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What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "<u>Embedded -</u> <u>Microcontrollers</u>"

Details

Product Status	Active
Core Processor	AVR
Core Size	8-Bit
Speed	16MHz
Connectivity	SPI, UART/USART, USI
Peripherals	Brown-out Detect/Reset, LCD, POR, PWM, WDT
Number of I/O	54
Program Memory Size	64KB (32K x 16)
Program Memory Type	FLASH
EEPROM Size	2K x 8
RAM Size	4K x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 5.5V
Data Converters	A/D 8x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	64-TQFP
Supplier Device Package	64-TQFP (14x14)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/atmega649p-au

Address: Room A, 16/F, Full Win Commercial Centre, 573 Nathan Road, Mongkok, Hong Kong

- Real Time Counter with separate oscillator
- Four PWM channels
- 8-channel, 10-bit ADC
- Programmable Serial USART
- Master/Slave SPI Serial Interface
- Universal Serial Interface with Start Condition Detector
- Programmable Watchdog Timer with Separate On-chip oscillator
- On-chip analog comparator
- Interrupt and Wake-up on pin change
- Special microcontroller features
 - Power-on reset and programmable Brown-out detection
 - Internal calibrated oscillator
 - External and internal interrupt sources
 - Five sleep modes: Idle, ADC Noise Reduction, Power-save, Power-down, and Standby
- I/O and packages
 - 54/69 programmable I/O lines
 - 64/100-lead TQFP, 64-pad QFN/MLF, and 64-pad DRQFN
- Speed Grade:
 - ATmega169A/169PA/649A/649P:
 - 0 16MHz @ 1.8 5.5V
 - ATmega3290A/3290PA/6490A/6490P:
 - 0 20MHz @ 1.8 5.5V
- Temperature range:
 - -40°C to 85°C industrial
- Ultra-low power consumption (picoPower[®] devices)
 - Active mode:
 - 1MHz, 1.8V: 215µA
 - 32kHz, 1.8V: 8µA (including oscillator)
 - 32kHz, 1.8V: 25µA (including oscillator and LCD)
 - Power-down mode:
 - 0.1µA at 1.8V
 - Power-save mode:
 - 0.6µA at 1.8V (Including 32kHz RTC)
 - 750nA at 1.8V

2. Overview

The Atmel ATmega169A/169PA/329A/329PA/3290A/3290PA/649A/649P/6490A/6490P is a low-power CMOS 8-bit microcontroller based on the Atmel®AVR® enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega169A/169PA/329A/329PA/3290A/3290PA/649A/649P/6490A/6490P achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

2.1 Block diagram

Figure 2-1. Block diagram.



The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one



single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

The Atmel ATmega169A/169PA/329A/329PA/3290A/3290PA/649A/649P/6490A/6490P provides the following features: 16K/32K/64K bytes of In-System Programmable Flash with Read-While-Write capabilities, 512/1K/2K bytes EEPROM, 1K/2K/4K byte SRAM, 54/69 general purpose I/O lines, 32 general purpose working registers, a JTAG interface for Boundary-scan, On-chip Debugging support and programming, a complete On-chip LCD controller with internal contrast control, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, Universal Serial Interface with Start Condition Detector, an 8-channel, 10-bit ADC, a programmable Watchdog Timer with internal Oscillator, an SPI serial port, and five software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next interrupt or hardware reset. In Power-save mode, the asynchronous timer and the LCD controller continues to run, allowing the user to maintain a timer base and operate the LCD display while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer, LCD controller and ADC, to minimize switching noise during ADC conversions. In Standby mode, the XTAL/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption.

Atmel offers the QTouch library for embedding capacitive touch buttons, sliders and wheels functionality into AVR microcontrollers. The patented charge-transfer signal acquisition offers robust sensing and includes fully debounced reporting of touch keys and includes Adjacent Key Suppression[®] (AKS[®]) technology for unambiguous detection of key events. The easy-to-use QTouch Suite toolchain allows you to explore, develop and debug your own touch applications.

The device is manufactured using the Atmel high density non-volatile memory technology. The On-chip In-System re-Programmable (ISP) Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, by a conventional non-volatile memory programmer, or by an On-chip Boot program running on the AVR core. The Boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true Read-While-Write operation.

By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the ATmega169A/169PA/329A/329PA/3290A/3290PA/649A/649P/6490A/6490P is a powerful microcontroller that provides a highly flexible and cost effective solution to many embedded control applications.

The ATmega169A/169PA/329A/329PA/3290A/3290PA/649A/649P/6490A/6490P AVR is supported with a full suite of program and system development tools including: C Compilers, Macro Assemblers, Program Debugger/Simulators, In-Circuit Emulators, and Evaluation kits.



