

Features

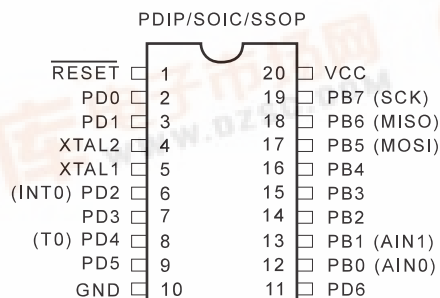
- Utilizes the AVR[®] RISC Architecture
- AVR – High-performance and Low-power RISC Architecture
 - 89 Powerful Instructions – Most Single Clock Cycle Execution
 - 32 x 8 General-purpose Working Registers
 - Up to 12 MIPS Throughput at 12 MHz
- Data and Nonvolatile Program Memory
 - 1K Byte of In-System Programmable Flash
Endurance: 1,000 Write/Erase Cycles
 - 64 Bytes of In-System Programmable EEPROM
Endurance: 100,000 Write/Erase Cycles
 - Programming Lock for Flash Program and EEPROM Data Security
- Peripheral Features
 - One 8-bit Timer/Counter with Separate Prescaler
 - On-chip Analog Comparator
 - Programmable Watchdog Timer with On-chip Oscillator
 - SPI Serial Interface for In-System Programming
- Special Microcontroller Features
 - Low-power Idle and Power-down Modes
 - External and Internal Interrupt Sources
 - Selectable On-chip RC Oscillator for Zero External Components
- Specifications
 - Low-power, High-speed CMOS Process Technology
 - Fully Static Operation
- Power Consumption at 4 MHz, 3V, 25°C
 - Active: 2.0 mA
 - Idle Mode: 0.4 mA
 - Power-down Mode: <1 μA
- I/O and Packages
 - 15 Programmable I/O Lines
 - 20-pin PDIP, SOIC and SSOP
- Operating Voltages
 - 2.7 - 6.0V (AT90S1200-4)
 - 4.0 - 6.0V (AT90S1200-12)
- Speed Grades
 - 0 - 4 MHz, (AT90S1200-4)
 - 0 - 12 MHz, (AT90S1200-12)

Description

The AT90S1200 is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture. By executing powerful instructions in a single clock cycle, the

(continued)

