New Distributed Power Architecture Gives Designers New Options for Mil-Aero Applications

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Today's commercial avionics, military and space electronics need higher performance while decreasing size, weight and cost. The power supply is a key determining factor in the final system size, weight, and thermal design.

The Right Power Architecture is Critical for Efficient Design

One way to decrease the power footprint is to move to today's updated method of distributed power architecture. Instead of having several isolated supplies to drive the loads, today's distributed architecture has one isolated converter and multiple, smaller, point of load (POL) converters. POL converters offer the advantages of smaller size, higher efficiency, and better performance than the isolated power converter method.

Many military, avionics, and space systems have a power source that is governed by MIL-STD-704. It highlights the power source limits for various conditions that include both transient and steady state limits. For example, MIL-STD-704 Rev F has transient limits for 28 VDC systems to be between 18 V and 50 V. Many applications in the military avionics systems are required to meet older revisions of MIL-STD-704 which can contain even more severe transients between 16 V and 80 V. These large input ranges, coupled with many systems having an isolation requirement, make some type of isolation stage between the source and load required.

In the past, the power users in the high reliability market have had difficulty finding power systems certified to MIL-PRF-38534 and MIL-STD-883 that also meet MIL-STD-704 for low voltage power systems with high efficiency, low weight, and satisfaction of today's strict power system specifications. Many of the systems either used multiple isolated power supplies or used one isolated supply followed by multiple linear regulators. Either method resulted in power systems that were inefficient, bulky, and expensive.

Figure 1 shows an example of using multiple isolated converters to drive each load. The main disadvantage of using multiple isolated converters is the increased system complexity. The isolation stage increases complexity, cost and size while decreasing efficiency and reliability. All of these factors make it difficult to efficiently power today's demanding low voltage power systems.

