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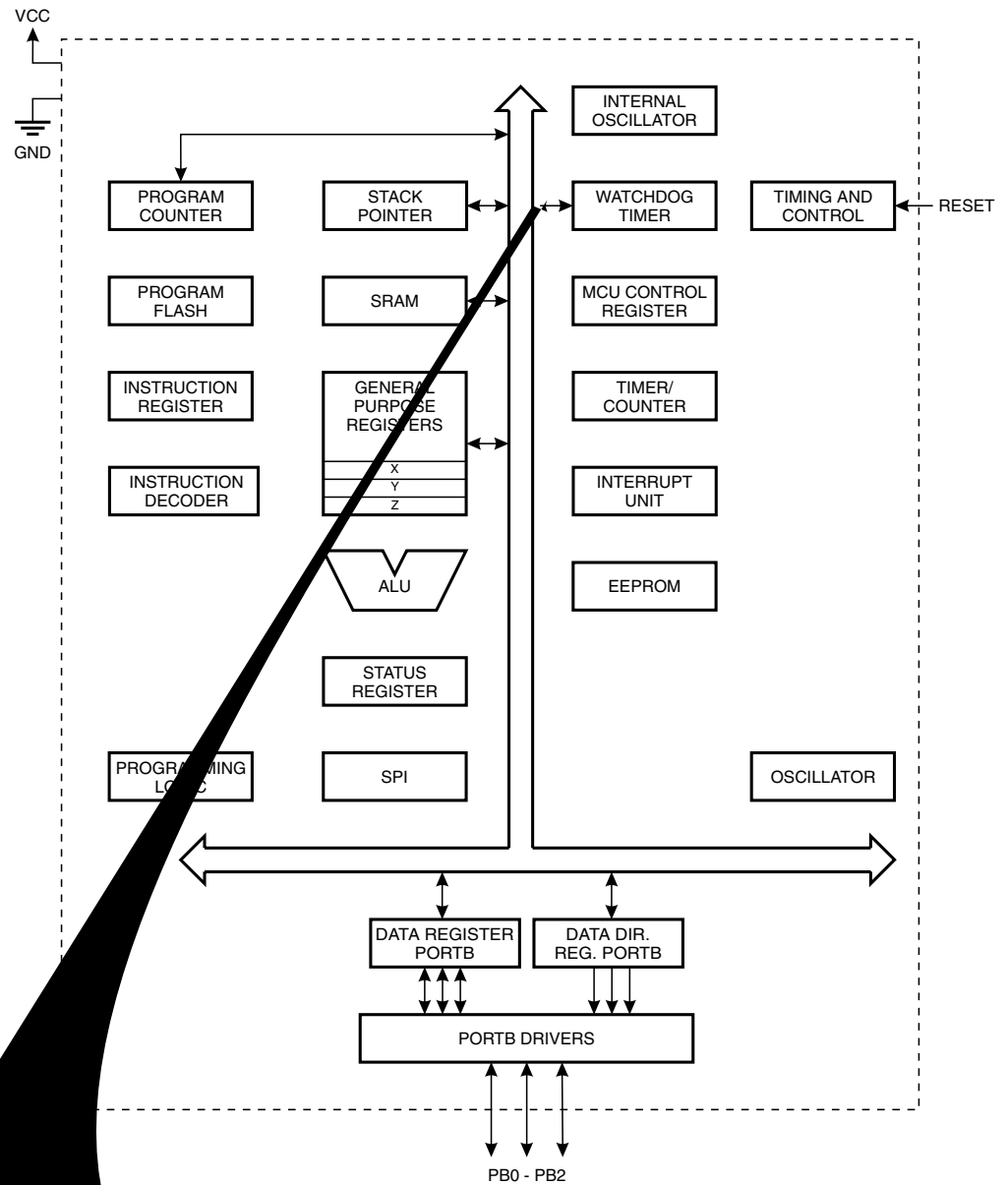
"[Embedded - Microcontrollers](#)" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

