



APPLICATION NOTE

VPT Series DC-DC Converters and
Power Accessory Modules

DC-DC CONVERTERS AND ACCESSORIES



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Introduction

Military and other high reliability system designers are under continual pressure to reduce costs and development times. Following the DoD's "COTS Directive," one of the primary methods of achieving these goals is to forego military standards and specifications, and instead use the best available commercial practices, standards, components, and hardware. COTS or "commercial off the shelf" hardware can offer the latest technology, is readily available, minimizes system development cycles, and reduces acquisition costs. These benefits are sensible, as long as the pitfalls can be avoided. The challenge is taking advantage of commercially available hardware without sacrificing system performance or reliability.

The VPT series of high reliability COTS DC-DC converters and EMI filters supports the need for a low-cost power solution without compromising performance and severely reducing reliability. Designed from the ground up for high reliability applications, the VPT series blends a proven design heritage and performance with low-cost components and assembly techniques in a rugged package.

Proven Design Heritage

Reducing costs is a worthwhile effort, but it should not be at the expense of system reliability or result in increased total cost of ownership. To that end, VPT series is optimized for the right blend of performance and reliability. High reliability is achieved by design. The VPT series electrical designs are based on VPT's proven MIL-PRF-38534 product line, which have been used in thousands of applications including space, aerospace, mobile, and ground. The VPT series offers similar features and performance and uses similar internal circuitry and components.

The VPT series DC-DC converters includes output power ratings of 5, 15, 30, and 100W, output voltages of 3.3, 5, 12, 15, +5, +12, and +15, all operating from a nominal 28V input. Additional modules offer EMI filtering, input transient protection, and operation over extended input voltage ranges.

Common military power bus standards such as MIL-STD-704 and MIL-STD-1275 require a wide input voltage range, and usually include voltage transients. The required low operating voltage and high transient typically exceed the capability of the typical 18 to 36V commercial telecom DC-DC module. The VPT series primarily uses flyback and forward topologies. They are simple, proven, and reliable. And they can accommodate a wide input voltage range as shown in Table 1. Continuous operation is from 15 or 16V up to 40 or 50V, and transient capability is up to 50 or 80V. This means the DC-DC converter can accommodate most input power requirements standalone. Operation down to 6V, long duration transients up to 100V, and spikes up to 600V can also be accommodated with the VPT series accessory preconditioning module, VPTPCM-12. All VPT series converters come with a dual output option and the VPT30 comes with an additional triple output voltage option.

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	Flyback	16 to 40V	50V
VPT100+	Forward	16 to 40V	50V

Table 1. DC-DC Converter Topologies

The VPT series can also simplify EMC compliance. Fixed frequency designs with internal L-C filters give low input current ripple and low output voltage ripple and noise. A standard six-sided metal package, utilized on all VPT series devices, reduces radiated emissions and susceptibility. And the companion VPT Series EMI filter modules recommendations are listed in Table 2. The filters are rated for a maximum current. Various combinations of converters, output powers, and input voltages are acceptable if the current rating of the filter is not exceeded. Multiple converters can be powered from a single filter.

System Output Power (Watts)	Recommended Filter	Rated Current (Amps)
25	VPTF1-28	1.0
75	VPTF3-28	3.0
200	VPTF10-28	10.0
400	VPTF20-28	20.0

Table 2. Filter Recommendations

The VPT series product line comes with many different power accessory modules such as power conditioning, transient suppression, and a high voltage bus converter. All the power accessory modules in the VPT series product line also work for VPT's DV series hybrid DC-DC

converters. VPTc10-28 and VPTi10-28 are input power modules with EMI filtering and voltage transient protection. Both these modules include inrush current limiting, 45dB minimum attenuation at 500kHz, and transient protection up to 600V. The VPTc10-28 meets the 202V per load dump requirement of ISO 7637-2 and DEF STAN 61-5. VPTPCM-12 is a power conditioning module that ensures a consistently smooth input power. It operates at a wide input voltage range from 9V to 40V and has transient protection up to 600V. The VPTHVM-270 is high efficiency bus converter that operates at a nominal input voltage of 270V and steps it down to 28V. VPTHVM-270 has a wide input voltage range between 180V to 350V and has current share capability up to five units.