Comparison between Atmel 2.2

ATmega169A/169PA/329A/329PA/649A/649P/3290A/3290PA/6490A/6490P 1. Differences between: ATmega169A/169PA/329A/329PA/649A/649P/3290A/3290PA/6490A/6490P.

Table 2-1.

ATmega169A	16Kbyte	512Bytes	1Kbyte	4 × 25
ATmega169PA	16Kbyte	512Bytes	1Kbyte	4 × 25
ATmega329A	32Kbyte	1Kbyte	2Kbyte	4 × 25
ATmega329PA	32Kbyte	1Kbyte	2Kbyte	4 × 25
ATmega3290A	32Kbytes	1Kbyte	2Kbyte	4 × 40
ATmega3290PA	32Kbyte	1Kbyte	2Kbyte	4 × 40
ATmega649A	64Kbyte	2Kbyte	4Kbyte	4 × 25
ATmega649P	64Kbyte	2Kbyte	4Kbyte	4 × 25
ATmega6490A	64Kbyte	2Kbyte	4Kbyte	4 × 40
ATmega6490P	64Kbyte	2Kbyte	4Kbyte	4 × 40





Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page
0x11 (0x31)	PORTF	PORTF7	PORTF6	PORTF5	PORTF4	PORTF3	PORTF2	PORTF1	PORTF0	92
0x10 (0x30)	DDRF	DDF7	DDF6	DDF5	DDF4	DDF3	DDF2	DDF1	DDF0	92
0x0F (0x2F)	PINF	PINF7	PINF6	PINF5	PINF4	PINF3	PINF2	PINF1	PINF0	92
0x0E (0x2E)	PORTE	PORTE7	PORTE6	PORTE5	PORTE4	PORTE3	PORTE2	PORTE1	PORTE0	91
0x0D (0x2D)	DDRE	DDE7	DDE6	DDE5	DDE4	DDE3	DDE2	DDE1	DDE0	92
0x0C (0x2C)	PINE	PINE7	PINE6	PINE5	PINE4	PINE3	PINE2	PINE1	PINE0	92
0x0B (0x2B)	PORTD	PORTD7	PORTD6	PORTD5	PORTD4	PORTD3	PORTD2	PORTD1	PORTD0	91
0x0A (0x2A)	DDRD	DDD7	DDD6	DDD5	DDD4	DDD3	DDD2	DDD1	DDD0	91
0x09 (0x29)	PIND	PIND7	PIND6	PIND5	PIND4	PIND3	PIND2	PIND1	PIND0	91
0x08 (0x28)	PORTC	PORTC7	PORTC6	PORTC5	PORTC4	PORTC3	PORTC2	PORTC1	PORTC0	91
0x07 (0x27)	DDRC	DDC7	DDC6	DDC5	DDC4	DDC3	DDC2	DDC1	DDC0	91
0x06 (0x26)	PINC	PINC7	PINC6	PINC5	PINC4	PINC3	PINC2	PINC1	PINC0	91
0x05 (0x25)	PORTB	PORTB7	PORTB6	PORTB5	PORTB4	PORTB3	PORTB2	PORTB1	PORTB0	90
0x04 (0x24)	DDRB	DDB7	DDB6	DDB5	DDB4	DDB3	DDB2	DDB1	DDB0	90
0x03 (0x23)	PINB	PINB7	PINB6	PINB5	PINB4	PINB3	PINB2	PINB1	PINB0	91
0x02 (0x22)	PORTA	PORTA7	PORTA6	PORTA5	PORTA4	PORTA3	PORTA2	PORTA1	PORTA0	90
0x01 (0x21)	DDRA	DDA7	DDA6	DDA5	DDA4	DDA3	DDA2	DDA1	DDA0	90
0x00 (0x20)	PINA	PINA7	PINA6	PINA5	PINA4	PINA3	PINA2	PINA1	PINA0	90

Notes: 1. For compatibility with future devices, reserved bits should be written to zero if accessed. Reserved I/O memory addresses should never be written.

- 2. I/O Registers within the address range 0x00 0x1F are directly bit-accessible using the SBI and CBI instructions. In these registers, the value of single bits can be checked by using the SBIS and SBIC instructions.
- Some of the Status Flags are cleared by writing a logical one to them. Note that, unlike most other AVRs, the CBI and SBI instructions will only operate on the specified bit, and can therefore be used on registers containing such Status Flags. The CBI and SBI instructions work with registers 0x00 to 0x1F only.
- 4. When using the I/O specific commands IN and OUT, the I/O addresses 0x00 0x3F must be used. When addressing I/O Registers as data space using LD and ST instructions, 0x20 must be added to these addresses. The Atmel ATmega169A/169PA/329A/329PA/3290A/3290PA/649A/649P/6490A/6490P is a complex microcontroller with more peripheral units than can be supported within the 64 location reserved in Opcode for the IN and OUT instructions. For the Extended I/O space from 0x60 0xFF in SRAM, only the ST/STS/STD and LD/LDS/LDD instructions can be used.