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

Details

Product Status	Obsolete
Core Processor	AVR
Core Size	8-Bit
Speed	1MHz
Connectivity	SPI
Peripherals	Brown-out Detect/Reset, POR, WDT
Number of I/O	5
Program Memory Size	2KB (1K x 16)
Program Memory Type	FLASH
EEPROM Size	128 x 8
RAM Size	128 x 8
Voltage - Supply (Vcc/Vdd)	2.7V ~ 6V
Data Converters	-
Oscillator Type	Internal
Operating Temperature	0°C ~ 70°C (TA)
Mounting Type	Through Hole
Package / Case	8-DIP (0.300", 7.62mm)
Supplier Device Package	8-PDIP
Purchase URL	https://www.e-xfl.com/product-detail/microchip-technology/at90ls2343-1pc

Figure 2. The AT90S/LS2323 Block Diagram

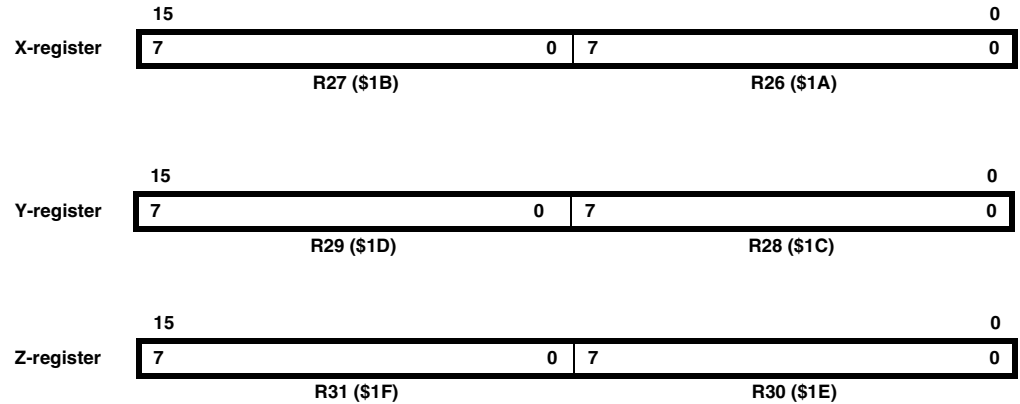


LS2323/2343 provides the following features: 2K bytes of In-System Program Flash, 128 bytes EEPROM, 128 bytes SRAM, 3 (AT90S/LS2323)/5 (AT90S/LS2343) general-purpose I/O lines, 32 general-purpose working registers, an 8-bit timer, internal and external interrupts, programmable Watchdog Timer with a non-volatile memory for the Watchdog Timer counter, an SPI serial port for Flash Memory downloading and two software-programmable sleep modes. The Idle mode stops the CPU while allowing the timer and interrupt system to continue functioning. The Standby mode stops the timer and interrupt system but freezes the oscillator, disabling all other peripheral hardware. A hardware reset is required to restart the device.

X-register, Y-register and Z-register

The registers R26..R31 have some added functions to their general-purpose usage. These registers are the address pointers for indirect addressing of the Data Space. The three indirect address registers X, Y, and Z, are defined in Figure 8.

Figure 8. The X-, Y-, and Z-registers



In the different addressing modes, these address registers have functions as fixed displacement, automatic increment and decrement (see the descriptions for the different instructions).

ALU – Arithmetic Logic Unit

The high-performance AVR ALU operates in direct connection with all the 32 general-purpose working registers. Within a single clock cycle, ALU operations between registers in the register file are executed. The ALU operations are divided into three main categories: arithmetic, logic and bit functions.

In-System Programmable Flash Program Memory

The AT90S2323/2343 contains 2K bytes On-chip, In-System Programmable Flash memory for program storage. Since all instructions are 16- or 32-bit words, the Flash is organized as 1K x 16. The Flash memory has an endurance of at least 1000 write/erase cycles.

The AT90S2323/2343 Program Counter (PC) is 10 bits wide, hence addressing the 1024 program memory addresses. See page 42 for a detailed description on Flash data programming.

