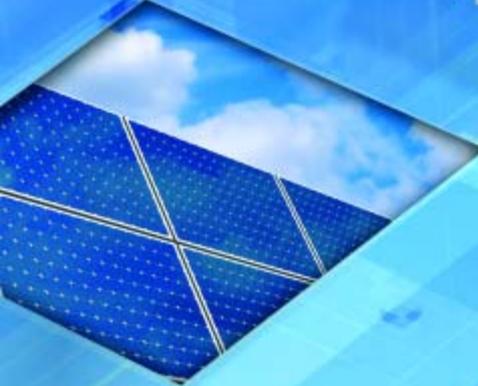


# **Bodo's Power Systems**<sup>®</sup>

**Electronics in Motion and Conversion**

**February 2011**



# Scalable Solutions for Cost and Energy-Efficient Drives

## *XE166 real-time signal controllers*

*Numerous providers of electric drives think about extending their product portfolios.*

*The reason for this is the trend towards improved energy efficiency which increases demand for variable speed drives. This applies both to consumer solutions in the low-end segment, where manufacturers can improve their margins with higher value drives, and to providers in the high-end segment, who look to use their technological expertise to realise innovative solutions for the low-end segment with correspondingly high volumes.*

*By Dr. Stephan Zizala, Senior Director, Microcontrollers, Industrial and Multimarket, Infineon Technologies*

With its new XE16xL and XE16xU real-time signal controllers, Infineon supports those customers in particular who extend their offerings over a wider performance range, but who prefer not to have to use multiple microcontroller platforms.

Electric motors play a key role in power consumption. According to a 2008 Study by the VDE Association for Electrical, Electronic & Information Technologies, industry alone in Germany accounts for 240 TWh/year of electrical energy consumption, households 140 TWh, service companies 130 TWh and transportation 16 TWh. Electrical drives used in industry and households alone account for 50% of the total electrical energy consumed. According to VDE, more efficient three-phase motors in the power range from 1.1 to 37 kW offer the greatest potential for saving electrical energy. Of the some 100 million household appliances operated by small electrical motors, most have efficiencies of between 40% and 75%. VDE estimates however that 85% would be possible. VDE puts the associated energy saving potential at 8.2 TWh per annum. In Germany, there are also around 30 million heating pumps with an output of less than 200 W. They consume around 3.5% of the total amount of electrical energy consumed in Germany. New, electronically controlled heating pumps use up to 50% less energy than standard pumps with asynchronous motors and up to 70% less than fixed-speed pumps, as these can still be found in many cases in buildings. The decisive factor here is that the pumps always run with the optimum speed, since a pump running at half speed requires only 1/8 of the energy compared with when running at full speed.

### **Predestined for cost and energy-efficient drives**

In many applications that involve the use of electrical motors, it is necessary to process numerous external signals quickly. In other words, high real-time performance is called for. With its low latency times for the interrupt response and rapid context switching, the XE166 family is optimised for precisely such applications as these. The CPU core, peripheral event controller (PEC) and the peripheral functions are designed accordingly for efficient interrupt handling. Particularly in applications involving multiple motors, the advantages in terms of a simple, rapid and energy-efficient implementation are

important. The efficient capture/compare (CCU6E) unit with two timers for signal generation permits efficient designs, irrespective of the type of motor to be driven and/or control algorithm.

1.6MB					XE16xL1 (1.6MB)	XE16xU1 (1.6MB)
1MB					XE16xL1 (1.6MB)	XE16xU1 (1.6MB)
768KB				XE16xL4 (768KB)	XE16xU4 (768KB)	
576KB			XE16xL6 (576KB)	XE16xU6 (576KB)	XE16xL6 (576KB)	
384KB			XE16xL8 (384KB)	XE16xU8 (384KB)	XE16xL8 (384KB)	
320KB			XE16xL8 (320KB)	XE16xU8 (320KB)		
192KB			XE16xL8 (192KB)	XE16xU8 (192KB)		
160KB		XE16xL1 (160KB)	XE16xU1 (160KB)			
128KB		XE16xL1 (128KB)	XE16xU1 (128KB)	XE16xU1 (128KB)		
96KB			XE16xL1 (96KB)			
64KB	XE16xL1 (64KB)	XE16xU1 (64KB)				
32KB	XE16xL1 (32KB)					
* NEW	TNSC1P16	VQ1668	QFP64	QFP68	QFP64	QFP76

