k
3.15	34.7k	4.6	43k	11.4	139k	14.25	147k
3.10	21k	4.5	30.4k	11.2	99k	14.00	105k
3.05	12.79k	4.4	22k	11.0	75.2k	13.75	80.2k
3.00	7.33k	4.3	16k	10.8	59.4k	13.50	63.5k
		4.2	11.5k	10.6	48k	13.25	51.6k
		4.1	8.0k	10.4	39.5k	13.00	42.6k
		4.0	5.2k	10.2	32.9k	12.75	35.6k
				10.0	27.6k	12.50	30k
				9.8	23.3k	12.25	25.5k
				9.6	19.7k	12.00	21.7k

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

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

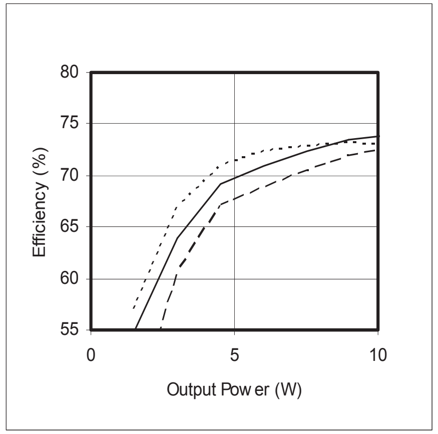


Figure 6 – VPT15-283R3S
Efficiency (%) vs. Output Power (W)

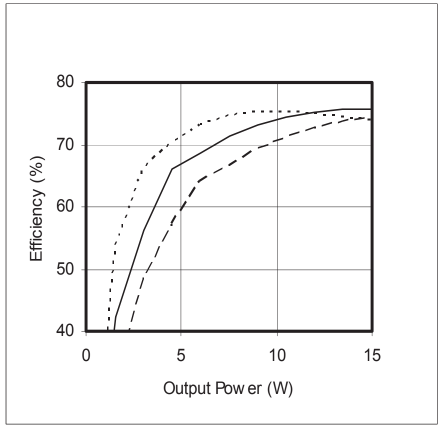


Figure 7 – VPT15-2805S
Efficiency (%) vs. Output Power (W)

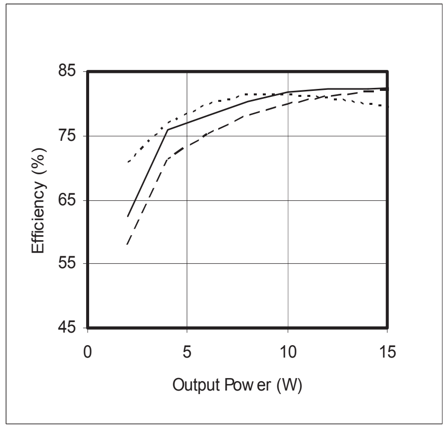


Figure 8 – VPT15-2812S
Efficiency (%) vs. Output Power (W)

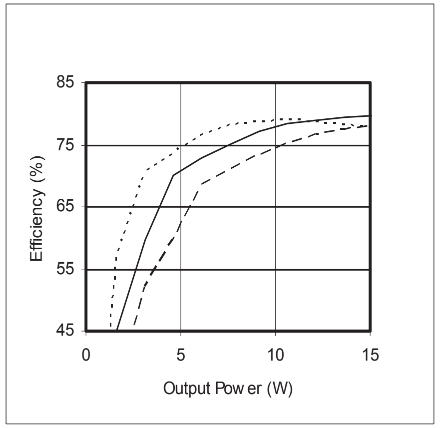


Figure 9 – VPT15-2815S
Efficiency (%) vs. Output Power (W)

EMI PERFORMANCE CURVES

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

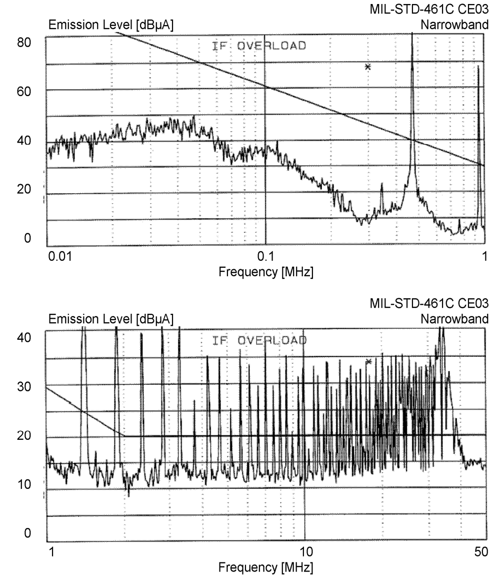


Figure 10 – VPT15-2800S without EMI Filter

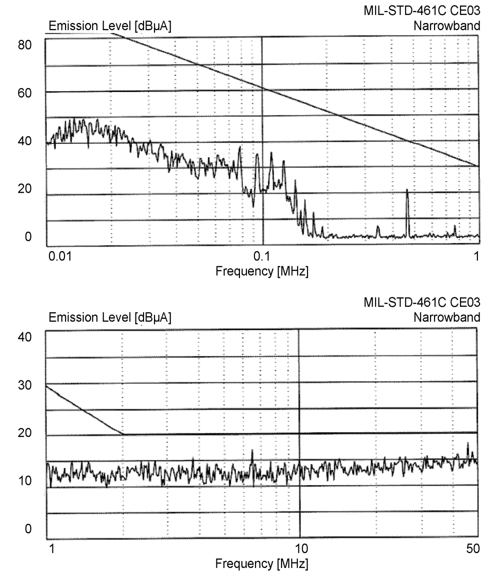


Figure 11 – VPT15-2800S with VPTF Series EMI Filter

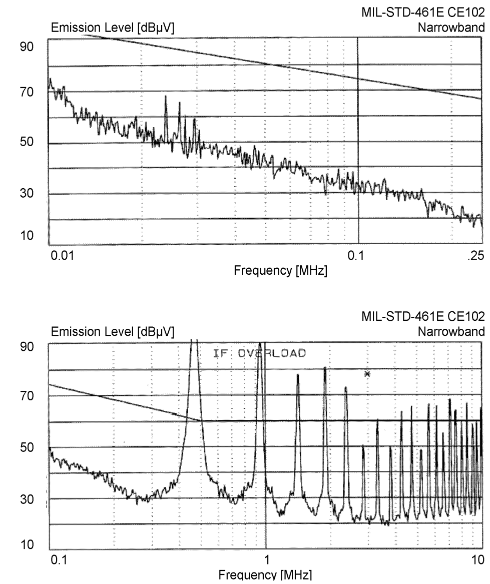


Figure 12 – VPT15-2800S without VPTF Series EMI Filter

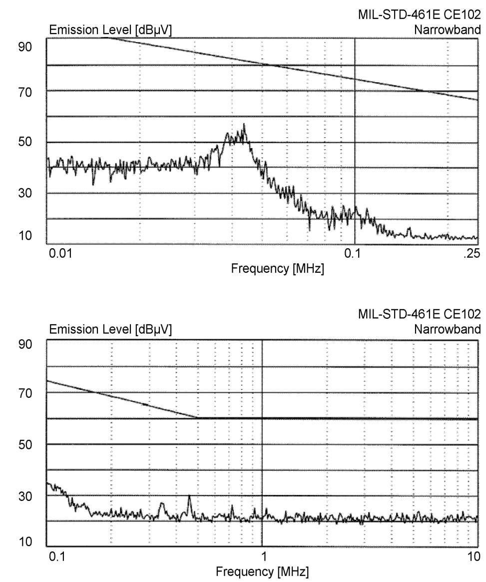
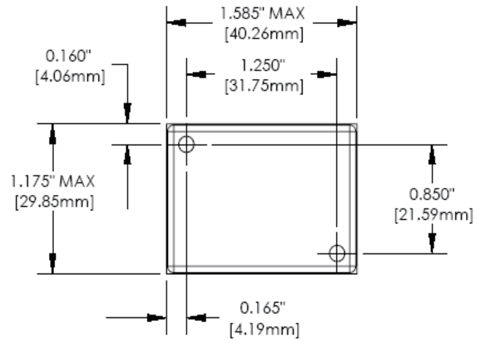
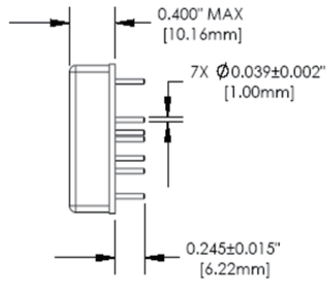


Figure 13 –VPT15-2800S with VPTF Series EMI Filter

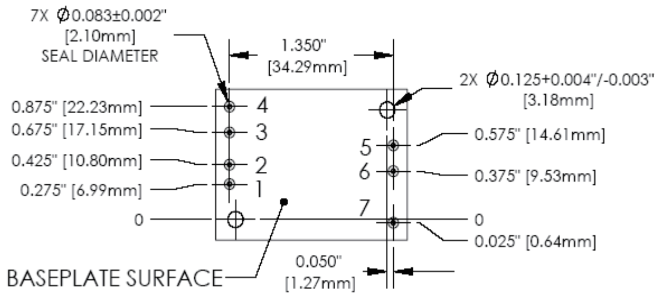
PACKAGE SPECIFICATIONS



TOP VIEW



SIDE VIEW



PIN	FUNCTION
1	INHIBIT
2	CASE
3	IN COM
4	28V IN
5	TRIM
6	OUT COM
7	+V OUT

BOTTOM VIEW

Figure 14 – Package and Pinout
(Dimensional Limits are ±0.005" Unless Otherwise Stated)

Package Notes:
1. Case temperature is measured on the center of the baseplate surface.
2. Materials: Baseplate – aluminum, chromate conversion coating.
   Cover – cold rolled steel, nickel plated.
   Pins – copper, gold over nickel plating.
3. Mounting holes are not threaded. Recommended fastener is 4-40.

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	INHIBIT	This is an open collector input. Logic Low = Disabled Output. Connect the inhibit pin to input common to disable the output. Unconnected, open collector or open drain = Enabled Output.
2	CASE	Case Connection.
3	IN COM	Input Return Connection.
4	28V IN	Positive Input Voltage Connection.
5	TRIM	Trim Output Voltage to +10%, -20% of Nominal Value. Leave open if not used.
6	OUT COM	Output Return Connection.
7	+V OUT	Positive Output Voltage Connection.

100% ENVIRONMENTAL SCREENING

Screening	Condition
Internal Visual	IPC-A-610
Stabilization Bake	MIL-STD-883, Method 1008, Condition B, 125°C, 24 hours
Temperature Cycling	MIL-STD-883, Method 1010, Condition B, -55°C to +125°C, 10 Cycles
Burn-In	MIL-STD-883, Method 1015, 96 hours at +100°C
Final Electrical	100% at 25°C
External Visual	MIL-STD-883, Method 2009

ORDERING INFORMATION

VPT15-	28	05	S
1	2	3	4

(1)	(2)		(3)		(4)	
Product Series	**Nominal Input Voltage**		**Output Voltage**		**Number of Outputs**	
VPT15-	**28**	28 Volts	**3R3** **05** **12** **15**	3.3 Volts 5 Volts 12 Volts 15 Volts	**S**	Single

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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VPT15-2800D Series

HIGH RELIABILITY COTS DC-DC CONVERTERS

DESCRIPTION

The VPT15 series of isolated COTS DC-DC converters is a cost effective solution for many demanding high reliability applications. A wide input voltage range accommodates nominal 28V inputs including avionics, mobile, ground systems, and other applications. Low input and output ripple, fixed operating frequency, and companion EMI filters simplify system design and compliance. A proven design heritage, no optoisolators and a rugged all metal package ensure long term reliability.

The VPT15 series is intended for harsh environments including severe vibration, shock and temperature cycling. Testing is to JESD22, MIL-STD-810, and MIL-STD-883.

These converters are designed and manufactured in the USA in a facility certified to ISO9001, J-STD-001 and IPC-A-610.

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 at Low Cost
- 15 Watts Output Power
- Wide Input Voltage Range: 15 to 50 Volts per MIL-STD-704 and MIL-STD-1275
- High Input Transient Voltage: 80 Volts for 1 sec per MIL-STD-704A
- Input Undervoltage Lockout
- Fixed Frequency
- Output Soft Start
- Current Limit Protection
- Short Circuit Protection
- Magnetic Feedback, no Optoisolators
- Wide Temperature Range, -55°C to 100°C
- Fully Encapsulated
- Six Sided Metal Rugged Enclosure
- Meets MIL-STD-461C/D/E Conducted Emissions Requirements When Used With a VPTF series EMI Filter

Figure 1 – VPT15-2800D Converter
(Not To Scale)

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SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, 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	-55°C to +125°C
Output Power[1]	15 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	6 Watts	Weight (Maximum)	31 Grams

Parameter		Conditions	VPT15-2805D			VPT15-2812D			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	-	-	6	-	-	6	mA
		No Load	-	40	65	-	40	65	mA
Ripple Current		Full Load, 20Hz to 10MHz	-	-	75	-	-	75	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	4.92	5.00	5.08	11.82	12.00	12.18	V
	$+V_{OUT}$	T_{CASE} = -55°C to +100°C	4.87	5.00	5.13	11.70	12.00	12.30	V
	$-V_{OUT}$	T_{CASE} = 25°C	4.87	5.00	5.13	11.70	12.00	12.30	V
	$-V_{OUT}$	T_{CASE} = -55°C to +100°C	4.82	5.00	5.18	11.58	12.00	12.42	V
Power[3,6]	Total		0	-	15	0	-	15	W
	±Vout	Either Output	0	-	10.5	0	-	10.5	W
Current[3,6]	$\pm V_{OUT}$	Either Output	0	-	2.1	0	-	0.88	A
Ripple Voltage	$\pm V_{OUT}$	Full Load[5], 20Hz to 10MHz	-	-	50	-	-	50	mV_{P-P}
Line Regulation	$+V_{OUT}$	V_{IN} = 15V to 50V	-	-	10	-	-	10	mV
	$-V_{OUT}$	V_{IN} = 15V to 50V	-	-	150	-	-	150	mV
Load Regulation	$+V_{OUT}$	No Load to Full Load[5]	-	-	10	-	-	10	mV
	$-V_{OUT}$	No Load to Full Load[5,7]	-	-	150	-	-	150	mV
Cross Regulation	$-V_{OUT}$	+Load 70%, -Load 30% +Load 30%, -Load 70%	-	-	400	-	-	500	mV
EFFICIENCY		Full Load[5]	72	-	-	77	-	-	%
LOAD FAULT POWER DISSIPATION		Overload[4]	-	-	8	-	-	8	W
		Short Circuit	-	-	8	-	-	8	W
CAPACITIVE LOAD[4]		Either Output	-	-	500	-	-	500	µF
SWITCHING FREQUENCY			400	500	550	400	500	550	kHz
ISOLATION		500 V_{DC}	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)		GM @ T_C = 55°C	-	363	-	-	363	-	kHrs

See notes on next page.

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, 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	-55°C to +125°C
Output Power[1]	15 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	6 Watts	Weight (Maximum)	31 Grams

Parameter		Conditions	VPT15-2805D			VPT15-2812D			Units
			Min	Typ	Max	Min	Typ	Max	
DYNAMIC									
Load Step Output Transient	$\pm V_{OUT}$	Half Load to Full Load	-	200	400	-	200	400	mV_{PK}
Load Step Recovery[2]			-	300	500	-	300	500	µSec
Line Step Output Transient[4]	$\pm V_{OUT}$	V_{IN} = 16V to 40V	-	400	900	-	400	900	mV_{PK}
Line Step Recovery[2, 4]			-	400	700	-	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 110°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 either of the two outputs.
7. 5% Load to Full Load at -55°C.

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, 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	-55°C to +125°C
Output Power[1]	15 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	6 Watts	Weight (Maximum)	31 Grams

Parameter		Conditions	VPT15-2815D			Units
			Min	Typ	Max	
STATIC						
INPUT Voltage[4]		Continuous	15	28	50	V
		Transient, 1 sec	-	-	80	V
Current		Inhibited	-	-	6	mA
		No Load	-	40	65	mA
Ripple Current		Full Load[5], 20Hz to 10MHz	-	-	75	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	$+V_{OUT}$	T_{CASE} = 25°C	14.77	15.0	15.23	V
	$+V_{OUT}$	T_{CASE} = -55°C to +100°C	14.62	15.0	15.38	V
	$-V_{OUT}$	T_{CASE} = 25°C	14.62	15.0	15.38	V
	$-V_{OUT}$	T_{CASE} = -55°C to +100°C	14.47	15.0	15.53	V
Power[3,6]	Total		0	-	15	W
	±Vout	Either Output	0	-	10.5	W
Current[3,6]	$\pm V_{OUT}$	Either Output	0	-	0.7	A
Ripple Voltage	$\pm V_{OUT}$	Full Load[5], 20Hz to 10MHz	-	-	50	mV_{p-p}
Line Regulation	$+V_{OUT}$	V_{IN} = 15V to 50V	-	-	10	mV
	$-V_{OUT}$	V_{IN} = 15V to 50V	-	-	150	mV
Load Regulation	$+V_{OUT}$	No Load to Full Load[5]	-	-	10	mV
	$-V_{OUT}$	No Load to Full Load[5,7]	-	-	150	mV
Cross Regulation	$-V_{OUT}$	+Load 70%, -Load 30% +Load 30%, -Load 70%	-	-	500	mV
EFFICIENCY		Full Load[5]	77	-	-	%
LOAD FAULT POWER DISSIPATION		Overload[4]	-	-	8	W
		Short Circuit	-	-	8	W
CAPACITIVE LOAD[4]		Either Output	-	-	500	µF
SWITCHING FREQUENCY			400	500	550	kHz
ISOLATION		500 V_{DC}	100	-	-	MΩ
MTBF (MIL-HDBK-217F)		GM @ T_C = 55°C	-	363	-	kHrs

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, 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	-55°C to +125°C
Output Power[1]	15 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	6 Watts	Weight (Maximum)	31 Grams

Parameter		Conditions	VPT15-2815D			Units
			Min	Typ	Max	
DYNAMIC						
Load Step Output Transient	$\pm V_{OUT}$	Half Load to Full Load[5]	-	200	400	mV_{PK}
Load Step Recovery[2]			-	300	500	µSec
Line Step Output Transient[4]	$\pm V_{OUT}$	V_{IN} = 16V to 40V	-	400	900	mV_{PK}
Line Step Recovery[2, 4]			-	300	500	µSec
Turn On Delay	$\pm V_{OUT}$	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 110°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

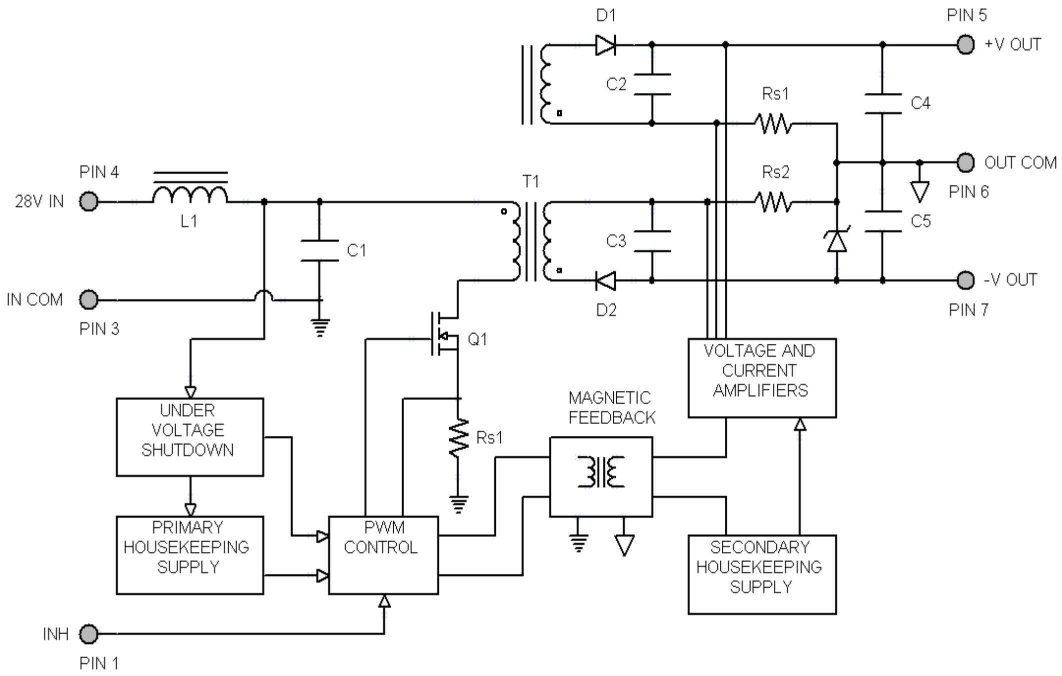


Figure 2

CONNECTION DIAGRAM

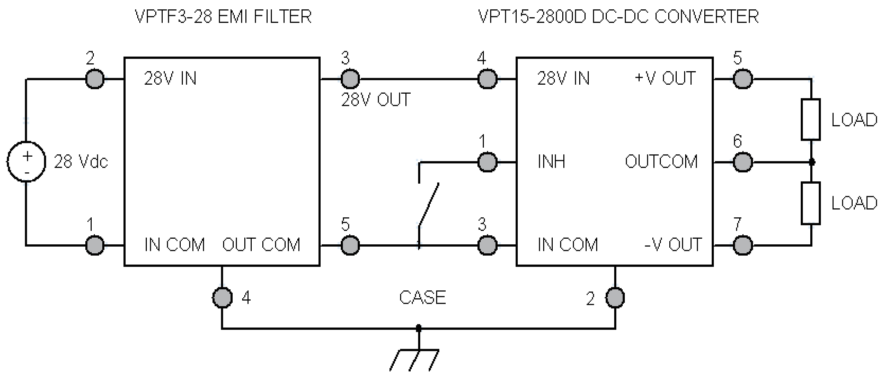


Figure 3
(Shown with optional EMI filter)

CONNECTION DIAGRAMS

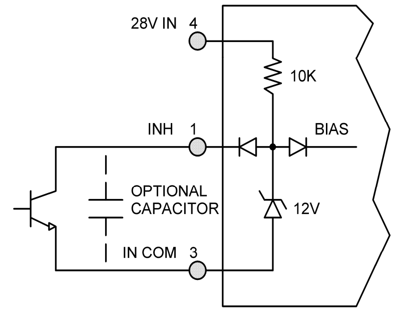


Figure 4 –Inhibit Circuit
(Shown with optional capacitor for turn-on delay)

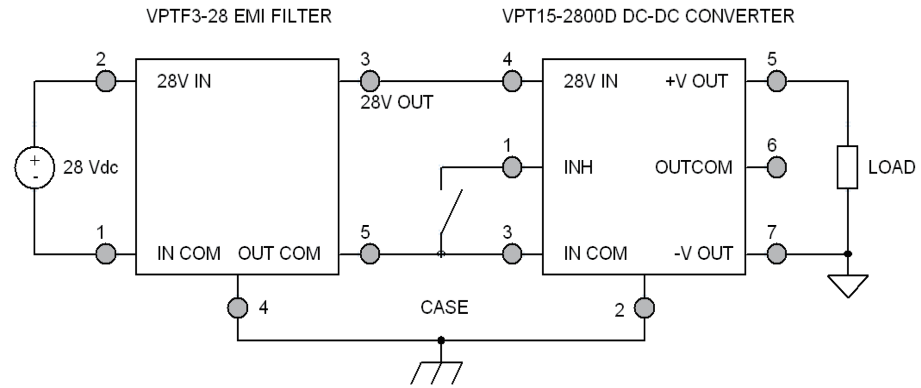


Figure 5 – Stacked Output Connection
(Shown with optional EMI filter)

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

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

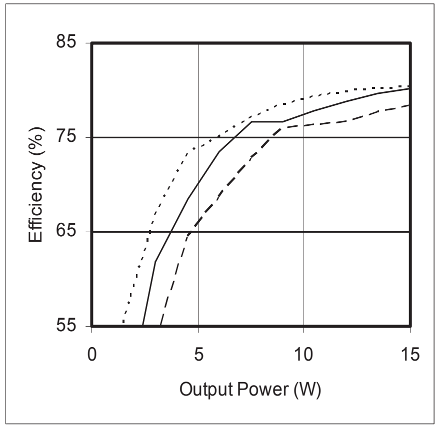


Figure 6 – VPT15-2805D
Efficiency (%) vs. Output Power (W)

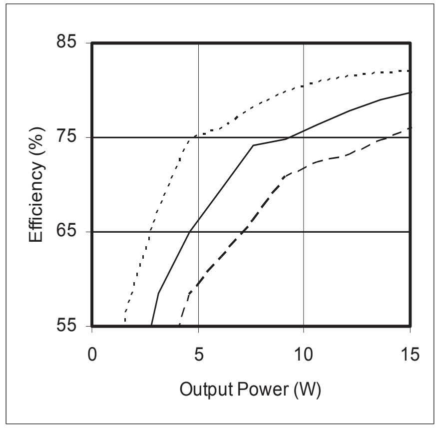


Figure 7 – VPT15-2812D
Efficiency (%) vs. Output Power (W)

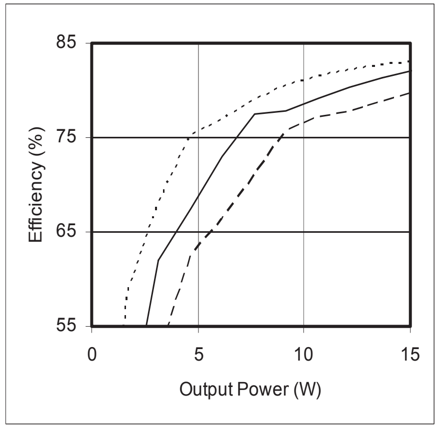


Figure 8 – VPT15-2815D
Efficiency (%) vs. Output Power (W)

EMI PERFORMANCE CURVES

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

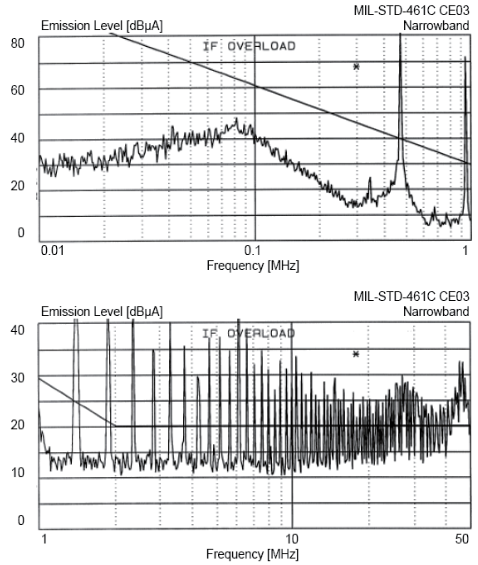


Figure 9 – VPT15-2800D without EMI Filter

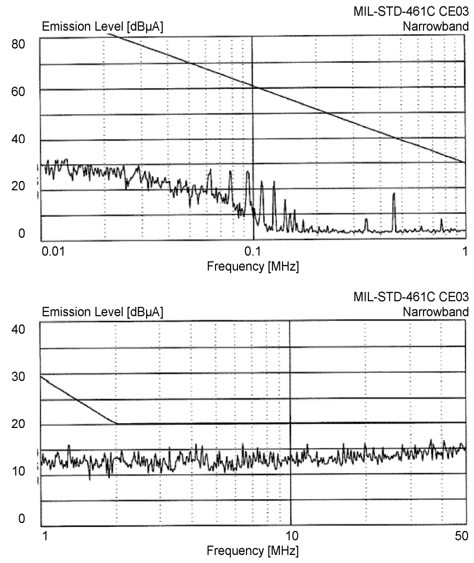


Figure 10 – VPT15-2800D with VPTF Series EMI Filter

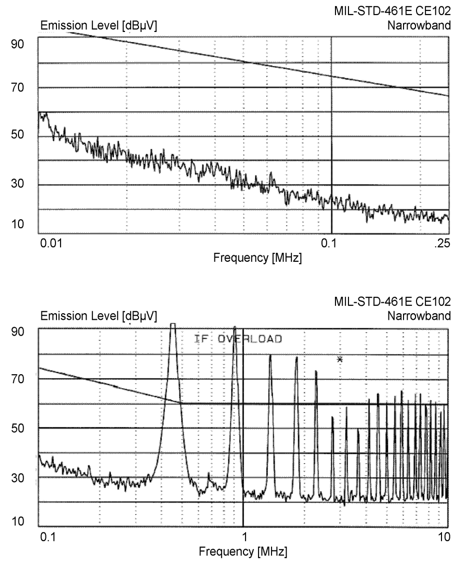


Figure 11 – VPT15-2800D without VPTF Series EMI Filter

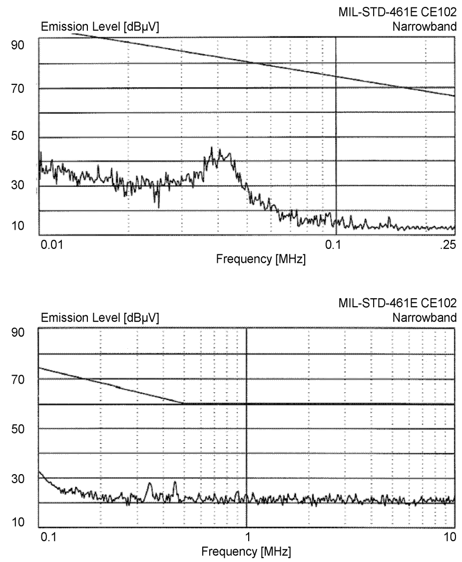
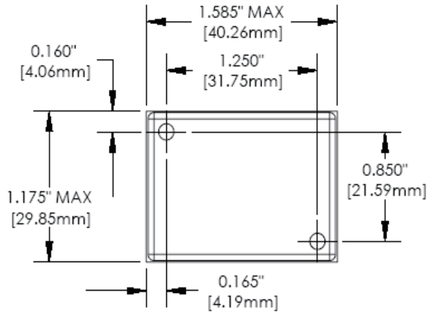
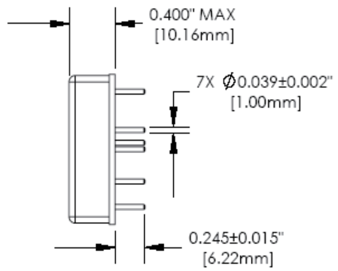


Figure 11 – VPT15-2800D with VPTF Series EMI Filter

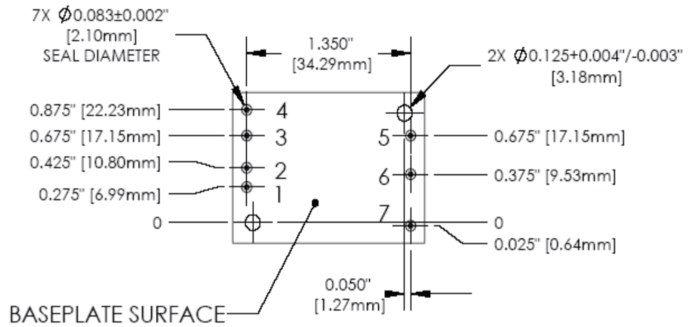
PACKAGE SPECIFICATIONS



TOP VIEW



SIDE VIEW



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

BOTTOM VIEW

Figure 13 – Package and Pinout
(Dimensional Limits are ±0.005" Unless Otherwise Stated)

Package Notes:
1. Case temperature is measured on the center of the baseplate surface.
2. Materials: Baseplate – aluminum, chromate conversion coating.
   Cover – steel, nickel plated.
   Pins – copper, gold over nickel plating.
3. Mounting holes are not threaded. Recommended fastener is 4-40.

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	INHIBIT	This is an open collector input. Logic Low = Disabled Output. Connect the inhibit pin to input common to disable the output. Unconnected, open collector or open drain = Enabled Output.
2	CASE	Case Connection.
3	IN COM	Input Return Connection.
4	28V IN	Positive Input Voltage Connection.
5	+VOUT	Positive Output Voltage Connection.
6	OUT COM	Output Return Connection.
7	-V OUT	Negative Output Voltage Connection.

100% ENVIRONMENTAL SCREENING

Screening	Condition
Internal Visual	IPC-A-610
Stabilization Bake	MIL-STD-883, Method 1008, Condition B, 125°C, 24 hours
Temperature Cycling	MIL-STD-883, Method 1010, Condition B, -55°C to +125°C, 10 Cycles
Burn-In	MIL-STD-883, Method 1015, 96 hours at +100°C
Final Electrical	100% at 25°C
External Visual	MIL-STD-883, Method 2009

ORDERING INFORMATION

VPT15-	28	05	D
1	2	3	4

(1) Product Series	(2) Nominal Input Voltage		(3) Output Voltage		(4) Number of Outputs	
VPT15-	**28**	28 Volts	**05** **12** **15**	±5 Volts ±12 Volts ±15 Volts	**D**	Dual

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

VPT30-2800S Series

HIGH RELIABILITY COTS DC-DC CONVERTERS

DESCRIPTION

The VPT30 series of isolated COTS DC-DC converters is a cost effective solution for many demanding high reliability applications. A wide input voltage range accommodates nominal 28V inputs including avionics, mobile, ground systems, and other applications. Low input and output ripple, fixed operating frequency, and companion EMI filters simplify system design and compliance. A proven design heritage, no optoisolators and a rugged all metal package ensure long term reliability.

The VPT30 series is intended for harsh environments including severe vibration, shock and temperature cycling. Testing is to JESD22, MIL-STD-810, and MIL-STD-883.

These converters are designed and manufactured in the USA in a facility certified to ISO9001, J-STD-001 and IPC-A-610.

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 at Low Cost
- Up to 30 Watts Maximum Output Power
- Wide Input Voltage Range: 15 to 50 Volts per MIL-STD-704 and MIL-STD-1275
- High Input Transient Voltage: 80 Volts for 1 sec per MIL-STD-704A
- Input Undervoltage Lockout
- Fixed Frequency
- Output Voltage Trim (+10% / -20%)
- Remote Sense
- Frequency Synchronization
- Output Soft Start
- Current Limit Protection
- Short Circuit Protection
- Magnetic Feedback, no Optoisolators
- Wide Temperature Range, -55°C to 100°C
- Fully Encapsulated
- Six Sided Metal Rugged Enclosure
- Meets MIL-STD-461C/D/E Conducted Emissions Requirements When Used With a VPTF series EMI Filter

Figure 1 – VPT30-2800S Converter
(Not To Scale)

11314 4th Avenue
West, Suite 206
Everett, WA 98204
http://www.vpt-inc.com

Sales Information:
Phone: (425) 353-3010
Fax: (425) 353-4030
E-mail: vptsales@vpt-inc.com

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Junction Temperature Rise to Case	+17°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-55°C to +125°C
Output Power[1]	30 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	14 Watts	Weight (Maximum)	41 Grams

Parameter	Conditions	VPT30-283R3S			VPT30-2805S			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	-	-	6	-	-	6	mA
	No Load	-	50	80	-	50	80	mA
Ripple Current	Full Load, 20Hz to 10MHz	-	-	75	-	-	85	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 V_{OUT}	T_{CASE} = 25°C	3.25	3.30	3.35	4.92	5.00	5.08	V
V_{OUT}	T_{CASE} = -55°C to +100°C	3.21	3.30	3.38	4.87	5.00	5.13	V
Power[3]		0	-	25	0	-	30	W
Current[3] V_{OUT}		0	-	7.6	0	-	6.0	A
Ripple Voltage V_{OUT}	Full Load, 20Hz to 10MHz	-	-	50	-	-	50	mV_{p-p}
Line Regulation V_{OUT}	V_{IN} = 15V to 50V	-	-	10	-	-	10	mV
Load Regulation V_{OUT}	No Load to Full Load	-	-	10	-	-	10	mV
EFFICIENCY		65	-	-	72	-	-	%
LOAD FAULT POWER DISSIPATION	Overload[4]	-	-	16	-	-	16	W
	Short Circuit	-	-	16	-	-	16	W
CAPACITIVE LOAD[4]		-	-	1000	-	-	1000	µF
SWITCHING FREQUENCY		400	450	550	400	450	550	kHz
SYNC FREQUENCY RANGE	V_H - V_L = 5V, D = 20-80%	500	-	600	500	-	600	kHz
ISOLATION	500 V_{DC}	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	GM @ T_C = 55°C	-	418	-	-	418	-	kHrs
DYNAMIC								
Load Step Output Transient V_{OUT}	Half Load to Full Load	-	200	400	-	250	500	mV_{PK}
Load Step Recovery[2]		-	300	500	-	300	500	µSec
Line Step Output Transient[4] V_{OUT}	V_{IN} = 16V to 40V	-	350	600	-	350	600	mV_{PK}
Line Step Recovery[2, 4]		-	400	600	-	400	600	µSec
Turn On Delay V_{OUT}	V_{IN} = 0V to 28V	-	10	20	-	10	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 110°C. 4. Verified by qualification testing.

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Junction Temperature Rise to Case	+17°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-55°C to +125°C
Output Power[1]	30 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	14 Watts	Weight (Maximum)	41 Grams

Parameter	Conditions	VPT30-2812S			VPT30-2815S			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	-	-	6	-	-	6	mA
	No Load	-	50	80	-	50	80	mA
Ripple Current	Full Load, 20Hz to 10MHz	-	-	75	-	-	75	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 V_{OUT}	T_{CASE} = 25°C	11.82	12.0	12.18	14.77	15.0	15.23	V
V_{OUT}	T_{CASE} = -55°C to +100°C	11.70	12.0	12.30	14.62	15.0	15.38	V
Power[3]		0	-	30	0	-	30	W
Current[3] V_{OUT}		0	-	2.5	0	-	2.0	A
Ripple Voltage V_{OUT}	Full Load, 20Hz to 10MHz	-	-	50	-	-	50	mV_{p-p}
Line Regulation V_{OUT}	V_{IN} = 15V to 50V	-	-	10	-	-	10	mV
Load Regulation V_{OUT}	No Load to Full Load	-	-	10	-	-	10	mV
EFFICIENCY		76	-	-	77	-	-	%
LOAD FAULT POWER DISSIPATION	Overload[4]	-	-	14	-	-	14	W
	Short Circuit	-	-	14	-	-	14	W
CAPACITIVE LOAD[4]		-	-	500	-	-	500	µF
SWITCHING FREQUENCY		400	450	550	400	450	550	kHz
SYNC FREQUENCY RANGE	V_H - V_L = 5V, D = 20-80%	500	-	600	500	-	600	kHz
ISOLATION	500 V_{DC}	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	GM @ T_C = 55°C	-	418	-	-	418	-	kHrs
DYNAMIC								
Load Step Output Transient V_{OUT}	Half Load to Full Load	-	350	700	-	350	700	mV_{PK}
Load Step Recovery[2]		-	250	500	-	250	500	µSec
Line Step Output Transient[4] V_{OUT}	V_{IN} = 16V to 40V	-	450	900	-	450	900	mV_{PK}
Line Step Recovery[2, 4]		-	250	500	-	250	500	µSec
Turn On Delay V_{OUT}	V_{IN} = 0V to 28V	-	10	20	-	10	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 110°C. 4. Verified by qualification testing.

BLOCK DIAGRAM

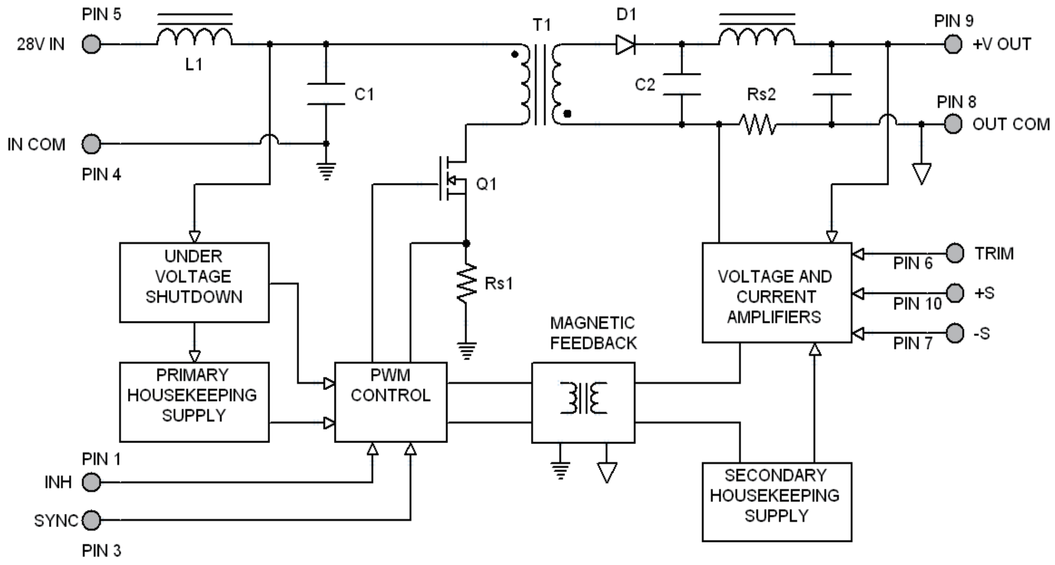


Figure 2

CONNECTION DIAGRAM

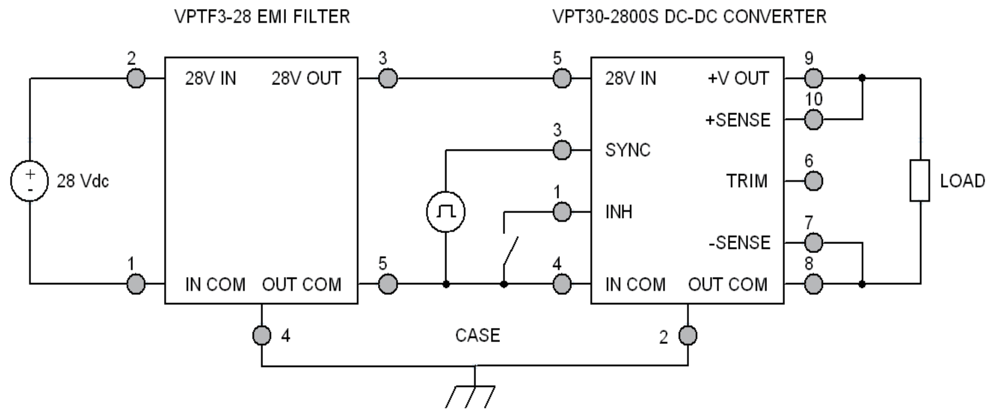


Figure 3
(Shown with optional EMI filter)

CONNECTION DIAGRAMS

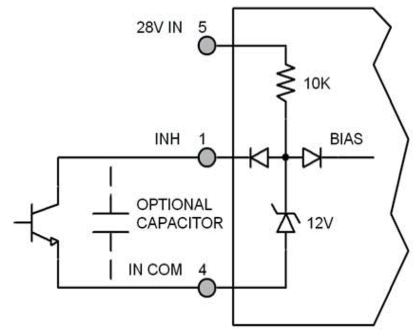


Figure 4 –Inhibit Circuit

(Shown with optional capacitor for turn-on delay)

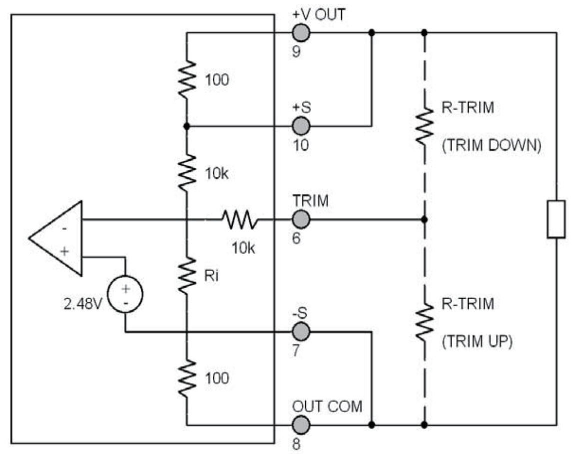


Figure 5 – Output Voltage Trim Circuit

OUTPUT VOLTAGE TRIM

The output voltage can be trimmed down by connecting a resistor between the TRIM pin and the +V OUT pin, or can be trimmed up by connecting a resistor between the TRIM pin and the OUT COM pin as shown in Figure 5. 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.