Constant tables must be allocated within the address 0 - 2K (see the LPM – Load Program Memory instruction description on page 60).

See page 12 for the different addressing modes.

EEPROM Data Memory

The AT90S2323/2343 contains 128 bytes of EEPROM data memory. It is organized as a separate data space, in which single bytes can be read and written. The EEPROM has an endurance of at least 100,000 write/erase cycles. The access between the EEPROM and the CPU is described on page 32, specifying the EEPROM address register, the EEPROM data register and the EEPROM control register.

For the SPI data downloading, see page 42 for a detailed description.

Table 4. Reset Characteristics ($V_{CC} = 5.0V$)

Symbol	Parameter	Min	Typ	Max	Units
$V_{POT}^{(1)}$	Power-on Reset Threshold Voltage, rising	1.0	1.4	1.8	V
	Power-on Reset Threshold Voltage, falling	0.4	0.6	0.8	V
V_{RST}	\overline{RESET} Pin Threshold Voltage		0.6 V_{CC}		V
t_{TOUT}	Reset Delay Time-out Period AT90S/LS2323 FSTRT Programmed	1.0	1.1	1.2	ms
t_{TOUT}	Reset Delay Time-out Period AT90S/LS2323 FSTRT Unprogrammed	11.0	16.0	21.0	ms
t_{TOUT}	Reset Delay Time-out Period AT90S/LS2343	11.0	16.0	21.0	μs

Note: 1. The Power-on Reset will not work unless the supply voltage has been below V_{POT} (falling).

Table 5. Reset Characteristics ($V_{CC} = 3.0V$)

Symbol	Parameter	Min	Typ	Max	Units
$V_{POT}^{(1)}$	Power-on Reset Threshold Voltage, rising	1.0	1.4	1.8	V
	Power-on Reset Threshold Voltage, falling	0.4	0.6	0.8	V
V_{RST}	\overline{RESET} Pin Threshold Voltage		0.6 V_{CC}		V
t_{TOUT}	Reset Delay Time-out Period AT90S/LS2323 FSTRT Programmed	2.0	2.2	2.4	ms

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Note: 1. The Power-on Reset will not work unless the supply voltage has been below V_{POT} (falling).

Power-on Reset

The AT90S2323/2343 is designed for use in systems where it can operate from the internal RC oscillator (AT90S/LS2343), on-chip oscillator (AT90S/LS2323), or in applications where a clock signal is provided by an external clock source. After V_{CC} has reached V_{POT} , the device will start after the time t_{TOUT} (see Figure 25). If the clock signal is provided by an external clock source, the clock must not be applied until V_{CC} has reached the minimum voltage defined for the applied frequency.

For AT90S2323, the user can select the start-up time according to typical oscillator start-up. The number of WDT oscillator cycles used for each time-out is shown in Table 6. For AT90S2343, the start-up time is one Watchdog cycle only. The frequency of the Watchdog oscillator is voltage-dependent as shown in "Typical Characteristics" on page 49.

The Stop condition provides a Timer Enable/Disable function. The timer modes are scaled directly from the CK oscillator clock. If the timer is used for Timer/Counter0, transitions on PB2/(T0) will clock the timer when configured as an output. This feature can give the user software control over the timer.

Timer/Counter0 – TCNT0

Bit	7	6	5	4	3	2
\$32 (\$52)	MSB					
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W
Initial Value	0	0	0	0	0	0

The Timer/Counter0 is realized as an up-counter with read/write access. When Timer/Counter0 is written and a clock source is present, the timer starts counting in the timer clock cycle following the write operation.

Watchdog Timer

The Watchdog Timer is clocked from a separate On-chip oscillator. By selecting the Watchdog Timer prescaler, the Watchdog reset interval can be selected. See Table 11. See characterization data for typical values at other temperatures. The Watchdog Reset instruction resets the Watchdog Timer. Every time the Watchdog Timer expires, the Watchdog Timer resets and executes a Watchdog Reset. If the Watchdog Timer expires again, the AT90S2323/2343 resets and executes a Watchdog Reset. For timing details on the Watchdog reset, refer to page 23.

