

Features

- Utilizes the AVR[®] Enhanced RISC Architecture
- AVR - High Performance and Low Power RISC Architecture
- 118 Powerful Instructions - Most Single Clock Cycle Execution
- 2K bytes of In-System Programmable ISP Flash
 - SPI Serial Interface for In-System Programming
 - Endurance: 1,000 Write/Erase Cycles
- 128 bytes EEPROM
 - Endurance: 100,000 Write/Erase Cycles
- 128 bytes Internal RAM
- 32 x 8 General Purpose Working Registers
 - 3 AT90S/LS2323 Programmable I/O Lines
 - 5 AT90S/LS2343 Programmable I/O Lines
- V_{CC}: 4.0 - 6.0V AT90S2323/AT90S2343
- V_{CC}: 2.7 - 6.0V AT90LS2323/AT90LS2343
- Power-On Reset Circuit
- Speed Grades: 0 - 10 MHz AT90S2323/AT90S2343
- Speed Grades: 0 - 4 MHz AT90LS2323/AT90LS2343
- Up to 10 MIPS Throughput at 10 MHz
- One 8-Bit Timer/Counter with Separate Prescaler
- External and Internal Interrupt Sources
- Programmable Watchdog Timer with On-Chip Oscillator
- Low Power Idle and Power Down Modes
- Programming Lock for Flash Program and EEPROM Data Security
- Selectable On-Chip RC Oscillator
- 8-Pin Device

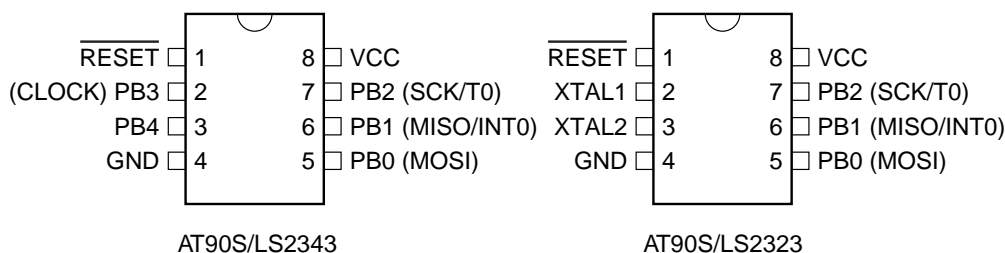
Description

The AT90S/LS2323 and AT90S/LS2343 is a low-power CMOS 8-bit microcontrollers based on the AVR[®] enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the AT90S/LS2323 and AT90S/LS2343 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 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.

Pin Configuration

PDIP/SOIC



8-Bit AVR[®]
Microcontroller
with 2K Bytes of
In-System
Programmable
Flash

AT90S2323
AT90LS2323
AT90S2343
AT90LS2343
Preliminary

Rev. 1004AS-05/98



Note: This is a summary document. For the complete 34 page document, please visit our website at www.atmel.com or e-mail at literature@atmel.com and request literature #1004A.

