

## Features

- High Performance, Low Power AVR<sup>®</sup> 8-Bit Microcontroller
- Advanced RISC Architecture
  - 125 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 16 MIPS Throughput at 16 MHz
- Non-volatile Program and Data Memories
  - 8K/16K/32K Bytes of In-System Self-Programmable Flash
  - 512/512/1024 EEPROM
  - 512/512/1024 Internal SRAM
  - Write/Erase Cycles: 10,000 Flash/ 100,000 EEPROM
  - Data retention: 20 years at 85°C/ 100 years at 25°C<sup>(1)</sup>
  - Optional Boot Code Section with Independent Lock Bits
    - In-System Programming by on-chip Boot Program hardware-activated after reset
    - True Read-While-Write Operation
    - Programming Lock for Software Security
- USB 2.0 Full-speed Device Module with Interrupt on Transfer Completion
  - Complies fully with Universal Serial Bus Specification REV 2.0
  - 48 MHz PLL for Full-speed Bus Operation : data transfer rates at 12 Mbit/s
  - Fully independent 176 bytes USB DPRAM for endpoint memory allocation
  - Endpoint 0 for Control Transfers: from 8 up to 64-bytes
  - 4 Programmable Endpoints:
    - IN or Out Directions
    - Bulk, Interrupt and Isochronous Transfers
    - Programmable maximum packet size from 8 to 64 bytes
    - Programmable single or double buffer
  - Suspend/Resume Interrupts
  - Microcontroller reset on USB Bus Reset without detach
  - USB Bus Disconnection on Microcontroller Request
- Peripheral Features
  - One 8-bit Timer/Counters with Separate Prescaler and Compare Mode (two 8-bit PWM channels)
  - One 16-bit Timer/Counter with Separate Prescaler, Compare and Capture Mode (three 8-bit PWM channels)
  - USART with SPI master only mode and hardware flow control (RTS/CTS)
  - Master/Slave SPI Serial Interface
  - Programmable Watchdog Timer with Separate On-chip Oscillator
  - On-chip Analog Comparator
  - Interrupt and Wake-up on Pin Change
- On Chip Debug Interface (debugWIRE)
- Special Microcontroller Features
  - Power-On Reset and Programmable Brown-out Detection
  - Internal Calibrated Oscillator
  - External and Internal Interrupt Sources
  - Five Sleep Modes: Idle, Power-save, Power-down, Standby, and Extended Standby
- I/O and Packages
  - 22 Programmable I/O Lines
  - QFN32 (5x5mm) / TQFP32 packages
- Operating Voltages
  - 2.7 - 5.5V
- Operating temperature
  - Industrial (-40°C to +85°C)
- Maximum Frequency
  - 8 MHz at 2.7V - Industrial range
  - 16 MHz at 4.5V - Industrial range

Note: 1. See “Data Retention” on page 6 for details.



**8-bit AVR<sup>®</sup>  
Microcontroller  
with  
8/16/32K Bytes  
of ISP Flash  
and USB  
Controller**

**ATmega8U2**

**ATmega16U2**

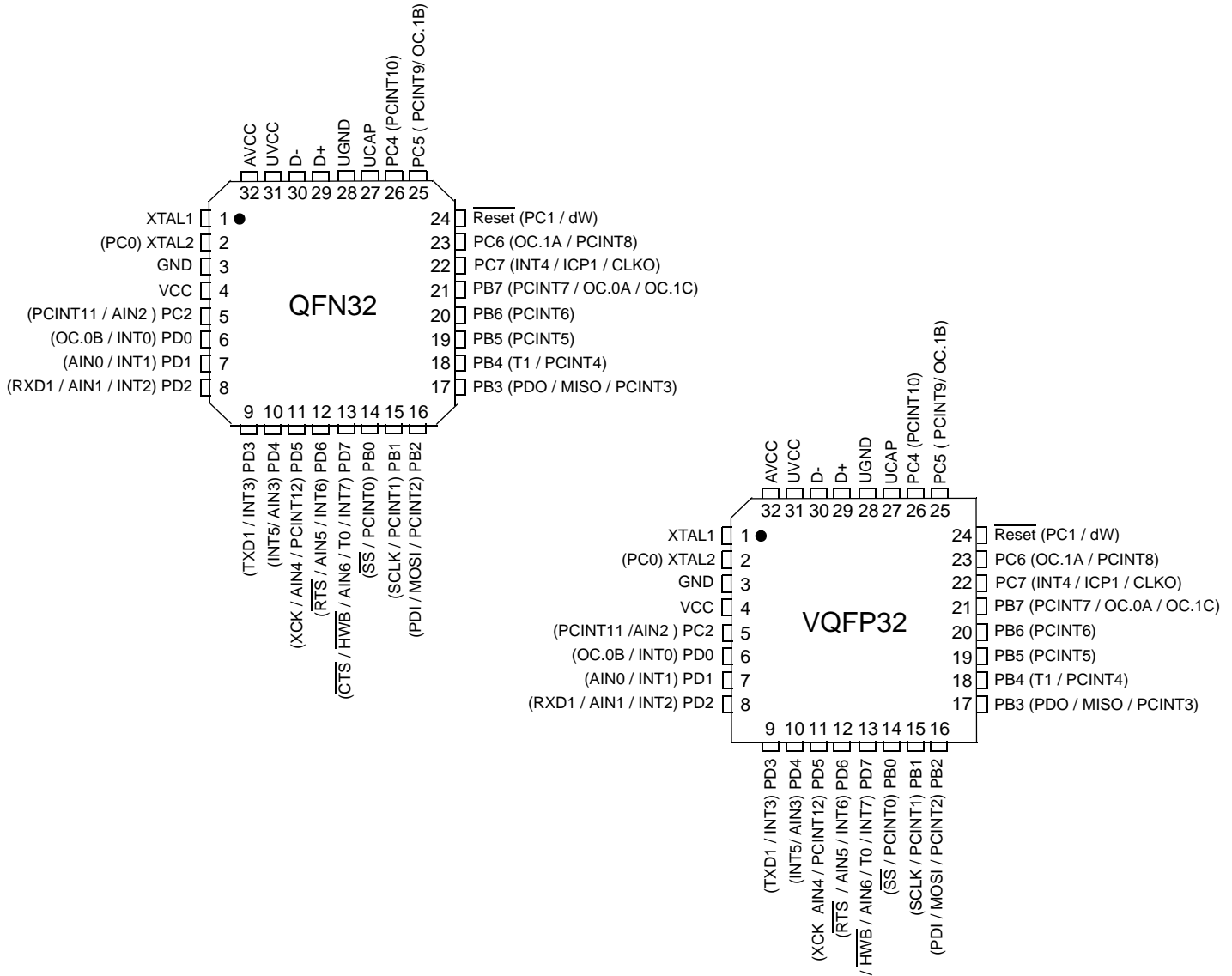
**ATmega32U2**

**Summary**



## 1. Pin Configurations

Figure 1-1. Pinout



Note: The large center pad underneath the VQFP and QFN package should be soldered to ground on the board to ensure good mechanical stability.

