Select the Best Isolated Brick DC-DC Converter For Your Application

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Selecting the best isolated brick DC/DC converter for an application can pose a challenging task for the design engineer. There are a number of circumstances that can motivate a particular choice. These could be transient response, efficiency, environmental conditions, or mechanical packaging. This article looks at some of the technical considerations when choosing the optimum brick converter for an application.

The Brick Format
Isolated brick converters are available in a range of standard formats including 1/16th, 1/8th, 1/4 and ½ bricks and full brick, with dimensions as shown in table 1.

The choice of a specific package is typically dictated by the power level required. Technology improvements over time mean the power levels deliverable from each have increased. The first half-brick products delivered just 50W, while products delivering several hundred Watts in the same package are available today.

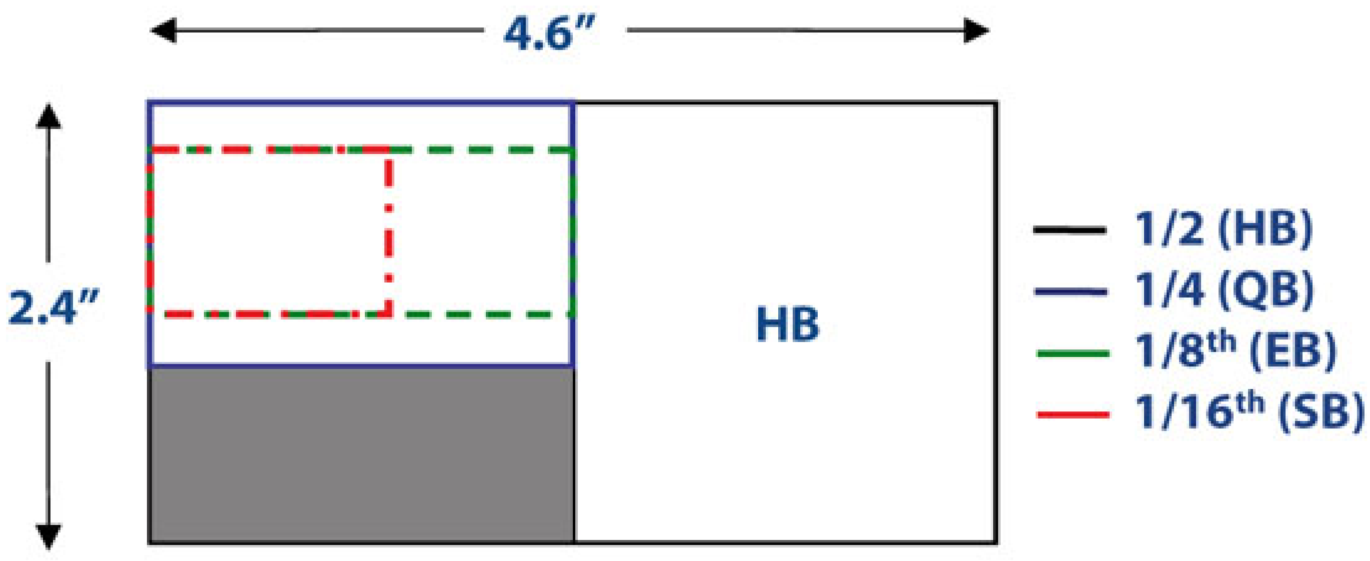

Fig 1: Form Factor of the "Brick" and Fractions thereof.

Board space is a key consideration in selecting a converter. Designers often want the most power in the least space; however, bearing in mind that technology will continue to lead to higher power densities, some users might be wise to select quarter-brick packages whenever possible. The reason for this is that when the need for cost-reduction arises later in the product life cycle, an eighth-brick offering the same power may be available. This allows the user to drop in a lower cost converter without having to alter the application PCB.

Isolation
Isolated converters use a transformer so there is no physical connection between the primary and secondary sides. Isolation can serve multiple purposes including compliance with safety requirements, noise immunity, and alternate ground reference. Isolation is particularly useful in telecom environments where the source voltage is often -48V (positive ground) while most secondary voltages are configured with a negative ground. Several standards exist for isolation voltage ratings and these sometimes call for a specific class of insulation as well.