Block Diagram

Figure 1. The AT90S/LS2343 Block Diagram

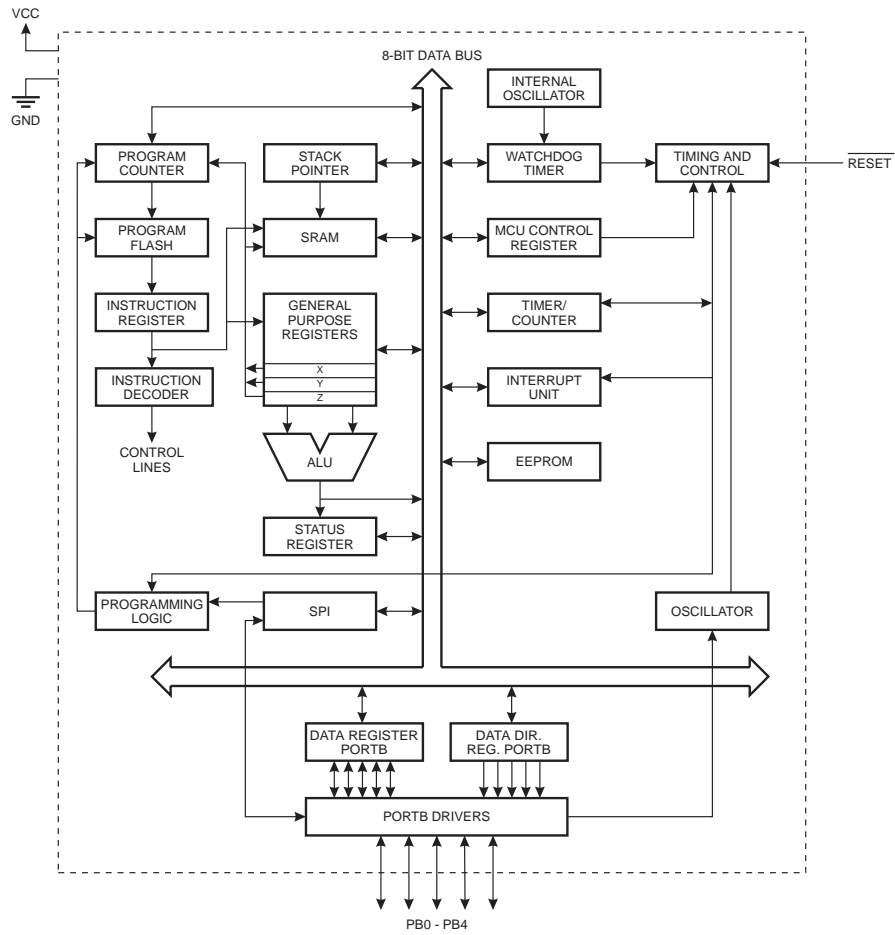
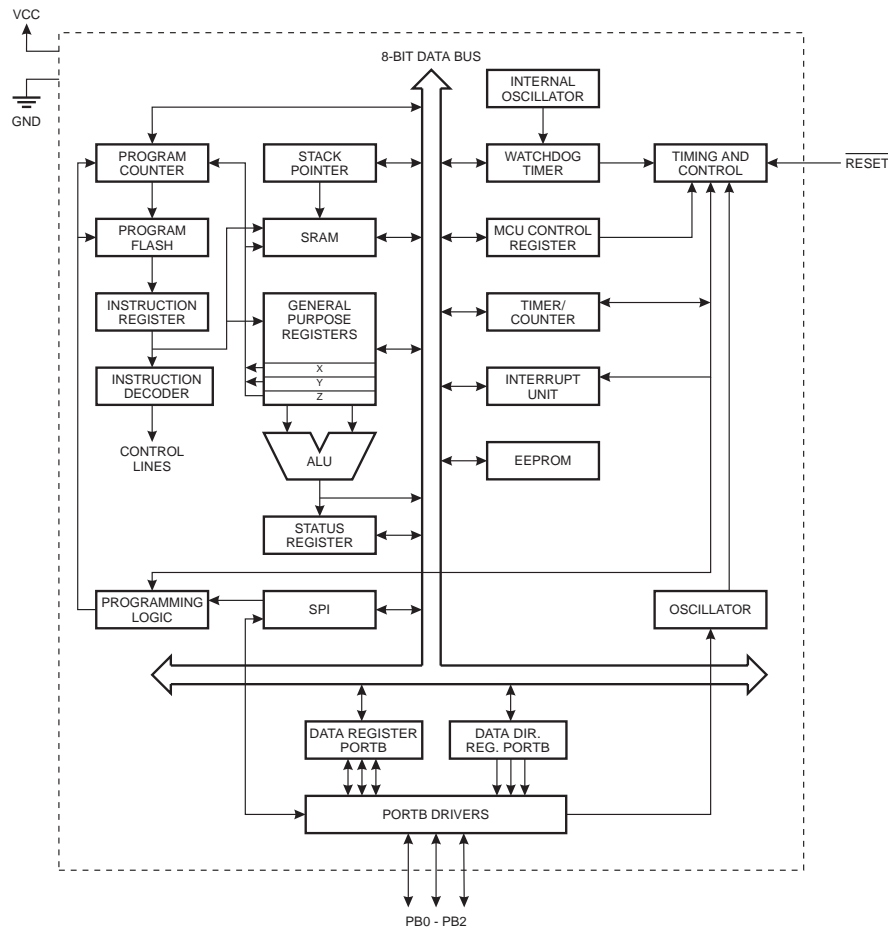


