XMEGA™

↗ **AVR XMEGA**

8/16-bit High Performance Low Power Flash Microcontrollers
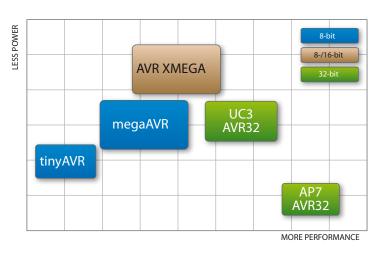
AVR

Introducing The AVR Family
High Performance/Low Power 8- to 32-bit microcontrollers/processors

AVR Devices — success through innovation

Atmel® offers both 8-bit and 32-bit AVR®'s, and since day one the AVR philosophy has always been clear: Highest performance with no power penalty.

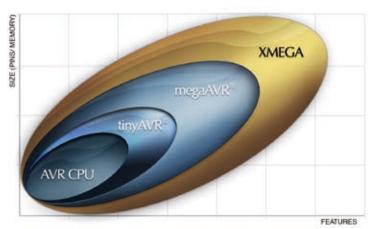*Atmel is offering a wide range of AVR microcontrollers:*

- *tinyAVR , 1-16 KBytes Flash, 8-32 pin packages*
- *megaAVR, 4-256 KBytes Flash, 28 to 100 pin packages*
- *AVR XMEGA, 16-384 KBytes Flash, 44-100 pin packages*
- *AVR32 UC3, 64-512 KBytes Flash, 48-144 pin packages*
- *AVR32 AP7, 210 DMIPS throughput at 150 MHz, 196-256 pin packages*

AVR XMEGA - For demanding embedded applications

With a DMA Controller, an Innovative Event System, crypto engine and high speed ADC and DAC, AVR XMEGA™ pushes the boundaries for high performance 8/16 bit MCUs while still remaining highly compatible with tinyAVR® and megaAVR®.

XMEGA highlights

- picoPower™ technology for ultra low power consumption
- True 1.6 volt operation and CPU speeds up to 32 MHz
- Event System and DMA controller
- High speed, high resolution 12-bit ADC and DAC
- Crypto engine, Timers/Counters and fast communication interfaces
- Accurate and flexible Clock System with automatic clock failure protection

All AVR devices from the smallest tinyAVR to the largest XMEGA uses the same CPU. They differ only in features, pin count and memory size. This enable AVR to cover the complete 8- and 16-bit market with one single, compatible product family.

picoPower Technology
Reducing power consumption—maintaining performance

picoPower — Best MCU power budget

Atmel's picoPower technology reduces power consumption in both sleep and active mode. With picoPower technology the embedded designer can reduce the applications power consumption while maintaining performance.

True 1.6 Volt Operation

AVR XMEGA offers true 1.6 Volt operation. All functions including ADC, DAC, Flash- and EEPROM memories are all operating down to 1.6V. This allows safe operation directly from a 1.8V ±10% power supply. It also enables deeper battery discharge to increase battery life.

Minimized Leakage Current

AVR XMEGA leakage current is only 100 nA while still maintaining full RAM and register retention. This reduces power consumption for applications spending most time in sleep mode.

Ultra Low Power 32 kHz Crystal Oscillator

AVR XMEGA's Real Time Counter consumes only 500 nA while running from a 32.768 kHz Crystal Oscillator.

Sleep modes

XMEGA has five different sleep modes to turn off unused modules and reduce the power consumption in the application. Many sleep modes makes it easy to f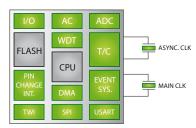ind the perfect fit for the application. The granularity is further enhanced by the innovative Power Reduction Register technology.

In idle sleep mode all peripherals operate while the CPU is sleeping to reduce the power consumption. with up to 50%, while event handling, communication and data input/output still run.
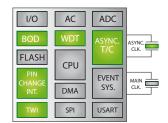
In power-save mode, XMEGA uses 650nA to run the Real Time Counter and have full SRAM and register retention offering industry leading low power numbers. Enabling Watchdog and Brown Out adds only 1uA.