VPT30-283R3S		VPT30-2805S		VPT30-2812S		VPT30-2815S	
$+V_{OUT}$ (V)	R_{TRIM} (Ω)	$+V_{OUT}$ (V)	R_{TRIM} (Ω)	$+V_{OUT}$ (V)	R_{TRIM} (Ω)	$+V_{OUT}$ (V)	R_{TRIM} (Ω)
3.60	7.27k	5.5	39.6k	13.2	10.7k	16.50	6.5k
3.55	89.2k	5.4	52k	13.0	14.8k	16.25	9.8k
3.50	114k	5.3	72.6k	12.8	21k	16.00	14.8k
3.45	155k	5.2	113.9k	12.6	31.3k	15.75	23k
3.40	238k	5.1	237k	12.4	51.9k	15.50	39.6k
3.35	487k	5.0	--	12.2	114k	15.25	89k
3.30	--	4.9	232.5k	12.0	--	15.00	--
3.25	144k	4.8	106.1k	11.8	457k	14.75	482k
3.20	61.9k	4.7	64k	11.6	218k	14.50	231k
3.15	34.7k	4.6	43k	11.4	139k	14.25	147k
3.10	21k	4.5	30.4k	11.2	99k	14.00	105k
3.05	12.79k	4.4	22k	11.0	75.2k	13.75	80.2k
3.00	7.33k	4.3	16k	10.8	59.4k	13.50	63.5k
		4.2	11.5k	10.6	48k	13.25	51.6k
		4.1	8.0k	10.4	39.5k	13.00	42.6k
		4.0	5.2k	10.2	32.9k	12.75	35.6k
				10.0	27.6k	12.50	30k
				9.8	23.3k	12.25	25.5k
				9.6	19.7k	12.00	21.7k

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

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

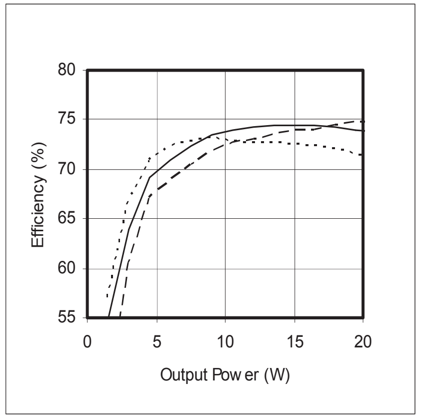


Figure 6 – VPT30-283R3S
Efficiency (%) vs. Output Power (W)

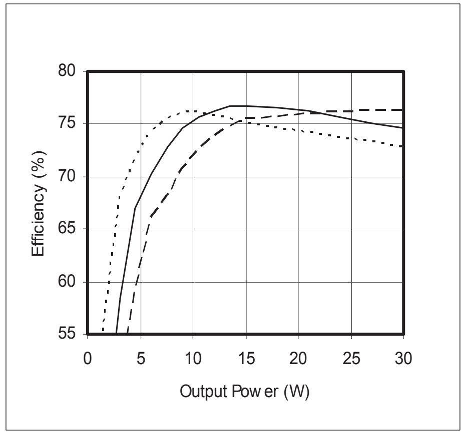


Figure 7 – VPT30-2805S
Efficiency (%) vs. Output Power (W)

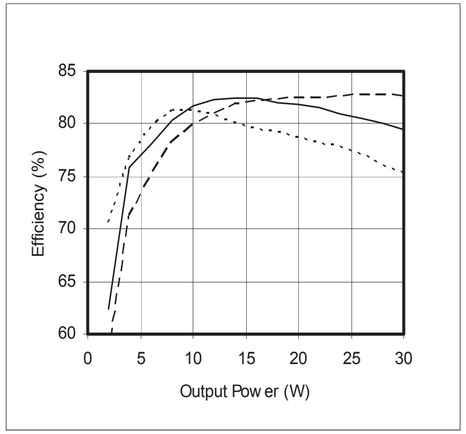


Figure 8 – VPT30-2812S
Efficiency (%) vs. Output Power (W)

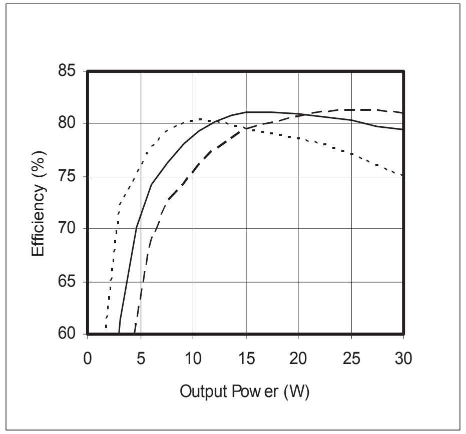


Figure 9 – VPT30-2815S
Efficiency (%) vs. Output Power (W)

VPT30-2800S Series

EMI PERFORMANCE CURVES

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

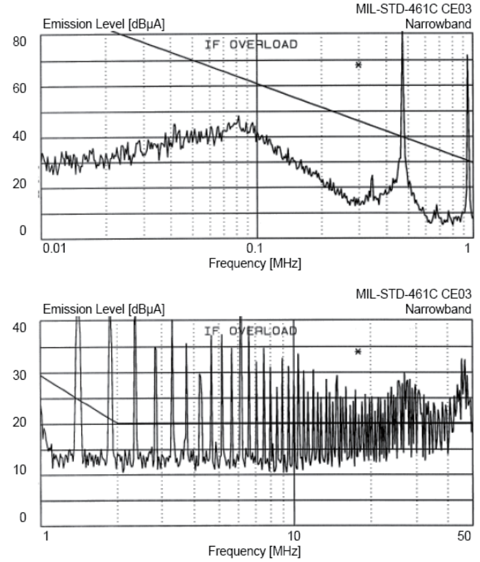


Figure 10 – VPT30-2800S without EMI Filter

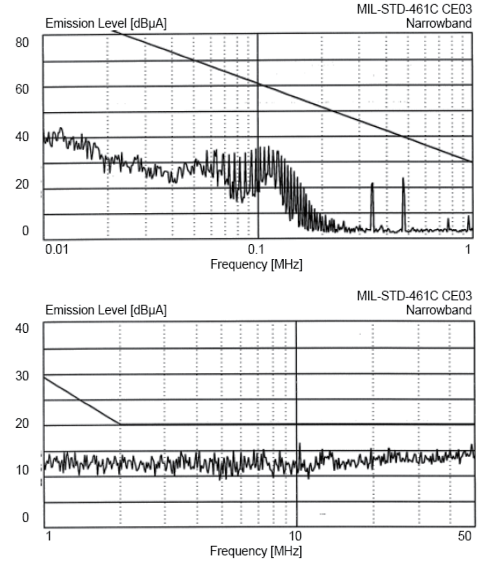


Figure 11 – VPT30-2800S with VPTF Series EMI Filter

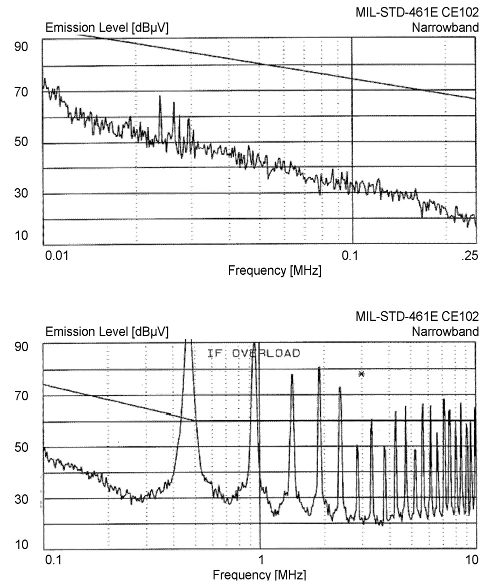


Figure 12 – VPT30-2800S without VPTF Series EMI Filter

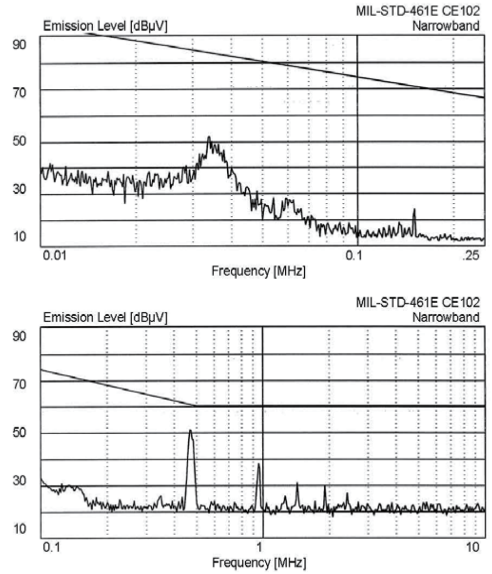
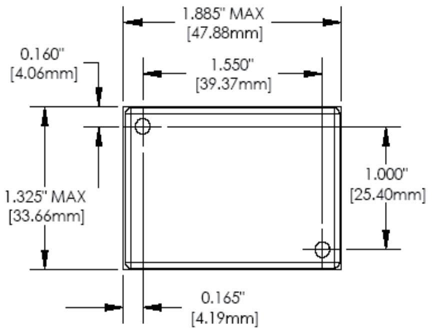
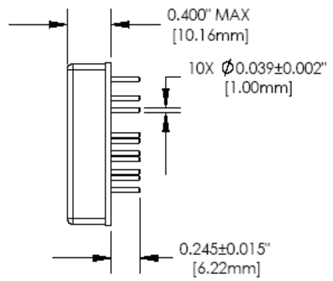


Figure 13 – VPT30-2800S with VPTF Series EMI Filter

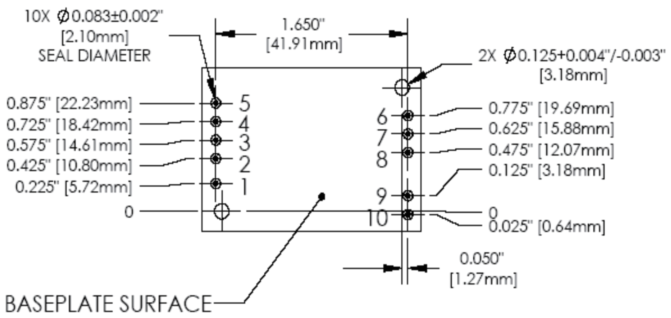
PACKAGE SPECIFICATIONS



TOP VIEW



SIDE VIEW



BOTTOM VIEW

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

Figure 14 – Package and Pinout
(Dimensional Limits are ±0.005" Unless Otherwise Stated)

Package Notes:
1. Case temperature is measured on the center of the baseplate surface.
2. Materials: Baseplate – aluminum, chromate conversion coating.
   Cover – steel, nickel plated.
   Pins – copper, gold over nickel plating.
3. Mounting holes are not threaded. Recommended fastener is 4-40.

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	INHIBIT	This is an open collector input. Logic Low = Disabled Output. Connect the inhibit pin to input common to disable the output. Unconnected, open collector or open drain = Enabled Output.
2	CASE	Case Connection.
3	SYNC	Frequency Synchronization Signal Input. TTL squarewave, 5Vpp, 20 – 80% duty cycle, internally capacitively coupled.
4	IN COM	Input Return Connection.
5	28V IN	Positive Input Voltage Connection.
6	TRIM	Trim Output Voltage to +10%, -20% of Nominal Value. Leave open if not used.
7	-SENSE	Output Return Remote Sense. Compensate for up to 0.5V total drop (positive and return).
8	OUT COM	Output Return Connection.
9	+V OUT	Positive Output Voltage Connection.
10	+SENSE	Positive Output Voltage Remote Sense. Compensate for up to 0.5V total drop (positive and return).

100% ENVIRONMENTAL SCREENING

Screening	Condition
Internal Visual	IPC-A-610
Stabilization Bake	MIL-STD-883, Method 1008, Condition B, 125°C, 24 hours
Temperature Cycling	MIL-STD-883, Method 1010, Condition B, -55°C to +125°C, 10 Cycles
Burn-In	MIL-STD-883, Method 1015, 96 hours at +100°C
Final Electrical	100% at 25°C
External Visual	MIL-STD-883, Method 2009

ORDERING INFORMATION

VPT30-	28	05	S
1	2	3	4

(1)	(2)		(3)		(4)	
Product Series	**Nominal Input Voltage**		**Output Voltage**		**Number of Outputs**	
VPT30-	**28**	28 Volts	**3R3** **05** **12** **15**	3.3 Volts 5 Volts 12 Volts 15 Volts	**S**	Single

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

VPT30-2800D Series

HIGH RELIABILITY COTS DC-DC CONVERTERS

DESCRIPTION

The VPT30 series of isolated COTS DC-DC converters is a cost effective solution for many demanding high reliability applications. A wide input voltage range accommodates nominal 28V inputs including avionics, mobile, ground systems, and other applications. Low input and output ripple, fixed operating frequency, and companion EMI filters simplify system design and compliance. A proven design heritage, no optoisolators and a rugged all metal package ensure long term reliability.

The VPT30 series is intended for harsh environments including severe vibration, shock and temperature cycling. Testing is to JESD22, MIL-STD-810, and MIL-STD-883.

These converters are designed and manufactured in the USA in a facility certified to ISO9001, J-STD-001 and IPC-A-610.

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 at Low Cost
- 30 Watts Output Power
- Wide Input Voltage Range: 15 to 50 Volts per MIL-STD-704 and MIL-STD-1275
- High Input Transient Voltage: 80 Volts for 1 sec per MIL-STD-704A
- Input Undervoltage Lockout
- Fixed Frequency
- Frequency Synchronization
- Output Soft Start
- Current Limit Protection
- Short Circuit Protection
- Magnetic Feedback, no Optoisolators
- Wide Temperature Range, -55°C to 100°C
- Fully Encapsulated
- Six Sided Metal Rugged Enclosure
- Meets MIL-STD-461C/D/E Conducted Emissions Requirements When Used With a VPTF series EMI Filter

Figure 1 – VPT30-2800D Converter
(Not To Scale)

11314 4th Avenue
West, Suite 206
Everett, WA 98204
http://www.vpt-inc.com

Sales Information:
Phone: (425) 353-3010
Fax: (425) 353-4030
E-mail: vptsales@vpt-inc.com

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Junction Temperature Rise to Case	+17°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-55°C to +125°C
Output Power[1]	30 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	12 Watts	Weight (Maximum)	42 Grams

Parameter		Conditions	VPT30-2805D			VPT30-2812D			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	-	-	6	-	-	6	mA
		No Load	-	65	90	-	65	90	mA
Ripple Current		Full Load[5], 20Hz to 10MHz	-	-	75	-	-	75	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	$+V_{OUT}$	T_{CASE} = 25°C	4.92	5.00	5.08	11.82	12.0	12.18	V
	$+V_{OUT}$	T_{CASE} = -55°C to +100°C	4.87	5.00	5.13	11.70	12.0	12.30	V
	$-V_{OUT}$	T_{CASE} = 25°C	4.87	5.00	5.13	11.70	12.00	12.30	V
	$-V_{OUT}$	T_{CASE} = -55°C to +100°C	4.82	5.00	5.18	11.58	12.00	12.42	V
Power[3,6]	Total		0	-	30	0	-	30	W
	±Vout	Either Output	0	-	21	0	-	21	W
Current[3,6]	$\pm V_{OUT}$	Either Output	0	-	4.2	0	-	1.75	A
Ripple Voltage	$\pm V_{OUT}$	Full Load[5], 20Hz to 10MHz	-	-	50	-	-	50	mV_{p-p}
Line Regulation	$+V_{OUT}$	V_{IN} = 15V to 50V	-	-	10	-	-	10	mV
	$-V_{OUT}$	V_{IN} = 15V to 50V	-	-	150	-	-	150	mV
Load Regulation	$+V_{OUT}$	No Load to Full Load[5]	-	-	10	-	-	10	mV
	$-V_{OUT}$	No Load to Full Load[5,7]	-	-	150	-	-	150	mV
Cross Regulation	$-V_{OUT}$	+Load 70%, -Load 30% +Load 30%, -Load 70%	-	-	650	-	-	650	mV
EFFICIENCY		Full Load[5]	73	-	-	78	-	-	%
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	450	550	400	450	550	kHz
SYNC FREQUENCY RANGE		V_H - V_L = 5V, D = 20-80%	500	-	600	500	-	600	kHz
ISOLATION		500 V_{DC}	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)		GM @ T_C = 55°C	-	371	-	-	371	-	kHrs

See notes on next page.

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Junction Temperature Rise to Case	+17°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-55°C to +125°C
Output Power[1]	30 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	12 Watts	Weight (Maximum)	42 Grams

Parameter		Conditions	VPT30-2805D			VPT30-2812D			Units
			Min	Typ	Max	Min	Typ	Max	
DYNAMIC									
Load Step Output Transient	$\pm V_{OUT}$	Half Load to Full Load	-	200	400	-	250	450	mV_{PK}
Load Step Recovery[2]			-	250	350	-	200	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 110°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.

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Junction Temperature Rise to Case	+17°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-55°C to +125°C
Output Power[1]	30 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	12 Watts	Weight (Maximum)	42 Grams

Parameter		Conditions	VPT30-2815D			Units
			Min	Typ	Max	
STATIC						
INPUT Voltage[4]		Continuous	15	28	50	V
		Transient, 1 sec	-	-	80	V
Current		Inhibited	-	-	6	mA
		No Load	-	65	90	mA
Ripple Current		Full Load[5], 20Hz to 10MHz	-	-	75	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	+V_{OUT}	T_{CASE} = 25°C	14.77	15.0	15.23	V
	+V_{OUT}	T_{CASE} = -55°C to +100°C	14.62	15.0	15.38	V
	-V_{OUT}	T_{CASE} = 25°C	14.62	15.0	15.38	V
	-V_{OUT}	T_{CASE} = -55°C to +100°C	14.47	15.0	15.53	V
Power[3,6]	Total		0	-	30	W
	±Vout	Either Output	0	-	21	W
Current[3,6]	±V_{OUT}	Either Output	0	-	1.4	A
Ripple Voltage	±V_{OUT}	Full Load[5], 20Hz to 10MHz	-	-	50	mV_{P-P}
Line Regulation	+V_{OUT}	V_{IN} = 15V to 50V	-	-	10	mV
	-V_{OUT}	V_{IN} = 15V to 50V	-	-	150	mV
Load Regulation	+V_{OUT}	No Load to Full Load[5]	-	-	10	mV
	-V_{OUT}	No Load to Full Load[5,7]	-	-	150	mV
Cross Regulation	-V_{OUT}	+Load 70%, -Load 30% +Load 30%, -Load 70%	-	-	650	mV
EFFICIENCY		Full Load[5]	78	-	-	%
LOAD FAULT POWER DISSIPATION		Overload[4]	-	-	14	W
		Short Circuit	-	-	14	W
CAPACITIVE LOAD[4]		Either Output	-	-	500	µF
SWITCHING FREQUENCY			400	450	550	kHz
SYNC FREQUENCY RANGE		V_H - V_L = 5V, D = 20-80%	500	-	600	kHz
ISOLATION		500 V_{DC}	100	-	-	MΩ
MTBF (MIL-HDBK-217F)		GM @ T_C = 55°C	-	371	-	kHrs

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Junction Temperature Rise to Case	+17°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-55°C to +125°C
Output Power[1]	30 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	12 Watts	Weight (Maximum)	42 Grams

Parameter		Conditions	VPT30-2815D			Units
			Min	Typ	Max	
DYNAMIC						
Load Step Output Transient	±V_{OUT}	Half Load to Full Load[5]	-	250	450	mV_{PK}
Load Step Recovery[2]			-	200	400	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 110°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

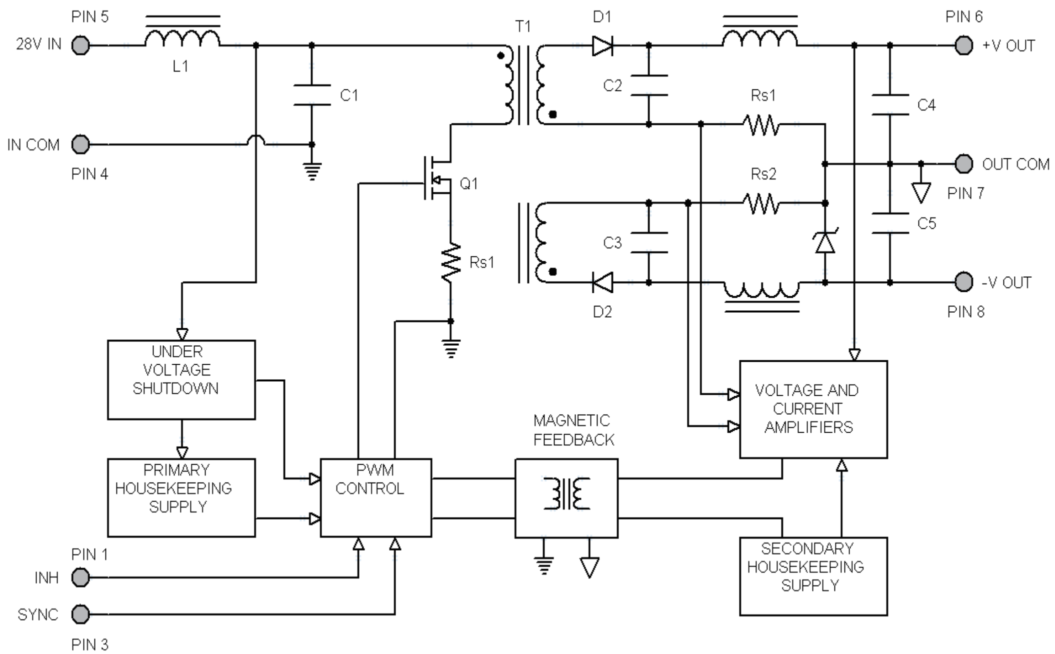


Figure 2

CONNECTION DIAGRAM

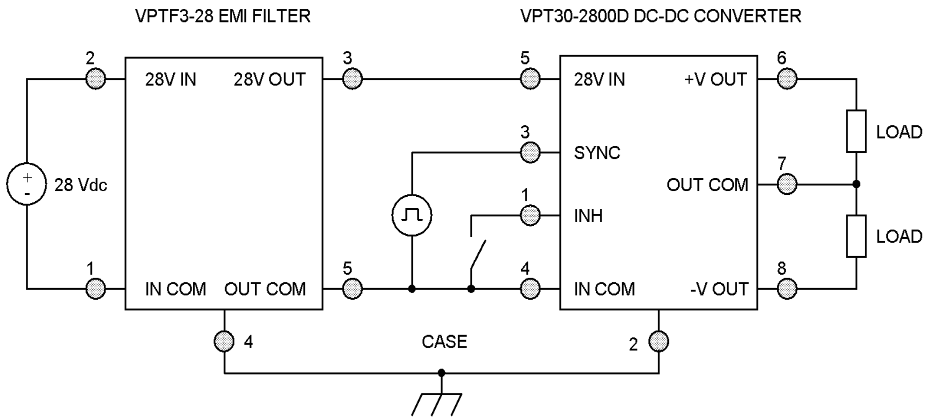


Figure 3
(Shown with optional EMI filter)

CONNECTION DIAGRAMS

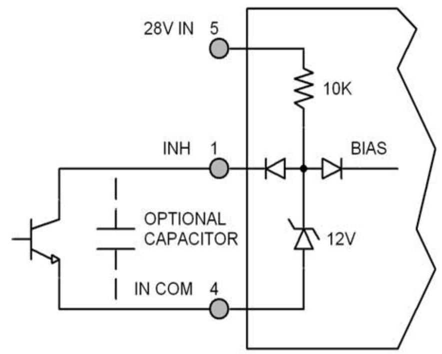


Figure 4 – Inhibit Circuit
(Shown with optional capacitor for turn-on delay)

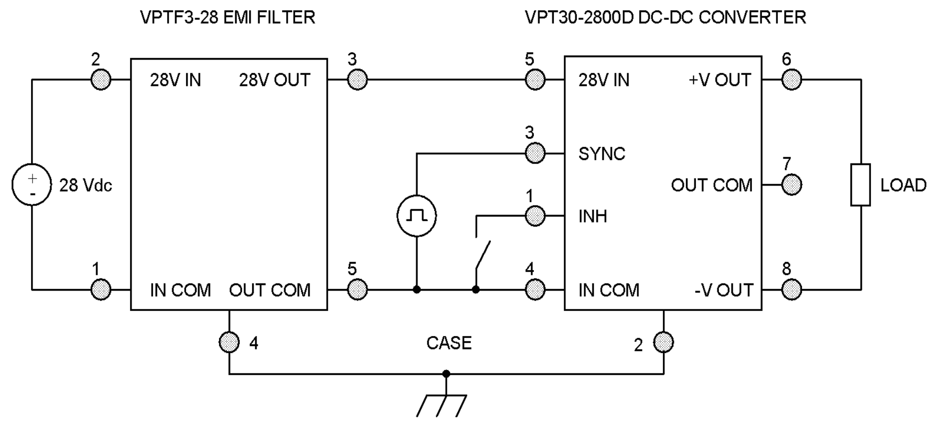


Figure 5 – Stacked Output Connection
(Shown with optional EMI filter)

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

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

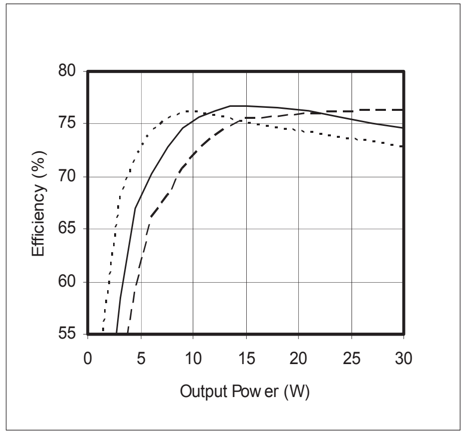


Figure 6 – VPT30-2805D
Efficiency (%) vs. Output Power (W)

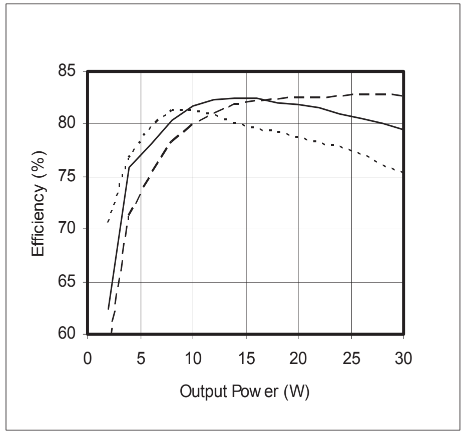


Figure 7 – VPT30-2812D
Efficiency (%) vs. Output Power (W)

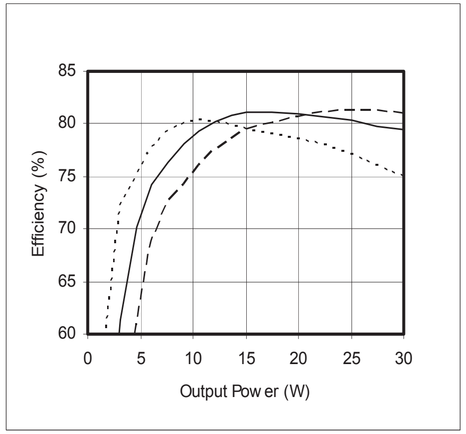
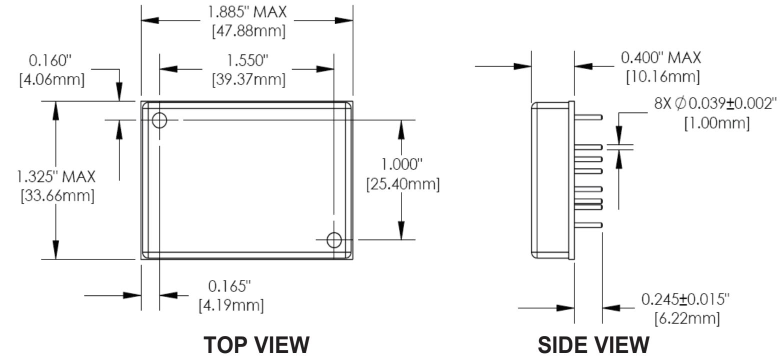
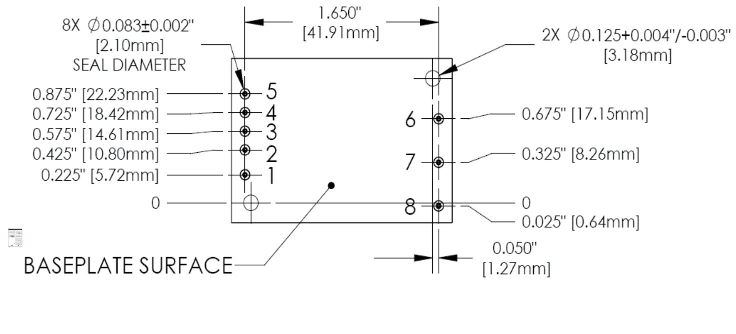


Figure 8 – VPT30-2815D
Efficiency (%) vs. Output Power (W)

PACKAGE SPECIFICATIONS





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

BOTTOM VIEW

Figure 13 – Package and Pinout
(Dimensional Limits are ±0.005" Unless Otherwise Stated)

Package Notes:
1. Case temperature is measured on the center of the baseplate surface.
2. Materials: Baseplate – aluminum, chromate conversion coating.
   Cover – steel, nickel plated.
   Pins – copper, gold over nickel plating.
3. Mounting holes are not threaded. Recommended fastener is 4-40.

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	INHIBIT	This is an open collector input. Logic Low = Disabled Output. Connect the inhibit pin to input common to disable the output. Unconnected, open collector or open drain = Enabled Output.
2	CASE	Case Connection.
3	SYNC	Frequency Synchronization Signal Input. TTL squarewave, 5Vpp, 20 – 80% duty cycle, internally capacitively coupled.
4	IN COM	Input Return Connection.
5	28V IN	Positive Input Voltage Connection.
6	+VOUT	Positive Output Voltage Connection.
7	OUT COM	Output Return Connection.
8	-V OUT	Negative Output Voltage Connection.

100% ENVIRONMENTAL SCREENING

Screening	Condition
Internal Visual	IPC-A-610
Stabilization Bake	MIL-STD-883, Method 1008, Condition B, 125°C, 24 hours
Temperature Cycling	MIL-STD-883, Method 1010, Condition B, -55°C to +125°C, 10 Cycles
Burn-In	MIL-STD-883, Method 1015, 96 hours at +100°C
Final Electrical	100% at 25°C
External Visual	MIL-STD-883, Method 2009

ORDERING INFORMATION

VPT30-	28	05	D
1	2	3	4

(1)	(2)		(3)		(4)	
Product Series	Nominal Input Voltage		Output Voltage		Number of Outputs	
VPT30-	**28**	28 Volts	**05** **12** **15**	±5 Volts ±12 Volts ±15 Volts	**D**	Dual

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

VPT100-2800S Series

HIGH RELIABILITY COTS DC-DC CONVERTERS

DESCRIPTION

The VPT100 series of isolated COTS DC-DC converters is a cost effective solution for many demanding high reliability applications. A wide input voltage range accommodates nominal 28V inputs including avionics, mobile, ground systems, and other applications. A high efficiency design using synchronous rectification reduces input power requirements and eases thermal management. Low input and output ripple, fixed operating frequency, and companion EMI filters simplify system design and compliance. A proven design heritage, no optoisolators and a rugged all metal package ensure long term reliability.

The VPT100 series is intended for harsh environments including severe vibration, shock and temperature cycling. Testing is to JESD22, MIL-STD-810, and MIL-STD-883.

These converters are designed and manufactured in the USA in a facility certified to ISO9001, J-STD-001 and IPC-A-610.

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 at Low Cost
- Up to 100 Watts Maximum Output Power
- High Efficiency, Up to 91%
- Wide Input Voltage Range: 16 to 40 Volts per MIL-STD-704 and MIL-STD-1275
- High Input Transient Voltage: 50 Volts for 1 sec
- Input Undervoltage Lockout
- Fixed Frequency
- Output Voltage Trim (+10% / -20%)
- Output Soft Start
- Current Limit Protection
- Short Circuit Protection
- Magnetic Feedback, no Optoisolators
- Wide Temperature Range, -55°C to 100°C
- Six Sided Metal Rugged Enclosure
- Meets MIL-STD-461C/D/E Conducted Emissions Requirements When Used With a VPTF series EMI Filter

Figure 1 – VPT100-2800S Converter (Not to Scale)

11314 4th Avenue West, Suite 206
Everett, WA 98204
http://www.vpt-inc.com

Sales Information:
Phone: (425) 353-3010
Fax: (425) 353-4030
E-mail: vptsales@vpt-inc.com

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	40 V_{DC}	Junction Temperature Rise to Case	+17°C
Input Voltage (Transient, 1 second)	50 Volts	Storage Temperature	-55°C to +125°C
Output Power[1]	100 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	18 Watts	Weight (Maximum)	90 Grams

Parameter	Conditions	VPT100-283R3S			VPT100-2805S			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	-	-	5	-	-	5	mA
	No Load	-	130	200	-	130	200	mA
Ripple Current	Full Load, 20Hz to 10MHz	-	-	180	-	-	200	mA_{P-P}
Inhibit Pin Input[4]		0	-	1.5	0	-	1.5	V
Inhibit Pin Open Circuit Voltage[4]		9.0	11.0	14.0	9.0	11.0	14.0	V
UVLO Turn On		14.5	-	15.8	14.5	-	15.8	V
UVLO Turn Off[4]		14.0	-	15.0	14.0	-	15.0	V
OUTPUT Voltage V_{OUT}	T_{CASE} = 25°C	3.25	3.30	3.35	4.925	5.00	5.075	V
V_{OUT}	T_{CASE} = -55°C to +100°C	3.217	3.30	3.383	4.875	5.00	5.125	V
Power[3]		0	-	66	0	-	100	W
Current[3] V_{OUT}		0	-	20	0	-	20	A
Ripple Voltage V_{OUT}	Full Load, 20Hz to 10MHz	-	-	150	-	-	150	mV_{P-P}
Line Regulation V_{OUT}	V_{IN} = 16V to 40V	-	-	20	-	-	20	mV
Load Regulation V_{OUT}	No Load to Full Load	-	-	50	-	-	50	mV
EFFICIENCY		83	87	-	85	90	-	%
LOAD FAULT POWER DISSIPATION	Overload[4]	-	-	24	-	-	24	W
	Short Circuit	-	-	24	-	-	24	W
CAPACITIVE LOAD[4]		-	-	1000	-	-	1000	µF
SWITCHING FREQUENCY		230	260	290	230	260	290	kHz
SYNC FREQUENCY RANGE	V_H-V_L=5V Duty Cycle = 50%	240	-	325	240	-	325	kHz
ISOLATION	500 V_{DC}	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	GM @ T_C = 55°C	-	344	-	-	344	-	kHrs
DYNAMIC								
Load Step Output Transient V_{OUT}	Half Load to Full Load	-	-	250	-	-	250	mV_{PK}
Load Step Recovery[2]		-	-	300	-	-	300	µSec
Line Step Output Transient[4] V_{OUT}	V_{IN} = 16V to 40V	-	-	300	-	-	300	mV_{PK}
Line Step Recovery[2,4]		-	-	150	-	-	150	µSec
Turn On Delay V_{OUT}	V_{IN} = 0V to 28V	-	6	10	-	6	10	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 110°C.
4. Verified by qualification testing.

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	40 V_{DC}	Junction Temperature Rise to Case	+17°C
Input Voltage (Transient, 1 second)	50 Volts	Storage Temperature	-55°C to +125°C
Output Power[1]	100 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	18 Watts	Weight (Maximum)	90 Grams

Parameter	Conditions	VPT100-2812S			VPT100-2815S			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	-	-	5	-	-	5	mA
	No Load	-	100	200	-	100	200	mA
Ripple Current	Full Load, 20Hz to 10MHz	-	-	200	-	-	200	mA_{p-p}
Inhibit Pin Input[4]		0	-	1.5	0	-	1.5	V
Inhibit Pin Open Circuit Voltage[4]		9.0	11.0	14.0	9.0	11.0	14.0	V
UVLO Turn On		14.5	-	15.8	14.5	-	15.8	V
UVLO Turn Off[4]		14.0	-	15.0	14.0	-	15.0	V
OUTPUT Voltage V_{OUT}	T_{CASE} = 25°C	11.82	12.0	12.18	14.775	15.0	15.225	V
V_{OUT}	T_{CASE} = -55°C to +100°C	11.70	12.0	12.30	14.625	15.0	15.375	V
Power[3]		0	-	100	0	-	100	W
Current[3] V_{OUT}		0	-	8.33	0	-	6.67	A
Ripple Voltage V_{OUT}	Full Load, 20Hz to 10MHz	-	-	150	-	-	150	mV_{p-p}
Line Regulation V_{OUT}	V_{IN} = 16V to 40V	-	-	20	-	-	20	mV
Load Regulation V_{OUT}	No Load to Full Load	-	-	100	-	-	100	mV
EFFICIENCY		86	90	-	86	90	-	%
LOAD FAULT POWER DISSIPATION	Overload[4]	-	-	24	-	-	24	W
	Short Circuit	-	-	24	-	-	24	W
CAPACITIVE LOAD[4]		-	-	500	-	-	500	µF
SWITCHING FREQUENCY		300	340	380	300	340	380	kHz
SYNC FREQUENCY RANGE	V_H-V_L=5V Duty Cycle = 50%	300	-	380	300	-	380	kHz
ISOLATION	500 V_{DC}	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	GM @ T_C = 55°C	-	344	-	-	344	-	kHrs
DYNAMIC								
Load Step Output Transient V_{OUT}	Half Load to Full Load	-	-	500	-	-	500	mV_{PK}
Load Step Recovery[2]		-	-	300	-	-	300	µSec
Line Step Output Transient[4] V_{OUT}	V_{IN} = 16V to 40V	-	-	300	-	-	300	mV_{PK}
Line Step Recovery[2, 4]		-	-	150	-	-	150	µSec
Turn On Delay V_{OUT}	V_{IN} = 0V to 28V	-	6	10	-	6	10	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 110°C. 4. Verified by qualification testing.

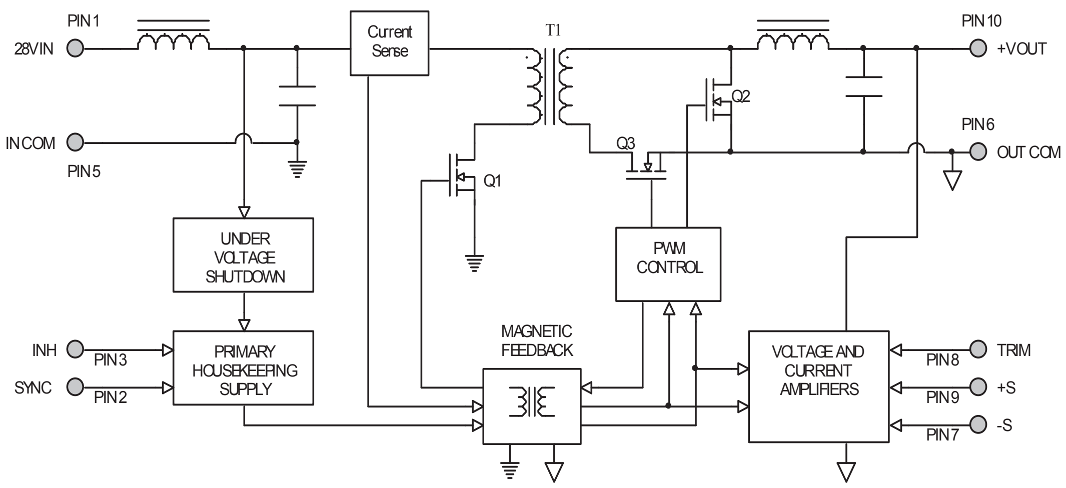
SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	40 V_{DC}	Junction Temperature Rise to Case	+17°C
Input Voltage (Transient, 1 second)	50 Volts	Storage Temperature	-55°C to +125°C
Output Power[1]	100 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	18 Watts	Weight (Maximum)	90 Grams

Parameter	Conditions	VPT100-2828S			Units
		Min	Typ	Max	
STATIC					
INPUT Voltage[4]	Continuous	16	28	40	V
	Transient, 1 sec	-	-	50	V
Current	Inhibited	-	-	5	mA
	No Load	-	30	100	mA
Ripple Current	Full Load, 20Hz to 10MHz	-	-	200	mA_{p-p}
Inhibit Pin Input[4]		0	-	1.5	V
Inhibit Pin Open Circuit Voltage[4]		9.0	11.0	14.0	V
UVLO Turn On		14.5	-	15.8	V
UVLO Turn Off[4]		14.0	-	15.0	V
OUTPUT Voltage V_{OUT}	T_{CASE} = 25°C	27.44	28.0	28.56	V
V_{OUT}	T_{CASE} = -55°C to +100°C	27.16	28.0	28.84	V
Power[3]		0	-	100	W
Current[3] V_{OUT}		0	-	3.57	A
Ripple Voltage V_{OUT}	Full Load, 20Hz to 10MHz	-	-	250	mV_{p-p}
Line Regulation V_{OUT}	V_{IN} = 16V to 40V	-	-	50	mV
Load Regulation V_{OUT}	No Load to Full Load	-	-	50	mV
EFFICIENCY		85	87	-	%
LOAD FAULT POWER DISSIPATION	Overload[4]	-	-	24	W
	Short Circuit	-	-	28	W
CAPACITIVE LOAD[4]		-	-	500	µF
SWITCHING FREQUENCY		300	340	380	kHz
SYNC FREQUENCY RANGE	V_H-V_L=5V Duty Cycle = 50%	300	-	380	kHz
ISOLATION	500 V_{DC}	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	GM @ T_C = 55°C	-	344	-	kHrs
DYNAMIC					
Load Step Output Transient V_{OUT}	Half Load to Full Load	-	-	1500	mV_{PK}
Load Step Recovery[2]		-	-	300	µSec
Line Step Output Transient[4] V_{OUT}	V_{IN} = 16V to 40V	-	-	1500	mV_{PK}
Line Step Recovery[2, 4]		-	-	300	µSec
Turn On Delay V_{OUT}	V_{IN} = 0V to 28V	-	6	10	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 110°C. 4. Verified by qualification testing.

BLOCK DIAGRAM



Note: Not applicable to VPT100-2828S

Figure 2

CONNECTION DIAGRAM

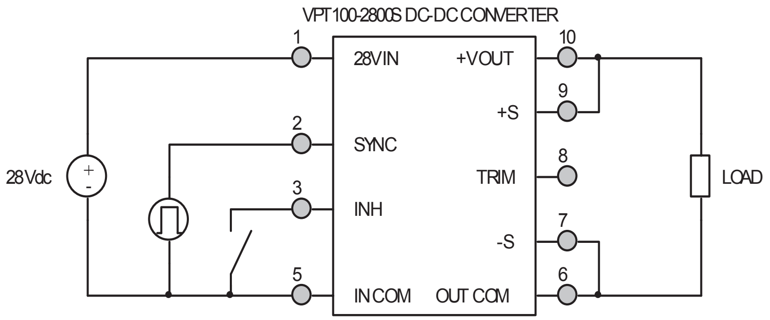


Figure 3

VPT100-2800S Series

CONNECTION DIAGRAMS

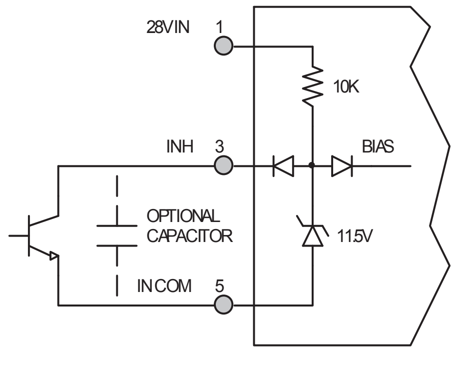


Figure 4 –Inhibit Circuit
(Shown with optional capacitor for turn-on delay)

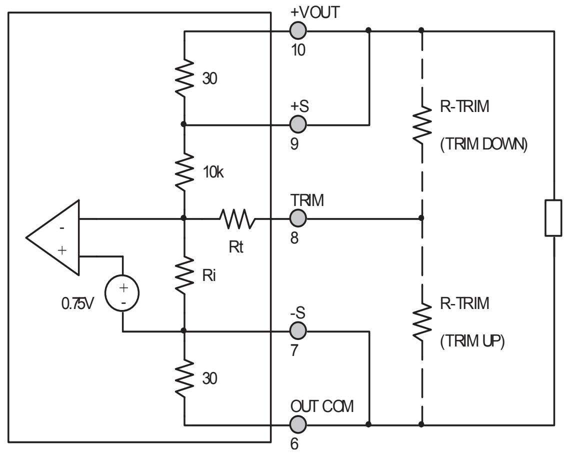


Figure 5 –Output Voltage Trim Circuit

OUTPUT VOLTAGE TRIM

The output voltage can be trimmed down by connecting a resistor between the TRIM pin and the +V OUT pin, or can be trimmed up by connecting a resistor between the TRIM pin and the OUT COM pin as shown in Figure 5. 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.