Figure 2. The AT90S/LS2323 Block Diagram



Description

The AT90S/LS2323 and AT90S/LS2343 provides the following features: 2K bytes of In-System Programmable Flash, 128 bytes EEPROM, 128 bytes SRAM, 3 (AT90S/LS2323) / 5 (AT90S/LS2343) general purpose I/O lines, 32 general purpose working registers, an 8-bit timer/counter, internal and external interrupts, programmable Watchdog Timer with internal oscillator, an SPI serial port for Flash Memory downloading and two 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.

The device is manufactured using Atmel's high density non-volatile memory technology. The on-chip Flash allows the program memory to be reprogrammed in-system through an SPI serial interface. By combining an 8-bit RISC CPU with ISP Flash on a monolithic chip, the Atmel AT90S/LS2323 and AT90S/LS2343 is a powerful micro-

controller that provides a highly flexible and cost effective solution to many embedded control applications.

The AT90S/LS2323 and AT90S/LS2343 AVR is 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.

Comparison Between AT90S/LS2323 and AT90S/LS2343

The AT90S/LS2323 is intended for use with external quartz crystal or ceramic resonator as the clock source. The start-up time is fuse selectable as either 1 ms (suitable for ceramic resonator) or 16 ms (suitable for crystal). The device has three I/O pins.

The AT90S/LS2343 is intended for use with either an external clock source or the internal RC oscillator as clock source. The device has five I/O pins.

Table 1 summarizes the differences in features of the two devices.

Table 1. Feature Difference Summary

| Part | AT90S/LS2323 | AT90S/LS2343 |
|------------------------------|--------------|---------------------|
| On-chip oscillator amplifier | yes | no |
| Internal RC Clock | no | yes |
| PB3 usable | never | internal clock mode |
| PB4 usable | never | always |
| Startup time | 1 ms / 16 ms | 16 μ s fixed |

Pin Descriptions AT90S/LS2323

VCC

Supply voltage pin.

GND

Ground pin.

Port B (PB2..PB0)

Port B is a 3-bit bi-directional I/O port. Port pins can provide internal pull-up resistors (selected for each bit).

RESET

Reset input. A low on this pin for two machine cycles while the oscillator is running resets the device.

XTAL1

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

XTAL2

Output from the inverting oscillator amplifier.

Pin Descriptions AT90S/LS2343

VCC

Supply voltage pin.

GND

Ground pin.

Port B (PB4..PB0)

Port B is a 5-bit bi-directional I/O port. Port pins can provide internal pull-up resistors (selected for each bit). When the device is clocked from an external clock source, PB3 is used as the clock input.

RESET

Reset input. A low on this pin for two machine cycles while the oscillator is running resets the device.

CLOCK

Clock signal input in external clock mode.

Clock Sources

The AT90S/LS2323 contains an inverting amplifier which can be configured for use as an on-chip oscillator, as shown in Figure 3. XTAL1 and XTAL2 are input and output respectively. Either a quartz crystal or a ceramic resonator may be used. It is recommended to use the AT90S/LS2343 if an external clock source is used, since this gives an extra I/O pin.

The AT90S/LS2343 can be clocked by an external clock signal, as shown in Figure 4, or by the on-chip RC oscillator. This RC oscillator runs at a nominal frequency of 1 MHz ($VCC = 5V$). A fuse bit - RCEN - in the Flash memory selects the on-chip RC oscillator as the clock source when programmed ('0'). The AT90S/LS2343 is shipped with this bit programmed.

