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Applications of "[Embedded - Microcontrollers](#)"

Details

Product Status	Active
Core Processor	AVR
Core Size	8-Bit
Speed	8MHz
Connectivity	SPI, UART/USART, USI
Peripherals	Brown-out Detect/Reset, LCD, POR, PWM, WDT
Number of I/O	54
Program Memory Size	32KB (16K x 16)
Program Memory Type	FLASH
EEPROM Size	1K x 8
RAM Size	2K 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/atmega329v-8mu

1. Pin Configurations

Figure 1-1. Pinout ATmega3290/6490

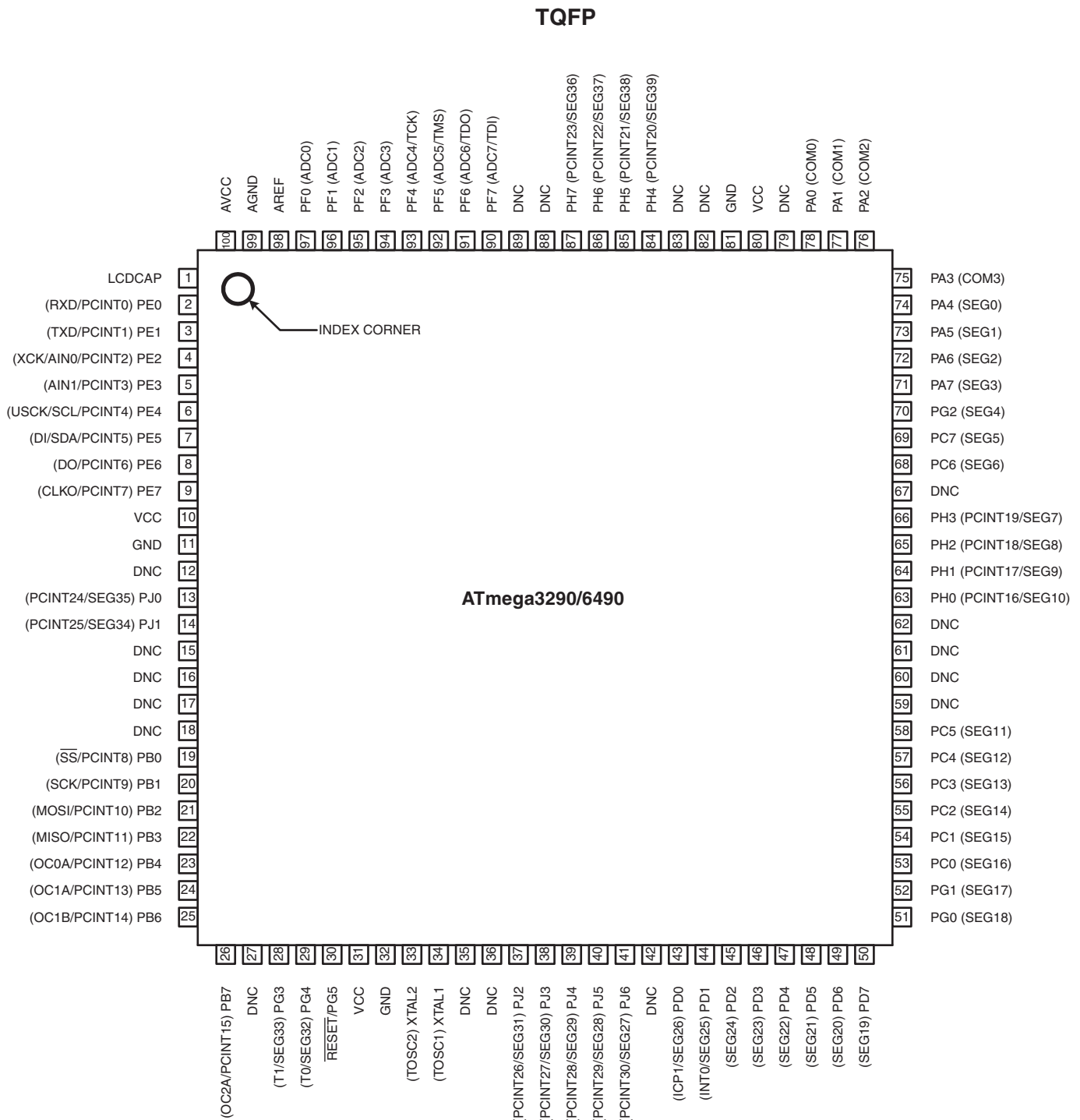
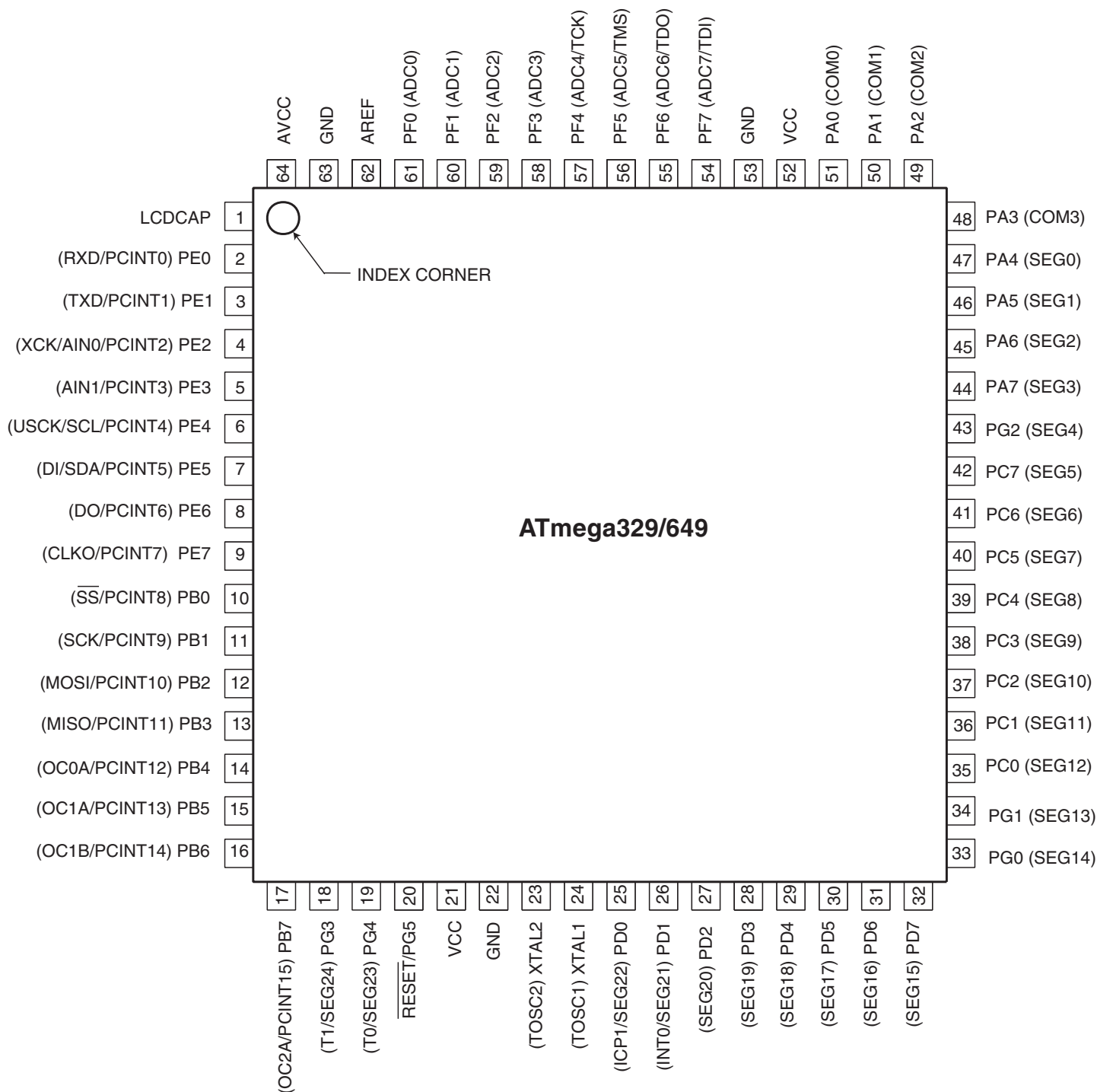