VPT100-283R3S		VPT100-2805S		VPT100-2812S		VPT100-2815S		VPT100-2828S	
$+V_{OUT}$ (V)	R_{TRIM} (Ω)	$+V_{OUT}$ (V)	R_{TRIM} (Ω)	$+V_{OUT}$ (V)	R_{TRIM} (Ω)	$+V_{OUT}$ (V)	R_{TRIM} (Ω)	$+V_{OUT}$ (V)	R_{TRIM} (Ω)
3.60	3.94k	5.5	980	13.2	1.14k	16.50	686	30.5	720
3.55	8.92k	5.4	4.72k	13.0	2.39k	16.25	1.69k	30.0	1.46k
3.50	16.4k	5.3	10.9k	12.8	4.26k	16.00	3.19k	29.5	2.68k
3.45	28.8k	5.2	23.4k	12.6	7.39k	15.75	5.7k	29.0	5.12k
3.40	53.5k	5.1	60.5k	12.4	13.6k	15.50	10.7k	28.5	12.3k
3.35	127k	5.0	--	12.2	32.4k	15.25	25.9k	28.0	--
3.30	--	4.9	404k	12.0	--	15.00	--	27.5	551k
3.25	486k	4.8	189k	11.8	548k	14.75	552k	27.0	265k
3.20	226k	4.7	118k	11.6	266k	14.50	270k	26.5	171k
3.15	140k	4.6	82.4k	11.4	172k	14.25	175k	26.0	125k
3.10	96.9k	4.5	61.1k	11.2	126k	14.00	128k	25.5	97.4k
3.05	71.3k	4.4	46.9k	11.0	97.4k	13.75	99.5k	25.0	79k
3.00	54.2k	4.3	36.8k	10.8	78.6k	13.50	80.6k	24.5	65.9k
2.95	42k	4.2	29.2k	10.6	65.3k	13.25	67k	24.0	56.1k
2.90	32.8k	4.1	23.3k	10.4	55.2k	13.00	56.9k	23.5	48.5k
2.85	25.7k	4.0	18.5k	10.2	47.4k	12.75	49k	23.0	42.4k
2.80	20.1k			10.0	41.1k	12.50	42.6k	22.5	37.4k
2.75	15.4k			9.8	36k	12.25	37.5k		
2.70	11.5k			9.6	31.8k	12.00	33.2k		
2.65	8.26k								

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

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

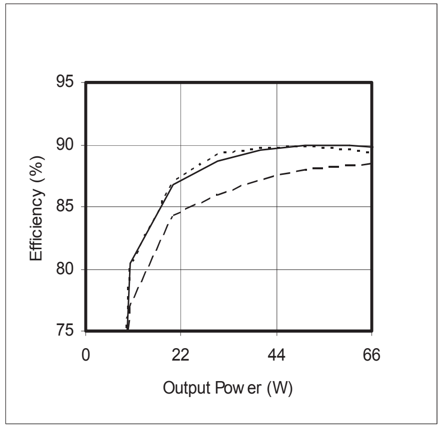


Figure 6 – VPT100-283R3S
Efficiency (%) vs. Output Power (W)

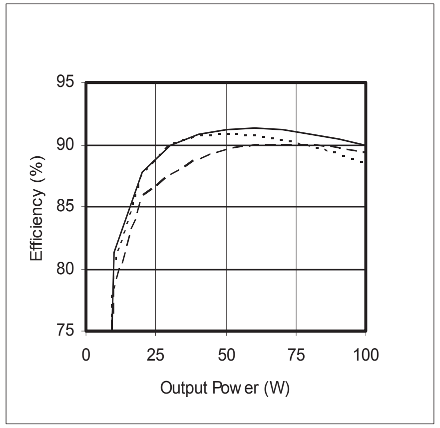


Figure 7 – VPT100-2805S
Efficiency (%) vs. Output Power (W)

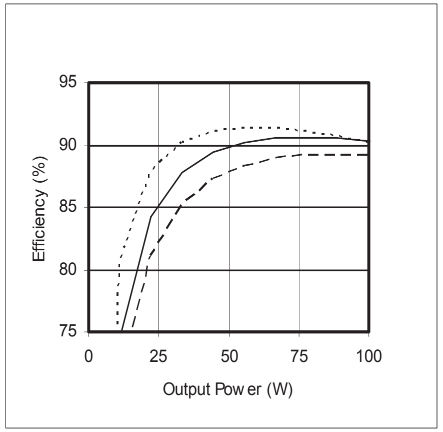


Figure 8 – VPT100-2812S
Efficiency (%) vs. Output Power (W)

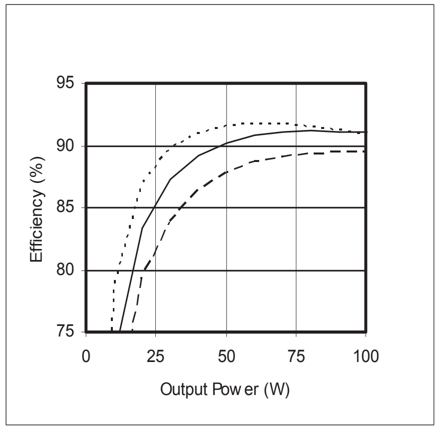


Figure 9 – VPT100-2815S
Efficiency (%) vs. Output Power (W)

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

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

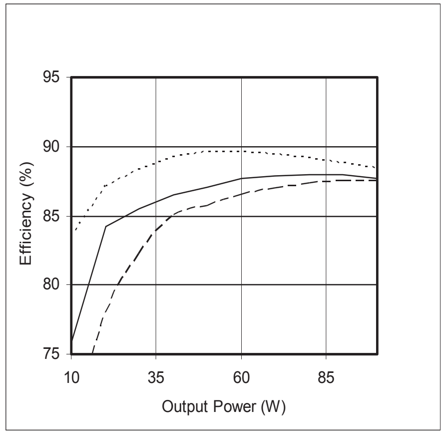


Figure 10 – VPT100-2828S
Efficiency (%) vs. Output Power (W)

EMI PERFORMANCE CURVES

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

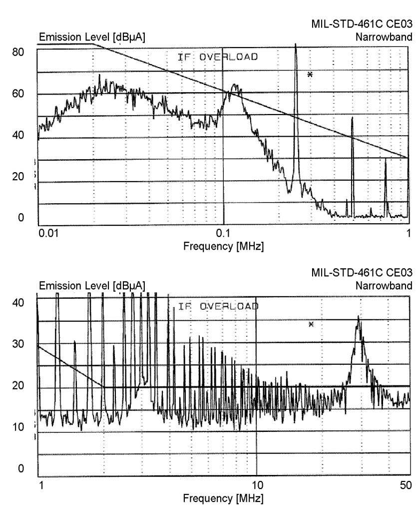


Figure 11 – VPT100-2800S without EMI Filter

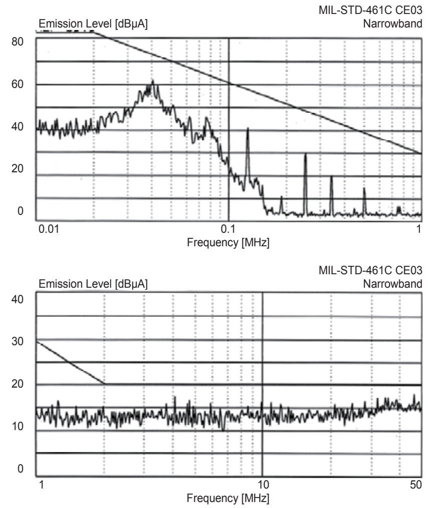


Figure 12 – VPT100-2800S with VPTF Series EMI Filter

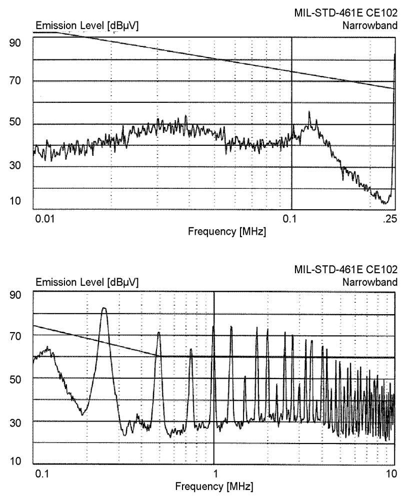


Figure 13 – VPT100-2800S without EMI Filter

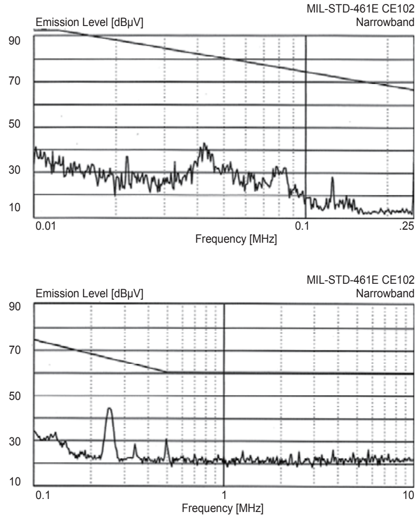
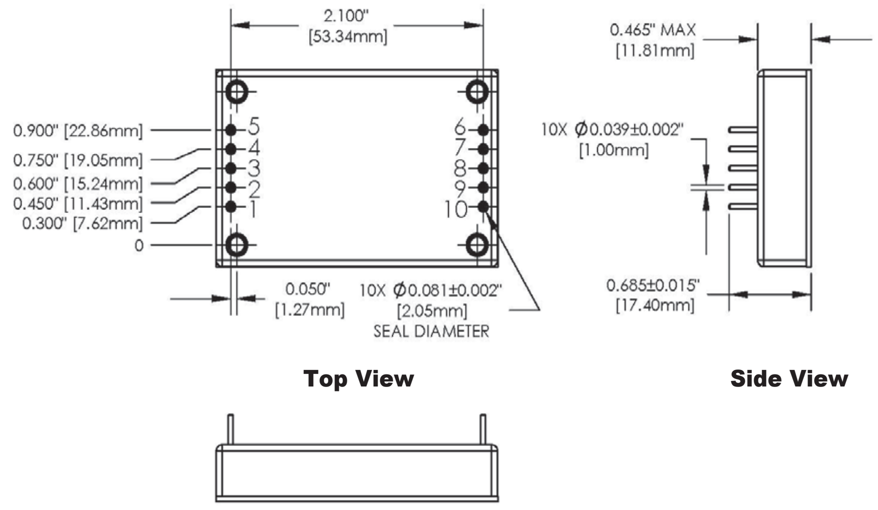
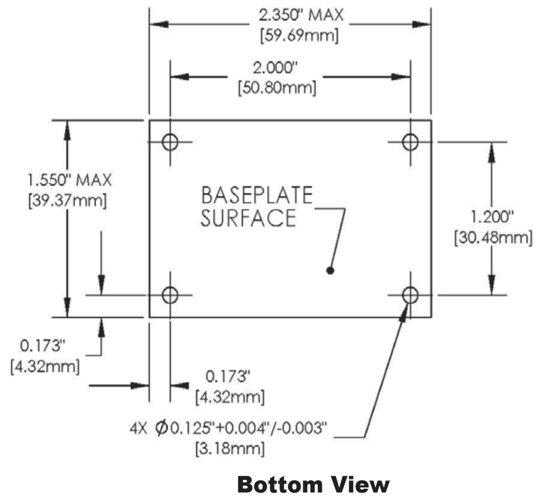


Figure 14 – VPT100-2800S with VPTF Series EMI Filter

PACKAGE SPECIFICATIONS





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

Figure 15 – Package and Pinout
(Dimensional Limits are ±0.005" Unless Otherwise Stated)

Package Notes:
1. Case temperature is measured on the center of the baseplate surface.
2. Materials: Baseplate – aluminum, conductive conversion coating.
Cover – nickel plated.
Pins – copper, gold over nickel plating.
3. Mounting holes are not threaded. Recommended fastener is 4-40.

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	28VIN	Positive Input Voltage Connection
2	SYNC	Input Synchronization Signal. TTL squarewave, 5Vpp, 20 - 80% duty cycle, internally capacitively coupled.
3	INHIBIT	This is an open collector input. Logic Low = Disabled Output. Connect the inhibit pin to input common to disable the output. Unconnected, open collector or open drain = Enabled Output.
4	CASE	Case Connection
5	INCOM	Input Return Connection
6	OUTCOM	Output Return Connection
7	-SENSE	Output Return Remote Sense. Compensate for up to 0.5V total drop (positive and return).
8	TRIM	Trim Output Voltage to +10%, -20% of Nominal Value. Leave open if not used.
9	+SENSE	Positive Output Voltage Remote Sense. Compensate for up to 0.5V total drop (positive and return).
10	+V OUT	Positive Output Voltage Connection

100% ENVIRONMENTAL SCREENING

Screening	Condition
Internal Visual	IPC-A-610
Stabilization Bake	MIL-STD-883, Method 1008, Condition B, 125°C, 24 hours
Temperature Cycling	MIL-STD-883, Method 1010, Condition B, -55°C to +125°C, 10 Cycles
Burn-In	MIL-STD-883, Method 1015, 96 hours at +100°C
Final Electrical	100% at 25°C
External Visual	MIL-STD-883, Method 2009

ORDERING INFORMATION

VPT100-	28	05	S
1	2	3	4

(1) Product Series	(2) Nominal Input Voltage		(3) Output Voltage		(4) Number of Outputs	
VPT100-	**28**	28 Volts	**3R3** **05** **12** **15** **28**	3.3 Volts 5 Volts 12 Volts 15 Volts 28 Volts	**S**	Single

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

VPT100-2800D Series

HIGH RELIABILITY COTS DC-DC CONVERTERS

DESCRIPTION

The VPT100 series of isolated COTS DC-DC converters is a cost effective solution for many demanding high reliability applications. A wide input voltage range accommodates nominal 28V inputs including avionics, mobile, ground systems, and other applications. A high efficiency design reduces input power requirements and eases thermal management. Low input and output ripple, fixed operating frequency, and companion EMI filters simplify system design and compliance. A proven design heritage, no optoisolators and a rugged all-metal package ensure long term reliability.

The VPT100 series is intended for harsh environments including severe vibration, shock and temperature cycling. Testing is to JESD22, MIL-STD-810, and MIL-STD-883.

These converters are designed and manufactured in the USA in a facility certified to ISO9001, J-STD-001 and IPC-A-610.

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 at Low Cost
- Up to 100 Watts Maximum Output Power
- High Efficiency, Up to 89%
- Wide Input Voltage Range: 16 to 40 Volts per MIL-STD-704 and MIL-STD-1275
- High Input Transient Voltage: 50 Volts for 1 sec
- Input Undervoltage Lockout
- Fixed Frequency
- Output Voltage Trim (+10% / -20%)
- Output Soft Start
- Current Limit Protection
- Short Circuit Protection
- Magnetic Feedback, no Optoisolators
- Wide Temperature Range, -55°C to 100°C
- Six Sided Metal Rugged Enclosure
- Meets MIL-STD-461C/D/E Conducted Emissions Requirements When Used With a VPTF series EMI Filter

Figure 1 – VPT100-2800D Converter
(Not To Scale)

11314 4th Avenue
West, Suite 206
Everett, WA 98204
http://www.vpt-inc.com

Sales Information:
Phone: (425) 353-3010
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SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	40 V_{DC}	Junction Temperature Rise to Case	+17°C
Input Voltage (Transient, 1 second)	50 Volts	Storage Temperature	-55°C to +125°C
Output Power	100 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	17 Watts	Weight (Maximum)	90 Grams

Parameter		Conditions	VPT100-2812D			VPT100-2815D			Units
			Min	Typ	Max	Min	Typ	Max	
STATIC									
INPUT Voltage[3]		Continuous	16	28	40	16	28	40	V
		Transient, 1 sec	-	-	50	-	-	50	V
Current		Inhibited	-	-	5	-	-	5	mA
		No Load	-	50	100	-	50	100	mA
Ripple Current		Full Load[4], 20Hz to 10MHz	-	-	200	-	-	200	mA_{p-p}
Inhibit Pin Input[3]			0	-	1.5	0	-	1.5	V
Inhibit Pin Open Circuit Voltage[3]			9.0	12.0	14.0	9.0	12.0	14.0	V
UVLO Turn On			14.5	-	15.8	14.5	-	15.8	V
UVLO Turn Off[3]			14.0	-	15.0	14.0	-	15.0	V
OUTPUT Voltage[4]	$+V_{OUT}$	T_{CASE} = 25°C	11.82	12.0	12.18	14.775	15.0	15.225	V
	$+V_{OUT}$	T_{CASE} = -55°C to +100°C	11.70	12.0	12.30	14.625	15.0	15.375	V
	$-V_{OUT}$	T_{CASE} = 25°C	11.70	12.0	12.30	14.625	15.0	15.375	V
	$-V_{OUT}$	T_{CASE} = -55°C to +100°C	11.58	12.0	12.42	14.475	15.0	15.525	V
Power[2,5]	Total		-	-	100	-	-	100	W
	$\pm V_{OUT}$	Either Output	-	-	70	-	-	70	W
Current[2,5]	$\pm V_{OUT}$	Either Output	-	-	5.83	-	-	4.66	A
Ripple Voltage	$\pm V_{OUT}$	Full Load[4], 20Hz to 10MHz	-	-	100	-	-	100	mV_{p-p}
Line Regulation	$+V_{OUT}$	V_{IN} = 16V to 40V	-	-	20	-	-	20	mV
	$-V_{OUT}$	V_{IN} = 16V to 40V	-	-	100	-	-	100	mV
Load Regulation	$+V_{OUT}$	No Load to Full Load[4]	-	-	100	-	-	100	mV
	$-V_{OUT}$	No Load to Full Load[4]	-	-	150	-	-	150	mV
Cross Regulation	$-V_{OUT}$	+Load 70%, -Load 30% +Load 30%, -Load 70%	-	-	450	-	-	450	mV
EFFICIENCY		Full Load[4]	86	88	-	87	89	-	%
LOAD FAULT POWER DISSIPATION		Overload[3]	-	-	24	-	-	24	W
		Short Circuit	-	-	24	-	-	24	W
CAPACITIVE LOAD[3]		Either Output	-	-	500	-	-	500	µF
SWITCHING FREQUENCY			300	-	380	300	-	380	kHz
SYNC FREQUENCY RANGE		$V_H - V_L$ = 5V, DC = 20-80%	300	-	380	300	-	380	kHz
ISOLATION		500 V_{DC}, T_{CASE} = 25°C	100	-	-	100	-	-	MΩ
MTBF (MIL-HDBK-217F)		GM @ T_C = 55°C	-	344	-	-	344	-	kHrs

See notes next page.

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	40 V_{DC}	Junction Temperature Rise to Case	+17°C
Input Voltage (Transient, 1 second)	50 Volts	Storage Temperature	-55°C to +125°C
Output Power	100 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	17 Watts	Weight (Maximum)	90 Grams

Parameter		Conditions	VPT100-2812D			VPT100-2815D			Units
			Min	Typ	Max	Min	Typ	Max	
DYNAMIC									
Load Step Output Transient	$\pm V_{OUT}$	Half Load to Full Load	-	-	600	-	-	600	mV_{PK}
Load Step Recovery[1]		Half Load to Full Load	-	-	300	-	-	300	µSec
Line Step Output Transient[3]	$\pm V_{OUT}$	V_{IN} = 16V to 40V	-	-	1200	-	-	1200	mV_{PK}
Line Step Recovery[1,3]		V_{IN} = 16V to 40V	-	-	300	-	-	300	µSec
Turn On Delay	$\pm V_{OUT}$	V_{IN} = 0V to 28V	-	6	10	-	6	10	mSec
Turn On Overshoot		V_{IN} = 0V to 28V	-	0	50	-	0	50	mV_{PK}

Notes:
1. Time for output voltage to settle within 1% of its nominal value.
2. Derate linearly to 0 at 110°C.
3. Verified by qualification testing.
4. Half load at $+V_{OUT}$ and half load at $-V_{OUT}$.
5. Up to 70% of the total power or current can be drawn from any one of the two outputs.

BLOCK DIAGRAM

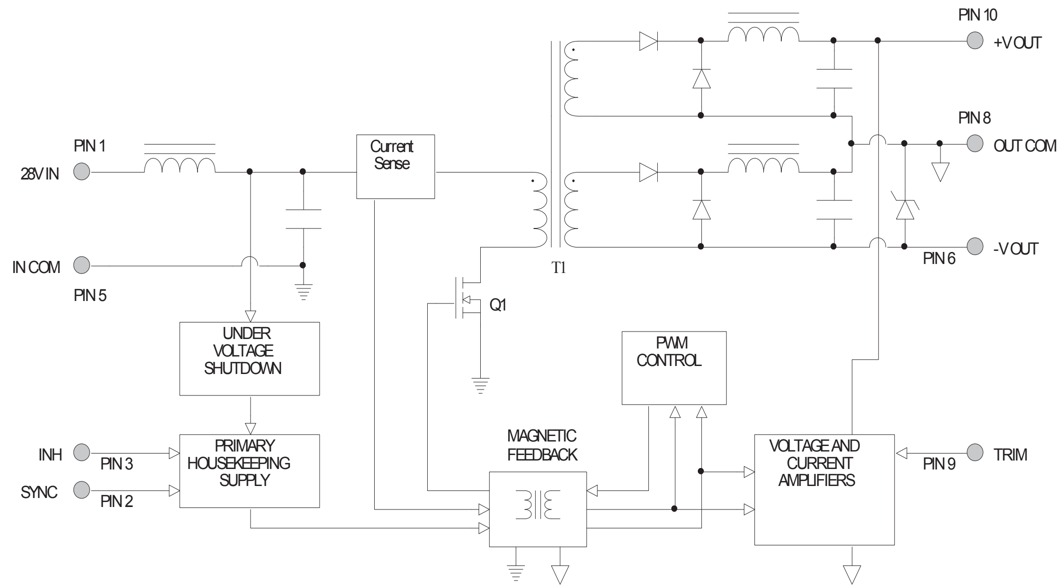


Figure 2

CONNECTION DIAGRAM

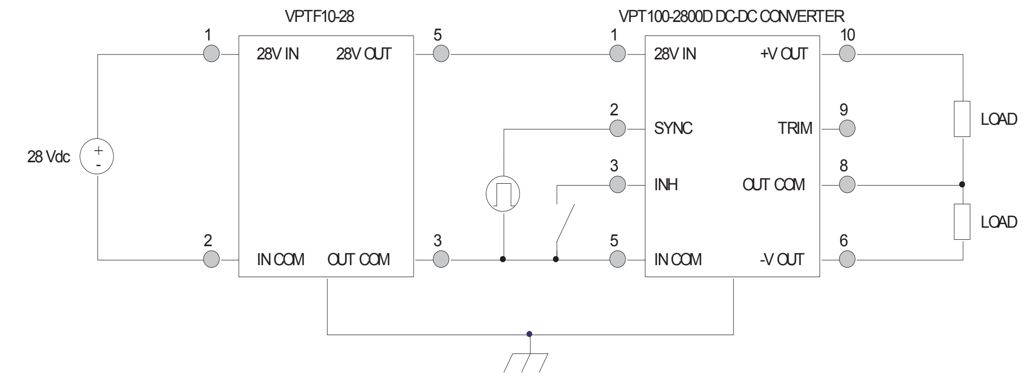


Figure 3

CONNECTION DIAGRAMS

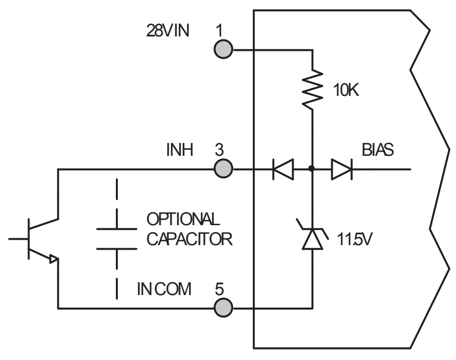


Figure 4 – Inhibit Circuit
(Shown with optional capacitor for turn-on delay)

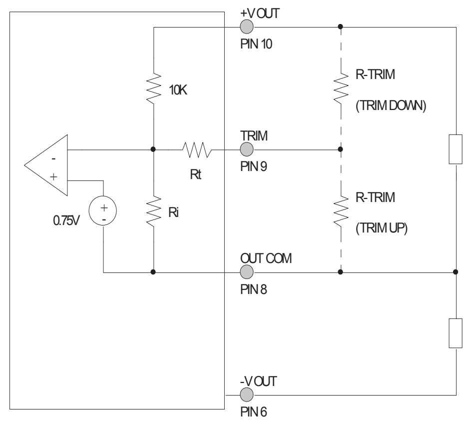


Figure 5 – Output Voltage Trim Circuit

OUTPUT VOLTAGE TRIM

The output voltage can be trimmed down by connecting a resistor between the TRIM pin and the +V OUT pin, or can be trimmed up by connecting a resistor between the TRIM pin and the OUT COM pin as shown in Figure 5. 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.

VPT100-2812D		VPT100-2815D	
$\pm V_{OUT}$ (V)	R_{TRIM} (Ω)	$\pm V_{OUT}$ (V)	R_{TRIM} (Ω)
13.2	1.14k	16.50	686
13.0	2.39k	16.25	1.69k
12.8	4.26k	16.00	3.19k
12.6	7.39k	15.75	5.7k
12.4	13.6k	15.50	10.7k
12.2	32.4k	15.25	25.9k
12.0	--	15.00	--
11.8	548k	14.75	551k
11.6	266k	14.50	270k
11.4	172k	14.25	175k
11.2	126k	14.00	128k
11.0	97.4k	13.75	99.5k
10.8	78.6k	13.50	80.6k
10.6	65.3k	13.25	67k
10.4	55.2k	13.00	56.9k
10.2	47.4k	12.75	49k
10.0	41.1k	12.50	42.6k
9.8	36k	12.25	37.5k
9.6	31.8k	12.00	33.2k

VPT100-2800D Series

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

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

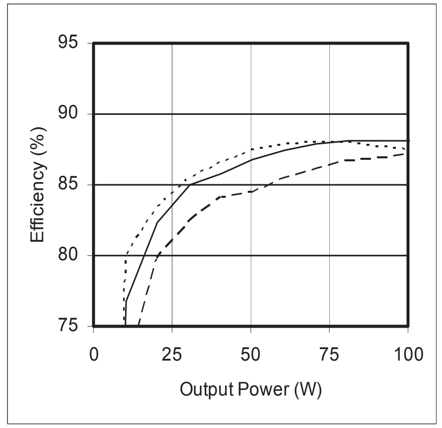


Figure 6 – VPT100-2812D
Efficiency (%) vs. Output Power (W)

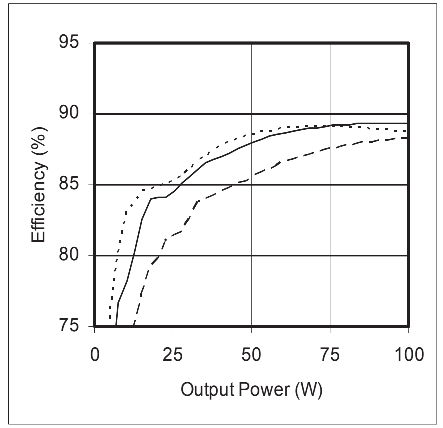


Figure 7 – VPT100-2815D
Efficiency (%) vs. Output Power (W)

EMI PERFORMANCE CURVES

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

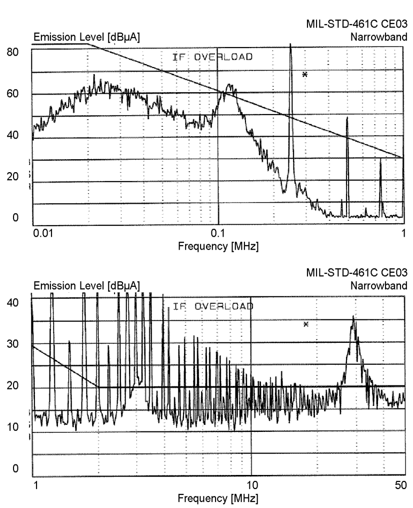


Figure 8 – VPT100-2800D without EMI Filter

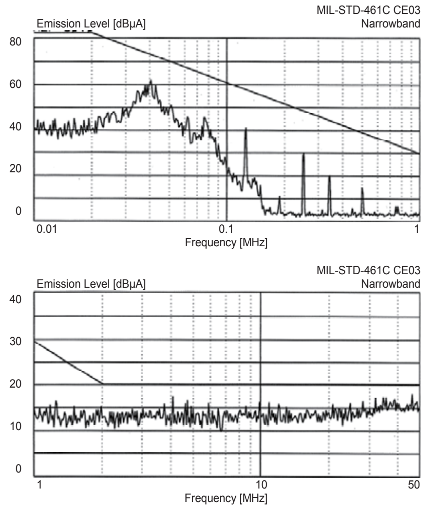


Figure 9 – VPT100-2800D with VPTF Series EMI Filter

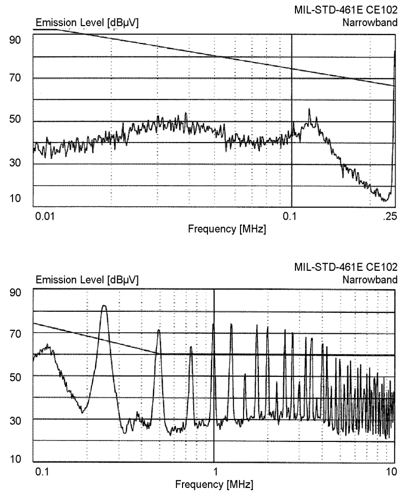


Figure 10 – VPT100-2800D without EMI Filter

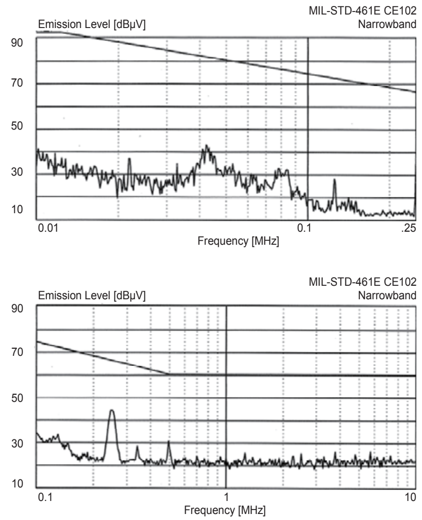
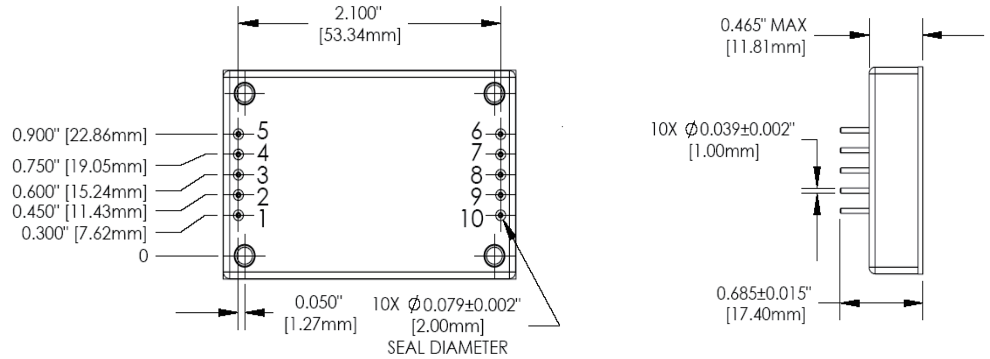


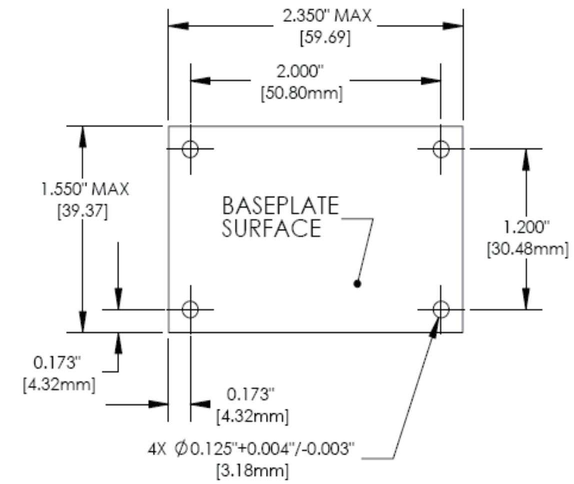
Figure 11 – VPT100-2800D with VPTF Series EMI Filter

PACKAGE SPECIFICATIONS



SIDE VIEW

TOP VIEW



BOTTOM VIEW

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

Figure 12 – Package and Pinout
(Dimensional Limits are ±0.005" Unless Otherwise Stated)

Package Notes:
1. Case temperature is measured on the center of the baseplate surface.
2. Materials: Baseplate – aluminum, conductive conversion coating.
Cover – nickel plated.
Pins – copper, gold over nickel plating.
3. Mounting holes are not threaded. Recommended fastener is 4-40.

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	28VIN	Positive Input Voltage Connection
2	SYNC	Input Synchronization Signal. TTL squarewave, 5Vpp, 20 - 80% duty cycle, internally capacitively coupled.
3	INHIBIT	This is an open collector input. Logic Low = Disabled Output. Connect the inhibit pin to input common to disable the output. Unconnected, open collector or open drain = Enabled Output.
4	CASE	Case Connection
5	INCOM	Input Return Connection
6	-VOUT	Negative Output Voltage Connection
7	NC	No Connection.
8	OUTCOM	Output Return Connection
9	TRIM	Trim Output Voltage to +10%, -20% of Nominal Value. Leave open if not used.
10	+VOUT	Positive Output Voltage Connection

100% ENVIRONMENTAL SCREENING

Screening	Condition
Internal Visual	IPC-A-610
Stabilization Bake	MIL-STD-883, Method 1008, Condition B, 125°C, 24 hours
Temperature Cycling	MIL-STD-883, Method 1010, Condition B, -55°C to +125°C, 10 Cycles
Burn-In	MIL-STD-883, Method 1015, 96 hours at +100°C
Final Electrical	100% at 25°C
External Visual	MIL-STD-883, Method 2009

ORDERING INFORMATION

VPT100-	28	12	D
1	2	3	4

(1) Product Series	(2) Nominal Input Voltage		(3) Output Voltage		(4) Number of Outputs	
VPT100-	**28**	28 Volts	**12** **15**	12 Volts 15 Volts	**D**	Dual

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
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DVST2800T Series

HIGH RELIABILITY DC-DC CONVERTERS

DESCRIPTION

The DVST series of high reliability DC-DC converters contains internal EMI filtering and meets MIL-STD-461C and MIL-STD-461D for conducted emissions, providing a one piece COTS solution for power conversion applications. The DVST series is operable over a wide (-55°C to +100°C) temperature range with no power derating. Unique to the DVST series is a magnetic feedback circuit that is radiation immune. The three low noise outputs are fully isolated from each other, allowing for maximum flexibility in system design.

FEATURES

- Up to 30 Watts Output Power
- Three Fully Isolated Outputs
- Wide Input Voltage Range: 15 to 50 Volts per MIL-STD-704 with 80 Volt Transient for 1 sec
- Internal Filter Meets MIL-STD-461C and MIL-STD-461D Conducted Emissions Requirements
- NO Use of Optoisolators
- Undervoltage Lockout
- Indefinite Short Circuit Protection
- Current Limit Protection
- Low Output Noise
- Custom Versions Available
- Low Profile (0.380 inches) Package
- Military Environmental Screening Available

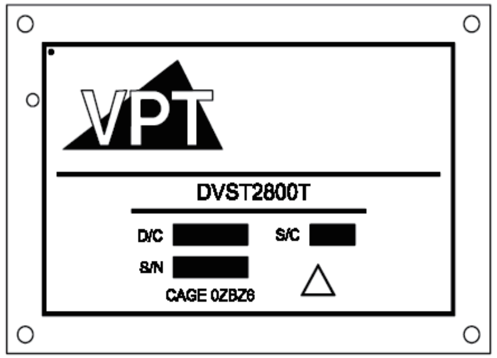

Figure 1 – DVST2800T DC-DC Converter
(Not To Scale)

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Bothell, WA 98012
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SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Operating Case Temperature	-55°C to +100°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-55°C to +125°C
Output Power[1]	30 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	15 Watts	Weight (Maximum)	100 Grams

INPUT

Parameter	Conditions	DVST2800T			Units
		Min	Typ	Max	
STATIC					
INPUT Voltage	Continuous	15	28	50	V
	Transient, 1 sec			80	V
Current	Inhibited		1.6	5.0	mA
	No Load		65	100	mA
Inhibit Pin Input		0		1.5	V
Inhibit Pin Open Circuit Voltage			11.0	14.0	V
UVLO Turn On				14.9	V
UVLO Turn Off		11.8			V
SWITCHING FREQUENCY		225		325	kHz
ISOLATION Input / Output / Case	500 V_{DC}	100			MΩ

MAIN OUTPUT

Parameter	Conditions	DVST283R3xxyyT			DVST285xxyyT			Units
		Min	Typ	Max	Min	Typ	Max	
STATIC								
OUTPUT Voltage V_{OUT}	T_{CASE} = 25°C	3.26	3.30	3.34	4.95	5.00	5.05	V
V_{OUT}	T_{CASE} = -55°C to +100°C	3.23	3.30	3.37	4.90	5.00	5.10	V
Power[2]		0		15	0		20	W
Current[2] V_{OUT}		0		4.5	0		4.0	A
Ripple Voltage V_{OUT}	Full Load, 20Hz to 10MHz		20	50		20	50	mV_{P-P}
Line Regulation V_{OUT}	V_{IN} = 15V to 50V		5	20		5	20	mV
Load Regulation V_{OUT}	No Load to Full Load		10	30		10	30	mV
EFFICIENCY			73			76		%
CAPACITIVE LOAD				1000			1000	µF
DYNAMIC								
Load Step Output Transient V_{OUT}	Half Load to Full Load		200	400		200	400	mV_{PK}
Load Step Recovery[3]			200	400		200	400	µSec
Line Step Output Transient V_{OUT}	V_{IN} = 15V to 50V		400	600		400	600	mV_{PK}
Line Step Recovery[3]			400	600		400	600	µSec
Turn On Delay V_{OUT}	V_{IN} = 0V to 28V		15	20		15	20	mSec
Turn On Overshoot			0	30		0	50	mV_{PK}

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Operating Case Temperature	-55°C to +100°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-55°C to +125°C
Output Power[1]	30 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	15 Watts	Weight (Maximum)	100 Grams

MAIN OUTPUT

Parameter		Conditions	DVST281R8xxyyT			DVST286R25xxyyT			Units
			Min	Typ	Max	Min	Typ	Max	
STATIC									
OUTPUT Voltage	V_{OUT}	T_{CASE} = 25°C	1.78	1.80	1.82	6.19	6.25	6.31	V
	V_{OUT}	T_{CASE} = -55°C to +100°C	1.76	1.80	1.84	6.12	6.25	6.38	V
Power[2]			0		13.5	0		20	W
Current[2]	V_{OUT}		0		7.5	0		3.2	A
Ripple Voltage	V_{OUT}	Full Load, 20Hz to 10MHz		20	75		20	50	mV_{P-P}
Line Regulation	V_{OUT}	V_{IN} = 15V to 50V		5	20		5	20	mV
Load Regulation	V_{OUT}	No Load to Full Load		10	30		10	30	mV
EFFICIENCY				66			76		%
CAPACITIVE LOAD					1000			1000	µF
DYNAMIC									
Load Step Output Transient	V_{OUT}	Half Load to Full Load		200	400		200	400	mV_{PK}
Load Step Recovery[3]				500	750		200	400	µSec
Line Step Output Transient	V_{OUT}	V_{IN} = 15V to 50V		400	600		400	600	mV_{PK}
Line Step Recovery[3]				400	750		400	600	µSec
Turn On Delay	V_{OUT}	V_{IN} = 0V to 28V		15	20		15	20	mSec
Turn On Overshoot				0	20		0	50	mV_{PK}

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Operating Case Temperature	-55°C to +100°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-55°C to +125°C
Output Power[1]	30 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	15 Watts	Weight (Maximum)	100 Grams

MAIN OUTPUT

Parameter		Conditions	DVST2812xxyyT			Units
			Min	Typ	Max	
STATIC						
OUTPUT Voltage	V_{OUT}	T_{CASE} = 25°C	11.88	12.00	12.12	V
	V_{OUT}	T_{CASE} = -55°C to +100°C	11.76	12.00	12.24	V
Power[2]					20	W
Current[2]	V_{OUT}				1.67	A
Ripple Voltage	V_{OUT}	Full Load, 20Hz to 10MHz			50	mV_{P-P}
Line Regulation	V_{OUT}	V_{IN} = 15V to 50V			50	mV
Load Regulation	V_{OUT}	No Load to Full Load			50	mV
EFFICIENCY				76		%
CAPACITIVE LOAD					500	µF
DYNAMIC						
Load Step Output Transient	V_{OUT}	Half Load to Full Load		200	400	mV_{PK}
Load Step Recovery[3]				200	400	µSec
Line Step Output Transient	V_{OUT}	V_{IN} = 15V to 50V		400	600	mV_{PK}
Line Step Recovery[3]				200	600	µSec
Turn On Delay	V_{OUT}	V_{IN} = 0V to 28V		15	20	mSec
Turn On Overshoot				0	50	mV_{PK}

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Operating Case Temperature	-55°C to +100°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-55°C to +125°C
Output Power[1]	30 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	15 Watts	Weight (Maximum)	100 Grams

AUXILIARY OUTPUT			DVST28x12yyT			DVST28x15yyT			
Parameter		Conditions	Min	Typ	Max	Min	Typ	Max	Units
STATIC									
OUTPUT Voltage	V_{OUT}	T_{CASE} = 25°C	11.76	12.00	12.24	14.70	15.00	15.30	V
	V_{OUT}	T_{CASE} = -55°C to +100°C	11.64	12.00	12.36	14.55	15.00	15.45	V
Power[2]			0		5	0		5	W
Current[2]	V_{OUT}		0		0.42	0		0.33	A
Ripple Voltage	V_{OUT}	Full Load, 20Hz to 10MHz		25	50		25	50	mV_{P-P}
Line Regulation	V_{OUT}	V_{IN} = 15V to 50V		5	20		5	20	mV
Load Regulation	V_{OUT}	No Load to Full Load		10	50		10	50	mV
CAPACITIVE LOAD					500			500	μF
DYNAMIC									
Load Step Output Transient	V_{OUT}	Half Load to Full Load		200	400		200	400	mV_{PK}
Load Step Recovery[3]				100	200		100	200	μSec
Line Step Output Transient	V_{OUT}	V_{IN} = 15V to 50V		100	400		100	400	mV_{PK}
Line Step Recovery[3]				100	200		100	200	μSec
Turn On Delay	V_{OUT}	V_{IN} = 0V to 28V		2	20		2	20	mSec
Turn On Overshoot				100	250		100	250	mV_{PK}

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Operating Case Temperature	-55°C to +100°C
Input Voltage (Transient, 1 second)	80 Volts	Storage Temperature	-55°C to +125°C
Output Power[1]	30 Watts	Lead Solder Temperature (10 seconds)	270°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	15 Watts	Weight (Maximum)	100 Grams

AUXILIARY OUTPUT			DVST28x3R3yyT			DVST28x5yyT			
Parameter		Conditions	Min	Typ	Max	Min	Typ	Max	Units
STATIC									
OUTPUT Voltage	V_{OUT}	T_{CASE} = 25°C	3.23	3.30	3.37	4.90	5.00	5.10	V
	V_{OUT}	T_{CASE} = -55°C to +100°C	3.20	3.30	3.40	4.85	5.00	5.15	V
Power[2]					4			5	W
Current[2]	V_{OUT}				1.2			1.0	A
Ripple Voltage	V_{OUT}	Full Load, 20Hz to 10MHz		25	50		25	50	mV_{P-P}
Line Regulation	V_{OUT}	V_{IN} = 15V to 50V		5	20		5	20	mV
Load Regulation	V_{OUT}	No Load to Full Load		10	30		10	30	mV
CAPACITIVE LOAD					1000			1000	μF
DYNAMIC									
Load Step Output Transient	V_{OUT}	Half Load to Full Load		100	200		100	200	mV_{PK}
Load Step Recovery[3]				100	200		100	200	μSec
Line Step Output Transient	V_{OUT}	V_{IN} = 15V to 50V		100	200		100	200	mV_{PK}
Line Step Recovery[3]				100	200		100	200	μSec
Turn On Delay	V_{OUT}	V_{IN} = 0V to 28V		2	20		2	20	mSec
Turn On Overshoot				0	50		0	50	mV_{PK}

Notes:
1. Dependant on output voltage.
2. Derate linearly from full rating at 100°C to 0 at 110°C.
3. Time for output voltage to settle to within 1% of its nominal value.

