Features

- Utilizes the AVR® RISC Architecture
- AVR – High-performance and Low-power RISC Architecture
  - 120 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 20 MIPS Throughput at 20 MHz
- Data and Non-volatile Program and Data Memories
  - 2K Bytes of In-System Self Programmable Flash
    Endurance 10,000 Write/Erase Cycles
  - 128 Bytes In-System Programmable EEPROM
    Endurance: 100,000 Write/Erase Cycles
  - 128 Bytes Internal SRAM
  - Programming Lock for Flash Program and EEPROM Data Security
- Peripheral Features
  - One 8-bit Timer/Counter with Separate Prescaler and Compare Mode
  - One 16-bit Timer/Counter with Separate Prescaler, Compare and Capture Modes
  - Four PWM Channels
  - On-chip Analog Comparator
  - Programmable Watchdog Timer with On-chip Oscillator
  - USI – Universal Serial Interface
  - Full Duplex USART
- Special Microcontroller Features
  - debugWIRE On-chip Debugging
  - In-System Programmable via SPI Port
  - External and Internal Interrupt Sources
  - Low-power Idle, Power-down, and Standby Modes
  - Enhanced Power-on Reset Circuit
  - Programmable Brown-out Detection Circuit
  - Internal Calibrated Oscillator
- I/O and Packages
  - 18 Programmable I/O Lines
  - 20-pin PDIP, 20-pin SOIC, 20-pad MLF
- Operating Voltages
  - 1.8 - 5.5V (ATtiny2313V)
  - 2.7 - 5.5V (ATtiny2313)
- Speed Grades
  - ATtiny2313V: 0 - 4 MHz @ 1.8 - 5.5V, 0 - 10 MHz @ 2.7 - 5.5V
  - ATtiny2313: 0 - 10 MHz @ 2.7 - 5.5V, 0 - 20 MHz @ 4.5 - 5.5V
- Typical Power Consumption
  - Active Mode
    1 MHz, 1.8V: 230 µA
    32 kHz, 1.8V: 20 µA (including oscillator)
  - Power-down Mode
    < 0.1 µA at 1.8V

8-bit AVR® Microcontroller with 2K Bytes In-System Programmable Flash

ATtiny2313/V

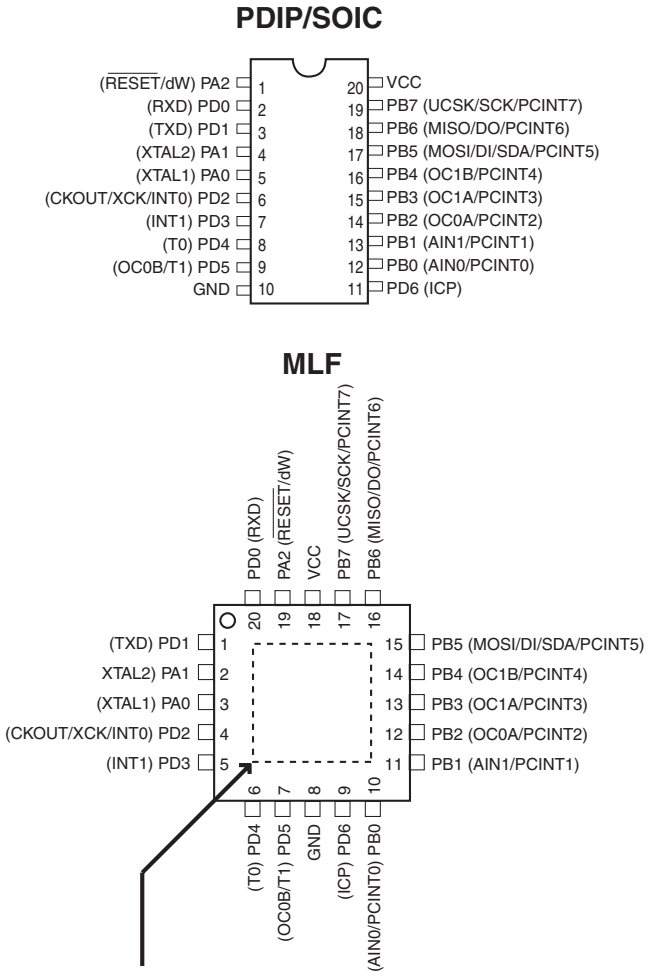
Preliminary Summary

Rev. 2543GS–AVR–10/04

Note: This is a summary document. A complete document is available on our Web site at www.atmel.com.

