

## Features

- Utilizes the AVR<sup>®</sup> 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 QFN/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  $\mu$ A
    - 32 kHz, 1.8V: 20  $\mu$ A (including oscillator)
  - Power-down Mode
    - < 0.1  $\mu$ A at 1.8V



## 8-bit AVR<sup>®</sup> Microcontroller with 2K Bytes In-System Programmable Flash

ATtiny2313/V

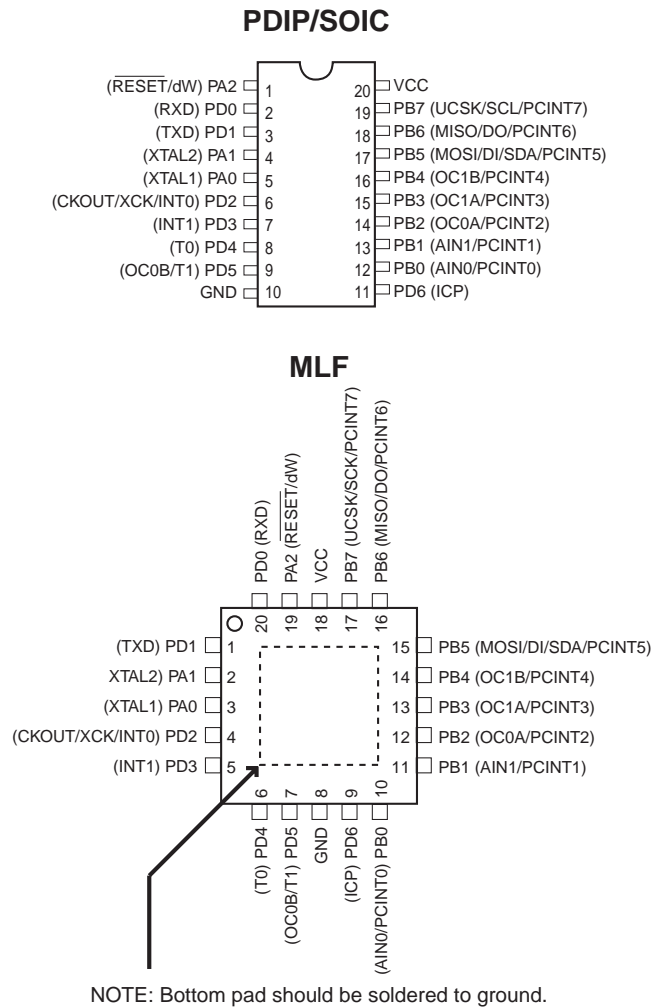
## Preliminary Summary

Rev. 2543IS-AVR-04/06



# Pin Configurations

Figure 1. Pinout ATtiny2313

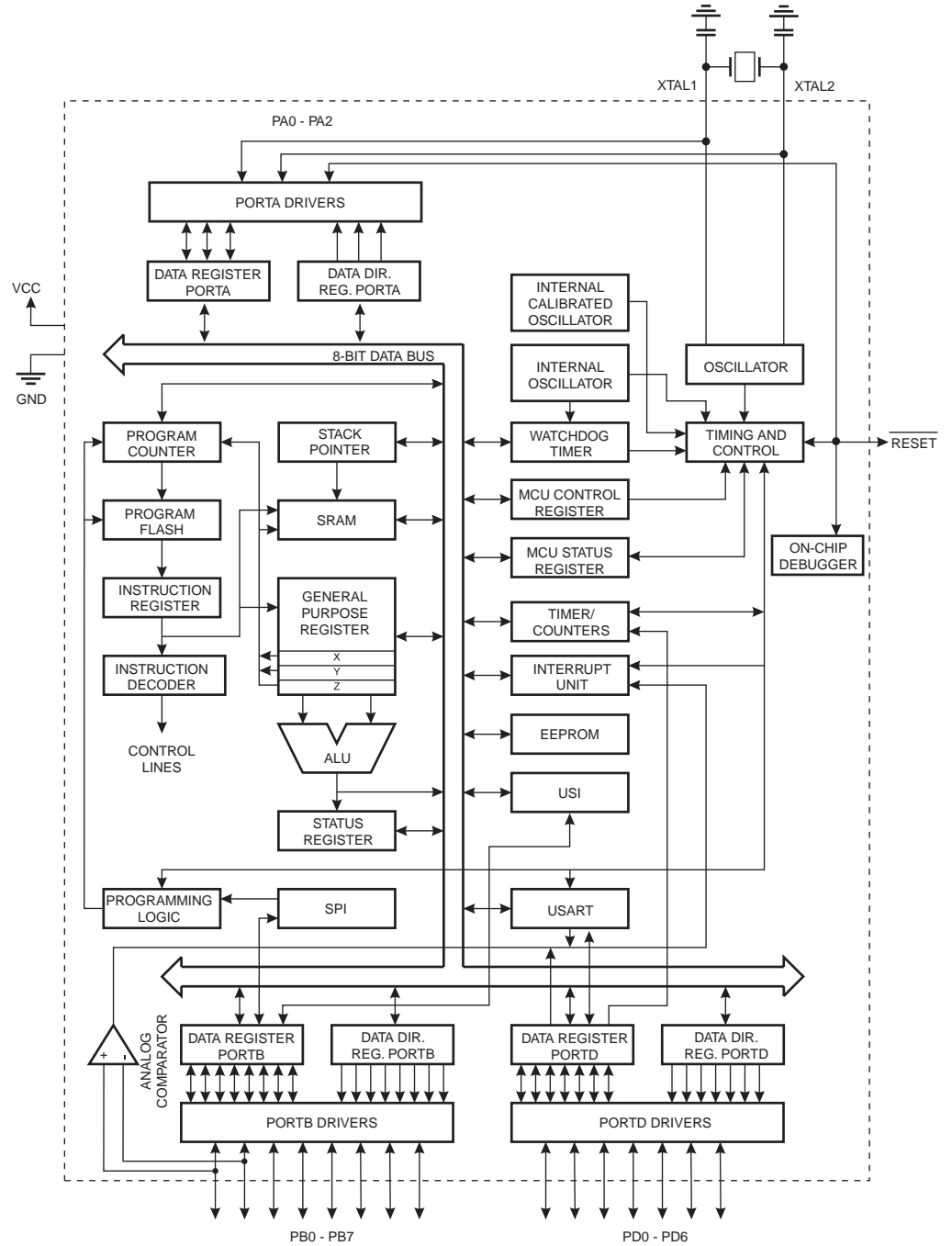


## Overview

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

<b>VCC</b>	Digital supply voltage.
<b>GND</b>	Ground.
<b>Port A (PA2..PA0)</b>	<p>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.</p> <p>Port A also serves the functions of various special features of the ATtiny2313 as listed on page 53.</p>
<b>Port B (PB7..PB0)</b>	<p>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.</p> <p>Port B also serves the functions of various special features of the ATtiny2313 as listed on page 53.</p>
<b>Port D (PD6..PD0)</b>	<p>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.</p> <p>Port D also serves the functions of various special features of the ATtiny2313 as listed on page 56.</p>
<b><u>RESET</u></b>	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 34. Shorter pulses are not guaranteed to generate a reset. The Reset Input is an alternate function for PA2 and dW.
<b>XTAL1</b>	Input to the inverting Oscillator amplifier and input to the internal clock operating circuit. XTAL1 is an alternate function for PA0.
<b>XTAL2</b>	Output from the inverting Oscillator amplifier. XTAL2 is an alternate function for PA1.