Figure 1: XE166 microcontrollers - complete, scalable 16-bit MCU portfolio for low-cost through to high-performance applications

The spectrum of applications addressed by the 16-bit MCUs of the XE166 family (Figure 1) ranges from relatively simple control tasks in pumps, fans, compressors and HVAC technology through to more sophisticated solutions for servo drives, CNC machines, process controls and robotics. A particularly important field of application for the XE166 products is the efficient control of inverters. This allows highly energy-saving solutions to be realised in the fields of transport (forklift trucks, construction machinery, agricultural machinery, tramways, etc.) as well as for renewable energies (photovoltaics, wind energy, fuel cells, etc.).

The XE166 real-time signal controllers have been specifically designed for the above-mentioned applications. In this respect, they offer a scalable computing performance from 66 to 160 MIPS, 32 KB up to 1.6 MB embedded flash memories, 12 to 138 KB RAM, PWM units for up to four motors, A/D converters with 8, 10 and 12-bit reso-

lutions, 10 to 30 channels, up to six CAN nodes and 2 to 10 software-defined serial interfaces. The package options range from 38 to 176 pins, with the controllers being available both for industrial and automotive temperature ranges of up to 125 °C ambient temperature.

Further integrated functions such as a voltage regulator, EEPROM emulation with additional flash modules, oscillator, watchdog and brown-out detection reduce the number of external components and, as such, the system costs (BOM).

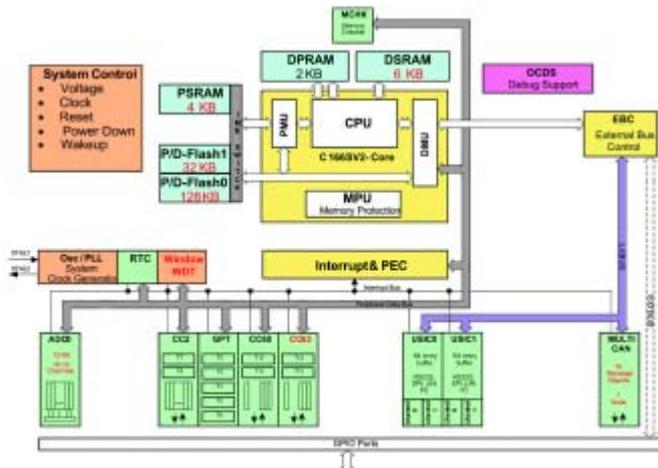


Figure 2: Block diagram of the XE166L series: Compared with the XE16xU series (Figure 3), it offers greater flash memory capacity (160 KB vs. 64 KB), more A/D converter channels (19 channels vs. 8 channels) and PWM units (2 vs. 1).

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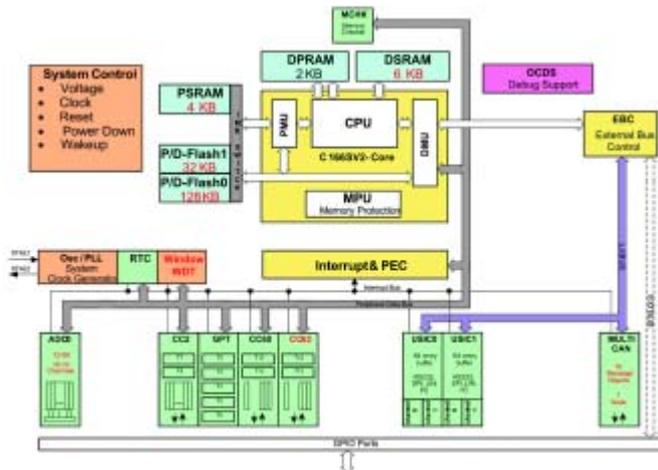


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### The new XE16xU and XE16xL series