Output Power
Isolated brick converters are generally available with output powers ranging from approximately 50W up to several hundred Watts. Achievable power levels for any given brick form factor remain a function of the output current and voltage, the input voltage range, the switching frequency, and the conversion efficiency. For any given output voltage, the power densities continue to increase as component technologies and optimized topologies continue to drive efficiencies ever higher.

Thermal Management
The environment in which an isolated brick DC/DC converter will be operated is perhaps the most important parameter to be fully understood. The key elements are maximum operating temperature and airflow across the converter, which can be either natural convection or forced convection airflow from a cooling fan.

In applications that need to be sealed against the outside environment, fans cannot be used. In this situation, cooling in addition to natural convection can be achieved by attaching the sealed module to a baseplate, heat spreader or heatsink; cooling then occurs by conduction.

For applications constrained to natural convection cooling, brick type converters must typically be de-rated from their maximum capabilities, depending upon the maximum ambient air temperature. Many of the brick type converters incorporate a baseplate for conduction cooling, or are offered with a baseplate option. The baseplate improves thermal performance when used in both natural convection and forced convection environments, but also allows units to be employed in conduction cooled applications where the baseplate is attached to a larger thermal sink, or 'cold plate'.

When considering the application temperature, it is crucial to understand the temperature at the converter and not the ambient air temperature in which the converter is operating.

Most isolated brick converters include thermal shutdown circuitry to protect the converter from damage under abnormal environmental excursions. These protective circuits result in shutdown of the converter with automatic recovery upon restoration of normal temperatures. Several degrees of hysteresis are added to avert oscillation.