### 1.1 Disclaimer

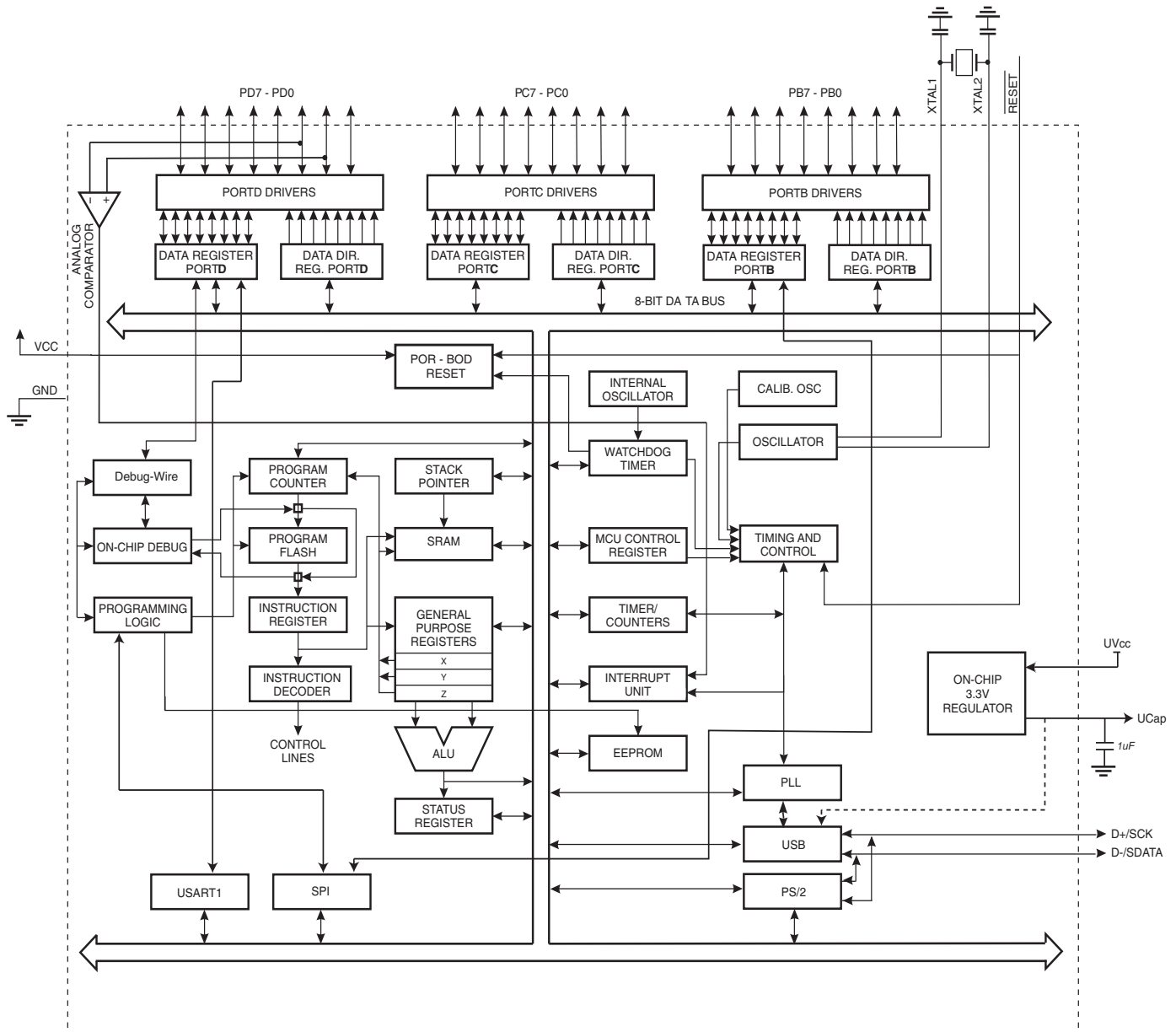
Typical values contained in this datasheet are based on simulations and characterization of other AVR microcontrollers manufactured on the same process technology. Min and Max values will be available after the device is characterized.

## 2. Overview

The ATmega8U2/16U2/32U2 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega8U2/16U2/32U2 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 ATmega8U2/16U2/32U2 provides the following features: 8K/16K/32K Bytes of In-System Programmable Flash with Read-While-Write capabilities, 512/512/1024 Bytes EEPROM, 512/512/1024 SRAM, 22 general purpose I/O lines, 32 general purpose working registers, two flexible Timer/Counters with compare modes and PWM, one USART, a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, debugWIRE interface, also used for accessing the On-chip Debug system and programming 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 Standby mode, the Crystal/Resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low power consumption. In Extended Standby mode, the main Oscillator continues to run.

The device is manufactured using Atmel's high-density nonvolatile memory technology. The on-chip ISP Flash allows the program memory to be reprogrammed in-system through an SPI serial interface, by a conventional nonvolatile 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 Atmel ATmega8U2/16U2/32U2 is a powerful microcontroller that provides a highly flexible and cost effective solution to many embedded control applications.

The ATmega8U2/16U2/32U2 are 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.

## 2.2 Pin Descriptions

### 2.2.1 VCC

Digital supply voltage.

### 2.2.2 GND

Ground.

### 2.2.3 AVCC

AVCC is the supply voltage pin (input) for all analog features (Analog Comparator, PLL). It should be externally connected to VCC through a low-pass filter.

### 2.2.4 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 also serves the functions of various special features of the ATmega8U2/16U2/32U2 as listed on [page 74](#).

## 2.2.5 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 tri-stated when a reset condition becomes active, even if the clock is not running.

Port C also serves the functions of various special features of the ATmega8U2/16U2/32U2 as listed on [page 77](#).

## 2.2.6 Port D (PD7..PD0)

Port D serves as analog inputs to the analog comparator.

Port D also serves as an 8-bit bi-directional I/O port, if the analog comparator is not used (concerns PD2/PD1 pins). Port pins can provide 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.

## 2.2.7 D-

USB Full Speed Negative Data Upstream Port

## 2.2.8 D+

USB Full Speed Positive Data Upstream Port

## 2.2.9 UGND

USB Ground.

## 2.2.10 UVCC

USB Pads Internal Regulator Input supply voltage.

## 2.2.11 UCAP

USB Pads Internal Regulator Output supply voltage. Should be connected to an external capacitor (1 $\mu$ F).

## 2.2.12 RESET/PC1/dW

Reset input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running. The minimum pulse length is given in “[System Control and Reset](#)” on [page 47](#). Shorter pulses are not guaranteed to generate a reset. This pin alternatively serves as debugWire channel or as generic I/O. The configuration depends on the fuses RST-DISBL and DWEN.

## 2.2.13 XTAL1

Input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

## 2.2.14 XTAL2/PC0

Output from the inverting Oscillator amplifier if enabled by Fuse. Also serves as a generic I/O.