Mnemonics	Operands	Description	Operation	Flags	#Clocks
MCU CONTROL INS	TRUCTIONS				
NOP		No Operation		None	1
SLEEP		Sleep	(see specific descr. for Sleep function)	None	1
WDR		Watchdog Reset	(see specific descr. for WDR/timer)	None	1
BREAK		Break	For On-chip Debug Only	None	N/A

9. Ordering information

9.1 Atmel ATmega169A

Speed [MHz] ⁽³⁾	Power supply	Ordering code ⁽²⁾	Package type ⁽¹⁾	Operational range
16	1.8 - 5.5V	ATmega169A-AU ATmega169A-AUR ⁽⁴⁾ ATmega169A-MU ATmega169A-MUR ⁽⁴⁾ ATmega169A-MCH ATmega169A-MCHR ⁽⁴⁾	64A 64A 64M1 64M1 64MC 64MC	Industrial (-40°C to 85°C)
		ATmega169A-AN ATmega169A-ANR ⁽⁴⁾ ATmega169A-MN ATmega169A-MNR ⁽⁴⁾	64A 64A 64M1 64M1	Extended (-40°C to 105°C)

Notes: 1. This device can also be supplied in wafer form. Please contact your local Atmel sales office for detailed ordering information and minimum quantities.

2. Pb-free packaging, complies to the European Directive for Restriction of Hazardous Substances (RoHS directive). Also Halide free and fully Green.

3. For Speed vs. $V_{CC},$ see Figure 29-1 on page 330.

4. Tape & Reel.

Package type					
	64-lead, thin (1.0mm) plastic Gull Wing Quad Flat Package (TQFP)				
	64-pad, 9 × 9 × 1.0mm body, lead pitch 0.50mm, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)				
	64-lead (2-row Staggered), 7 × 7 × 1.0mm body, 4.0 × 4.0 mm Exposed Pad, Quad Flat No-Lead Package (QFN)				



9.2 Atmel ATmega169PA

Speed [MHz] ⁽³⁾	Power supply	Ordering code ⁽²⁾	Package type ⁽¹⁾	Operational range
16	1.8 - 5.5V	ATmega169PA-AU ATmega169PA-AUR ⁽⁴⁾ ATmega169PA-MU ATmega169PA-MUR ⁽⁴⁾ ATmega169PA-MCH ATmega169PA-MCHR ⁽⁴⁾	64A 64A 64M1 64M1 64MC 64MC	Industrial (-40°C to 85°C)
		ATmega169PA-AN ATmega169PA-ANR ⁽⁴⁾ ATmega169PA-MN ATmega169PA-MNR ⁽⁴⁾	64A 64A 64M1 64M1	Extended (-40°C to 105°C) ⁽⁵⁾

Notes: 1. This device can also be supplied in wafer form. Please contact your local Atmel sales office for detailed ordering information and minimum quantities.

2. Pb-free packaging, complies to the European Directive for Restriction of Hazardous Substances (RoHS directive). Also Halide free and fully Green.

3. For Speed vs. V_{CC} , see Figure 29-1 on page 330.

- 4. Tape & Reel.
- 5. See characterization specification at 105°C.

Package type				
	64-lead, thin (1.0mm) plastic Gull Wing Quad Flat Package (TQFP)			
	64-pad, 9 × 9 × 1.0mm body, lead pitch 0.50mm, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)			
	64-lead (2-row Staggered), 7 × 7 × 1.0mm body, 4.0 × 4.0mm Exposed Pad, Quad Flat No-Lead Package (QFN)			

9.6 Atmel ATmega3290PA

Speed [MHz] ⁽³⁾	Power supply	Ordering code ⁽²⁾	Package type ⁽¹⁾	Operational range
20	1.9 5 5)/	ATmega3290PA-AU ATmega3290PA-AUR ⁽⁴⁾	100A 100A	Industrial (-40°C to 85°C)
20	1.0 - 5.5V	ATmega3290PA-AN ATmega3290PA-ANR ⁽⁴⁾	100A 100A	Industrial (-40°C to 105°C) ⁽⁵⁾

Notes: 1. This device can also be supplied in wafer form. Please contact your local Atmel sales office for detailed ordering information and minimum quantities.

2. Pb-free packaging complies to the European Directive for Restriction of Hazardous Substances (RoHS directive). Also Halide free and fully Green.