To prevent unintentional disabling of the Watchdog, a special sequence must be followed when the Watchdog is disabled. Refer to the description of the Watchdog Control Register for details.

Figure 31. Watchdog Timer



For the EEPROM, an auto-erase cycle is provided within the self-timed Write instruction and there is no need to first execute the Chip Erase instruction. The Chip Erase instruction turns the content of every memory location in both the program and EEPROM arrays into \$FF.

The program and EEPROM memory arrays have separate address spaces: \$0000 to \$03FF for Flash program memory and \$000 to \$07F for EEPROM data memory.

Either an external clock is applied to the XTAL1/PB3 pin or the device must be clocked from the internal RC oscillator (AT90S/LS2343 only). The minimum low and high periods for the serial clock (SCK) input are defined as follows:

Low: > 2 MCU clock cycles

High: > 2 MCU clock cycles

Low-voltage Serial Programming Algorithm

When writing serial data to the AT90S2323/2343, data is clocked on the rising edge of SCK.

When reading data from the AT90S2323/2343, data is clocked on the falling edge of SCK. See Figure 36, Figure 37 and Table 20 for timing details.

To program and verify the AT90S2323/2343 in the low-voltage Serial Programming mode, the following sequence is recommended (see 4-byte instruction formats in Table 19):

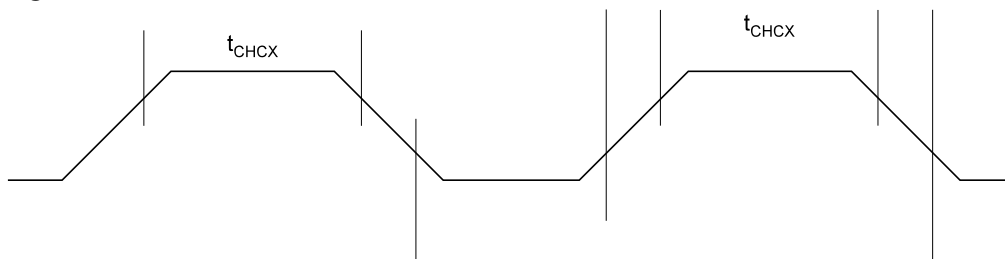
1. Power-up sequence:

Apply power between V_{CC} and GND while RESET and SCK are set to "0". (If the programmer cannot guarantee that SCK is held low during power-up, RESET must be given a positive pulse after SCK has been set to "0".) If the device is programmed for external clocking, apply a 0 - 8 MHz clock to the XTAL1/PB3 pin. If the internal RC oscillator is selected as the clock source, no external clock source needs to be applied (AT90S/LS2343 only).

2. Wait for at least 20 ms and enable serial programming by sending the Program-

External Clock Drive Waveforms

Figure 38. Waveforms



External Clock Drive

$T_A = -40^{\circ}\text{C}$ to 85°C

Symbol	Parameter	$V_{CC}: 2.7\text{V to } 4.0\text{V}$		$V_{CC}: 4.0\text{V to } 6.0\text{V}$		Units
		Min	Max	Min	Max	
$1/t_{CLCL}$	Oscillator Frequency	0	4.0	0	10.0	MHz
t_{CLCL}	Clock Period	250.0		100.0		ns
t_{CHCX}	High Time	100.0		40.0		ns
t_{CLCX}	Low Time	100.0		40.0		ns
t_{CLCH}	Rise Time		1.6		0.5	μs
t_{CHCL}	Fall Time		1.6		0.5	μs

Typical Characteristics

The following charts show typical behavior. These figures are not tested during manu-