Pin Configuration



8-bit AVR[®] Microcontroller with 1K Byte of In-System Programmable Flash

AT90S1200

Summary



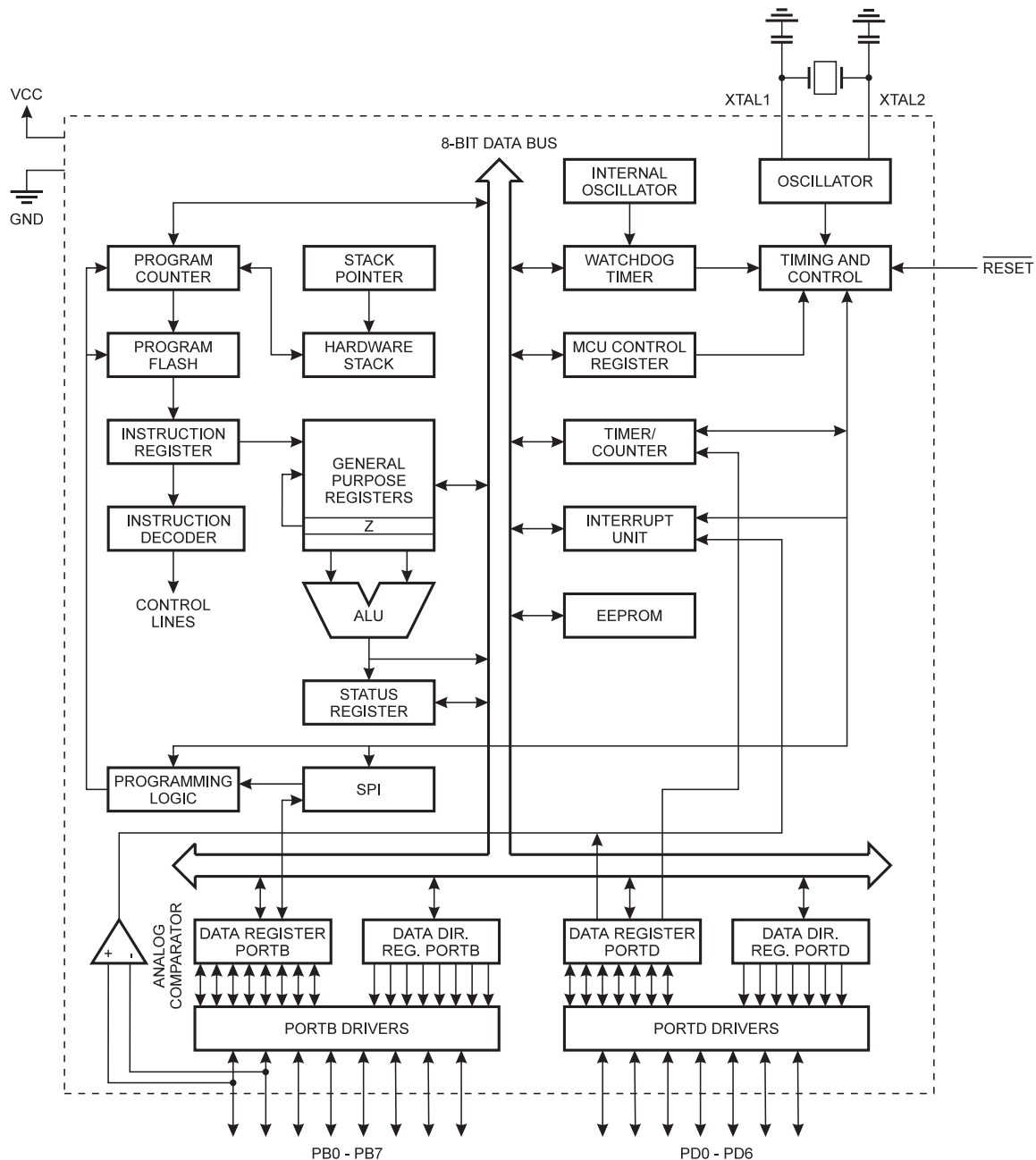


AT90S1200 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

The AVR core combines a rich instruction set with the 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.

Block Diagram

Figure 1. The AT90S1200 Block Diagram



The architecture supports high-level languages efficiently as well as extremely dense assembler code programs. The AT90S1200 provides the following features: 1K byte of In-System Programmable Flash, 64 bytes EEPROM, 15 general-purpose I/O lines, 32 general-purpose working registers, internal and external interrupts, programmable Watchdog Timer with internal oscillator, an SPI serial port for program downloading and two software selectable power-saving modes. The Idle Mode stops the CPU while allowing the registers, timer/counter, watchdog 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 external interrupt or hardware reset.

The device is manufactured using Atmel's high-density nonvolatile memory technology. The on-chip In-System Programmable Flash allows the program memory to be reprogrammed in-system through an SPI serial interface or by a conventional nonvolatile memory programmer. By combining an enhanced RISC 8-bit CPU with In-System Programmable Flash on a monolithic chip, the Atmel AT90S1200 is a powerful microcontroller that provides a highly flexible and cost-effective solution to many embedded control applications.

The AT90S1200 AVR is supported with a full suite of program and system development tools including: macro assemblers, program debugger/simulators, in-circuit emulators, and evaluation kits.

Pin Descriptions

VCC

Supply voltage pin.

GND

Ground pin.

Port B (PB7..PB0)

Port B is an 8-bit bi-directional I/O port. Port pins can provide internal pull-up resistors (selected for each bit). PB0 and PB1 also serve as the positive input (AIN0) and the negative input (AIN1), respectively, of the on-chip analog comparator. The Port B output buffers can sink 20 mA and thus drive LED displays directly. When pins PB0 to PB7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not active.