## 3. Resources

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

## 4. 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".

## 5. 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.

## 6. Register Summary

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page	
(0xFF)	Reserved	-	-	-	-	-	-	-	-		
(0xFE)	Reserved	-	-	-	-	-	-	-	-		
(0xFD)	Reserved	-	-	-	-	-	-	-	-		
(0xFC)	Reserved	-	-	-	-	-	-	-	-		
(0xFB)	UPOE	UPWE1	UPWE0	UPDRV1	UPDRV0	SCKI	DATAI	DPI	DMI	<a href="#">page 195</a>	
(0xFA)	Reserved	-	-	-	-	-	-	-	-		
(0xF9)	Reserved	-	-	-	-	-	-	-	-		
(0xF8)	Reserved	-	-	-	-	-	-	-	-		
(0xF7)	Reserved	-	-	-	-	-	-	-	-		
(0xF6)	Reserved	-	-	-	-	-	-	-	-		
(0xF5)	Reserved	-	-	-	-	-	-	-	-		
(0xF4)	UEINT	EPINT4:0									<a href="#">page 222</a>
(0xF3)	Reserved	-	-	-	-	-	-	-	-		
(0xF2)	UEBCLX	BYCT7:0									<a href="#">page 221</a>
(0xF1)	UEDATX	DAT7:0									<a href="#">page 221</a>
(0xF0)	UEIENX	FLERRE	NAKINE	-	NAKOUTE	RXSTPE	RXOUTE	STALLEDE	TXINE	<a href="#">page 220</a>	
(0xEF)	UESTA1X	-	-	-	-	-	CTRLDIR	CURRBK1:0		<a href="#">page 218</a>	
(0xEE)	UESTA0X	CFGOK	OVERFI	UNDERFI	-	DTSEQ1:0		NBUSYBK1:0		<a href="#">page 217</a>	
(0xED)	UECFG1X	-	-	EPSIZE2:0		EPBK1:0		ALLOC	-	<a href="#">page 216</a>	
(0xEC)	UECFG0X	EPTYPE1:0		-	-	-	-	-	EPDIR	<a href="#">page 215</a>	
(0xEB)	UECONX	-	-	STALLRQ	STALLRQC	RSTDT	-	-	EPEN	<a href="#">page 214</a>	
(0xEA)	UERST	-	-	-	-	-	EPRST4:0			<a href="#">page 214</a>	
(0xE9)	UENUM	-	-	-	-	-	EPNUM2:0			<a href="#">page 214</a>	
(0xE8)	UEINTX	FIFOCON	NAKINI	RWAL	NAKOUTI	RXSTPI	RXOUTI	STALLEDI	TXINI	<a href="#">page 219</a>	
(0xE7)	Reserved	-	-	-	-	-	-	-	-		
(0xE6)	UDMFN	-	-	-	FNCERR	-	-	-	-	<a href="#">page 213</a>	
(0xE5)	UDFNUMH	-	-	-	-	-	FNUM10:8			<a href="#">page 213</a>	
(0xE4)	UDFNULM	FNUM7:0									<a href="#">page 213</a>
(0xE3)	UDADDR	ADDEN	UADD6:0								<a href="#">page 212</a>
(0xE2)	UDIEN	-	UPRSME	EORSME	WAKEUPE	EORSTE	SOFE	-	SUSPE	<a href="#">page 211</a>	
(0xE1)	UDINT	-	UPRSMI	EORSMI	WAKEUPI	EORSTI	SOFI	-	SUSPI	<a href="#">page 210</a>	
(0xE0)	UDCON	-	-	-	RPUTX	-	RSTCPU	RMWKUP	DETACH	<a href="#">page 209</a>	
(0xDF)	Reserved	-	-	-	-	-	-	-	-		
(0xDE)	Reserved	-	-	-	-	-	-	-	-		
(0xDD)	Reserved	-	-	-	-	-	-	-	-		
(0xDC)	Reserved	-	-	-	-	-	-	-	-		
(0xDB)	Reserved	-	-	-	-	-	-	-	-		
(0xDA)	Reserved	-	-	-	-	-	-	-	-		
(0xD9)	Reserved	-	-	-	-	-	-	-	-		
(0xD8)	USBCON	USBE	-	FRZCLK	-	-	-	-	-	<a href="#">page 195</a>	
(0xD7)	Reserved	-	-	-	-	-	-	-	-		
(0xD6)	Reserved	-	-	-	-	-	-	-	-		
(0xD5)	Reserved	-	-	-	-	-	-	-	-		
(0xD4)	Reserved	-	-	-	-	-	-	-	-		
(0xD3)	Reserved	-	-	-	-	-	-	-	-		
(0xD2)	CLKSTA	-	-	-	-	-	-	RCON	EXTON	<a href="#">page 38</a>	
(0xD1)	CLKSEL1	RCCKSEL3	RCCKSEL2	RCCKSEL1	RCCKSEL0	EXCKSEL3	EXCKSEL2	EXCKSEL1	EXCKSEL0	<a href="#">page 38</a>	
(0xD0)	CLKSEL0	RCSUT1	RCSUT0	EXSUT1	EXSUT0	RCE	EXTE	-	CLKS	<a href="#">page 37</a>	
(0xCF)	Reserved	-	-	-	-	-	-	-	-		
(0xCE)	UDR1	USART1 I/O Data Register									<a href="#">page 167</a>
(0xCD)	UBRR1H	-	-	-	-	USART1 Baud Rate Register High Byte				<a href="#">page 171</a>	
(0xCC)	UBRR1L	USART1 Baud Rate Register Low Byte									<a href="#">page 171</a>
(0xCB)	UCSR1D	-	-	-	-	-	-	CTSEN	RTSEN	<a href="#">page 171</a>	
(0xCA)	UCSR1C	UMSEL11	UMSEL10	UPM11	UPM10	USBS1	UCSZ11	UCSZ10	UCPOL1	<a href="#">page 169</a>	
(0xC9)	UCSR1B	RXCIE1	TXCIE1	UDRIE1	RXEN1	TXEN1	UCSZ12	RXB81	TXB81	<a href="#">page 168</a>	
(0xC8)	UCSR1A	RXC1	TXC1	UDRE1	FE1	DOR1	PE1	U2X1	MPCM1	<a href="#">page 167</a>	
(0xC7)	Reserved	-	-	-	-	-	-	-	-		
(0xC6)	Reserved	-	-	-	-	-	-	-	-		
(0xC5)	Reserved	-	-	-	-	-	-	-	-		
(0xC4)	Reserved	-	-	-	-	-	-	-	-		
(0xC3)	Reserved	-	-	-	-	-	-	-	-		
(0xC2)	Reserved	-	-	-	-	-	-	-	-		
(0xC1)	Reserved	-	-	-	-	-	-	-	-		
(0xC0)	Reserved	-	-	-	-	-	-	-	-		
(0xBF)	Reserved	-	-	-	-	-	-	-	-		

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page
(0xBE)	Reserved	-	-	-	-	-	-	-	-	
(0xBD)	Reserved	-	-	-	-	-	-	-	-	
(0xBC)	Reserved	-	-	-	-	-	-	-	-	
(0xBB)	Reserved	-	-	-	-	-	-	-	-	
(0xBA)	Reserved	-	-	-	-	-	-	-	-	
(0xB9)	Reserved	-	-	-	-	-	-	-	-	
(0xB8)	Reserved	-	-	-	-	-	-	-	-	
(0xB7)	Reserved	-	-	-	-	-	-	-	-	
(0xB6)	Reserved	-	-	-	-	-	-	-	-	
(0xB5)	Reserved	-	-	-	-	-	-	-	-	
(0xB4)	Reserved	-	-	-	-	-	-	-	-	
(0xB3)	Reserved	-	-	-	-	-	-	-	-	
(0xB2)	Reserved	-	-	-	-	-	-	-	-	
(0xB1)	Reserved	-	-	-	-	-	-	-	-	
(0xB0)	Reserved	-	-	-	-	-	-	-	-	
(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	-	-	-	-	-	-	-	-	
(0x99)	Reserved	-	-	-	-	-	-	-	-	
(0x98)	Reserved	-	-	-	-	-	-	-	-	
(0x97)	Reserved	-	-	-	-	-	-	-	-	
(0x96)	Reserved	-	-	-	-	-	-	-	-	
(0x95)	Reserved	-	-	-	-	-	-	-	-	
(0x94)	Reserved	-	-	-	-	-	-	-	-	
(0x93)	Reserved	-	-	-	-	-	-	-	-	
(0x92)	Reserved	-	-	-	-	-	-	-	-	
(0x91)	Reserved	-	-	-	-	-	-	-	-	
(0x90)	Reserved	-	-	-	-	-	-	-	-	
(0x8F)	Reserved	-	-	-	-	-	-	-	-	
(0x8E)	Reserved	-	-	-	-	-	-	-	-	
(0x8D)	OCR1CH	Timer/Counter1 - Output Compare Register C High Byte								<a href="#">page 135</a>
(0x8C)	OCR1CL	Timer/Counter1 - Output Compare Register C Low Byte								<a href="#">page 135</a>
(0x8B)	OCR1BH	Timer/Counter1 - Output Compare Register B High Byte								<a href="#">page 135</a>
(0x8A)	OCR1BL	Timer/Counter1 - Output Compare Register B Low Byte								<a href="#">page 135</a>
(0x89)	OCR1AH	Timer/Counter1 - Output Compare Register A High Byte								<a href="#">page 135</a>
(0x88)	OCR1AL	Timer/Counter1 - Output Compare Register A Low Byte								<a href="#">page 135</a>
(0x87)	ICR1H	Timer/Counter1 - Input Capture Register High Byte								<a href="#">page 135</a>
(0x86)	ICR1L	Timer/Counter1 - Input Capture Register Low Byte								<a href="#">page 135</a>
(0x85)	TCNT1H	Timer/Counter1 - Counter Register High Byte								<a href="#">page 134</a>
(0x84)	TCNT1L	Timer/Counter1 - Counter Register Low Byte								<a href="#">page 134</a>
(0x83)	Reserved	-	-	-	-	-	-	-	-	
(0x82)	TCCR1C	FOC1A	FOC1B	FOC1C	-	-	-	-	-	<a href="#">page 134</a>
(0x81)	TCCR1B	ICNC1	ICES1	-	WGM13	WGM12	CS12	CS11	CS10	<a href="#">page 133</a>
(0x80)	TCCR1A	COM1A1	COM1A0	COM1B1	COM1B0	COM1C1	COM1C0	WGM11	WGM10	<a href="#">page 129</a>
(0x7F)	Reserved	-	-	-	-	-	-	-	-	
(0x7E)	Reserved	-	-	-	-	-	-	-	-	
(0x7D)	ACMUX	-	-	-	-	-	CMUX2	CMUX1	CMUX0	<a href="#">page 225</a>





Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page
0x7C	Reserved	-	-	-	-	-	-	-	-	
0x7B	Reserved	-	-	-	-	-	-	-	-	
0x7A	Reserved	-	-	-	-	-	-	-	-	
0x79	Reserved	-	-	-	-	-	-	-	-	
0x78	Reserved	-	-	-	-	-	-	-	-	
0x77	Reserved	-	-	-	-	-	-	-	-	
0x76	Reserved	-	-	-	-	-	-	-	-	
0x75	Reserved	-	-	-	-	-	-	-	-	
0x74	Reserved	-	-	-	-	-	-	-	-	
0x73	Reserved	-	-	-	-	-	-	-	-	
0x72	Reserved	-	-	-	-	-	-	-	-	
0x71	Reserved	-	-	-	-	-	-	-	-	
0x70	Reserved	-	-	-	-	-	-	-	-	
0x6F	TIMSK1	-	-	ICIE1	-	OCIE1C	OCIE1B	OCIE1A	TOIE1	<a href="#">page 135</a>
0x6E	TIMSK0	-	-	-	-	-	OCIE0B	OCIE0A	TOIE0	<a href="#">page 106</a>
0x6D	Reserved	-	-	-	-	-	-	-	-	
0x6C	PCMSK1	-	-	-	PCINT12	PCINT11	PCINT10	PCINT9	PCINT8	<a href="#">page 87</a>
0x6B	PCMSK0	PCINT7	PCINT6	PCINT5	PCINT4	PCINT3	PCINT2	PCINT1	PCINT0	<a href="#">page 87</a>
0x6A	EICRB	ISC71	ISC70	ISC61	ISC60	ISC51	ISC50	ISC41	ISC40	<a href="#">page 85</a>
0x69	EICRA	ISC31	ISC30	ISC21	ISC20	ISC11	ISC10	ISC01	ISC00	<a href="#">page 84</a>
0x68	PCICR	-	-	-	-	-	-	PCIE1	PCIE0	<a href="#">page 86</a>
0x67	Reserved	-	-	-	-	-	-	-	-	
0x66	OSCCAL	Oscillator Calibration Register								<a href="#">page 38</a>
0x65	PRR1	PRUSB	-	-	-	-	-	-	PRUSART1	<a href="#">page 46</a>
0x64	PRR0	-	-	PRTIM0	-	PRTIM1	PRSPI	-	-	<a href="#">page 46</a>
0x63	REGCR	-	-	-	-	-	-	-	REGDIS	<a href="#">page 196</a>
0x62	WDTCKD	-	-	WDEWIFCM	WCLKD2	WDEWIF	WDEWIE	WCLKD1	WCLKD0	<a href="#">page 57</a>
0x61	CLKPR	CLKPCE	-	-	-	CLKPS3	CLKPS2	CLKPS1	CLKPS0	<a href="#">page 39</a>
0x60	WDTCSR	WDIF	WDIE	WDP3	WDCE	WDE	WDP2	WDP1	WDP0	<a href="#">page 56</a>
0x5F (0x5F)	SREG	I	T	H	S	V	N	Z	C	<a href="#">page 9</a>
0x5E (0x5E)	SPH	SP15	SP14	SP13	SP12	SP11	SP10	SP9	SP8	<a href="#">page 12</a>
0x5D (0x5D)	SPL	SP7	SP6	SP5	SP4	SP3	SP2	SP1	SP0	<a href="#">page 12</a>
0x5C (0x5C)	Reserved	-	-	-	-	-	-	-	-	
0x5B (0x5B)	Reserved	-	-	-	-	-	-	-	-	
0x5A (0x5A)	Reserved	-	-	-	-	-	-	-	-	
0x59 (0x59)	Reserved	-	-	-	-	-	-	-	-	
0x58 (0x58)	Reserved	-	-	-	-	-	-	-	-	
0x57 (0x57)	SPMCSR	SPMIE	RWWSB	SIGRD	RWWSRE	BLBSET	PGWRT	PGERS	SPMEN	<a href="#">page 242</a>
0x56 (0x56)	Reserved	-	-	-	-	-	-	-	-	
0x55 (0x55)	MCUCR	-	-	-	-	-	-	IVSEL	IVCE	<a href="#">page 65, 82</a>
0x54 (0x54)	MCUSR	-	-	USBRF	-	WDRF	BORF	EXTRF	PORF	<a href="#">page 55</a>
0x53 (0x53)	SMCR	-	-	-	-	SM2	SM1	SM0	SE	<a href="#">page 45</a>
0x52 (0x52)	Reserved	-	-	-	-	-	-	-	-	
0x51 (0x51)	DWDR	debugWIRE Data Register								<a href="#">page 245</a>
0x50 (0x50)	ACSR	ACD	ACBG	ACO	ACI	ACIE	ACIC	ACIS1	ACIS0	<a href="#">page 224</a>
0x4F (0x4F)	Reserved	-	-	-	-	-	-	-	-	
0x4E (0x4E)	SPDR	SPI Data Register								<a href="#">page 147</a>
0x4D (0x4D)	SPSR	SPIF	WCOL	-	-	-	-	-	SPI2X	<a href="#">page 146</a>
0x4C (0x4C)	SPCR	SPIE	SPE	DORD	MSTR	CPOL	CPHA	SPR1	SPR0	<a href="#">page 145</a>
0x4B (0x4B)	GPOR2	General Purpose I/O Register 2								<a href="#">page 24</a>
0x4A (0x4A)	GPOR1	General Purpose I/O Register 1								<a href="#">page 24</a>
0x49 (0x49)	PLLCSR	-	-	-	PLL2	PLL1	PLL0	PLLE	PLOCK	<a href="#">page 40</a>
0x48 (0x48)	OCR0B	Timer/Counter0 Output Compare Register B								<a href="#">page 106</a>
0x47 (0x47)	OCR0A	Timer/Counter0 Output Compare Register A								<a href="#">page 106</a>
0x46 (0x46)	TCNT0	Timer/Counter0 (8 Bit)								<a href="#">page 106</a>
0x45 (0x45)	TCCR0B	FOC0A	FOC0B	-	-	WGM02	CS02	CS01	CS00	<a href="#">page 105</a>
0x44 (0x44)	TCCR0A	COM0A1	COM0A0	COM0B1	COM0B0	-	-	WGM01	WGM00	<a href="#">page 105</a>
0x43 (0x43)	GTCCR	TSM	-	-	-	-	-	PSRASY	PSRSYNC	<a href="#">page 89</a>
0x42 (0x42)	EEARH	-	-	-	-	EEPROM Address Register High Byte				<a href="#">page 20</a>
0x41 (0x41)	EEARL	EEPROM Address Register Low Byte								<a href="#">page 20</a>
0x40 (0x40)	EEDR	EEPROM Data Register								<a href="#">page 20</a>
0x3F (0x3F)	EECR	-	-	EEDM1	EEDM0	EERIE	EEMPE	EEPE	EERE	<a href="#">page 21</a>
0x3E (0x3E)	GPOR0	General Purpose I/O Register 0								<a href="#">page 25</a>
0x3D (0x3D)	EIMSK	INT7	INT6	INT5	INT4	INT3	INT2	INT1	INT0	<a href="#">page 86</a>
0x3C (0x3C)	EIFR	INTF7	INTF6	INTF5	INTF4	INTF3	INTF2	INTF1	INTF0	<a href="#">page 86</a>
0x3B (0x3B)	PCIFR	-	-	-	-	-	-	PCIF1	PCIF0	<a href="#">page 86</a>



Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page
0x1A (0x3A)	Reserved	-	-	-	-	-	-	-	-	
0x19 (0x39)	Reserved	-	-	-	-	-	-	-	-	
0x18 (0x38)	Reserved	-	-	-	-	-	-	-	-	
0x17 (0x37)	Reserved	-	-	-	-	-	-	-	-	
0x16 (0x36)	TIFR1	-	-	ICF1	-	OCF1C	OCF1B	OCF1A	TOV1	<a href="#">page 136</a>
0x15 (0x35)	TIFR0	-	-	-	-	-	OCF0B	OCF0A	TOV0	<a href="#">page 107</a>
0x14 (0x34)	Reserved	-	-	-	-	-	-	-	-	
0x13 (0x33)	Reserved	-	-	-	-	-	-	-	-	
0x12 (0x32)	Reserved	-	-	-	-	-	-	-	-	
0x11 (0x31)	Reserved	-	-	-	-	-	-	-	-	
0x10 (0x30)	Reserved	-	-	-	-	-	-	-	-	
0x0F (0x2F)	Reserved	-	-	-	-	-	-	-	-	
0x0E (0x2E)	Reserved	-	-	-	-	-	-	-	-	
0x0D (0x2D)	Reserved	-	-	-	-	-	-	-	-	
0x0C (0x2C)	Reserved	-	-	-	-	-	-	-	-	
0x0B (0x2B)	PORTD	PORTD7	PORTD6	PORTD5	PORTD4	PORTD3	PORTD2	PORTD1	PORTD0	<a href="#">page 83</a>
0x0A (0x2A)	DDRD	DDD7	DDD6	DDD5	DDD4	DDD3	DDD2	DDD1	DDD0	<a href="#">page 83</a>
0x09 (0x29)	PIND	PIND7	PIND6	PIND5	PIND4	PIND3	PIND2	PIND1	PIND0	<a href="#">page 83</a>
0x08 (0x28)	PORTC	PORTC7	PORTC6	PORTC5	PORTC4	-	PORTC2	PORTC1	PORTC0	<a href="#">page 82</a>
0x07 (0x27)	DDRC	DDC7	DDC6	DDC5	DDC4	-	DDC2	DDC1	DDC0	<a href="#">page 82</a>
0x06 (0x26)	PINC	PINC7	PINC6	PINC5	PINC4	-	PINC2	PINC1	PINC0	<a href="#">page 82</a>
0x05 (0x25)	PORTB	PORTB7	PORTB6	PORTB5	PORTB4	PORTB3	PORTB2	PORTB1	PORTB0	<a href="#">page 82</a>
0x04 (0x24)	DDRB	DDB7	DDB6	DDB5	DDB4	DDB3	DDB2	DDB1	DDB0	<a href="#">page 82</a>
0x03 (0x23)	PINB	PINB7	PINB6	PINB5	PINB4	PINB3	PINB2	PINB1	PINB0	<a href="#">page 82</a>
0x02 (0x22)	Reserved	-	-	-	-	-	-	-	-	
0x01 (0x21)	Reserved	-	-	-	-	-	-	-	-	
0x00 (0x20)	Reserved	-	-	-	-	-	-	-	-	

- Note:
1. For compatibility with future devices, reserved bits should be written to zero if accessed. Moreover reserved bits are not guaranteed to be read as "0". Reserved I/O memory addresses should never be written.
  2. I/O registers within the address range \$00 - \$1F 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.
  3. Some of the status flags are cleared by writing a logical one to them. Note that the CBI and SBI instructions will operate on all bits in the I/O register, writing a one back into any flag read as set, thus clearing the flag. 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 \$00 - \$3F must be used. When addressing I/O registers as data space using LD and ST instructions, \$20 must be added to these addresses. The ATmega8U2/16U2/32U2 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 \$60 - \$1FF in SRAM, only the ST/STS/STD and LD/LDS/LDD instructions can be used.

