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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

E·XFI

Product Status	Active
Core Processor	AVR
Core Size	8-Bit
Speed	16MHz
Connectivity	SPI, UART/USART, USI
Peripherals	Brown-out Detect/Reset, POR, PWM, WDT
Number of I/O	54
Program Memory Size	16KB (8K x 16)
Program Memory Type	FLASH
EEPROM Size	512 x 8
RAM Size	1K 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-VFQFN Exposed Pad
Supplier Device Package	64-QFN (9x9)
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/atmega165a-mur

Email: info@E-XFL.COM

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

- 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:
 - ATmega 165A/165PA/645A/645P: 0 16MHz @ 1.8 5.5V
 - ATmega325A/325PA/3250A/3250PA/6450A/6450P: 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)
 - Power-down mode: 0.1µA at 1.8V
 - Power-save mode: 0.6µA at 1.8V (Including 32kHz RTC)

Note: 1. Reliability Qualification results show that the projected data retention failure rate is much less than 1 PPM over 20 years at 85°C or 100 years at 25°C.



2.2 Comparison between Atmel

ATmega165A/165PA/325A/325PA/3250A/3250PA/645A/645P/6450A/6450P

 Table 2-1.
 Differences between: ATmega165A/165PA/325A/325PA/3250A/3250PA/645A/645P/6450A/6450P.

Device	Flash	EEPROM	RAM	MHz
ATmega165A	16Kbyte	512Bytes	1Kbyte	16
ATmega165PA	16Kbyte	512Bytes	1Kbyte	16
ATmega325A	32Kbyte	1Kbyte	2Kbyte	20
ATmega325PA	32Kbyte	1Kbyte	2Kbyte	20
ATmega3250A	32Kbytes	1Kbyte	2Kbyte	20
ATmega3250PA	32Kbyte	1Kbyte	2Kbyte	20
ATmega645A	64Kbyte	2Kbyte	4Kbyte	16
ATmega645P	64Kbyte	2Kbyte	4Kbyte	16
ATmega6450A	64Kbyte	2Kbyte	4Kbyte	20
ATmega6450P	64Kbyte	2Kbyte	4Kbyte	20

2.3 Pin descriptions

2.3.1 VCC

Digital supply voltage.

2.3.2 GND

Ground.

2.3.3 Port A (PA7:PA0)

Port A is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port A output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port A pins that are externally pulled low will source current if the pull-up resistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port A also serves the functions of various special features of the ATmega165A/165PA/325A/325PA/3250A/3250PA/645A/645P/6450A/6450P as listed on "Alternate functions of Port B" on page 73.

2.3.4 Port B (PB7:PB0)

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port B has better driving capabilities than the other ports.

Port B also serves the functions of various special features of the ATmega165A/165PA/325A/325PA/3250A/3250PA/645A/645P/6450A/6450P as listed on "Alternate functions of Port B" on page 73.

2.3.5 Port C (PC7:PC0)

Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins



that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tristated when a reset condition becomes active, even if the clock is not running.

Port C also serves the functions of special features of the Atmel ATmega165A/165PA/325A/325PA/3250A/3250PA/645A/645P/6450A/6450P as listed on "Alternate functions of Port D" on page 75.

2.3.6 Port D (PD7:PD0)

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port D also serves the functions of various special features of the ATmega165A/165PA/325A/325PA/3250A/3250PA/645A/645P/6450A/6450P as listed on "Alternate functions of Port D" on page 75.

2.3.7 Port E (PE7:PE0)

Port E is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port E output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port E pins that are externally pulled low will source current if the pull-up resistors are activated. The Port E pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port E also serves the functions of various special features of the ATmega165A/165PA/325A/325PA/3250A/3250PA/645A/645P/6450A/6450P as listed on "Alternate functions of Port E" on page 76.

2.3.8 Port F (PF7:PF0)

Port F serves as the analog inputs to the A/D Converter.

Port F also serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used. Port pins can provide internal pull-up resistors (selected for each bit). The Port F output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port F pins that are externally pulled low will source current if the pull-up resistors are activated. The Port F pins are tri-stated when a reset condition becomes active, even if the clock is not running. If the JTAG interface is enabled, the pull-up resistors on pins PF7(TDI), PF5(TMS), and PF4(TCK) will be activated even if a reset occurs.

Port F also serves the functions of the JTAG interface, see "Alternate functions of Port F" on page 78.

