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WHITE PAPER

Optimize Custom Power Supplies in System Designs

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Abstract

When sourcing low- and high-voltage power supplies for either military or commercial applications, system design engineers must choose between commercial off-the-shelf (COTS) products or units built to custom specifications. However, misunderstandings abound regarding the cost of each option — in terms of both initial price and total cost of ownership — as well as delivery timelines, ease of integration, and real-world performance.

Understanding the pros and cons of COTS versus custom power supplies helps engineers make timely, defensible decisions about the products they implement in their projects. This knowledge is particularly consequential in military applications, where size, weight, power, and cost (SWaP-C) requirements usually are inflexible.

Overview

A commercial application is more likely to be set up in a controlled environment, where operating space and power draw are not as critical. Form factors tend to be typical (standardized, even). Conversely, military applications often require unique form factors to ensure proper fit on the platform, precise weights to maximize flight longevity, and strict center of gravity requirements, as well as near-infallible reliability to preserve operation in scenarios where human lives are at stake. Each application is different; what remains constant is that power supply parameters already have been figured into the engineer's design.

Background

COTS power supplies generally are faster to procure than custom power supplies but redesigning and customizing packaging to accommodate COTS designs may cause delays in the form of multiple restarts or customer requests for waivers. Consider that the integration task begins by determining and designing the external circuity required for operation and protection of the power supply. Next, a PCB must be designed to integrate the external circuity before thermal management solutions are analyzed and designed. Finally, designers must find a way to mount the whole assembly into its intended enclosure.

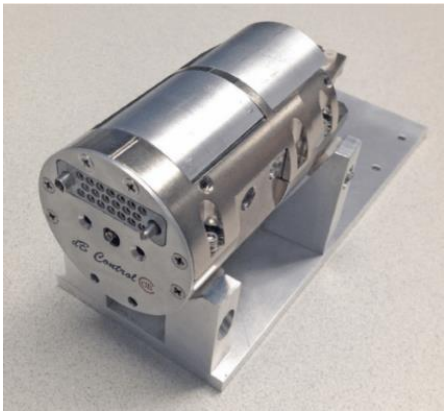
Purchasers are limited to predefined voltage/power/temperature/performance ranges, as well as form factors and heat management. A one-size-fits-all power supply often forces system cooling and mechanical layout to be designed around the power supply, and the power supply usually has to be overrated (size/cost) for the application. Even if the unit's predefined ranges fall within the application's needs, they are not optimizing SWaP-C.

Additionally, the data sheets and reference designs accompanying most COTS products (outlining their performance parameters) can be imprecise or convoluted. For example, heat dissipation usually is overlooked (or deliberately buried) in the data sheets, making implementation seem straightforward even though achieving the promised performance often requires significant analysis and design work.

This is because the numbers on the front of those data sheets represent best-case scenario — analogous to the mileage sticker on the window of a new vehicle. The COTS power supply *can* conceivably achieve the stated performance, but perhaps it has to be kept at a constant cool temperature or operate under a precise load. The data sheet's last page might contain a curve hidden amongst a hundred others that indicates operating at a higher-than-optimal temperature leads to only half the stated output power noted on the front of the data sheet.

In terms of price, based solely on raw materials and components, COTS always will be less expensive up front than a custom power supply. However, after additional design time and multiple iterations of the final assembly to hash out any bugs, custom designs surpass COTS as the better value overall — particularly in military and defense applications.

One of the biggest misconceptions about custom power supplies is that they take too long to procure; must be designed from scratch and have long lead times. While custom power supply timelines ultimately depend on the application requirements (e.g., SWaP-C and operating environment demands), dB Control regularly completes difficult designs and ships a first unit within six months.



The dB-2347-01 is an Airborne Power Supply is a compact, lightweight, conduction-cooled power supply designed to operate in extreme military environments. The power supply provides an output power of 6.4 VDC at 68 Amps, with an input voltage operating in the range of 1270 VDC to 1500 VDC. It features both over current and under voltage protection so as to not damage the power supply. dB Control also manufactures the **dB-2348 Towed Decoy**, a DC-to-DC converter, operating in the range of +1500 VDC to +10 VDC at 43 Amps.

Solution

dB Control has applied a modular architecture to its power supplies for more than 15 years, allowing the company to create and modify designs quickly using modules that have been MIL-qualified to EMI DO-160, MIL-STD-461, MIL-STD-704E, and MIL-STD-810E guidelines, as well as field-proven. Very little, if anything, has to be designed from scratch. The company knows each module's capabilities and the applications it is designed for, from low-voltage up to 40kV systems. These modules operate at power ranges from 100W to 1.2kW average, and up to 90 kW pulsed, with efficiency typically >90%, while utilizing any combination of high- and low-voltage inputs/outputs. dB Control continuously creates and approves new modules that improve upon SWaP-C, drawing on a library of designs that date back to the company's inception in 1990.