Figure 1-2. Pinout ATmega329/649



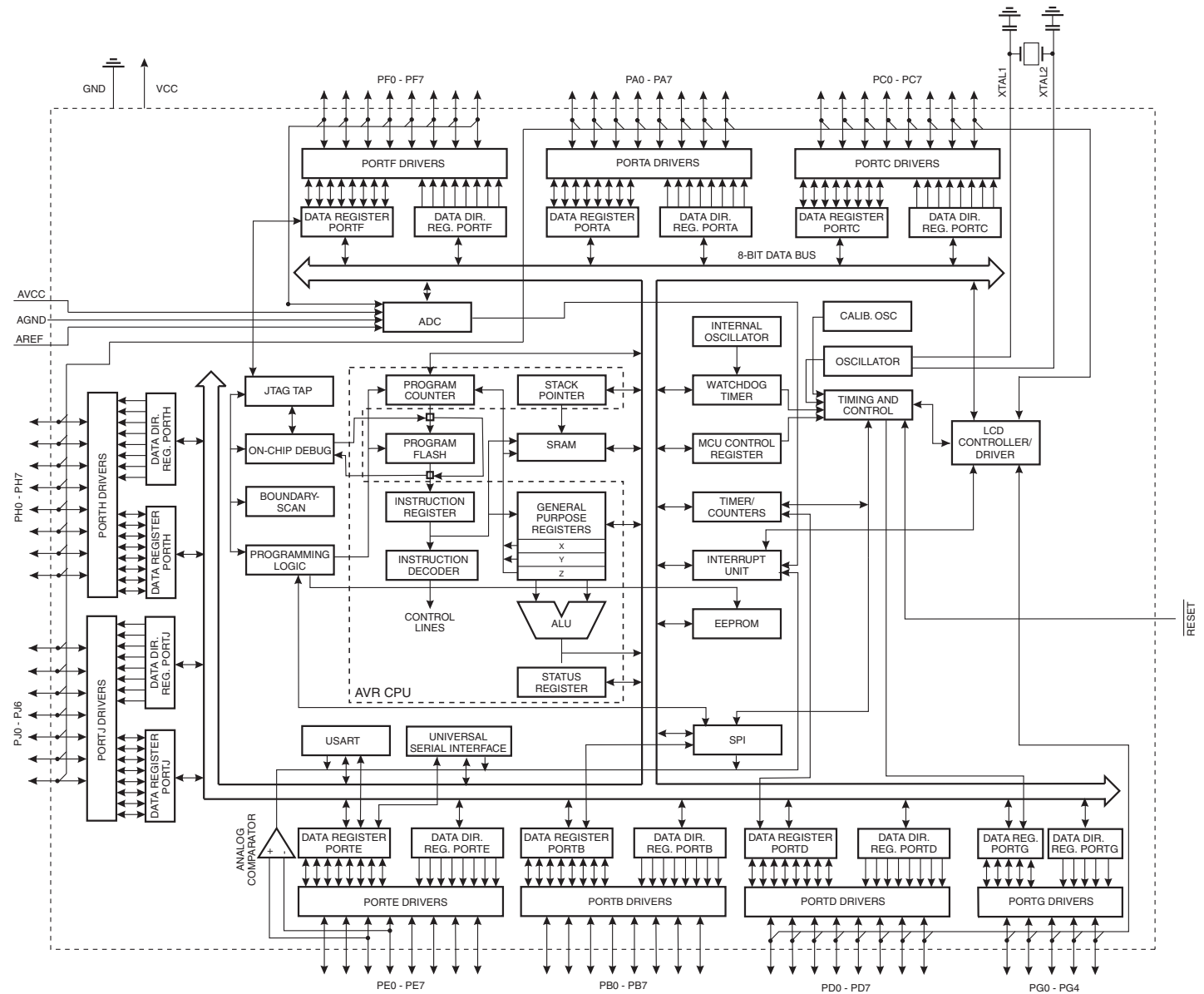
Note: The large center pad underneath the QFN/MLF packages is made of metal and internally connected to GND. It should be soldered or glued to the board to ensure good mechanical stability. If the center pad is left unconnected, the package might loosen from the board.