2.3.9 Port G (PG5:PG0)

Port G is a 6-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port G output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port G pins that are externally pulled low will source current if the pull-up resistors are activated. The Port G pins are tristated when a reset condition becomes active, even if the clock is not running.

Port G also serves the functions of various special features of the ATmega165A/165PA/325A/325PA/3250A/3250PA/645A/645P/6450A/6450P as listed on page 80.

2.3.10 Port H (PH7:PH0)

Port H is a 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port H output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port H pins that are externally pulled low will source current if the pull-up resistors are activated. The Port H pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port H also serves the functions of various special features of the ATmega3250A/3250PA/6450A/6450P as listed on page 81.



3. Resources

A comprehensive set of development tools, application notes and datasheets are available for download on http://www.atmel.com/avr.

4. Data retention

Reliability Qualification results show that the projected data retention failure rate is much less than 1 PPM over 20 years at 85°C or 100 years at 25°C.

5. About code examples

This documentation contains simple code examples that briefly show how to use various parts of the device. Be aware that not all C compiler vendors include bit definitions in the header files and interrupt handling in C is compiler dependent. Please confirm with the C compiler documentation for more details.

These code examples assume that the part specific header file is included before compilation. For I/O registers located in extended I/O map, "IN", "OUT", "SBIS", "SBIC", "CBI", and "SBI" instructions must be replaced with instructions that allow access to extended I/O. Typically "LDS" and "STS" combined with "SBRS", "SBRC", "SBR", and "CBR".

6. Capacitive touch sensing

The Atmel QTouch Library provides a simple to use solution to realize touch sensitive interfaces on most Atmel AVR microcontrollers. The QTouch Library includes support for the Atmel QTouch and QMatrix acquisition methods.

Touch sensing can be added to any application by linking the appropriate Atmel QTouch Library for the AVR Microcontroller. This is done by using a simple set of APIs to define the touch channels and sensors, and then calling the touch sensing API's to retrieve the channel information and determine the touch sensor states.

The QTouch Library is FREE and downloadable from the Atmel website at the following location: www.atmel.com/qtouchlibrary. For implementation details and other information, refer to the Atmel QTouch Library User Guide - also available for download from the Atmel website.



7. Register Summary

Note: Registers with bold type only available in ATmega3250A/3250PA/6450A/6450P.