Port D (PD6..PD0)

Port D has seven bi-directional I/O pins with internal pull-up resistors, PD6..PD0. The Port D output buffers can sink 20 mA. 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 active.

RESET

Reset input. A low level on this pin for more than 50 ns will generate a reset, even if the clock is not running. Shorter pulses are not guaranteed to generate a reset.

XTAL1

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

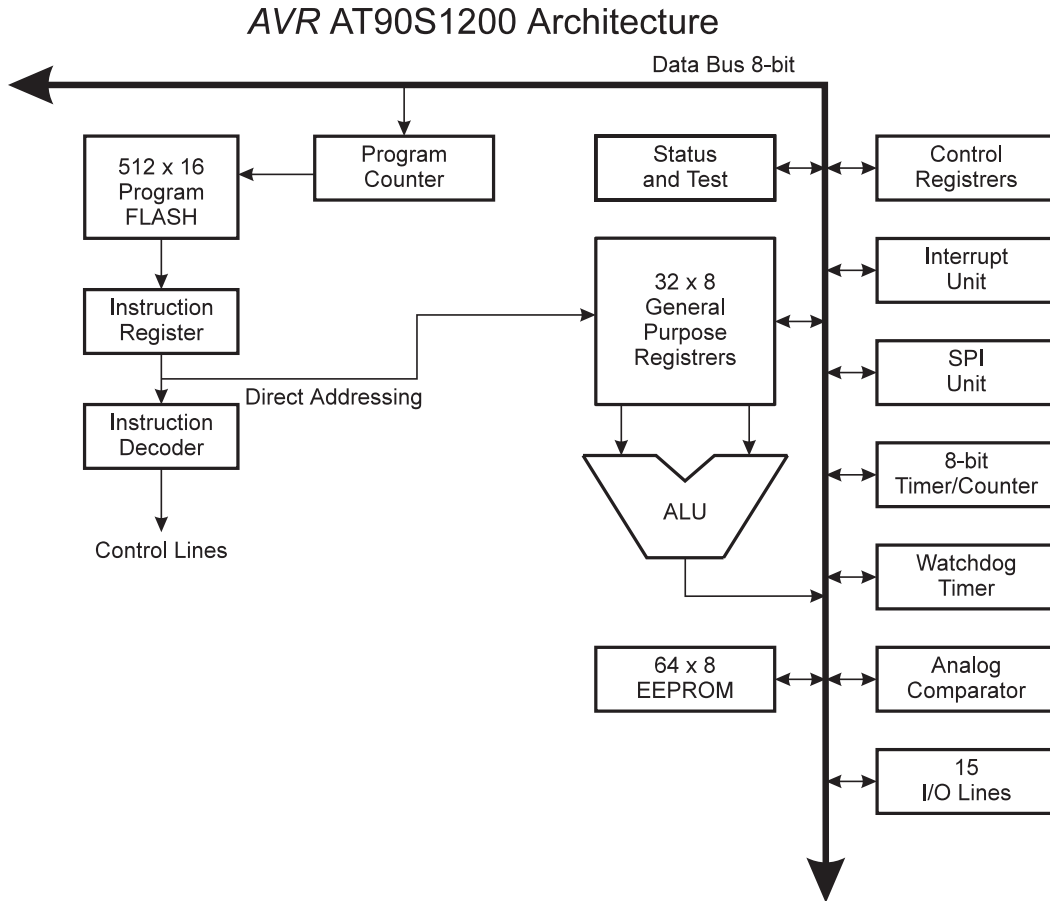
XTAL2

Output from the inverting oscillator amplifier.

Architectural Overview

The fast-access register file concept contains 32 x 8-bit general-purpose working registers with a single clock cycle access time. This means that during one single clock cycle, one ALU (Arithmetic Logic Unit) operation is executed. Two operands are output from the register file, the operation is executed, and the result is stored back in the register file – in one clock cycle.