CONNECTION DIAGRAM

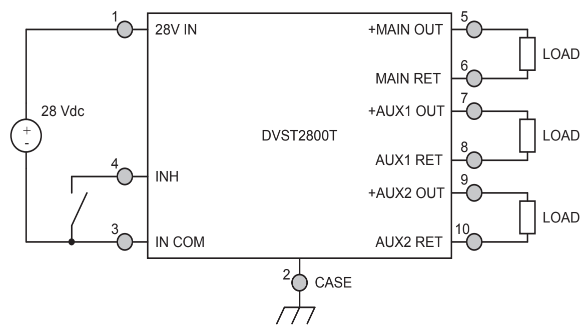


Figure 2

BLOCK DIAGRAM

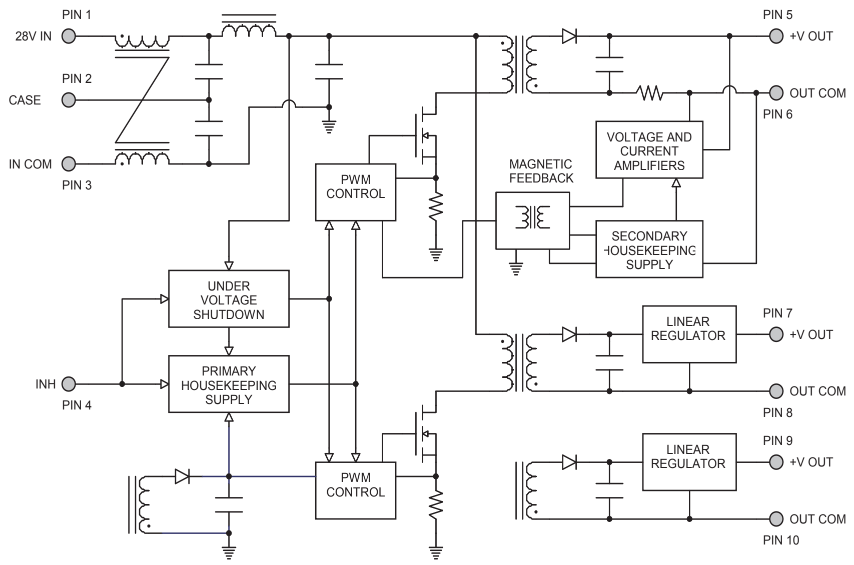


Figure 3

INHIBIT DRIVE CONNECTION DIAGRAMS

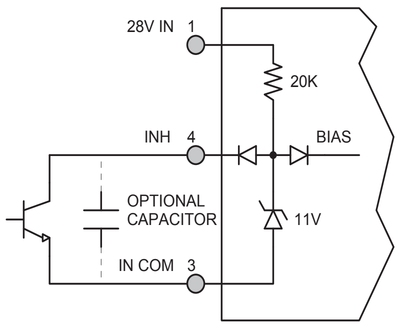


Figure 4 – Internal Inhibit Circuit and Recommended Drive

(Shown with optional capacitor for turn-on delay)

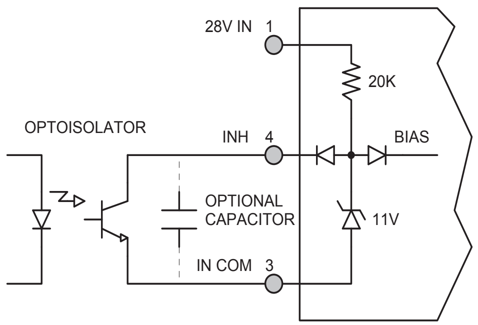


Figure 5 – Isolated Inhibit Drive

(Shown with optional capacitor for turn-on delay)

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

------- V_{IN} = 15V	——— V_{IN} = 28V	– – – – – V_{IN} = 50V

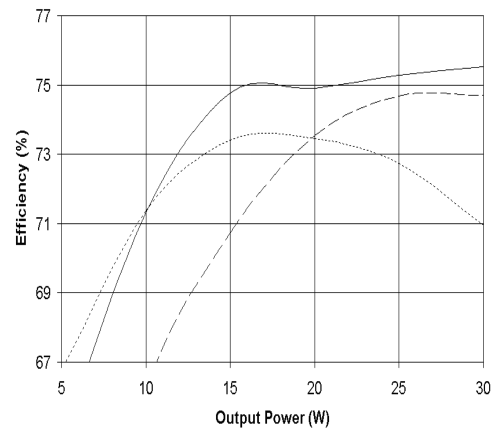


Figure 6 – DVST2851212T

Efficiency (%) vs. Output Power (W)

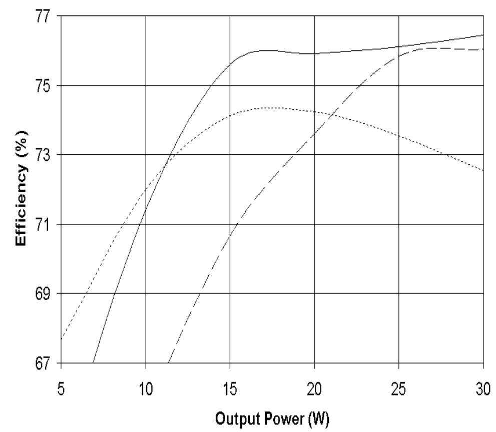


Figure 7 – DVST2851515T

Efficiency (%) vs. Output Power (W)

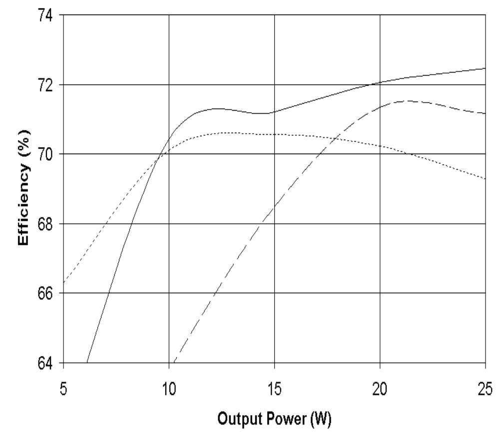


Figure 8 – DVST283R31212T

Efficiency (%) vs. Output Power (W)

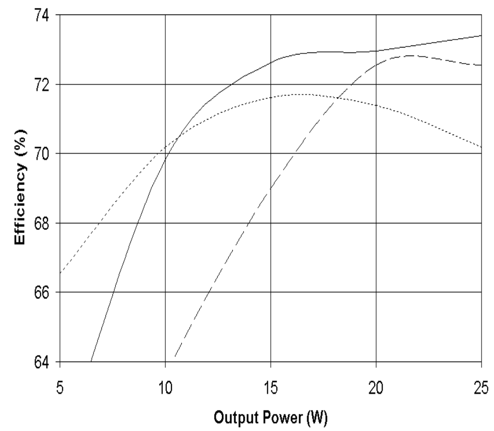


Figure 9 – DVST283R31515T

Efficiency (%) vs. Output Power (W)

EMI PERFORMANCE CURVES

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

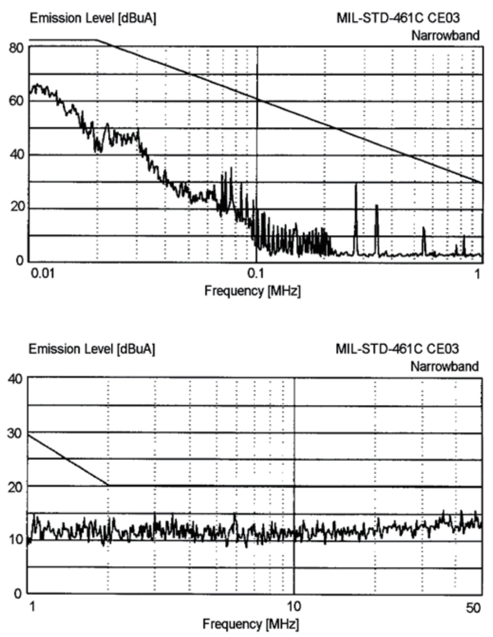


Figure 10 –
MIL-STD-461C CE03 Conducted Emissions

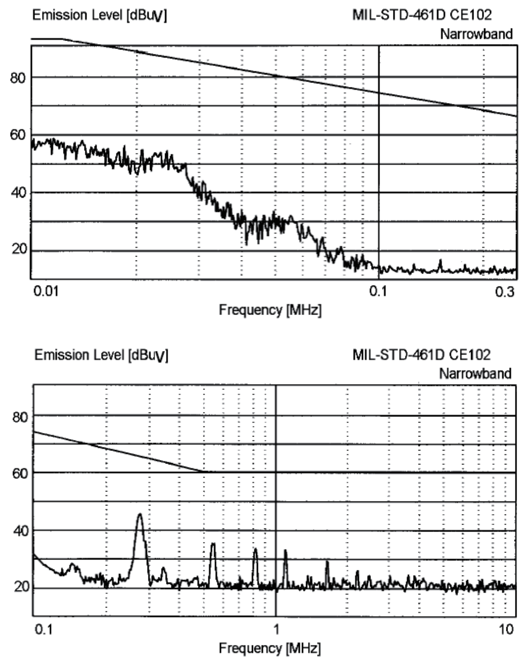
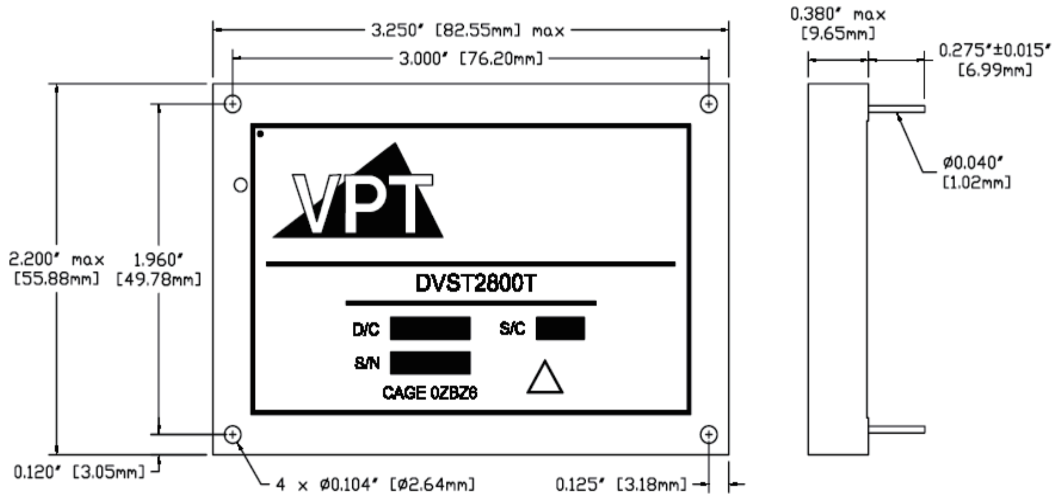


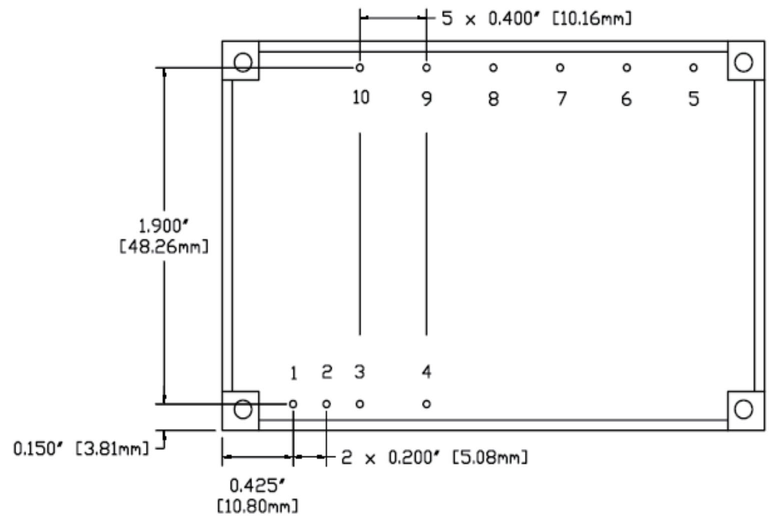
Figure 11 –
MIL-STD-461D CE102 Conducted Emissions

ENVIRONMENTAL QUALIFICATION

Description	MIL-STD-883	MIL-STD-202	Test Condition
Temperature Cycling	1010	102A	-55°C to +100°C, 100 cycles
Constant Acceleration	2001	212A	500g, 1min.
Mechanical Shock	2002 Cond. A	213B Cond. D	500g, 1ms
Random Vibration	2026 Cond. D	214A Cond. D	11.6G RMS, operating
Moisture Resistance	1004	106F	10 days
Barometric Pressure	1001 Cond. D	105C Cond. C	70,000 ft, operating
Salt Atmosphere	1009 Cond. B	101D Cond. B	48 hrs.
Resistance to Solvents	2015	215J	
Solderability	2003	208H	

PACKAGE SPECIFICATIONS





PIN	FUNCTION
1	28V IN
2	CASE
3	IN COM
4	INHIBIT
5	+MAIN OUT
6	MAIN RET
7	+AUX1 OUT
8	AUX1 RET
9	+AUX2 OUT
10	AUX2 RET

Note: Additional mounting options are available. Consult the factory for details.

Figure 12 – Package and Pinout
(Dimensional Limits are ±0.005" Unless Otherwise Stated)

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	28V IN	Positive Input voltage Connection
2	CASE	Case Connection
3	IN COM	Input Common Connection
4	INHIBIT	Logic Low = Disabled Output. Connecting the inhibit pin to input common (PIN 7) causes converter shutdown. Logic High = Enabled Output. Unconnected or open collector TTL.
5	+MAIN OUT	Main Positive Output Voltage Connection
6	MAIN RET	Main Output Return Connection
7	+AUX1 OUT	Auxiliary Positive Output Voltage Connection
8	AUX1 RET	Auxiliary Output Return Connection
9	+AUX2 OUT	Auxiliary Positive Output Voltage Connection
10	AUX2 RET	Auxiliary Output Return Connection

ENVIRONMENTAL SCREENING

Screening	MIL-STD-883	Standard (No Suffix)	Extended /ML
Pre-Cap Inspection	IPC-A-610 Class III	•	•
Temperature Cycling	-55°C, 100°C, 10 Cycles		•
Burn-In	96 hours at +100°C 24 hours at +100°C	 •	•
Final Electrical	100% at 25°C	•	•
Final Inspection	Method 2009	•	•

ORDERING INFORMATION

DVST	28	5	15	15	T		/ML	-	XXX
1	2	3	4	5	6	7	8		9

(1) Product Series	(2) Nominal Input Voltage		(3) Main Output		(4) Auxiliary Output 1		(5) Auxiliary Output 2	
DVST	**28**	28 Volts	**1R8** **3R3** **5** **6R25** **12**	1.8 Volts 3.3 Volts 5 Volts 6.25 Volts 12 Volts	**3R3** **5** **12** **15**	3.3 Volts 5 Volts 12 Volts 15 Volts	**5** **12** **15**	5 Volts 12 Volts 15 Volts

(6) Number of Outputs		(7) Package Option		(8) Screening Code		(9) Additional Screening Code
T	Triple	**None**	Standard	**None** **/ML**	Standard Military	Contact Sales

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, or packaging requirements.

CONTACT INFORMATION

To request a quotation or place orders please contact your sales representative or the VPT Inc. Sales Department at:

Phone: (425) 487-4850
Fax: (425) 487-4802
E-mail: sales@vpt-inc.com

DVMN28

HIGH RELIABILITY
EMI FILTER AND INPUT ATTENUATOR

DESCRIPTION

The DVMN28 is a combined EMI filter and voltage spike protection module that is operable over a wide temperature range (-55 °C to +100 °C) with no power derating. The DVMN28 EMI filter works with VPT/Delta's DV200 series DC-DC converters to meet the surge requirements of MIL-STD-704A, B, C, and D with up to 250 watts of output power. These devices also reduce the reflected noise of the DC-DC converters to meet MIL-STD-461C CE03 and MIL-STD-461D CE102 limits. The DVMN28 filter also protects the DC-DC converters against the voltage spikes specified in MIL-STD-461C CS06 and conducted susceptibility in MIL-STD-461C CS01 and CS02.

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

FEATURES

- High Reliability
- 250 Watt Output Power
- 50 dB Minimum Attenuation at 500 kHz
- Soft Start
- Under Voltage Lockout
- Clamps Output Voltage to 58 Volts Maximum
- Standard Quarter-Brick Size
- Custom Versions Available
- Additional Environmental Screening Available
- Meets MIL-STD-704A, B, C, and D Surge Limits
- Designed to meet MIL-STD-461C CE03 and MIL-STD-461D CE102 and DEF STAN 59-41 and 61-5 EMC Requirements
- Protects Against Conducted Susceptibility Specified in MIL-STD-461C, CS01 and CS02 and Against Voltage Spikes Specified in MIL-STD-461C CS06

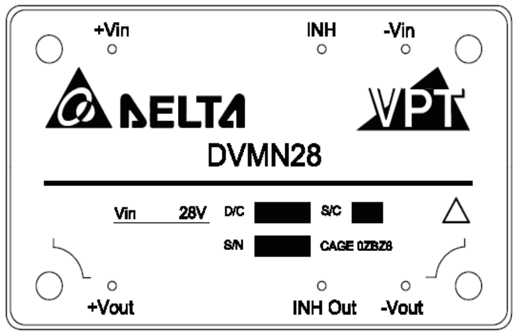


Figure 1 – DVMN28 EMI Filter
(Not To Scale)

11314 4th Avenue
West, Suite 206
Everett, WA 98204
http://www.vpt-inc.com

Sales Information:
Phone: (425) 353-3010
Fax: (425) 353-4030
E-mail: sales@vpt-inc.com

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Power Dissipation (Continuous)	12 Watts
Input Voltage (Transient, up to 10µs)	600 Volts	Storage Temperature	-65°C to +135°C
Output Current[1]	14 Amps	Lead Solder Temperature (10 seconds)	300°C
Weight (Maximum)	75 Grams		

Parameter	Conditions	DVMN28 Min	DVMN28 Typ	DVMN28 Max	Units
STATIC					
INPUT Voltage[2] Continuous	With load	16	28	50	V
INPUT Voltage[2] Transient	5 ms, R_S = 0.5 Ω	-40	-	70	V
INPUT Voltage[2] Transient[3]	50 ms, R_S = 0.5 Ω	-	-	110	V
INPUT Voltage[2] Transient	10 µs, R_S = 50 Ω	-	-	600	V
Current	No Load	-	-	12	mA
Current	Inhibited	-	-	2.0	mA
OUTPUT Voltage	Continuous	$V_{OUT} = V_{IN} - (I_{IN} \times R_{DC})$			V
Power[1,4]	Continuous			250	W
Current[1,4]	Continuous			14	A
INHIBIT PIN VOLTAGE[2]	Open Circuit	-	14	16	V
INHIBIT PIN VOLTAGE[2]	Inhibited	0	-	0.8	V
INHIBIT PIN CURRENT[2]	Inhibit Pin Voltage = 0 to 0.8 V	-	-	-300	µA
UNDERVOLTAGE LOCKOUT		7	-	14	V
OUTPUT CLAMP VOLTAGE		51	-	55	V
DC RESISTANCE	Continuous			60	mΩ
POWER DISSIPATION	Continuous	-	-	12	W
NOISE REJECTION	f = 500 kHz	50	60	-	dB
CAPACITANCE[2]	Pin to Case	-	85	-	nF
ISOLATION	Any Pin to Case, 500 V_{DC}	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	GB @ T_C = 55°C	-	2052	-	kHrs

Notes:
1. Derate linearly to 0 at 110°C.
2. Verified by qualification testing.
3. Output inhibit used with load converters as in Figure 3.
4. Maximum rating applies at any voltage.

BLOCK DIAGRAM

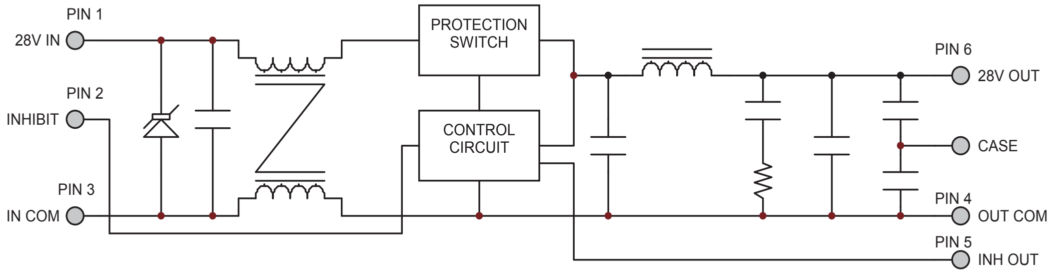


Figure 2

CONNECTION DIAGRAM

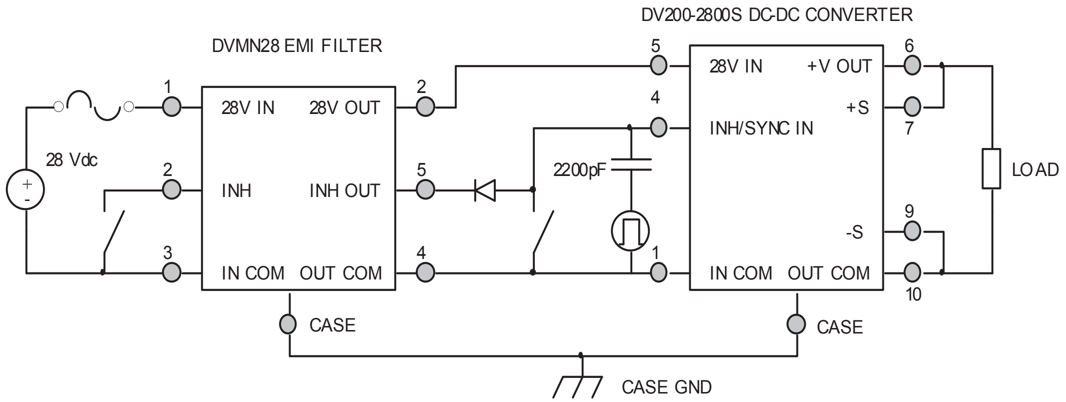


Figure 3 – DVMN28 EMI Filter Hookup with Single Converter
(Diode on pin 5 of DVMN28 is needed when synchronization function of the converter is used.)

DVMN28

INHIBIT DRIVE CONNECTION DIAGRAM

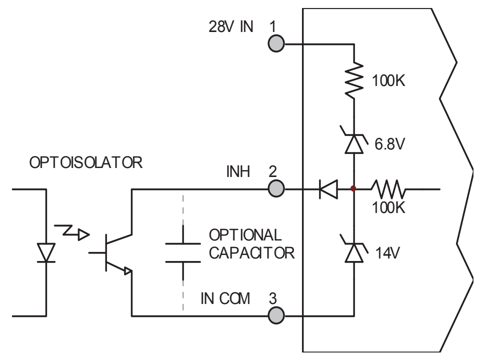


Figure 4 – Isolated Inhibit Drive
(Shown with optional capacitor for turn-on delay)

EMI MEASUREMENT METHODS CONNECTION DIAGRAMS

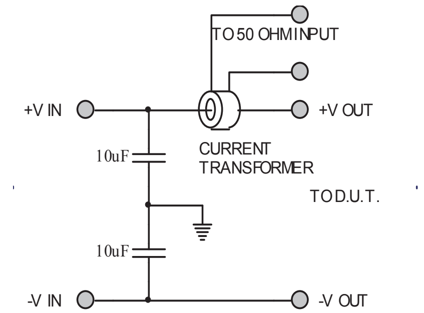


Figure 5 – MIL-STD-461C Measurement Method (Feedthrough Capacitor)

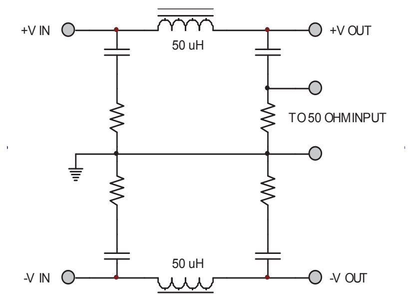


Figure 6 – MIL-STD-461D Measurement Method (LISN)

EMI PERFORMANCE CURVES

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

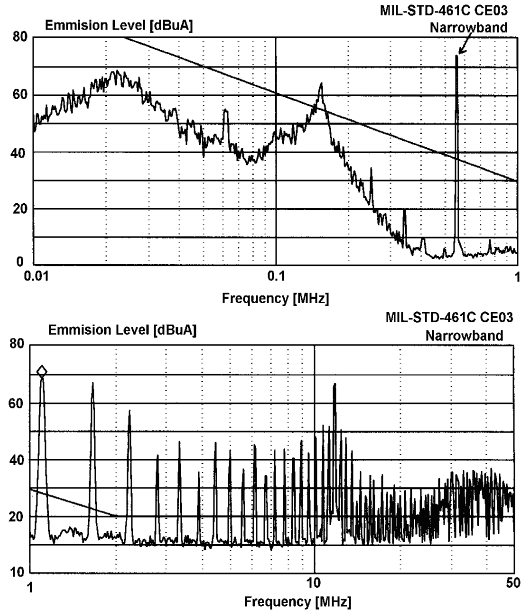


Figure 7 – MIL-STD-461C
DV200-2815D Without EMI Filter

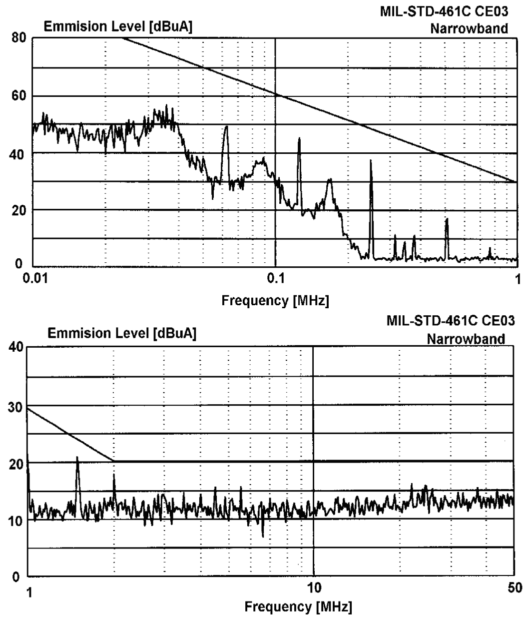


Figure 8 – MIL-STD-461C
DV200-2805S With DVMN28 EMI Filter

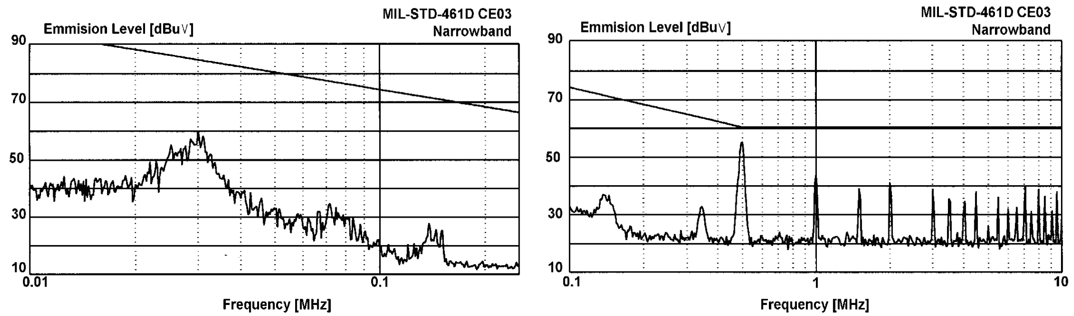
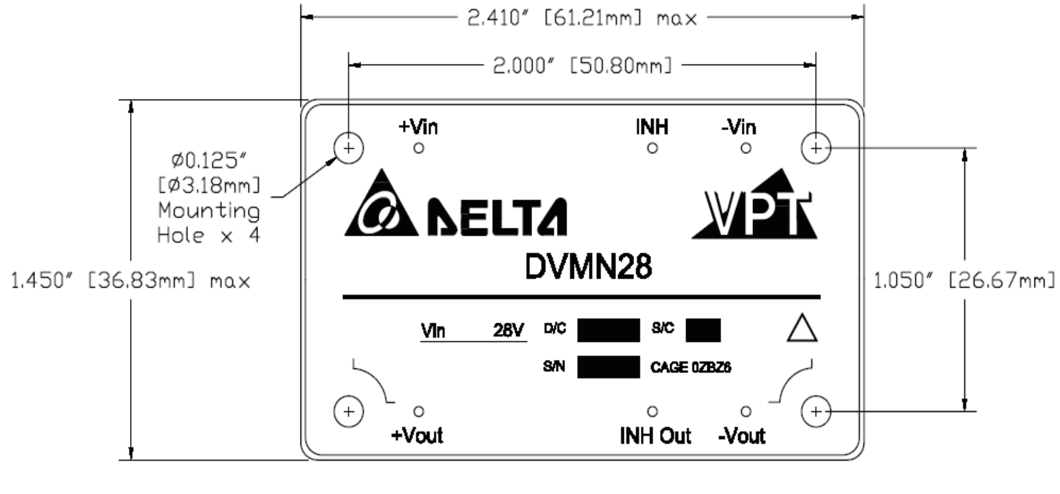
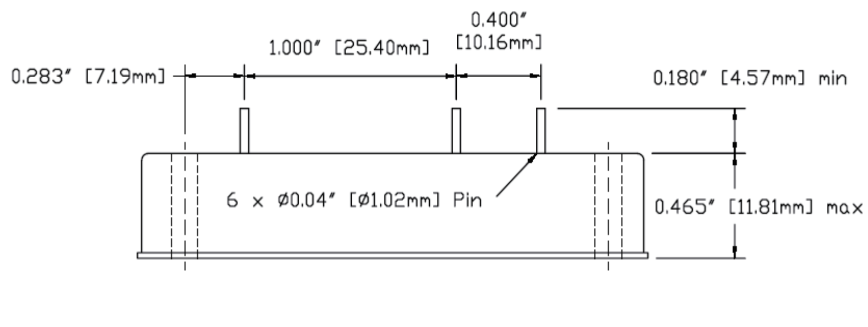


Figure 9 – MIL-STD-461D
DV200-2805S With DVMN28 EMI Filter

PACKAGE SPECIFICATIONS



TOP VIEW



PIN	FUNCTION
1	+Vin
2	INH
3	-Vin
4	-Vout
5	INH OUT
6	+V OUT

SIDE VIEW

Figure 10 - Package and Pinout
(Dimensional Limits are ±0.005" Unless Otherwise Stated)

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	+Vin	28V Input: Positive Input Voltage Connection
2	INH	Logic Low = Disabled Output.
3	-Vin	Input Common Connection
4	-Vout	Output Common Connection
5	INH OUT	Output Inhibit. Open Collector Output. Connects to Load Converter INH Input.
6	+Vout	28V Output: Positive Output Voltage Connection

ENVIRONMENTAL SCREENING

Screening	MIL-STD-883	Standard (No Suffix)	Military /ML
Pre-Cap Inspection	IPC-A-610 Class II	•	•
Temperature Cycling	-55°C, 100°C, 10 cycles		•
Burn-In	96 hours at +100°C 12 hours at +100°C	 •	•
Final Electrical	100% at -55°C, 25°C, 100°C[1] 100% at 25°C	 •	•
Final Inspection	Method 2009	•	•

Note: 1. 100% R&R testing at –55°C, +25°C, and +100°C with all test data included in product shipment.

ORDERING INFORMATION

DVMN	28	/ML	-	XXX
1	2	3		4

(1) Product Series	(2) Nominal Input Voltage		(3) Screening Code		(4) Additional Screening Code
DVMN	**28**	28 Volts	**None** **/ML**	Standard Military	Contact Sales

Please contact your sales representative or the VPT Inc. Sales Department for more information concerning additional environmental screening and testing, different input voltage, power requirement, source inspection, and/or special element evaluation for space or other higher quality applications.

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: sales@vpt-inc.com

HIGH RELIABILITY COTS EMI FILTERS

DESCRIPTION

The VPTF1 series of COTS EMI filters is a cost effective solution for many demanding high reliability applications. A wide input voltage range accommodates nominal 28V inputs including avionics, mobile, ground systems, and other applications. The VPTF1 EMI filter is designed to filter the conducted emissions of multiple VPT series DC-DC converters up to its current rating, providing compliance to MIL-STD-461C/D/E for conducted emissions. A proven design heritage and a rugged all metal package ensure long term reliability.

The VPTF1 series is intended for harsh environments including severe vibration, shock and temperature cycling. Testing is to JESD22, MIL-STD-810, and MIL-STD-883.

These converters are designed and manufactured in the USA in a facility certified to ISO9001, J-STD-001 and IPC-A-610.

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 at Low Cost
- Up to 1.0 Amp Maximum Current
- Up to 25W Output Power
- Wide Input Voltage Range: 0 to 50 Volts per MIL-STD-704 and MIL-STD-1275
- High Input Transient Voltage: 80 Volts for 1 sec per MIL-STD-704A
- 55 dB Minimum Attenuation at 500 kHz
- Wide Temperature Range, -55°C to 100°C
- Fully Encapsulated
- Six Sided Metal Rugged Enclosure
- Meets MIL-STD-461C/D/E Conducted Emissions Requirements When Used With a VPT Series DC-DC Converter
- Meets Conducted Susceptibility Requirements of MIL-STD-461C, CS01 and CS02, and MIL-STD-461D/E when used with a VPT Series DC-DC Converter

Figure 1 – VPTF1-28
(Not To Scale)

11314 4th Avenue
West, Suite 206
Everett, WA 98204
http://www.vpt-inc.com

Sales Information:
Phone: (425) 353-3010
Fax: (425) 353-4030
E-mail: vptsales@vpt-inc.com

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Storage Temperature	-55°C to +125°C
Input Voltage (Transient, 1 second)	80 Volts	Lead Solder Temperature (10 seconds)	300°C
Output Current	1.0 Amps	Weight (Maximum)	15 Grams
Power Dissipation (Full Load, T_{CASE} = +100°C)	0.25 Watt		

Parameter	Conditions	VPTF1-28			Units
		Min	Typ	Max	
STATIC					
INPUT Voltage	Continuous	0	28	50	V
	Transient, 1 sec[2]	-	-	80	V
OUTPUT Voltage		$V_{OUT} = V_{IN} - (I_{IN} \times R_{DC})$			V
Current[1]		0	-	1.0	A
Power		0	-	25	W
DC RESISTANCE		-	-	250	mΩ
POWER DISSIPATION[2]		-	-	0.25	W
NOISE REJECTION	f = 500 kHz	55	-	-	dB
CAPACITANCE	Any Pin to Case	10	-	30	nF
ISOLATION	Any Pin to Case, 500 VDC	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	GM @ T_C = 55°C	-	1.67	-	MHrs

Notes: 1. Derate linearly to 0 at 110°C.
2. Verified by qualification testing.

BLOCK DIAGRAM

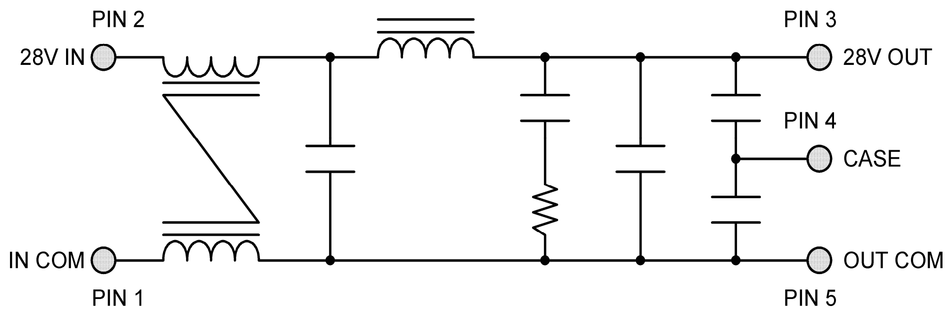


Figure 2

CONNECTION DIAGRAMS

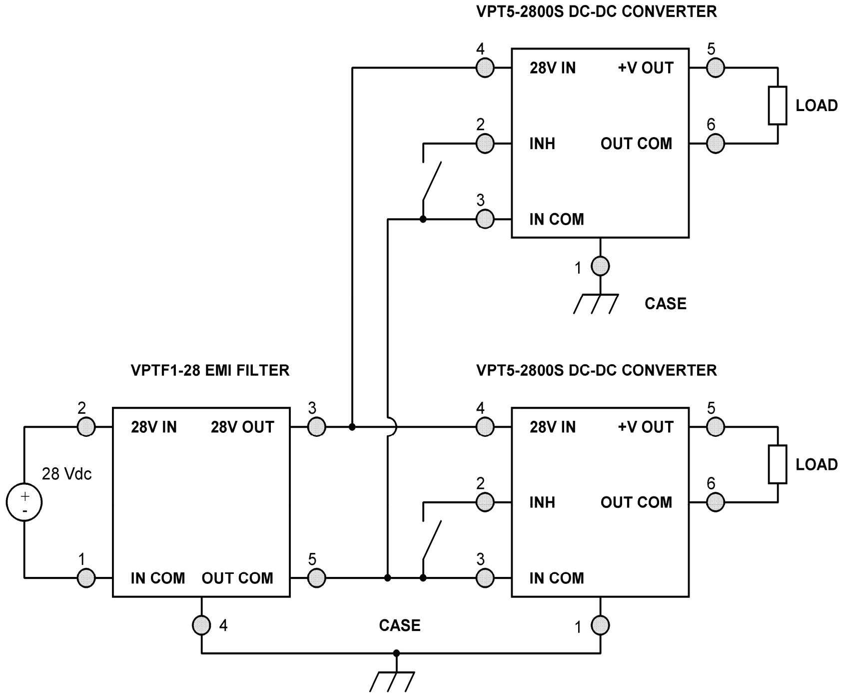


Figure 3
(Shown with multiple VPT Series DC-DC Converters)

EMI PERFORMANCE CURVES

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

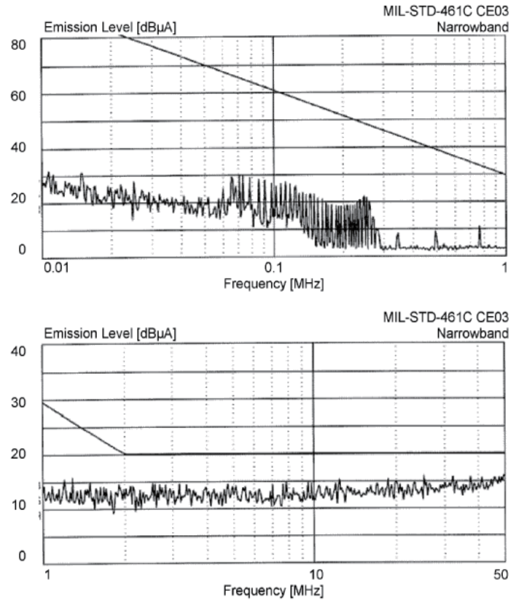
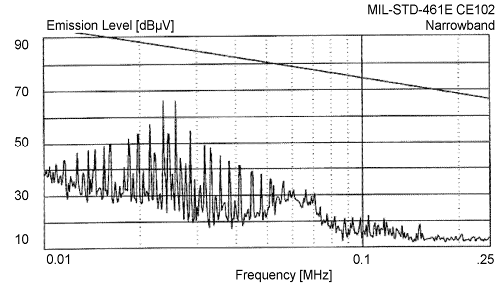


Figure 4 – MIL-STD-461C
Two VPT5-2800S With VPTF1-28 EMI Filter



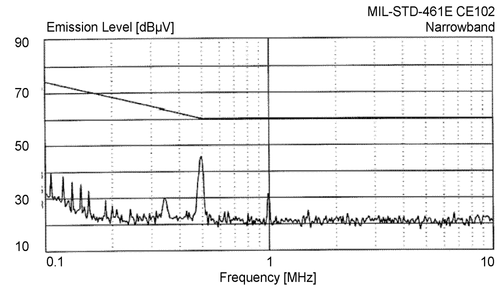
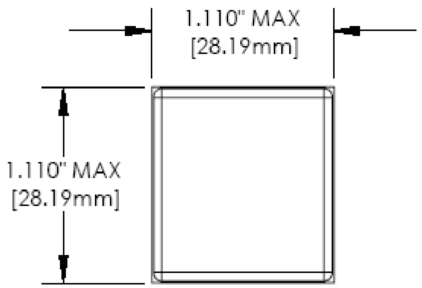
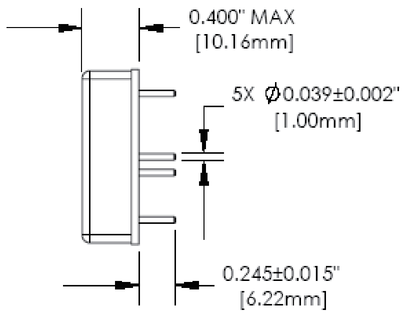


Figure 5 – MIL-STD-461D/E
Two VPT5-2800S With VPTF1-28 EMI Filter

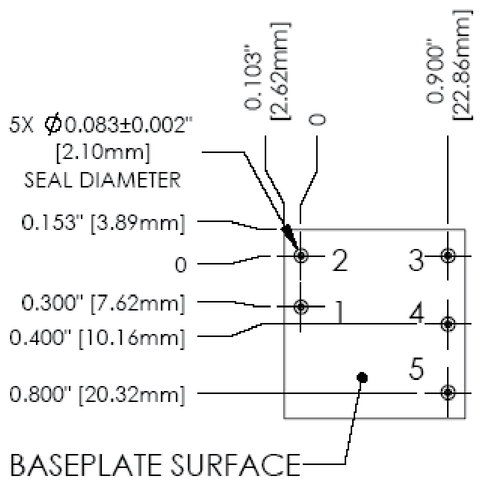
PACKAGE SPECIFICATIONS



TOP VIEW



SIDE VIEW



BOTTOM VIEW

PIN	FUNCTION
1	IN COM
2	28V IN
3	28V OUT
4	CASE
5	OUT COM

Figure 6 –Package and Pinout
(Dimensional Limits are ±0.005" Unless Otherwise Stated)

Package Notes:
1. Case temperature is measured on the center of the baseplate surface.
2. Materials: Baseplate – aluminum, conductive conversion coating.
   Cover – nickel plated.
   Pins – copper, gold over nickel plating.

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	IN COM	Input Return Connection
2	28V IN	Positive Input Voltage Connection
3	28V OUT	Positive Output Voltage Connection
4	CASE	Case Connection
5	OUT COM	Output Return Connection

100% ENVIRONMENTAL SCREENING

Screening	Condition
Internal Visual	IPC-A-610
Stabilization Bake	MIL-STD-883, Method 1008, Condition B, 125°C, 24 hours
Temperature Cycling	MIL-STD-883, Method 1010, Condition B, -55°C to +125°C, 10 Cycles
Burn-In	MIL-STD-883, Method 1015, 96 hours at +100°C
Final Electrical	100% at 25°C
External Visual	MIL-STD-883, Method 2009

ORDERING INFORMATION

VPTF1-	28
1	2

(1) Product Series	(2) Nominal Input Voltage	
VPTF1-	28	28 Volts

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

VPTF3-28 Series

HIGH RELIABILITY COTS EMI FILTERS

DESCRIPTION

The VPTF3 series of COTS EMI filters is a cost effective solution for many demanding high reliability applications. A wide input voltage range accommodates nominal 28V inputs including avionics, mobile, ground systems, and other applications. The VPTF3 EMI filter is designed to filter the conducted emissions of multiple VPT series DC-DC converters up to its current rating, providing compliance to MIL-STD-461C/D/E for conducted emissions. A proven design heritage and a rugged all metal package ensure long term reliability.

The VPTF3 series is intended for harsh environments including severe vibration, shock and temperature cycling. Testing is to JESD22, MIL-STD-810, and MIL-STD-883.

These converters are designed and manufactured in the USA in a facility certified to ISO9001, J-STD-001 and IPC-A-610.

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 at Low Cost
- Up to 3.0 Amp Maximum Current
- Up to 75W Output Power
- Wide Input Voltage Range: 0 to 50 Volts per MIL-STD-704 and MIL-STD-1275
- High Input Transient Voltage: 80 Volts for 1 sec per MIL-STD-704A
- 55 dB Minimum Attenuation at 500 kHz
- Wide Temperature Range, -55°C to 100°C
- Fully Encapsulated
- Six Sided Metal Rugged Enclosure
- Meets MIL-STD-461C/D/E Conducted Emissions Requirements When Used With a VPT Series DC-DC Converter
- Meets Conducted Susceptibility Requirements of MIL-STD-461C, CS01 and CS02, and MIL-STD-461D/E when used with a VPT Series DC-DC Converter

Figure 1 – VPTF3-28 EMI Filter
(Not To Scale)

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SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Storage Temperature	-55°C to +125°C
Input Voltage (Transient, 1 second)	80 Volts	Lead Solder Temperature (10 seconds)	300°C
Output Current	3.0 Amps	Weight (Maximum)	30 Grams
Power Dissipation (Full Load, T_{CASE} = +100°C)	2.3 Watt		

Parameter	Conditions	VPTF3-28			Units
		Min	Typ	Max	
STATIC					
INPUT Voltage	Continuous	0	28	50	V
	Transient, 1 sec[2]	-	-	80	V
OUTPUT Voltage		$V_{OUT} = V_{IN} - (I_{IN} \times R_{DC})$			V
Current[1]		0	-	3.0	A
Power[1]		0	-	75	W
DC RESISTANCE		-	-	250	mΩ
POWER DISSIPATION[2]		-	-	2.3	W
NOISE REJECTION	f = 500 kHz	55	-	-	dB
CAPACITANCE	Any Pin to Case	10	-	30	nF
ISOLATION	Any Pin to Case, 500 VDC	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	GM @ TC = 55°C	-	1.67	-	MHrs

Notes: 1. Derate linearly to 0 at 110°C.
2. Verified by qualification testing.

BLOCK DIAGRAM

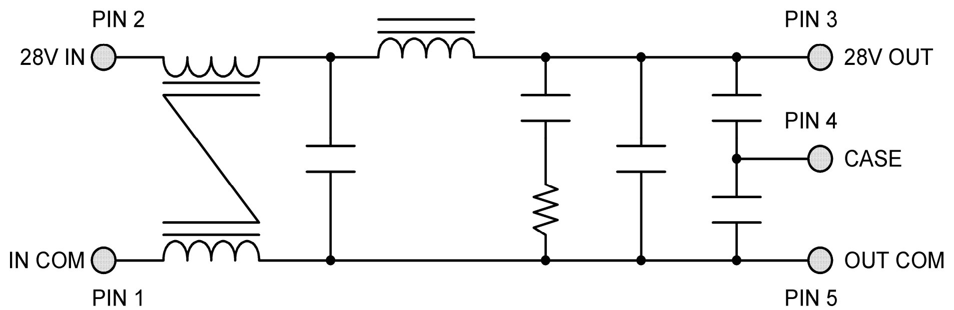


Figure 2

CONNECTION DIAGRAM

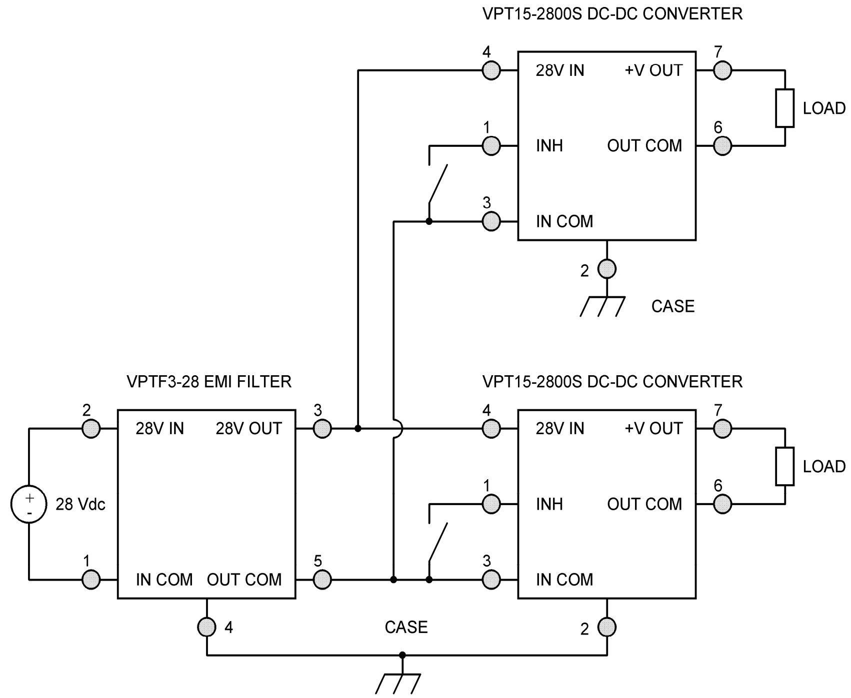


Figure 3
(Shown with multiple VPT Series DC-DC Converters)

EMI PERFORMANCE CURVES

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

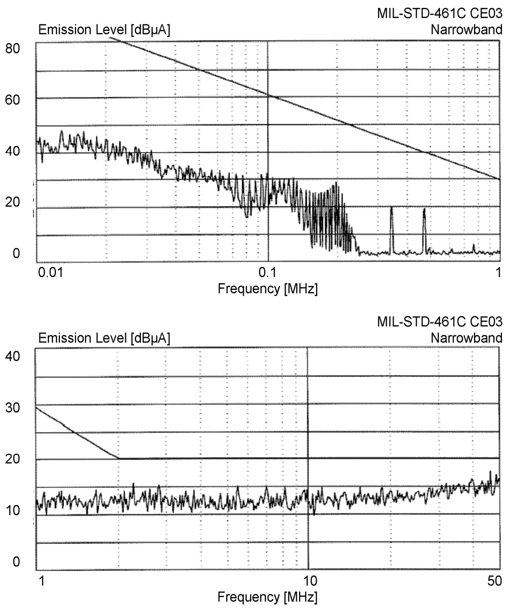


Figure 4 – MIL-STD-461C
Two VPT15-2800S With VPTF3-28 EMI Filter

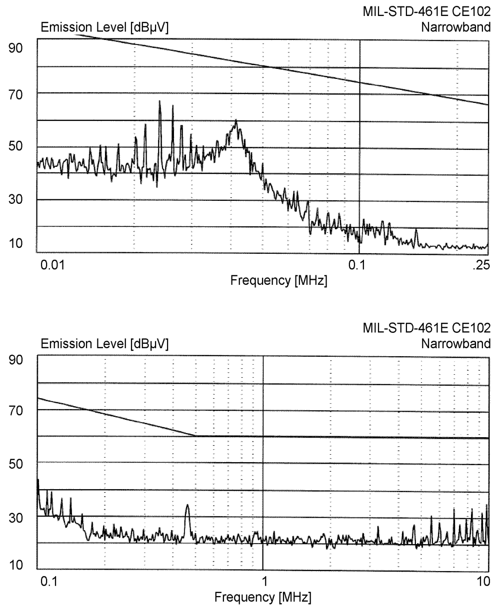
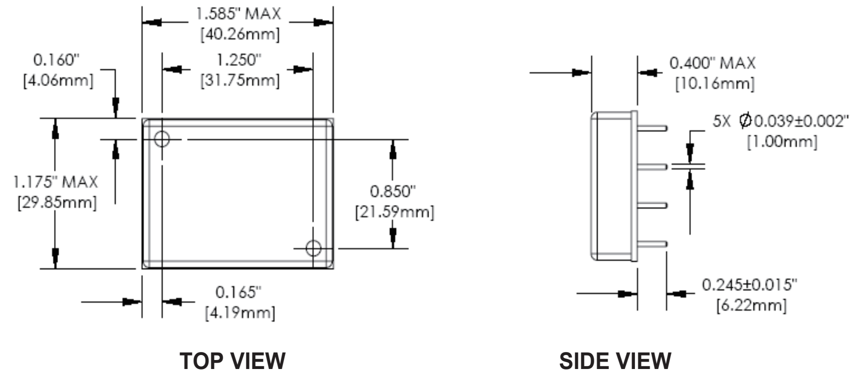
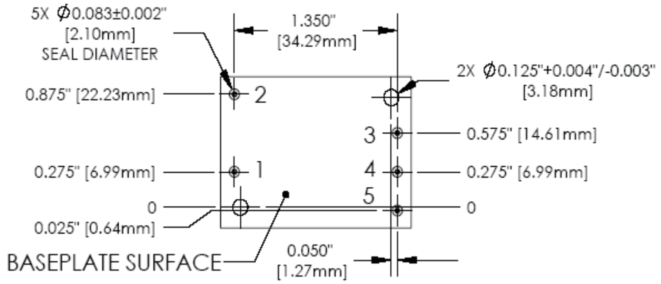


Figure 5 – MIL-STD-461D/E
Two VPT15-2800S With VPTF3-28 EMI Filter

PACKAGE SPECIFICATIONS





BOTTOM VIEW

PIN	FUNCTION
1	IN COM
2	28V IN
3	28V OUT
4	CASE
5	OUT COM

Figure 6 –Package and Pinout
(Dimensional Limits are ±0.005" Unless Otherwise Stated)

Package Notes:
1. Case temperature is measured on the center of the baseplate surface.
2. Materials: Baseplate – aluminum, conductive conversion coating.
   Cover – nickel plated.
   Pins – copper, gold over nickel plating.
3. Mounting holes are not threaded. Recommended fastener is 4-40.