Figure 3. Oscillator Connection

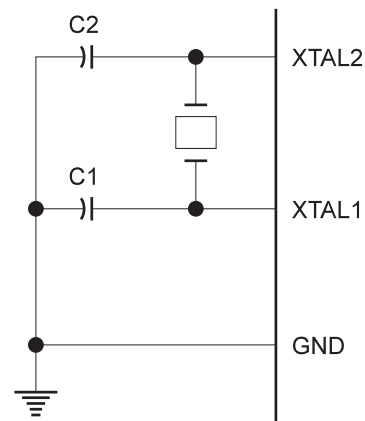
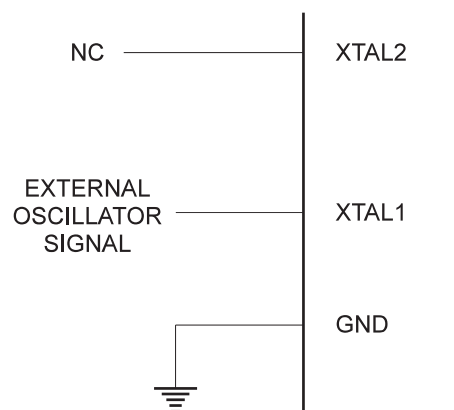


Figure 4. External Clock Drive Configuration



AT90S/LS2323 and AT90S/LS2343 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.

Six of the 32 registers can be used as three 16-bits indirect address register pointers for Data Space addressing-enabling efficient address calculations. One of the three address pointers is also used as the address pointer for the constant table look up function. These added function registers are the 16-bit X-register, Y-register and Z-register.

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 5 shows the AT90S/LS2323 and AT90S/LS2343 AVR Enhanced RISC microcontroller architecture.

In addition to the register operation, the conventional memory addressing modes can be used on the register file as well. This is enabled by the fact that the register file is assigned the 32 lowermost Data Space addresses (\$00 - \$1F), allowing them to be accessed as though they were ordinary memory locations.

The I/O memory space contains 64 addresses for CPU peripheral functions as Control Registers, Timer/Counters,

A/D-converters, and other I/O functions. The I/O memory can be accessed directly, or as the Data Space locations following those of the register file, \$20 - \$5F.

The AVR has Harvard architecture - with separate memories and buses for program and data. The program memory is accessed with a two 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 downloadable Flash memory.

With the relative jump and call instructions, the whole 1K address space is directly accessed. Most AVR instructions have a single 16-bit word format. Every program memory address contains a 16- or 32-bit instruction.

During interrupts and subroutine calls, the return address program counter (PC) is stored on the stack. The stack is effectively allocated in the general data SRAM, and consequently the stack size is only limited by the total SRAM size and the usage of the SRAM. All user programs must initialize the SP in the reset routine (before subroutines or interrupts are executed). The 8-bit stack pointer SP is read/write accessible in the I/O space.

The 128 bytes data SRAM + register file and I/O registers can be easily accessed through the five different addressing modes supported in the AVR architecture.

The memory spaces in the AVR architecture are all linear and regular memory maps.