The new MCU series are aimed at cost-efficient motor control units which, to date, have mostly been addressed by high-end 8-bit MCUs or low-end DSPs. In this regard, they offer real-time performance and high computing power at low cost. Key features include a high DSP performance, a superfast 12-bit A/D converter with synchronisation features, an efficient capture/compare unit and a high-speed PWM unit with <math><12.5\text{ ns}</math>. The new low-end series from the XE166 family deliver a computing power of 66 MIPS, 32 to 160 KB embedded flash and an optimised 12-bit SAR A/D converter with a conversion time of just 600 ns. The package offering comprises versions with 38, 48 and 64 pins. Performance-wise, they extend Infineon's 8-bit microcontroller family thanks to an efficient MAC unit for DSP operations. The A/D conversion functionality and the established PWM unit (CCU6) are retained via the MCU platform, such that the often most complex of code for the peripherals can be easily ported. The new XE16xU and XE16xL low-end variants are opcode and peripheral compatible and thus permit simple scalability and the re-use of existing software.

The main differences between the XE16xL (L stands for low-end, Figure 2) and XE16xU (U for ultra-low-end, Figure 3) series are the capacity of the flash memory (160 KB compared with 64 KB), the 12 bit A/D converter (19 channels vs. 10 channels) and the PWM units (two vs. one). What is more, the XE16xL microcontrollers feature a high-speed MultiCAN module.

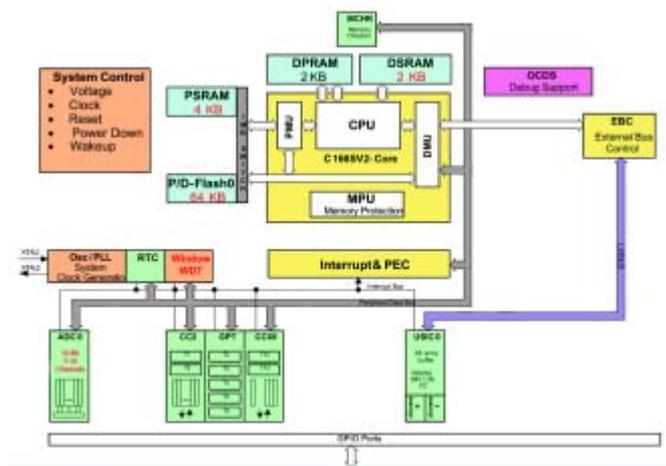


Figure 3: Block diagram of the XE166U series optimised for highly cost-critical applications

### Efficient design

The XE166 family is supported by comprehensive development tools, which include evaluations boards, debuggers, compilers and corresponding documentation. For the initialisation, configuration and code generation, DAVe (Digital Application virtual Engineer) is available. Using the DAVe Drive auto-code generator (Figure 4), it is possible to generate even the most complex motor control code automatically and quickly. In conjunction with customised application kits, it is possible, for example, to generate the code for a sensorless field-oriented control of a PMSM motor in just 15 minutes. Whereas experienced users can simply re-use their existing code, newcomers enjoy the benefits of being able to get started quickly in design.

Configuration tools such as DAVe help with the programming of the microcontroller with the aid of smart wizards. DAVe automatically generates C code with the correct driver functions for the peripheral equipment integrated on the chip and the interrupt control – interacting directly with the compiler in doing so. The tool generates com-

plete algorithms in source code (C or Assembler), which can then be compiled and tested with the aid of standard development environments (e.g. Keil or Tasking).