Pin Configurations

Figure 1. Pinout ATtiny2313



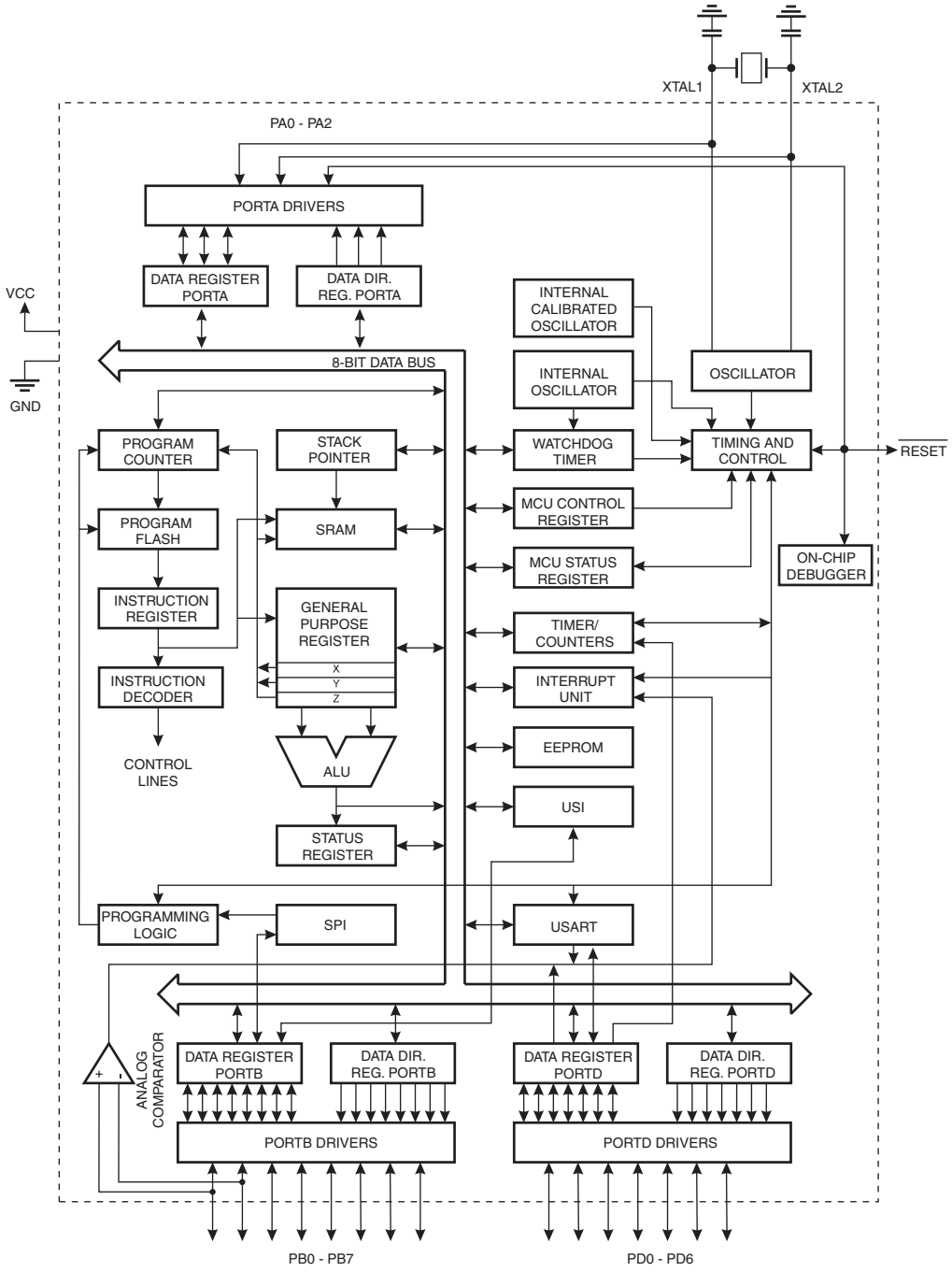
NOTE: Bottom pad should be soldered to ground.

Overview

The ATtiny2313 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 ATtiny2313 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

Block Diagram

Figure 2. Block Diagram



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.

The ATtiny2313 provides the following features: 2K bytes of In-System Programmable Flash, 128 bytes EEPROM, 128 bytes SRAM, 18 general purpose I/O lines, 32 general purpose working registers, a single-wire Interface for On-chip Debugging, two flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, Universal Serial Interface with Start Condition Detector, a programmable Watchdog Timer with internal Oscillator, and three software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, 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. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption.

The device is manufactured using Atmel's high density non-volatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, or by a conventional non-volatile memory programmer. By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel ATtiny2313 is a powerful microcontroller that provides a highly flexible and cost effective solution to many embedded control applications.

The ATtiny2313 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.

Pin Descriptions

VCC Digital supply voltage.

GND Ground.

Port A (PA2..PA0) Port A is a 3-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 ATtiny2313 as listed on page 52.

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 also serves the functions of various special features of the ATtiny2313 as listed on page 52.

Port D (PD6..PD0) Port D is a 7-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 ATtiny2313 as listed on page 55.

