

Digital I/O

PORTB / PINB (output / input)	PB7	PB6	PB5	PB4	PB3	PB2	PB1	PB0
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PORTC / PINC (output / input)	PC7	PC6	PC5	PC4	PC3	PC2	PC1	PC0
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PORTD / PIND (output / input)	PD7	PD6	PD5	PD4	PD3	PD2	PD1	PD0
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DDRB / DDRC / DDRD	DDB7 DDC7 DDD7	DDB6 DDC6 DDD6	DDB5 DDC5 DDD5	DDB4 DDC4 DDD4	DDB3 DDC3 DDD3	DDB2 DDC2 DDD2	DDB1 DDC1 DDD1	DDB0 DDC0 DDD0
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Set Pin as Output $\text{DDRB} |= (1 \ll \text{DDB4});$ **Set Pin as Input** $\text{DDRB} \&= \sim(1 \ll \text{DDB4});$
Set Output Value to 1 $\text{PORTB} |= (1 \ll \text{PB4});$ **Check Pin is 1** $(\text{PINB} \& (1 \ll \text{PB4})) != 0$
Clear Output Value to 0 $\text{PORTB} \&= \sim(1 \ll \text{PB4});$ **Check Pin is 0** $(\text{PINB} \& (1 \ll \text{PB4})) == 0$

Analog to Digital Conversion

ADMUX	REFS1	REFS0	ADLAR	unused	MUX3	MUX2	MUX1	MUX0
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ADCSRA	ADEN	ADSC	ADATE	ADIF	ADIE	ADPS2	ADPS1	ADPS0
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ADCH (8-bit ADC res.)								
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ADC (10-bit ADC res. / 16-bit value)	15	14	13	12	11	10	9	8
	0	0	0	0	0	0		
	7	6	5	4	3	2	1	0

After initialization, start, poll, capture result
 $\text{ADCSRA} |= (1 \ll \text{ADSC});$
 $\text{while}(\text{ADCSRA} \& (1 \ll \text{ADSC})) \{ \}$
 $\text{unsigned char result} = \text{ADCH};$
 $// \text{ if 10-bit result (ADLAR} = 0) \text{ use this}$
 $// \text{ unsigned int result} = \text{ADC};$

Serial (UART / RS-232) Comm.

UCSR0A	RXC0		UDRE0					
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UCSR0B			RXEN0	TXEN0				
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UCSR0C					UCSZ01	UCSZ00		
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UDR0 (RX & TX Data)								
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UBRR0 (Baud Rate)	15	14	13	12	11	10	9	8
	0	0	0	0				
	7	6	5	4	3	2	1	0

Helpful Arduino Library Functions

<avr/io.h> All register and bit position definitions
<util/delay.h> $_delay_ms(10);$ // delay 10 milli(m)-sec
 $_delay_us(10);$ // delay 10 micro(u)-sec
<avr/interrupt.h> $sei();$ // turn on global interrupt enable
 $cli();$ // turn off global interrupt enable

16-bit Timer and Pulse Width Modulation (PWM)

TCCR1A	7	6	5	4	3	2	1	0
	COM1A1	COM1A0	COM1B1	COM1B0			WGM11	WGM10

TCCR1B	7	6	5	4	3	2	1	0
				WGM13	WGM12	CS12	CS11	CS10

TIMSK1	7	6	5	4	3	2	1	0
						OCIE1B	OCIE1A	

OCR1A (16-bit value) Timer MAX or PWM	15	14	13	12	11	10	9	8
	7	6	5	4	3	2	1	0

OCR1B (16-bit value) PWM	15	14	13	12	11	10	9	8
	7	6	5	4	3	2	1	0

TCNT1 (16-bit current count value)	15	14	13	12	11	10	9	8
	7	6	5	4	3	2	1	0

8-bit Timers and Pulse Width Modulation (PWM)

TCCR0A TCCR2A	7	6	5	4	3	2	1	0
	COM0A1	COM0A0	COM0B1	COM0B0			WGM01	WGM00
	COM2A1	COM2A0	COM2B1	COM2B0			WGM21	WGM20

TCCR0B TCCR2B	7	6	5	4	3	2	1	0
				WGM03	WGM02	CS02	CS01	CS00
				WGM23	WGM22	CS22	CS21	CS20

TIMSK0 TIMSK2	7	6	5	4	3	2	1	0
						OCIE0B	OCIE0A	
						OCIE2B	OCIE2A	

OCR0A / OCR2A (8-bit value) Timer MAX or PWM	7	6	5	4	3	2	1	0

OCR0B / OCR2B (8-bit value) for PWM	7	6	5	4	3	2	1	0

TCNT0 / TCNT2 (8-bit current count value)	7	6	5	4	3	2	1	0

Pin Change Interrupts

PCICR Int. Enables						PCIE2 (D)	PCIE1 (C)	PCIE0 (B)
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PCMSK0 (for Port B)	PCINT7 (PB7)	PCINT6 (PB6)	PCINT5 (PB5)	PCINT4 (PB4)	PCINT3 (PB3)	PCINT2 (PB2)	PCINT1 (PB1)	PCINT0 (PB0)
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PCMSK1 (for Port C)		PCINT14 (PC6)	PCINT13 (PC5)	PCINT12 (PC4)	PCINT11 (PC3)	PCINT10 (PC2)	PCINT9 (PC1)	PCINT8 (PC0)
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PCMSK2 (for Port D)	PCINT23 (PD7)	PCINT22 (PD6)	PCINT21 (PD5)	PCINT20 (PD4)	PCINT19 (PD3)	PCINT18 (PD2)	PCINT17 (PD1)	PCINT16 (PD0)
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Helpful C-Library Functions

$\text{sprintf}(\text{char}^* \text{buf}, \text{int} \text{max}, \text{char}^* \text{fmt}, \dots);$
<stdio.h>
Example:
 $\text{char buf}[9];$ // "Val=" + max 4-digits + null int val;
 $// \text{ val set to some integer}$
 $\text{sprintf}(\text{buf}, 5, \text{"Val}=\text{"}, \text{val});$
 $// \text{ to ensure fixed space (num. digits) for val}$
 $\text{sprintf}(\text{buf}, 5, \text{"Val}=\text{"}, \text{val});$