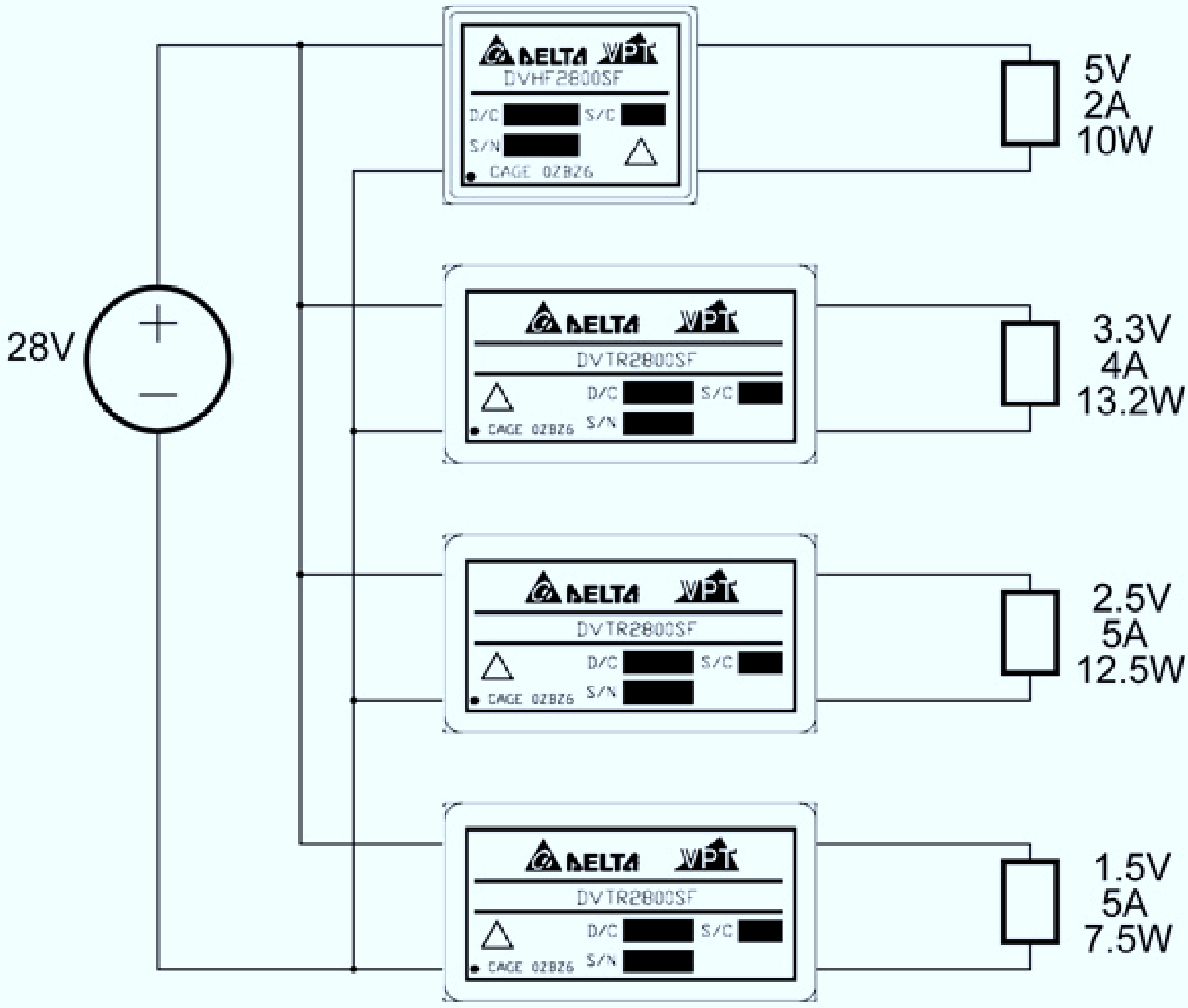

Figure 1. Isolated Approach. Total Power Loss = 21W

A More Efficient Power Solution: Point of Load DC/DC Converters
Today power supply companies, including VPT, are offering better solutions that provide a single isolation stage followed by several POLs. The isolation stage converter is optimized for low voltage systems demanding the highest levels of reliability, which operates from MIL-STD-704. The POLs are very efficient, low cost and have a very high power density. In VPT POLs, this is achieved by using a non-isolated synchronous buck converter topology. Removing the isolation reduces the complexity and allows the design to be optimized. Figure 2 shows a solution for today’s high reliability low voltage systems. In this example the power dissipated is reduced to 6.8 W, which is a reduction of 68 percent (14.2 W) over the method shown in Figure 1.

In addition to the large savings in power loss, the simplicity and tiny size of POL converters greatly reduces the size, weight and ultimately cost of a system while increasing the system’s reliability. POL DC/DC converters can be placed very close to the load, reducing load regulation errors and voltage variations during load current transients. This type of distributed power architecture results in a finished system that is not only cheaper and lighter, but also will perform much better when compared to the previous approach.