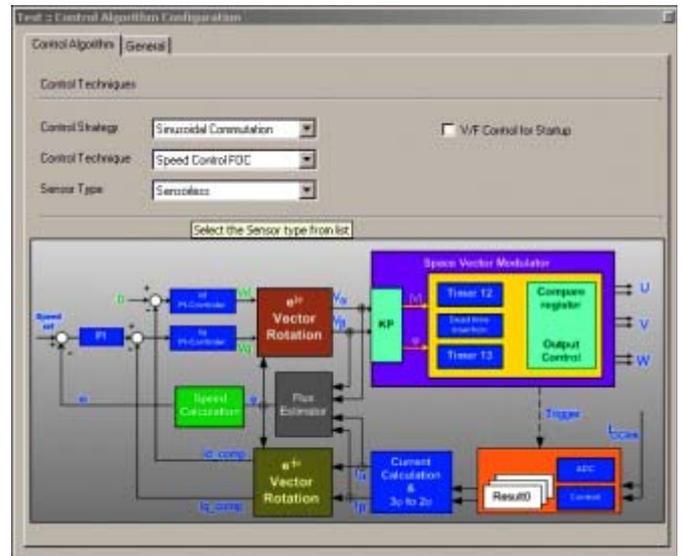


Figure 4: The XE166 family is supported by a complete design environment, which includes compilers, debuggers, operating systems, application kits in addition to configuration and auto-generator tools. The DAVe Drive auto-code generator permits the fast and simple realisation of even the most complex of motor controls, e.g. sensorless field-oriented control (FOC).

Auto-code generators are an important point for quickly getting a motor running efficiently. With DAVe Drive, the motor control code is automatically generated via a GUI, instead of writing thousands of program lines from scratch. What is more, the code generator uses the full performance of the associated microcontrollers. In addition, a complete reference system including an evaluation board and PMSM motor is available. DAVe Drive supports both BLDC and PMSM motors in addition to various control algorithms: block commutation with Hall sensors and without, in addition to sensorless FOC (field-oriented control). This enables designers to focus from an early stage on the development of the application-specific software of drives and accelerate prototype production significantly. Compared with other configuration tools, the DAVe Drive software generates complete algorithms and is not based on libraries. In addition, flexible code



Figure 5: The IO-Link kit permits the simple evaluation of the functionality of a complete IO-Link-based master device configuration on the basis of the XE166 MCUs and XC800 devices (8 bit).

generation is also possible for customer-specific motors, as a result of which the development time can be significantly reduced, whilst the system differentiation is simplified.

The XE166 family comes with OCDS debugger support and also supports the new single-pin debug interface. Some compilers also feature a real-time kernel and simulator. Furthermore, in collaboration with Infineon, Altium offers a free Tasking XE166 C compiler with a renewable 12-month licence. The version of the Altium Tasking C166 compiler toolset specially developed for the XE166 family offers efficient functions. The integrated development environment simplifies access to the CrossView Pro source level debugger, which in turn simplifies the connection to each XE166 EasyKit evaluation board. Pre-installed and working design examples, the step-by-step instructions and additional, advanced tools such as an automatically generated start-up code facilitate getting started in design.

#### Scalable solutions

Besides the performance and peripheral equipment, there is another aspect with regard to the scalability – namely, the integration into industrial networks. Networks such as these have at least three levels: the field level, the control level and the operations level. Against this background, the XE166 family offers a wide range of interfaces and customised solutions for the field and control level. By way of example, for communication with sensors and actuators, up to six serial interfaces are available, e.g. SPI, UART and I2C. In addition, Infineon offers an evaluation kit for the development of communications systems on the basis of the IO-Link V1.1 standard. The IO-Link kit (Figure 5) permits the simple evaluation of the functionality of a complete IO-Link-based master device configuration. Thanks to the real-time performance of the XE166 MCUs (for the master side) and the cost-effective XC800 modules (on the device side), the first solution in the entire industry is available with up to eight IO-Link channels on the master and FIFO buffers for each channel. A CANopen solution which can use up to six CAN nodes of the XE166 controllers is conceivable as an efficient connection on operations level.

#### Every percentage point is important

The new low-end series extend the scalability of the XE166 family even further for a broad spectrum of energy-efficient motor control applications, from simple drives used in pumps through to the most powerful servo drives. In this regard, it is worth “teasing out” every percentage point in energy efficiency, since, as mentioned at the outset, electric motors are the prime consumers of electrical energy. And one final aspect of scalability is time! Being focussed on industrial and automotive markets, the product life cycles of Inf-

neon's microcontroller solutions are designed with the long-term availability needs of the respective industries in mind.

[www.infineon.com/xe166](http://www.infineon.com/xe166)

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