Typically, customers requesting a preliminary design review within 30 days of placing an order are impressed by the details the company shares with them, as well as how close early iterations of the custom design are to their requirements.

dB Control has extensive documentation to help support qualification-by-similarity (Qual-by-Sim) opportunities. Whether the client's application demands uncompromising electrical performance, electromagnetic interference/electromagnetic compliance (EMI/EMC) qualification, or survivability in extreme temperature changes, we have tested each module to comply with a wide range of regulations, from benign environments to the most severe airborne, shipboard, and ground mobile environments.

Each operating environment presents different challenges, whether it is temperature extremes (shifting from very cold to very hot), extreme vibration/shock, EMI, EMC, fungus growth, dust/dirt, high humidity, severe weather (e.g., for a unit mounted on an outdoor antenna), pressures from altitude, and decompression shock — to name just a few.

Often, dB Control can create a report for its clients showing the similarities between their product and previously qualified modules, saving that client significant time and money on qualification testing.

This design-to-fit approach does not end after the initial order. When dB Control receives initial specifications, the customer‘s requirements may still be evolving. Thus, the specifications can change during design: perhaps the load manufacturer updates its voltage or current requirement during development, or excessive margin was built into the initial spec and SWaP can be improved.

Often, a COTS solution cannot accommodate this change in requirements, forcing the designer to start again from scratch. Alternately, dB Control’s custom solutions are easily reconfigured through an engineering process that constantly works toward fine-tuning the unit to the client’s exacting requirements — even if that means venturing into the field and modifying units on the customer’s platform, at their site.

Comprehensive technical support is at the heart of dB Control custom products’ advantages over COTS. Every customer question is answered pre- and post-design. Client weekly or bi-weekly technical interchange meetings ensure there are no surprises with the delivery of the first unit. COTS product support generally is limited to reference documentation, which is not all-inclusive.

When dB Control begins a custom power supply project, it assigns a program manager who serves as a single point of contact for queries into engineering, schedules, etc. Ease of communication and access to the engineering team ensures success, no matter whether it is a one-off project or a long-term collaboration.

Custom solutions begin with technical discussions before moving to preliminary design review (PDR), critical design review (CDR), and pre-production review to ensure SWaP-C requirements are met. Constant communication and collaboration with clients guarantee products are delivered within budget and on-time with no surprises.

dB Control provides dedicated engineering resources from start to finish, versus COTS products that offer inadequate (if any) support, leaving engineers to rely on white papers and trial-and-error to jam a generalized product into a specific application.

Additionally, clients receive post-sale technical support. This allows for design modifications and enhancements after the design is finalized, whereas COTS unit designs are fixed and not customizable at any stage. Often, clients who have struggled to implement a reference design end up turning to a custom-designed product after wasting valuable time and money on a COTS solution.

Conclusion

Power supply optimization helps system design engineers understand the pros and cons of COTS versus custom power supplies. This enables engineers to make timely, defensible decisions about the power supplies they implement in their projects.

Resources

Datasheets for dB Control's Instantaneous Frequency Measurement Units, Integrated Stabilized RF Sources and Integrated Digital Control Units can be downloaded from **https://www.dbcontrol.com/datasheet-library/**

About The Author

Robert Richardson is a senior design engineer at dB Control. His designs are found in many of the defense industry's latest generation fixed and rotary wing aircraft, drones, and naval vessels, as well as in satellites and operating rooms. Richardson has been end of lifing electronics in pursuit of reliable designs and SWaP-C optimization for nearly 20 years, working for mission-critical companies Stryker Endoscopy, L-3 Narda-Microwave West, Polarity Inc. and dB Control. He graduated with honors from San Jose State University with a BS in Electrical Engineering, specializing in power electronics.

About dB Control

Established in 1990, dB Control supplies mission-critical (often sole-source) products worldwide to military organizations, major defense contractors, and commercial manufacturers. The company designs and manufactures reliable high- and low-voltage power supplies, high-power TWT Amplifiers (TWTAs), microwave power modules (MPMs), transmitters, and high-voltage power supplies (HVPS) for radar, electronic countermeasures (ECM) and communication applications on airborne, maritime, and ground-based military platforms. Since acquiring Paciwave in 2021 and TTT-Cubed in 2019, dB Control now offers specialized RF/microwave components, integrated microwave subsystems and custom radio frequency (RF) receivers and sources, including Instantaneous Frequency Measurement Units (IFMs), Frequency Locked Oscillators (FLOs), Digital Control Units (DCUs), Antenna Control Units (ACUs) and Integrated DCUs. In addition, dB Control provides specialized contract manufacturing and repair depot services from its modern 40,000-square-foot facilities in Fremont, California. The company is AS9100D and ISO 9001:2015 certified. More information is available at www.dBControl.com.

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