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	IN COM	Input Return Connection
2	28V IN	Positive Input Voltage Connection
3	28V OUT	Positive Output Voltage Connection
4	CASE	Case Connection
5	OUT COM	Output Return Connection

100% ENVIRONMENTAL SCREENING

Screening	Condition
Internal Visual	IPC-A-610
Stabilization Bake	MIL-STD-883, Method 1008, Condition B, 125°C, 24 hours
Temperature Cycling	MIL-STD-883, Method 1010, Condition B, -55°C to +125°C, 10 Cycles
Burn-In	MIL-STD-883, Method 1015, 96 hours at +100°C
Final Electrical	100% at 25°C
External Visual	MIL-STD-883, Method 2009

ORDERING INFORMATION

VPTF3-	28
1	2

(1) Product Series	(2) Nominal Input Voltage	
VPTF3-	28	28 Volts

CONTACT INFORMATION

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Phone: (425) 353-3010
Fax: (425) 353-4030
E-mail: vptsales@vpt-inc.com

VPTF10-28 Series

HIGH RELIABILITY
COTS EMI FILTERS

DESCRIPTION

The VPTF10 series of COTS EMI filters is a cost effective solution for many demanding high reliability applications. A wide input voltage range accommodates nominal 28V inputs including avionics, mobile, ground systems, and other applications. The VPTF10 EMI filter is designed to filter the conducted emissions of multiple VPT series DC-DC converters up to its current rating, providing compliance to MIL-STD-461C/D/E for conducted emissions. A proven design heritage and a rugged all metal package ensure long term reliability.

The VPTF10 series is intended for harsh environments including severe vibration, shock and temperature cycling. Testing is to JESD22, MIL-STD-810, and MIL-STD-883.

These converters are designed and manufactured in the USA in a facility certified to ISO9001, J-STD-001 and IPC-A-610.

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 at Low Cost
- Up to 10.0 Amp Maximum Current
- Up to 200W Output Power
- Wide Input Voltage Range: 0 to 50 Volts per MIL-STD-704 and MIL-STD-1275
- High Input Transient Voltage: 80 Volts for 1 sec per MIL-STD-704A
- 45 dB Minimum Attenuation at 500 kHz
- Wide Temperature Range, -55°C to 100°C
- Six Sided Metal Rugged Enclosure
- Meets MIL-STD-461C/D/E Conducted Emissions Requirements When Used With a VPT Series DC-DC Converter
- Meets Conducted Susceptibility Requirements of MIL-STD-461C, CS01 and CS02, and MIL-STD-461D/E when used with a VPT Series DC-DC Converter

Figure 1 – VPTF10-28 EMI Filter
(Not To Scale)

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West, Suite 206
Everett, WA 98204
http://www.vpt-inc.com

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SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Storage Temperature	-55°C to +125°C
Input Voltage (Transient, 1 second)	80 Volts	Lead Solder Temperature (10 seconds)	300°C
Output Current	10.0 Amps	Weight (Maximum)	37 Grams
Power Dissipation (Full Load, T_{CASE} = +100°C)	8 Watt		

Parameter	Conditions	VPTF10-28			Units
		Min	Typ	Max	
STATIC					
INPUT Voltage	Continuous	0	28	50	V
	Transient, 1 sec[2]	-	-	80	V
OUTPUT Voltage		$V_{OUT} = V_{IN} – (I_{IN} \times R_{DC})$			V
Current[1]		0	-	10.0	A
Power[1]		0	-	200	W
DC RESISTANCE		-	45	80	mΩ
POWER DISSIPATION[2]		-	-	8	W
NOISE REJECTION	f = 500 kHz	45	-	-	dB
CAPACITANCE	Any Pin to Case	70	-	130	nF
ISOLATION	Any Pin to Case, 500 VDC	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	GM @ TC = 55°C	-	802	-	kHrs

Notes: 1. Derate linearly to 0 at 110°C.
2. Verified by qualification testing.

BLOCK DIAGRAM

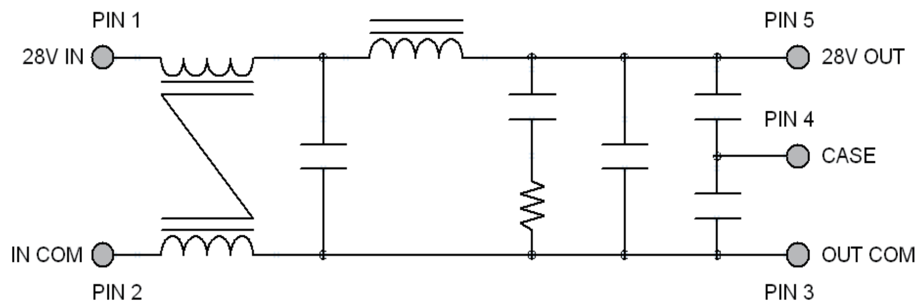


Figure 2

CONNECTION DIAGRAM

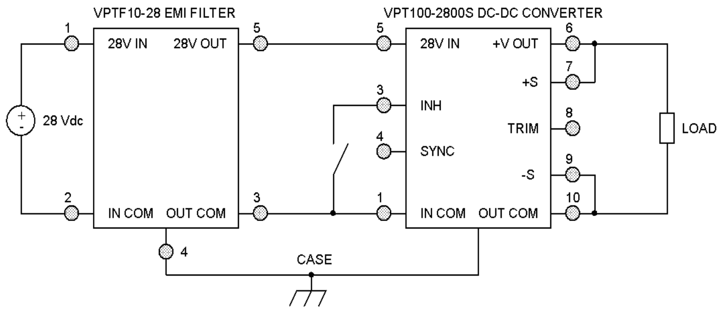


Figure 3
(Shown with VPT100-2800S Series DC-DC Converters)

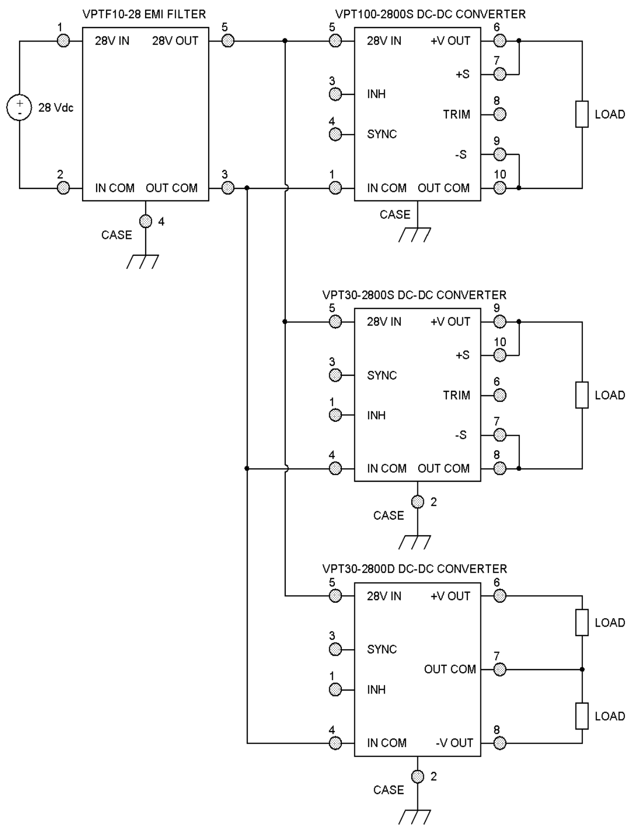


Figure 4
(Shown with VPT100-2800S & VPT30-2800S&D Series DC-DC Converters)

EMI PERFORMANCE CURVES

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

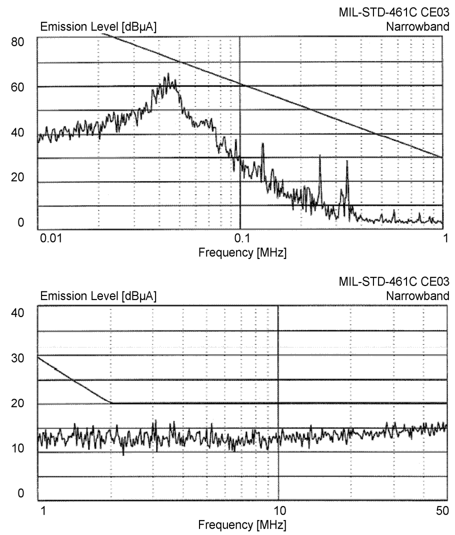


Figure 5 – MIL-STD-461C
One VPT100-2800S With VPTF10-28 EMI Filter

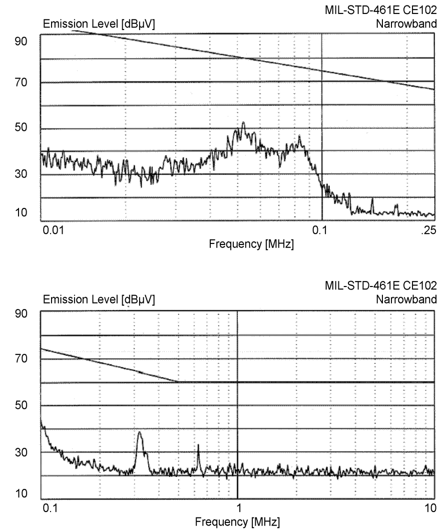


Figure 6 – MIL-STD-461D/E
One VPT100-2800S With VPTF10-28 EMI Filter

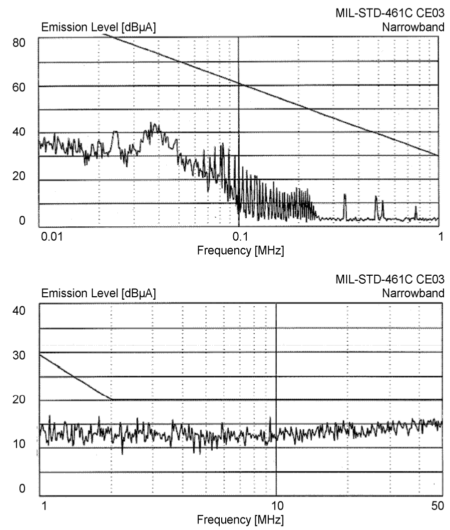


Figure 7 – MIL-STD-461C
Three VPT30-2800S With VPTF10-28 EMI Filter

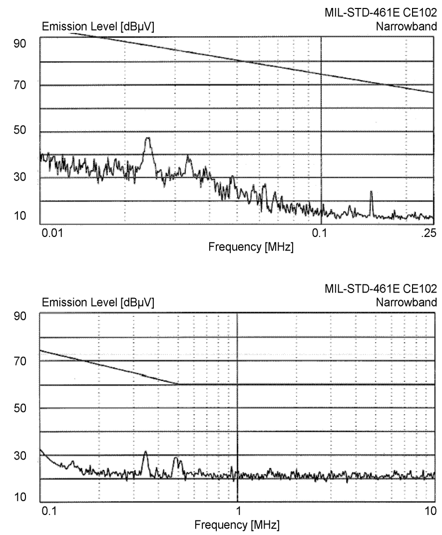
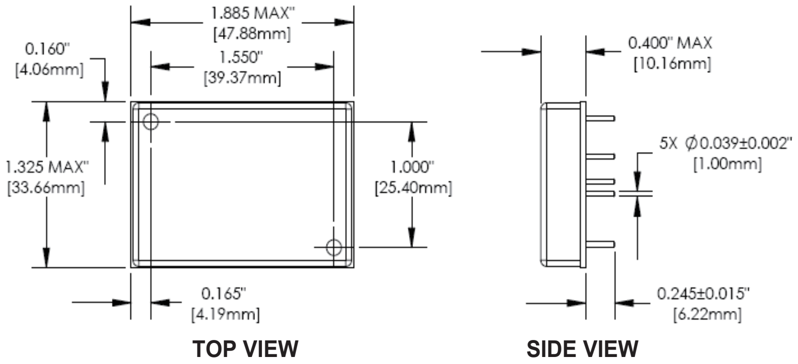
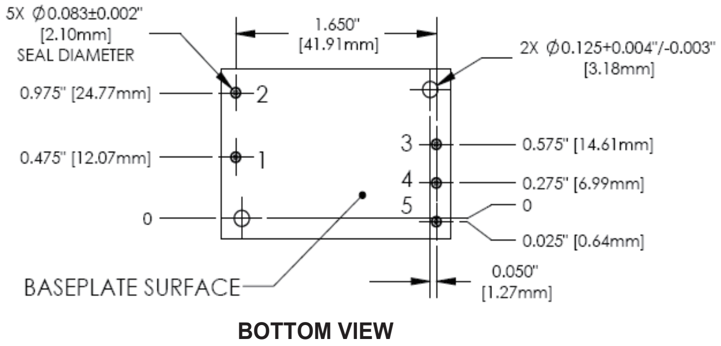


Figure 8 – MIL-STD-461D/E
Three VPT30-2800S With VPTF10-28 EMI Filter

PACKAGE SPECIFICATIONS





PIN	FUNCTION
1	28V IN
2	IN COM
3	OUT COM
4	CASE
5	28V OUT

Figure 9 – Package and Pinout
(Dimensional Limits are ±0.005” Unless Otherwise Stated)

Package Notes:
1. Case temperature is measured on the center of the baseplate surface.
2. Materials: Baseplate – aluminum, conductive conversion coating.
Cover –nickel plated.
Pins – copper, gold over nickel plating.
3. Mounting holes are not threaded. Recommended fastener is 4-40.

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	28V IN	Positive Input Voltage Connection
2	IN COM	Input Return Connection
3	OUT COM	Output Return Connection
4	CASE	Case Connection
5	28V OUT	Positive Output Voltage Connection

100% ENVIRONMENTAL SCREENING

Screening	Condition
Internal Visual	IPC-A-610
Stabilization Bake	MIL-STD-883, Method 1008, Condition B, 125°C, 24 hours
Temperature Cycling	MIL-STD-883, Method 1010, Condition B, -55°C to +125°C, 10 Cycles
Burn-In	MIL-STD-883, Method 1015, 96 hours at +100°C
Final Electrical	100% at 25°C
External Visual	MIL-STD-883, Method 2009

ORDERING INFORMATION

VPTF10-	28
1	2

(1) Product Series	(2) Nominal Input Voltage	
VPTF10-	**28**	28 Volts

CONTACT INFORMATION

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Fax: (425) 353-4030
E-mail: vptsales@vpt-inc.com

VPTF20-28 Series

HIGH RELIABILITY COTS EMI FILTERS

DESCRIPTION

The VPTF20 series of COTS EMI filters is a cost effective solution for many demanding high reliability applications. A wide input voltage range accommodates nominal 28V inputs including avionics, mobile, ground systems, and other applications. The VPTF20 EMI filter is designed to filter the conducted emissions of multiple VPT series DC-DC converters up to its current rating, providing compliance to MIL-STD-461C/D/E for conducted emissions. A proven design heritage and a rugged all metal package ensure long term reliability.

The VPTF20 series is intended for harsh environments including severe vibration, shock and temperature cycling. Testing is to JESD22, MIL-STD-810, and MIL-STD-883.

These EMI filters are designed and manufactured in the USA in a facility certified to ISO9001, J-STD-001 and IPC-A-610.

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 at Low Cost
- Up to 20.0 Amp Maximum Current
- Up to 400W Output Power
- Wide Input Voltage Range: 0 to 50 Volts per MIL-STD-704 and MIL-STD-1275
- High Input Transient Voltage: 80 Volts for 1 sec per MIL-STD-704A
- 45 dB Minimum Attenuation at 500 kHz
- Wide Temperature Range, -55°C to 100°C
- Six Sided Metal Rugged Enclosure
- Meets MIL-STD-461C/D/E Conducted Emissions Requirements When Used With a VPT Series DC-DC Converter
- Meets Conducted Susceptibility Requirements of MIL-STD-461C, CS01 and CS02, and MIL-STD-461D/E when used with a VPT Series DC-DC Converter

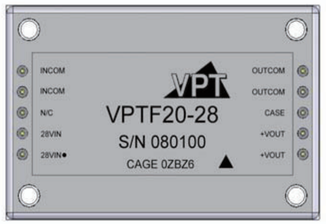

Figure 1 – VPTF20-28 EMI Filter
(Not To Scale)

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Sales Information:
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SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +28V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	50 V_{DC}	Storage Temperature	-55°C to +125°C
Input Voltage (Transient, 1 second)	80 Volts	Lead Solder Temperature (10 seconds)	300°C
Output Current	20.0 Amps	Weight (Maximum)	75 Grams
Power Dissipation (Full Load, T_{CASE} = +100°C)	20 Watts		

Parameter	Conditions	VPTF20-28			Units
		Min	Typ	Max	
STATIC					
INPUT Voltage	Continuous	0	28	50	V
	Transient, 1 sec[2]	-	-	80	V
OUTPUT Voltage		$V_{OUT} = V_{IN} – (I_{IN} \times R_{DC})$			V
Current[1]		0	-	20	A
Power		0	-	400	W
DC RESISTANCE		-	25	50	mΩ
POWER DISSIPATION[2]		-	-	20	W
NOISE REJECTION	f = 500 kHz	45	-	-	dB
CAPACITANCE	Any Pin to Case	70	-	130	nF
ISOLATION	Any Pin to Case, 500 VDC	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	GM @ TC = 55°C	-	739	-	kHrs

Notes: 1. Derate linearly to 0 at 110°C.
2. Verified by qualification testing.

BLOCK DIAGRAM

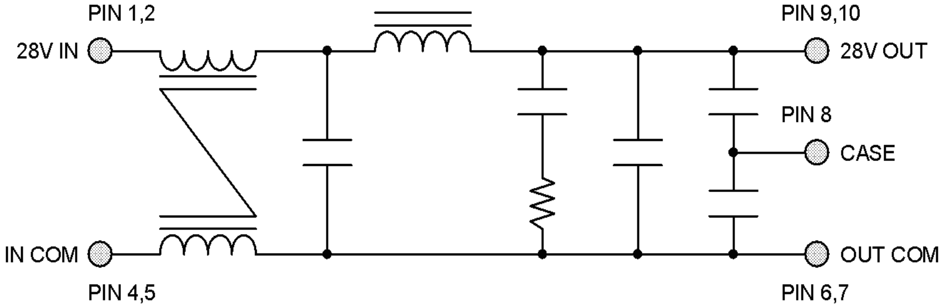


Figure 2

CONNECTION DIAGRAM

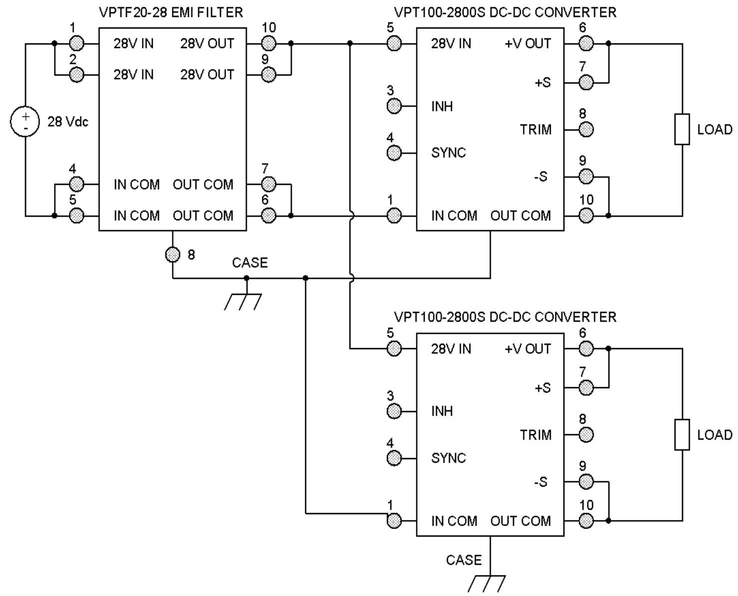


Figure 3
(Shown with multiple VPT Series DC-DC Converters)

EMI PERFORMANCE CURVES

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

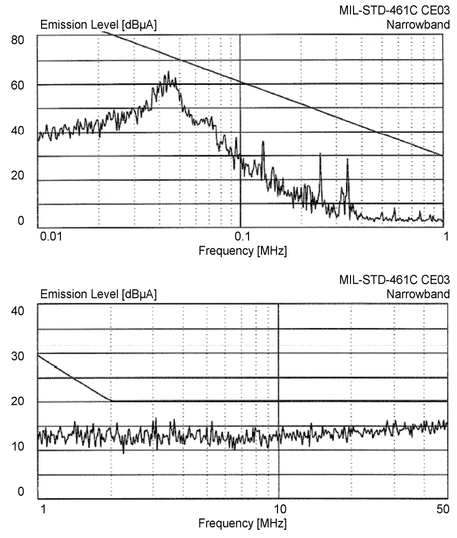


Figure 4 – MIL-STD-461C
Two VPT100-2800S With VPTF20-28 EMI Filter

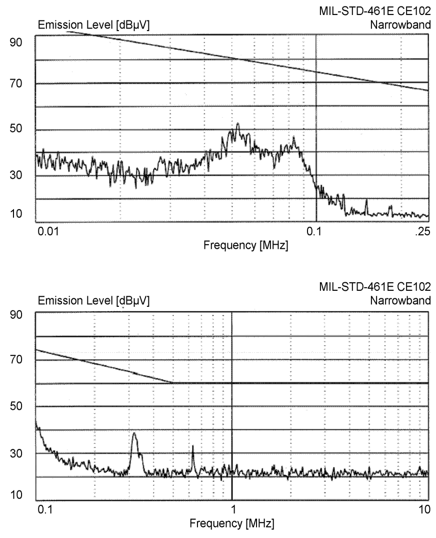
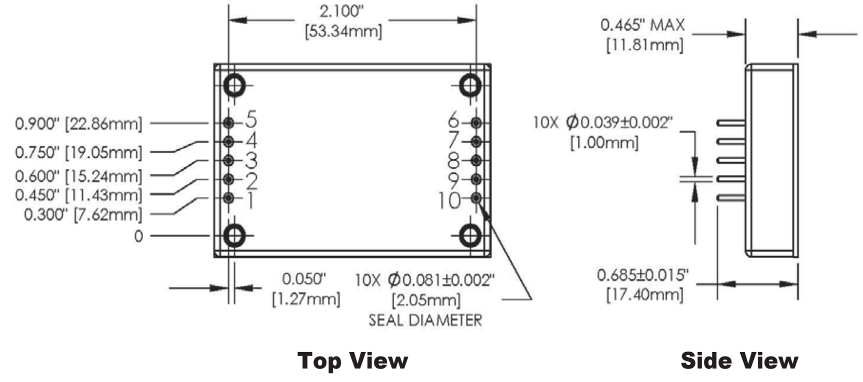
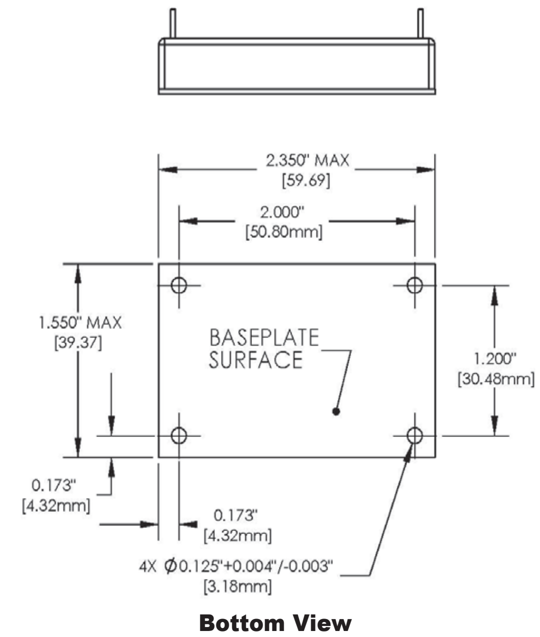


Figure 5 – MIL-STD-461D/E
Two VPT100-2800S With VPTF20-28 EMI Filter

PACKAGE SPECIFICATIONS





PIN	FUNCTION
1	V IN
2	V IN
3	N/C
4	IN COM
5	IN COM
6	OUT COM
7	OUT COM
8	CASE
9	V OUT
10	V OUT

Figure 6 – Package and Pinout
(Dimensional Limits are ±0.005" Unless Otherwise Stated)

Package Notes:
1. Case temperature is measured on the center of the baseplate surface.
2. Materials: Baseplate – aluminum, conductive conversion coating.
Cover – nickel plated.
Pins – copper, gold over nickel plating.
3. Mounting holes are not threaded. Recommended fastener is 4-40.

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	28V IN	Positive Input Voltage Connection
2	28V IN	Positive Input Voltage Connection
3	N/C	No Connection
4	IN COM	Input Return Connection
5	IN COM	Input Return Connection
6	OUT COM	Output Return Connection
7	OUT COM	Output Return Connection
8	CASE	Case Connection
9	28V OUT	Positive Output Voltage Connection
10	28V OUT	Positive Output Voltage Connection

100% ENVIRONMENTAL SCREENING

Screening	Condition
Internal Visual	IPC-A-610
Stabilization Bake	MIL-STD-883, Method 1008, Condition B, 125°C, 24 hours
Temperature Cycling	MIL-STD-883, Method 1010, Condition B, -55°C to +125°C, 10 Cycles
Burn-In	MIL-STD-883, Method 1015, 96 hours at +100°C
Final Electrical	100% at 25°C
External Visual	MIL-STD-883, Method 2009

ORDERING INFORMATION

VPTF20-	28
1	2

(1) Product Series	(2) Nominal Input Voltage	
VPTF20-	28	28 Volts

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

VPTPCM-12 Series

HIGH RELIABILITY COTS PRECONDITIONING MODULE

DESCRIPTION

The VPTPCM-12 is a Pre-Conditioning Module which allows VPT's DV and VPT series isolated DC-DC converters to operate over an extended input voltage range and provides compliance to both MIL-STD-704 and MIL-STD-1275 input power requirements. A wide input voltage range accommodates both nominal 12V and 28V inputs including avionics, mobile, ground systems, and other applications. A high efficiency design reduces input power requirements and eases thermal management. Low input and output ripple, fixed operating frequency, and companion EMI filters simplify system design and compliance. A proven design heritage, no optoisolators and a rugged all metal package ensure long term reliability.

The VPTPCM-12 intended for harsh environments including severe vibration, shock and temperature cycling. Testing is to JESD22, MIL-STD-810, and MIL-STD-883.

These converters are designed and manufactured in the USA in a facility certified to ISO9001, J-STD-001 and IPC-A-610.

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 at Low Cost
- Up to 120 Watts of Output Power
- Wide Input Voltage Range: 9 to 40 Volts per MIL-STD-704 and MIL-STD-1275
- Transient Operation down to 6 Volts and up to 100 Volts per MIL-STD-1275
- High Efficiency, Up to 99%
- Inrush Current Limiting
- Input Undervoltage Lockout
- Fixed Frequency
- Output Soft Start
- Wide Temperature Range, -55°C to 100°C
- Six Sided Metal Rugged Enclosure

Figure 1 – VPTPCM-12 Pre-Conditioning Module (Not To Scale)

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Everett, WA 98204
http://www.vpt-inc.com

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SPECIFICATIONS (T_{CASE} = -55°C to +100°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, 50 ms)	100 Volts	Storage Temperature	-55°C to +125°C
Output Power	120 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	17 Watts	Weight (Maximum)	76 Grams

Parameter		Conditions	VPTPCM-12 Min	Typ	Max	Units
STATIC						
INPUT Voltage	Continuous		9	-	40	V
	Transient[3]	10 sec	8	-	-	V
	Transient[1,3]	1 sec, Pout = 100W maximum	6	-	-	V
	Transient	1 sec	-	-	50	V
	Transient	50 ms, 500 mΩ	-	-	100	V
	Transient	70 µs, 15 mJ	-250	-	250	V
	Transient	10 µs, 50Ω	-	-	600	V
Current		Inhibited	-	-	25	mA
		Vin = 12V, No Load	-	-	300	mA
		Vin = 28V, No Load	-	-	35	mA
Inrush Current[3]		Vin = 0 to 28V, Full Load	-	3	5	A
Ripple Current		Vin = 12V, Full Load, 20Hz to 10MHz	-	-	250	mA_{p-p}
Inhibit Pin Input[3]			0	-	1.5	V
Inhibit Pin Open Circuit Voltage			14	16	18	V
UVLO Turn On			6.5	-	7.9	V
UVLO Turn Off[3]			4.5	-	5.9	V
OUTPUT Voltage		Continuous	17	-	40	V
		Transient	-	-	50	V
Power[2]			0	-	120	W
Ripple Voltage		Vin = 12V, 20Hz to 10MHz	-	-	400	mV_{p-p}
EFFICIENCY		Vin = 28V	97	99	-	%
		Vin = 12V	88	92	-	%
CAPACITIVE LOAD[3]			-	-	500	µF
SWITCHING FREQUENCY			400	500	550	kHz
CASE ISOLATION		500 V_{DC}	100	-	-	MΩ
MTBF (MIL-HDBK-217F)		GM @ T_C = 55°C	-	400	-	kHrs
DYNAMIC						
Turn On Delay		V_{IN} = 0V to 28V	-	2	6	mSec
		V_{IN} = 0V to 12V	-	10	25	mSec

Notes:
1. Operation down to 6V is possible after the input voltage is taken above 8V to start the module.
2. Derate linearly to 0 at 110°C.
3. Verified by qualification testing.

BLOCK DIAGRAM

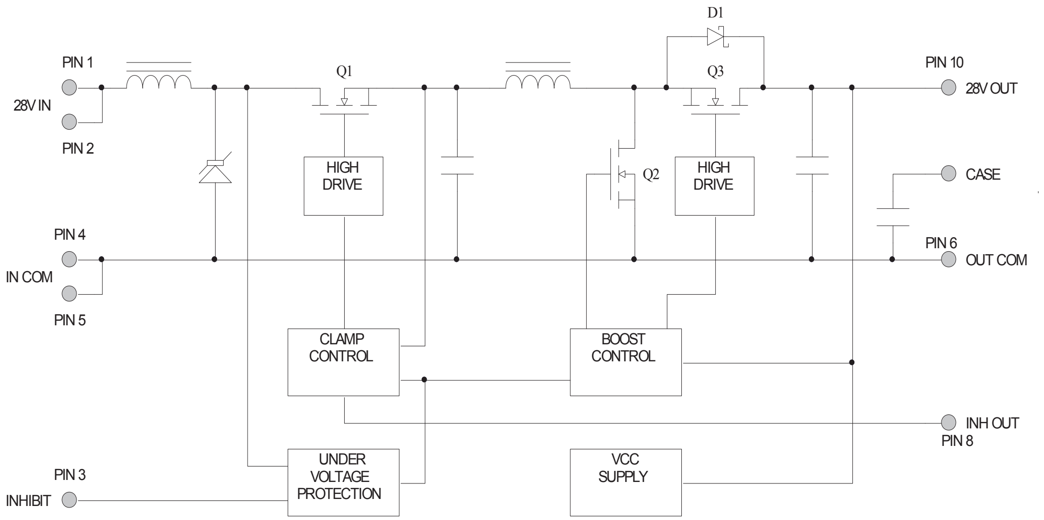


Figure 2

CONNECTION DIAGRAM

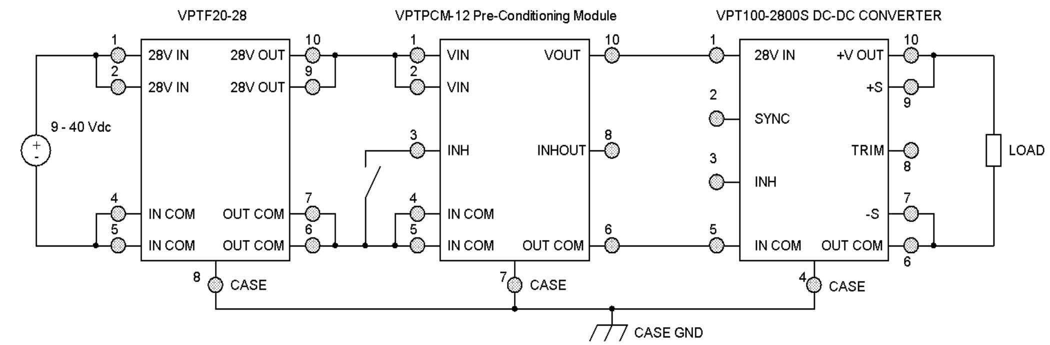


Figure 3

PERFORMANCE CURVES

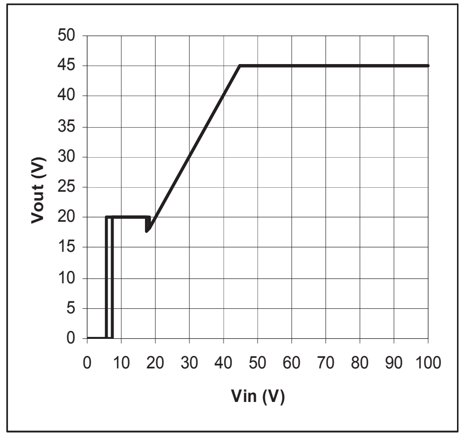


Figure 4 – Output Voltage vs Input Voltage

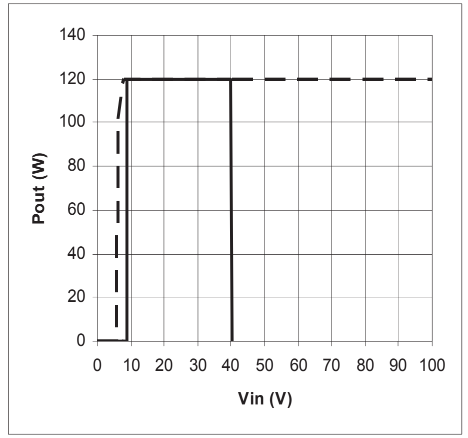


Figure 5 – Output Power Rating vs Input Voltage

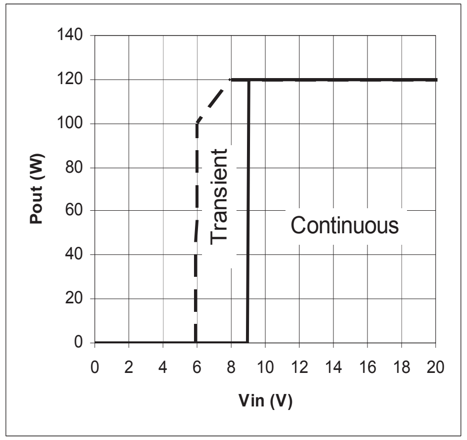


Figure 6 – Output Power Rating vs Input Voltage

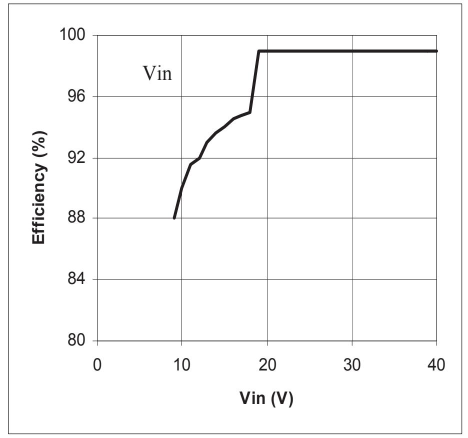


Figure 7 – Full Load Efficiency vs Input Voltage

PERFORMANCE CURVES

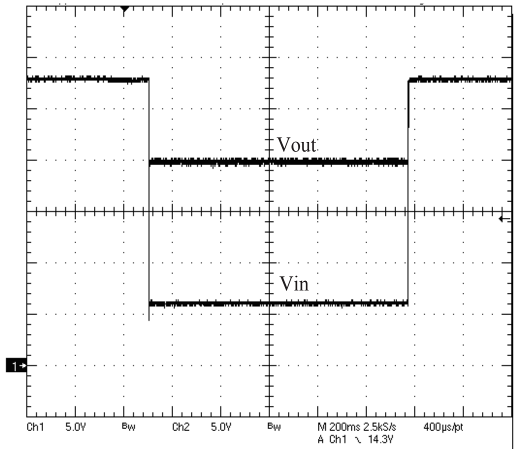


Figure 8 – Vin, Vout during 6V, 1 sec Transient

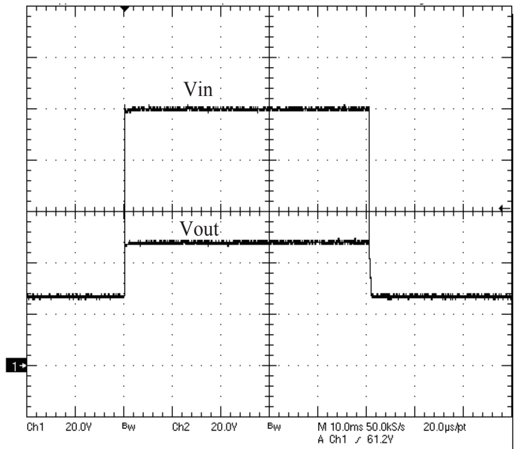


Figure 9 – Vin, Vout during 100V, 50ms Transient

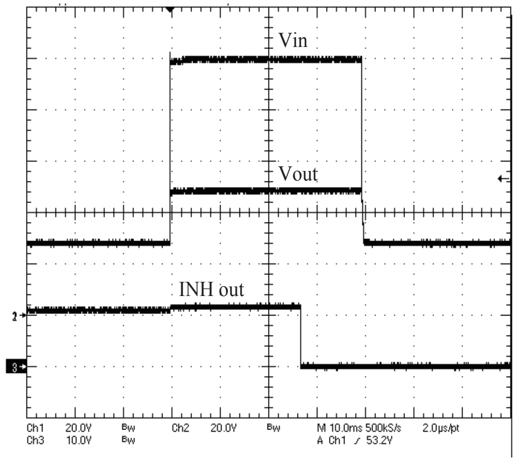


Figure 10 – Inhibit Out during 100V, 50ms Transient

PERFORMANCE CURVES

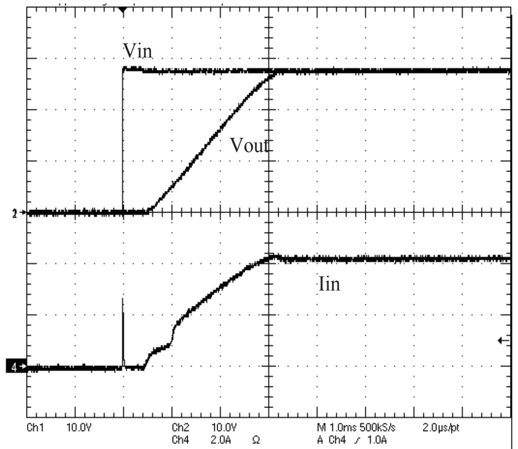


Figure 11 – Vout, Iin (inrush current) during turn-on at 28V

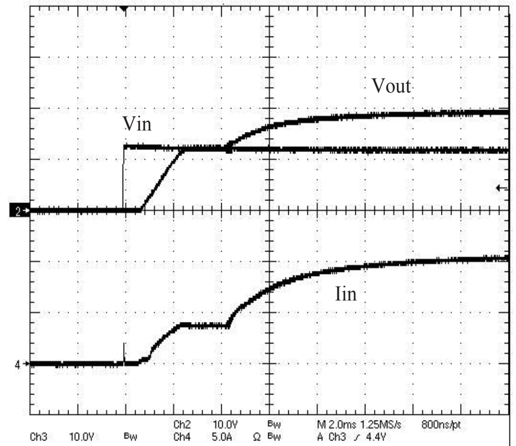


Figure 12 – Vout, Iin (inrush current) during turn-on at 12V

EMI PERFORMANCE CURVES

(T_{CASE} = 25°C, V_{IN} = +12V ± 5%, Full Load, Unless Otherwise Specified)

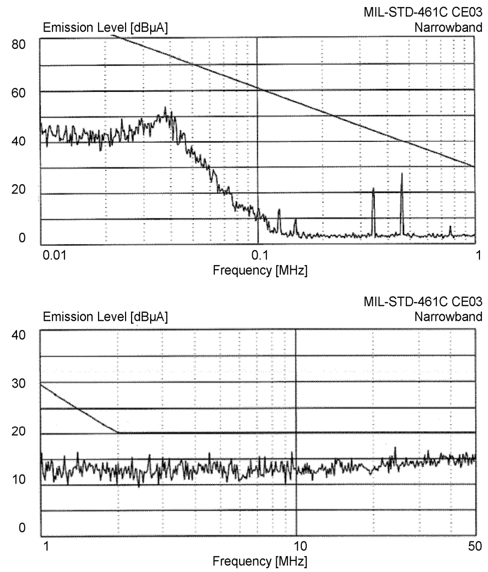


Figure 13 – VPTPCM with VPTF20-28

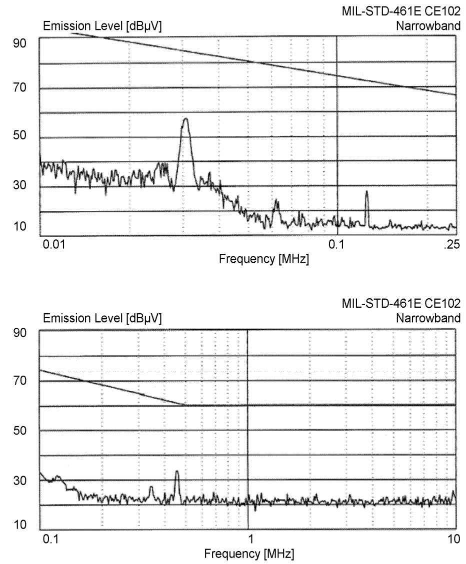
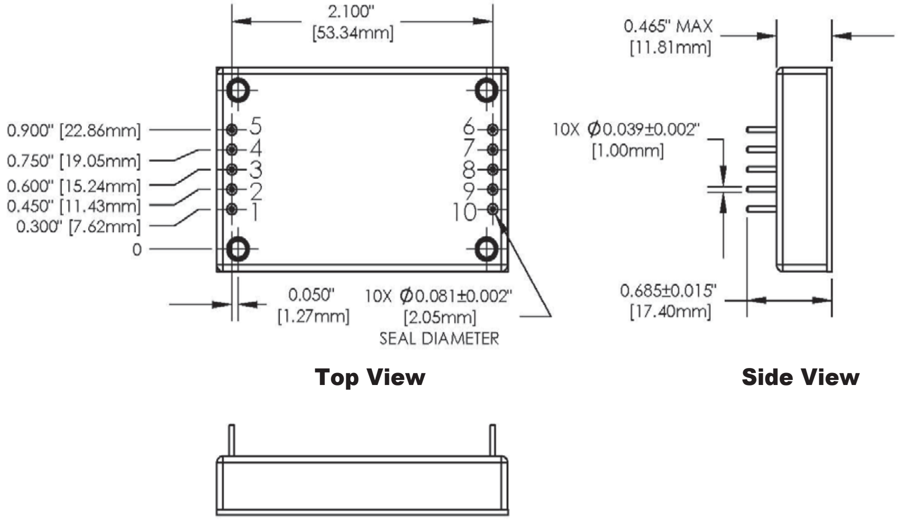
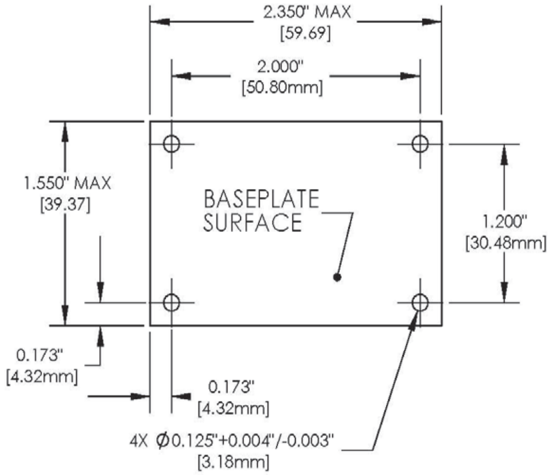


Figure 14 – VPTPCM with VPTF20-28

PACKAGE SPECIFICATIONS





Bottom View

PIN	FUNCTION
1	V IN
2	V IN
3	INHIBIT
4	IN COM
5	IN COM
6	OUT COM
7	CASE
8	INH OUT
9	N/C
10	V OUT

Figure 15 – Package and Pinout
(Dimensional Limits are ±0.005" Unless Otherwise Stated)

Package Notes:
1. Case temperature is measured on the center of the baseplate surface.
2. Materials: Baseplate – aluminum, chromate conversion coating.
Cover – steel, nickel plated.
Pins – copper, gold over nickel plating.
3. Mounting holes are not threaded. Recommended fastener is 4-40.