3. For Speed vs. V_{CC} see Figure 29-2 on page 330.

4. Tape & Reel.

5. See characterization specification at 105°C.

Package type

100-lead, 14 × 14 × 1.0mm, 0.5mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)



9.8 Atmel ATmega649P

Speed [MHz] ⁽³⁾	Power supply	Ordering code ⁽²⁾	Package type ⁽¹⁾	Operational range
16	1.8 - 5.5 V	ATmega649P-AU ATmega649P-AUR ⁽⁴⁾ ATmega649P-MU ATmega649P-MUR ⁽⁴⁾	64A 64A 64M1 64M1	Industrial (-40°C to 85°C)

Notes: 1. This device can also be supplied in wafer form. Please contact your local Atmel sales office for detailed ordering information and minimum quantities.

2. Pb-free packaging complies to the European Directive for Restriction of Hazardous Substances (RoHS directive). Also Halide free and fully Green.

3. For Speed vs. V_{CC} see Figure 29-1 on page 330.

4. Tape & Reel.

Package type					
	64-lead, 14 × 14 × 1.0mm, Thin Profile Plastic Quad Flat Package (TQFP)				
64-pad, 9 × 9 × 1.0mm, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)					

9.10 Atmel ATmega6490P

Speed [MHz] ⁽³⁾	Power supply	Ordering code ⁽²⁾	Package type ⁽¹⁾	Operational range
20	1.8 - 5.5V	ATmega6490P-AU ATmega6490P-AUR ⁽⁴⁾	100A 100A	Industrial (-40°C to 85°C)

Notes: 1. This device can also be supplied in wafer form. Please contact your local Atmel sales office for detailed ordering information and minimum quantities.

2. Pb-free packaging complies to the European Directive for Restriction of Hazardous Substances (RoHS directive). Also Halide free and fully Green.

3. For Speed vs. V_{CC} see Figure 29-2 on page 330.

4. Tape & Reel.

Package Type

100-lead, 14 × 14 × 1.0mm, 0.5mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)



10. Packaging Information

10.1 64A





Atmel





Atmel

11. Errata

11.1 Atmel ATmega169A

No known errata

11.2 Atmel ATmega169A/169PA Rev. A to F

Not sampled.

11.3 Atmel ATmega169PA Rev. G

No known errata.

11.4 Atmel ATmega329A/329PA rev. A

- · Interrupts may be lost when writing the timer registers in the asynchronous timer
- Using BOD disable will make the chip reset

1. Interrupts may be lost when writing the timer registers in the asynchronous timer

The interrupt will be lost if a timer register that is synchronous timer clock is written when the asynchronous Timer/Counter register (TCNTx) is 0x00.

Problem Fix/ Workaround

Always check that the asynchronous Timer/Counter register neither have the value 0xFF nor 0x00 before writing to the asynchronous Timer Control Register (TCCRx), asynchronous Timer Counter Register (TCNTx), or asynchronous Output Compare Register (OCRx).

2. Using BOD disable will make the chip reset

If the part enters sleep with the BOD turned off with the BOD disable option enabled, a BOD reset will be generated at wakeup and the chip will reset.

Problem Fix/Workaround

Do not use BOD disable

11.5 Atmel ATmega329A/329PA rev. B

Interrupts may be lost when writing the timer registers in the asynchronous timer

1. Interrupts may be lost when writing the timer registers in the asynchronous timer

The interrupt will be lost if a timer register that is synchronous timer clock is written when the asynchronous Timer/Counter register (TCNTx) is 0x00.

Problem Fix/ Workaround

Always check that the asynchronous Timer/Counter register neither have the value 0xFF nor 0x00 before writing to the asynchronous Timer Control Register (TCCRx), asynchronous Timer Counter Register (TCNTx), or asynchronous Output Compare Register (OCRx).



11.9 Atmel ATmega3290A/3290PA rev. C

· Interrupts may be lost when writing the timer registers in the asynchronous timer

1. Interrupts may be lost when writing the timer registers in the asynchronous timer

The interrupt will be lost if a timer register that is synchronous timer clock is written when the asynchronous Timer/Counter register (TCNTx) is 0x00.

Problem Fix/ Workaround

Always check that the asynchronous Timer/Counter register neither have the value 0xFF nor 0x00 before writing to the asynchronous Timer Control Register (TCCRx), asynchronous Timer Counter Register (TCNTx), or asynchronous Output Compare Register (OCRx).

11.10 Atmel ATmega649A/649P/ATmega6490A/6490P

No known errata.



12.5 Rev. 8284B - 03/11

- 1. Updated the datasheet according to the Atmel new Brand Style Guide.
- 2. Updated all "Ordering information" on page 20.
- 3. Updated "Packaging Information" on page 30.

12.6 Rev. 8284A - 10/10

1. Initial revision



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Atmel Corporation 1600 Technology Drive, San Jose, CA 95110 USA T: (+1)(408) 441.0311 F: (+1)(408) 436.4200 | www.atmel.com

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