(0xFF)	Reserved									
(0xFE)	Reserved									
(0xFD)	Reserved									
(0xFC)	Reserved									
(0xFB)	Reserved									
(0xFA)	Reserved									
(0xF9)	Reserved									
(0xF8)	Reserved									
(0xF7)	Reserved									
(0.77)	Received									
(UXF6)	Reserved	-	-							
(0xF5)	Reserved									
(0xF4)	Reserved									
(0xF3)	Reserved									
(0xF2)	Reserved									
(0xF1)	Reserved									
(0xF0)	Reserved									
(0xEF)	Reserved									
(0xFF)	Reserved									
(0xED)	Reserved									
	Reserved									
(0xEC)	Received									
(UXEB)	Reserved	-	-	-	-	-	-	-	-	
(0xEA)	Reserved	-	-	-	-	-	-	-	-	
(0xE9)	Reserved	-	-	-	-	-	-	-	-	
(0xE8)	Reserved	-	-	-	-	-	-	-	-	
(0xE7)	Reserved									
(0xE6)	Reserved									
(0xE5)	Reserved									
(0xE4)	Reserved									
(0xE3)	Reserved	-	-	-	-	-	-	-	-	
(0xE2)	Reserved	-	-	-	-	-	-	-	-	
(UKEZ)										
(0vE1)	Reserved	-	-	-	-	-	-	-	_	
(0xE1)	Reserved	-	-	-	-	-	-	-	-	
(0xE1) (0xE0)	Reserved Reserved	-	-	-	-	-	-	-	-	
(0xE1) (0xE0) (0xDF)	Reserved Reserved Reserved	-	-							
(0xE1) (0xE0) (0xDF) (0xDE)	Reserved Reserved Reserved Reserved	- - - -					- - - -	- - -		
(0xE1) (0xE0) (0xDF) (0xDE) (0xDD)	Reserved Reserved Reserved PORTJ	- - - -	- - - - PORTJ6	- - - - PORTJ5	- - - - PORTJ4	- - - - PORTJ3	- - - - PORTJ2	- - - - PORTJ1	- - - - PORTJ0	88
(0xE1) (0xE0) (0xDF) (0xDE) (0xDD) (0xDC)	Reserved Reserved Reserved PORTJ DDRJ	- - - - - -	- - - - PORTJ6 DDJ6	- - - PORTJ5 DDJ5	- - - PORTJ4 DDJ4	- - - PORTJ3 DDJ3	- - - PORTJ2 DDJ2	- - - PORTJ1 DDJ1	- - - PORTJ0 DDJ0	88 88
(0xE1) (0xE0) (0xDF) (0xDE) (0xDD) (0xDD) (0xDC) (0xDB)	Reserved Reserved Reserved PORTJ DDRJ PINJ	- - - - - -	- - - PORTJ6 DDJ6 PINJ6	- - - - - - - - - - - - - - - - - - -	- - PORTJ4 DDJ4 PINJ4	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - PORTJ1 DDJ1 PINJ1	- - - - - - DDJ0 PINJ0	88 88 88 88
(0xE1) (0xE0) (0xDF) (0xDE) (0xDD) (0xDC) (0xDB) (0xDA)	Reserved Reserved Reserved PORTJ DDRJ PINJ PORTH	- - - - - - PORTH7	- - - PORTJ6 DDJ6 PINJ6 PORTH6	- - - PORTJ5 DDJ5 PINJ5 PORTH5	- - - PORTJ4 DDJ4 PINJ4 PORTH4	- - - PORTJ3 DDJ3 PINJ3 PORTH3	- - - PORTJ2 DDJ2 PINJ2 PORTH2	- - - PORTJ1 DDJ1 PINJ1 PORTH1	- - - PORTJ0 DDJ0 PINJ0 PORTH0	88 88 88 88 88 87
(0xE1) (0xE0) (0xDF) (0xDE) (0xDD) (0xDC) (0xDB) (0xDA) (0xD9)	Reserved Reserved Reserved PORTJ DDRJ PINJ PORTH DDRH	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - DDJ1 PINJ1 PINJ1 PORTH1 DDH1	- - - - - - - - - - - - - - - - - - -	88 88 88 88 87 87
(0xE1) (0xE0) (0xDF) (0xDE) (0xDD) (0xDC) (0xDB) (0xDA) (0xDA) (0xD9) (0xD8)	Reserved Reserved Reserved PORTJ DDRJ PINJ PORTH DDRH PINH	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	88 88 88 87 87 87 88
(0xE1) (0xE0) (0xDF) (0xDE) (0xDD) (0xDC) (0xDB) (0xDA) (0xDA) (0xD9) (0xD8) (0xD7)	Reserved Reserved Reserved PORTJ DDRJ PINJ PORTH DDRH PINH Reserved	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - -	- - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - -	- - - - - - - - - - - - - - -	88 88 88 87 87 87 88