Figure 44. Idle Supply Current vs. V_{CC}

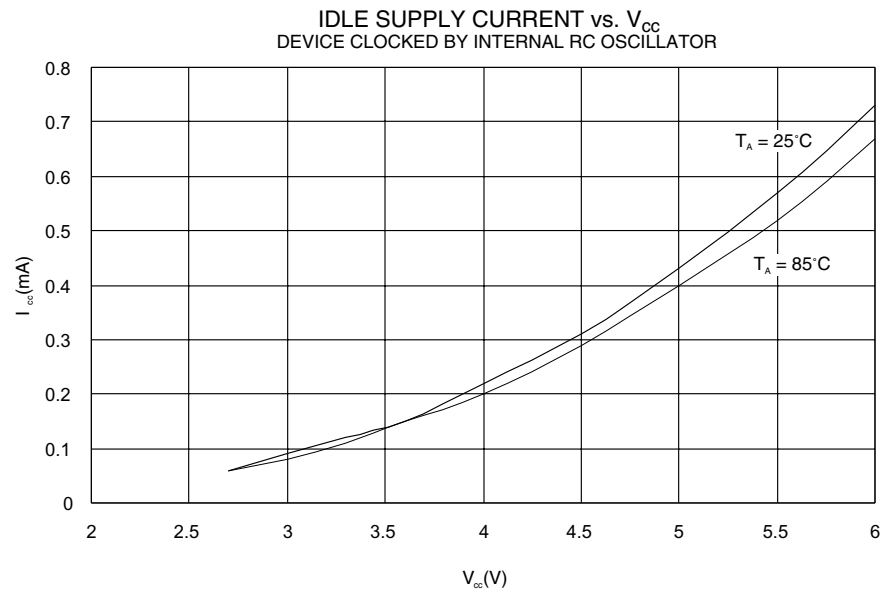


Figure 45. Power-down Supply Current vs. V_{CC}

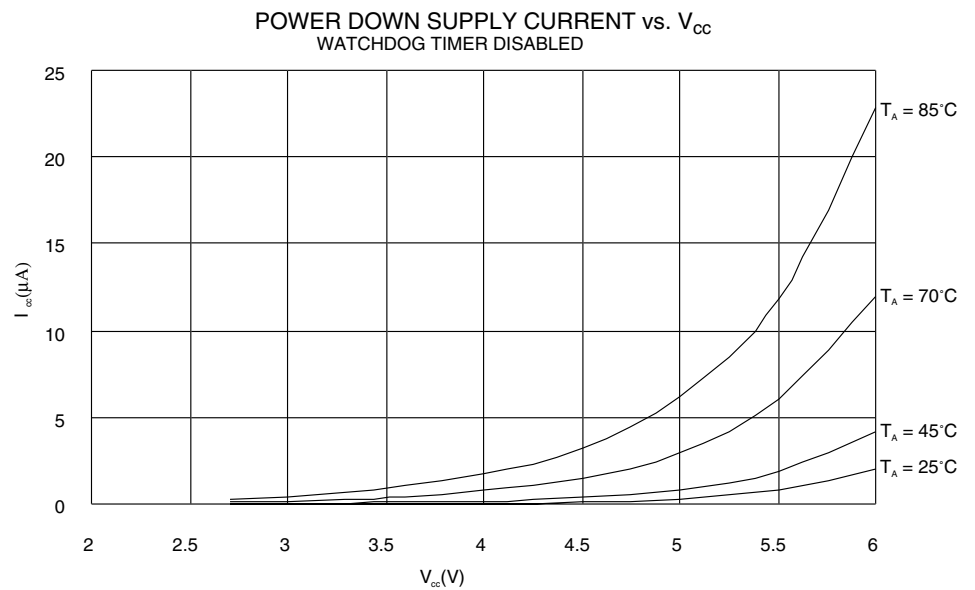


Figure 52. I/O Pin Sink Current vs. Output Voltage

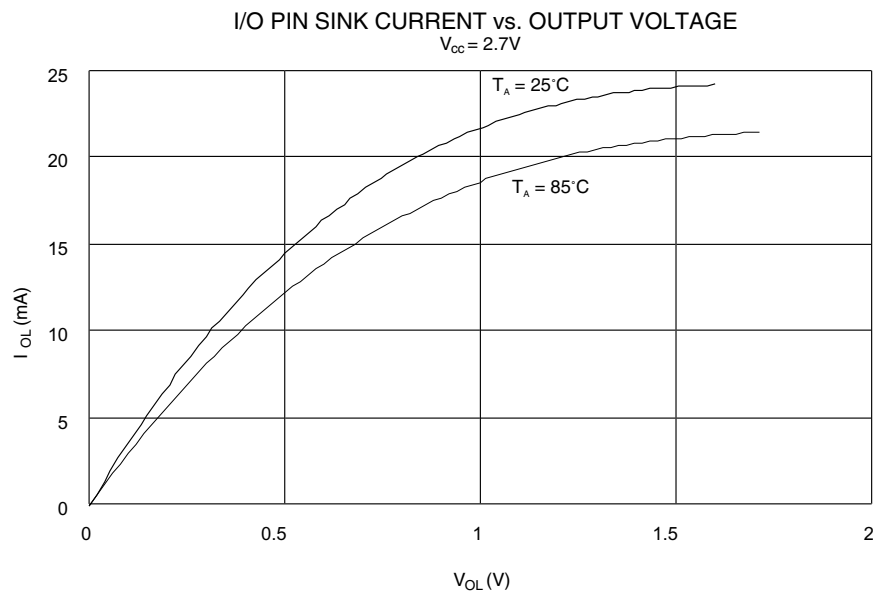
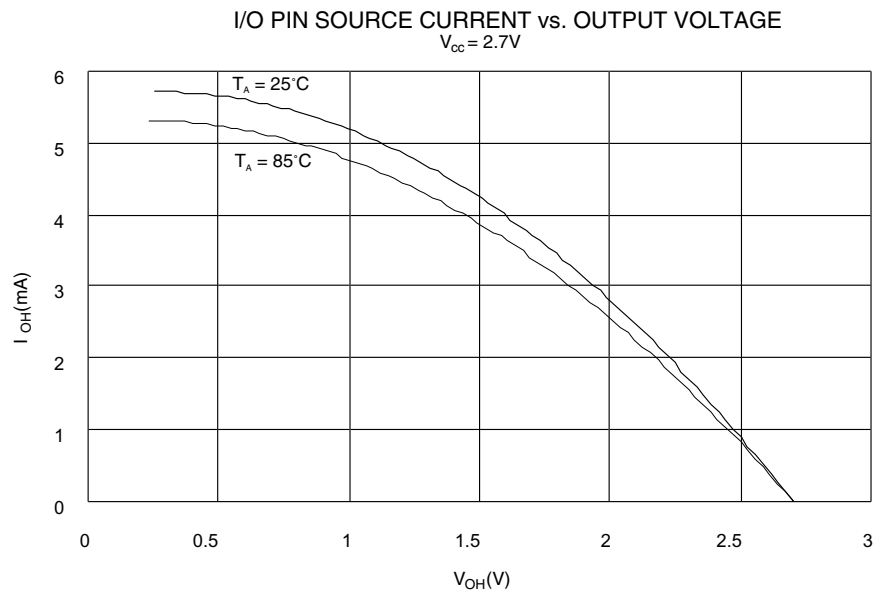


Figure 53. I/O Pin Source Current vs. Output voltage



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
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	$Rd \leftarrow Rd \bullet Rr$	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	$Rd \leftarrow \$FF - Rd$	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	$Rd \leftarrow Rd \bullet (\$FF - K)$	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	$Rd \leftarrow Rd \bullet Rd$	Z,N,V	1
CLR	Rd	Clear Register	$Rd \leftarrow Rd \oplus Rd$	Z,N,V	1
SER	Rd	Set Register	$Rd \leftarrow \$FF$	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	1/2/3
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
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

Instruction Set Summary (Continued)

Mnemonic	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	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
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 Two's Complement Overflow	$V \leftarrow 1$	V	1
CLV		Clear Two's 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 function)	None	1
WDR		Watchdog Reset	(see specific descr. for WDR/timer)	None	1



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