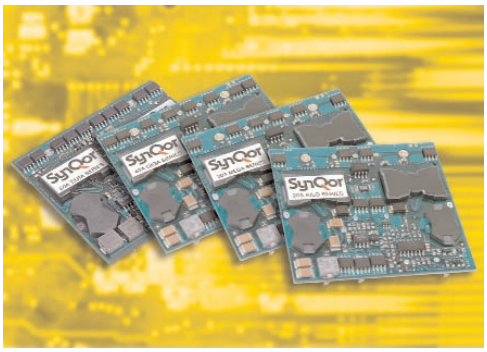
Overview of SynQor's Kilo, Mega, Giga, Tera DC/DC Converters

A Technical White Paper by SynQor



SynQor's Kilo, Mega, Giga & Tera high-efficiency dc/dc converters offer enhanced performance in a wide range of power levels.

Introduction

SynQor continues its tradition of leading dc/dc converter technology with the introduction of their Kilo, Mega, Giga & Tera product lines. Each converter series has been optimized for efficiency, current/power output and price. The "Tera" grade provides maximum output current, power and efficiency, while the "Giga", "Mega", and "Kilo" grades are fine-tuned for successively lower performance requirements. SynQor's expanded product line provides customers with the flexibility to chose the appropriate current/power level that matches their need and budget. This document is intended to summarize SynQor's new product introductions, their technical differences and performance improvements while answering some frequently asked questions about compatibility and part number changes for the *Power*Qor family of dc/dc converter modules.

The Need for Higher Efficiency and Output Current

One problem with conventional dc/dc converters is that the output current is limited at the lower voltage levels (3.3V and below). Most traditional half-brick converters provide 150 Watts of power or 30 amps of output current, with the breakpoint occurring at 5V (30A x 5V = 150W). This design was satisfactory when the dominant output voltage was 5 volts. However, as standard output voltages quickly drop and current demands increase for lower voltages, converters must deliver more amperage at 3.3V and below. The problem with conventional Schottky diode converters is that their efficiencies decline rapidly as the output voltage drops below 5V. As a result, these converters dissipate large amounts of heat and must be current limited (typical 30A for half-brick) at voltages below 5 volts. These old-style converters also require bulky heatsinks to remove the dissipated heat.

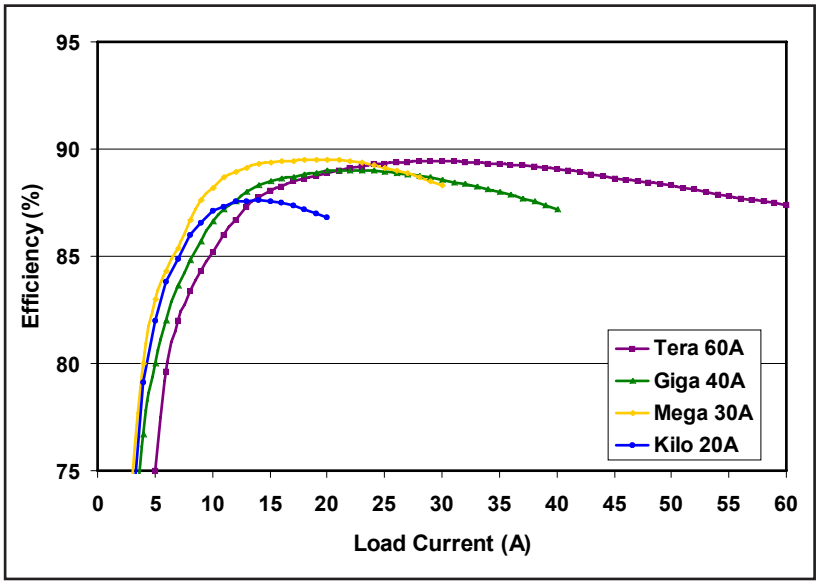


Figure 1: *Efficiency curves for the Kilo, Mega, Giga, and Tera versions of the 48Vin, 2.5Vout PowerQor dc/dc converters.*

However, today's customers have less room for a heatsink, require more output current and are using voltages at 3.3V and below. SynQor converters use synchronous rectification, which provides much greater efficiency at the lower volt-

ages (ie. 90% vs. 80% at 3.3Vout and 84% vs. 62% at 1.5Vout). Figure 1 shows efficiency curves for the 2.5Vout unit from each of the new performance series. Higher efficiencies mean that the SynQor converters dissipate far less heat and can provide greater output current than their traditional Schottky diode counterparts, even without a heatsink. As a result the SynQor line of dc/dc converters are not current limited at the low voltages. For example the "Giga" half-brick can deliver 40A of current at 3.3V and below while the high-performance "Tera" half-brick can provide 60A at 2.5V and below.