2. Overview

The ATmega329/3290/649/6490 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 ATmega329/3290/649/6490 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



2.2 Comparison between ATmega329, ATmega3290, ATmega649 and ATmega6490

The ATmega329, ATmega3290, ATmega649, and ATmega6490 differs only in memory sizes, pin count and pinout. [Table 2-1 on page 6](#) summarizes the different configurations for the four devices.

Table 2-1. Configuration Summary

Device	Flash	EEPROM	RAM	LCD Segments	General Purpose I/O Pins
ATmega329	32Kbytes	1Kbytes	2Kbytes	4 x 25	54
ATmega3290	32Kbytes	1K bytes	2Kbytes	4 x 40	69
ATmega649	64Kbytes	2Kbytes	4Kbytes	4 x 25	54
ATmega6490	64Kbytes	2Kbytes	4Kbytes	4 x 40	69

2.3 Pin Descriptions

The following section describes the I/O-pin special functions.

2.3.1 V_{CC}

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 ATmega329/3290/649/6490 as listed on [page 67](#).

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 ATmega329/3290/649/6490 as listed on [page 68](#).

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

Port C also serves the functions of special features of the ATmega329/3290/649/6490 as listed on [page 71](#).

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 ATmega329/3290/649/6490 as listed on [page 73](#).

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 ATmega329/3290/649/6490 as listed on [page 75](#).

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.

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 tri-stated 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 ATmega329/3290/649/6490 as listed on [page 75](#).

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 ATmega3290/6490 as listed on [page 75](#).

2.3.11 Port J (PJ6..PJ0)

Port J is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port J output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port J pins that are externally pulled low will source current if the pull-up resistors are activated. The Port J pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port J also serves the functions of various special features of the ATmega3290/6490 as listed on [page 75](#).

2.3.12 $\overline{\text{RESET}}$

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 and Reset Characteristics](#)” on [page 330](#). Shorter pulses are not guaranteed to generate a reset.

2.3.13 XTAL1

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

2.3.14 XTAL2

Output from the inverting Oscillator amplifier.

2.3.15 AVCC

AVCC is the supply voltage pin for Port F and the A/D Converter. It should be externally connected to V_{CC} , even if the ADC is not used. If the ADC is used, it should be connected to V_{CC} through a low-pass filter.

2.3.16 AREF

This is the analog reference pin for the A/D Converter.

6. Register Summary

Note: Registers with bold type only available in ATmega3290/6490.