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	VIN	Positive Input Voltage Connection
2	VIN	Positive Input Voltage Connection
3	INHIBIT	This is an open collector input. Logic Low = Disabled Output. Connect the inhibit pin to input common to disable the output. Unconnected, open collector or open drain = Enabled Output.
4	INCOM	Return Connection
5	INCOM	Return Connection
6	OUTCOM	Return Connection
7	CASE	Case Connection
8	INH OUT	This is an open collector output. It will activate low during a positive input voltage transient. It can be used as a status flag or connected to the Inhibit input of the downstream DC-DC converter to turn the converter off during a transient, when uninterrupted operation is not required. This connection is usually not required. This pin should be left open if not used.
9	N/C	No Connection
10	VOUT	Positive Output Voltage Connection

100% ENVIRONMENTAL SCREENING

Screening	Condition
Internal Visual	IPC-A-610
Stabilization Bake	MIL-STD-883, Method 1008, Condition B, 125°C, 24 hours
Temperature Cycling	MIL-STD-883, Method 1010, Condition B, -55°C to +125°C, 10 Cycles
Burn-In	MIL-STD-883, Method 1015, 96 hours at +100°C
Final Electrical	100% at 25°C
External Visual	MIL-STD-883, Method 2009

ORDERING INFORMATION

VPTPCM-	12
1	2

(1) Product Series	(2) Nominal Input Voltage	
VPTPCM	12	12 - 28 Volts

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
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VPTi10-28 Series

HIGH RELIABILITY COTS EMI FILTER / TRANSIENT PROTECTION MODULE

DESCRIPTION

The VPTi10-28 input module is a combined EMI filter and voltage transient protection module with built-in reverse polarity protection. Compatible with VPT's DV and VPT series isolated DC-DC converters, the VPTi10-28 provides compliance for both MIL-STD-704 and MIL-STD-1275 input power requirements for avionics, mobile, ground systems, and other applications. The VPTi10-28 also reduces the reflected noise of the DC-DC converters to meet MIL-STD-461 requirements for conducted emissions and protects the converters from conducted susceptibility. A proven design heritage, no optoisolators and a rugged all metal package ensure long term reliability.

The VPTi10-28 intended for harsh environments including severe vibration, shock and temperature cycling. Testing is to JESD22, MIL-STD-810, and MIL-STD-883.

These converters are designed and manufactured in the USA in a facility certified to ISO9001, J-STD-001 and IPC-A-610.

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 at Low Cost
- Up to 10 Amps of Output Current
- Up to 200W of Output Power
- Wide Input Voltage Range
- Transient Operation up to 80 Volts per MIL-STD-704 and 100 Volts per MIL-STD-1275
- 45 dB Minimum Attenuation at 500 kHz
- Provides Inrush Current Limiting
- True Reverse Polarity Protection
- Wide Temperature Range, -55°C to 100°C
- Six Sided Metal Rugged Enclosure
- Meets MIL-STD-461C/D/E Conducted Emissions Requirements When Used With a VPT Series DC-DC Converter
- Meets Conducted Susceptibility Requirements of MIL-STD-461C, CS01 and CS02, and MIL-STD-461D/E when used with a VPT Series DC-DC Converter

Figure 1 – VPTi10-28 Input Module
(Not To Scale)

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SPECIFICATIONS (T_{CASE} = -55°C to +100°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, 100 ms)	100 Volts	Storage Temperature	-55°C to +125°C
Output Current	10 Amps	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	12 Watts	Weight (Maximum)	66 Grams

Parameter		Conditions	VPTi10-28			Units
			Min	Typ	Max	
STATIC						
INPUT Voltage	Continuous		-40	28	40	V
	Transient	1 sec[2]	-	-	50	V
	Transient	100 ms, 500 mΩ	-	-	100	V
	Transient	70 µs, 15 mJ	-250	-	250	V
	Transient	10 µs, 50Ω	-	-	600	V
Current		Inhibited	-	-	10	mA
Inrush Current[2]		Vin = 0 to 28V, Full Load	-	5	10	A
Inhibit Pin Input[2]			0	-	1.5	V
Inhibit Pin Open Circuit Voltage[2]			10	12	16	V
UVLO Turn On			-	9	11	V
UVLO Turn Off[2]			5	8	-	V
OUTPUT Voltage		Continuous	0	-	40	V
		Transient	0	-	50	V
Current[1]			0	-	10	A
Power[1]			0	-	200	W
DC RESISTANCE			-	50	120	mΩ
NOISE REJECTION		f = 500 kHz	45	65	-	dB
CAPACITANCE		Any Pin to Case	57	-	135	nF
CASE ISOLATION		1500 V_{DC}	100	-	-	MΩ
MTBF (MIL-HDBK-217F)		GM @ T_C = 55°C	-	501	-	kHrs
DYNAMIC						
Turn On Delay		V_{IN} = 0V to 28V	-	4	10	mSec

Notes:
1. Derate linearly to 0 at 110°C.
2. Verified by qualification testing.

VPTi10-28 Series

BLOCK DIAGRAM

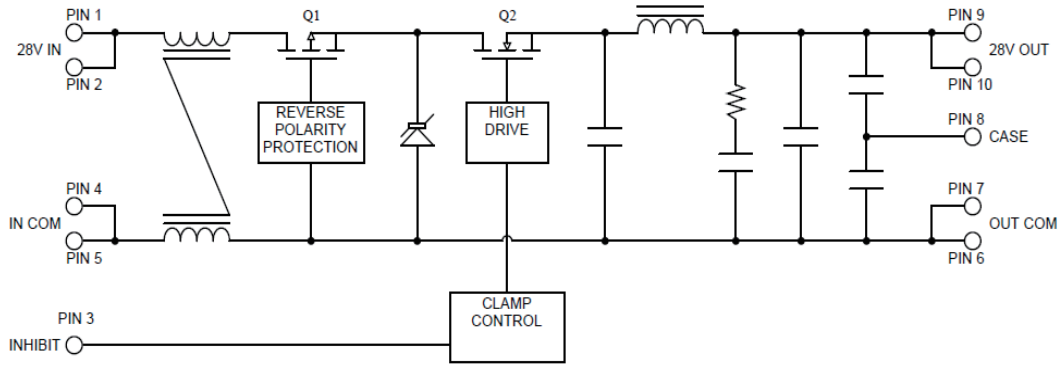


Figure 2

CONNECTION DIAGRAM

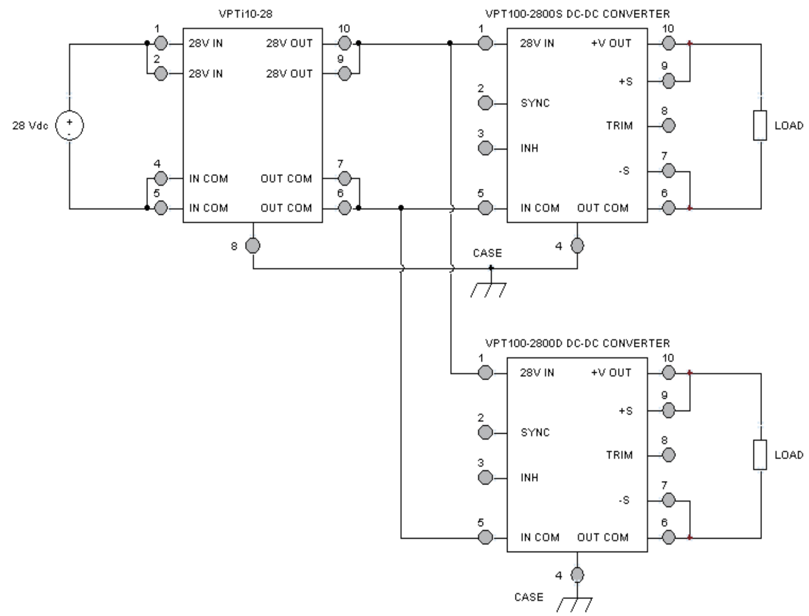


Figure 3

(Shown with Two VPT100-2800S&D Series DC-DC Converters)

CONNECTION DIAGRAM

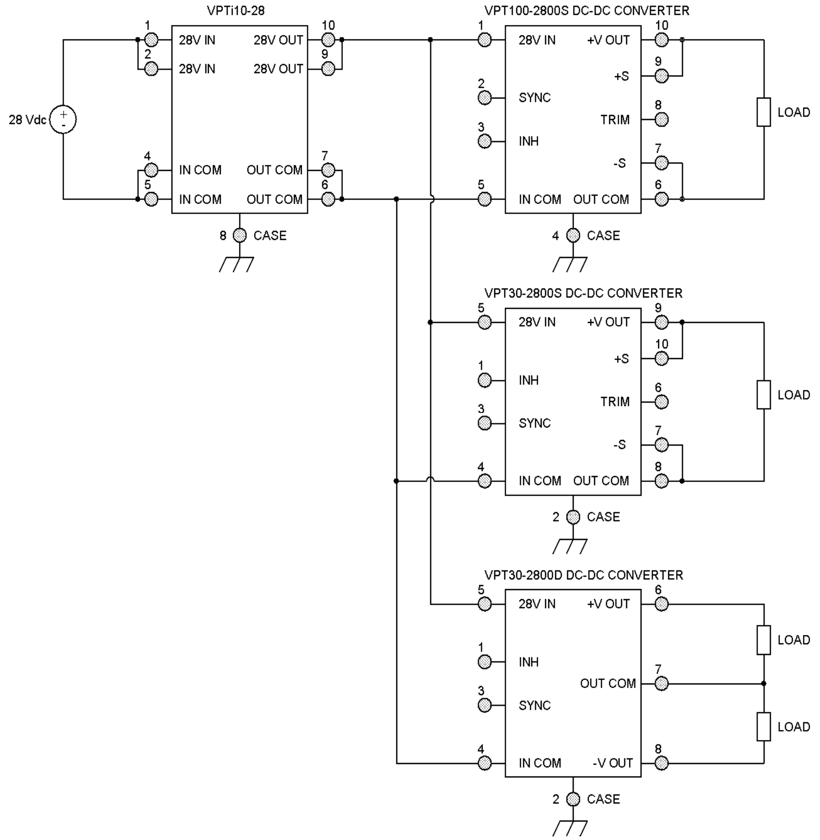


Figure 4

(Shown with VPT100-2800S & VPT30-2800S&D Series DC-DC Converters)

PERFORMANCE CURVES

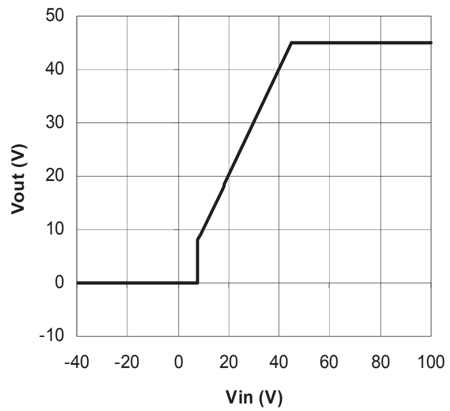


Figure 5 – Output Voltage vs Input Voltage

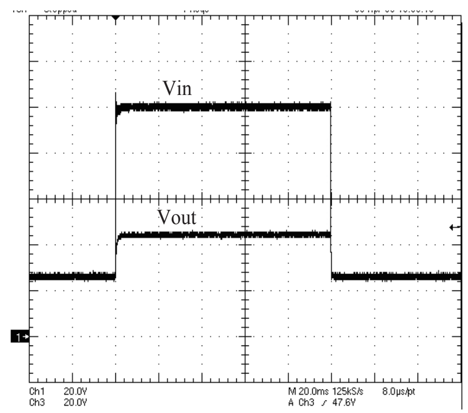


Figure 6 – Vin, Vout during 100V, 100ms Transient

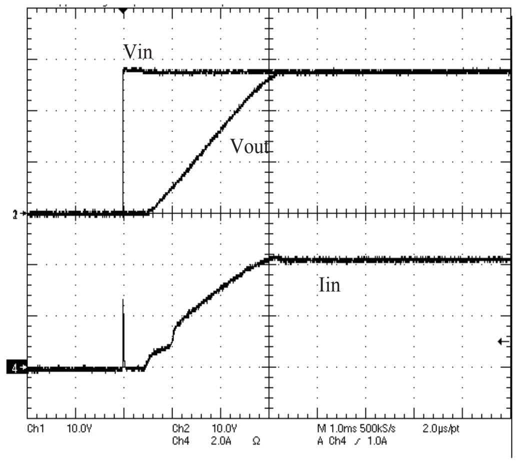


Figure 7 – Vout, Iin (inrush current) during turn-on

EMI PERFORMANCE CURVES

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

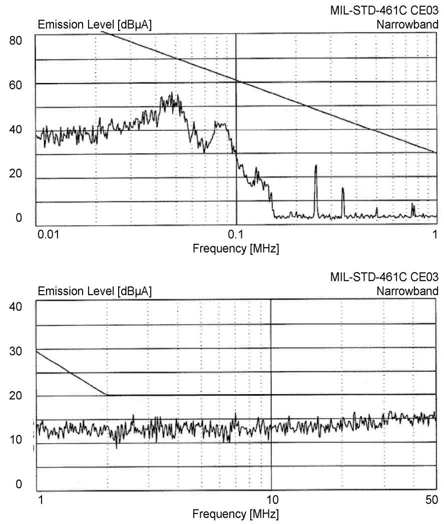


Figure 8 – MIL-STD-461C
Two VPT100-2800S With VPTi10-28 Input Module

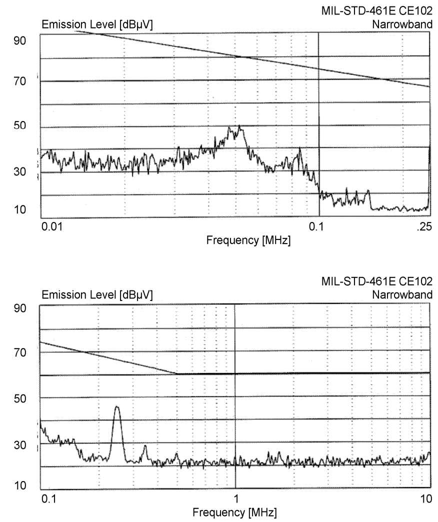


Figure 9 – MIL-STD-461D/E
Two VPT100-2800S With VPTi10-28 Input Module

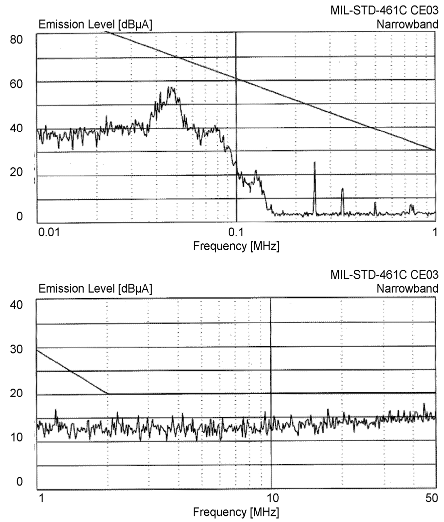


Figure 10 – MIL-STD-461C
Two VPT30-2800S and One VPT100-2800S
With VPTi10-28 Input Module

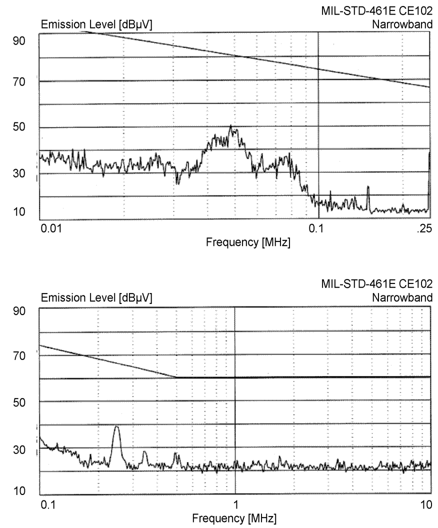
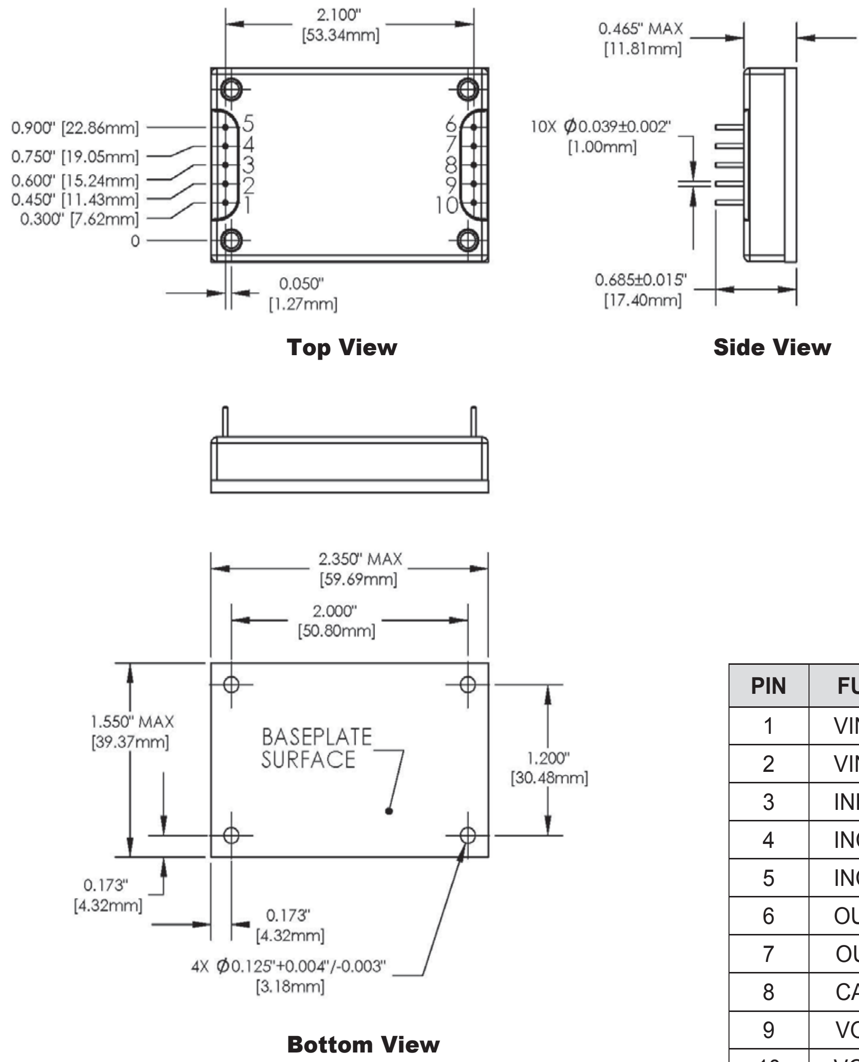


Figure 11 – MIL-STD-461D/E
Two VPT30-2800S and One VPT100-2800S
With VPTi10-28 Input Module

PACKAGE SPECIFICATIONS



PIN	FUNCTION
1	VIN
2	VIN
3	INHIBIT
4	INCOM
5	INCOM
6	OUTCOM
7	OUTCOM
8	CASE
9	VOUT
10	VOUT

Figure 12 – Package and Pinout
(Dimensional Limits are ±0.005" Unless Otherwise Stated)

Package Notes:
1. Case temperature is measured on the center of the baseplate surface.
2. Materials: Baseplate – aluminum, conductive conversion coating.
Cover – nickel plated.
Pins – copper, gold over nickel plating.
3. Mounting holes are not threaded. Recommended fastener is 4-40.

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	VIN	Positive Input Voltage Connection
2	VIN	Positive Input Voltage Connection
3	INHIBIT	This is an open collector input. Logic Low = Disabled Output. Connect the inhibit pin to input common to disable the output. Unconnected, open collector or open drain = Enabled Output.
4	INCOM	Input Return Connection
5	INCOM	Input Return Connection
6	OUTCOM	Output Return Connection
7	OUTCOM	Output Return Connection
8	CASE	Case Connection
9	VOUT	Positive Output Voltage Connection
10	VOUT	Positive Output Voltage Connection

100% ENVIRONMENTAL SCREENING

Screening	Condition
Internal Visual	IPC-A-610
Stabilization Bake	MIL-STD-883, Method 1008, Condition B, 125°C, 24 hours
Temperature Cycling	MIL-STD-883, Method 1010, Condition B, -55°C to +125°C, 10 Cycles
Burn-In	MIL-STD-883, Method 1015, 96 hours at +100°C
Final Electrical	100% at 25°C
External Visual	MIL-STD-883, Method 2009

ORDERING INFORMATION

VPTi10-	28
1	2

(1) Product Series	(2) Nominal Input Voltage	
VPTi10	28	28 Volts

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@vpt-inc.com

VPTHVM-270 Series

HIGH RELIABILITY COTS REGULATED BUS CONVERTER MODULE

TECHNICAL PREVIEW

DESCRIPTION

The VPTHVM-270 is an Isolated Regulated Bus Converter Module which allows VPT's DV and VPT series 28V input DC-DC converters to operate from a nominal 270V DC input. A wide input voltage range accommodates MIL-STD-704 input power requirements for avionics, mobile, ground, and other applications. A regulated high efficiency design reduces input power requirements and eases thermal management. A proven design heritage and a rugged all metal package ensure long term reliability.

The VPTHVM-270 intended for harsh environments including severe vibration, shock and temperature cycling. Testing is to JESD22, MIL-STD-810, and MIL-STD-883.

These converters are designed and manufactured in the USA in a facility certified to ISO9001, J-STD-001 and IPC-A-610.

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 at Low Cost
- Up to 200 Watts of Output Power
- Wide Input Voltage Range: 180 to 350 Volts per MIL-STD-704
- High Input Transient Voltage: 500V for 1 second
- Low Input Transient Voltage: 160V for 1 second
- High Efficiency, Up to 91%
- High Isolation, 3000V
- Parallel up to 5 Units with Current Sharing
- Input Undervoltage Lockout
- Fixed Frequency
- Output Soft Start
- Magnetic Feedback, no Optoisolators
- Wide Temperature Range: -55°C to 100°C Baseplate Temperature Full Performance
- Six Sided Metal Rugged Enclosure

Figure 1 – VPTHVM-270 Regulated Bus Converter Module (Not To Scale)

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http://www.vpt-inc.com

Sales Information:
Phone: (425) 353-3010
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E-mail: vptsales@vpt-inc.com

SPECIFICATIONS (T_{CASE} = -55°C to +100°C, V_{IN} = +270V ± 5%, Full Load, Unless Otherwise Specified)

ABSOLUTE MAXIMUM RATINGS			
Input Voltage (Continuous)	350 V_{DC}	Junction Temperature Rise to Case	+15°C
Input Voltage (Transient, 1 second)	500 Volts	Storage Temperature	-55°C to +125°C
Output Power	200 Watts	Lead Solder Temperature (10 seconds)	300°C
Power Dissipation (Full Load, T_{CASE} = +100°C)	22 Watts	Weight (Maximum)	85 Grams

Parameter	Conditions	VPHVM-270 Min	Typ	Max	Units
STATIC					
INPUT Voltage	Continuous	180	-	350	V
	Transient, 1 sec	160	-	500	V
Current	Inhibited	-	2	4	mA
	No Load	-	4	8	mA
Ripple Current	Vin = 270V, Full Load, 20Hz to 10MHz	-	150	250	mA_{P-P}
Inhibit Pin Input[2]		0	-	1.5	V
Inhibit Pin Open Circuit Voltage[2]		3	4.5	6	
UVLO Turn On		-	175	179	V
UVLO Turn Off[2]		-	155	159	V
OUTPUT Voltage	Continuous	26	27	28	V
Power[1]		0	-	200	W
Ripple Voltage	Vin = 270V, 20Hz to 10MHz	-	450	-	mV_{P-P}
EFFICIENCY	Vin = 270V	89	91	-	%
CAPACITIVE LOAD[2]		-	-	500	µF
SWITCHING FREQUENCY		350	450	550	kHz
SYNC FREQUENCY RANGE	V_H-V_L=5V, Duty=50%	500	-	600	kHz
ISOLATION	3000 V_{DC}	100	-	-	MΩ
MTBF (MIL-HDBK-217F)	GM @ T_C = 55°C	-	429	-	kHrs
DYNAMIC					
Turn On Delay	V_{IN} = 0V to 270V	-	12	20	mSec

Notes: 1. Derate linearly to 0 at 110°C.
2. Verified by qualification testing.

BLOCK DIAGRAM

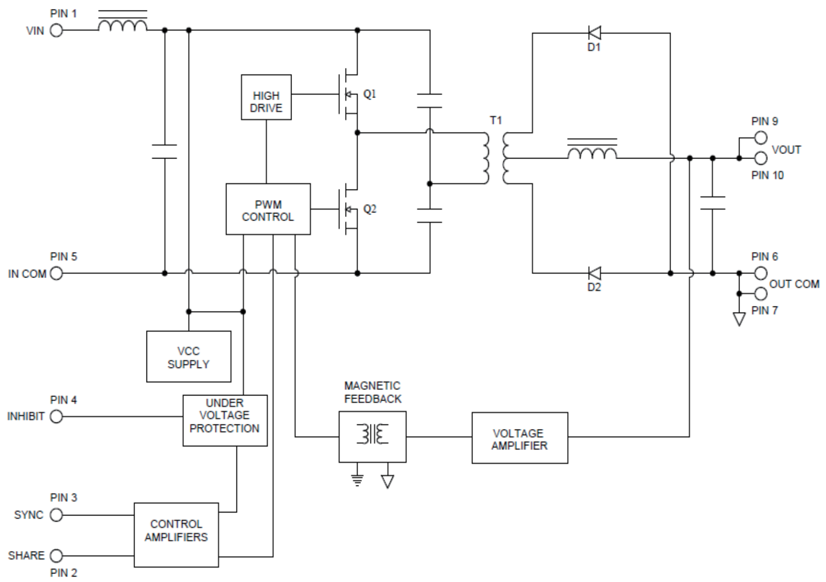


Figure 2

CONNECTION DIAGRAM

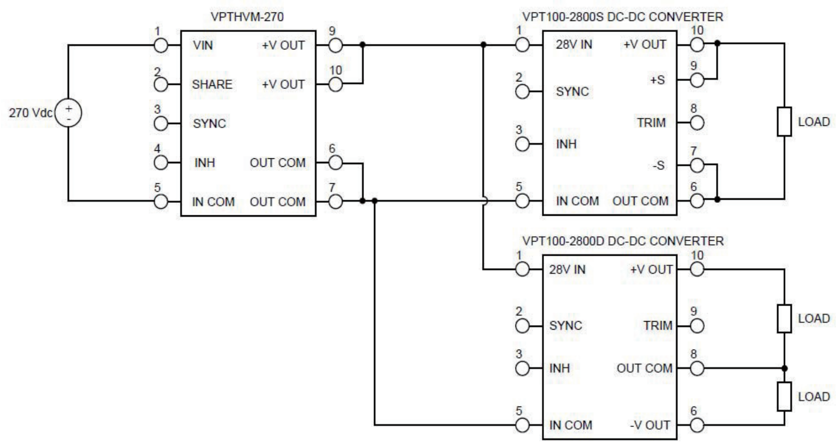


Figure 3

CONNECTION DIAGRAM

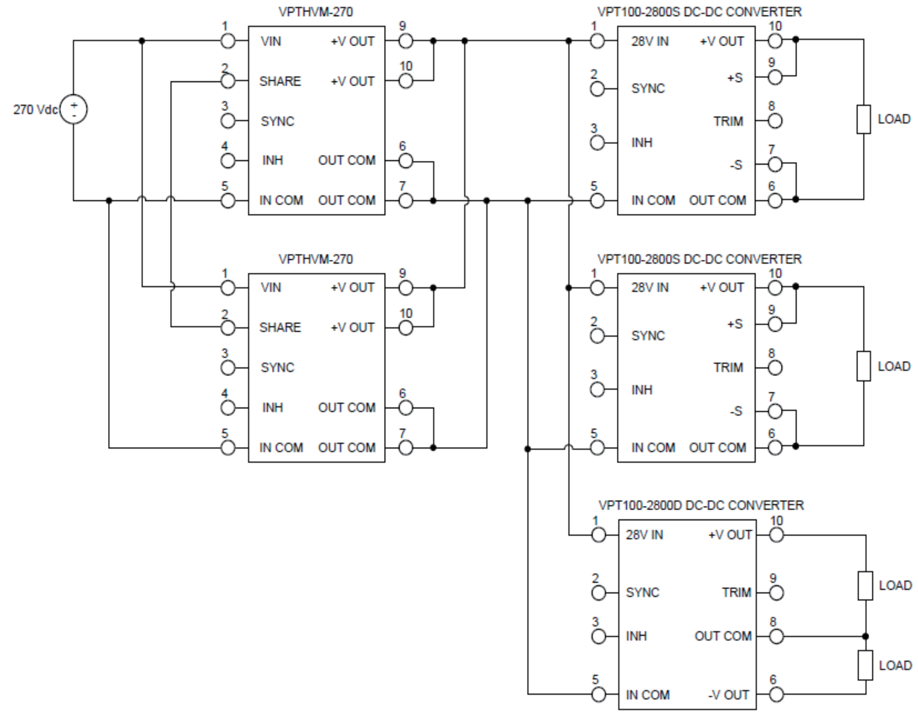


Figure 4

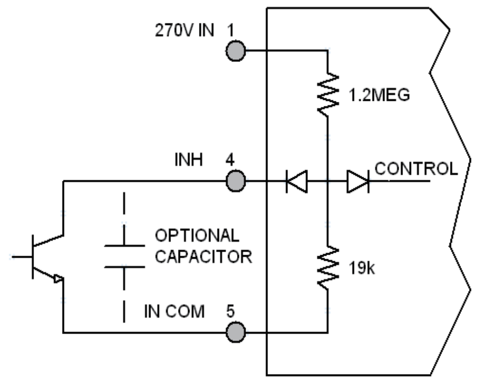
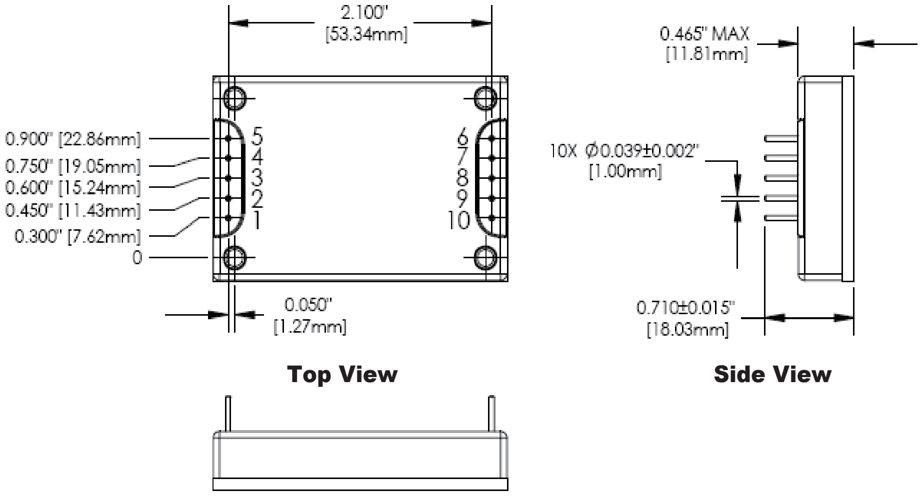
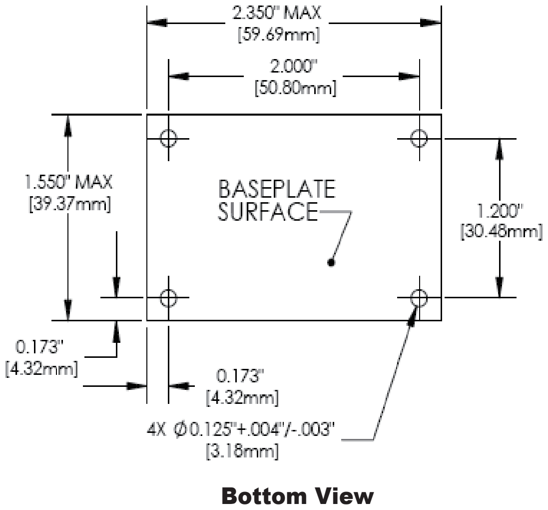


Figure 5-Inhibit Circuit
(Shown with optional capacitor for turn-on delay)

PACKAGE SPECIFICATIONS





PIN	FUNCTION
1	VIN
2	SHARE
3	SYNC
4	INHIBIT
5	IN COM
6	OUT COM
7	OUT COM
8	CASE
9	V OUT
10	V OUT

Figure 6 – Package and Pinout
(Dimensional Limits are ±0.005" Unless Otherwise Stated)

Package Notes:
1. Case temperature is measured on the center of the baseplate surface.
2. Materials: Baseplate – aluminum, conductive conversion coating.
   Cover – nickel plated.
   Pins – copper, gold over nickel plating.
3. Mounting holes are not threaded. Recommended fastener is 4-40.

PACKAGE PIN DESCRIPTION

Pin	Function	Description
1	VIN	Positive Input Voltage Connection
2	SHARE	Positive Input Voltage Connection
3	SYNC	Input Synchronization Signal. TTL squarewave, 5Vpp, 20 - 80% duty cycle, internally capacitively coupled.
4	INHIBIT	This is an open collector input. Logic Low = Disabled Output. Connect the inhibit pin to input common to disable the output. Unconnected, open collector or open drain = Enabled Output.
5	INCOM	Input Return Connection
6	OUTCOM	Output Return Connection
7	OUTCOM	Output Return Connection
8	CASE	Case Connection
9	VOUT	Positive Output Voltage Connection
10	VOUT	Positive Output Voltage Connection

100% ENVIRONMENTAL SCREENING

Screening	Condition
Internal Visual	IPC-A-610
Stabilization Bake	MIL-STD-883, Method 1008, Condition B, 125°C, 24 hours
Temperature Cycling	MIL-STD-883, Method 1010, Condition B, -55°C to +125°C, 10 Cycles
Burn-In	MIL-STD-883, Method 1015, 96 hours at +100°C
Final Electrical	100% at 25°C
External Visual	MIL-STD-883, Method 2009

ORDERING INFORMATION

VPTHVM-	270
1	2

(1)	(2)	
Product Series	Nominal Input Voltage	
VPTHVM	270	180 - 350 Volts

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

Interpoint-VPT 产品对照表

DC-DC CONVERTERS

Model Series	Input DC Voltage/V	Max Output Power	Output Voltage/V	EMI Filter	Equivalent Interpoint P/N*
Standard DC-DC Converter-Hybrid Technology, Hermetic Packaging					
DVSA2800S/D	15-50	6	Single 3.3,5,5.2,12,15 Dual ±5, ±12, ±15	DVMA28 DVMSA28	**MSA2800S** **ASA2800S**
DVHV2800S/D	15-50	15	Single 3.3,5,5.2,12,15 Dual ±5, ±12, ±15	DVMH28 DVMC28	**MHV2800S/D** **AHV2800S/D**
DVHF2800S/D	15-50	20	Single1.9,3.3,5,5.2,12,15,18,28 Dual ±5,±12,±15	DVMH28 DVMA28	**MHF2800S/D** **AHF2800S/D** **MHF+2800S/D**
DVHF+2800T	15-50	15	Triple 5/±12, 5/±15	DVMH28 DVMA28	**MHF+2800T**
DVTR2800S/D	15-50	40	Single2.5,3.3,5,5.2,7,8,12,15,18,28 Dual±5,±8,±12,±15,±18	DVMC28 DVMH28	**MTR2800S/D** **ATR2800S/D** **MHD2800S/D**
DVTR2800T	15-50	30	Triple 5/±12, 5/±15	DVMC28 DVMH28	**MTR2800T** **ATR2800T** **MHV2800T** **AHV2800T**
DVFL2800S/D	16-40	120	Single3.3,5,6.3,7,8,9.5,12,15,18,28 Dual±5,±6.3*,±9.5*,±12,±15	DVME28 DVMD28	**MFL2800S/D** **AFL2800S/D** **MOR2800S/D**
Standard DC-DC Converters-Hybrid Technology, Hermetic Packaging, Integral EMI Filter					
DVEHF2800T	15-50	10	Triple 5/±12, 5/±15	Included	**MDI3011 Triple**

Model Series	Input DC Voltage/V	Max Output Power	Output Voltage/V	EMI Filter	Equivalent Interpoint P/N*
DVETR2800S/D	15-50	40	Single 3.3,5,5.2,12,15 Dual ±5, ±12, ±15	Included	MDI3001 Single/Dual
Standard DC-DC Converters-Potted Modules for COTS Applications					
DVST2800T	15-50	30	Triple:3 Output3.3,5,12,15 each independent	Included	
DV200-28S/D	16-50	200	Single 3.3,5,5.2,12,15 Dual ±5, ±12, ±15	DVMN28	MK200,MI-J00

EMI FILTERS

Model Series	Input DC Voltage/V	Max Output Current	Equivalent Industry P/N*
Standard DC-DC Converters-Hybrid Technology, Hermetic Packaging, Integral EMI Filter			
DVMSA28	0-50	0.8	FMSA
DVMA28	0-50	1.0	
DVMH28	0-50	2.0	FMH-461,AFH-461
DV704A	0-50	2.0	FM704A,AF704A
DVMC28	0-50	4.0	FMC-461,AFC-461
DVMD28	0-50	7.0	FMD-461
DVME28	0-50	15.0	FME-461,AME-461
Standard DC-DC Converters-Potted Modules for COTS Applications			
DVMN28	0-50	10	

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MIL-STD-461 Compliance

For DV Series DC-DC Converters

INTRODUCTION

The control of electromagnetic interference for electronic subsystems is governed by MIL-STD-461 for the US Department of Defense. This document details compliance to revisions C, D, and E . The standard is divided into four areas, each of which must be dealt with by the systems designer to ensure overall compliance:

- Conducted Emissions
- Conducted Susceptibility
- Radiated Emissions
- Radiated Susceptibility

Some systems are governed by similar standards including RTCA DO-160D for civilian aircraft, and DEF STAN 59-41 for the United Kingdom Ministry of Defense.

SUMMARY OF MIL-STD-461:

MIL-STD-461C Requirements

CE01	Conducted Emission, 30Hz TO 20kHz, Power Leads
CE03	Conducted Emission, 20kHz to 50MHz, Power Leads
CE07	Conducted Switching spikes
CS01	Conducted Susceptibility, 30Hz to 50kHz, Power Leads
CS02	Conducted Susceptibility, 50kHz to 400MHz, Power Leads
CS06	Conducted Susceptibility, Spike, Power Leads
RE01	Radiated Emission, 30Hz to 30kHz, Magnetic Field
RE02	Radiated Emission, 30kHz to 10GHz, Electric Field
RS01	Radiated Susceptibility, 30Hz to 30kHz, Magnetic Field
RS02	Radiated Susceptibility, Magnetic Induction Fields
RS03	Radiated Susceptibility, 14kHz to 10GHz, Electric Field

MIL-STD-461D and MIL-STD-461E Requirements

CE101	Conducted Emissions, Power Leads, 30Hz TO 10kHz
CE102	Conducted Emission, Power Leads, 10kHz to 10MHz
CS101	Conducted Susceptibility, Power Leads, 30Hz to 150kHz
CS114	Conducted Susceptibility, Bulk Cable Injection, 10kHz to 200MHz
CS115	Conducted Susceptibility, Bulk Cable Injection, Impulse Excitation
CS116	Conducted Susceptibility, Damped Sinusoidal Transients, Cables and Power Leads, 10kHz to 100MHz
RE101	Radiated Emission, 30Hz to 100kHz Magnetic Field
RE102	Radiated Emission, 10kHz to 18GHz, Electric Field
RS101	Radiated Susceptibility, 30Hz to 100kHz Magnetic Field
RS103	Radiated Susceptibility, 2MHz to 40GHz, Electric Field

CONDUCTED EMISSIONS

VPT's DC-DC converters use modern switchmode or switching power conversion technology to provide high efficiency and a small size. All switchmode DC-DC converters inherently generate some switching noise. DV series DC-DC converters use advanced design techniques to minimize this noise, offering both low input and output ripple.

Conducted emissions requirements govern noise generated by the DC-DC converter and conducted onto the input power lines, usually 28V. This noise is defined in terms of input ripple current and consists of a fundamental component, usually around 500kHz, and its harmonics. All DV Series converters have internal input filters and low input ripple on the order of 50mApp. In some applications this is sufficient. Where full compliance to MIL-STD-461 is required, VPT offers several options which are listed in **Table 1**:

Table 1. Filter Products

Function	Products
EMI filter modules	DVMSA28, DVMA28, DVMH28, DVMC28, DVME28, DVMD28
EMI filter / transient suppression modules	DV704A, DVMN28
DC-DC converters with integral EMI filter	DVEHF28, DVETR28, DVETR28, DVST28

The EMI filter modules attenuate both differential and common mode noise on the input power lines. One filter can power several converters of different types up to its current rating. Recommended filters for a given system power are listed in **Table 2**. For higher power levels, the system can be divided with several converters per filter, or filters of like types can be paralleled for higher current.

Table 2. Filter Recommendations

System Output Power (Watts)	Recommended Filter	Rated Current (Amps)
6	DVMSA28	0.8
15	DVMA28	1.0
40	DVMH28	2.0
40	DV704A	2.0
80	DVMC28	4.0
120	DVMD28	7.0
240	DVME28	15.0
250	DVMN28	10

Careful system design is always necessary to maintain compliance. In general the filter should be placed at the power input to the board or enclosure. The DC-DC converters should then be placed as close as possible to the filter. Some tradeoff in the placement usually occurs, but it is important to keep the filtered input lines away from any noise sources. Typical noise sources which should be avoided include the converter output lines and any high speed digital circuitry.

Occasionally, CE03 or CE102 may be required on the DC output of the DC-DC converter. Additional filtering will be needed, including both common and differential mode filters. In some cases VPT's EMI filter modules can be placed at the output of the converter to meet this requirement.

CONDUCTED SUSCEPTIBILITY

Electronic circuits not only generate noise but also can be susceptible to noise generated elsewhere. Conducted susceptibility requirements define various noise sources which when conducted on the power lines should not cause degradation or malfunction of the system. Conducted susceptibility is tested on the input power leads only. The control or output leads may require additional external protection if they are to meet these requirements as well.

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VPT's DV series DC-DC converters provide approximately 30dB of input attenuation from DC up to 1MHz. An input filter as described in Table 1 provides additional attenuation above 10kHz for CS01 and CS101, and up to several hundred MHz as required by CS02, and CS114. The DC-DC converter is determined to comply to these requirements if the output voltage is maintained within its total static regulation limits.

The input filter also contains significant capacitance which filters the higher voltage and short duration transients of CS06, CS115, and CS116 to safe levels. The 0.15µs spike of CS06 has a low impedance but is of such short duration that it is effectively filtered. The same is true for the impulse excitation of CS115. The damped sinusoidal transient of CS116 has a much higher source impedance, such that the voltage seen by the filter is much smaller than the calibration voltage, and it too will be filtered to acceptable levels. Compliance is determined if the output of the DC-DC converter is maintained within its specified dynamic limits.

For longer duration input voltage transients such as the CS06 spike requirement with pulse width greater than 0.15µs, a transient suppression module is required. The source impedance is low and the duration long enough such that an EMI filter alone is not sufficient to protect the converter. The transient suppressor blocks the spike, limiting the voltage seen by the converter to a safe level. To protect against negative transients, a series diode should be added at the input of the DV704A or a shunt diode added at the output. The DVMN28 contains the shunt diode internally. Compliance is determined if the output of the DC-DC converter is maintained within its specified dynamic limits.

For sensitive loads, where the specified performance is not sufficient to avoid system upset, additional capacitance can be added at the input or output of the DC-DC converter. Significant capacitance added at the input should be appropriately damped.

RADIATED EMISSIONS

Radiated emissions requirements govern the electric and magnetic fields emitted by a subsystem. Compliance should be tested at the completed subsystem level and is heavily dependent on the system design, especially the grounding, shielding, and cabling. VPT's hermetic hybrid DC-DC converters have six-sided metal packages which limit high frequency emissions from the converter itself. Most radiation usually emanates from the input cabling or load circuitry, and that is where careful system design is essential. The fundamental switching frequency of DV series DC-DC converters is above 300kHz, with no noise source in the range of RE01 or RE101. An input filter as described in **Table 1** will provide sufficient filtering of the input lines to meet RE02 and RE102. In cases where there is an outage, a ferrite EMI bead on the input or output lines usually brings the system back into compliance.

