Modified COTS Power Supplies Provide Optimum Solution

By Ron Storm, Behlman Electronics, Inc.

Since the 1990's, the U.S. Department of Defense has stressed the need to use COTS components wherever possible as a way to reduce military system cost of ownership. However, due to the extreme rigors of shipboard, airborne, and mobile military applications, and because military systems are typically required to have a service life of 20 years or longer, COTS products from some manufacturers do not readily meet the requirements and specifications for the task at hand. In the case of power supplies, ruggedized COTS products with some necessary modifications can be an excellent solution, combining the cost benefits and streamlined development time of a standard COTS product with the features and performance characteristics necessary for military applications.

Modified COTS power supplies from qualified vendors generally deliver the value and performance required by all branches of the military, in a broad range of applications and systems. A qualified power supply vendor should have significant design engineering experience with power supplies for military applications, and whenever necessary will take a partnered approach with armed forces managers, prime contractors, and system integrators to ensure that the modified COTS power supply precisely meets all performance specifications.

AC to DC or DC to DC Power Supplies

A preferred approach to designing cost-effective modified COTS AC-to-DC or DC-to-DC power supplies is to use standard DC-to-DC modules (COTS "bricks"), along with the necessary circuitry, mechanical and thermal design considerations to meet the specifications. This approach significantly reduces non-recurring engineering (NRE) costs, as well as reducing turnaround times.

However, it pays to scrutinize performance specifications. For example, some power supplies are specified with power densities in excess of 70 W/in^3. Unfortunately, upon closer inspection, the data may also show that the advertised power density is only achieved at moderately low temperatures and at a specific input and output voltage. The advertised power density figures sometimes do not account for additional necessary components needed to meet the complete power system specification, and the result is an overall power density of between 10 and 15 W/in.^{3}, much lower than the advertised 70 W.

When choosing the right power supply, several issues must be considered to ensure a reliable design that meets all specifications. Consulting with the vendor, it should be possible to determine the answers to questions such as:

- Which standard module is best suited for the application at hand
- What needs to be done to meet EMI requirements of MIL-STD 461
- What needs to be done to meet hold-up and transient requirements of MIL-STD-704
- Is conduction or convection cooling required to meet temperature specifications
- Do the power supplies need to be used in parallel
- Is redundancy and N+1required
- Which control circuits are necessary
- Is built-in test (BIT) required

In addition, the power supply vendor should be able to specify the inclusion and impact of such elements as protection circuitry, filtering, monitoring and control, environmental conditions, and the physical size and weight of the finished power supply, in order to produce a reliable power supply meeting all system and environmental requirements.

AC to AC Power Supplies / Frequency Converters

A similar approach applies to designing modified COTS AC-to-AC power supplies/frequency converters. Using standard linear or PWM switching topology, mechanical and thermal design considerations (and with the aforementioned questions answered), additional important considerations for AC to AC power supplies/frequency converters include:

- Input harmonics to meet MIL-STD-1399 requirements
- Output total harmonic distortion (THD)
- Whether fixed or variable frequency and voltage are required
- Power factor

These approaches to designing modified COTS power supplies are supported by the Office of the Assistant Secretary of the Navy, in the document More

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Figure 1: The Behlman MK119 Power Supply is a modified COTS modular design with three LRUs, all of which share the load. If one LRU is lost, the remaining two can support the full load while the third unit is hot-swap replaced.

Figure 2: The Behlman 94018 COTS power supply is a switch-mode unit built for high-end applications powering work stations. It accepts a wide range of AC inputs and supplies a variety of DC outputs, supports airborne, shipboard, and mobile applications, and meets the input requirements of MIL-STD-704 and RTCA-DO160.

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Power for the Dollar: A Technical Guide for Price vs. Value (NAVSO P-3641A). In fact, a cost comparison table in the document indicates that a modified COTS power supply is the least costly option compared to COTS and custom supplies. The capabilities of what is possible in a modified COTS power supply for military applications are exemplified by a number of recent contracts fulfilled by Behlman Electronics.

Having unexpectedly lost its power supply vendor in the middle of a contract to provide MK119 fire control systems for U.S. Navy AEGIS ships, a Navy contractor turned to Behlman to quickly provide a form-fit-function replacement power supply solution. Using a modified COTS design, in just three months Behlman built, tested, and delivered a first article system, which passed rigorous qualification testing with a single minor modification.

Behlman's solution consisted of three multi-output 600-W, N+1, hot-swappable DC power supplies in a 19-in. rack. The new power supply system was compatible with the corresponding system manufactured by the previous vendor, so the contractor was able to proceed with production of its MK119 Fire Control Cabinet system without costly design changes.

The Marine Corps needed a highly-reliable ruggedized power supply for ground-based equipment that would be powered by a large diesel generator, and located in a shelter exposed to extreme weather conditions. Behlman provided a modified COTS three phase, 400-Hz to three-phase, 60-Hz frequency converter in a stainless steel housing with a heat exchanger and sealed input/output connectors to make the unit impervious to severe environmental conditions. The unit is transportable, and features a number of protective circuits including input, short circuit, constant current, and thermal protection.

Behlman has designed and manufactured a ruggedized uninterruptible power supply (UPS) to be used on board the U.S. Navy's LHD WASP class ships. The UPS needed to be able to supply 250 to 750 W of power with 30 min. of run time, and also needed to be as compact as possible because of space limitations. The modified COTS UPS meets all performance specifications in a package featuring the shortest chassis depth in the industry (5.25 in. high and 12 in. deep with internal batteries for the basic UPS system). Higher-power units use the same UPS but require either a 1U (1.75-in. high) or 2U (3.5-in. high) battery chassis to meet the run times.) The Royal Australian Air Force (RAAF) needed a power supply for a server onboard an RAAF aircraft. Behlman's modified COTS solution was a low-cost, highly-reliable switch-mode 350-W multi-output, AC-to-DC power supply.

In short, power supplies for military applications involve dealing with a complex combination of multiple design considerations dedicated to the unique requirements of the system they support. Despite these complexities, the design and manufacturing costs, as well as time-to-production savings realized by utilizing modified COTS power supplies, can be significant over a program's lifetime.

About the Author

Ron Storm is vice president of sales and marketing at Behlman Electronics, Inc., a subsidiary of Orbit International Corp. Behlman manufactures standard, modified standard, custom, and COTS power solutions, including AC power supplies, frequency converters, inverters, DC-to-DC, AC-to-DC, DC-to-AC, and uninterruptible power supplies.

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