In power-down mode, XMEGA uses only 100nA with SRAM and register retetion, and 5us wake-up time from pin change on any I/O pin and TWI address match.
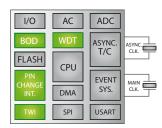
Standby and extended standby sleep modes are identical to power-down and power-save, except the external oscillator is kept running to reduce wake-up time.

Idle mode   *Power-save mode*   *Power-down mode*

AVR XMEGA
The new XMEGA microcontrollers feature

- Based on the AVR CPU
- Increased CPU speed -> 32 MHz
- Supports ultralow 1.6 Volt operation
- Reduced power consumption

Brand New Event System!

- Off-loads the CPU
- Reducing power usage
- Up to 8 simultaneous events
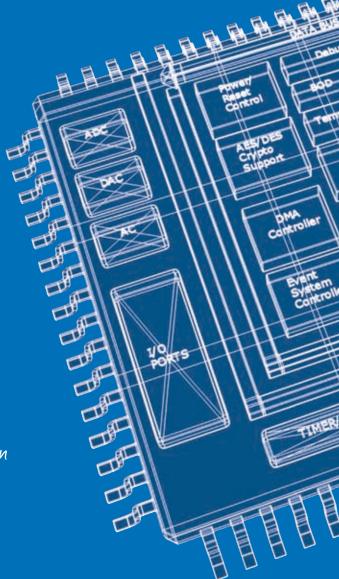-> 100% predictable response time

The Fast AVR CPU!

- Up to 32 MIPS
- Single cycle execution
- Instruction set optimized for C
- 32x8 general purpose registers
- hardware multiplier
-> Perfect for 8/16-bit applications

Built-in Crypto Engine

- Supports both AES and DES
- Reducing CPU time and power consumption
- Minimal CPU overhead for secure communication

Additional DMA Controller

- Off-loads the CPU
- Saves power
- 4-channels
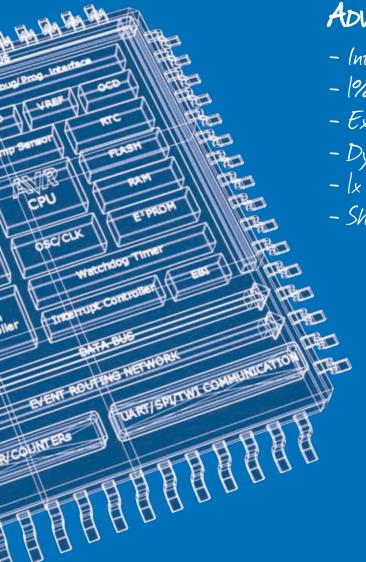-> Fast transfer between memories
    and peripherals

Timer/Counters

- 16-bit (32-bit cascaded)
- Advanced Waveform eXtensions
- 16-bit RTC

XMEGA includes a programmable and SAMPLED BOD and a low power, CPU independent WATCH-DOG TIMER.
XMEGA has flexible I/O pin conﬁguration, sensing, and wake-up signaling plus PROGRAMMABLE MULTI-LEVEL INTERRUPT Controller

ADVANCED CLOCK SYSTEM

- Internal 32 kHz, 2 MHz, 32 MHz + PLL
- 1% accuracy
- External oscillator or clock input
- Dynamic and safe clock switching
- 1x – 2048x prescaling
- Short wake-up from sleep modes

ONBOARD MEMORY

- FAST and SECURE!
- Up to 384 KB FLASH
- Up to 4 KB EEPROM
- Up to 32 KB SRAM

HIGH SPEED ANALOG INTEGRATION

- 12-bit resolution
- 2 Msps ADC
- 1 Msps DAC
- ANALOG COMPARATOR

COMMUNICATION INTERFACES

- USART + SPI + Two-Wire Interface (I2C compatible)
- External Bus Interface
- Debugging/Programming

System Performance

For Embedded systems, system performance is much more than a good MIPS number. It is important to have powerful peripherals and features that allow the application to run smoothly with minimum power consumption.

AVR CPU and Instruction Set

The AVR XMEGA uses the AVR RISC CPU which is created for high level C code development. The instruction set and CPU design are tuned for minimum code size and maximum execution speed. Due to the true single cycle execution of arithmetic and logic operations, AVR microcontrollers perform close to 1 MIPS per MHz.