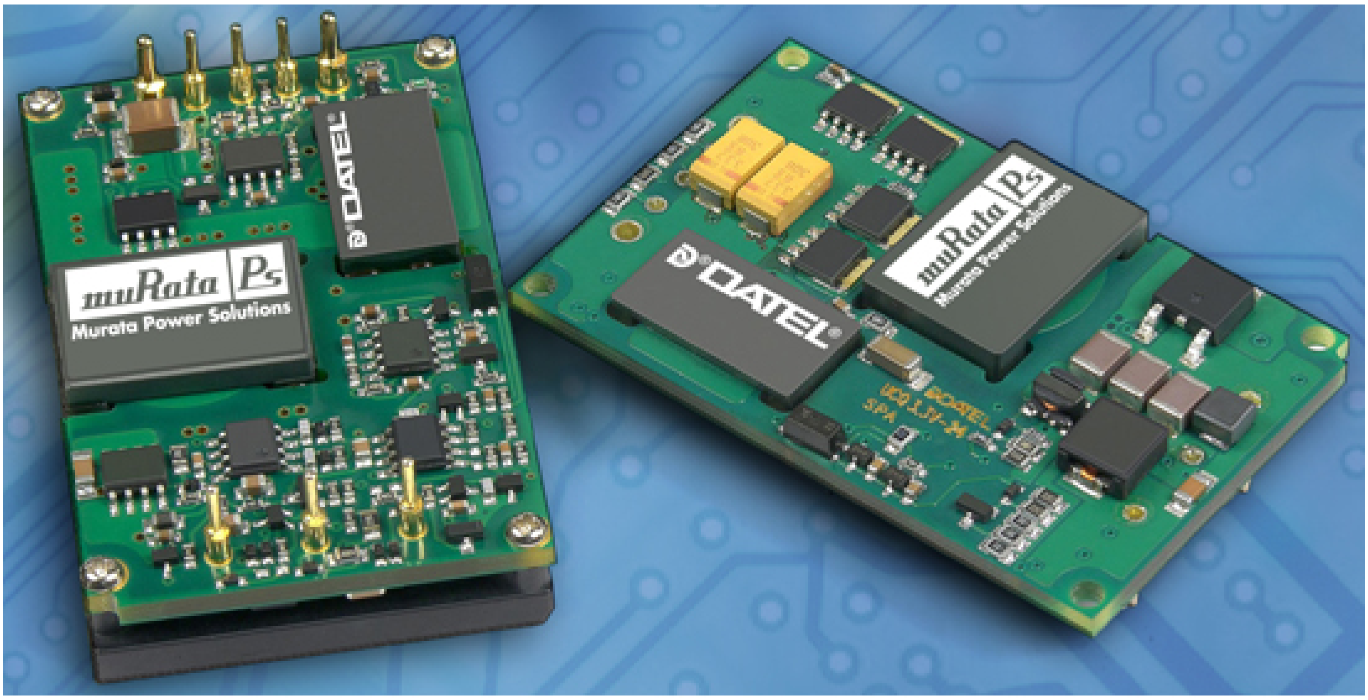

Fig 2: Murata Power Solutions UCQ Series.

Input Voltage

Input voltage ranges for brick type converters are most typically 2:1, meaning that the maximum operating voltage is approximately twice the minimum. Typical examples are 18-36V and 36-75V. Murata Power Solutions also offers models with wider 4:1 input ranges of 9-36V and 18-75V. These 4:1 modules are particularly useful when system designers are confronted with the reality that their equipment may be deployed in environments where the available voltage can be quite disparate.

Before the best brick converter for the task can be chosen there are a number of module and application considerations that must be understood. These include: understanding the load, operating environment, the effect the input voltage has on the converter efficiency ratings, trimming the output voltage and derating.

Understanding the Load
In order to perform a comprehensive analysis of the converter output requirements, several details of the load profile need to be evaluated. The first is how the load current was determined. It is all too frequent that it is calculated using worst case power numbers from the silicon specifications, compounded with safety margins. On the other hand, an average number can be used for the calculation, which may be appropriate for thermal management, but ignore the peak demands. Another frequently employed method is to utilize requirements established with a previous generation of the product. Each of these methods has validity within limits and pitfalls when those limits are overlooked.

A further question in understanding the load is whether the application presents a highly dynamic or quasi-static load profile. If the load is dynamic, then a few additional questions need to be answered such as the particular slew rate (di/dt) associated with the load changes, the load step amplitude, and the maximum voltage excursion that the load will tolerate during these excursions. In cases where the load step is significant and the voltage excursion must be minimal, capacitors are frequently used to provide the short-term response while the converter handles the longer-term recovery. To this end, the effective switching frequency and the maximum load capacitance play a role in converter selection.

The last question regarding a dynamic load is the particular duty cycle. If the duty cycle were 90% it would mean that for 90% of the time the load would be higher than the static level, resulting in an average load higher than the static level.