A Broader Range of Output Currents

Increased efficiency and output current are extremely beneficial but what about the customers that do not require this level of output? Of course, they always have the option of using a quarter-brick, which has lower output current and a smaller footprint. However, most quarter-bricks can only provide 15-20 amps of current, leaving a large gap in the current range from quarter-brick to half-brick package size. The SynQor product line allows customers to choose from 4 different half-brick current/power levels, ranging from 20 to 60 amps (30-165W), to suit specific requirements and thermal conditions. By offering lower priced converters in the lower current/power levels, the customer can optimize the converter for their performance needs and minimize their costs.

The need for an expanded line of converter options and added flexibility is evident when you examine the process of designing a distributed power system. A major concern when evaluating a dc/dc converter is "How much current/power can this unit deliver in my worst case environment conditions?" To determine this number, one must derive a power derating curve which indicates exactly how much useable current/power can be delivered by the converter for a given set of ambient temperature and airflow. Figure 2 provides the derating curves for the 48Vin, 2.5Vout converters from the Tera, Giga, Mega, and Kilo product series. The Tera provides the highest output under all conditions while the other grades offer lower levels of current for varying performance requirements.

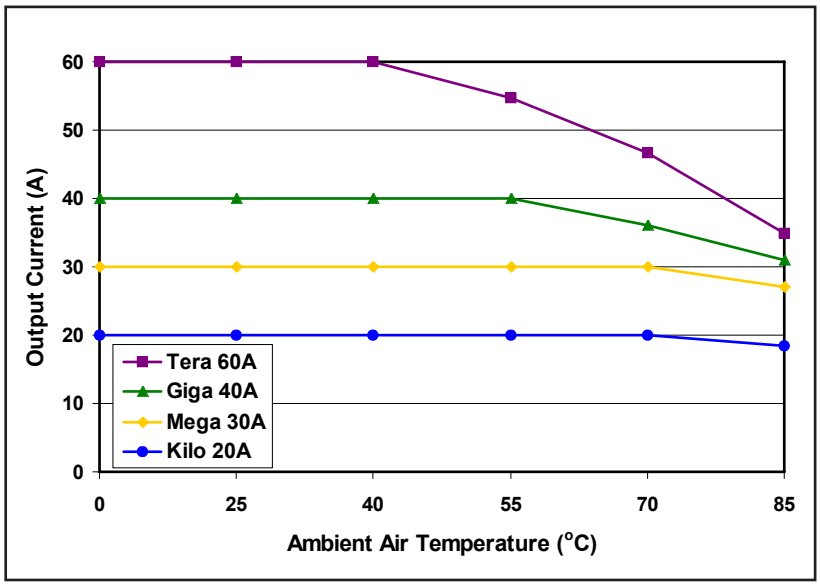


Figure 2: *Power derating curves at 300 LFM airflow for the Kilo, Mega, Giga, and Tera versions of the 48Vin, 2.5Vout PowerQor dc/dc converters.*

This range of product choices is extremely beneficial to a designer who is unsure of their power requirements in the prototype stage of their board design. Power requirements are typically the last piece of the puzzle to be solved when designing a new board layout since most designers do not know the exact load requirements, thermal conditions or airflow at the onset of the design project. Towards the end of the design cycle, these unknown factors are better quantified and designers often struggle to meet their power requirements in the board space allotted. SynQor's expanded line of *Power*Qor converters solves this common problem. A designer can chose to evaluate and qualify any power level of the *Power*Qor converter series during the initial design stage. Later in the project, when the exact loads and environmental conditions are known, the

designer can easily change to a higher or lower current/power level with no worries. For example, one might first specify a Giga level converter because the anticipated load is 35 amps at 55°C and 300LFM. Upon completion of the design, the designer realizes that they require more power and have harsher environmental conditions. Instead of redesigning the board to accommodate a full brick, they upgrade to a Tera unit that can meet the additional current/power requirements in the hotter environment. Similarly, they may realize they have lower requirements and more favorable thermal conditions. At that point they may chose to use a more cost-effective Mega or Kilo unit. Since all the SynQor converters use the same topology, circuitry, footprint and pin out, the designer can be assured "plug and play" compatibility when moving among different current/power levels of a particular package size.