Auto increment/Decrement example

```
C Source:
unsigned char *var1, *var2;
*var1++ = *--var2;

Generated assembly code:
LD  R16, -x
ST  z+, R16
```
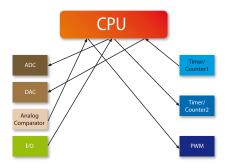

Central in the AVR architecture is the fast-access register file with 32 x 8-bit general purpose working registers directly connected to the Arithmetic Logic Unit. Within a single clock cycle the ALU can be fed two arbitrary registers, do a requested operation, and write back the result.
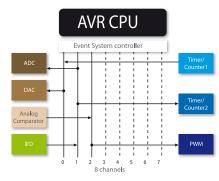The AVR XMEGA instruction set also support atomic 16-bit register access, 32-bit arithmetics, and have three 24-bit memory pointers.

Event System

The innovative AVR XMEGA Event System allow peripherals to send signals (events) directly to other peripherals without involving the CPU. This ensures short and 100% predictable response time and at the same time offloads the CPU.
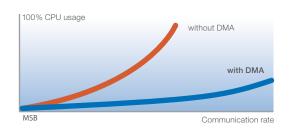

Without Event System all Peripheral Requests need to be handled by the CPU.

With Event System peripherals can send signals (events) to other peripherals.

DMA Controller

The AVR XMEGA's 4-channel Direct Memory Access (DMA) Controller enables fast, CPU independent data transfer between any locations in the data memory space and the peripherals. Flexi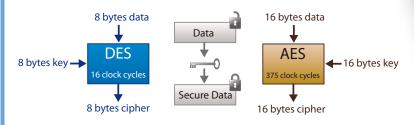ble channel priority selection, several address-ing modes and double buffering capabilities. The DMA Controller a powerful module for all data oriented applications such as signal processing and industrial control. Each DMA transfer can range from 1 byte to 16 Mbytes, increasing CPU computing performance and lowering power consumption.

100% CPU usage

without DMA

with DMA

MSB

Communication rate

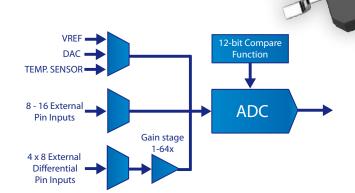| CPU load at various communication speeds					
SPI (kbps)	with DMA	No DMA	UART (kbps)	with DMA	No DMA
250	0 %	8 %	19.2	0 %	1 %
500	0 %	16 %	116.2	0 %	3 %
1	1 %	30 %	921.6	1 %	26 %
2	1 %	57 %	1.2	1 %	34 %
4	2 %	98 %	2	1 %	58 %

Crypto Engine

AVR XMEGA includes a crypto engine for 64-bit DES and 128-bit AES encryption and decryption.

There are no export limitations for the AVR XMEGA with crypto engine, so using XMEGA for crypto function do not limit where you can sell your product.
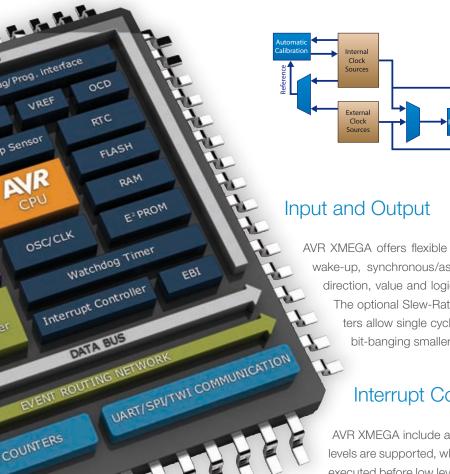
8 bytes data

8 bytes key →

DES
16 clock cycles

8 bytes cipher

Data

Secure Data

16 bytes data

AES
375 clock cycles

← 16 bytes key

16 bytes cipher

Analog and Digital Conversion

AVR XMEGA is highly integrated with high performance 12-bit ADC and DAC. The ADC sup-port up to 2 million samples per second. The DAC has con-version rates up to 1 msps and comes with built-in offset and gain compensation. XMEGA also include several analog comparators with window func-tion and flexible input selection.