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page
(0xFF)	LCDDR19	SEG339	SEG338	SEG337	SEG336	SEG335	SEG334	SEG333	SEG332	244
(0xFE)	LCDDR18	SEG331	SEG330	SEG329	SEG328	SEG327	SEG326	SEG325	SEG324	244
(0xFD)	LCDDR17	SEG323	SEG322	SEG321	SEG320	SEG319	SEG318	SEG317	SEG316	244
(0xFC)	LCDDR16	SEG315	SEG314	SEG313	SEG312	SEG311	SEG310	SEG309	SEG308	244
(0xFB)	LCDDR15	SEG307	SEG306	SEG305	SEG304	SEG303	SEG302	SEG301	SEG300	244
(0xFA)	LCDDR14	SEG239	SEG238	SEG237	SEG236	SEG235	SEG234	SEG233	SEG232	244
(0xF9)	LCDDR13	SEG231	SEG230	SEG229	SEG228	SEG227	SEG226	SEG225	SEG224	244
(0xF8)	LCDDR12	SEG223	SEG222	SEG221	SEG220	SEG219	SEG218	SEG217	SEG216	244
(0xF7)	LCDDR11	SEG215	SEG214	SEG213	SEG212	SEG211	SEG210	SEG209	SEG208	244
(0xF6)	LCDDR10	SEG207	SEG206	SEG205	SEG204	SEG203	SEG202	SEG201	SEG200	244
(0xF5)	LCDDR09	SEG139	SEG138	SEG137	SEG136	SEG135	SEG134	SEG133	SEG132	244
(0xF4)	LCDDR08	SEG131	SEG130	SEG129	SEG128	SEG127	SEG126	SEG125	SEG124	244
(0xF3)	LCDDR07	SEG123	SEG122	SEG121	SEG120	SEG119	SEG118	SEG117	SEG116	244
(0xF2)	LCDDR06	SEG115	SEG114	SEG113	SEG112	SEG111	SEG110	SEG109	SEG108	244
(0xF1)	LCDDR05	SEG107	SEG106	SEG105	SEG104	SEG103	SEG102	SEG101	SEG100	244
(0xF0)	LCDDR04	SEG039	SEG038	SEG037	SEG036	SEG035	SEG034	SEG033	SEG032	244
(0xEF)	LCDDR03	SEG031	SEG030	SEG029	SEG028	SEG027	SEG026	SEG025	SEG024	244
(0xEE)	LCDDR02	SEG023	SEG022	SEG021	SEG020	SEG019	SEG018	SEG017	SEG016	244
(0xED)	LCDDR01	SEG015	SEG014	SEG013	SEG012	SEG011	SEG010	SEG009	SEG008	244
(0xEC)	LCDDR00	SEG007	SEG006	SEG005	SEG004	SEG003	SEG002	SEG001	SEG000	244
(0xEB)	Reserved	-	-	-	-	-	-	-	-	
(0xEA)	Reserved	-	-	-	-	-	-	-	-	
(0xE9)	Reserved	-	-	-	-	-	-	-	-	
(0xE8)	Reserved	-	-	-	-	-	-	-	-	
(0xE7)	LCDDCR	LCDDC2	LCDDC1	LCDDC0	-	LCDDC3	LCDDC2	LCDDC1	LCDDC0	243
(0xE6)	LCDFRR	-	LCDFPS2	LCDFPS1	LCDFPS0	-	LCDFCD2	LCDFCD1	LCDFCD0	241
(0xE5)	LCDCRB	LCDCS	LCDCB	LCDCM1	LCDCM0	LCDCPM3	LCDCPM2	LCDCPM1	LCDCPM0	239
(0xE4)	LCDCRA	LCDCEN	LCDCAB	-	LCDCIF	LCDCIE	-	-	LCDCBL	239
(0xE3)	Reserved	-	-	-	-	-	-	-	-	
(0xE2)	Reserved	-	-	-	-	-	-	-	-	
(0xE1)	Reserved	-	-	-	-	-	-	-	-	
(0xE0)	Reserved	-	-	-	-	-	-	-	-	
(0xDF)	Reserved	-	-	-	-	-	-	-	-	
(0xDE)	Reserved	-	-	-	-	-	-	-	-	
(0xDD)	PORTJ	-	PORTJ6	PORTJ5	PORTJ4	PORTJ3	PORTJ2	PORTJ1	PORTJ0	90
(0xDC)	DDRJ	-	DDJ6	DDJ5	DDJ4	DDJ3	DDJ2	DDJ1	DDJ0	90
(0xDB)	PINJ	-	PINJ6	PINJ5	PINJ4	PINJ3	PINJ2	PINJ1	PINJ0	90
(0xDA)	PORTH	PORTH7	PORTH6	PORTH5	PORTH4	PORTH3	PORTH2	PORTH1	PORTH0	89
(0xD9)	DDRH	DDH7	DDH6	DDH5	DDH4	DDH3	DDH2	DDH1	DDH0	90
(0xD8)	PINH	PINH7	PINH6	PINH5	PINH4	PINH3	PINH2	PINH1	PINH0	90
(0xD7)	Reserved	-	-	-	-	-	-	-	-	
(0xD6)	Reserved	-	-	-	-	-	-	-	-	
(0xD5)	Reserved	-	-	-	-	-	-	-	-	
(0xD4)	Reserved	-	-	-	-	-	-	-	-	
(0xD3)	Reserved	-	-	-	-	-	-	-	-	
(0xD2)	Reserved	-	-	-	-	-	-	-	-	
(0xD1)	Reserved	-	-	-	-	-	-	-	-	
(0xD0)	Reserved	-	-	-	-	-	-	-	-	
(0xCF)	Reserved	-	-	-	-	-	-	-	-	
(0xCE)	Reserved	-	-	-	-	-	-	-	-	
(0xCD)	Reserved	-	-	-	-	-	-	-	-	
(0xCC)	Reserved	-	-	-	-	-	-	-	-	
(0xCB)	Reserved	-	-	-	-	-	-	-	-	
(0xCA)	Reserved	-	-	-	-	-	-	-	-	
(0xC9)	Reserved	-	-	-	-	-	-	-	-	
(0xC8)	Reserved	-	-	-	-	-	-	-	-	
(0xC7)	Reserved	-	-	-	-	-	-	-	-	
(0xC6)	UDR0	USART0 Data Register								190
(0xC5)	UBRR0H	USART0 Baud Rate Register High								194
(0xC4)	UBRR0L	USART0 Baud Rate Register Low								194

