Power Supply Designers Turn to Magnetics Suppliers for Solutions

By Jim Earley
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In many applications the power supply is the last element to be designed in, a task that often falls on the shoulders of engineers with considerable skills but without much experience in the intricacies of switch-mode power. It is not uncommon for engineers faced with the prospect of creating a power supply design to search for an off-the-shelf solution in the form of a reference design. However, a recent Google search of the term “power supply reference design” returned an astonishing 20,900,000 citations!

For many faced with the need to complete the power supply design function, the basic reference design is a source of some comfort but when the specific requirements of the design vary from the reference parameters, it often comes down to understanding the details of the magnetics that makes the difference. In such cases, the quickest path to a satisfactory solution runs straight through the engineering department of the magnetics supplier.

What makes this possible is the fact that manufacturers of power supply components, most notably semiconductor producers, have awakened to the realities of power supply design and have begun to offer a wide range of supporting services including everything from the afore-mentioned reference designs to complete custom design services. Likewise, to succeed in today’s competitive magnetics market, suppliers are beginning to realize they need to offer a higher level of technical support **(Figure 1)**. The ability to engineer a suitable transformer or magnetic component has typically been the limit of a transformer supplier’s involvement or capability. However, the magnetics supplier who understands power circuits as well as his customer, or nearly so, will be capable of providing a much more comprehensive solution and will enjoy, by extension, a “leg up” on competing suppliers who do not offer this increasingly important value-added capability.

Real-World Application

One such case in point occurred in June 2005 when Premier Magnetics was contacted by an OEM manufacturer of remote server monitoring equipment whose product provided power and environmental management in a server cabinet, including temperature and humidity.

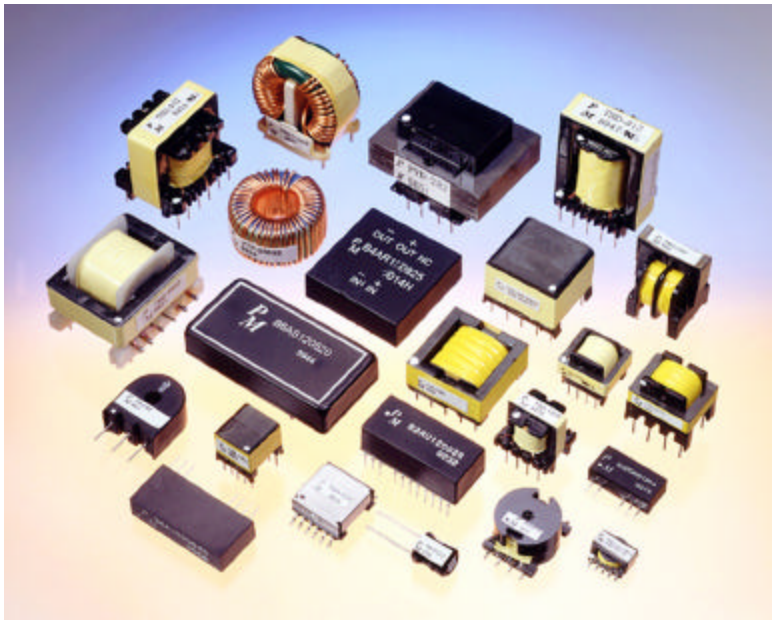

Figure 1: Power supply component vendors are gaining new appreciation for the intricacies of power supply design and are beginning to offer a wide range of supporting services including complete custom design services.

The problem arose when a new customer approached the OEM with a power option requirement that differed from the manufacturer's standard DC output voltages and power levels. The application called for universal input voltage capability and outputs of 26V @ 1A and 7.5V @ 3.5A. An option required that the latter output could be switched to 5V @ 5A, or both outputs utilized at lower current levels without changing the transformer or affecting the 26V output. Size was also important; the product needed to fit in a small area in an existing rack assembly. There were no off-the shelf supply options due to size and time constraints.

A Few Design Considerations

In preparing to provide this level of technical support the design engineer needs to take several issues into consideration. In this application, for example, the general design goals included providing a cost-effective solution to meet the required efficiency level, and a design that would comply with the necessary safety standards, leakage reduction, inter-winding capacitance, temperature rise, power loss and other operational characteristics. To offer this level of service requires the magnetics supplier to be absolutely up to speed on the latest power semiconductor technologies, offerings and relevant international safety standards. Other design considerations included:

- Total power required and the appropriate topology to be used—flyback, for example, is useful up to 250W or more with single or multiple outputs.