VREF
DAC
TEMP. SENSOR

8 - 16 External Pin Inputs

4 x 8 External Differential Pin Inputs

Gain stage 1-64x

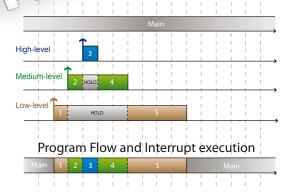12-bit Compare Function

ADC

Clock System

AVR XMEGA's clock system allow flexible change of frequency. Dynamic Clock Switching allows the Embedded Designer to tune performance and power consumption to fit the application. The internal PLL and prescaler can be used to scale the clock sources dynamically up or down to further match application requirements. With a built-in External Oscillator failure detection and internal RC oscillator with ± 1% accuracy over temperature and voltage, XMEGA offers the most safe, reliable and flexible clock system.

Input and Output

AVR XMEGA offers flexible I/O pin configuration with various sensing, wake-up, synchronous/asynchronous, and driver settings. I/O pin's direction, value and logic state are read through separate registers. The optional Slew-Rate limitation reduces EMI. Virtual ports registers allow single cycle pin manipulation. This makes software for bit-banging smaller and faster.

Interrupt Controller

AVR XMEGA include a multi level interrupt controller. Three priority levels are supported, where higher level interrupts are prioritized and executed before low level interrupts. All peripherals can be assigned any interrupt level.

Program Flow and Interrupt execution

A higher level interrupt will halt execution of a lower level interrupt routine. The lower level interrupt routine will continue and finish after the higher level interrupt routine finishes.

Program Flow and Interrupt execution

A second interrupt at an interrupt level already being serviced, will pend until the first interrupt routine finishes.

Interfaces

AVR XMEGA comes with various interfaces that combined with DMA or Event System creates a powerful and fast communication platform.

USART

Full asynchronous and clocked synchronous operation.
- Fractional BAUD Rate Generator
- Master SPI mode
- IRCOM module for IrDA Compliance
- Up to 4 Mbps communication

SPI

Fast full duplex synchronous serial communication
- Master and Slave Operation
- Up to 16 Mbps communication

EBI

External Bus Interface, for easy access to
- SRAM
- SDRAM
- External peripherals (e.g. LCDs)
- Memory mapped devices

TWI (The Two Wire Interface)

Bi-directional 2-wire bus communication,
- I^2C and SMBus compliant
- Slave operates in all Sleep Modes
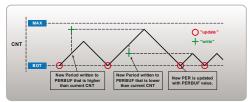- Full 100 kHz and 400 kHz support
- Master and Slave operation

Timer/Counters

All AVR XMEGA Timer/Counter modules are 16-bit with Input Capture and Pulse Width Modulation (PWM) functionality. Up to 128 MHz PWM is possible from internal PLL by using the Hi-Res extension. Using the Event System and Advanced Waveform Extension (AWeX) and high resolution extention, implementation of advanced motor control (AC, BLDC, SR, and Stepper) and power control applications is made easy.
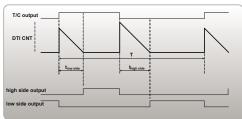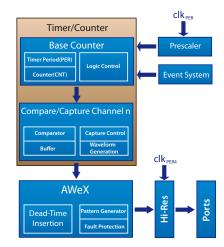

Normal mode of operation, counting up or down

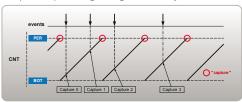*Changing the period with buffering in dual slope mode*

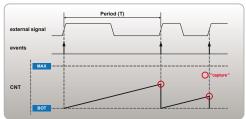*AWeX Dead Time Insertion (DTI) with separate high side and low side period*

Input capture of pin change using the Event System
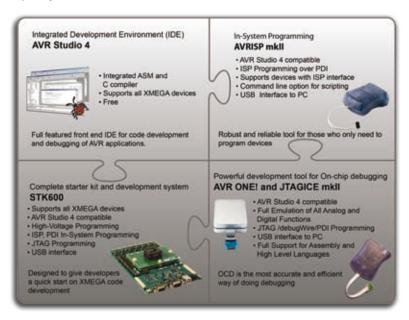

Frequency capture of an external signal

Ease of use

AVR XMEGA microcontrollers benefit from the already existing AVR tools- and software chain. With a large ecosystem including hardware, software, documentation, and partners available, embedded developers will find it easy to succeed with the XMEGA!