## 7. Instruction Set Summary

Mnemonics	Operands	Description	Operation	Flags	#Clocks
ARITHMETIC AND LOGIC INSTRUCTIONS					
ADD	Rd, Rr	Add two Registers	$Rd \leftarrow Rd + Rr$	Z,C,N,V,H	1
ADC	Rd, Rr	Add with Carry two Registers	$Rd \leftarrow Rd + Rr + C$	Z,C,N,V,H	1
ADIW	RdI, K	Add Immediate to Word	$Rdh:Rdl \leftarrow Rdh:Rdl + K$	Z,C,N,V,S	2
SUB	Rd, Rr	Subtract two Registers	$Rd \leftarrow Rd - Rr$	Z,C,N,V,H	1
SUBI	Rd, K	Subtract Constant from Register	$Rd \leftarrow Rd - K$	Z,C,N,V,H	1
SBC	Rd, Rr	Subtract with Carry two Registers	$Rd \leftarrow Rd - Rr - C$	Z,C,N,V,H	1
SBCI	Rd, K	Subtract with Carry Constant from Reg.	$Rd \leftarrow Rd - K - C$	Z,C,N,V,H	1
SBIW	RdI, K	Subtract Immediate from Word	$Rdh:Rdl \leftarrow Rdh:Rdl - K$	Z,C,N,V,S	2
AND	Rd, Rr	Logical AND Registers	$Rd \leftarrow Rd \cdot Rr$	Z,N,V	1
ANDI	Rd, K	Logical AND Register and Constant	$Rd \leftarrow Rd \cdot K$	Z,N,V	1
OR	Rd, Rr	Logical OR Registers	$Rd \leftarrow Rd \vee Rr$	Z,N,V	1
ORI	Rd, K	Logical OR Register and Constant	$Rd \leftarrow Rd \vee K$	Z,N,V	1
EOR	Rd, Rr	Exclusive OR Registers	$Rd \leftarrow Rd \oplus Rr$	Z,N,V	1
COM	Rd	One's Complement	$Rd \leftarrow 0xFF - Rd$	Z,C,N,V	1
NEG	Rd	Two's Complement	$Rd \leftarrow 0x00 - Rd$	Z,C,N,V,H	1
SBR	Rd, K	Set Bit(s) in Register	$Rd \leftarrow Rd \vee K$	Z,N,V	1
CBR	Rd, K	Clear Bit(s) in Register	$Rd \leftarrow Rd \cdot (0xFF - K)$	Z,N,V	1
INC	Rd	Increment	$Rd \leftarrow Rd + 1$	Z,N,V	1
DEC	Rd	Decrement	$Rd \leftarrow Rd - 1$	Z,N,V	1
TST	Rd	Test for Zero or Minus	$Rd \leftarrow Rd \cdot Rd$	Z,N,V	1
CLR	Rd	Clear Register	$Rd \leftarrow Rd \oplus Rd$	Z,N,V	1
SER	Rd	Set Register	$Rd \leftarrow 0xFF$	None	1
BRANCH INSTRUCTIONS					
RJMP	k	Relative Jump	$PC \leftarrow PC + k + 1$	None	2
IJMP		Indirect Jump to (Z)	$PC \leftarrow Z$	None	2
JMP	k	Direct Jump	$PC \leftarrow k$	None	3
RCALL	k	Relative Subroutine Call	$PC \leftarrow PC + k + 1$	None	4
ICALL		Indirect Call to (Z)	$PC \leftarrow Z$	None	4
CALL	k	Direct Subroutine Call	$PC \leftarrow k$	None	5
RET		Subroutine Return	$PC \leftarrow STACK$	None	5
RETI		Interrupt Return	$PC \leftarrow STACK$	I	5
CPSE	Rd, Rr	Compare, Skip if Equal	if (Rd = Rr) $PC \leftarrow PC + 2$ or 3	None	1/2/3
CP	Rd, Rr	Compare	$Rd - Rr$	Z, N, V, C, H	1
CPC	Rd, Rr	Compare with Carry	$Rd - Rr - C$	Z, N, V, C, H	1
CPI	Rd, K	Compare Register with Immediate	$Rd - K$	Z, N, V, C, H	1
SBRC	Rr, b	Skip if Bit in Register Cleared	if (Rr(b)=0) $PC \leftarrow PC + 2$ or 3	None	1/2/3
SBRS	Rr, b	Skip if Bit in Register is Set	if (Rr(b)=1) $PC \leftarrow PC + 2$ or 3	None	1/2/3
SBCI	P, b	Skip if Bit in I/O Register Cleared	if (P(b)=0) $PC \leftarrow PC + 2$ or 3	None	1/2/3
SBIS	P, b	Skip if Bit in I/O Register is Set	if (P(b)=1) $PC \leftarrow PC + 2$ or 3	None	1/2/3
BRBS	s, k	Branch if Status Flag Set	if (SREG(s) = 1) then $PC \leftarrow PC + k + 1$	None	1/2
BRBC	s, k	Branch if Status Flag Cleared	if (SREG(s) = 0) then $PC \leftarrow PC + k + 1$	None	1/2
BREQ	k	Branch if Equal	if (Z = 1) then $PC \leftarrow PC + k + 1$	None	1/2
BRNE	k	Branch if Not Equal	if (Z = 0) then $PC \leftarrow PC + k + 1$	None	1/2
BRCS	k	Branch if Carry Set	if (C = 1) then $PC \leftarrow PC + k + 1$	None	1/2
BRCC	k	Branch if Carry Cleared	if (C = 0) then $PC \leftarrow PC + k + 1$	None	1/2
BRSH	k	Branch if Same or Higher	if (C = 0) then $PC \leftarrow PC + k + 1$	None	1/2
BRLO	k	Branch if Lower	if (C = 1) then $PC \leftarrow PC + k + 1$	None	1/2
BRMI	k	Branch if Minus	if (N = 1) then $PC \leftarrow PC + k + 1$	None	1/2
BRPL	k	Branch if Plus	if (N = 0) then $PC \leftarrow PC + k + 1$	None	1/2
BRGE	k	Branch if Greater or Equal, Signed	if (N $\oplus$ V = 0) then $PC \leftarrow PC + k + 1$	None	1/2
BRLT	k	Branch if Less Than Zero, Signed	if (N $\oplus$ V = 1) then $PC \leftarrow PC + k + 1$	None	1/2
BRHS	k	Branch if Half Carry Flag Set	if (H = 1) then $PC \leftarrow PC + k + 1$	None	1/2
BRHC	k	Branch if Half Carry Flag Cleared	if (H = 0) then $PC \leftarrow PC + k + 1$	None	1/2
BRTS	k	Branch if T Flag Set	if (T = 1) then $PC \leftarrow PC + k + 1$	None	1/2
BRTC	k	Branch if T Flag Cleared	if (T = 0) then $PC \leftarrow PC + k + 1$	None	1/2
BRVS	k	Branch if Overflow Flag is Set	if (V = 1) then $PC \leftarrow PC + k + 1$	None	1/2
BRVC	k	Branch if Overflow Flag is Cleared	if (V = 0) then $PC \leftarrow PC + k + 1$	None	1/2
BRIE	k	Branch if Interrupt Enabled	if (I = 1) then $PC \leftarrow PC + k + 1$	None	1/2
BRID	k	Branch if Interrupt Disabled	if (I = 0) then $PC \leftarrow PC + k + 1$	None	1/2
BIT AND BIT-TEST INSTRUCTIONS					
SBI	P, b	Set Bit in I/O Register	$I/O(P, b) \leftarrow 1$	None	2
CBI	P, b	Clear Bit in I/O Register	$I/O(P, b) \leftarrow 0$	None	2
LSL	Rd	Logical Shift Left	$Rd(n+1) \leftarrow Rd(n), Rd(0) \leftarrow 0$	Z,C,N,V	1
LSR	Rd	Logical Shift Right	$Rd(n) \leftarrow Rd(n+1), Rd(7) \leftarrow 0$	Z,C,N,V	1