Figure 5. The AT90S/LS2323 and AT90S/LS2343 AVR Enhanced RISC Architecture

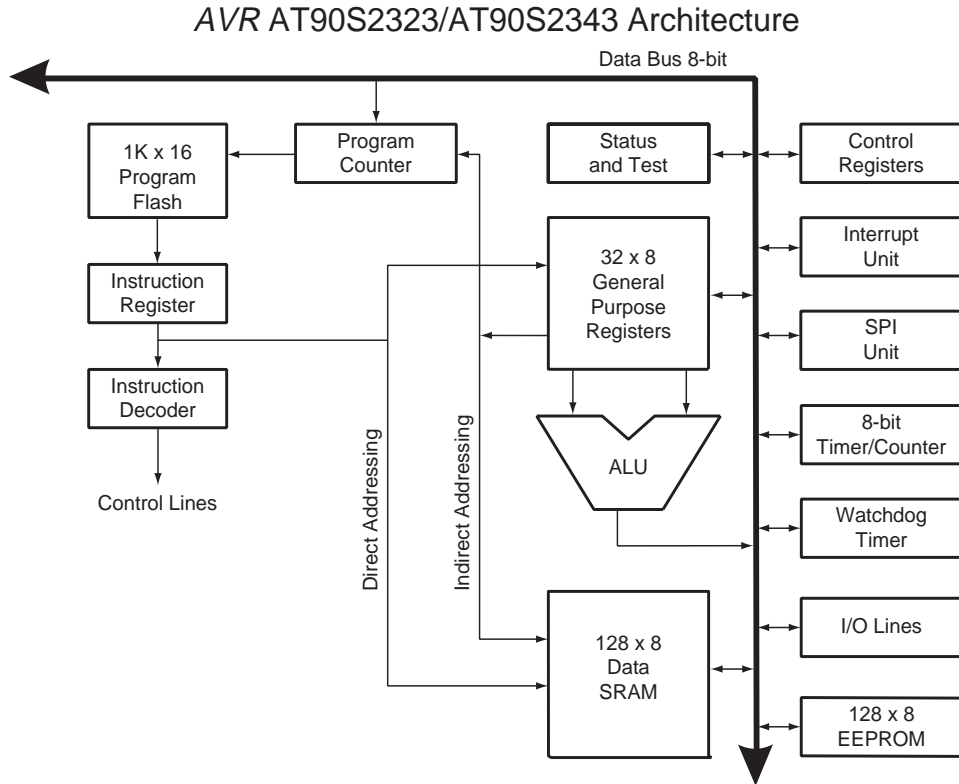
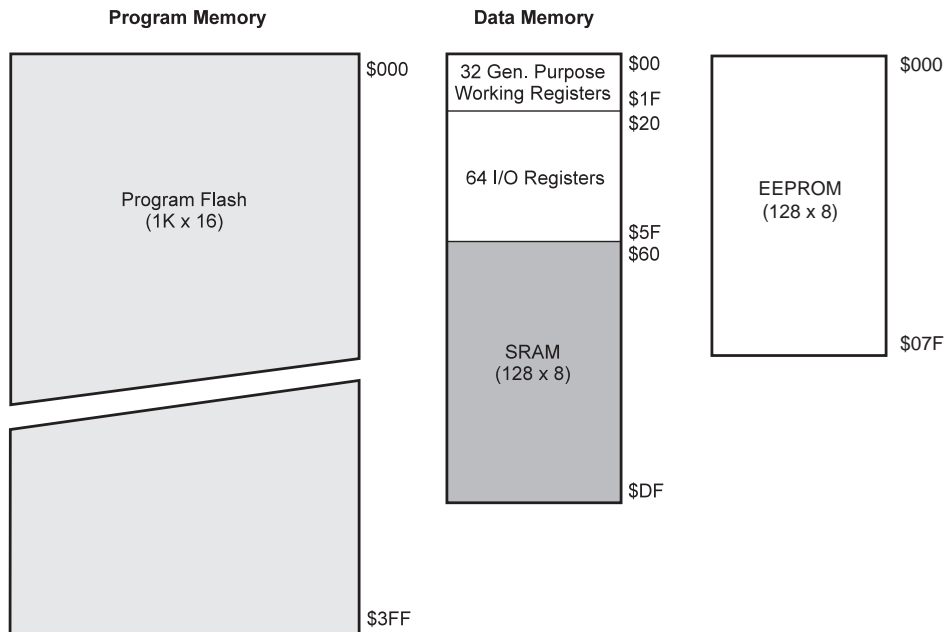