Performance Improvements in Kilo, Mega, Giga, Tera

The new Kilo, Mega, Giga, Tera units have an improved circuitry and layout to increase performance over the original *Power*Qor 30/40 amp half-brick series. The new converters feature a solution to the "Back Bias" or "Reverse Conduction" issue that must be considered when implementing any Synchronous Rectifier based converter solution. Each converter has been optimized for efficiency, power output and price. The Tera provides the highest efficiency for the widest current/power range, and the maximum available output. The Giga, Mega, and Kilo, provide lower levels of efficiency and current/power but have been optimized to reduce cost so that customers only pay for the power that they use.

In addition, all of SynQor's new half-brick models will be available in both standard and full-feature versions. Full feature units include current sharing for N+1 redundancy and parallel applications. Using multiple half-bricks in parallel allows customers to achieve virtually any power level they require. Other features include an external clock synchronization pin for improved EMI performance, a startup synchronization pin for more consistent start up sequencing, and an ORing FET drive supply for efficient ORing protection. Details on implementing full feature modules can be found in the application note “Current Sharing and Other Full-Feature Applications” located on the the SynQor website.

Common Questions and Answers about Kilo, Mega, Giga, Tera

Why the change?

SynQor's goal with our new Kilo, Mega, Giga, Tera series is to offer a product family that encompasses a wider range of current/power outputs for each available package size. In the process, we have improved on our original ultra high-efficiency, no heatsink, no baseplate, converter design. The Kilo, Mega, Giga, Tera half-bricks will offer the broadest range of high performance, synchronous rectifier dc/dc converters on the market.

What improvements do the new converters offer?

As detailed above, the new Kilo, Mega, Giga & Tera units have an improved circuitry and layout to increase efficiency and performance over the original *Power*Qor HNA30/40 amp half-brick series (see figures 3 - 6). The new converters also solve the "Back Bias" or "Reverse Conduction" issue that must be considered when implementing Synchronous Rectifier based converters in parallel or sequencing applications. In addition, all of SynQor's new half-brick models will be available in both standard and full-feature versions to allow for current sharing and additional functionality.

What if I am using the original HNA30 or HNA40 converters?

SynQor's new Mega (30A) and Giga (40A) series of *Power*Qor converters will displace but not obsolete the original HNA30 and HNA40 series respectively. SynQor will continue to manufacture and support our original *Power*Qor line of 30 and 40 amp converters for all existing customers. However, we will encourage all customers to transition to the new series over time since they offer significant performance improve-

ments. Our customers are also encouraged to use the new Kilo, Mega, Giga & Tera series on all new designs since this family offers a more scalable solution to meet their diverse power conversion requirements. The Mega and Giga series will also be similarly priced with the HNA30 and HNA40 series while the Tera will be priced slightly higher and the Kilo will have the lowest cost. However, as you will see below, all converters from the new Kilo, Mega, Giga, Tera series provide added functionality, higher efficiency and better power derating performance than the original HNA30/40 series.

How much better is the Efficiency and Derating performance of the new KMGT series?
Figures 3 & 4 show the improvement in efficiency from the original HNA30/40 series compared to the new Mega (30A) and Giga (40A) series. Higher efficiency translates into less dissipated heat, which means lower component temperatures and increased output power.

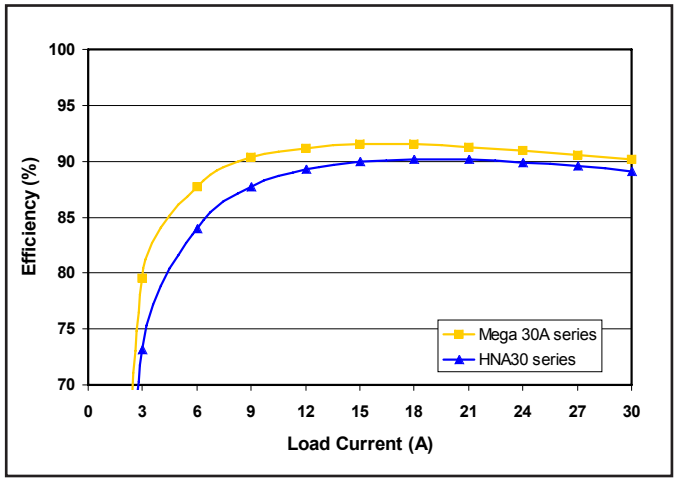


Figure 3: *Comparison of Efficiency curves for Mega series versus the original HNA 30 series for 3.3Vout modules at 48Vin.*