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page
0x25 (0x45)	Reserved	-	-	-	-	-	-	-	-	
0x24 (0x44)	TCCR0A	FOC0A	WGM00	COM0A1	COM0A0	WGM01	CS02	CS01	CS00	103
0x23 (0x43)	GTCCR	TSM	-	-	-	-	-	PSR2	PSR10	108/157
0x22 (0x42)	EEARH	-	-	-	-	-	EEPROM Address Register High			22
0x21 (0x41)	EEARL	EEPROM Address Register Low								22
0x20 (0x40)	EEDR	EEPROM Data Register								22
0x1F (0x3F)	EECR	-	-	-	-	EERIE	EEMWE	EWE	EERE	22
0x1E (0x3E)	GPIOR0	General Purpose I/O Register								25
0x1D (0x3D)	EIMSK	PCIE3	PCIE2	PCIE1	PCIE0	-	-	-	INT0	55
0x1C (0x3C)	EIFR	PCIF3	PCIF2	PCIF1	PCIF0	-	-	-	INTF0	56
0x1B (0x3B)	Reserved	-	-	-	-	-	-	-	-	
0x1A (0x3A)	Reserved	-	-	-	-	-	-	-	-	
0x19 (0x39)	Reserved	-	-	-	-	-	-	-	-	
0x18 (0x38)	Reserved	-	-	-	-	-	-	-	-	
0x17 (0x37)	TIFR2	-	-	-	-	-	-	OCF2A	TOV2	157
0x16 (0x36)	TIFR1	-	-	ICF1	-	-	OCF1B	OCF1A	TOV1	138
0x15 (0x35)	TIFR0	-	-	-	-	-	-	OCF0A	TOV0	106
0x14 (0x34)	PORTG	-	-	-	PORTG4	PORTG3	PORTG2	PORTG1	PORTG0	89
0x13 (0x33)	DDRG	-	-	-	DDG4	DDG3	DDG2	DDG1	DDG0	89
0x12 (0x32)	PING	-	-	PING5	PING4	PING3	PING2	PING1	PING0	89
0x11 (0x31)	PORTF	PORTF7	PORTF6	PORTF5	PORTF4	PORTF3	PORTF2	PORTF1	PORTF0	89
0x10 (0x30)	DDRF	DDF7	DDF6	DDF5	DDF4	DDF3	DDF2	DDF1	DDF0	89
0x0F (0x2F)	PINF	PINF7	PINF6	PINF5	PINF4	PINF3	PINF2	PINF1	PINF0	89
0x0E (0x2E)	PORTE	PORTE7	PORTE6	PORTE5	PORTE4	PORTE3	PORTE2	PORTE1	PORTE0	88
0x0D (0x2D)	DDRE	DDE7	DDE6	DDE5	DDE4	DDE3	DDE2	DDE1	DDE0	88
0x0C (0x2C)	PINE	PINE7	PINE6	PINE5	PINE4	PINE3	PINE2	PINE1	PINE0	89
0x0B (0x2B)	PORTD	PORTD7	PORTD6	PORTD5	PORTD4	PORTD3	PORTD2	PORTD1	PORTD0	88
0x0A (0x2A)	DDRD	DDD7	DDD6	DDD5	DDD4	DDD3	DDD2	DDD1	DDD0	88
0x09 (0x29)	PIND	PIND7	PIND6	PIND5	PIND4	PIND3	PIND2	PIND1	PIND0	88
0x08 (0x28)	PORTC	PORTC7	PORTC6	PORTC5	PORTC4	PORTC3	PORTC2	PORTC1	PORTC0	88
0x07 (0x27)	DDRC	DDC7	DDC6	DDC5	DDC4	DDC3	DDC2	DDC1	DDC0	88
0x06 (0x26)	PINC	PINC7	PINC6	PINC5	PINC4	PINC3	PINC2	PINC1	PINC0	88
0x05 (0x25)	PORTB	PORTB7	PORTB6	PORTB5	PORTB4	PORTB3	PORTB2	PORTB1	PORTB0	87
0x04 (0x24)	DDRB	DDB7	DDB6	DDB5	DDB4	DDB3	DDB2	DDB1	DDB0	87
0x03 (0x23)	PINB	PINB7	PINB6	PINB5	PINB4	PINB3	PINB2	PINB1	PINB0	87
0x02 (0x22)	PORTA	PORTA7	PORTA6	PORTA5	PORTA4	PORTA3	PORTA2	PORTA1	PORTA0	87
0x01 (0x21)	DDRA	DDA7	DDA6	DDA5	DDA4	DDA3	DDA2	DDA1	DDA0	87
0x00 (0x20)	PINA	PINA7	PINA6	PINA5	PINA4	PINA3	PINA2	PINA1	PINA0	87

- Note:
- For compatibility with future devices, reserved bits should be written to zero if accessed. Reserved I/O memory addresses should never be written.
 - 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.
 - 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 ATmega329/3290/649/6490 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.