Figure 6. Memory Maps





AT90S/LS2323 and AT90S/LS2343 Register Summary

| Address | Name | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | Page |
|-------------|----------|------------------------|-------------------------|-------|-------|-------|-------|-------|-------|---------|
| \$3F (\$5F) | SREG | I | T | H | S | V | N | Z | C | page 13 |
| \$3E (\$5E) | Reserved | | | | | | | | | |
| \$3D (\$5D) | SPL | SP7 | SP6 | SP5 | SP4 | SP3 | SP2 | SP1 | SP0 | page 13 |
| \$3C (\$5C) | Reserved | | | | | | | | | |
| \$3B (\$5B) | GIMSK | - | INT0 | - | - | - | - | - | - | page 17 |
| \$3A (\$5A) | GIFR | - | INTF0 | | | | | | | page 17 |
| \$39 (\$59) | TIMSK | - | - | - | - | - | - | TOIE0 | - | page 15 |
| \$38 (\$58) | TIFR | - | - | - | - | - | - | TOV0 | - | page 16 |
| \$37 (\$57) | Reserved | | | | | | | | | |
| \$36 (\$56) | Reserved | | | | | | | | | |
| \$35 (\$55) | MCUCR | - | - | SE | SM | - | - | ISC01 | ISC00 | page 16 |
| \$34 (\$54) | MCUSR | - | - | - | - | - | - | EXTRF | PORF | page 14 |
| \$33 (\$53) | TCCR0 | - | - | - | - | - | CS02 | CS01 | CS00 | page 20 |
| \$32 (\$52) | TCNT0 | Timer/Counter0 (8 Bit) | | | | | | | | page 20 |
| \$31 (\$51) | Reserved | | | | | | | | | |
| \$30 (\$50) | Reserved | | | | | | | | | |
| \$2F (\$4F) | Reserved | | | | | | | | | |
| \$2E (\$4E) | Reserved | | | | | | | | | |
| \$2D (\$4D) | Reserved | | | | | | | | | |
| \$2C (\$4C) | Reserved | | | | | | | | | |
| \$2B (\$4B) | Reserved | | | | | | | | | |
| \$2A (\$4A) | Reserved | | | | | | | | | |
| \$29 (\$49) | Reserved | | | | | | | | | |
| \$28 (\$48) | Reserved | | | | | | | | | |
| \$27 (\$47) | Reserved | | | | | | | | | |
| \$26 (\$46) | Reserved | | | | | | | | | |
| \$25 (\$45) | Reserved | | | | | | | | | |
| \$24 (\$44) | Reserved | | | | | | | | | |
| \$23 (\$43) | Reserved | | | | | | | | | |
| \$22 (\$42) | Reserved | | | | | | | | | |
| \$21 (\$41) | WDTCR | - | - | - | WDTO | WDE | WDP2 | WDP1 | WDP0 | page 21 |
| \$20 (\$40) | Reserved | | | | | | | | | |
| \$1F (\$3F) | Reserved | | | | | | | | | |
| \$1E (\$3E) | EEAR | - | EEPROM Address Register | | | | | | | page 22 |
| \$1D (\$3D) | EEDR | EEPROM Data register | | | | | | | | page 22 |
| \$1C (\$3C) | EEDR | - | - | - | - | - | EEMW | EWE | EERE | page 22 |
| \$1B (\$3B) | Reserved | | | | | | | | | |
| \$1A (\$3A) | Reserved | | | | | | | | | |
| \$19 (\$39) | Reserved | | | | | | | | | |
| \$18 (\$38) | PORTB | - | - | - | PORTB | PORTB | PORTB | PORTB | PORTB | page 23 |
| \$17 (\$37) | DDRB | - | - | - | DDB4 | DDB3 | DDB2 | DDB1 | DDB0 | page 23 |
| \$16 (\$36) | PINB | - | - | - | PINB4 | PINB3 | PINB2 | PINB1 | PINB0 | page 23 |
| \$15 (\$35) | Reserved | | | | | | | | | |
| \$14 (\$34) | Reserved | | | | | | | | | |
| \$13 (\$33) | Reserved | | | | | | | | | |
| \$12 (\$32) | Reserved | | | | | | | | | |
| \$11 (\$31) | Reserved | | | | | | | | | |
| \$10 (\$30) | Reserved | | | | | | | | | |
| \$0F (\$2F) | Reserved | | | | | | | | | |
| \$0E (\$2E) | Reserved | | | | | | | | | |
| \$0D (\$2D) | Reserved | | | | | | | | | |
| \$0C (\$2C) | Reserved | | | | | | | | | |
| \$0B (\$2B) | Reserved | | | | | | | | | |
| \$0A (\$2A) | Reserved | | | | | | | | | |
| \$09 (\$29) | Reserved | | | | | | | | | |
| \$08 (\$28) | Reserved | | | | | | | | | |
| ... | Reserved | | | | | | | | | |
| \$00 (\$20) | Reserved | | | | | | | | | |