$\overline{\text{RESET}}$ 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 Table 15 on page 33. Shorter pulses are not guaranteed to generate a reset. The Reset Input is an alternate function for PA2 and dW.

XTAL1 Input to the inverting Oscillator amplifier and input to the internal clock operating circuit. XTAL1 is an alternate function for PA0.

XTAL2 Output from the inverting Oscillator amplifier. XTAL2 is an alternate function for PA1.

Register Summary

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page
0x3F (0x5F)	SREG	I	T	H	S	V	N	Z	C	7
0x3E (0x5E)	Reserved	–	–	–	–	–	–	–	–	
0x3D (0x5D)	SPL	SP7	SP6	SP5	SP4	SP3	SP2	SP1	SP0	10
0x3C (0x5C)	OCR0B	Timer/Counter0 – Compare Register B								76
0x3B (0x5B)	GIMSK	INT1	INT0	PCIE	–	–	–	–	–	59
0x3A (0x5A)	EIFR	INTF1	INTF0	PCIF	–	–	–	–	–	60
0x39 (0x59)	TIMSK	TOIE1	OCIE1A	OCIE1B	–	ICIE1	OCIE0B	TOIE0	OCIE0A	77, 108
0x38 (0x58)	TIFR	TOV1	OCF1A	OCF1B	–	ICF1	OCF0B	TOV0	OCF0A	77
0x37 (0x57)	SPMCSR	–	–	–	CTPB	RFLB	PGWRT	PGERS	SELFPRGEN	154
0x36 (0x56)	OCR0A	Timer/Counter0 – Compare Register A								76
0x35 (0x55)	MCUCR	PUD	SM1	SE	SM0	ISC11	ISC10	ISC01	ISC00	52
0x34 (0x54)	MCUSR	–	–	–	–	WDRF	BORF	EXTRF	PORF	36
0x33 (0x53)	TCCR0B	FOC0A	FOC0B	–	–	WGM02	CS02	CS01	CS00	75
0x32 (0x52)	TCNT0	Timer/Counter0 (8-bit)								76
0x31 (0x51)	OSCCAL	–	CAL6	CAL5	CAL4	CAL3	CAL2	CAL1	CAL0	25
0x30 (0x50)	TCCR0A	COM0A1	COM0A0	COM0B1	COM0B0	–	–	WGM01	WGM00	72
0x2F (0x4F)	TCCR1A	COM1A1	COM1A0	COM1B1	COM1BO	–	–	WGM11	WGM10	103
0x2E (0x4E)	TCCR1B	ICNC1	ICES1	–	WGM13	WGM12	CS12	CS11	CS10	106
0x2D (0x4D)	TCNT1H	Timer/Counter1 – Counter Register High Byte								107
0x2C (0x4C)	TCNT1L	Timer/Counter1 – Counter Register Low Byte								107
0x2B (0x4B)	OCR1AH	Timer/Counter1 – Compare Register A High Byte								107
0x2A (0x4A)	OCR1AL	Timer/Counter1 – Compare Register A Low Byte								107
0x29 (0x49)	OCR1BH	Timer/Counter1 – Compare Register B High Byte								108
0x28 (0x48)	OCR1BL	Timer/Counter1 – Compare Register B Low Byte								108
0x27 (0x47)	Reserved	–	–	–	–	–	–	–	–	
0x26 (0x46)	CLKPR	CLKPCE	–	–	–	CLKPS3	CLKPS2	CLKPS1	CLKPS0	27