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(0xE1) (0xE0) (0xDF) (0xDE) (0xDD) (0xDD) (0xDB) (0xDB) (0xDA) (0xD9) (0xD8) (0xD7) (0xD6) (0xD5)	Reserved Reserved Reserved PORTJ DDRJ PINJ PORTH DDRH PINH Reserved Reserved Reserved	- - - - - - - - - - - - - - - - - - -	- - PORTJ6 DDJ6 PINJ6 PORTH6 DDH6 PINH6 - -	- - - - - - - - - - - -	- - - - - - - - - - - -	PORTJ3 DDJ3 PINJ3 PORTH3 DDH3 PINH3 -	PORTJ2 DDJ2 PINJ2 PORTH2 DDH2 PINH2 -	- - - - - - - - - - -	- - - - - - - - - - - -	88 88 88 87 87 87 88
(0xE1) (0xE0) (0xDF) (0xDE) (0xDD) (0xDD) (0xDA) (0xDA) (0xDA) (0xD9) (0xD8) (0xD7) (0xD6) (0xD5) (0xD4)	Reserved Reserved Reserved PORTJ DDRJ PINJ PORTH DDRH PINH Reserved Reserved Reserved Reserved	- - - - - - - - - - - - - -	- - - - - - - - - - - - -	- - - - - - - - - - -	- - - - - - - - - - - - -	PORTJ3 DDJ3 PINJ3 PINJ3 DDH3 DDH3 PINH3	- PORTJ2 DDJ2 PINJ2 PORTH2 DDH2 PINH2 - -	- - - - - - - - - - - - -	- - - - - - - - - - - - - -	88 88 88 87 87 87 88
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(0xE1) (0xE0) (0xDF) (0xDD) (0xDD) (0xDA) (0xDA) (0xD9) (0xD8) (0xD7) (0xD6) (0xD7) (0xD6) (0xD5) (0xD4) (0xD3) (0xD1) (0xD0)	Reserved Reserved Reserved PORTJ DDRJ PINJ PORTH DDRH PINH Reserved Reserved Reserved Reserved Reserved Reserved Reserved Reserved	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	88 88 88 87 87 87 88
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(0xE1) (0xE0) (0xDF) (0xDD) (0xDD) (0xDA) (0xDB) (0xDA) (0xDB) (0xDB) (0xDA) (0xDB) (0xDB) (0xDB) (0xDB) (0xD5) (0xD4) (0xD2) (0xD1) (0xCF) (0xCD)	Reserved Reserved Reserved PORTJ DDRJ PINJ PORTH DDRH PINH Reserved		- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	88 88 88 87 87 87 88
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(0xE1) (0xE0) (0xDF) (0xDD) (0xDD) (0xDC) (0xDB) (0xDA) (0xDA) (0xDB) (0xDA) (0xDB) (0xD7) (0xD6) (0xD5) (0xD4) (0xD4) (0xD2) (0xD4) (0xD2) (0xCD) (0xCC) (0xCC) (0xCB)	Reserved Reserved Reserved PORTJ DDRJ PINJ PORTH DDRH PINH Reserved	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - PORTJ5 DDJ5 PINJ5 PORTH5 DDH5 PINH5 - - - - - - - - - - - - - - - - - - -	- - - PORTJ4 DDJ4 PINJ4 PORTH4 DDH4 PINH4 - - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	- - PORTJ1 DDJ1 PINJ1 PORTH1 DDH1 PINH1 - - - - - - - - - - - - - - - - - - -	- - - - - - - - - - - - - - - - - - -	88 88 88 87 87 87 88
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(0xC4)	UBRR0L			1	USART0 Baud R	ate Register Low	I	I		182
(0xC3)	Reserved	-	-	-	-	-	-	-	-	
(0xC3)	UCSR0C	-	UMSEL0	UPM01	UPM00	USBS0	UCSZ01	UCSZ00	UCPOL0	180
(0xC2)	UCSR0B	RXCIE0	TXCIE0	UDRIE0	RXEN0	TXEN0	UCSZ02	RXB80	TXB80	179
(0xC0)	UCSR0A	RXC0	TXC0	UDRE0	FE0	DOR0	UPE0	U2X0	MPCM0	178