Figure 2. The AT90S1200 AVR Enhanced RISC Architecture



The ALU supports arithmetic and logic functions between registers or between a constant and a register. Single register operations are also executed in the ALU. Figure 2 shows the AT90S1200 AVR Enhanced RISC microcontroller architecture. The AVR uses a Harvard architecture concept – with separate memories and buses for program and data memories. The program memory is accessed with a 2-stage pipeline. While one instruction is being executed, the next instruction is pre-fetched from the program memory. This concept enables instructions to be executed in every clock cycle. The program memory is In-System Programmable Flash memory.

With the relative jump and relative call instructions, the whole 512 address space is directly accessed. All AVR instructions have a single 16-bit word format, meaning that every program memory address contains a single 16-bit instruction.

During interrupts and subroutine calls, the return address program counter (PC) is stored on the stack. The stack is a 3-level-deep hardware stack dedicated for subroutines and interrupts.

The I/O memory space contains 64 addresses for CPU peripheral functions such as control registers, timer/counters, A/D converters and other I/O functions. The memory spaces in the AVR architecture are all linear and regular memory maps.

A flexible interrupt module has its control registers in the I/O space with an additional global interrupt enable bit in the status register. All the different interrupts have a separate interrupt vector in the interrupt vector table at the beginning of the program memory. The different interrupts have priority in accordance with their interrupt vector position. The lower the interrupt vector address, the higher the priority.

AT90S1200 Register Summary

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
\$3F	SREG	I	T	H	S	V	N	Z	C
\$3E	Reserved								
\$3D	Reserved								
\$3C	Reserved								
\$3B	GIMSK	-	INT0	-	-	-	-	-	-
\$3A	Reserved								
\$39	TIMSK	-	-	-	-	-	-	TOIE0	-
\$38	TIFR	-	-	-	-	-	-	TOV0	-
\$37	Reserved								
\$36	Reserved								
\$35	MCUCR	-	-	SE	SM	-	-	ISC01	ISC00
\$34	Reserved								
\$33	TCCR0	-	-	-	-	-	CS02	CS01	CS00
\$32	TCNT0	Timer/Counter0 (8 Bits)							
\$31	Reserved								
\$30	Reserved								
\$2F	Reserved								
\$2E	Reserved								
\$2D	Reserved								
\$2C	Reserved								
\$2B	Reserved								
\$2A	Reserved								
\$29	Reserved								
\$28	Reserved								
\$27	Reserved								
\$26	Reserved								
\$25	Reserved								
\$24	Reserved								
\$23	Reserved								
\$22	Reserved								
\$21	WDTCR	-	-	-	-	WDE	WDP2	WDP1	WDP0
\$20	Reserved								
\$1F	Reserved								
\$1E	EEAR	-	EEPROM Address Register						
\$1D	EEDR	EEPROM Data Register							
\$1C	EECR	-	-	-	-	-	-	EEWE	EERE
\$1B	Reserved								
\$1A	Reserved								
\$19	Reserved								
\$18	PORTB	PORTB7	PORTB6	PORTB5	PORTB4	PORTB3	PORTB2	PORTB1	PORTB0
\$17	DDRB	DDB7	DDB6	DDB5	DDB4	DDB3	DDB2	DDB1	DDB0
\$16	PINB	PINB7	PINB6	PINB5	PINB4	PINB3	PINB2	PINB1	PINB0
\$15	Reserved								
\$14	Reserved								
\$13	Reserved								
\$12	PORTD	-	PORTD6	PORTD5	PORTD4	PORTD3	PORTD2	PORTD1	PORTD0
\$11	DDRD	-	DDD6	DDD5	DDD4	DDD3	DDD2	DDD1	DDD0
\$10	PIND	-	PIND6	PIND5	PIND4	PIND3	PIND2	PIND1	PIND0
\$0F	Reserved								
...	Reserved								
\$09	Reserved								
\$08	ACSR	ACD	-	ACO	ACI	ACIE	-	ACIS1	ACIS0
...	Reserved								
\$00	Reserved								