0x25 (0x45)	ICR1H	Timer/Counter1 - Input Capture Register High Byte								108
0x24 (0x44)	ICR1L	Timer/Counter1 - Input Capture Register Low Byte								108
0x23 (0x43)	GTCCR	–	–	–	–	–	–	–	PSR10	80
0x22 (0x42)	TCCR1C	FOC1A	FOC1B	–	–	–	–	–	–	107
0x21 (0x41)	WDTCSR	WDIF	WDIE	WDP3	WDCE	WDE	WDP2	WDP1	WDP0	41
0x20 (0x40)	PCMSK	PCINT7	PCINT6	PCINT5	PCINT4	PCINT3	PCINT2	PCINT1	PCINT0	60
0x1F (0x3F)	Reserved	–	–	–	–	–	–	–	–	
0x1E (0x3E)	EEAR	–	EEPROM Address Register							15
0x1D (0x3D)	EEDR	EEPROM Data Register								16
0x1C (0x3C)	EECR	–	–	EEPM1	EEPM0	EERIE	EEMPE	EEPE	EERE	16
0x1B (0x3B)	PORTA	–	–	–	–	–	PORTR2	PORTA1	PORTA0	57
0x1A (0x3A)	DDRA	–	–	–	–	–	DDA2	DDA1	DDA0	57
0x19 (0x39)	PINA	–	–	–	–	–	PINA2	PINA1	PINA0	57
0x18 (0x38)	PORTB	PORTB7	PORTB6	PORTB5	PORTB4	PORTB3	PORTB2	PORTB1	PORTB0	57
0x17 (0x37)	DDRB	DDB7	DDB6	DDB5	DDB4	DDB3	DDB2	DDB1	DDB0	57
0x16 (0x36)	PINB	PINB7	PINB6	PINB5	PINB4	PINB3	PINB2	PINB1	PINB0	57
0x15 (0x35)	GPIOR2	General Purpose I/O Register 2								20
0x14 (0x34)	GPIOR1	General Purpose I/O Register 1								20
0x13 (0x33)	GPIOR0	General Purpose I/O Register 0								20
0x12 (0x32)	PORTD	–	PORTD6	PORTD5	PORTD4	PORTD3	PORTD2	PORTD1	PORTD0	57
0x11 (0x31)	DDRD	–	DDD6	DDD5	DDD4	DDD3	DDD2	DDD1	DDD0	57
0x10 (0x30)	PIND	–	PIND6	PIND5	PIND4	PIND3	PIND2	PIND1	PIND0	57
0x0F (0x2F)	USIDR	USI Data Register								143
0x0E (0x2E)	USISR	USISIF	USIOIF	USIPF	USIDC	USICNT3	USICNT2	USICNT1	USICNT0	144
0x0D (0x2D)	USICR	USISIE	USIOIE	USIWM1	USIWM0	USICS1	USICS0	USICLK	USITC	145
0x0C (0x2C)	UDR	UART Data Register (8-bit)								128
0x0B (0x2B)	UCSRA	RXC	TXC	UDRE	FE	DOR	UPE	U2X	MPCM	128
0x0A (0x2A)	UCSRB	RXCIE	TXCIE	UDRIE	RXEN	TXEN	UCSZ2	RXB8	TXB8	130
0x09 (0x29)	UBRRL	UBRRH[7:0]								132
0x08 (0x28)	ACSR	ACD	ACBG	ACO	ACI	ACIE	ACIC	ACIS1	ACIS0	148
0x07 (0x27)	Reserved	–	–	–	–	–	–	–	–	
0x06 (0x26)	Reserved	–	–	–	–	–	–	–	–	
0x05 (0x25)	Reserved	–	–	–	–	–	–	–	–	
0x04 (0x24)	Reserved	–	–	–	–	–	–	–	–	
0x03 (0x23)	UCSRC	–	UMSEL	UPM1	UPM0	USBS	UCSZ1	UCSZ0	UCPOL	131
0x02 (0x22)	UBRRH	–	–	–	–	UBRRH[11:8]				132
0x01 (0x21)	DIDR	–	–	–	–	–	–	AIN1D	AIN0D	149
0x00 (0x20)	Reserved	–	–	–	–	–	–	–	–	