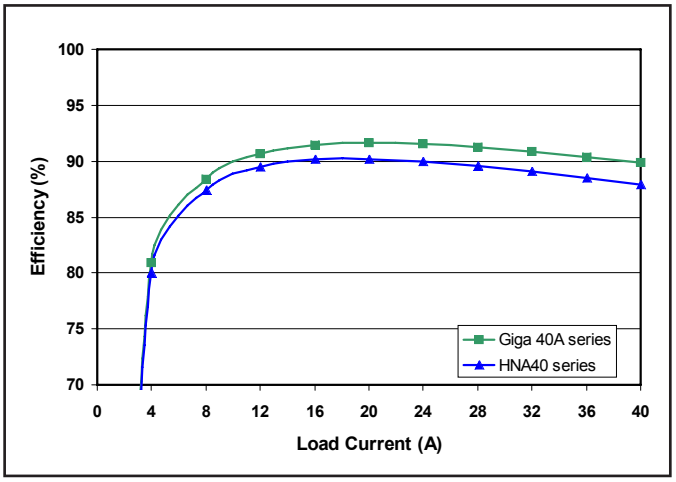


Figure 4: *Comparison of Efficiency curves for Giga series versus the original HNA 40 series for 3.3Vout modules at 48Vin.*

Figures 5 & 6 show the improvement in the power derating curves from the original HNA30/40 series compared to the new Mega (30A) and Giga (40A) series. Improved power derating performance means more available output power under any environmental conditions.

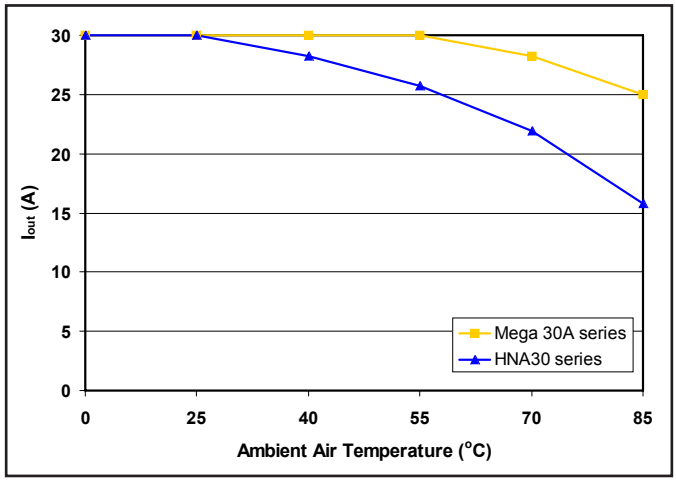


Figure 5: *Comparison of Power Derating curves for Mega series versus the original HNA 30 series for 3.3Vout modules at nominal 48Vin and 200 LFM of airflow.*

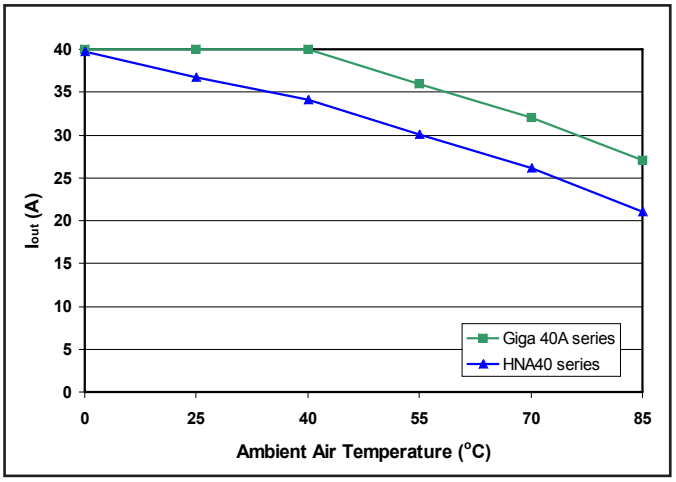


Figure 6: *Comparison of Power Derating curves for Giga series versus the original HNA 40 series for 3.3Vout modules at nominal 48Vin and 200 LFM of airflow.*

What types of customers should transition to the new KMGT series?