AT90S/LS2323 and AT90S/LS2343 Instruction Set Summary

| Mnemonics | Operands | Description | Operation | Flags | #Clock |
|--|----------|--|---|------------|--------|
| 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 | Rdl,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 |
| SBIW | Rdl,K | Subtract Immediate from Word | $Rdh:Rdl \leftarrow Rdh:Rdl - K$ | Z,C,N,V,S | 2 |
| 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 | $Rd \leftarrow Rd \cdot (\$FF - K)$ | 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 |
| IJMP | | Indirect Jump to (Z) | $PC \leftarrow Z$ | None | 2 |
| RCALL | k | Relative Subroutine Call | $PC \leftarrow PC + k + 1$ | None | 3 |
| ICALL | | Indirect Call to (Z) | $PC \leftarrow Z$ | None | 3 |
| 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 |
| 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 |
| 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 |

(continued)



| Mnemonics | Operands | Description | Operation | Flags | #Clocks |
|--------------------------------------|----------|----------------------------------|--|---------|---------|
| DATA TRANSFER INSTRUCTIONS | | | | | |
| MOV | Rd, Rr | Move Between Registers | $Rd \leftarrow Rr$ | 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 |
| 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 |
| BIT AND BIT-TEST INSTRUCTIONS | | | | | |
| SBI | Pb | Set Bit in I/O Register | $I/O(Pb) \leftarrow 1$ | None | 2 |
| CBI | Pb | Clear Bit in I/O Register | $I/O(Pb) \leftarrow 0$ | 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 |
| 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 |
| NOP | | No Operation | | None | 1 |
| SLEEP | | Sleep | (see specific descr. for Sleep) | None | 3 |
| WDR | | Watchdog Reset | (see specific descr. for WDR/timer) | None | 1 |

Ordering Information

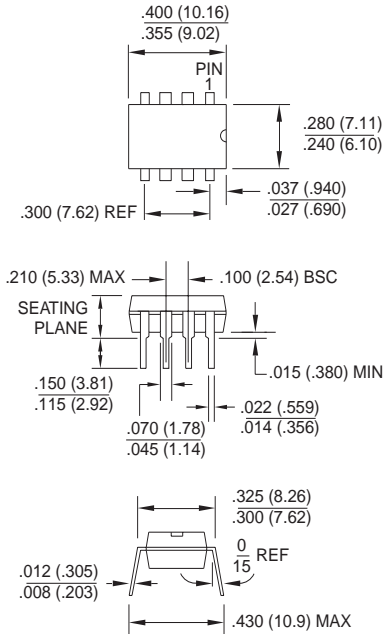
| Power Supply | Speed (MHz) | Ordering Code | Package | Operation Range |
|--------------|-------------|----------------|---------|-------------------------------|
| 2.7 - 6.0V | 4 | AT90LS2343-4PC | 8P3 | Commercial (0°C to 70°C) |
| | | AT90LS2343-4SC | 8S2 | |
| 4.0 - 6.0V | 10 | AT90S2343-10PC | 8P3 | Commercial (0°C to 70°C) |
| | | AT90S2343-10SC | 8S2 | |
| 2.7 - 6.0V | 4 | AT90LS2323-4PC | 8P3 | Commercial (0°C to 70°C) |
| | | AT90LS2323-4SC | 8S2 | |
| 4.0 - 6.0V | 10 | AT90S2323-10PC | 8P3 | Commercial (0°C to 70°C) |
| | | AT90S2323-10SC | 8S2 | |
| 2.7 - 6.0V | 4 | AT90LS2323-4PI | 8P3 | Industrial (-40°C to 85°C) |
| | | AT90LS2323-4SI | 8S2 | |
| 4.0 - 6.0V | 10 | AT90S2323-10PI | 8P3 | Industrial (-40°C to 85°C) |
| | | AT90S2323-10SI | 8S2 | |

| Package Type | |
|--------------|---|
| 8P3 | 8-Lead, 0.300" Wide, Plastic Dual Inline Package (PDIP) |
| 8S2 | 8-Lead, 0.200" Wide, Plastic Gull Wing Small Outline (SOIC) |



Packaging Information

8P3, 8-Lead, 0.300" Wide,
Plastic Dual Inline Package (PDIP)
Dimensions in Inches and (Millimeters)
JEDEC STANDARD MS-001 BA



8S2, 8-Lead, 0.200" Wide,
Plastic Gull Wing Small Outline (EIAJ SOIC)
Dimensions in Inches and (Millimeters)