Note:
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. 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.
3. 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.
4. 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.

Instruction Set Summary

Mnemonics	Operands	Description	Operation	Flags	#Clocks
ARITHMETIC AND LOGIC INSTRUCTIONS					
ADD	Rd, Rr	Add two Registers	Rd ← Rd + Rr	Z,C,N,V,H	1
ADC	Rd, Rr	Add with Carry two Registers	Rd ← Rd + Rr + C	Z,C,N,V,H	1
ADIW	Rdl,K	Add Immediate to Word	Rdh:Rdl ← Rdh:Rdl + K	Z,C,N,V,S	2
SUB	Rd, Rr	Subtract two Registers	Rd ← Rd - Rr	Z,C,N,V,H	1
SUBI	Rd, K	Subtract Constant from Register	Rd ← Rd - K	Z,C,N,V,H	1
SBC	Rd, Rr	Subtract with Carry two Registers	Rd ← Rd - Rr - C	Z,C,N,V,H	1
SBCI	Rd, K	Subtract with Carry Constant from Reg.	Rd ← Rd - K - C	Z,C,N,V,H	1
SBIW	Rdl,K	Subtract Immediate from Word	Rdh:Rdl ← Rdh:Rdl - K	Z,C,N,V,S	2
AND	Rd, Rr	Logical AND Registers	Rd ← Rd • Rr	Z,N,V	1
ANDI	Rd, K	Logical AND Register and Constant	Rd ← Rd • K	Z,N,V	1
OR	Rd, Rr	Logical OR Registers	Rd ← Rd v Rr	Z,N,V	1
ORI	Rd, K	Logical OR Register and Constant	Rd ← Rd v K	Z,N,V	1
EOR	Rd, Rr	Exclusive OR Registers	Rd ← Rd ⊕ Rr	Z,N,V	1
COM	Rd	One's Complement	Rd ← 0xFF − Rd	Z,C,N,V	1
NEG	Rd	Two's Complement	Rd ← 0x00 − Rd	Z,C,N,V,H	1
SBR	Rd,K	Set Bit(s) in Register	Rd ← Rd v K	Z,N,V	1
CBR	Rd,K	Clear Bit(s) in Register	Rd ← Rd • (0xFF - K)	Z,N,V	1
INC	Rd	Increment	Rd ← Rd + 1	Z,N,V	1
DEC	Rd	Decrement	Rd ← Rd − 1	Z,N,V	1
TST	Rd	Test for Zero or Minus	Rd ← Rd • Rd	Z,N,V	1
CLR	Rd	Clear Register	Rd ← Rd ⊕ Rd	Z,N,V	1
SER	Rd	Set Register	Rd ← 0xFF	None	1
BRANCH INSTRUCTIONS					
RJMP	k	Relative Jump	PC ← PC + k + 1	None	2
IJMP		Indirect Jump to (Z)	PC ← Z	None	2
RCALL	k	Relative Subroutine Call	PC ← PC + k + 1	None	3
ICALL		Indirect Call to (Z)	PC ← Z	None	3
RET		Subroutine Return	PC ← STACK	None	4
RETI		Interrupt Return	PC ← STACK	I	4
CPSE	Rd,Rr	Compare, Skip if Equal	if (Rd = Rr) PC ← 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 ← PC + 2 or 3	None	1/2/3
SBRS	Rr, b	Skip if Bit in Register is Set	if (Rr(b)=1) PC ← PC + 2 or 3	None	1/2/3
SBIC	P, b	Skip if Bit in I/O Register Cleared	if (P(b)=0) PC ← 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 ← PC + 2 or 3	None	1/2/3
BRBS	s, k	Branch if Status Flag Set	if (SREG(s) = 1) then PC←PC+k + 1	None	1/2
BRBC	s, k	Branch if Status Flag Cleared	if (SREG(s) = 0) then PC←PC+k + 1	None	1/2
BREQ	k	Branch if Equal	if (Z = 1) then PC ← PC + k + 1	None	1/2
BRNE	k	Branch if Not Equal	if (Z = 0) then PC ← PC + k + 1	None	1/2
BRCS	k	Branch if Carry Set	if (C = 1) then PC ← PC + k + 1	None	1/2
BRCC	k	Branch if Carry Cleared	if (C = 0) then PC ← PC + k + 1	None	1/2
BRSH	k	Branch if Same or Higher	if (C = 0) then PC ← PC + k + 1	None	1/2
BRLO	k	Branch if Lower	if (C = 1) then PC ← PC + k + 1	None	1/2
BRMI	k	Branch if Minus	if (N = 1) then PC ← PC + k + 1	None	1/2
BRPL	k	Branch if Plus	if (N = 0) then PC ← PC + k + 1	None	1/2
BRGE	k	Branch if Greater or Equal, Signed	if (N ⊕ V= 0) then PC ← PC + k + 1	None	1/2
BRLT	k	Branch if Less Than Zero, Signed	if (N ⊕ V= 1) then PC ← PC + k + 1	None	1/2
BRHS	k	Branch if Half Carry Flag Set	if (H = 1) then PC ← PC + k + 1	None	1/2
BRHC	k	Branch if Half Carry Flag Cleared	if (H = 0) then PC ← PC + k + 1	None	1/2
BRTS	k	Branch if T Flag Set	if (T = 1) then PC ← PC + k + 1	None	1/2
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

Mnemonics	Operands	Description	Operation	Flags	#Clocks
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	-
IN	Rd, P	In Port	Rd ← P	None	1
OUT	P, Rr	Out Port	P ← Rr	None	1
PUSH	Rr	Push Register on Stack	STACK ← Rr	None	2
POP	Rd	Pop Register from Stack	Rd ← 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

Ordering Information

Speed (MHz)[3]	Power Supply	Ordering Code	Package[1]	Operation Range
10	1.8 - 5.5V	ATtiny2313V-10PI ATtiny2313V-10PU[2] ATtiny2313V-10SI ATtiny2313V-10SU[2] ATtiny2313V-10MI ATtiny2313V-10MU[2]	20P3 20P3 20S 20S 20M1 20M1	Industrial (-40°C to 85°C)
20	2.7 - 5.5V	ATtiny2313-20PI ATtiny2313-20PU[2] ATtiny2313-20SI ATtiny2313-20SU[2] ATtiny2313-20MI ATtiny2313-20MU[2]	20P3 20P3 20S 20S 20M1 20M1	Industrial (-40°C to 85°C)

Note: 1. This device can also be supplied in wafer form. Please contact your local Atmel sales office for detailed ordering information and minimum quantities.