RADIATED SUSCEPTIBILITY

Radiated susceptibility requirements dictate electric and magnetic field levels which should not cause degradation or malfunction of a system. As with emissions, potential problem areas include input cables and output circuitry. An input filter as specified in **Table 1** for the input power lines is required for compliance. If the load circuitry is not enclosed or shielded, or if testing is performed on output or signal cables, additional filtering may be required on those outputs and signals.

Table 3. MIL-STD-461C Compliance[1] of VPT DV Series of Converters

	CE01	CE03	CE07	CS01	CS02	CS06
Standalone converter compliance	•		•	•		
Converter with VPT filter compliance	•	•	•	•	•	• [2]
Converter with VPT filter/transient suppressor compliance	•	•	•	•	•	•

	RE01	RE02	RS01	RS02	RS03	
Standalone converter compliance	•		•			
Converter with VPT filter compliance	•	•	•	•	•	
Converter with VPT filter/transient suppressor compliance	•	•	•	•	•	

Table 4. MIL-STD-461D and MIL-STD-461E Compliance[1,3] of VPT DV Series of Converters

	CE101	CE102	CS101	CS114	CS115	CS116
Standalone converter compliance	•					
Converter with VPT filter compliance	•	•	•	•	•	•
Converter with VPT filter/transient suppressor compliance	•	•	•	•	•	•

	RE101	RE102	RS101	RS103		
Standalone converter compliance						
Converter with VPT filter compliance	•	•	•	•		
Converter with VPT filter/transient suppressor compliance	•	•	•	•		

[1]Proper system design necessary to maintain radiated compliance.
[2]For pulsewidth t≤0.15us
[3]CS114 curve 3. CS116 for Air Force Procurements.

CONCLUSION

The EMI performance of VPT's standard DC-DC converters and EMI filters has been documented, including both emissions and susceptibility. This characterization of standard module performance enables simplified system design where compliance to MIL-STD-461 is required.

ADDITIONAL INFORMATION

For additional information on MIL-STD-461 compliance, or to learn about VPT's products for EMI and voltage spike suppression, contact VPT at 425.487.4850 or sales@vpt.com. Or, visit VPT at www.vpt-inc.com.

Steve Butler is the Vice President of Engineering for VPT, Inc.

符合 MIL-STD-461 标准的 DV 系列直流-直流电源转换器

史蒂夫·巴特勒 (Steve Butler)

VPT 公司工程部副总裁

一、前言

关于电子子系统(electronic subsystems)的电磁干扰控制由美国国防部 MIL-STD-461 标准规定。本文件将详细阐述符合此标准规定的 C，D 和 E 修正版。

本标准划分为四个方面，系统设计者在每个方面都必须符合其规定。

1. 传导发射（Conducted Emissions）
2. 传导敏感度 (Conducted Susceptibility)
3. 辐射发射 (Radiated Emissions)
4. 辐射敏感度 (Radiated Susceptibility)

相似的规定，包括国内航空的 RTCA DO-160D 标准和英国国防部的 DEF STAN 59-41 标准。

二、MIL-STD-461 标准概要:

MIL-STD-461C Requirements	
CE01	Conducted Emission,30Hz to 20kHz,Power Leads
CE03	Conducted Emission,20kHz to 50MHz,Power Leads
CE07	Conducted Switching spikes
CS01	Conducted Susceptibility, 30Hz to 50kHz, Power Leads
CS02	Conducted Susceptibility, 50kHz to 400MHz, Power Leads
CS06	Conducted Susceptibility ,spike, Power Leads
RE01	Radiated Emission,30Hz to 30kHz,Magnetic Field
RE02	Radiated Emission,30kHz to 10GHz,Electric Field
RS01	Radiated Susceptibility, 30Hz to 30kHz,Magnetic Field
RS02	Radiated Susceptibility, Magnetic Induction Field
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CS114	Conducted Susceptibility, Bulk Cable Injection,10kHz to 200MHz
CS115	Conducted Susceptibility, Bulk Cable Injection, Impulse Excitation
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RS101	Radiated Susceptibility,30Hz to 100kHz Magnetic Field
RS103	Radiated Susceptibility,2MHz to 40GHz Electric Field

（一）传导发射 (Conducted Emissions)

VPT 直流-直流电源转换器采用调制解调器开关模式(modem switchmode)或开关电源转换(switching power conversion)技术，它不仅体积小还能实现高效的运转。所有开关模式的直流-直流转换器都会不可避免地产生开关噪声(switching noise), 但是 DV 系列的直流-直流转换器利用先进的设计技术可以将这种噪声最小化，同时提供低的输入和输出纹波 (input and output ripple)。

传导发射要求是控制由直流-直流转换器产生并且在输入电源线路里传播的噪声，电源通常为28V。这种噪声以输入纹波电流(input ripple current)形式表现，组成成分为一个基波(fundamental component)（一般为 500kHz 左右）和其谐波(harmonics)。所有的 DV 系列电源转换器都具有内置的输入滤波器和大约 50mApp 的低输入纹波，在某些应用上这些已经足够。但为完全符合 MIL-STD-461 的标准，VPT 提供更多选择，如表 1：

Functions	Products
电磁干扰滤波器模块 （EMI filter modules）	DVMSA28，DVMA28，DVMH28，DVMC28，DVME28，DVMD28
电磁干扰滤波器/瞬态电压抑制模块 (EMI filter/transient suppression modules)	DV704A，DVMN28
带内置滤波器的直流-直流转换器 (DC-DC converters with integral EMI filer)	DVEHF28，DVETR28，DVST28

表 1. 符合 MIL-STD-461 标准的滤波器产品

滤波器模块可减少输入电源线路上的共模及差模噪声(common and differential mode noise)。一个滤波器可根据电流等级与多种不同型号电源转换器配套使用。在特定的电源系统环境中，可供参考的滤波器如表 2 所示。对于级别较高的电源，系统可将一个滤波器供多个转换器或者将型号相似的滤波器并联使用以适用较大的电流。

系统输出功率(Watts)	参考滤波器	额定电流(Amps)
6	DVMSA28	0.8
15	DVMA28	1.0
40	DVMH28	2.0
40	DV704A	2.0
80	DVMC28	4.0
120	DVMD28	7.0
240	DVME28	15.0
250	DVMN28	10

表 2. 参考滤波器

精确的系统设计对于保证产品符合规范至关重要。一般说来，滤波器应放置在模板电源输入

或尾端，电源转换器则要尽量靠近滤波器放置。有时在放置安排上必须有些取舍，但滤波器输入必须远离任何噪声源，典型的噪声源包括转换器的输出线(output lines)和任何高速的数字电路(digital circuitry)。

偶尔，电源转换器的直流输出要求满足 MIL-STD-461CE03 或 CE102 的标准，此时就需要附加的滤波设备，包括差模和共模方式的滤波器。为满足这种要求，在某些器件中 VPT 的滤波器需要放置在转换器的输出处。

（二）传导敏感度(Conducted Susceptibility)

电子线路不仅产生噪声而且对于其它地方产生的噪声会有敏感反应。**传导敏感度要求**规定为在电源线路中传导不会造成性能降级或系统故障的各种噪声源。传导敏感度只能在输入电源线路处测量。如果控制或输出也需满足这些要求，则可能必须附加控制或输出管脚外部保护装置。

VPT DV系列直流-直流转换器提供约30dB的输入衰减值(input attenuation)，频率高达1MHz。表1中的输入滤波器提供符合CS01和CS101要求大于10kHz; CS02和CS114要求高达几百MHz的额外衰减值。输出电压若保持在总静态调节范围(total static regulation limits)内，直流-直流转换器就必定会符合这些要求。

输入滤波器也包含重要的电容，这种电容可以滤除较高的, 瞬时的电压, 使达到CS06，CS115以及 CS116 要求的安全级。虽然 CS06 在脉冲宽度(pulse width)0.15us 的峰值（spike）有较低的电阻，但它在短时间内可以完全有效的滤掉，这种情况同样适用于 CS115 的脉冲激发(impulse excitation)。CS116 的阻尼正弦瞬时电压(damped sinusoidal transient)具有较高的源阻抗(source impedance)，所以滤波器可视电压远小于标准电压，它也可以被滤到可接受的级别上。要保证满足以上规定要求，直流-直流电源转换器的输出必须在它特定的动态范围内(specified dynamic limits)。

对于瞬时输入电压持续时间较长时，如峰值要求脉冲宽度大于 0.15us 的 CS06，此时需要一个瞬态电压抑制模块(transient suppression module)。若源阻抗过低与持续时间过长, 单独一个滤波器不足以保护转换器，而瞬态电压抑制模块可以封锁峰值，同时限制电压至安全级。为防护消极的瞬态电压(negative transients)，可在 VPT DV704A 的输入处添加串联二极管(series diode)或在输出处添加分流二极管(shunt diode)。VPT DVMN28 已内置一分流二极管。是否满足规定要求, 取决于电源转换器的输出是否在它特定的动态范围内。

对于敏感性负载(sensitive loads)，即系统特定性能不足时，附加的电容需添加在电源转换器的输入和输出处，并且应适当地控制输入处的添加电容。

（三）辐射发射(Radiated Emissions)

辐射发射要求控制由子系统发射产生的电场和磁场。其标准完全在子系统上测量并且很大程度上依赖于系统设计，尤其是接地(grounding)，屏蔽(shielding)和电缆(cabling)三方面。VPT 密封混合式电源转换器由六边金属包装，这种包装可限制来自转换器本身的高频发射。大多数辐射通常源于输入电缆或负载电路，在这些地方往往需要精确的系统设计。DV 系列的电源转换器的基本开关频率高于 300kHz，在 RE01 和 RE02 的范围内无噪声源。表 1 所示的输入滤波器可提供输入线路的良好滤波功能，从而满足 RS02 和 RS102 的要求。在失灵的器件中，输入和输出线路上的铁氧磁珠(Ferrite EMI bead) 常能使系统回到规范要求。

（四）辐射敏感度(Radiated Susceptibility)

辐射敏感度规范要求能决定辐射电磁场的量值却不应引起系统性能降级或故障。就像发射

一样，辐射敏感度潜在的问题领域包括输入电缆和输出线路。表 1 所列的输入滤波器需符合规范。如果负载电路没有封严(enclosed)或屏蔽(shielded)，或必须在输出信号线处做性能测试，额外的滤波设备需配置在输出和信号线上。

	CE01	CE03	CE07	CS01	CS02	CS06
单独的转换器兼容性 （Standalone converter compliance）	■		■	■		
具有 VPT 滤波器的转换器兼容性 （Converter with VPT filter compliance）	■	■	■	■	■	■
具有 VPT 滤波器/瞬态抑制器的转换器兼容性 (Converter with VPT filter/transient Suppressor compliance)	■	■	■	■	■	■
	RE01	**RE02**	**RS01**	**RS02**	**RS03**	
单独的转换器兼容性 (Standalone converter compliance)	■		■			
具有 VPT 滤波器的转换器兼容性 (Converter with VPT filter compliance)	■	■	■	■		
具有 VPT 滤波器/瞬态抑制器的转换器兼容性 (Converter with VPT filter/transient Suppressor compliance)	■	■	■	■		

表 3.VPT DV 系列转换器的 MIL-STD-461C 标准

	CE101	CE102	CS101	CS114	CS115	CS116
单独的转换器兼容性 (Standalone converter Compliance)	■					
具有 VPT 滤波器的转换器兼容性 (Converter with VPT filter compliance)	■	■	■	■	■	■
具有 VPT 滤波器/瞬态抑制器的转换器兼容性 (Converter with VPT filter/transient Suppressor compliance)	■	■	■	■	■	■
	RE101	**RE102**	**RS101**	**RS103**		
单独的转换器兼容性 Standalone converter Compliance)						
具有 VPT 滤波器的转换器兼容性 (Converter with VPT filter compliance)	■	■	■	■		
具有 VPT 滤波器/瞬态抑制器的转换器兼容性 (Converter with VPT filter/transient Suppressor compliance)	■	■	■	■		

表 4. VPT DV 系列转换器的 MIL-STD-461D 和 MIL-STD-461E 标准

三、结论

VPT 标准 DC-DC 转换器和滤波器的电磁干扰性能已由文件记录，包括发射和敏感度。标准模块的性能描述使得简单系统设计符合 MIL-STD-461 的要求。

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Lead Trimming and Hand Soldering Guidelines For VPT DC-DC Converters

INTRODUCTION

VPT's DV Series hybrid thick-film DC-DC Converters and EMI Filters (hereafter referred to as "product(s)") are hermetically sealed to keep moisture and/or contaminates from entering the package cavity. Products of this type use a solder seal, projection weld, or seam weld process to create the hermetic seal between the lid and the package body. Depending on lead (pin) diameter/length and package configuration, products of this type will use either a compression glass or brazed ceramic disc to create a hermetic seal between the lead and package body. This glass or ceramic seal also serves the dual purpose of electrically isolating the lead from the package body.

VPT's products use uniform lead lengths across all standard product families. Customers may request a specific lead length as a paid custom modification. However, it is often more efficient to save cost and time by ordering a standard product and trimming the leads in-house.

VPT's products can be mounted and connected in customer's systems in many different configurations with various processes. The most popular and well controlled soldering methods for PCB attachment is wave soldering. In many systems, however, this is not a viable option because of limiting configurations, resources, or hard wiring. This usually leaves hand soldering using a soldering iron, hot air system, or other method as the best option.

This document details the proper processes for trimming leads and hand soldering products into systems and applications while ensuring product safety and maintaining functional integrity.

LEAD TRIMMING

The lead trimming process, if not performed correctly, can either bend the leads at unacceptable angles or damage the glass or ceramic seals. Seal damage can cause chip-out or micro-cracking, which can result in a loss of hermeticity. VPT performs 100% external visual inspection and leak testing after trimming leads for purchase order requirements to verify that the leads and seals have not been damaged as part of the trimming process. It is strongly suggested that customers do the same when performing these operations in-house. Micro-cracks are undetectable by the naked eye and require a visual test under high magnification. MIL-STD-883, Test Method 2009 specifies the proper visual inspection criteria to be used when determining acceptable bent lead angles or cracking, crazing, or chip-out of the glass or ceramic seals after trimming. Leads trimmed by the customer should always be trimmed to length before insertion, attachment, or soldering into the application.

VPT recommends the following process when trimming leads:

1. **Create a trimming fixture.** One trimming block should be created for each type of VPT product used. It should be the same thickness as the desired final length of the lead and should be manufactured from aluminum or other similarly rigid, inexpensive, easily drilled and machined material. Holes should be drilled in the block in the locations for all pins of the product to be trimmed. These holes should be slightly larger than the pin diameter (approximately 0.010 to 0.020 inches) to guard against the scraping or bending of the leads during insertion and removal. The lead dimensions and locations are detailed in the product's corresponding datasheet located at www.vpt-inc.com/datasheets.

2. **Insertion into the trimming fixture.** The product should be inserted straight down over the pins until it sits flat on the trimming fixture, ensuring only the lead length to be trimmed, or waste area, is visible from the other side. See Figure 1.

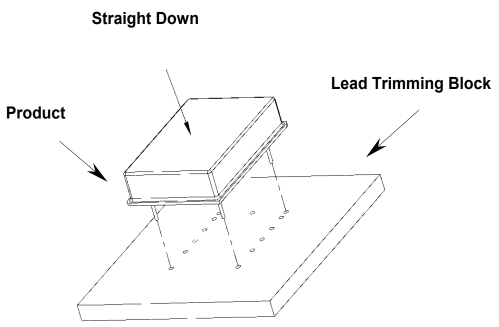

Figure 1

3. **Position correctly.** The trimming block and product should be placed upside down, with pins up, on a firm, ESD-safe surface that will keep the product and fixture from sliding. High quality flush cutters should be used to trim the leads even with the surface of the trimming block. See Figure 2.

4. **Test for success.** After lead trimming is completed, VPT recommends that customers measure the final lead lengths with calipers. VPT also recommends a visual inspection and leak test to verify that the product remains undamaged after the trimming process.

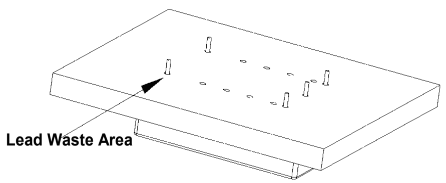

Figure 2

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HAND SOLDERING

At **no time** during soldering operations should any VPT product or pin be exposed to 270°C or higher for more than 10 seconds. This can melt solder inside of the unit, causing internal solder joint and attachment failures. VPT performs 100% external visual inspection and electrical verification testing after hand soldering operations to verify that the leads and internal components have not been damaged as part of the process. It is strongly suggested that customers do the same when performing any hand soldering process.

VPT recommends customers follow these steps when hand soldering products into application PCBs and systems:

1. **Careful insertion.** Insert the unit into the application PCB. Be sure to place the product straight into the mounting holes to prevent bent leads or seal damage.

2. **Pre-heating.** Heat the area around the lead to be soldered (PCB pad, plane, relief, etc.) with a high quality, heat-controlled soldering iron. Ensure that no contact is made with the lead itself. Wire solder (electronic grade with a non-corrosive - RMA, no-clean, etc. - flux core) should be held to the area (not the tip of the soldering iron) until it starts to melt and can be moved over the pad with the soldering iron. It is helpful to pre-tin the solder pads before the product is installed to help with solder transfer.

3. **Applying solder to the leads.** As soon as the solder starts to melt, move the soldering iron into contact with the lead (while maintaining contact with the solder pad), add enough solder to complete the joint, and remove.

4. **Troubleshooting.** If the soldering iron must stay in contact with the PCB solder pad for more than 5-7 seconds to ensure melting, the board may be too thick, have solder pads that are too large, or simply need more heat for soldering. In this case the board may need to be pre-heated before soldering to ensure that the soldering iron can achieve solder melt temperature quickly enough.

5. **Test for success.** After soldering is completed, VPT recommends that customers perform a visual inspection to verify solder joint acceptability and attachment to the PCB. Remaining flux from the soldering operation should be cleaned per the customer's normal process. VPT's products are resistant to cleaning solvents.

CONCLUSION

VPT's DV Series hybrid thick-film DC-DC converters and EMI filters are reliable and robust products which perform well under system level electrical and mechanical stresses when handled and installed correctly. Proper testing after customer lead trimming or soldering will ensure that the products have not been damaged during these operations.

ADDITIONAL INFORMATION

For additional information on lead trimming and hand soldering, or to learn about VPT's products and services, contact VPT at 425.487.4850 or sales@vpt.com. Or, visit VPT at www.vpt-inc.com.

VPT 直流-直流转换器的管脚修整和手工焊接指南

肖恩葛汉（Shawn Graham)

VPT 公司质检部执行总裁

一、 前言

VPT DV 系列混合厚膜式直流-直流转换器和滤波器（后称“产品”）通过密封包装(hermetically sealed) 来阻止湿气、污染物进入包装盒内。此类型产品采用密封焊接技术(solder seal) 或凸焊(projection welding)、缝焊技术(seam weld) 来实现盖子和包装物之间的密封。根据管脚的直径/长度和包装的配置，这种类型的产品采用压缩玻璃或铜焊陶瓷圆板(brazed ceramic disc)来确保管脚和包装物之间的密封。玻璃或陶瓷密封也同时确保了管脚与包装盒之间的电隔离。

VPT 产品在整个标准产品家族中采用统一的管脚长度。客户也可要求特定的管脚长度，然而客户则需支付定制修改的金额。当然订购标准产品较节省成本和时间。

VPT 的产品可用多种不同的配置方法安装并连接在客户系统中。最为普遍且易于控制的 PCB 焊接接入法是波焊(wave soldering)。但是，在许多系统中，有限的配置、资源或是硬接线使得波焊成为一个非可行的选择，而手焊(hand soldering) 就成了最佳选择——手焊可以使用烙铁(soldering iron)，热风系统(hot air system) 或其它方法。

本文件详细阐述管脚修整和手焊产品至系统与应用的正确步骤，以及保证产品的安全性与维护功能的完整性 。

二、管脚修整 (Lead Trimming)

管脚修整过程中，若操作不当，会致使管脚过度扭曲，损坏玻璃或者陶瓷的封装。封装一旦被破坏会引起破裂或细裂纹，而这些都会引起密封性能的降低。VPT 根据客户订购要求, 管脚修整之后还将进行 100%外部视检和泄漏测试来确保管脚和封装没有损坏。我们强烈建议客户也按照我们建议的步骤进行检测和测试。微裂纹无法通过肉眼来观察，需在倍率较高的放大镜下做视测。MIL-STD-883，Test Method2009 规定视检标准，在管脚修整之后，管脚弯曲度、或者玻璃、陶瓷的破裂、有一定容许的范围。若客户自行对管脚的修整，那么在插入，连接或焊接到接合处前，最好能调节一下管脚长度。

VPT 推荐以下的管脚修整步骤：

1. **建造一个修整的固定装置**。每款VPT产品必须对应一适合的修整板 (Lead trimming block)。修整板厚度需与最终要求的管脚的长度一致，由铝金属或其它同等坚硬、经济以及易于钻孔和加工的材料制成。板上钻孔的位置与待修整的产品管脚位置相对应。这些孔应略大于管脚直径（约 0.010 到 0.020 英寸），以保证插入或再次移动时避免刮擦或弯曲管脚。管脚的尺寸和位置在对应的产品数据表中有明确说明，具体可登陆网站www.vpt-inc.com查阅。

2. **插入修整板。**产品应沿管脚直插而下，直到平放在修整板上。必须保证只有管脚长被修整，或从板的另一侧可以看到多余管脚部分。如图 1 所示。

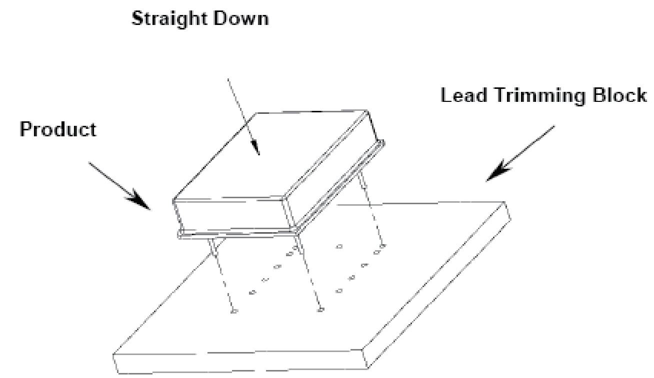

图 1：插入修整板

3. **正确放置。**将修整板和产品（管脚朝上）放置在一个牢固的、防静电 (ESD safe) 的平面上，这样可防止产品和固定装置之间的滑动。高质的剪钳(flush cutter)可修整管脚，如图 2 所示。

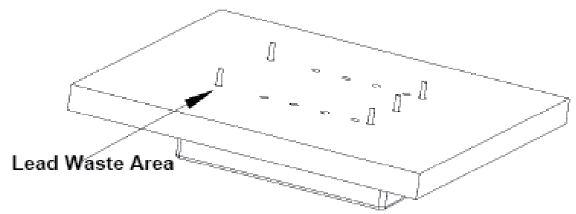

图 2：正确放置

4. **合格测试。**管脚修整完毕，VPT 建议客户用卡尺 (caliper) 测量最终管脚长度。VPT 同时也建议客户做一个视测和泄漏测试以检验产品修整之后产品有无损伤。

三、手工焊锡

焊锡时，任何 VPT 的产品或管脚都不可置于 270 摄氏度或更高温度下超过 10 秒钟，这种情况会融化部件内部的焊锡从而导致内部焊锡点和连接处发生故障。手工焊锡完成后,VPT 执行 100%的外部视测和电气检验测试来保证在过程中管脚和内置部件没有收到破坏。VPT 强烈建议客户在执行任何手焊操作过程中按照我们建议的步骤进行。

在手工焊锡产品到印刷电路板(PCB)或系统中时，VPT 建议客户遵循以下步骤：

1. 小心插入。将组件插入到应用 PCB 板，确定产品直插入至底座孔，避免管脚弯曲或封装受损。
2. 预热。用一高质、控温的烙铁加热待焊接的区域（PCB 垫，平面或立体面等等）。

确保无其它物体与管脚接触。焊线要紧贴待焊位置（烙铁尖端），直到焊线开始融化，且可随烙铁在板上移动。为帮助焊锡移动，在产品安装前可在焊垫上预镀锡。

3. 管脚焊锡。一旦焊锡融化，移动烙铁到管脚的接触面（同时保持接触焊锡垫）。添加足够的锡来焊接接点，然后再移动。

4. 故障处理。如果烙铁与 PCB 焊垫的接触时间超过 5 至 7 秒之后才融化，那么可能的问题在于板太厚，焊锡垫太大或只是需要更多的焊接热量。这样的话，板在焊锡前就需预热，以保证烙铁能够尽快达到焊锡融化温度。

5. 合格测试。焊接完成后，VPT 建议客户进行视测以确保焊锡点与 PCB 板相连。焊锡过程中残留物应在每一次的常规操作中及时清理。VPT 产品不受清洗溶剂的影响。

四、结论

VPTDV 系列混合厚膜式直流-直流转换器和滤波器是可信赖的坚固产品。在超级要求的电气和机械系统下，若产品操作和安装正确便可运作良好。客户对管脚修整或焊锡后做适当的检测可确保产品在这些操作过程中未受损坏。

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Meeting Military Requirements for EMI and Transient Voltage Spike Suppression

BACKGROUND: THE EMI AND VOLTAGE TRANSIENT CHALLENGE

Military and aerospace engineers face several challenges with respect to electromagnetic interference (EMI) and transient voltage compliance. The standards developed by the various military organizations are much more stringent than comparable standards in commercial applications, and the standards do not always agree with each other concerning test limits and methods. The intention of an EMI standard is to prevent problems that can arise when electronic noise from one piece of equipment adversely effects the operation of other equipment. Lack of proper EMI control can result in noise interference such as unwanted noise in communication and computing equipment as well as false triggering and faulty readings in sensor circuits.

In addition to noise signals that can cause interference, the normal operation of equipment can result in significant voltage transients that appear on equipment input terminals. These transient voltages are specified by military standards and are tailored for the specific environments encountered by different classes of equipment. For example, land-based equipment can have different requirements than airborne equipment.

One challenge for the military systems designer, therefore, is to address EMI and transient performance in a timely fashion with equipment that is designed to meet the most stringent requirements imposed by the end customer. This application note addresses the basics of EMI and transient compliance for military systems that make use of switched-mode power supplies (SMPS). It focuses on basic terms encountered in EMI and transient suppression and on ways to approach the varied requirements of several different military organizations.

ELECTROMAGNETIC INTERFERENCE (EMI)

Electromagnetic interference is divided into in four main classifications:

1) conducted emission
2) conducted susceptibility
3) radiated emission, and
4) radiated susceptibility.

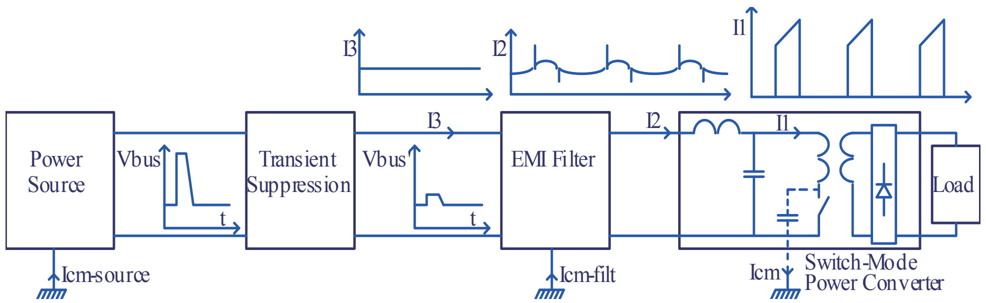
Conducted noise is transmitted along the electrical cables that connect the input power bus to the equipment while radiated interference occurs through the unintended transmission or reception of noise signals. EMI emission standards address noise generated by the equipment whereas EMI susceptibility standards describe the noise environments that the equipment must tolerate without malfunction.

From a design perspective, conducted emissions are further divided into common-mode and differential-mode noise. Differential-mode conducted noise results from currents flowing into one terminal of the converter and out the other, which is the normal current flow in the circuit[1]. Common-mode current, on the other hand, flows through the chassis ground and returns in the same direction in both the power and return lines. Differential-mode current is generally associated with switching currents in the power converter whereas the common-mode currents are primarily a result of pulsating voltages in the circuit.

EMI compliance requires that the system meet standards for all of types of conducted and radiated interference. When one considers the function of an EMI filter, however, it is usually with respect to how well the filter prevents the equipment *emissions* from reaching the main power distribution system. Figure 1 shows a typical SMPS supplied load along with an external EMI filter and transient suppression circuit. The SMPS switching current, I1, is attenuated by both the built-in and external filters.

The input current of the SMPS, I2, is primarily DC with a specified ripple current component. The ripple component of this current along with the higher frequency spikes are further attenuated by the EMI filter such that the current drawn from the power bus, I3, is essentially DC. While I3 still has a small AC component to it, the filter must be designed to assure that this AC component is below the level specified in the applicable standard. This attenuation of the switching current to a DC level is a measure of the differential-mode performance of the filter. The common-mode effectiveness of the EMI filter is determined by the reduction in the generated common-mode current, Icm, that passes through the source, Icm-source. An effective EMI filter must keep the combined common-mode and differential-mode current in the power source leads below specified levels.

Figure 1. Effect of the EMI Filter and Transient Suppression Functions.



[1] For this reason, the terms "common-mode" and "normal-mode" noise are often used interchangeably.

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TRANSIENT SUPPRESSION

While EMI filtering is used to attenuate the electrical noise that results from the normal operation of electronic equipment, transient voltage suppression addresses the need to survive infrequent or intermittent disturbances that occur on the power distribution bus. Such power disturbances are caused by the switching of large motors, engine starting, load transients, etc. They are classified as one of three main types:

1) voltage ripple
2) voltage surges, and
3) voltage spikes.

Voltage ripple refers to the variation of the input voltage about a nominal DC input voltage. Surges result from load transients on the power distribution bus and generally last on the order of several milliseconds to 100mS. Spikes, on the other hand, are generally caused by the switching of reactive loads, which induces relatively high-frequency, high-voltage oscillations that last for less than 5mS.

The role of a transient suppression circuit is to protect the EMI filter and in turn the downstream circuitry from damage due to such transients. Figure 1 shows an input bus voltage, Vbus, with an input surge superimposed on the nominal DC level. The transient suppressor clamps the input voltage to a level that is safe for the EMI filter and downstream converter, shown as Vbus in Figure 1. In this way, the transient suppression function is similar to the EMI filter's susceptibility function: they both protect the load equipment from disturbances that originate on the power distribution bus.

EMI AND TRANSIENT SUPPRESSION STANDARDS

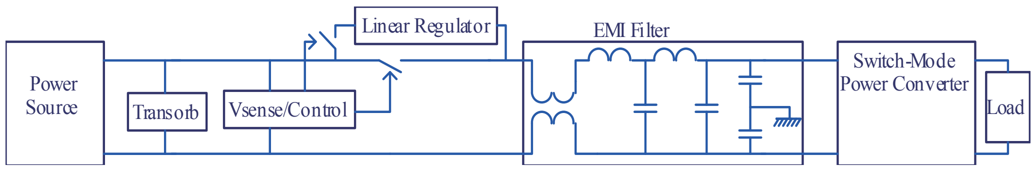
Both EMI and transient suppression are addressed by a number of standards issued by different organizations around the world. For EMI compliance these include the MIL-STD-461 EMI/EMC standard for the US military, RTCA DO-160D for civilian aircraft, and DEF STAN 59-41 for United Kingdom Ministry of Defense applications. Standards that address transients and bus characteristics include MIL-STD-704, MIL-STD-1275, DO-160, and DEF STAN 61-5.

In light of the many standards that apply to EMI compliance and transient suppression, there is good reason to approach the design of a power system by meeting the strictest of the standards wherever possible. Such a "design once, deploy worldwide" approach maximizes the return on development costs and allows for designs that can meet a wider range of end applications. For example, a design that meets MIL-STD-704A specifications for input voltage bus characteristics will usually meet all requirements up to MIL-STD-704E.

TYPICAL DISCREET EMI/TRANSIENT SUPPRESSION SYSTEMS:

The block diagram in Figure 1 shows the basics of a discreet system for transient suppression and EMI filtering. The specific requirements of the different standards must be addressed through the design of each section of the system. Figure 2 shows how the functional blocks of Figure 1 can be implemented in a typical power system. The transient suppression function uses a linear regulation function that is switched into the circuit when the input voltage exceeds a particular value. When the linear regulator is functioning, the output of the transient suppression circuit is clamped at a regulated value and the difference between the input voltage and the clamp voltage is dropped across the series pass element of the linear regulator.

Figure 2. Transient Protection and EMI Filter Discreet Solution Block Diagram.



Since the power drawn from the source is assumed constant, the dissipation in the linear regulator can be quite high, and this limits the duration of the input transient that can be blocked by the transient protection module. In order to protect the transient protection module, either the input voltage must be limited in time and amplitude or the load must be shut down. The specific performance requirements of the transient specification will dictate the size and power ratings of the transient linear regulator. The transorb element shown in the front of the transient protection circuit protects the circuitry from short duration, limited energy spikes. The transorb voltage must be low enough to provide adequate protection from high-voltage spikes, but must not be so low that longer duration overvoltage conditions damage the transorb itself.

The EMI filter is generally composed of several stages of LC filtering as well as capacitance from each rail to chassis ground. The LC stages provide differential-mode filtering while the input common-mode choke and output common-mode capacitors determine the filter's common-mode filter performance. The transient protection circuitry is placed in front of the EMI filter. In this way the EMI filter components are protected from the input transient spikes and surges and the EMI filter can be designed to filter the specific load requirement.

EMI/TRANSIENT SUPPRESSION DESIGN SOLUTIONS

PLAN FOR WHERE YOUR DESIGN WILL BE USED

One of the key aspects of successful EMI and transient suppression system design is to plan from the outset for the specific needs of the end market the product will serve. A design that is meant only for the US market may take a very different approach than one intended for Europe or Asia. While most of the EMI and transient standards have similar roots—and some are nearly identical in many respects—it is best to work directly with the specifications for the target market. Note also, however, that the military market is different from the commercial market in that specific performance criteria are often left to the discretion of the program management team. This adds another level of difficulty in that some programs may, for example, require that circuitry operate through particular surge voltages whereas others will allow equipment to shut down and recover for the same input condition. The designer must make sure that such specific operating requirements are clear early in the design process.

UNDERSTAND HOW EMI AND TRANSIENT VOLTAGE TESTS ARE PERFORMED

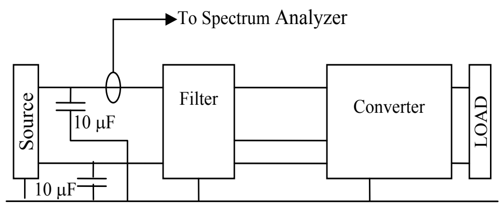
One of the main functions of the various EMI and transient voltage standards is to establish a common technique for the measurement and characterization of EMI performance. Such standards are required in order to make EMI characteristics reproducible from one test lab to another. However, while test conditions are designed to simulate the actual installation environment, the correlation between results in the test lab with those in the field is often difficult to establish.

A further complicating issue for EMI compliance design is that not all standards measure the same characteristic in the same way. For example, MIL-STD-461C measures input conducted emissions using a current probe and states the emissions in terms of dBμA but MIL-STD-461E uses an input line impedance stabilization network (LISN) and measures noise in terms of dbμV. DEF-STAN 59-41, on the other hand uses a current probe and specifies the emission levels in terms of dBμA, like 461C, but also uses an input LISN like that used in 461E. For this reason, it is necessary to specify the test method used to state the emission levels.

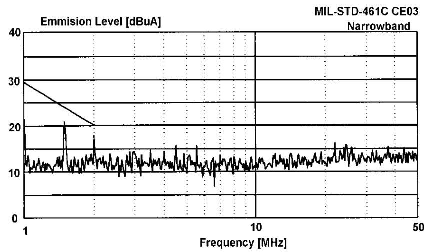
UTILIZE PACKAGED SOLUTIONS THAT ADDRESS YOUR NEEDS

There is considerable work involved in meeting the various EMI and transient suppression requirements spelled out by the different worldwide agencies. This filter design task is often accomplished through the use of discrete filters and one-of-a-kind designs. However, packaged filter solutions that are designed to operate with specific power converters can significantly reduce the time required to achieve a compliant system. In addition, the packaged filter solution can be procured as a single unit, thereby reducing parts count and simplifying the qualification process. The performance of packaged solutions can generally be determined ahead of time and this can increase confidence that a given solution will work for a particular application. Figure 3 and Figure 4 show the conducted EMI and transient performance of VPT's DVMN EMI filter/transient suppression module. This type of information is generally available from module vendors for a variety of application conditions. In addition, application notes and application specific information is available that aids in the use of the packaged filter module for specific situations not covered by the standard datasheet.

Figure 3 – MIL-STD-461C
DV200-2812D With DVMN28 EMI Filter



MIL-STD-461 Conducted Emissions



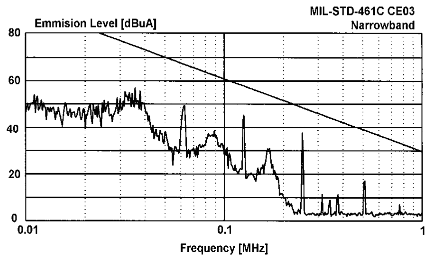
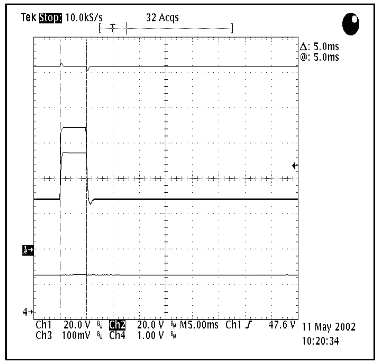
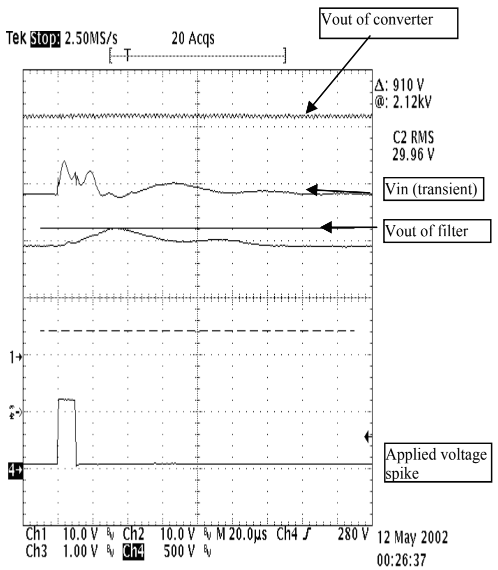


Figure 4 – Transient Performance of a Packaged DVMN28 EMI Filter/Transient Suppression Module with DV200-2812D Converter

Input Transient: 70V/5mS/0.5 ohm source/Full Load



Input Transient: 600V/10uS/Full Power



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CONCLUSION

EMI filtering and transient suppression are needed in military systems to ensure that

1) the various electrical components do not generate excessive electrical disturbances that will impact other equipment, and
2) all electrical components attached to the power bus can tolerate and/or operate through the power bus disturbances that are typical for given operating environments.

Several different sets of EMI and voltage transient specifications have been established over the years to address these requirements. In some cases the standards from the various agencies are very similar and in other cases they are quite different either in the methods used to test the equipment for compliance or in the actual levels of the interference signals. Solutions that meet as many of the performance standards as possible result in hardware that can be used in a variety of locations worldwide. The designer must realize, however, that a design that meets the requirements of many different specifications is usually over-designed (and therefore more expensive, larger and heavier) for some applications. It is therefore necessary to trade off the overall performance of a system with the specifics of each application and the schedule requirements of the project. Nonetheless, packaged EMI/Transient suppression modules tailored for the load converters they supply can offer a significant advantage in addressing the conflicting needs for rapid system development, wide-ranging end use and efficient packaging.

ADDITIONAL INFORMATION

For additional information on EMI and transient voltage spike suppression, or to learn about VPT's products for EMI and voltage spike suppression, contact VPT at 425.487.4850 or sales@vpt.com. Or, visit VPT at www.vpt-inc.com.

Dr. Glenn Skutt is the Vice President of Technology for VPT, Inc.

