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WHITE PAPER

Using Modular Designs in Custom RF/Microwave Components and Assemblies

By Jeffrey Bly, dB Control Director of Custom Products and Components

Abstract

RF/microwave components and integrated microwave subsystems serve numerous signal routing and conditioning purposes across a variety of applications, ranging from electronic warfare and direction-finding systems to radar cross-section and broadband test/measurement. Even though standard COTS components and assemblies are often ill-suited to meet evolving design and deadline requirements, some companies are still wary of custom products. This can stem from misconceptions about the cost, production time, or concern that a custom design is not field-proven. dB Control addresses these concerns and delivers on performance by leveraging a collaborative, transparent working relationship with its customer's system engineers.

Overview

Efficient mechanical design comprises fitting more functions into a smaller physical space (high-density integration). This is a key aspect of SWaP optimization and a long-running trend in the industry. Individual component demand has declined in favor of integrating multiple functions into one unit, contributing to efficient use of space and more efficient unit performance overall.

As for electrical efficiency, higher signal isolation and lower signal loss generally are system designers' principal parameter concerns. But other specifications, including requirements for switching speed or power handling, must be balanced against the isolation and loss that can be achieved. Accordingly, custom component and subsystem design requires some back-and-forth communication between the vendor and its customers during the proposal and initial system test to ensure the custom component achieves the desired functionality at the system level.

dB Control works closely with each customer to pinpoint their system's most important specifications and determine how to achieve them while maintaining other system parameters within an acceptable range.

This bespoke approach has become a necessity, as system priorities and physical space for each unit vary from project to project, based on the application.

Background

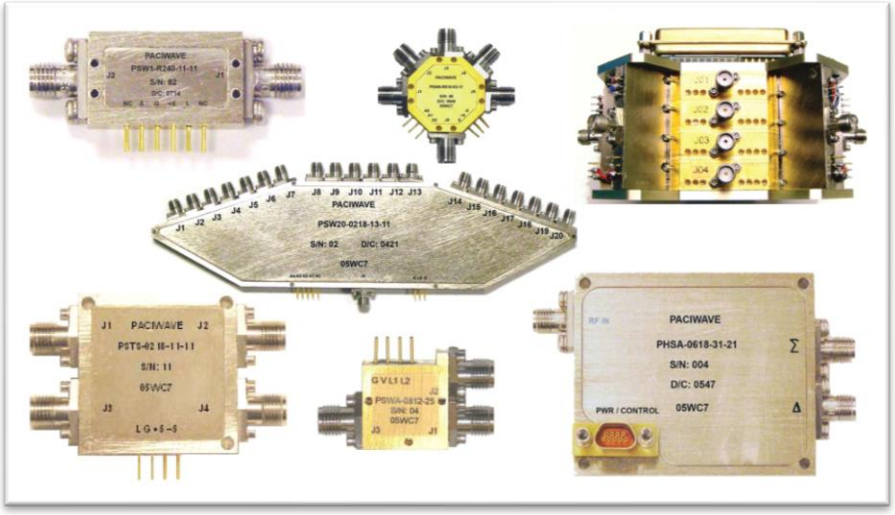
dB Control's design process typically begins with the customer's block diagram that details functions, layout, inputs/outputs, etc. From this diagram, its engineers gain an understanding of the customer's requirements and then generate a proposal detailing our design approach to achieve their electrical and mechanical requirements.

Next, the engineering design team assesses the customer's desired form factor, because that can steer a design from being planer or H frame to being stacked in multiple levels. Properly routing signals through different levels can be a complicated endeavor, but it is one in which we have a breadth of experience and expertise.

Volume is also a consideration. Production typically is scheduled out in reasonable quantities over a given period. However, when a customer has a tight schedule that requires expediting the process, dB Control tracks all potential schedule risks to proactively manage them up front and prevent unnecessary delays.

If the customer deems the proposal acceptable, the project progresses to producing that design. If not, dB Control revises the proposal the customer is satisfied. The redesign process generally depends on the size of the teams involved and the timeframe, but it can include biweekly or monthly calls. Ultimately, dB Control tries to match its customer's sense of urgency. In most cases, customers are simultaneously dealing with other system design issues. When provided with the initial proposal, the customer must reconcile that data with the rest of the system. This generally takes longer than dB Control's adjustment process.