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	$Rd \leftarrow Rd \bullet Rr$	Z,N,V	1
ANDI	Rd, K	Logical AND Register and Constant	$Rd \leftarrow Rd \bullet K$	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	$Rd \leftarrow Rd \bullet (0xFF - K)$	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	$Rd \leftarrow Rd \bullet Rd$	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
MUL	Rd, Rr	Multiply Unsigned	$R1:R0 \leftarrow Rd \times Rr$	Z,C	2
MULS	Rd, Rr	Multiply Signed	$R1:R0 \leftarrow Rd \times Rr$	Z,C	2
MULSU	Rd, Rr	Multiply Signed with Unsigned	$R1:R0 \leftarrow Rd \times Rr$	Z,C	2
FMUL	Rd, Rr	Fractional Multiply Unsigned	$R1:R0 \leftarrow (Rd \times Rr) \ll 1$	Z,C	2
FMULS	Rd, Rr	Fractional Multiply Signed	$R1:R0 \leftarrow (Rd \times Rr) \ll 1$	Z,C	2
FMULSU	Rd, Rr	Fractional Multiply Signed with Unsigned	$R1:R0 \leftarrow (Rd \times Rr) \ll 1$	Z,C	2
BRANCH INSTRUCTIONS					
RJMP	k	Relative Jump	$PC \leftarrow PC + k + 1$	None	2
JMP		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	3
ICALL		Indirect Call to (Z)	$PC \leftarrow Z$	None	3
CALL	k	Direct Subroutine Call	$PC \leftarrow k$	None	4
RET		Subroutine Return	$PC \leftarrow STACK$	None	4
RETI		Interrupt Return	$PC \leftarrow STACK$	I	4
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
SBIC	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

Mnemonics	Operands	Description	Operation	Flags	#Clocks
BRTC	k	Branch if T Flag Cleared	if (T = 0) then PC ← PC + k + 1	None	1/2
BRVS	k	Branch if Overflow Flag is Set	if (V = 1) then PC ← PC + k + 1	None	1/2
BRVC	k	Branch if Overflow Flag is Cleared	if (V = 0) then PC ← PC + k + 1	None	1/2
BRIE	k	Branch if Interrupt Enabled	if (I = 1) then PC ← PC + k + 1	None	1/2
BRID	k	Branch if Interrupt Disabled	if (I = 0) then PC ← PC + k + 1	None	1/2
BIT AND BIT-TEST INSTRUCTIONS					
SBI	P,b	Set Bit in I/O Register	I/O(P,b) ← 1	None	2
CBI	P,b	Clear Bit in I/O Register	I/O(P,b) ← 0	None	2
LSL	Rd	Logical Shift Left	Rd(n+1) ← Rd(n), Rd(0) ← 0	Z,C,N,V	1
LSR	Rd	Logical Shift Right	Rd(n) ← Rd(n+1), Rd(7) ← 0	Z,C,N,V	1
ROL	Rd	Rotate Left Through Carry	Rd(0) ← C, Rd(n+1) ← Rd(n), C ← Rd(7)	Z,C,N,V	1
ROR	Rd	Rotate Right Through Carry	Rd(7) ← C, Rd(n) ← Rd(n+1), C ← Rd(0)	Z,C,N,V	1
ASR	Rd	Arithmetic Shift Right	Rd(n) ← Rd(n+1), n=0..6	Z,C,N,V	1
SWAP	Rd	Swap Nibbles	Rd(3..0) ← Rd(7..4), Rd(7..4) ← Rd(3..0)	None	1
BSET	s	Flag Set	SREG(s) ← 1	SREG(s)	1
BCLR	s	Flag Clear	SREG(s) ← 0	SREG(s)	1
BST	Rr, b	Bit Store from Register to T	T ← Rr(b)	T	1
BLD	Rd, b	Bit load from T to Register	Rd(b) ← T	None	1
SEC		Set Carry	C ← 1	C	1
CLC		Clear Carry	C ← 0	C	1
SEN		Set Negative Flag	N ← 1	N	1
CLN		Clear Negative Flag	N ← 0	N	1
SEZ		Set Zero Flag	Z ← 1	Z	1
CLZ		Clear Zero Flag	Z ← 0	Z	1
SEI		Global Interrupt Enable	I ← 1	I	1
CLI		Global Interrupt Disable	I ← 0	I	1
SES		Set Signed Test Flag	S ← 1	S	1
CLS		Clear Signed Test Flag	S ← 0	S	1
SEV		Set Twos Complement Overflow	V ← 1	V	1
CLV		Clear Twos Complement Overflow	V ← 0	V	1
SET		Set T in SREG	T ← 1	T	1
CLT		Clear T in SREG	T ← 0	T	1
SEH		Set Half Carry Flag in SREG	H ← 1	H	1
CLH		Clear Half Carry Flag in SREG	H ← 0	H	1
DATA TRANSFER INSTRUCTIONS					
MOV	Rd, Rr	Move Between Registers	Rd ← Rr	None	1
MOVW	Rd, Rr	Copy Register Word	Rd+1:Rd ← Rr+1:Rr	None	1
LDI	Rd, K	Load Immediate	Rd ← K	None	1
LD	Rd, X	Load Indirect	Rd ← (X)	None	2
LD	Rd, X+	Load Indirect and Post-Inc.	Rd ← (X), X ← X + 1	None	2
LD	Rd, -X	Load Indirect and Pre-Dec.	X ← X - 1, Rd ← (X)	None	2
LD	Rd, Y	Load Indirect	Rd ← (Y)	None	2
LD	Rd, Y+	Load Indirect and Post-Inc.	Rd ← (Y), Y ← Y + 1	None	2
LD	Rd, -Y	Load Indirect and Pre-Dec.	Y ← Y - 1, Rd ← (Y)	None	2
LDD	Rd,Y+q	Load Indirect with Displacement	Rd ← (Y + q)	None	2
LD	Rd, Z	Load Indirect	Rd ← (Z)	None	2
LD	Rd, Z+	Load Indirect and Post-Inc.	Rd ← (Z), Z ← Z+1	None	2
LD	Rd, -Z	Load Indirect and Pre-Dec.	Z ← Z - 1, Rd ← (Z)	None	2
LDD	Rd, Z+q	Load Indirect with Displacement	Rd ← (Z + q)	None	2
LDS	Rd, k	Load Direct from SRAM	Rd ← (k)	None	2
ST	X, Rr	Store Indirect	(X) ← Rr	None	2
ST	X+, Rr	Store Indirect and Post-Inc.	(X) ← Rr, X ← X + 1	None	2
ST	-X, Rr	Store Indirect and Pre-Dec.	X ← X - 1, (X) ← Rr	None	2
ST	Y, Rr	Store Indirect	(Y) ← Rr	None	2
ST	Y+, Rr	Store Indirect and Post-Inc.	(Y) ← Rr, Y ← Y + 1	None	2
ST	-Y, Rr	Store Indirect and Pre-Dec.	Y ← Y - 1, (Y) ← Rr	None	2
STD	Y+q,Rr	Store Indirect with Displacement	(Y + q) ← Rr	None	2
ST	Z, Rr	Store Indirect	(Z) ← Rr	None	2
ST	Z+, Rr	Store Indirect and Post-Inc.	(Z) ← Rr, Z ← Z + 1	None	2
ST	-Z, Rr	Store Indirect and Pre-Dec.	Z ← Z - 1, (Z) ← Rr	None	2
STD	Z+q,Rr	Store Indirect with Displacement	(Z + q) ← Rr	None	2
STS	k, Rr	Store Direct to SRAM	(k) ← Rr	None	2
LPM		Load Program Memory	R0 ← (Z)	None	3
LPM	Rd, Z	Load Program Memory	Rd ← (Z)	None	3
LPM	Rd, Z+	Load Program Memory and Post-Inc	Rd ← (Z), Z ← Z+1	None	3
SPM		Store Program Memory	(Z) ← R1:R0	None	-