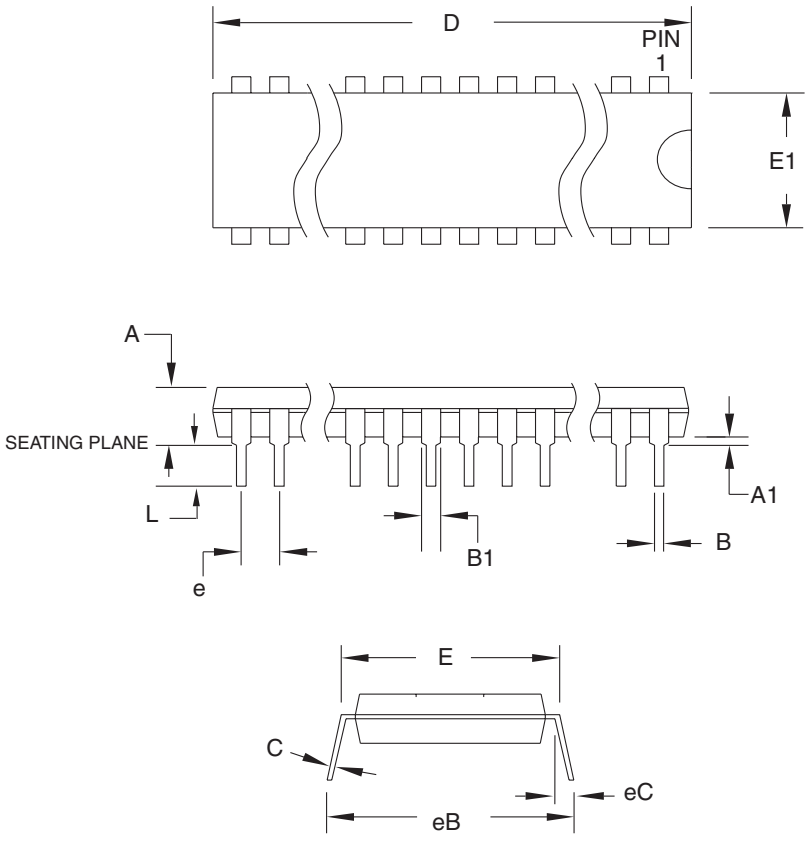
2. Pb-free packaging alternative, complies to the European Directive for Restriction of Hazardous Substances (RoHS directive).Also Halide free and fully Green.

3. For Speed vs. $V_{CC,}$ see Figure 81 on page 178 and Figure 82 on page 178.

Package Type	
20P3	20-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
20S	20-lead, 0.300" Wide, Plastic Gull Wing Small Outline Package (SOIC)
20M1	20-pad, 4 x 4 x 0.8 mm Body, Micro Lead Frame Package (MLF)

Packaging Information

20P3



COMMON DIMENSIONS
(Unit of Measure = mm)

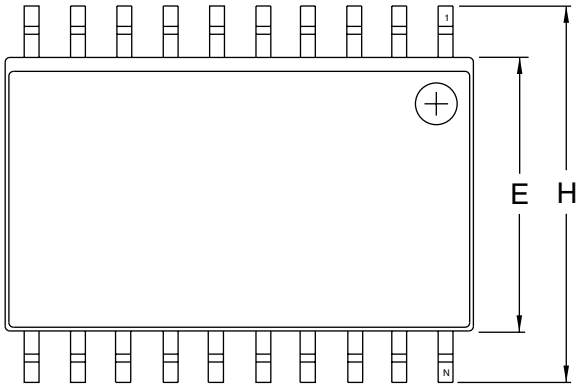
SYMBOL	MIN	NOM	MAX	NOTE
A	–	–	5.334	
A1	0.381	–	–	
D	25.493	–	25.984	Note 2
E	7.620	–	8.255	
E1	6.096	–	7.112	Note 2
B	0.356	–	0.559	
B1	1.270	–	1.551	
L	2.921	–	3.810	
C	0.203	–	0.356	
eB	–	–	10.922	
eC	0.000	–	1.524	
e	2.540 TYP			

Notes:
1. This package conforms to JEDEC reference MS-001, Variation AD.
2. Dimensions D and E1 do not include mold Flash or Protrusion. Mold Flash or Protrusion shall not exceed 0.25 mm (0.010").