- Notes:
1. For compatibility with future devices, reserved bits should be written to zero if accessed. Reserved I/O memory addresses should never be written.
 2. Some of the status flags are cleared by writing a logical "1" to them. Note that the CBI and SBI instructions will operate on all bits in the I/O register, writing a "1" back into any flag read as set, thus clearing the flag. The CBI and SBI instructions work with registers \$00 to \$1F only.



Instruction Set Summary

Mnemonic	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
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
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	$Rd \leftarrow \$FF - Rd$	Z,C,N,V	1
NEG	Rd	Two's Complement	$Rd \leftarrow \$00 - Rd$	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	$Rd \leftarrow Rd \cdot (\text{FFh} - K)$	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	$Rd \leftarrow \$FF$	None	1
BRANCH INSTRUCTIONS					
RJMP	k	Relative Jump	$PC \leftarrow PC + k + 1$	None	2
RCALL	k	Relative Subroutine Call	$PC \leftarrow PC + k + 1$	None	3
RET		Subroutine Return	$PC \leftarrow \text{STACK}$	None	4
RETI		Interrupt Return	$PC \leftarrow \text{STACK}$	I	4
CPSE	Rd, Rr	Compare, Skip if Equal	if (Rd = Rr) $PC \leftarrow PC + 2$ or 3	None	1/2
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
SBRS	Rr, b	Skip if Bit in Register is Set	if (Rr(b) = 1) $PC \leftarrow PC + 2$ or 3	None	1/2
SBIC	P, b	Skip if Bit in I/O Register Cleared	if (P(b) = 0) $PC \leftarrow PC + 2$ or 3	None	1/2
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
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
BRREQ	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
DATA TRANSFER INSTRUCTIONS					
LD	Rd, Z	Load Register Indirect	$Rd \leftarrow (Z)$	None	2
ST	Z, Rr	Store Register Indirect	$(Z) \leftarrow Rr$	None	2
MOV	Rd, Rr	Move between Registers	$Rd \leftarrow Rr$	None	1
LDI	Rd, K	Load Immediate	$Rd \leftarrow K$	None	1
IN	Rd, P	In Port	$Rd \leftarrow P$	None	1
OUT	P, Rr	Out Port	$P \leftarrow Rr$	None	1

Instruction Set Summary (Continued)

Mnemonic	Operands	Description	Operation	Flags	# Clocks
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 Two's Complement Overflow	V ← 1	V	1
CLV		Clear Two's 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
NOP		No Operation		None	1
SLEEP		Sleep	(see specific descr. for Sleep function)	None	3
WDR		Watchdog Reset	(see specific descr. for WDR/timer)	None	1



Ordering Information⁽¹⁾

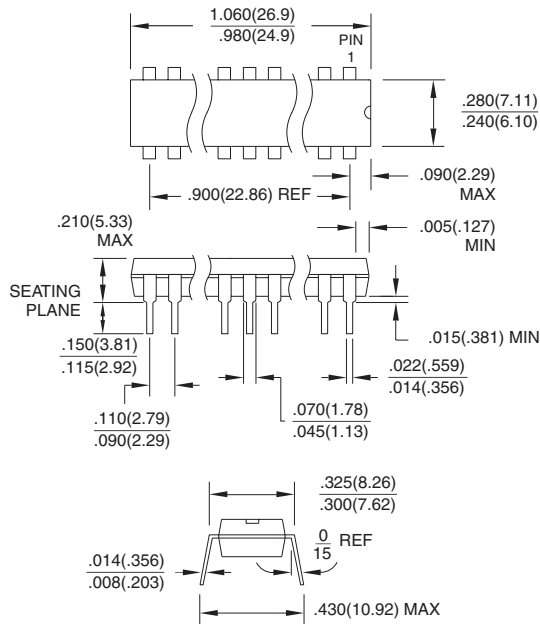
Speed (MHz)	Power Supply	Ordering Code	Package	Operation Range
4	2.7 - 6.0V	AT90S1200-4PC	20P3	Commercial (0°C to 70°C)
		AT90S1200-4SC	20S	
		AT90S1200-4YC	20Y	
		AT90S1200-4PI	20P3	Industrial (-40°C to 85°C)
		AT90S1200-4SI	20S	
		AT90S1200-4YI	20Y	
12	4.0 - 6.0V	AT90S1200-12PC	20P3	Commercial (0°C to 70°C)
		AT90S1200-12SC	20S	
		AT90S1200-12YC	20Y	
		AT90S1200-12PI	20P3	Industrial (-40°C to 85°C)
		AT90S1200-12SI	20S	
		AT90S1200-12YI	20Y	