Mnemonics	Operands	Description	Operation	Flags	#Clocks
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
MCU CONTROL INSTRUCTIONS					
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 ATmega329

Speed (MHz) ⁽³⁾	Power Supply	Ordering Code ⁽²⁾	Package Type ⁽¹⁾	Operational Range
8	1.8 - 5.5V	ATmega329V-8AU ATmega329V-8AUR ⁽⁴⁾ ATmega329V-8MU ATmega329V-8MUR ⁽⁴⁾	64A 64A 64M1 64M1	Industrial (-40°C to 85°C)
16	2.7 - 5.5V	ATmega329-16AU ATmega329-16AUR ⁽⁴⁾ ATmega329-16MU ATmega329-16MUR ⁽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 alternative, 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 328](#) and [Figure 28-2 on page 328](#).
 4. Tape & Reel

Package Type	
64A	64-lead, 14 x 14 x 1.0 mm, Thin Profile Plastic Quad Flat Package (TQFP)
64M1	64-pad, 9 x 9 x 1.0 mm, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)
100A	100-lead, 14 x 14 x 1.0 mm, 0.5 mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)

8.2 ATmega3290

Speed (MHz) ⁽³⁾	Power Supply	Ordering Code ⁽²⁾	Package Type ⁽¹⁾	Operational Range
8	1.8 - 5.5V	ATmega3290V-8AU ATmega3290V-8AUR ⁽⁴⁾	100A 100A	Industrial (-40°C to 85°C)
16	2.7 - 5.5V	ATmega3290-16AU ATmega3290-16AUR ⁽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 alternative, 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 328](#) and [Figure 28-2 on page 328](#).
 4. Tape & Reel

Package Type	
64A	64-lead, 14 x 14 x 1.0 mm, Thin Profile Plastic Quad Flat Package (TQFP)
64M1	64-pad, 9 x 9 x 1.0 mm, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)
100A	100-lead, 14 x 14 x 1.0 mm, 0.5 mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)

8.3 ATmega649

Speed (MHz) ⁽³⁾	Power Supply	Ordering Code ⁽²⁾	Package Type ⁽¹⁾	Operational Range
8	1.8 - 5.5V	ATmega649V-8AU ATmega649V-8AUR ⁽⁴⁾ ATmega649V-8MU ATmega649V-8MUR ⁽⁴⁾	64A 64A 64M1 64M1	Industrial (-40°C to 85°C)
16	2.7 - 5.5V	ATmega649-16AU ATmega649-16AUR ⁽⁴⁾ ATmega649-16MU ATmega649-16MUR ⁽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 alternative, 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 328](#) and [Figure 28-2 on page 328](#).
 4. Tape & Reel