电磁干扰和抑制瞬时电压峰值的军事标准要求

格林.斯科特 博士 (Dr. Glenn Skutt)

VPT 公司技术部执行副总裁

一、背景：来自电磁干扰和瞬态电压的挑战

关于电磁干扰（EMI）和瞬态电压兼容(transient voltage compliance)方面，军事以及航空领域的工程师们面临着诸多挑战。不同的军事组织制定不同标准，与在商业应用中的相似标准相比，具有更高的严格性。这些标准就测试限制和方法上有时未能达成一致意见。来自某设备的电子噪声可能影响到其它设备正常运行，电磁干扰标准的目的就是预防那些可能产生的问题。缺乏必要的电磁干扰控制会导致噪声干扰, 例如在通讯或计算设备中产生多余的噪声，同样还会在传感器电路中造成假触发(false triggering)以及错误读数(falty reading)。

设备的正常运转除了会产生能引起干扰的噪声信号，也会产生相当大的瞬态电压。这些瞬态电压发生在设备的输入终端，在军事标准中有着详细的说明，且随不同级别的设备所在的特定环境进行调整。例如，陆地设备就比空降设备具有较多不同的要求。

因此，对于军事系统设计者的挑战，是提到设备的电磁干扰和瞬态电压性能，而这些设备的制成将适时满足最终客户提出的最严格要求。本操作说明书将阐述运用于使用开关式电源(switched-mode power supplies, SMPS)的军事系统中的电磁干扰和瞬态电压兼容的基础，集中说明电磁干扰和瞬态电压抑制中出现的基本术语以及处理数个不同军事组织提出的各种要求。

二、电磁干扰（EMI）

电磁干扰可划分为四大类：

1) 传导发射 (conducted emission)
2) 传导敏感度 (conducted susceptibility)
3) 辐射发射 (radiated emission)
4) 辐射敏感度 (radiated susceptibility)

传导噪声(conducted noise) 产生于连接输入电源总线和设备的电缆传输; 而辐射干扰(radiation interference) 则产生于非预期性的传输或接收噪声信号。电磁干扰发射标准(EMI emission standards)是有关设备产生的"噪声"; 而电磁干扰敏感度标准(EMI susceptibility standards) 则描述，设备能够容忍的"噪声环境"----以便正常运作。

从设计角度出发，传导发射可进一步划分为共模噪声(common-mode noise)和差模噪声(differential-mode noise)。差模传导噪声产生于转换器的输入输出电流 (电路中的正常电流[1])。另一方面，共模电流在底盘(chassis ground)流动与电源线路(power line)和地面回路(return line)同向。差模电流一般与电源转换器中的开关电流(switching currents)有关, 而共模电流主要是电路中电压脉动(pulsating voltages)的结果。

[1] 因此，"差模噪音" 和 "常模噪音" (normal mode noise)两者术语经常被交替使用。

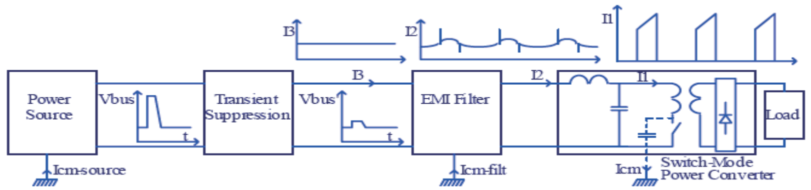


图 1、电磁干扰滤波器和瞬态电压抑制功能的实现

电磁兼容要求系统满足传导(conducted)干扰和幅射(radiated)干扰所有类型的标准。然而，考虑滤波器功能时，通常是看滤波器在预防主电源供应系受其设备发射干扰(emissions)的效果如何。 图 1 显示的是带有外部滤波器和瞬态电压抑制电路的典型开关式电源负载。开关电流(SMPS switching current) I_1 可由内置和外部滤波器来衰减。

开关式电源的输入电流I_2 主要为直流，加上特定的电流纹波(ripple current)。这种电流纹波与较高频率的峰值可由滤波器进一步衰减，因此从电源总线流出的电流I_3基本为直流。如果I_3中仍有一小部分的交流，那么滤波器必须设计成能保证交流成分低于应用标准中规定的水平。开关电流到直流水平的衰减值是衡量滤波器差模性能的一种标准。滤波器共模的有效性可由产生的共模电流（Icm）减少值确定，此共模电流（Icm）通过共模电流源（Icm-source）来传递。有效的电磁干扰滤波器必须使在电源电路中的共模电流和差模电流在规定的标准下

三、瞬态抑制

滤波器被用于衰减电子设备正常运转产生的电气噪声，而瞬态电压抑制则致力于克服偶尔干扰或间歇干扰，这些干扰通常发生在配电总线处。这种电源干扰发生于大发电机开关、发动引擎、瞬变负载等。它们大致可划分为三类：

1) 电压纹波 (voltage ripple)

2) 电压浪涌 (voltage surge)

3) 电压尖峰 (voltage spike)

电压纹波指的是实际直流输入电压与标准直流输入电压的差异。浪涌由配电总线上的负载瞬变产生，通常持续几毫秒到一百毫秒左右。另一方面，电压尖峰一般因负载的有无开关(reactive load switching)而产生，尖峰有相当的高频、高压振荡，持续时间少于5毫秒。瞬态电压抑制电路(transient suppression circuit)的作用是保护EMI滤波器，同时保护下游的电路免于来自瞬态电压的破坏。图1显示一输入总线电压（Vbus），以及活动在标准直流电平上的输入浪涌(input surge)。瞬态电压抑制器强制输入电压到一定水平，而这个水平能保证EMI滤波器和下游转换器的安全性，如图1中Vbus所示。这样，瞬态电压抑制功能就与EMI滤波器的敏感度功能相似：它们都保护负载设备免于源自配电总线的干扰。

四、电磁干扰和瞬态电压抑制标准

全世界的不同组织颁布的诸多标准都提到了电磁干扰和瞬态电压抑制。电磁兼容标准包括美国军事部的 MIL-STD-461 EMI/EMC 标准，国内航空的 RTCA DO-160D 标准以及英国国防应用部门的 DEF STAN59-41 标准.关于瞬态电压和总线特性的标准则包括 MIL-STD-704，MIL-STD-1275，DO-160 和 DEF STAN61-5。

应用于电磁兼容和瞬态电压抑制有多种标准，对于电源系统的设计我们相信应满足最为严格的标准。这种"一旦设计，全球应用"的方式可将开发成本回收最大化，同时设计也

可能满足更多终端应用。例如，一个满足 MIL-STD-704A 设计规格的输入电压总线，通常能满足 MIL-STD-704E 标准的所有要求。

五、典型离散电磁干扰系统/瞬态电压抑制系统 typical discrete EMI/transient suppression systems

图 1 中的方框图(block diagram)展示了瞬态电压抑制和电磁干扰滤波离散系统的基础。设计系统的每个部分必须符合不同标准的特殊要求。图 2 展示了图 1 中的功能块是如何在典型电源系统中工作的。瞬态电压抑制功能采用一线性调节功能，这种线性调节功能在输入电压超过某特定值时，会切入电路。当线性调节器(linear regulator)工作时，瞬态电压抑制电路的输出被钳制在某一特定值，输入电压和钳制电压之间的差额在线性调节器的系列传递组件的传输中会减小。

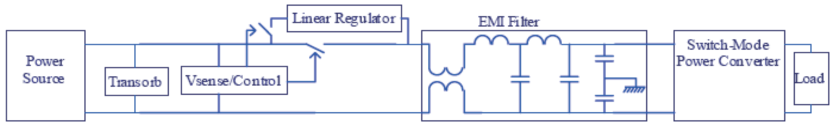


图 2、瞬态保护和离散电磁干扰滤波器结构图

源极电源是假设为恒值，线性调节器的电耗散可能很高 阻挡输入瞬态电压的持续时间因而被限制，为了保证瞬态保护模块的安全，必须限制电压的输入时间和振幅，或停止负载。对瞬态电压的特定要求会决定瞬态线性调节器的型号和电力功率等级。

瞬态电压保护电路前端的吸收组件(transorb elements)保护电路免于短时、有限能量尖峰的破坏。吸收电压必须够低，从而充分避免因高压尖峰所引起的破坏，但不允许太低以至于长时处于过压状态导致吸收组件自身受到损坏。

电磁干扰滤波器一般由几个电感电容阶段(LC)构成，同时还包括连接每个电轨(rail)和底盘地面(chassis ground)的电容。LC 各阶段提供差模滤波，而输入共模阻塞门(input common mode choke)和输出共模电容(output common mode capacitors)决定滤波器共模滤波的性能。瞬态保护电路放置在电磁干扰滤波器的前端，电磁干扰滤波器各部件可避免受到输入瞬态尖峰和浪涌的影响，同时电磁干扰滤波器可设计成过滤特定负载的要求。

六、电磁兼容/瞬态电压抑制设计方案

(一) 为设计所用之处计划

抑制电磁干扰和瞬态电压系统设计成功的关键因素之一是从一开始就对产品的最终市场特殊要求进行计划，譬如，针对美国市场所作的设计与针对欧洲或亚洲市场所作的设计采用的方法不同。由于电磁干扰和瞬态电压标准大部分具相似性（而且许多方面近乎相同)，所以直接为目标市场的规格服务是最佳途径。然而，同样得注意军事市场方面商业市场的不同之处在于，特殊规格标准通常是留给项目管理团队处理。这增加了另一个水平的难度，举个例子，某些方案要求电路必须通过特定浪涌电压。而在相似输入条件下，其它方案允许设备关闭再恢复。设计者必须在设计过程早期确知这些特定的运行要求。

(二) 了解电磁干扰和瞬态电压测试如何进行

各样的电磁干扰和瞬态电压标准的主要功能之一就是建立能够度量和描述电磁干扰性能的普遍技术。这些标准必须使相同电磁干扰特性能够在不同的测试研发室中得到相同结果。然而，虽然测试环境设计成仿真实际安装环境，通常测试结果与实地结果的相关性仍难以确定。

电磁兼容设计更复杂的难题在于不是所有的标准都按相同的方式测量同一特征。例如，MIL-STD-461C利用电流探针(current probe) 测量输入传导发射并且用dBuA规定发射量，而MIL-STD-461E采用输入线路阻抗稳网络（LISN）并且以dbuV测量噪声。另一方面，像461C DEF-STAN 59-41采用电流探针并且以dBuA说明发射量，同时还采用与461E一样的输入线路阻抗稳网络。因此，规定发射量的测试方法必要明确说明。

(三) 按所需拟定包装方案

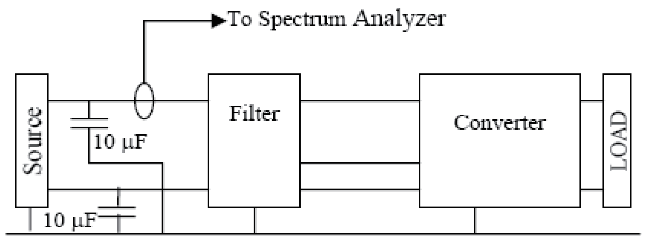
为满足全世界各代理所提出的各种各样关于电磁兼容和瞬态电压抑制的要求，需要付诸相当大的工作量。这种滤波器设计任务常常通过离散滤波器的使用以及其独一无二的设计方案来实现。然而，与特定电源转换器配套使用的包装滤波器方案可以大大减少系统兼容的时间。此外，包装滤波器的方案可以单路组件(single unit)实现，从而减少零件数目和简化认证进程。包装方案的性能通常可提前决定，这可以增加特定方案在特殊应用中的可信赖性。图3和图4展示了VPT的DVMN电磁干扰滤波器/瞬态电压抑制模块的传导电磁干扰和瞬态电压性能。这种类型的数据一般可从模块销售商处获得。此外，应用手册和应用特定数据，(也可从模块销售商处获得)，可用来辅助特殊情况下对于包装滤波器模块的使用，(这些特殊情况并未在标准数据单表中列出)。

七、结论

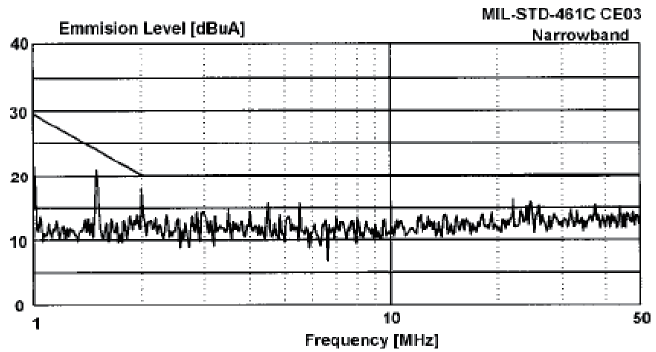
军事系统中所需的电磁干扰滤波和瞬态电压抑制必须保证：

1. 各种各样的电气零件不可产生额外的电气干扰影响其它设备。
2. 附于电源总线的所有部件可以容忍电源总线干扰且在此典型的干扰方式中操作运行。

几套不同的电磁干扰和电压瞬态规格,建立多年以来说明许多需求。在一些情况下，各种的组织的标准非常相似，而在另外一些情况下它们是差异颇大的，它们的差异要么在测试设备兼容性的方法上，要么在干扰信号的实际电平上。满足多标准规格的方案可使得硬件应用于全世界各种区域。然而，设计者必须意识到在某些应用中，一个满足多种不同规格要求的设计通常是过度设计（因此这种设计会更昂贵，更庞大，更笨重)。因此有必要在系统的全部性能作取舍，以符合特定应用以及进度的要求。为负载转换器配套的包装电磁干扰/瞬态抑制模块在解决一些冲突需求上占重要的优势: 有助迅速的系统研制，广泛的最终用途和高效的包装等。



MIL-STD-461 传导发射



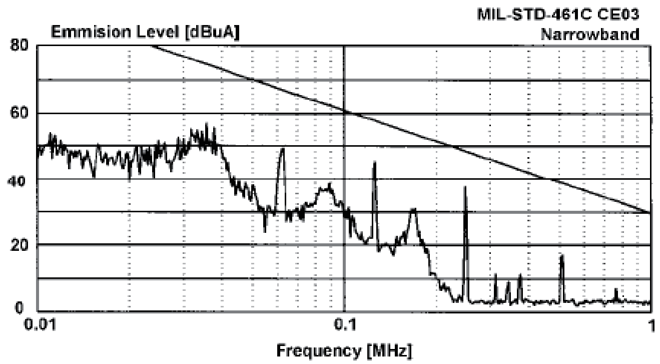
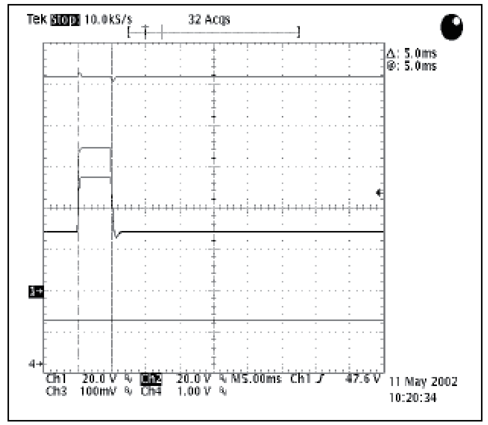


图 3、MIL-STD-461C DV200-2812D with DVMN28 EMI 滤波器

Input Transient: 70V/5mS/0.5 ohm source/Full Load



Input Transient: 600V/10uS/Full Power

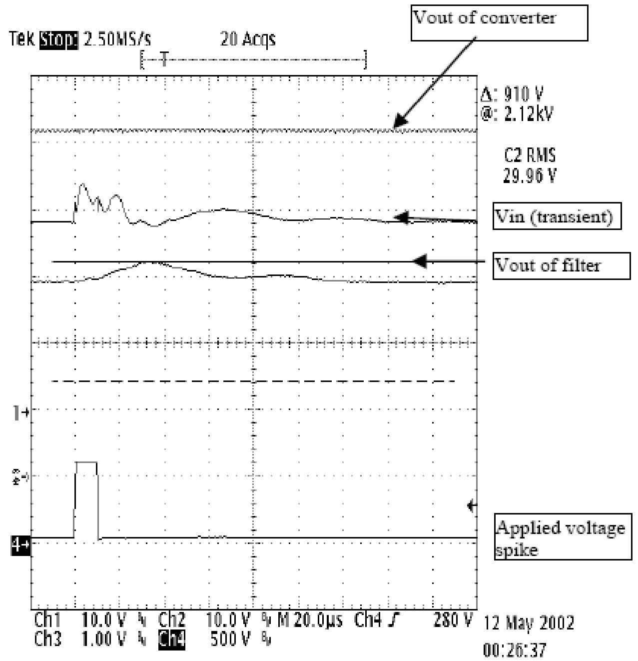


图 4、DV200-2812D 转换器的包装 DVMN28 EMI Filter/瞬态抑制模块

Thermal Considerations for Hybrid DC-DC Power Converters

Sam Wood and Steve Butler, VPT Inc

INTRODUCTION

Hybrid DC-DC converters such as VPT's DV Series are usually rated for the full military temperature range of -55ºC to +125ºC and can be operated at full rated power within that range as long as the power dissipation and temperature rise is properly addressed. DC-DC power converters always have an efficiency less than 100% and therefore always waste a percentage of their input power. This wasted power is dissipated as heat and will cause the temperature of the DC-DC converter to rise above the ambient system temperature. The temperature rise of the DC-DC converter must be considered during the system mechanical and thermal design to ensure the converter does not exceed its maximum rated operating temperature.

CHARACTERISTICS OF HYBRID PACKAGING

Hybrid packaging technology uses thick film conductors, bare semiconductor die and high thermal conductivity materials to achieve high temperature operation. A diagram of the typical hybrid package is shown in Figure 1. In its basic form, the bare silicon die is mounted to a ceramic substrate, usually Al_2O_3 (alumina), which is mounted to the metal package, usually steel or Kovar. Power is dissipated in the semiconductor die, which may be an IC, power transistor, or power rectifier. The die has a maximum semiconductor junction operating temperature, typically 150ºC or 175ºC, as specified by the manufacturer.

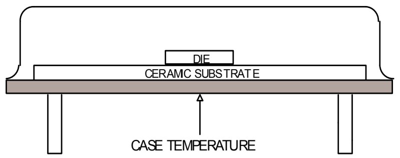


Figure 1. Internal Hybrid Construction

The semiconductor junction temperature inside the hybrid, Tj, is determined by the following formula:

$$Tj = Tcase + \Delta T \quad (1)$$

$$\Delta T = Pd \cdot \theta jc \quad (2)$$

Tcase is the case temperature of the hybrid; ΔT is the temperature rise from junction to case; Pd is the power dissipated in the die; and θjc is the thermal resistance from the junction to the case. θjc is the sum of

any intermediary thermal resistances, in this case the ceramic substrate, the attachment materials, and the case itself.

THERMAL RESISTANCE CALCULATION

The thermal resistance θ for any material can be calculated according to the formula:

$$\theta = \frac{x}{K \cdot A} \quad (3)$$

where A is the cross sectional area normal to the direction of the heat flow, x is the distance that the heat travels, and K is the thermal conductivity of the material. For example a 0.5" tall aluminum heat spreader with dimensions 3" x 1.5" which could be used under a side leaded hybrid package has a thermal resistance of:

$$\theta = \frac{0.5in}{3.957\frac{W}{in-C}\cdot 3.0in \cdot 1.5in} = 0.028\frac{°C}{W} \quad (4)$$

The thermal conductivity of aluminum is 3.957W/in-C. From (2), each Watt of power dissipated through this aluminum block causes a temperature rise across the block of 0.028°C.

DC-DC CONVERTER APPLICATION

From Figure 1, it is apparent that the thermal path of the hybrid is entirely through the bottom of the package. The operating temperature is specified, and must be measured, on the bottom surface of the case. The lid offers very little path for heat transfer. Any temperatures measured on the lid will give inaccurate results and any heatsinking added to the lid will have only minimal effect. The system thermal design must allow for the primary thermal path through the bottom of the package.

The case temperature will always be slightly higher than the heatsink or ambient temperature due to the power dissipated in the hybrid and the thermal resistance of the assembly. Case temperature cannot be assumed to be equal to the heatsink or ambient temperature. This wrong assumption is the cause of many system thermal problems. Proper system design will allow high system temperatures, in excess of 100ºC, yet maintain hybrid component temperatures well below 12ºC.

If the case of the hybrid is maintained below +125ºC, the internal semiconductor junction temperatures will remain at safe levels, typically between 130º and 140ºC, well below their maximum ratings. If the output power of the hybrid is reduced, it is possible that the maximum allowable case temperature can be increased further without increasing the internal junction temperatures. Consult the hybrid manufacturer for details.

Although hybrid DC-DC converters can be operated up to +125ºC, reliability can be increased by operating them at a lower case temperature. Every electronic component has a failure rate which is in theory related to its operating temperature. Lowering the operating temperature of the hybrid by 5°C can result in a 10-20% increase in MTBF according to MIL-HDBK-217 type calculations. In general the system design should attempt to reduce thermal resistances and minimize the temperature rise between the DC-DC converter and the system ambient. For maximum reliability, the DC-DC converter should be operated as close as possible to the ambient temperature rather than near its maximum operating temperature.

CONSIDERATIONS FOR PROPER MOUNTING

DV series DC-DC converters are typically used in applications where the dominant mode of heat transfer is conduction. Any radiation or convection cooling is usually neglected in the thermal analysis. Lower power or high efficiency hybrids can often be mounted without a heatsink or rely on the PCB for heatsinking. On the other hand, higher power hybrids will usually require a low thermal resistance connection to a substantial heatsink, such as a system chassis.

Aluminum is typically used for a heatsink or heatspreader material, since it has high thermal conductivity, low weight and is easily machined. A thermally conductive gap filler material should be used between the mounting surface of the hybrid and the heatsink. This gap filler is typically a thermal pad, thermal grease, or adhesive. It will fill any surface irregularities and decrease the thermal resistance of the interface. Materials are available from various manufacturers with various properties: thickness, hardness, dielectric breakdown, adhesive, outgassing, etc.

The DC-DC converter should be mounted securely to the heatsink for good thermal conductivity. A flanged package, adhesive, or a mounting strap is recommended for best performance. Some gap filler materials require adequate mounting pressure to maintain good thermal performance. Solder connections to the pins are usually not sufficient if a good thermal interface is required.

DETERMINING THE CASE TEMPERATURE

The operating temperature of the hybrid should be verified by both analysis and measurement. For design purposes the operating temperature can be calculated using computerized finite element analysis methods or a simple thermal resistance model. A thermocouple mounted on the baseplate of the hybrid in the actual system is a good method of verification but usually must wait until late in the development cycle. Basic thermal resistance calculations, although approximate, are a good design tool early in the development cycle before full system thermal models are developed.

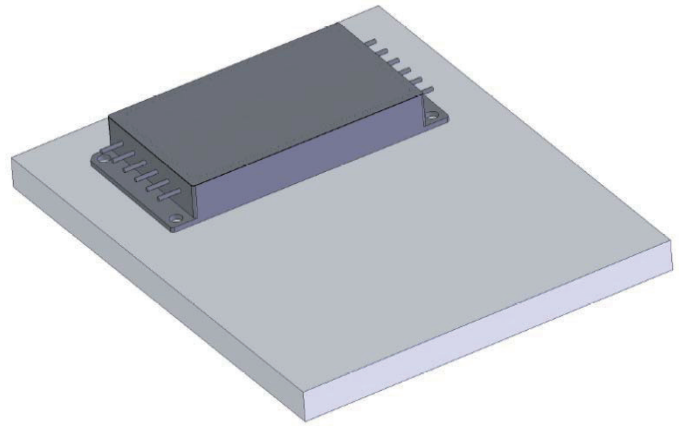


Figure 2. Hybrid DC-DC Converter Mounted to a Metal Heat Spreader.

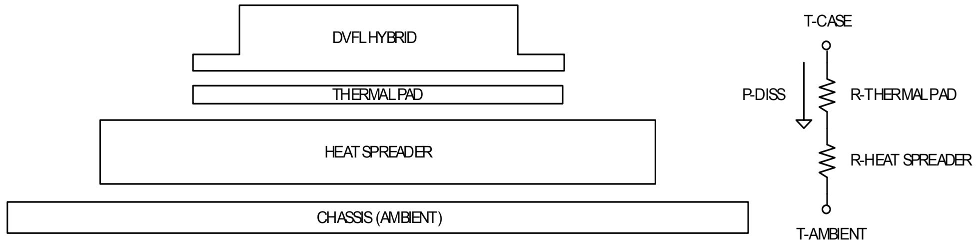


Figure 3. Mechanical Stackup and Thermal Resistance Model for DVFL.

Figure 2 shows a side-leaded power hybrid mounted directly to a heatspreader. Figure 3 shows the mechanical stackup and equivalent thermal resistance model, assuming the heatspreader is mounted to a chassis with a known ambient temperature.

The case temperature of the hybrid is calculated similarly to (1) and (2):

$$T_{case} = T_{amb} + P_d \cdot \sum\theta \quad (5)$$

Tamb is the known ambient temperature of the system chassis. Pd is the total power dissipation of the hybrid. It can be calculated from the output power and efficiency of the hybrid. The efficiency can be measured or read from the datasheet. The total thermal resistance $\sum\theta$ is the sum of the all intermediate thermal resistances from the hybrid to the ambient, in this case the thermal pad and the heat spreader. The thermal resistance of the thermal pad can be read from the manufacturers datasheet. The thermal resistance of the heatsink can be obtained from its manufacturer or calculated according to equation (3).

The power dissipated internal to the hybrid can be assumed to be spread evenly across its baseplate, so the area in (3) would be the area of the hybrid baseplate, not the entire area of the heat spreader. If the heatsink is unusual or nonrectangular in shape, its thermal resistance can be approximated by breaking it up into rectangular blocks which are in series with respect to the heat flow. The thermal resistance of each block can be calculated individually and summed to obtain the total thermal resistance.

For this example: the ambient temperature is 70ºC; the power dissipated for the DVFL2815S hybrid DC-DC converter at 28V input; full load is 30W; the thermal resistance of the thermal pad TP-001 is 0.06°C/W. The aluminum heat spreader is 0.5” thick. From (4) the thermal resistance of the heat spreader is 0.028°C/W and from (5) the case temperature of the DVFL hybrid is:

$$Tcase = 70C + 30W \cdot (0.06C/W + 0.028C/W) = 72.64C \qquad (6)$$

This configuration with the hybrid mounted directly to a heatsink will usually result in the lowest possible operating case temperature. It can be applied to down-leaded type packages by adding clearance holes in the heatsink for electrical connections to the pins.

“DEADBUG” STYLE MOUNTING

Figure 4 shows an example of “deadbug” style mounting for a power hybrid with a flanged package. This is a common mounting configuration for severe vibration environments. Electrical connections to the pins can be made with discrete wires or a flexible or rigid printed circuit board.

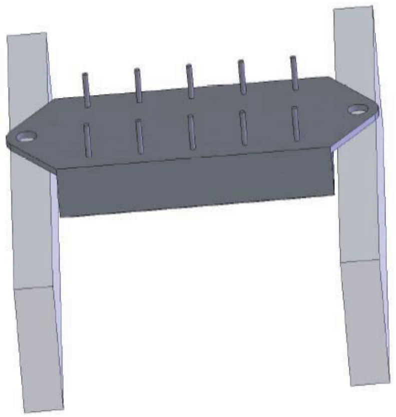


Figure 4. “Deadbug” Style Mounting for Downleaded Flanged Units.

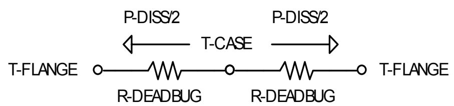


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Figure 5. “Deadbug” Thermal Model.

In this case, heat is transferred only through the mounting flanges. The maximum temperature is assumed to be in the center of the hybrid and there is an additional thermal resistance and temperature rise from the center to the mounting flange. For this configuration since power is dissipated across the surface of the baseplate, finite element methods can be used to obtain an effective thermal resistance, R-deadbug, from the center of the package to the flange, as shown in Figure 6. This effective thermal resistance will give a valid hot spot case temperature when used in conjunction with the total power dissipation of the hybrid. This effective thermal resistance can be obtained from the manufacturer. For reference, R-deadbug = 6°C/W for VPT’s DVTR flanged package.

The hot spot temperature in the center of the hybrid is given by (7) where each flange is held at the same temperature, T_{flange}. The power dissipated, P_d is divided by 2 since there are two parallel thermal paths, one to each flange.

$$T_{case} = T_{flange} + \frac{P_d}{2} \cdot \theta_{deadbug} \qquad (7)$$

The “deadbug” mounting method will usually result in higher case temperatures than the direct heatsink configuration of Figure 2.

“DEADBUG” STYLE MOUNTING WITH HEAT SPREADER

For applications with high power dissipation or high ambient temperature, the case temperature of the hybrid can be lowered by adding a heat spreader to the basic “deadbug” mounting configuration, as shown in Figure 6. The heat spreader should have a thermal conductivity greater than that of the hybrid package. For example, for a cold rolled steel package, an aluminum heat spreader could be used with a thickness twice the thickness of the hybrid package. To be effective, the spreader must clear the electrical pins and maintain thermal contact along its entire length; a thermally conductive adhesive is recommended.

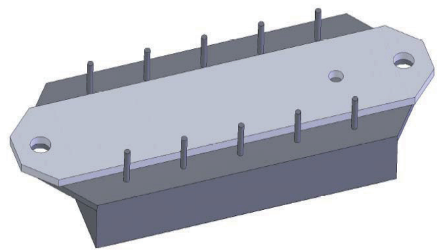

Figure 6. Heat Spreader Attached to Baseplate to Reduce Thermal Resistance.

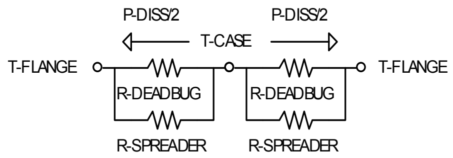

Figure 7. Thermal Model for "Deadbug" Mounting with Heat Spreader.

Again using finite element methods, an approximate thermal resistance model can be derived for this configuration. The thermal resistance of the heat spreader can be assumed to be in parallel with the effective thermal resistance of the package with an additional factor of 2. This additional factor was derived through finite element modeling to account for the fact that heat is actually transferred to the heat spreader along its entire length, instead of simply at the center of the hybrid. The thermal resistance of the spreader is calculated from (3) for heat flow along its length, where *x* is the distance from the center of the package to the center of the flange. Using the formula for parallel resistors, the case temperature of the hybrid would be:

$$T_{case} = T_{flange} + \frac{P_d}{2} \cdot \frac{1}{\frac{1}{\theta_{deadbug}} + \frac{1}{\theta_{spreader}/2}} \tag{8}$$

Note that θ-spreader is divided by 2 as mentioned above. It is apparent that this configuration with the heat spreader (8) will always result in a lower temperature case temperature than the previous configuration without the heat spreader (7). The thermal resistance of the heat spreader must be low enough to have a significant impact; it must be made of a high thermal conductivity material and have adequate size.

PCB MOUNTING

Lower power hybrids can often be mounted directly to the circuit board or PCB as shown in Figure 8. Good thermal contact should be maintained between the hybrid and the board. An adhesive is often used. Mounting flanges or a mounting strap across the top of the hybrid can also help maintain good thermal contact. The thermal resistance of the PCB should be calculated lengthwise through the PCB material from the center of the hybrid to the mounting locations of the PCB using (3). The case temperature can be calculated from (5). Typical PCB materials are not good thermal conductors. Copper planes are often employed to improve thermal conductivity along the length of the PCB. Likewise, thermal vias are used to improve thermal conductivity through the PCB, usually under the hybrid or at the board mounting locations.

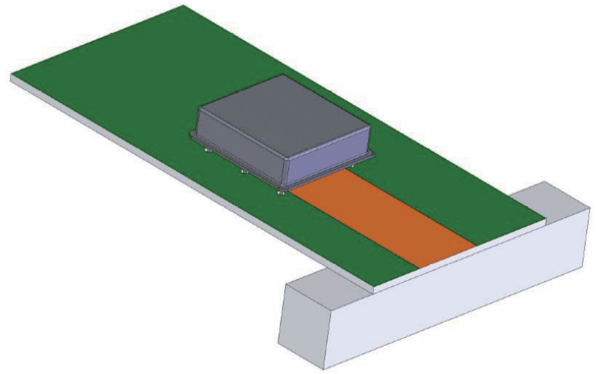

Figure 8. Small Hybrid Mounted to a Circuit Board.

PCB MOUNTING WITH HEAT SPREADER

When the PCB alone is not sufficient to carry heat away from the hybrid, a heat spreader can be added to the assembly as shown in Figure 9. In this case, the thermal path through the PCB can usually be ignored and the case temperature of the hybrid can be calculated directly from (5). Additionally, intentionally isolating the thermal spreader and hybrid from the PCB can serve to lower the temperature of the PCB and surrounding components.

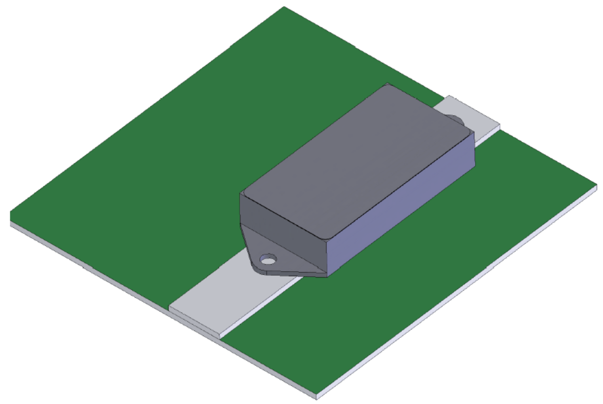

Figure 9. Converter/Heat Spreader/PCB Assembly.

Another option is to cut a hole in the PCB, allowing a heat spreader to protrude up and make contact with the base of the hybrid. The mechanical mounting should again be sufficient to ensure good thermal contact between the hybrid and the heat spreader.

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CONCLUSION

Proper system thermal design is necessary to allow hybrid DC-DC converters to operate reliably over the full military temperature range. To ensure maximum ratings are not exceeded, it must be recognized that the hybrid operating temperature will be greater than the ambient or heatsink temperature. The hybrid operating temperature is specified at the bottom center of the baseplate. It can be determined either by analysis or measurement. Knowing the actual temperature will allow accurate reliability calculations and proper tradeoffs between design complexity and reliability.

ADDITIONAL INFORMATION

For additional information on designing power systems for low voltage applications or VPT products, contact VPT:

Phone 425.353.3010
E-mail: vptsales@vpt.com.
Web: www.vpt-inc.com.

混合式直流-直流电源转换器的散热设计

斯蒂芬.巴特勒 (Steve Butler) VPT 工程部副总裁
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引言

混合式 DC-DC 转换器，如 VPT DV 系列产品通常被定级在整个军事级温度范围-55℃到+125℃，只要功率耗散和温升被合理地设定，转换器就可以在这个温度范围内以全额功率运行。DC-DC 电源转换器的效率永远低于 100%，因此输入功率总有一定比例的浪费。这些被浪费的功率以热量的形式流失，同时会导致 DC-DC 转换器的温度上升而高于周围系统温度。在系统机械和散热设计时必须考虑 DC-DC 转换器的温升以保证转换器不会超过最大额定工作温度。

混合式封装的特征

混合式封装(hybrid packaging)技术采用厚膜导体(thick film conductors)，裸半导体压膜(bare semiconductor die)和高热导材料(high thermal conductivity materials)实现高温运行。典型混合式封装如图 1 所示。在它的基本结构中，裸露硅压膜(bare silicon die) 被固定在一个陶瓷基板(ceramic substrate)上，一般是氧化铝 Al_2O_3 (Alumina)，这个基板则被固定在金属基材上，通常是钢铁或铁镍钴合金.功率在半导体压膜处耗散，半导体压膜可能是集成电路（IC），功率晶体管(power transitor) 或者功率整流管(power rectifier)。压膜具有一个最大的半导体结点工作温度(junction operating temperature)，典型温度为 150℃或 175℃，如制造商所列。

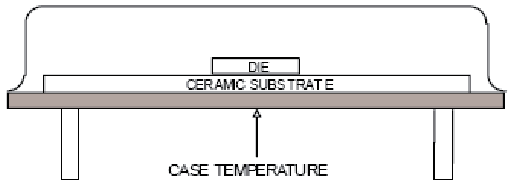

图1：内部混合式结构

混合结构中的半导体结点工作温度(结温) T_j 由下面公式确定：

$$T_j = T_{case} + \Delta T \ \mathrm{L\ L}\ (1)$$

$$\Delta T = P_d + \theta_{jc} \mathrm{L\ L}\ (2)$$

T_{case} 是混合转换器的底壳温度；ΔT 是结点到底壳的温升；P_d 是压膜处的功率耗散；θ_{jc} 是从结点到底壳的热阻。θ_{jc} 是所有中间热阻的总和，包括陶瓷基片，附属材料和底壳本身。

热阻(Thermal resistance)的计算

任何材料的热阻 θ 可以根据以下公式计算：

$$\theta = \frac{x}{K \cdot A} \text{L L} \ (3)$$

A 是垂直于热流方向的横截面面积，x 是热流传导的距离，K 是材料的热导率。举个例子，一个高 $0.5''$，尺寸为 $3'' \times 1.5''$ 的铝散热器，可用于一个侧边引线混合封装(side leaded hybrid package)下，其热阻：

$$\theta = \frac{0.5in}{3.957\frac{W}{in-c} \cdot 3.0in \cdot 1.5in} = 0.028\frac{^{\circ}C}{W} \text{L L} \ (4)$$

铝的热导率为 $3.957W/in-C$。根据（2）式，通过这个铝方块的功率耗散的每一瓦都会产生 0.028 ℃的温升。

DC-DC 转换器的应用

根据图 1，显而易见，混合器件的散热路径全部通过包装的底部。特定工作温度必须在管壳的底层表面测量。盖子提供非常小的热量传递路径。任何在盖子上测量得到的温度都具有不精确的结果，任何加在盖子上的散热器都具有很小的影响。因此，系统散热设计必须考虑使用包装底壳为主散热路径。

由于转换器的功耗和配件的热阻，管壳温度总是稍高于散热器温度或环境温度。管壳温度不可以被假定与散热器温度或环境温度相等。这种错误的假定是产生许多系统散热问题的根源。合理的系统设计应容许高的系统温度，甚至超过 100℃，但保持混合转换器的组件(component)温度低于125℃。

如果混合式转换器的管壳保持低于+125℃，则内部半导体结温会处在安全级别内，一般在 130℃和140℃之间，仍低于它们的最大额定值。如果混合器件的输出功率减少，那么管壳的耐温极限可能可以增加，但内部结温无增加。细节问题请咨询混合式转换器制造商。

尽管混合式 DC-DC 转换器可在高达+125℃的温度条件下工作，但是可靠性可在较低壳温下运行转换器而提高。每个电子组件都有故障率(failure rate)，这个故障率从理论上来讲与它的工作温度有关。根据 MIL-HDBK-217 的分布式计算，每降低混合组件的工作温度 5℃会增加平均故障间隔时间 10%~20%。一般来说，系统设计要尽量降低热阻和最小化 DC-DC 转换器和系统环境之间的温升。

合理的安装

DV 系列 DC-DC 转换器一般使用于传热的主要方式为传导(conduction)。散热分析过程中辐射(radiation)或对流冷却(convection cooling)常被忽略。低功率耗散或高效率的混合转换器通常是无散热器的安装,并且依赖电路板来散热。另一方面，较高功率混合组件一般需有低热阻连接到主散热器，如系统底盘。

铝是典型的用于热沉(散热器, Heatsink)或均热片 (Heatspreader)的材料，因其具有高热导率，轻重量以及易于加工的特点。在混合转换器和热沉的安装界面处可用耐热传导性的空隙填充物。这种空隙填充物一般是一个散热焊盘，散热润滑脂或黏合剂。它可以填充界面处的任何不规则空隙，并且降低交界面的的热阻。这些材料与参数可从许多制造商处获得，参数包括：厚度，硬度，介质击穿(dielectric breakdown)，黏合剂，释气量 (outgassing) 等等。

为保证良好的热传导率，DC-DC 转换器应牢固地安装在热沉上。我们推荐法兰盘封装(flanged package)，黏合剂或固定夹带 (mounting strap) 的方式来达到最好的性能。一些空隙填充物材料要求有足够的安装压力(mounting pressure)以保持良好的散热性能。如果要求一个良好的散热界面，仅有与管脚的焊接通常是不够的。

确定管壳温度

混合转换器的工作温度必须通过分析和测量来验证。对于设计目的而言，工作温度可以利用有限元分析(finite element analysis)计算方法或一个简单的热阻模型来计算。实际系统中，安装在混合器件底板上的热电偶(thermalcouple)，是一个测量的好方法但一般必须等到研发周期的晚期。在整个系统散热模型研制完成之前，初步的热阻计算，虽然是大致估计，但不失为研发早期的一个好的设计工具。

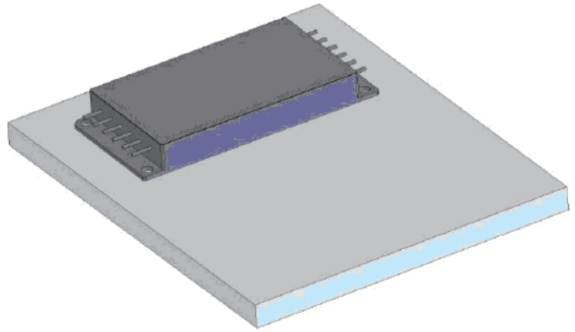

图2：安装在金属散热器上的混合式DC-DC转换器

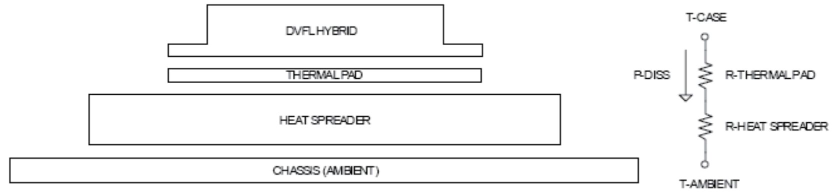

图3：DVFL的机械层和热阻模型

图 2 展示了一个直接固定在一个均热片上的侧边引线型的电源混合组件。图 3 展示了机械层以及对应的热阻模型，假定均热片是安装在一个室温已知的底盘上。

混合器管壳温度的计算与公式（1）、公式（2）相似：

$$T_{case} = T_{amb} + P_d \cdot \sum \theta \text{L L} \ (5)$$

T_{amb} 是已知的系统底盘的环境温度。P_d 是混合器的总功耗。它可由混合器的输出功率和效率计算出。效率可以测量或在数据手册中读到。总热阻 $\sum \theta$ 是从混合器到环境的所有中间的热阻的总和，在这个器件中包括散热焊盘(thermal pad) 和均热片。散热焊盘的热阻可从制造商的数据手册中读到。均热片的热阻可从它的制造商处获得或者根据方程式(3)计算出。

混合器内部耗散的功率可假设为沿着底盘均匀扩散，所以公式（3）中的面积应该是混合器底盘的面积，而不是均热片的整个面积。如果散热器的形状是奇特或者非矩形的，那么它的热阻可以矩形块来近似估计，这些矩形块是与热流成串联(in series)。每块的热阻可分别计算出，最后求和得到总热阻。

例如：环境温度是 70℃；DFL2815S 混合式 DC-DC 转换器输入电压 28V；满载时 30W；散热焊盘 TPO-01 的热阻 0.06℃/W。铝散热器厚 0.5*。根据公式（4）散热器的热阻是 0.028℃/W，根据公式（5）DVPL 的管壳温度为：

$$T_{case} = 70^{\circ}C + 30W \cdot (0.06^{\circ}C/W + 0.028^{\circ}C/W) = 72.64^{\circ}C \cdots\cdots (6)$$

这种混合组转换器直接安装在散热器上的结构通常会使得运行时的管壳温度尽可能最低。这同样适用于底部引线型封装(down-leaded type package)，只要散热器钻有转换器管脚的导电插孔

“四脚朝天式安装(“DEADBUG” style mounting)

图 4 展示了一个具有法兰盘的电源混合器的"四脚朝天式"(“deadbug”)安装的例子。这是一种普遍用于严重振荡环境下的安装结构。管脚的电气连接可通过离散布线或者一个灵活或坚硬的印刷电路板来实现。

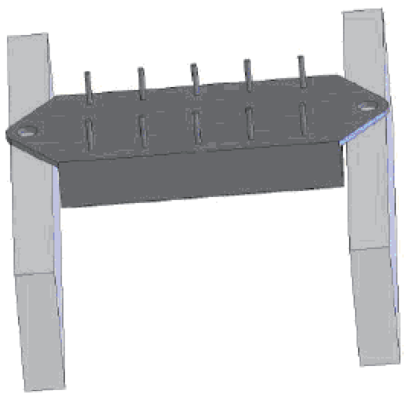

图4：底部引线式带法兰盘组件的“DEADBUG”式安装

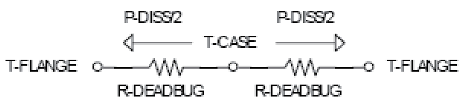

图5：“DEADBUG”散热模型

在这个组件中，热量只通过法兰盘传递。最大温度是假定在混合器的中心处，从中心到法兰盘有一个附加的热阻和温升。对于这种结构，因为功率沿着底盘的表面耗散，所以利用有限元方法从封装的中心处到法兰盘可获得一个有效的热阻值，R-deadbug 值，如图 6 所示。当与混合器件的总功耗共同作用时，这个有效热阻就会产生一个有效热点管壳温度。有效热阻值(effective thermal resistance)可从制造商处获得。VPT 法兰盘封装的 DVTR 可供参考的 R-deadbug=6℃/W。

当每个法兰盘保持在相同温度 T_{flange} 时，组件中心处的热点温度由公式（7）给出。由于存在两路并联的散热途径，每个法兰盘是一路，所以功耗 P_d 除以 2。

$$T_{case} = T_{flange} + \frac{P_d}{2} \cdot \theta_{deadbug} \cdots\cdots (7)$$

“朝天式”安装法通常得到管壳温度比图 2 的散热器直接配置法得到的管壳温度更高。

均热片(Heat Spreader)的”朝天式”(“DEADBUG”)安装

对于那些大功耗或高环境温度的应用场合，添加一个均热片到“朝天式”混合器的基部可降低组件的管壳温度，如图 6 所示。均热片的热导率必须好于组件封装的热传导率。例如，对于冷轧钢封装，铝散热器的厚度是组件封装的厚度的两倍。为达到更好的效果，均热片与电气管脚须保持距离以确保热力接点沿着整个混合器的长度，这里推荐使用具有导热性的黏合剂。

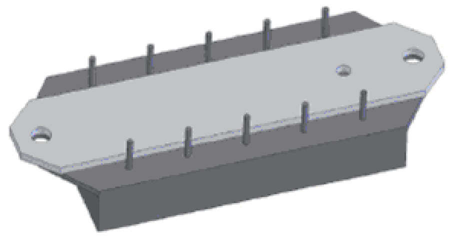

图6：用来减少热阻的附于底盘的散热器

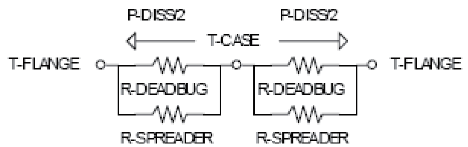

图7：带散热器“Deadbug”安装的散热模型

再次利用有限元方法，我们可推导出这个结构的近似热阻模型。此时均热片的热阻是与封装的 2 倍有效热阻并联。2 倍附加率是通过有限元建模获得，因为热量是实际上沿散均热片的总长传热，而不是简单传递到组件的中心处。均热片的热阻可根据公式（3）计算出，这里的 x 是沿封装的中心到法兰盘的中心。利用并联电阻的计算公式，组件的管壳温度为：

$$T_{case} = T_{flange} + \frac{P_d}{2} \cdot \frac{1}{\frac{1}{\theta_{deadbug}} + \frac{1}{\theta_{spreader}/2}} \cdots\cdots (8)$$

注意上式中的 $\theta_{spreader}$ 要除以 2。显而易见，均热片的结构导致管壳温度(见式 8)低于上述不带散热器的结构所产生的管壳温度(见式 7)。均热片的热阻必须保证足够低以确保显着的效果，同时热阻必须是由高热导率材料制成，且型号大小适当。

安装印刷电路板（PCB）

较低功率的混合器一般是直接被安装到电路板或印刷电路板（PCB）上，如图 8 所示。良好的热力接点保持在混合器和电路板之间，这里经常要用到黏合剂。混合器的法兰盘或固定夹也能帮助良好的热力接点。利用公式（3），电路板的热阻可从混合器中心的 PCB 材料测到电路板的安装位置，计算得出。管壳温度可根据公式（5）推导出。典型的 PCB 材料并不是良好的热导体。沿 PCB 板长度的铜板则被经常用来提高热导率(thermal conductivity)。同样，散热通孔(thermal vias)被用来提高电路板的热导率，一般是在混合器下方或电路板的安装位置。

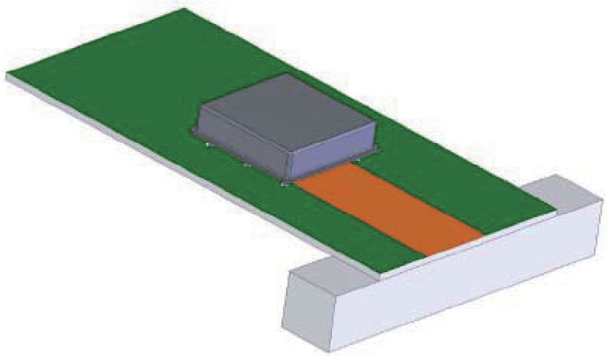

图8:安装在电路板上的小组件

PCB 上安装均热片

当单个印刷电路板不足以带走来自混合器的热量，那么就需要添加一个均热片到这个组装上，如图 9 所示。在这个情况下， 印刷电路板的散热途径常常可以忽略不计而混合器的管壳温度可直接根据公式（5）计算得出。此外，有意地将散热器、混合器与印刷电路板隔离有助降低印刷电路板和周围零件的温度。

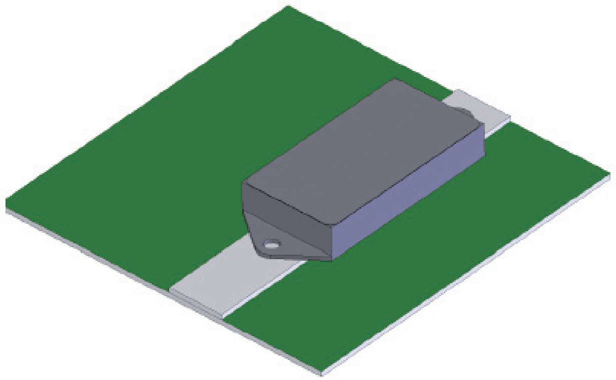

图9：转换器/散热器/PCB板装配

另一个选择就是在印刷电路板穿孔，允许均热片突出且与混合器的基部接触。再者，机械安装必须充分保证混合器和均热片之间良好的热力接触。

结论

合理的系统散热设计对于保证混合式 DC-DC 转换器在军事级范围内可靠性工作必不可少。为保证不超过温度等级，必须知道转换器的工作温度会大于环境温度或散热器温度。转换器的工作温度以在底盘中心为准，可由分析或测量来确定。了解实际温度有助于计算精确的可靠性, 而且可在设计复杂性和可靠性之间作取舍。