Mnemonics	Operands	Description	Operation	Flags	#Clocks
ROL	Rd	Rotate Left Through Carry	$Rd(0) \leftarrow C, Rd(n+1) \leftarrow Rd(n), C \leftarrow Rd(7)$	Z,C,N,V	1
ROR	Rd	Rotate Right Through Carry	$Rd(7) \leftarrow C, Rd(n) \leftarrow Rd(n+1), C \leftarrow Rd(0)$	Z,C,N,V	1
ASR	Rd	Arithmetic Shift Right	$Rd(n) \leftarrow Rd(n+1), n=0..6$	Z,C,N,V	1
SWAP	Rd	Swap Nibbles	$Rd(3..0) \leftarrow Rd(7..4), Rd(7..4) \leftarrow Rd(3..0)$	None	1
BSET	s	Flag Set	$SREG(s) \leftarrow 1$	SREG(s)	1
BCLR	s	Flag Clear	$SREG(s) \leftarrow 0$	SREG(s)	1
BST	Rr, b	Bit Store from Register to T	$T \leftarrow Rr(b)$	T	1
BLD	Rd, b	Bit load from T to Register	$Rd(b) \leftarrow T$	None	1
SEC		Set Carry	$C \leftarrow 1$	C	1
CLC		Clear Carry	$C \leftarrow 0$	C	1
SEN		Set Negative Flag	$N \leftarrow 1$	N	1
CLN		Clear Negative Flag	$N \leftarrow 0$	N	1
SEZ		Set Zero Flag	$Z \leftarrow 1$	Z	1
CLZ		Clear Zero Flag	$Z \leftarrow 0$	Z	1
SEI		Global Interrupt Enable	$I \leftarrow 1$	I	1
CLI		Global Interrupt Disable	$I \leftarrow 0$	I	1
SES		Set Signed Test Flag	$S \leftarrow 1$	S	1
CLS		Clear Signed Test Flag	$S \leftarrow 0$	S	1
SEV		Set Twos Complement Overflow	$V \leftarrow 1$	V	1
CLV		Clear Twos Complement Overflow	$V \leftarrow 0$	V	1
SET		Set T in SREG	$T \leftarrow 1$	T	1
CLT		Clear T in SREG	$T \leftarrow 0$	T	1
SEH		Set Half Carry Flag in SREG	$H \leftarrow 1$	H	1
CLH		Clear Half Carry Flag in SREG	$H \leftarrow 0$	H	1
<b>DATA TRANSFER INSTRUCTIONS</b>					
MOV	Rd, Rr	Move Between Registers	$Rd \leftarrow Rr$	None	1
MOVW	Rd, Rr	Copy Register Word	$Rd+1:Rd \leftarrow Rr+1:Rr$	None	1
LDI	Rd, K	Load Immediate	$Rd \leftarrow K$	None	1
LD	Rd, X	Load Indirect	$Rd \leftarrow (X)$	None	2
LD	Rd, X+	Load Indirect and Post-Inc.	$Rd \leftarrow (X), X \leftarrow X + 1$	None	2
LD	Rd, -X	Load Indirect and Pre-Dec.	$X \leftarrow X - 1, Rd \leftarrow (X)$	None	2
LD	Rd, Y	Load Indirect	$Rd \leftarrow (Y)$	None	2
LD	Rd, Y+	Load Indirect and Post-Inc.	$Rd \leftarrow (Y), Y \leftarrow Y + 1$	None	2
LD	Rd, -Y	Load Indirect and Pre-Dec.	$Y \leftarrow Y - 1, Rd \leftarrow (Y)$	None	2
LDD	Rd, Y+q	Load Indirect with Displacement	$Rd \leftarrow (Y + q)$	None	2
LD	Rd, Z	Load Indirect	$Rd \leftarrow (Z)$	None	2
LD	Rd, Z+	Load Indirect and Post-Inc.	$Rd \leftarrow (Z), Z \leftarrow Z + 1$	None	2
LD	Rd, -Z	Load Indirect and Pre-Dec.	$Z \leftarrow Z - 1, Rd \leftarrow (Z)$	None	2
LDD	Rd, Z+q	Load Indirect with Displacement	$Rd \leftarrow (Z + q)$	None	2
LDS	Rd, k	Load Direct from SRAM	$Rd \leftarrow (k)$	None	2
ST	X, Rr	Store Indirect	$(X) \leftarrow Rr$	None	2
ST	X+, Rr	Store Indirect and Post-Inc.	$(X) \leftarrow Rr, X \leftarrow X + 1$	None	2
ST	-X, Rr	Store Indirect and Pre-Dec.	$X \leftarrow X - 1, (X) \leftarrow Rr$	None	2
ST	Y, Rr	Store Indirect	$(Y) \leftarrow Rr$	None	2
ST	Y+, Rr	Store Indirect and Post-Inc.	$(Y) \leftarrow Rr, Y \leftarrow Y + 1$	None	2
ST	-Y, Rr	Store Indirect and Pre-Dec.	$Y \leftarrow Y - 1, (Y) \leftarrow Rr$	None	2
STD	Y+q, Rr	Store Indirect with Displacement	$(Y + q) \leftarrow Rr$	None	2
ST	Z, Rr	Store Indirect	$(Z) \leftarrow Rr$	None	2
ST	Z+, Rr	Store Indirect and Post-Inc.	$(Z) \leftarrow Rr, Z \leftarrow Z + 1$	None	2
ST	-Z, Rr	Store Indirect and Pre-Dec.	$Z \leftarrow Z - 1, (Z) \leftarrow Rr$	None	2
STD	Z+q, Rr	Store Indirect with Displacement	$(Z + q) \leftarrow Rr$	None	2
STS	k, Rr	Store Direct to SRAM	$(k) \leftarrow Rr$	None	2
LPM		Load Program Memory	$R0 \leftarrow (Z)$	None	3
LPM	Rd, Z	Load Program Memory	$Rd \leftarrow (Z)$	None	3
LPM	Rd, Z+	Load Program Memory and Post-Inc	$Rd \leftarrow (Z), Z \leftarrow Z + 1$	None	3
SPM		Store Program Memory	$(Z) \leftarrow R1:R0$	None	-
IN	Rd, P	In Port	$Rd \leftarrow P$	None	1
OUT	P, Rr	Out Port	$P \leftarrow Rr$	None	1
PUSH	Rr	Push Register on Stack	$STACK \leftarrow Rr$	None	2
POP	Rd	Pop Register from Stack	$Rd \leftarrow STACK$	None	2
<b>MCU CONTROL INSTRUCTIONS</b>					
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



## 8. Ordering Information

### 8.1 ATmega8U2

Speed	Power Supply	Ordering Code	Package	Operational Range
16 MHz	2.7 - 5.5V	ATmega8U2-AU	32A	-40°C to +85°C
		ATmega8U2-MU	32M1-A	

Package Type	
<b>32A</b>	32-lead, 7 x7 x 1.2 mm, lead pitch 0.8 mm Thin Quad Flat Package
<b>32M1</b>	32-pad, 5 x 5 x 1 mm body, pad pitch 0.50 mm Quad Flat No lead (QFN)

## 8.2 ATmega16U2

Speed	Power Supply	Ordering Code	Package	Operational Range
16 MHz	2.7 - 5.5V	ATmega16U2-AU	32A	-40°C to +85°C
		ATmega16U2-MU	32M1-A	

Package Type	
<b>32A</b>	32-lead, 7 x7 x 1.2 mm, lead pitch 0.8 mm Thin Quad Flat Package
<b>32M1</b>	32-pad, 5 x 5 x 1 mm body, pad pitch 0.50 mm Quad Flat No lead (QFN)

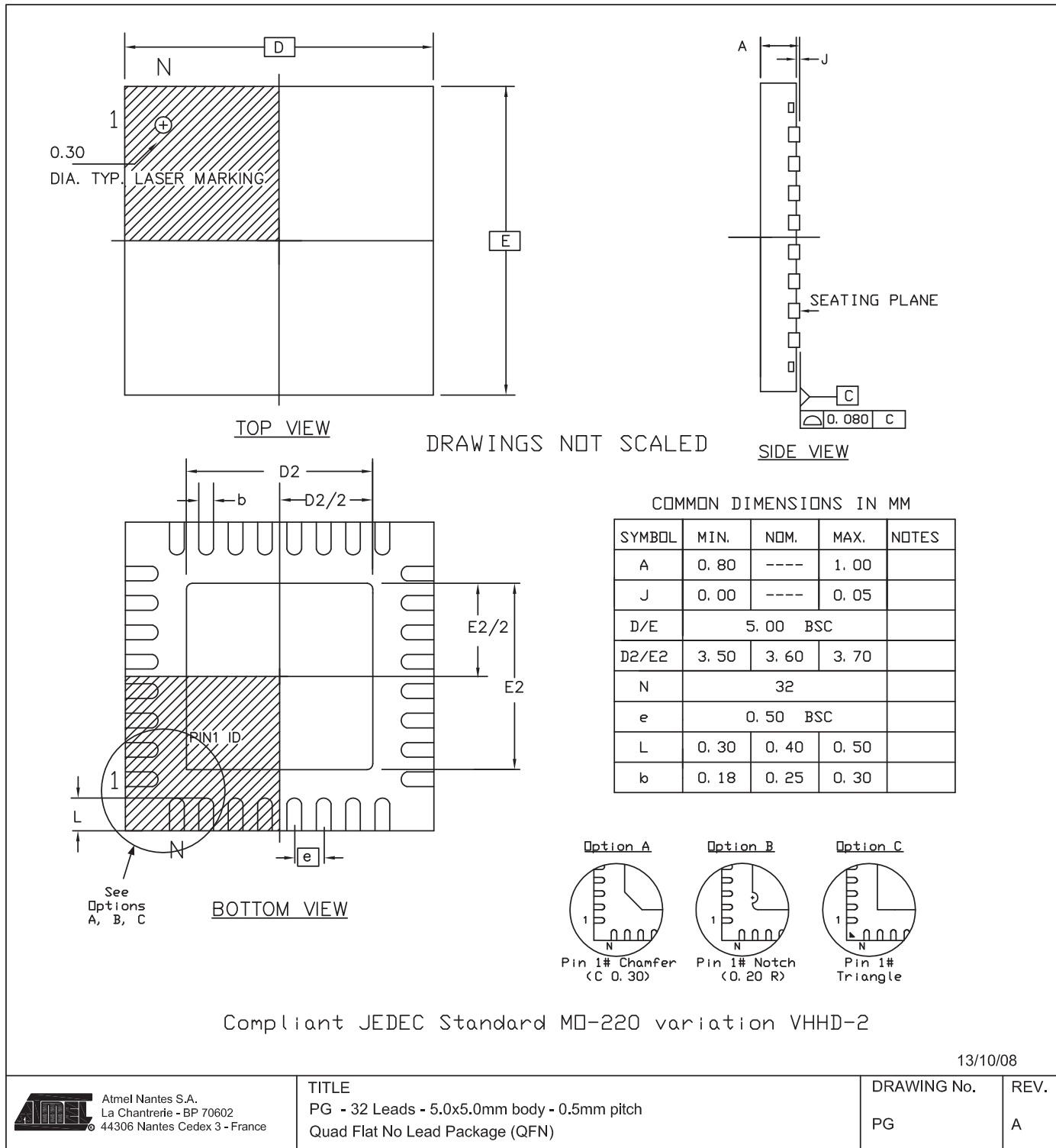
## 8.3 ATmega32U2

Speed	Power Supply	Ordering Code	Package	Operational Range
16 MHz	2.7 - 5.5V	ATmega32U2-AU	32A	-40°C to +85°C
		ATmega32U2-MU	32M1-A	