(0x86)	Reserved	-	-	-	-		-	-	-	
(0xBF)	Reserved	-	-	-	-	-	-	-	-	
	Reserved	-	-	_	-	-	_	-	_	
	Reserved	_	_	_	-	-		_	_	·
(UXBC)	Reserved				-	-		-		
(UXBB)				_	 LISI Data	Register	_	_	_	190
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(0xB9)	USISK	USISIF	USIOIF							190
(0xB8)	Beenred	USISIL	USICIL	0310001	0310100	031031	031030	USICER	03/10	191
(0xB7)	Reserved	-	-	-		-	-	-	-	140
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(0xB5)	Reserved	-	-	-	-	-	-	-	-	
(0xB4)	Reserved	-	-	-	-	-	-	-	-	
(0xB3)	OCR2A			Lim	er/Counter 2 Outp	ut Compare Regist	er A			145
(0xB2)	TCN12		i		Fimer/C	ounter2			i	144
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(0xB0)	TCCR2A	FOC2A	WGM20	COM2A1	COM2A0	WGM21	CS22	CS21	CS20	143
(0xAF)	Reserved	-	-	-	-	-	-	-	-	
(0xAE)	Reserved	-	-	-	-	-	-	-	-	
(0xAD)	Reserved	-	-	-	-	-	-	-	-	
(0xAC)	Reserved	-	-	-	-	-	-	-	-	
(0xAB)	Reserved	-	-	-	-	-	-	-	-	
(0xAA)	Reserved	-	-	-	-	-	-	-	-	
(0xA9)	Reserved	-	-	-	-	-	-	-	-	
(0xA8)	Reserved	-	-	-	-	-	-	-	-	
(0xA7)	Reserved	-	-	-	-	-	-	-	-	
(0xA6)	Reserved	-	-	-	-	-	-	-	-	
(0xA5)	Reserved	-	-	-	-	-	-	-	-	
(0xA4)	Reserved	-	-	-	-	-	-	-	-	
(0xA3)	Reserved	-	-	-	-	-	-	-	-	
(0xA2)	Reserved	-	-	-	-	-	-	-	-	
(0xA1)	Reserved	-	-	-	-	-	-	-	-	
(0xA0)	Reserved	-	-	-	-	-	-	-	-	
(0x9F)	Reserved	-	-	-	-	-	-	-	-	
(0x9E)	Reserved	-	-	-	-	-	-	-	-	
(0x9D)	Reserved	-	-	-	-	-	-	-	-	
(0x9C)	Reserved	-	-	-	-	-	-	-	-	
(0x9B)	Reserved	-	-	-	-	-	-	-	-	
(0x9A)	Reserved	-	-	-	-	-	-	-	-	
(0x00)	Reserved	-	-	-	-	-	-	-	-	
(0x08)	Reserved	-	-	-	-	-	-	-	-	
(0x07)	Reserved	_	-	_	-	-	-	-	_	┝────┤
(0,97)	Reserved	-	-	-	-	-	-	-	_	┝────┤
(0,90)	Reserved	_	_	_	_	_	_	_	_	
(0x93)	Reserved									┝────┤
(UX94)	Reserved							-		┝────┤
(UX93)	Reserved									<u> </u>
(UX92)	Reserved	-	-	-	-	-	-	-	-	<u> </u>
(0x91)	Reserved	-	-	-	-	-	-	-	-	<u> </u>
(0x90)	Reserved	-	-	-	-	-	-	-	-	
(0x8F)	Reserved	-	-	-	-	-	-	-	-	
(0x8E)	Reserved	-	-	-	-	-	-	-	-	
(0x8D)	Reserved	-	-	-	-	-	-	-	-	<u> </u>
(0x8C)	Reserved	-	-	-	-	-	-	-	-	
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(0x8A)	OCR1BL			Timer	Counter1 Output	Compare Register	B LOW			126
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(0x78)	ADCL				ADC Data F	Register Low				214	
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(0x76)	Reserved	-	-	-	-	-	-	-	-		
(0x75)	Reserved	-	-	-	-	-	-	-	-		
(0x74)	Reserved	-	-	-	-	-	-	-	-		
(0x73)	PCMSK3	-	PCINT30	PCINT29	PCINT28	PCINT27	PCINT26	PCINT25	PCINT24	63	
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(0x71)	Reserved	-	-	-	-	-	-	-	-		
(0x70)	TIMSK2	-	-	-	-	-	-	OCIE2A	TOIE2	145	
(0x6F)	TIMSK1	-	-	ICIE1	-	-	OCIE1B	OCIE1A	TOIE1	127	
(0x6E)	TIMSK0	-	-	-	-	-	-	OCIE0A	TOIE0	101	
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(0x6C)	PCMSK1	PCINT15	PCINT14	PCINT13	PCINT12	PCINT11	PCINT10	PCINT9	PCINT8	63	
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(0x6A)	Reserved	-	-	-	-	-	-	-	-		