Package Type	
64A	64-lead, 14 x 14 x 1.0 mm, Thin Profile Plastic Quad Flat Package (TQFP)
64M1	64-pad, 9 x 9 x 1.0 mm, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)
100A	100-lead, 14 x 14 x 1.0 mm, 0.5 mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)



8.4 ATmega6490

Speed (MHz) ⁽³⁾	Power Supply	Ordering Code ⁽²⁾	Package Type ⁽¹⁾	Operational Range
8	1.8 - 5.5V	ATmega6490V-8AU ATmega6490V-8AUR ⁽⁴⁾	100A 100A	Industrial (-40°C to 85°C)
16	2.7 - 5.5V	ATmega6490-16AU ATmega6490-16AUR ⁽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 alternative, complies to the European Directive for Restriction of Hazardous Substances (RoHS directive). Also Halide free and fully Green.
 3. For Speed Grades see [Figure 28-1 on page 328](#) and [Figure 28-2 on page 328](#).
 4. Tape & Reel

Package Type	
64A	64-lead, 14 x 14 x 1.0 mm, Thin Profile Plastic Quad Flat Package (TQFP)
64M1	64-pad, 9 x 9 x 1.0 mm, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)
100A	100-lead, 14 x 14 x 1.0 mm, 0.5 mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)

10. Errata

10.1 ATmega329

10.1.1 ATmega329 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 (TCCR_x), asynchronous Timer Counter Register (TCNT_x), or asynchronous Output Compare Register (OCR_x).

10.1.2 ATmega329 rev. B

Not sampled.

10.1.3 ATmega329 rev. A

- LCD contrast voltage too high
- Interrupts may be lost when writing the timer registers in the asynchronous timer

1. LCD contrast voltage too high

When the LCD is active and using low power waveform, the LCD contrast voltage can be too high. This occurs when V_{CC} is higher than V_{LCD} , and when using low LCD drivetime.

Problem Fix/Workaround

There are several possible workarounds:

- Use normal waveform instead of low power waveform
- Use drivetime of 375 μ s or longer

2. 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 (TCNT_x) 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 (TCCR_x), asynchronous Timer Counter Register (TCNT_x), or asynchronous Output Compare Register (OCR_x).

10.2 ATmega3290

10.2.1 ATmega3290 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 (TCCR_x), asynchronous Timer Counter Register (TCNT_x), or asynchronous Output Compare Register (OCR_x).

10.2.2 ATmega3290 rev. B

Not sampled.

10.2.3 ATmega3290 rev. A

- LCD contrast voltage too high
- Interrupts may be lost when writing the timer registers in the asynchronous timer

1. LCD contrast voltage too high

When the LCD is active and using low power waveform, the LCD contrast voltage can be too high. This occurs when V_{CC} is higher than V_{LCD} , and when using low LCD drivetime.

Problem Fix/Workaround

There are several possible workarounds:

- Use normal waveform instead of low power waveform
- Use drivetime of 375 μ s or longer

2. 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 (TCNT_x) 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 (TCCR_x), asynchronous Timer Counter Register (TCNT_x), or asynchronous Output Compare Register (OCR_x).

10.3 ATmega649

10.3.1 ATmega649 rev. A

- 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/Wortkaround

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

10.4 ATmega6490

10.4.1 ATmega6490 rev. A

- 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 (TCNT_x) is 0x00.

Problem Fix/Wortkaround

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

11. Datasheet Revision History

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

11.1 Rev. 2552K – 04/11

1. Removed “Preliminary” from the front page.
2. Removed “Disclaimer Section” from the datasheet.
3. Updated [Table 28-5 on page 330](#) “BODLEVEL Fuse Coding(1)” .
4. Updated [Table 28-8 on page 334](#) “LCD Controller Characteristics” .
5. Updated “[Ordering Information](#)” on page 372 to include “Tape & Reel” devices. The “AI” and “MI” devices removed.
6. Updated “[Errata](#)” on page 379.
7. Updated the datasheet according to the Atmel new brand style guide, including the last page.

11.2 Rev. 2552J – 08/07

1. Updated “[Features](#)” on page 1.
2. Added “[Data Retention](#)” on page 9.
3. Updated “[Serial Programming Algorithm](#)” on page 309.
4. Updated “[Speed Grades](#)” on page 328.
5. Updated “[System and Reset Characteristics](#)” on page 330.
6. Moved Register Descriptions to the end of each chapter.

11.3 Rev. 2552I – 04/07

1. Updated date in backpage
2. Updated column in [Table 28-5 on page 330](#).

11.4 Rev. 2552H – 11/06

1. Updated [Table 28-7 on page 333](#).
2. Updated note in [Table 28-7 on page 333](#) and [Table 28-2 on page 329](#).

11.10 Rev. 2552B – 05/05

1. MLF-package alternative changed to “Quad Flat No-Lead/Micro Lead Frame Package QFN/MLF”.
2. Added “Pin Change Interrupt Timing” on page 54.
3. Updated Table 23-6 on page 242, Table 23-7 on page 243 and Table 27-15 on page 310.
4. Added Figure 27-12 on page 312.
5. Updated Figure 22-9 on page 219 and Figure 27-5 on page 304.
6. Updated algorithm “Enter Programming Mode” on page 299.
7. Added “Supply Current of I/O modules” on page 340.
8. Updated “Ordering Information” on page 372.

11.11 Rev. 2552A –11/04

1. Initial version.