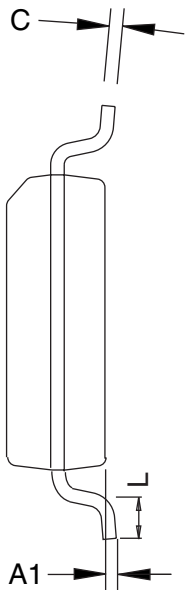
1/12/04

	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**20P3**, 20-lead (0.300"/7.62 mm Wide) Plastic Dual Inline Package (PDIP)	20P3	C

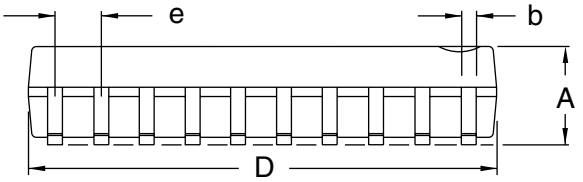
20S



Top View



End View



Side View

COMMON DIMENSIONS
(Unit of Measure = inches)

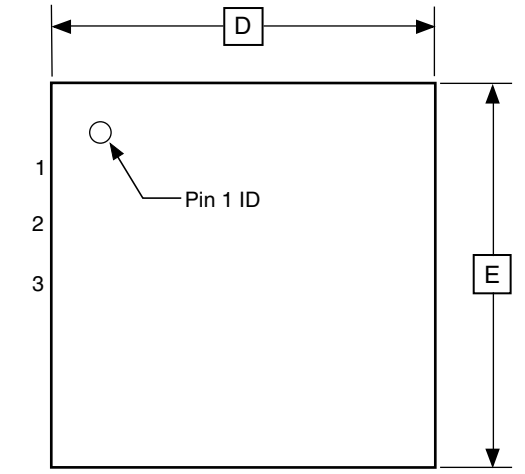
SYMBOL	MIN	NOM	MAX	NOTE
A	0.0926		0.1043	
A1	0.0040		0.0118	
b	0.0130		0.0200	4
C	0.0091		0.0125	
D	0.4961		0.5118	1
E	0.2914		0.2992	2
H	0.3940		0.4190	
L	0.0160		0.050	3
e	0.050 BSC			

Notes:
1. This drawing is for general information only; refer to JEDEC Drawing MS-013, Variation AC for additional information.
2. Dimension "D" does not include mold Flash, protrusions or gate burrs. Mold Flash, protrusions and gate burrs shall not exceed 0.15 mm (0.006") per side.
3. Dimension "E" does not include inter-lead Flash or protrusion. Inter-lead Flash and protrusions shall not exceed 0.25 mm (0.010") per side.
4. "L" is the length of the terminal for soldering to a substrate.
5. The lead width "b", as measured 0.36 mm (0.014") or greater above the seating plane, shall not exceed a maximum value of 0.61 mm (0.024") per side.

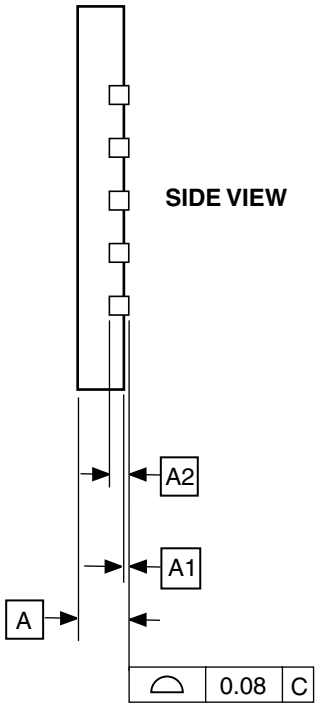
1/9/02

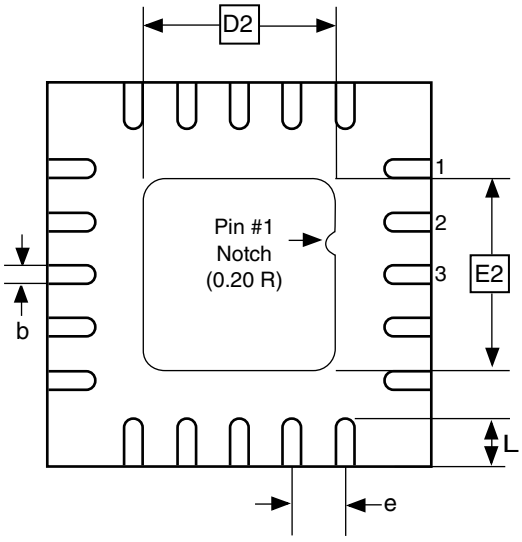
	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**20S2**, 20-lead, 0.300" Wide Body, Plastic Gull Wing Small Outline Package (SOIC)	20S2	A

20M1



TOP VIEW





BOTTOM VIEW

COMMON DIMENSIONS
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	0.70	0.75	0.80	
A1	–	0.01	0.05	
A2		0.20 REF		
b	0.18	0.23	0.30	
D		4.00 BSC		
D2	2.45	2.60	2.75	
E		4.00 BSC		
E2	2.45	2.60	2.75	
e		0.50 BSC		
L	0.35	0.40	0.55	

Note: Reference JEDEC Standard MO-220, Fig. 1 (SAW Singulation) WGGD-5.

10/27/04

	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**20M1**, 20-pad, 4 x 4 x 0.8 mm Body, Lead Pitch 0.50 mm, 2.6 mm Exposed Pad, Micro Lead Frame Package (MLF)	20M1	A

Errata

The revision in this section refers to the revision of the ATtiny2313 device.