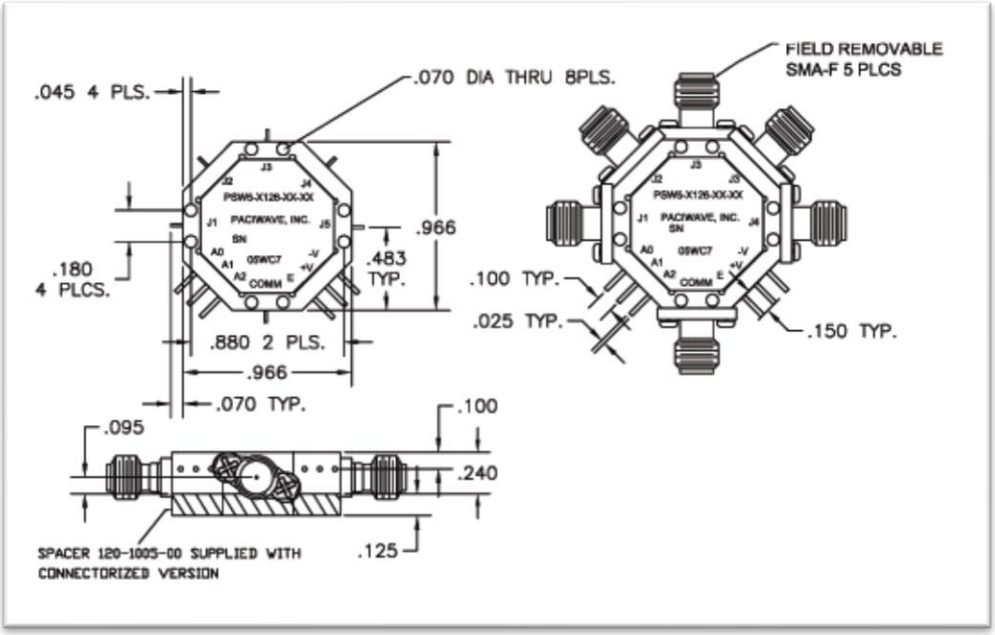
When the customer receives an updated proposal/design, they must re-address how the changes fit in with other components in the system. To build and maintain their confidence throughout the process, dB Control can build a subset of the proposed hardware — the part of the design relevant to a specific parameter or other concern. Building that leg of the system enables dB Control to share live data with its customers to give them confidence that the proposed design solution will meet required specifications.



Top Row: SPST Millimeter Wave, Single Pole Five Throw, 4x9 Switch Matrix

Middle Row: SP20T Packaged for Antenna Array

Bottom Row: Transfer Switch, Limiter/Switch Assembly, Switch/Hybrid Assembly



Single Pole, 5 Throw RF PIN Diode switch

Solution

dB Control provides components for a multitude of military, medical, instrumentation and telecom applications. It has experience working with numerous platforms and operating environments that demands flexibility and adaptability not only in the designs, but in the thought processes used to generate those designs. The company's unique modular design approach enables it to (1) integrate more functions into smaller and more form-constricted spaces than our competitors, (2) conceive, execute and manufacture custom RF/microwave components and integrated assemblies faster and more cost-effectively than units created "from scratch" and (3) use similar modules to support multiple applications. As a result, modules do not have to completely redesign for every new assembly. In addition to design flexibility and timeline reduction, the modular approach minimizes materials cost because similar materials can be used in numerous applications.

While technically many of the RF/microwave components and subsystems dB Control provides are custom, the creation of these products is standard within the company. For example, modules from similar designs (e.g., drivers, switches, analog control functions) can be used for multiple layouts and formats. Such adaptability means dB Control can offer, for example, 2 to 36 port switches, manage all the drivers required and package the product to meet specific needs. Another advantage is that customers are not forced to use a static layout.

dB Control's expertise drives performance and function integration in many of its designs. Consider switching, for example. With high isolation and power handling requirements: crosstalk and similar problems such as spurs bleeding out throughout the system can confound vendors lacking the switching expertise to isolate signals. As most systems specs have spur requirements (e.g., minimum 60 dB or 80 dB down), ineptitude chasing the source of those spurs wastes time, or worse, results in failure to meet customer requirements.

Readily available commercial off-the-shelf (COTS) components such as MMIC amplifiers, filters or MMIC switches have limited performance. When integrated, there is little tuning flexibility to meet tough system requirements. However, many improvements can be made while integrating these individual functions along with carefully selected discrete device designs and carefully aligning them to provide additional tuning options. The result is excellent functionality for a system.

Conclusion

Organizations in need of RF/microwave components and microwave subsystems often have difficulty identifying standard catalog solutions that will perform optimally, or even fit adequately, within their specific systems. dB Control works with its customer to balance design requirements with cost and performance trade-offs. This enables it to produce custom layouts that adhere to its customer's specifications. dB Control combines proven designs with intuitive customization that optimizes SWaP. By using a fielded, Mil-Qualified modular design approach, the company has the increased flexibility to meet a customer's challenging requirements.

Resources

Datasheets for dB Control's RF PIN Diode Switches and Assemblies, and for its compact Detector Logarithmic Video Amplifiers (DLVA) and Successive DLVAs, be downloaded from **https://www.dbcontrol.com/datasheet-library/**

About The Author

Jeffrey Bly is the director of sales, custom products and components at dB Control. With 22 years of industry experience, he is a valuable resource for dB Control's customers, including defense contractors and military organizations, that need custom RF/microwave components and integrated assemblies. Previously, Bly was the senior director of space products and components at Teledyne Microwave Solutions. He received his BSEE in Electrical Engineering from California State Polytechnic University and was awarded the Meritorious Achievement Medal from the US Air Force.

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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