- Is the design off-line or is there an internal bus that will be the main power source?

- Isolation voltage and safety agency requirements—a transformer design that will meet UL requirements may not satisfy European agencies. Magnetics going into a medical environment often have much higher breakdown voltage requirements than those for communication equipment.

- Operating environment—will there be temperature extremes or other issues?
- Required efficiency—to some degree determines component count and total materials costs. If efficiency needs to be very high, 92-94% of the circuit may require opto-couplers or other additional components.
- Budgetary goals
- Size constraints

Solutions, Not Components

The most efficient option for this application proved to be a discrete, onboard, off-line switching power supply, a high-precision 55W model with dual fixed outputs and a third optionally available output configuration. The recommended switching regulator was a popular high-efficiency unit used in the flyback buck-boost topology. The vendor's standard components were suitable for the filter magnetics needed for the outputs and EMI/RFI Filtering.

Figure 2: Circuit schematic of a high-precision 55W flyback buck boost configuration with referenced component values. This conversion topology provides isolated multiple outputs with efficiencies up to 95%.

A circuit schematic **(Figure 2)**, including all required components and component values to engineer the necessary optimized custom switching transformer, was e-mailed to the customer within 48 hours, along with specifications for the new custom transformer **(Figure 3)** and off-the-shelf filter inductors. Magnetics samples were shipped the following day. The fact that all magnetic components were designed to meet or exceed UL and IEC safety requirements saved the customer time and the approval costs associated with these agencies. This collaborative effort between magnetics supplier and customer resulted in a cost-effective, timely solution that saved the OEM several weeks in engineering time, while providing a solution that met both the physical rack space and production schedule requirements.

PARAMETER	SPEC LIMITS MIN.	TYP.	MAX.	UNITS
PRIMARY INDUCTANCE (3-1) VOLTAGE = 0.250Vrms FREQUENCY = 100 KHZ	310	330	350	µHY
TURN RATIO'S:				
SEC (12-7) : PRIMARY (3-1)	-------	1: 4.2	-------	± 4%
SEC (12-9) : PRIMARY (3-1)	-------	1: 5.25	-------	± 4%
SEC (12-10 : PRIMARY (3-1)	-------	1: 6.0	-------	± 4%
BIAS (6-5) : PRIMARY (3-1)	-------	1: 8.4	-------	± 4%
PRI LEAKAGE IND. (SEC SHORTED) VOLTAGE = 0.250Vrms FREQUENCY = 100 KHZ	-------	-------	50	µHY
HIPOT:				
PRIMARY TO SECONDARY	3000	-------	-------	Vrms
BIAS TO SECONDARY	3000	-------	-------	Vrms
APP CIRCUIT PARAMETERS: (1)				
AC LINE VOLTAGE 47/400 Hz	85	-------	265	Vac
SEC #1 OUTPUT VOLTAGE	-------	5.0	-------	Vdc
SEC #1 OUTPUT CURRENT	-------	-------	3.5	A
SEC #2* OUTPUT VOLTAGE	-------	7.5	-------	Vdc
SEC #2* OUTPUT CURRENT	-------	-------	3.5	A
SEC #3 OUTPUT VOLTAGE	-------	26	-------	Vdc
SEC #3 OUTPUT CURRENT	-------	-------	1	A

Figure 3: Switching transformer electrical specifications at 25C

Conclusion

The "real world" message here is that most engineers confronted with the challenge of designing or adapting power supplies are probably experts in other aspects of the systems they are designing. The intricacies of common switch-mode power supply topologies demand careful attention to the selection of the proper magnetic components. For their part, magnetics suppliers are deploying engineering resources outside their traditional bailiwick to help solve customers' perplexing design issues as true partners who have started bringing much more than just components to the banquet.

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Jim Earley, president of Premier Magnetics, is an electrical engineer with over 30 years of experience in magnetics and power supply design. He has founded two successful technology companies and serves on the boards of several others.