ATtiny2313 Rev B

- **Wrong values read after Erase Only operation**
- **Parallel Programming does not work**
- **Watchdog Timer Interrupt disabled**
- **EEPROM can not be written below 1.9 volts**

1. **Wrong values read after Erase Only operation**

   At supply voltages below 2.7 V, an EEPROM location that is erased by the Erase Only operation may read as programmed (0x00).

   Problem Fix/Workaround

   If it is necessary to read an EEPROM location after Erase Only, use an Atomic Write operation with 0xFF as data in order to erase a location. In any case, the Write Only operation can be used as intended. Thus no special considerations are needed as long as the erased location is not read before it is programmed.

2. **Parallel Programming does not work**

   Parallel Programming is not functioning correctly. Because of this, reprogramming of the device is impossible if one of the following modes are selected:

   – In-System Programming disabled (SPIEN unprogrammed)

   – Reset Disabled (RSTDISBL programmed)

   Problem Fix/Workaround

   Serial Programming is still working correctly. By avoiding the two modes above, the device can be reprogrammed serially.

3. **Watchdog Timer Interrupt disabled**

   If the watchdog timer interrupt flag is not cleared before a new timeout occurs, the watchdog will be disabled, and the interrupt flag will automatically be cleared. This is only applicable in interrupt only mode. If the Watchdog is configured to reset the device in the watchdog time-out following an interrupt, the device works correctly.

   Problem fix / Workaround

   Make sure there is enough time to always service the first timeout event before a new watchdog timeout occurs. This is done by selecting a long enough time-out period.

4. **EEPROM can not be written below 1.9 volts**

   Writing the EEPROM at V_{CC} below 1.9 volts might fail.

   Problem fix / Workaround

   Do not write the EEPROM when V_{CC} is below 1.9 volts.

ATtiny2313 Rev A

Revision A has not been sampled.

Datasheet Revision History

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

Changes from Rev. 2514F-08/04 to Rev. 2514G-10/04

1. Updated “Features” on page 1.
2. Updated “Pinout ATtiny2313” on page 2.
3. Updated “Ordering Information” on page 10.
4. Updated “Packaging Information” on page 11.
5. Updated “Errata” on page 14.

Changes from Rev. 2514E-04/04 to Rev. 2514F-08/04

1. Updated “Features” on page 1.
2. Updated “Alternate Functions of Port B” on page 52.
3. Updated “Calibration Byte” on page 159.
4. Moved Table 69 on page 159 and Table 70 on page 160 to “Page Size” on page 159.
5. Updated “Enter Programming Mode” on page 162.
6. Updated “Serial Programming Algorithm” on page 172.
7. Updated Table 78 on page 173.
8. Updated “DC Characteristics” on page 176.
9. Updated “ATtiny2313 Typical Characteristics” on page 179.
10. Changed occurences of PCINT15 to PCINT7, EEMWE to EEMPE and EEWE to EEPE in the document.

Changes from Rev. 2514D-03/04 to Rev. 2514E-04/04

1. Speed Grades changed
   - 12MHz to 10MHz
   - 24MHz to 20MHz
2. Updated Figure 1 on page 2.
3. Updated “Ordering Information” on page 10.
4. Updated “Maximum Speed vs. VCC” on page 178.
5. Updated “ATtiny2313 Typical Characteristics” on page 179.

Changes from Rev. 2514C-12/03 to Rev. 2514D-03/04

1. Updated Table 2 on page 22.
2. Replaced “Watchdog Timer” on page 38.
3. Added “Maximum Speed vs. VCC” on page 178.
4. “Serial Programming Algorithm” on page 172 updated.
5. Changed mA to µA in preliminary Figure 135 on page 205.
6. “Ordering Information” on page 10 updated.
   MLF package option removed
7. Package drawing “20P3” on page 11 updated.
8. Updated C-code examples.
9. Renamed instances of SPMEN to SELFPRGEN, Self Programming Enable.

Changes from Rev. 2514B-09/03 to Rev. 2514C-12/03

1. Updated “Calibrated Internal RC Oscillator” on page 24.

Changes from Rev. 2514A-09/03 to Rev. 2514B-09/03

1. Fixed typo from UART to USART and updated Speed Grades and Power Consumption Estimates in “Features” on page 1.
2. Updated “Pin Configurations” on page 2.
3. Updated Table 15 on page 33 and Table 80 on page 177.
4. Updated item 5 in “Serial Programming Algorithm” on page 172.
5. Updated “Electrical Characteristics” on page 176.
6. Updated Figure 81 on page 178 and added Figure 82 on page 178.
7. Changed SFIOR to GTCCR in “Register Summary” on page 6.
8. Updated “Ordering Information” on page 10.
9. Added new errata in “Errata” on page 14.

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