AVR Tools — quality and low cost

Debugging and Programming

All XMEGA devices include a non-intrusive On-Chip Debug system that requires no device resources. This gives real time access to all peripheral registers, data and program memories, and support unlimited number of break points. XMEGA has a fast, serial programming interface for production line- or in system programming. Using a bootloader XMEGA can receive flash upgrades in the field through any interface without reset or halt of critical program execution. The crypto engine and a serial number in each device ease implementation of safe crypto bootloaders, networking applications, authentication and life cycle product tracking.

AVR Documentation and Software — ready, steady, go!

With both devices and tools available designers need good documentation. From the smallest devices to the largest processors, reference datasheets describing features and use are available from the Atmel web pages. Free application notes and library with complete code make it easy to start development. Partner software brings your product to the market with no hassle.

Support

On our dedicated MCU pages you can easily submit questions and get technical support. All relevant AVR XMEGA FAQs, datasheets, application notes, and software are also available online:

http://www.atmel.com/avr
 Selection Guides, Data Sheets and Errata Sheets
 Application Notes and Reference Library
 Atmel and Third Party Tools
 Software, User Guides
 Consultants, Distributors and Atmel Representatives

http://support.atmel.no
 Official Atmel MCU technical support center with FAQ and
 email notification service

http://www.avrtv.com
 Official AVR podcasts

http://www.avrfreaks.net
 AVR Experts Discussion Forum, Selection Guides for Tools and
 Products, Third Party Tools Information, FAQs

The XMEGA Product Range

All AVR XMEGA are pin and 100% code-compatibility across all devices from the smallest to the largest. It is possible to development with any XMEGA device, and switch to any other XMEGA device later without having to change any code. It enables companies to keep and maintain only one code base and use and re-use this across multiple projects. The result is a much faster development and prototyping cycles.

- Operating voltage form 1.6 to 3.6V
- CPU speed up to 32 MHz
- 16 to 384 Kbytes of Internal Flash Memory
- 44 to 100 pin packages

- 100% code compatibility
- Pin compatibility
- Easy to migrate between XMEGA devices