System Output Power (Watts)	Power Accessory Modules	Rated Current (Amps)
150	VPTc10-28	10.0
200	VPTi10-28	10.0
120	VPTPCM-12	N/A
200	VPTHVM-270	N/A

Table 3. Other Power Accessory Modules

Standard features allow easy integration of VPT's DC-DC converters into any system, including a primary referenced inhibit on/off control that provides low standby power consumption. Input undervoltage lockout and output soft start eliminate peak current draw during brownout or startup conditions and provide a well-controlled startup sequence without output voltage overshoot. Output voltage trim capability allows the output to be adjusted to various nonstandard voltages; the adjustment range is usually -20% to =10%. Remote sensing for higher output power models compensate for pin, trace, or connector drop and improves output regulation. Overcurrent and short circuit protection protect the converter and adjacent components and traces in the event of a fault condition. Fixed frequency design reduces the chance of compatibility issues with RF systems. And a frequency synchronization input on some models allow synchronization to an external clock for precise control of the ripple frequency.

Lower Cost and Rugged Construction

The VPT series' unique construction joins low-cost assembly techniques and components with a rugged package design to achieve high performance and reliability. The assembly is highly automated using surface mount technology. A single multilayer printed circuit board integrates the power and control circuitry with the planar power magnetics, as shown in Figure 1. Internal components are commercial or industrial grade including chip components and plastic encapsulated semiconductors.

The single board construction reduces assembly steps, material costs, and circuit interconnects, increasing reliability for low power modules compared to multiple board designs. The integrated planar magnetics reduce complexity, eliminating flying wires, terminations, and solder joints. They also maintain a low profile and reduce leakage inductance and associated losses, increasing circuit efficiency.

The circuit board and components are coated with a urethane-based polymer coating. This coating protects the assembly against moisture, a primary cause of long-term failure in plastic microcircuits. The circuit board is then installed onto the baseplate with a filled elastomer. This elastomer, formulated for high thermal conductivity and low modulus, provides a thermal path from the circuit board to the baseplate. A second thermal path is through mounting standoffs on the baseplate. Thermal planes and thermal vias are used to conduct heat away from the semiconductor junctions. This construction enables efficient baseplate cooling and allows full power operation up to 100°C with no airflow, while maintaining component temperatures at acceptable levels.

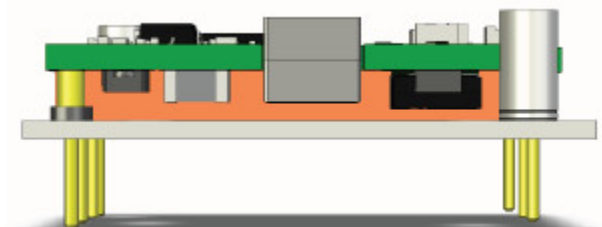


Figure 1. A filled elastomer provides a thermal path to the baseplate.

The VPT series has a wide operating temperature range suitable for most high reliability applications. The modules are rated for continuous operation from -55°C to 100°C at full rated power. 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 and any heatsinking added to the lid will have only minimal effect. The system thermal design should allow for the primary thermal path through the bottom of the package to a printed circuit board, heatsink or other heat spreader. Startup and operation down to -55°C is standard and is fully guaranteed by design.



Figure 2. All metal package simplifies EMI compliance.

A six-sided metal package provides ruggedness and effective EMI shielding. The metal lid and baseplate are mechanically and electrically connected to each other and to the internal PCB. Internal common mode capacitors provide a return path for radiated and common mode noise, reducing radiated emissions and susceptibility, and greatly simplifying EMI compliance.



Figure 3. Epoxy Encapsulated V-Shield® packaging.