(0x69)	EICRA	-	-	-	-	-	-	ISC01	ISC00	61	
(0x68)	Reserved	-	-	-	-	-	-	-	-		
(0x67)	Reserved	-	-	-	-	-	-	-	-		
(0x66)	OSCCAL			(Dscillator Calibratio	n Register [CAL7:0]			36	
(0x65)	Reserved	-	-	-	-	-	-	-	-		
(0x64)	PRR	-	-	-	-	PRTIM1	PRSPI	PSUSART0	PRADC	43	
(0x63)	Reserved	-	-	-	-	-	-	-	-		
(0x62)	Reserved	-	-	-	-	-	-	-	-		
(0x61)	CLKPR	CLKPCE	-	-	-	CLKPS3	CLKPS2	CLKPS1	CLKPS0	36	
(0x60)	WDTCR	-	-	-	WDCE	WDE	WDP2	WDP1	WDP0	50	
	SREG	1	т	н	S	V	N	Z	С	13	
0x3F (0x5F)	0.120									15	
0x3F (0x5F) 0x3E (0x5E)	SPH		·	1	Stack Pointer High						
0x3F (0x5F) 0x3E (0x5E) 0x3D (0x5D)	SPH SPL			l	Stack Po Stack Po	inter High inter Low				15	
0x3F (0x5F) 0x3E (0x5E) 0x3D (0x5D) 0x3C (0x5C)	SPH SPL Reserved	-	-	-	Stack Po Stack Po –	inter High inter Low –	-	-	-	15	
0x3F (0x5F) 0x3E (0x5E) 0x3D (0x5D) 0x3C (0x5C) 0x3B (0x5B)	SPH SPL Reserved Reserved	-	-		Stack Po Stack Po – –	inter High inter Low – –	-		-	15	
0x3F (0x5F) 0x3E (0x5E) 0x3D (0x5D) 0x3C (0x5C) 0x3B (0x5B) 0x3A (0x5A)	SPH SPL Reserved Reserved Reserved	-			Stack Po Stack Po – – –	inter High inter Low – – –		- - -	- - -	15	
0x3F (0x5F) 0x3E (0x5E) 0x3D (0x5D) 0x3C (0x5C) 0x3B (0x5B) 0x3A (0x5A) 0x39 (0x59)	SPH SPL Reserved Reserved Reserved Reserved	-		- - -	Stack Po Stack Po – – – –	inter High inter Low – – –	- - - -	- - -	- - -	15	
0x3F (0x5F) 0x3E (0x5E) 0x3D (0x5D) 0x3C (0x5C) 0x3B (0x5B) 0x3A (0x5A) 0x39 (0x59) 0x38 (0x58)	SPH SPL Reserved Reserved Reserved Reserved Reserved	- - - - -		- - - -	Stack Po Stack Po – – – –	inter High inter Low - - - - -	- - - - -	- - - -	- - - -	15	
0x3F (0x5F) 0x3E (0x5E) 0x3D (0x5D) 0x3C (0x5C) 0x3B (0x5B) 0x3A (0x5A) 0x39 (0x59) 0x38 (0x58) 0x37 (0x57)	SPH SPL Reserved Reserved Reserved Reserved Reserved SPMCSR	- - - - - - SPMIE	- - - - - RWWSB	- - - -	Stack Po Stack Po - - - - - - - - - - - - - - - - - - -	inter High inter Low – – – – BLBSET	– – – – – PGWRT	- - - - - - - - - - - - - - - - - - -	- - - - - SPMEN		
0x3F (0x5F) 0x3E (0x5E) 0x3D (0x5D) 0x3C (0x5C) 0x3B (0x5B) 0x3A (0x5A) 0x39 (0x59) 0x38 (0x58) 0x37 (0x57) 0x36 (0x56)	SPH SPL Reserved Reserved Reserved Reserved SPMCSR Reserved	- - - - - - SPMIE -	- - - - - - - - - - - - - - - - - - -	- - - - -	Stack Po Stack Po – – – – – RWWSRE	inter High inter Low - - - BLBSET - -	- - - - PGWRT -	- - - - PGERS -	- - - - - - SPMEN -	262	
0x3F (0x5F) 0x3E (0x5E) 0x3D (0x5D) 0x3C (0x5C) 0x3B (0x5B) 0x3A (0x5A) 0x39 (0x59) 0x38 (0x58) 0x37 (0x57) 0x36 (0x56) 0x35 (0x55)	SPH SPL Reserved Reserved Reserved Reserved SPMCSR Reserved MCUCR	- - - - - - - - - - - - - - JTD	- - - RWWSB - BODS	- - - - - - BODSE	Stack Po Stack Po – – – – RWWSRE – PUD	inter High inter Low – – – BLBSET –	- - - - PGWRT - -	- - - - PGERS - IVSEL	- - - - - - SPMEN - IVCE	15 15 262 58/85/247	
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9. Ordering Information