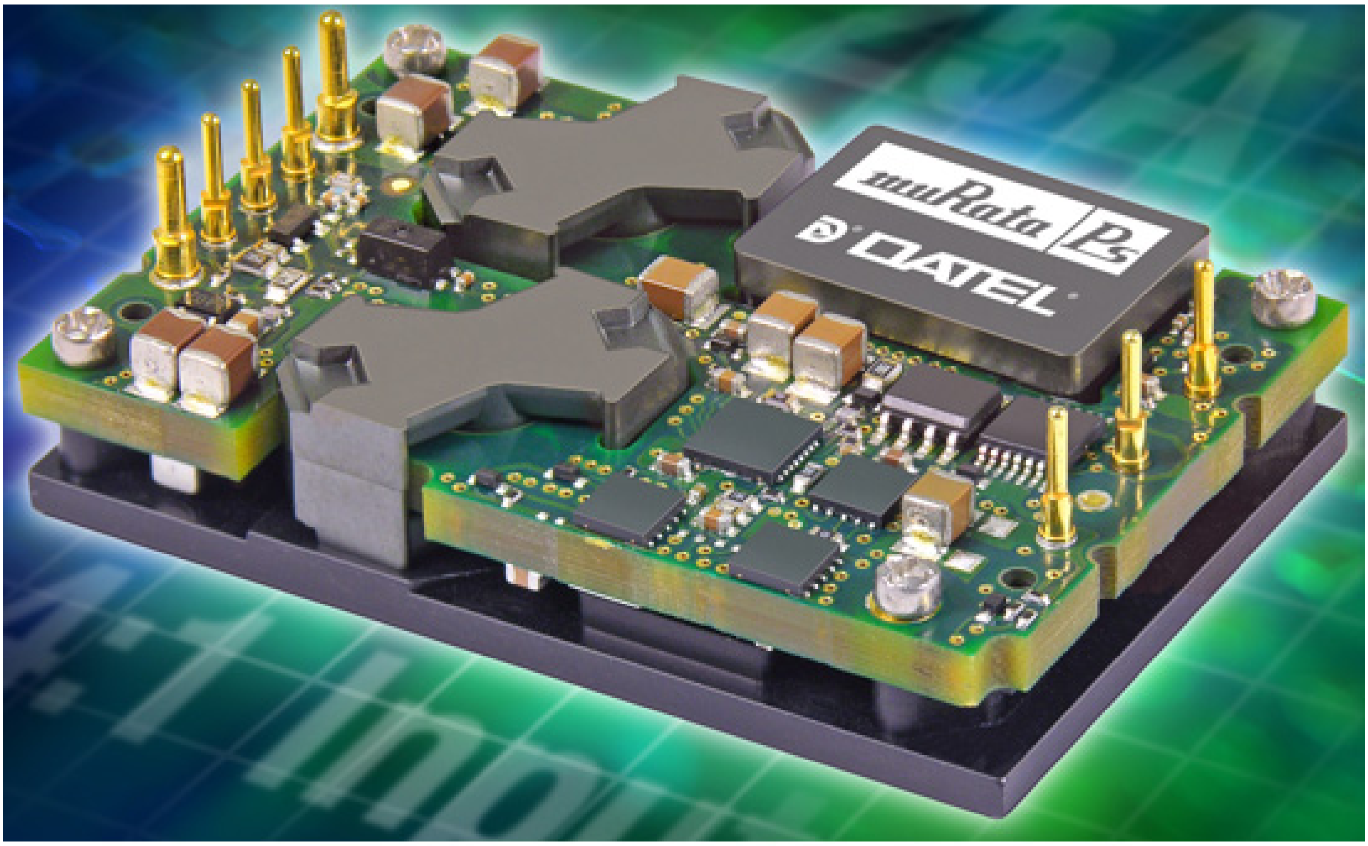

Fig 3: Murata Power Solutions UQQ Series.

Efficiency

The biggest contributors to modeling of efficiency in the application are the input voltage at which the converter will be used and the output load. The higher the input voltage for a given DC output voltage, the less efficient the converter. The primary contributor to reduced efficiency at a high-line condition is the switching losses of the Field Effect transistors (FETs) on both the primary and secondary sides of the converter. The second contributor is temperature; as temperature rises, the FET RDS on goes up which results in higher conduction losses. Typical efficiency levels for isolated DC/DC converters range from around 80% up to approximately 97.5%.

Trim

If output voltage margining or trimming is to be employed in the application, then this needs to be taken into account too. If we consider a DC/DC converter with an output of 5V at a 10A load (50W output power) then adjusting the output up by +10% to give 5.5V, and the output power increases to 55W. The designer needs to carefully consider whether this extra 5W will have an impact on the performance of the module bearing in mind that the airflow and ambient temperature for the application remain the same regardless of the increased power output. This same consideration applies to the use of remote sensing.

Summary

There are many factors affecting selection of an isolated brick DC/DC converter for a given application. It is important to carefully consider the factors described in order to achieve the most efficient path from initial concept to a market-ready finished design.

In general, for a given project, it is a good idea for the engineer to develop his design with a higher power DC/DC converter. A smaller less powerful version can be substituted after all the testing is complete if necessary and without having to revisit large parts of the overall design.

About Murata Power Solutions
Murata Power Solutions (www.murata-ps.com) is headquartered in Mansfield, Massachusetts, with over 1,300 employees, and locations in the USA, Canada, England, France, Germany, Singapore, Japan and China. Murata Power Solutions designs, manufactures and distributes DC/DC Converters, AC/DC Power Supplies, Magnetics, Data Acquisition devices and Panel Meters, and offers these products in custom, standard and modified-standard variations. These products, which are built to exacting requirements in ISO9000:2000-approved facilities, are typically used worldwide within telecommunications, computing, industrial and other high-tech applications.