Note: 1. Order AT90S1200A-XXX for devices with the RCEN fuse programmed.

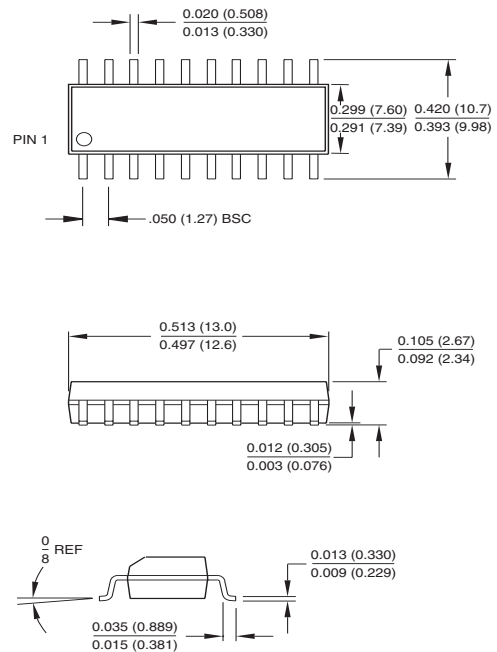
Package Type	
20P3	20-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
20S	20-lead, 0.300" Wide, Plastic Gull Wing Small Outline (SOIC)
20Y	20-lead, 5.3 mm Wide, Plastic Shrink Small Outline Package (SSOP)

Packaging Information

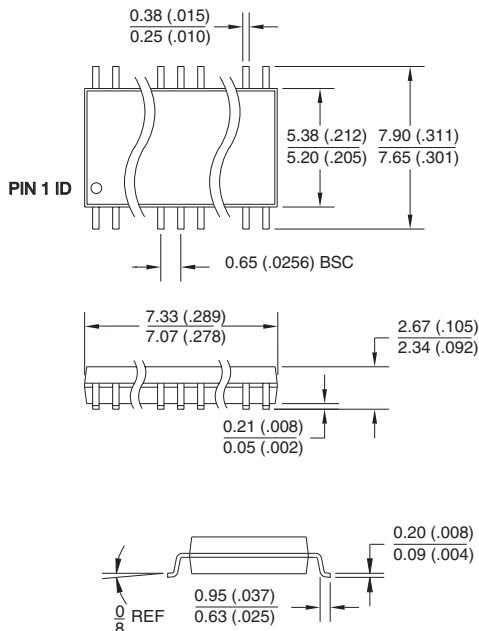
20P3, 20-lead, 0.300" Wide,
Plastic Dual Inline Package (PDIP)
Dimensions in Inches and (Millimeters)
JEDEC STANDARD MS-001 BA



20S, 20-lead, 0.300" Wide,
Plastic Gull Wing Small Outline (SOIC)
Dimensions in Inches and (Millimeters)



20Y, 20-lead, 5.3 mm Wide,
Plastic Shrink Small Outline Package (SSOP)
Dimensions in Millimeters and (Inches)





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