SynQor recommends that all customers using the existing HNA30/40 modules should switch over to the Kilo, Mega, Giga, Tera series. We realize that it is often not cost effective to make a part change during a product life cycle. However, we do recommend that you convert to the KMGT series if you meet one or more of the following conditions:

1. You are beginning a new design.
2. You are currently using or plan to use the converters in parallel or sequencing applications and you want to take advantage of the "back bias" solution in the KMGT series.
3. You want to take advantage of the increased efficiency and improved circuitry that the Kilo, Mega, Giga, Tera units provide.
4. You need more current/power output than the HNA30/40 series can provide or you wish to take advantage of the improved derating performance of the KMGT series.
5. You desire less power than the existing HNA30 series, in which case you could use the low power Kilo half-brick, which sells at a lower price.
6. You wish to take advantage of the additional features on the full-feature modules such as current sharing.

Will I need to re-test and re-qualify the new units?

The standard feature Kilo, Mega, Giga, Tera series have the same industry-standard footprint and pin out as the existing HNA30/40 series. This means they are a direct replacement from a form and fit standpoint to the original series. The functionality has changed only slightly. Therefore, we recommend that anyone replacing HNA30/40 units would be safe to fully evaluate the Kilo, Mega, Giga, Tera units in their application.

The full feature units have the 4 additional pins to provide their added functionality. Therefore, replacing HNA30/40 modules with full-feature KMGT units would require a board layout change in addition to functional testing of the units.

How does the Part Numbering change for the new series?

SynQor's original family of 48Vin half-brick converters consisted of a 30Amp series and a 40Amp series. The part number scheme for each series was PQ48xxxHNA30zzz and PQ48xxxHNA40zzz. The xxx refers to the output voltage (ie. 033 = 3.3V). The zzz refers to enable logic, pin length and feature set. The part number scheme for the Kilo, Mega, Giga, Tera series will be the exact same as the HNA30/40 series except that the "N" will be replaced by a "K", "M", "G", or "T" depending on the performance level of the product. For example a 3.3Vout Kilo unit will be called PQ48033HKA20zzz.

Will SynQor's Quarter-brick line be offered in Kilo, Mega, Giga, Tera grades?

SynQor's 48Vin, 25A/100W quarter-brick line, which was introduced in Q4 1999, has the exact same circuitry improvements as the new KMGT half-brick line. This existing line of quarter-bricks was introduced with the following part number scheme, PQ48xxxQNy25zzz. SynQor did not develop the Kilo/Mega/Giga/Tera naming convention until after the release of this quarter-brick line. To keep our family names consistent SynQor will now refer to the 25A/100W quarter-brick line as the "Giga" performance series. The new part number would be as follows; PQ48xxxQGy25zzz. The only difference between QN and QG is that QG now has Lucent/Tyco trim compatibility as a standard feature. This was previously offered as a revision level option (Rev. E) on the older QN product. SynQor will continue to retain the QN part number for customers that prefer not to have to make any administrative changes. However, other than the trim equation, there is no change in form, fit or function to the actual product. The part number changes only reflect the new naming convention and the Lucent/Tyco trim compatibility. SynQor has recently announced higher power "Tera" series (40 amp) and a lower power (15 amp) "Mega" version of our quarter-brick series.

SynQor's 24Vin, 25A/100W quarter-brick line, released in 2001, has been referred to as the "Giga" performance series from the time of its introduction. These units have the following familiar part number scheme, PQ24xxxQGy25zzz. This is consistent with the Kilo, Mega, Giga, Tera half-brick part number system and no changes are necessary.

Are the Kilo, Mega, Giga, Tera units available in baseplated versions?

All models are available in a baseplated version to provide optional heatsinking for increased power output in severe thermal environments. Baseplated modules are identified with a "B" as the 10th letter of the part number. The entire 48V input half-brick product line will be available in Q2 2001 in open frame or baseplated options. The 48V input and 24V input Quarter-brick models are also available in both open frame or baseplated options. Please contact SynQor if you have any questions regarding our baseplating process and baseplated unit pricing.

Conclusion

SynQor is meeting today's power design challenges by increasing efficiency and reliability while reducing converter size and eliminating the need for a heatsink. The Kilo, Mega, Giga, Tera product strategy will offer the most complete line of synchronous rectifier half-brick and quarter-brick converters available on the market. Customers will now have a complete array of scalable power choices for industry standard converters that match their individual needs for performance, price and functionality.

SynQor

Advancing The Power Curve

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