9.1 ATmega165A

Speed (MHz) ⁽³⁾	Power Supply	Ordering Code ⁽²⁾	Package ⁽¹⁾	Operation Range
16	1.8 - 5.5V	ATmega165A-AU ATmega165A-AUR ⁽⁴⁾ ATmega165A-MU ATmega165A-MUR ⁽⁴⁾ ATmega165A-MCH ATmega165A-MCHR ⁽⁴⁾	64A 64A 64M1 64M1 64MC 64MC	Industrial (-40°C to 85°C)
		ATmega165A-AN ATmega165A-ANR ⁽⁴⁾ ATmega165A-MN ATmega165A-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 28-1 on page 302.

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

Package Type					
64A	64-Lead, Thin (1.0mm) Plastic Gull Wing Quad Flat Package (TQFP)				
64M1	64-pad, 9 x 9 x 1.0mm body, lead pitch 0.50mm, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)				
64MC	64-lead (2-row Staggered), 7 x 7 x 1.0 mm body, 4.0 x 4.0mm Exposed Pad, Quad Flat No-Lead Package (QFN)				

9.2 ATmega165PA

Speed (MHz) ⁽³⁾	Power Supply	Ordering Code ⁽²⁾	Package ⁽¹⁾	Operation Range
16	1.8 - 5.5V	ATmega165PA-AU ATmega165PA-AUR ⁽⁴⁾ ATmega165PA-MU ATmega165PA-MUR ⁽⁴⁾ ATmega165PA-MCH ATmega165PA-MCHR ⁽⁴⁾	64A 64A 64M1 64M1 64MC 64MC	Industrial (-40°C to 85°C)
		ATmega165PA-AN ATmega165PA-ANR ⁽⁴⁾ ATmega165PA-MN ATmega165PA-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 28-1 on page 302.
- 4. Tape & Reel.
- 5. See characterization specifications at 105°C.

Package Type					
64A	64-Lead, Thin (1.0mm) Plastic Gull Wing Quad Flat Package (TQFP)				
64M1	64-pad, 9 x 9 x 1.0mm body, lead pitch 0.50mm, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)				
64MC	64-lead (2-row Staggered), 7 x 7 x 1.0mm body, 4.0 x 4.0 mm Exposed Pad, Quad Flat No-Lead Package (QFN)				



9.4 ATmega325PA

Speed (MHz) ⁽³⁾	Power Supply	Ordering Code ⁽²⁾	Package ⁽¹⁾	Operation Range
20	1.8 - 5.5V	ATmega325PA-AU ATmega325PA-AUR ⁽⁴⁾ ATmega325PA-MU ATmega325PA-MUR ⁽⁴⁾	64A 64A 64M1 64M1	Industrial (-40°C to 85°C)
20		ATmega325PA-AN ATmega325PA-ANR ⁽⁴⁾ ATmega325PA-MN ATmega325PA-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. $V_{\text{CC}},$ see Figure 28-1 on page 302.
- 4. Tape & Reel
- 5. See characterization specifications at 105°C.

Package Type					
64A	64-Lead, Thin (1.0mm) Plastic Gull Wing Quad Flat Package (TQFP)				
64M1	64-pad, 9 x 9 x 1.0mm body, lead pitch 0.50mm, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)				



9.5 ATmega3250A

Speed (MHz) ⁽³⁾	Power Supply	Ordering Code ⁽²⁾	Package ⁽¹⁾	Operation Range
20	19 551/	ATmega3250A-AU ATmega3250A-AUR ⁽⁴⁾	100A 100A	Industrial (-40°C to 85°C)
	1.0 - 5.5 V	ATmega3250A-AN ATmega3250A-ANR ⁽⁴⁾	100A 100A	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 28-1 on page 302.

4. Tape & Reel

5. See characterization specifications at 105°C.

Package Type			
100A	100-lead, 14 x 14 x 1.0mm, 0.5mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)		
IUUA			



9.6 ATmega3250PA

Speed (MHz) ⁽³⁾	Power Supply	Ordering Code ⁽²⁾	Package ⁽¹⁾	Operation Range
20	19 5 5)/	ATmega3250PA-AU ATmega3250PA-AUR ⁽⁴⁾	100A 100A	Industrial (-40°C to 85°C)
	1.0 - 3.5 V	ATmega3250PA-AN ATmega3250PA-ANR ⁽⁴⁾	100A 100A	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 28-1 on page 302.

4. Tape & Reel

5. See characterization specifications at 105°C.

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



9.7 ATmega645A

Speed (MHz) ⁽³⁾	Power Supply	Ordering Code ⁽²⁾	Package ⁽¹⁾	Operation Range
20	1.8 - 5.5V	ATmega645A-AU ATmega645A-AUR ⁽⁴⁾ ATmega645A-MU ATmega645A-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 28-1 on page 302.

Package Type			
64A	64-Lead, Thin (1.0mm) Plastic Gull Wing Quad Flat Package (TQFP)		
64M1	64-pad, 9 x 9 x 1.0mm body, lead pitch 0.50mm, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)		



9.8 ATmega645P

Speed (MHz) ⁽³⁾	Power Supply	Ordering Code ⁽²⁾	Package ⁽¹⁾	Operation Range
20	1.8 - 5.5V	ATmega645P-AU ATmega645P-AUR ⁽⁴⁾ ATmega645P-MU ATmega645P-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 28-1 on page 302.