Many VPT series DC-DC converters and power accessory modules are also available with the option of a fully epoxy encapsulated package instead of the original metal package. The epoxy encapsulated packaging option is compatible with aqueous cleaning processes making it water washable. This packaging come with V-Shield® technology with an integrated six-sided metalized EMI shield, for maximum EMI performance. Epoxy encapsulated packaged VPT series products have dual sided conduction cooling for flexible thermal management solutions. The epoxy encapsulated packaging is available for the VPT15 and VPT30 converters and on all VPT series EMI filters. Furthermore, this packaging option is available for the VPTPCM, VPTc10-28, and VPTi10-28.



Quality and Reliability

With the VPT series, reliability begins at the design stage, not added as an afterthought. Each internal component is selected only after being carefully evaluated for its electrical and mechanical performance over the full environmental conditions including temperature, moisture, shock, and vibration. Optoisolators, electrolytic capacitors and other limited life, high failure rate, or temperature limited parts are eliminated for use in VPT products. Reliability calculations are performed using MIL-HDBK-217. Assembly is performed in accordance with best commercial practices, specifically J-STD-001, IPC-A-610 class 3 and ISO-9001. Leaded solders are used for their proven performance in high reliability applications. With concern by system designers regarding the long-term reliability use of pure tin the VPT Series is not ROHS compliant and takes mitigation to eliminate these concerns. A high level of quality is maintained without the cost of full MIL standard compliance.

While the components and the assembly are to best commercial practices, the environmental screening and qualification are to military levels, specifically MIL-STD-810 and MIL-STD-883. The VPT series is offered in one screening level, which includes stabilization bake, temperature cycle, and 96-hour burn-in. 100% environmental screening and final electrical test is performed on every part. A rigorous qualification process includes extensive temperature cycling, accelerated (temperature humidity bias) life test, and a power cycling life test. Mechanical shock and random vibration are performed to extreme levels typical of harsh military environments.

By using low cost commercially available components and processes, adding careful component and material selection, product qualification and screening, the per unit cost is kept low, and the reliability is enhanced.



Don't Risk Your Design

Programs are often under such cost and schedule pressure, they are tempted to use the lowest cost, most readily available part, regardless of the risk. A “cheap” commercial or telecom DC-DC converter might get an engineering proof of concept up and running or might meet a cost target, but has been proven to be a poor long-term solution. It will often fail later in the design cycle, qualification, or in the field and need to be replaced at a much greater cost in time and money. The main weaknesses of commercial grade or telecom parts are: limited input voltage and transient range, limited temperature range, and limited ability to withstand severe environmental conditions, such as, temperature cycling, shock and vibration, HALT and HASS. The worst-case scenario is eventual field failures. When commercial grade products do make it into a final product design, they can be immediately subject to obsolescence issues. The typical high reliability program can take many years to go from initial design to full production, then can run for 10 to 20 years or more. The typical commercial or telecom DC-DC product may only have a 2-to-5-year lifespan or less. A system designed with commercial grade DC-DC converter products can be expected to face redesign only 3 years into production.

Right for Your Next Application

VPT has extensive experience in military, space, avionics and other high reliability applications. VPT parts have performed in thousands of applications, from the US Air Force's most critical satellites to ruggedized laptop computers, countless aircraft systems, UAVs, weapons, vehicles, ground, man portable, to almost any application imaginable. VPT is certified to MIL-PRF-38534 class K, the highest quality certification awarded by the US Defense Supply Center Columbus (DSCC). VPT is the only manufacturer to offer both full MIL-SPEC and an extensive COTS DC-DC converter solution.

Leverage VPT's hi-rel MIL-PRF-38534 expertise for your cost sensitive applications with the VPT series. The VPT series products are not up screened or repackaged commercial designs. They have been designed from the start for high reliability applications and harsh environments. VPT understands the specific requirements of military and avionics markets, provides long-term production support and technical assistance, and can accept low volume orders. For the most demanding or critical applications choose from VPT's MIL-PRF-38534 hybrid DC-DC converter product line: fully hermetic, fully qualified to MIL-PRF-38534 and MIL-STD-883, and available on standard microcircuit drawings.



Contact Information

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