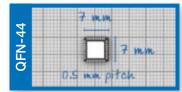| Product (a)	Status (b)	Flash (KB)	Boot code (Bytes)	EEPROM (KB)	SRAM (KB)	DMA (channels)	Event (Channels)	I/O pins	16-bit Timers	PWM (channel)	RTC 16-bit	RTC 32-bit (d)	SPI	TWI (I2C)	USART	12-bit ADC (ch.)	12-bit DAC (ch.)	Analog Comp.	Interrupts	Interrupts Ext.	Vcc Range (V)	Clock Speed (MHz)	Package (c)
ATxmega64A1	I	64	4	2	4	4	8	78	8	24	Y		4	4	8	2x8	2x2	4	122	78	1.6 - 3.6	32	TQFP100, BGA100
ATxmega128A1	I	128	8	2	8	4	8	78	8	24	Y		4	4	8	2x8	2x2	4	122	78	1.6 - 3.6	32	TQFP100, BGA100
ATxmega192A1	I	192	8	4	16	4	8	78	8	24	Y		4	4	8	2x8	2x2	4	122	78	1.6 - 3.6	32	TQFP100, BGA100
ATxmega256A1	I	256	8	4	16	4	8	78	8	24	Y		4	4	8	2x8	2x2	4	122	78	1.6 - 3.6	32	TQFP100, BGA100
ATxmega384A1	I	384	8	4	32	4	8	78	8	24	Y		4	4	8	2x8	2x2	4	122	78	1.6 - 3.6	32	TQFP100, BGA100
ATxmega64A3	I	64	4	2	4	4	8	50	7	22	Y		3	2	7	2x8	1x2	4	102	50	1.6 - 3.6	32	TQFP64, QFN64
ATxmega128A3	I	128	8	2	8	4	8	50	7	22	Y		3	2	7	2x8	1x2	4	102	50	1.6 - 3.6	32	TQFP64, QFN64
ATxmega192A3	I	192	8	4	16	4	8	50	7	22	Y		3	2	7	2x8	1x2	4	102	50	1.6 - 3.6	32	TQFP64, QFN64
ATxmega256A3B	I	256	8	4	16	4	8	49	7	22		Y	2	2	6	2x8	1x2	4	102	49	1.6 - 3.6	32	TQFP64, QFN64
ATxmega256A3	I	256	8	4	16	4	8	50	7	22	Y		3	2	7	2x8	1x2	4	102	50	1.6 - 3.6	32	TQFP64, QFN64
ATxmega16A4	F	16	4	1	2	4	8	34	5	16	Y		2	2	5	1x12	1x2	2	77	34	1.6 - 3.6	32	TQFP44, QFN44
ATxmega32A4	F	32	4	1	4	4	8	34	5	16	Y		2	2	5	1x12	1x2	2	77	34	1.6 - 3.6	32	TQFP44, QFN44
ATxmega64A4	F	64	4	2	4	4	8	34	5	16	Y		2	2	5	1x12	1x2	2	77	34	1.6 - 3.6	32	TQFP44, QFN44
ATxmega128A4	F	128	4	2	8	4	8	34	5	16	Y		2	2	5	1x12	1x2	2	77	34	1.6 - 3.6	32	TQFP44, QFN44
ATxmega64D3	F	64	4	2	4		4	50	5	18	Y		2	1	3	1x16		2	67	50	1.6 - 3.6	32	TQFP64, QFN64
ATxmega128D3	F	128	8	2	8		4	50	5	18	Y		2	1	3	1x16		2	67	50	1.6 - 3.6	32	TQFP64, QFN64
ATxmega192D3	F	192	8	2	16		4	50	5	18	Y		2	1	3	1x16		2	67	50	1.6 - 3.6	32	TQFP64, QFN64
ATxmega256D3	F	256	8	4	16		4	50	5	18	Y		2	1	3	1x16		2	67	50	1.6 - 3.6	32	TQFP64, QFN64
ATxmega16D4	F	16	4	1	2		4	34	4	14	Y		2	1	2	1x12		2	55	34	1.6 - 3.6	32	TQFP44, QFN44
ATxmega32D4	F	32	4	1	4		4	34	4	14	Y		2	1	2	1x12		2	55	34	1.6 - 3.6	32	TQFP44, QFN44

a) All XMEGA devices have Event System channels, and temperature range from -40°C to +85°C and 32 MHz, 2 MHz and 32 KHz calibrated PC oscillators.
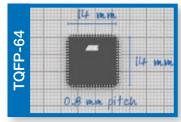b) F: Future product, I: Device under Introduction.
c) Pb-free packaging alternative, complies to the European Directive for Restriction of Hazardous Substances (RoHS directive). Also Halide free and fully Green.
d) Include Battery backup function

For samples and pricing offer, please contact you local distributor or Atmel sales representative. http://www.atmel.com/contacts/

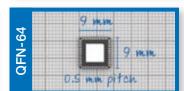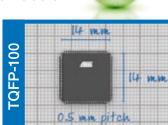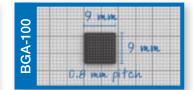## Pins/packages

AVR XMEGA is delivered in different package options, including fully green versions.

TQFP-44 — 10 mm × 10 mm, 0.8 mm pitch

TQFP-64 — 14 mm × 14 mm, 0.8 mm pitch

TQFP-100 — 14 mm × 14 mm, 0.5 mm pitch

QFN-44 — 7 mm × 7 mm, 0.5 mm pitch

QFN-64 — 9 mm × 9 mm, 0.5 mm pitch

BGA-100 — 9 mm × 9 mm, 0.8 mm pitch

ATMEL®

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from durably managed forests.
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