Package Type			
64A	64-Lead, Thin (1.0mm) Plastic Gull Wing Quad Flat Package (TQFP)		
64M1	64-pad, 9 x 9 x 1.0mm body, lead pitch 0.50mm, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)		



9.9 ATmega6450A

Speed (MHz) ⁽³⁾	Power Supply	Ordering Code ⁽²⁾	Package ⁽¹⁾	Operation Range
20	1.8 - 5.5V	ATmega6450A-AU ATmega6450A-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 28-1 on page 302.

Package Type			
100A 10	00-lead, 14 x 14 x 1.0mm, 0.5mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)		



9.10 ATmega6450P

Speed (MHz) ⁽³⁾	Power Supply	Ordering Code ⁽²⁾	Package ⁽¹⁾	Operation Range
20	1.8 - 5.5V	ATmega6450P-AU ATmega6450P-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 28-1 on page 302.

	Package Type
100A 1	100-lead, 14 x 14 x 1.0mm, 0.5mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)



Packaging Information 10.

10.1 64A



Notes:

1. This package conforms to JEDEC reference MS-026, Variation AEB.

2. Dimensions D1 and E1 do not include mold protrusion. Allowable protrusion is 0.25mm per side. Dimensions D1 and E1 are maximum plastic body size dimensions including mold mismatch.

3. Lead coplanarity is 0.10mm maximum.

COMMON DIMENSIONS (Unit of measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
А	-	-	1.20	
A1	0.05	_	0.15	
A2	0.95	1.00	1.05	
D	15.75	16.00	16.25	
D1	13.90	14.00	14.10	Note 2
E	15.75	16.00	16.25	
E1	13.90	14.00	14.10	Note 2
В	0.30-	0.45		
С	0.09	_	0.20	
L	0.45	-	0.75	
e		0.80 TYP		

2010-10-20

Atmel		TITLE	DRAWING NO.	REV.
	2325 Orchard Parkway San Jose, CA 95131	64A, 64-lead, 14 x 14mm Body Size, 1.0mm Body Thickness, 0.8mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)	64A	с

12. Datasheet Revision History

Please note that the referring page numbers in this section are referring to this document. The referring revisions in this section are referring to the document revision.

12.1 8285F - 08/2014

- 1. New back page from datasheet template 2014-0502
- 2. Changed chip definition in the text in Section 9.6 "Low-frequency XTAL Oscillator" on page 32.

12.2 8285E - 02/2013

- 1. Applied partially the Atmel new template. New log, front page, page layout and last page changed.
- 2. Added "Electrical Characteristics TA = -40°C to 105°C" on page 308.
- 3. Removed sections 28.5 and 28.6, page 326.
- 4. Added "Typical Characteristics $TA = -40^{\circ}C$ to $105^{\circ}C$ " on page 630.
- 5. Changed Input hysteresis (mV) to Input hysteresis (V) throughout the "Typical characteristics TA = -40°C to 85°C".
- 6. Updated the typical characteristics to include Port H for all 100-pin devices: ATmega3250A/PA/6450/P. Port H has the same performance as Port A, C, D, E, F, G.
- 7. Updated "Packaging Information" on page 28 to take into account the added the 105°C devices.

12.3 8285D - 06/11

1. Removed "Preliminary" from the front page.

12.4 8285C - 06/11

- 1. Updated "Signature bytes" on page 267. A, P and PA devices have different signature (0x002) bytes.
- 2. Updated "DC characteristics" on page 295 for all devices.

12.5 8285B - 03/11

- 1. Updated the datasheet according to the Atmel new Brand Style Guide
- 2. Updated "Signature bytes", Table 27.3 on page 267.
- 3. Updated the power supply voltage (1.5 5.5V) for all devices in "Ordering Information" on page 18.
- 4. Added "Ordering Information" for Extended Temperature (-40°C to 105°C)

12.6 8285A - 09/10

- 1. Initial revision (Based on the ATmega165P/325P/3250P/645/6450/V).
- 2. Changes done compared to ATmega165P/325P/3250P/645/6450/V datasheet:
 - New EIMSK and EIFR register overview
 - New graphics in "Typical characteristics TA = -40°C to 85°C" on page 314.
 - Ordering Information includes Tape & Reel
 - New "Ordering Information" on page 18.
 - QTouch Library Support Features



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