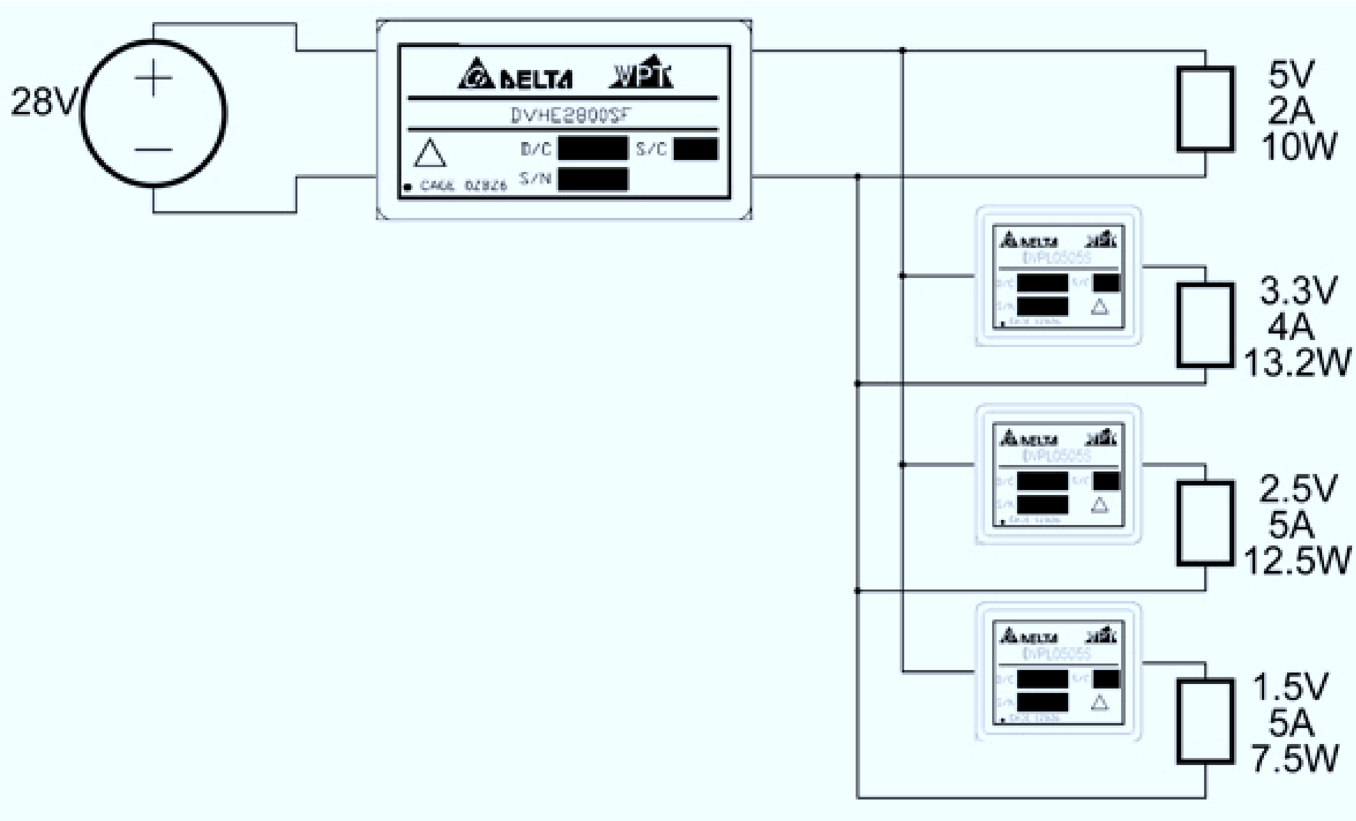

Figure 2. Point of Load Approach. Total Power Loss = 6.8W

Important Design Issues to Consider When Implementing Your System
When implementing a power architecure using POLs, look for options in flexibility and application usage. For example, if your system is intended for space, be sure to seek out a radiation hardened version. Flexibility in output voltage is crucial, and if you can, find one that can be adjusted using just a single resistor. This decreases the quantity of parts the customer must qualify when creating a new high performance power system. Additionally, it gives the designer important flexibility by eliminating the need to order a new part should the voltage requirements change.

Today's high performance digital systems also require ultra-tight regulation on the output voltage to prevent damage. Accomplish this by using a POL mounted very close to the load. This will decrease the load variation by eliminating the need for long wires or long copper traces on a circuit board. Because of their small size and light weight, it's possible to mount POLs very close to the load, which saves space by eliminating the potential requirements for large heat sinks or reinforcing structures.

Another very useful function to look for is the ability of a POL to control the timing and rate of rise and fall of the output voltage. On VPT POLs, this is done by using the "Track" pin on the DVPL0505S and DVPL0510S. The track pin allows the customer to control the rate of rise of the output voltage by placing an external signal at the track pin. Figure 3 shows this use of the track pin, which is extremely beneficial if multiple voltages are supplying the same part. The track pin is flexible and can be configured to suit your system.