Package Type	
<b>32A</b>	32-lead, 7 x7 x 1.2 mm, lead pitch 0.8 mm Thin Quad Flat Package
<b>32M1</b>	32-pad, 5 x 5 x 1 mm body, pad pitch 0.50 mm Quad Flat No lead (QFN)

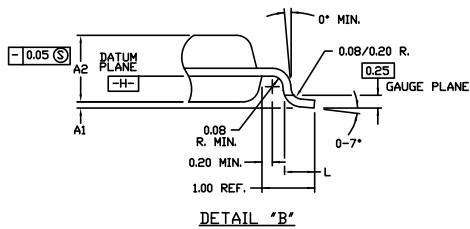
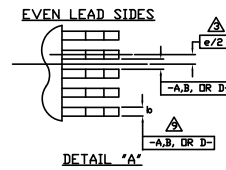
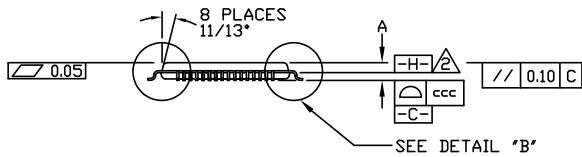
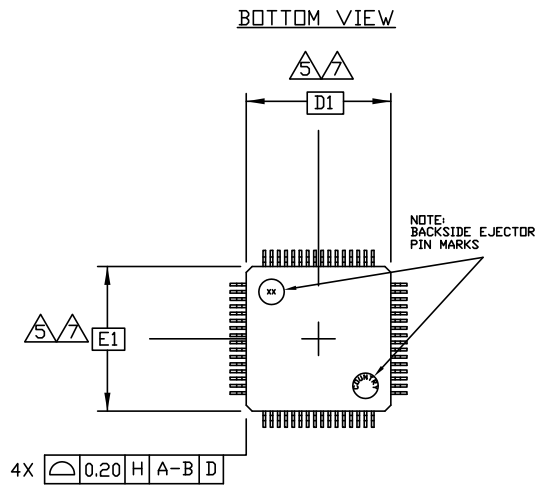
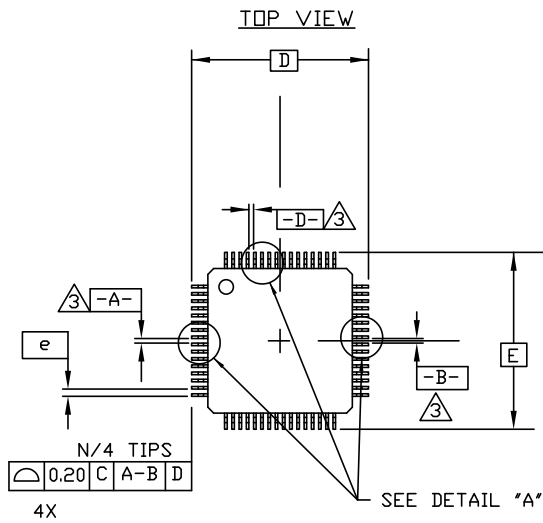
## 9. Packaging Information

### 9.1 QFN32





## 9.2 TQFP32



SYMBOL	JEDEC VARIATION ALL DIMENSIONS IN MILLIMETERS			NOTE
	MIN.	NDM.	MAX.	
A	<i>the</i>	<i>the</i>	1.20	
A <sub>1</sub>	0.05	<i>the</i>	0.15	
A <sub>2</sub>	0.95	1.00	1.05	
D	9.00 BSC.			
D <sub>1</sub>	7.00 BSC.			
E	9.00 BSC.			
E <sub>1</sub>	7.00 BSC.			
L	0.45	0.60	0.75	
N	32			
e	0.80 BSC.			
b	0.30	0.37	0.45	
ccc	<i>the</i>	<i>the</i>	0.10	

## 10. Errata

### 10.1 Errata ATmega8U2

The revision letter in this section refers to the revision of the ATmega8U2 device.

#### 10.1.1 rev. A and rev B

- **Full Swing oscillator**

##### 1. Full Swing oscillator

The maximum frequency for the Full Swing Crystal Oscillator is 8MHz. For Crystal frequencies > 8MHz the Full Swing Crystal Oscillator is not guaranteed to operate correctly.

##### **Problem fix/Workaround**

If a Crystal with frequency > 8MHz is used, the Low Power Crystal Oscillator option should be used instead. See table 8-1 for an overview of the Device Clocking Options. Note that the Low Power Crystal Oscillator will not provide full rail-to-rail swing on the XTAL2 pin. If system clock output is needed to drive other clock inputs while running from the Low Power Crystal Oscillator, the system clock can be output on PORTC7 by programming the CKOUT fuse.

### 10.2 Errata ATmega16U2

The revision letter in this section refers to the revision of the ATmega16U2 device.

#### 10.2.1 rev. A and rev B

- **Full Swing oscillator**

##### 1. Full Swing oscillator

The maximum frequency for the Full Swing Crystal Oscillator is 8MHz. For Crystal frequencies > 8MHz the Full Swing Crystal Oscillator is not guaranteed to operate correctly.

##### **Problem fix/Workaround**

If a Crystal with frequency > 8MHz is used, the Low Power Crystal Oscillator option should be used instead. See table 8-1 for an overview of the Device Clocking Options. Note that the Low Power Crystal Oscillator will not provide full rail-to-rail swing on the XTAL2 pin. If system clock output is needed to drive other clock inputs while running from the Low Power Crystal Oscillator, the system clock can be output on PORTC7 by programming the CKOUT fuse.

### 10.3 Errata ATmega32U2

The revision letter in this section refers to the revision of the ATmega32U2 device.

#### 10.3.1 rev. C

No Known Errata

**10.3.2 rev. A and rev B**

- **Full Swing oscillator**

1. **Full Swing oscillator**

The maximum frequency for the Full Swing Crystal Oscillator is 8MHz. For Crystal frequencies > 8MHz the Full Swing Crystal Oscillator is not guaranteed to operate correctly.

**Problem fix/Workaround**

If a Crystal with frequency > 8MHz is used, the Low Power Crystal Oscillator option should be used instead. See table 8-1 for an overview of the Device Clocking Options. Note that the Low Power Crystal Oscillator will not provide full rail-to-rail swing on the XTAL2 pin. If system clock output is needed to drive other clock inputs while running from the Low Power Crystal Oscillator, the system clock can be output on PORTC7 by programming the CKOUT fuse.

## 11. Datasheet Revision History

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

### 11.1 Rev. 7799C – 12/09

1. Updated “Features” on page 1.
2. Added description of “AVCC” on page 4.
3. Updated Figure 7-2 on page 18.
4. Updated Figure 20-3 on page 186 and Figure 20-4 on page 187.
5. Updated “Fuse Bits” on page 247.
6. Updated “DC Characteristics” on page 264.
7. Updated Table 26-3 on page 267, by removing Vr<sub>st</sub>.
8. Updated Table 26-4 on page 268.
9. Updated “Typical Characteristics” on page 273.
10. Added new “Errata” on page 299.

### 11.2 Rev. 7799B – 06/09

1. Updated “Typical Characteristics” on page 273.

### 11.3 Rev. 7799A – 03/09

1. Initial revision.



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