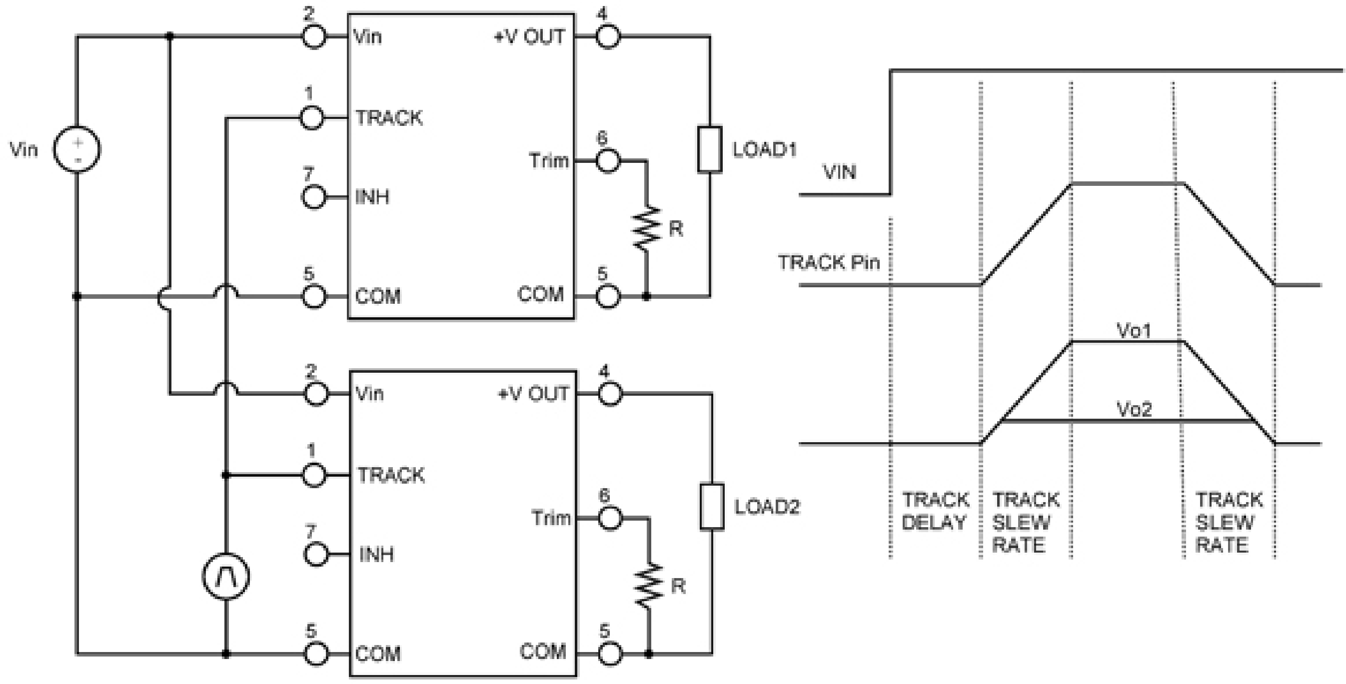

Figure 3. Tracking Waveforms.

If higher performance than what is specified in the product datasheet is required, the user can add external components to improve parameters like output voltage ripple, load transient changes or input current ripple. If the output voltage ripple needs to be less than specified on the datasheet, the user can add external low ESR capacitors. To assure optimum performance, place a ceramic cap very close to the output pins of the POL. Adding an LC filter to reduce the ripple is not advisable because this can cause instabilities in the control loop and result in low frequency oscillations.

If the user needs to reduce the load transient performance, adding a bulk capacitor to the output pins is possible. All of VPT's POLs have the ability to add capacitance up to 5000 µF. This capacitance can decrease output voltage variations from very fast load current changes.

Finally, should the power designer want to decrease the input current ripple, a bulk capacitor can be added to the input of the POL. There is no upper limit to the amount of necessary to account for is if the POL is driven from another DC-DC converter. If so, this part could have a requirement for the maximum amount of output capacitance.

A New Distributed Power Architecture for Tomorrow's Systems
With the new variety of POLs available with current ratings of 3 A, 5 A, and 10 A that meet MIL-PRF-38534 and MIL-STD-883, today's commercial avionics, military

and space systems designers have smarter, newer options in designing high performance systems that meet evolving light weight, high performance, and low cost system requirements.

For further information and a demonstration video on distributed power architectures using isolated and point of load DC-DC power converters, visit VPT's Web site at www.vpt-inc.com [1].

Links:
[1] http://www.vpt-inc.com