<b>Resources</b>	A comprehensive set of development tools, application notes and datasheets are available for download on <a href="http://www.atmel.com/avr">http://www.atmel.com/avr</a> .



# 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								78
0x3B (0x5B)	GIMSK	INT1	INT0	PCIE	–	–	–	–	–	60
0x3A (0x5A)	EIFR	INTF1	INTF0	PCIF	–	–	–	–	–	62
0x39 (0x59)	TIMSK	TOIE1	OCIE1A	OCIE1B	–	ICIE1	OCIE0B	TOIE0	OCIE0A	79, 110
0x38 (0x58)	TIFR	TOV1	OCF1A	OCF1B	–	ICF1	OCF0B	TOV0	OCF0A	79
0x37 (0x57)	SPMCSR	–	–	–	CTPB	RFLB	PGWRT	PGERS	SELFPRGEN	156
0x36 (0x56)	OCR0A	Timer/Counter0 – Compare Register A								78
0x35 (0x55)	MCUCR	PUD	SM1	SE	SM0	ISC11	ISC10	ISC01	ISC00	53
0x34 (0x54)	MCUSR	–	–	–	–	WDRF	BORF	EXTRF	PORF	37
0x33 (0x53)	TCCR0B	FOC0A	FOC0B	–	–	WGM02	CS02	CS01	CS00	77
0x32 (0x52)	TCNT0	Timer/Counter0 (8-bit)								78
0x31 (0x51)	OSCCAL	–	CAL6	CAL5	CAL4	CAL3	CAL2	CAL1	CAL0	25
0x30 (0x50)	TCCR0A	COM0A1	COM0A0	COM0B1	COM0B0	–	–	WGM01	WGM00	74
0x2F (0x4F)	TCCR1A	COM1A1	COM1A0	COM1B1	COM1B0	–	–	WGM11	WGM10	105
0x2E (0x4E)	TCCR1B	ICNC1	ICES1	–	WGM13	WGM12	CS12	CS11	CS10	108
0x2D (0x4D)	TCNT1H	Timer/Counter1 – Counter Register High Byte								109
0x2C (0x4C)	TCNT1L	Timer/Counter1 – Counter Register Low Byte								109
0x2B (0x4B)	OCR1AH	Timer/Counter1 – Compare Register A High Byte								109
0x2A (0x4A)	OCR1AL	Timer/Counter1 – Compare Register A Low Byte								109
0x29 (0x49)	OCR1BH	Timer/Counter1 – Compare Register B High Byte								110
0x28 (0x48)	OCR1BL	Timer/Counter1 – Compare Register B Low Byte								110
0x27 (0x47)	Reserved	–	–	–	–	–	–	–	–	
0x26 (0x46)	CLKPR	CLKPCE	–	–	–	CLKPS3	CLKPS2	CLKPS1	CLKPS0	27
0x25 (0x45)	ICR1H	Timer/Counter1 - Input Capture Register High Byte								110
0x24 (0x44)	ICR1L	Timer/Counter1 - Input Capture Register Low Byte								110
0x23 (0x43)	GTCCR	–	–	–	–	–	–	–	PSR10	82
0x22 (0x42)	TCCR1C	FOC1A	FOC1B	–	–	–	–	–	–	109
0x21 (0x41)	WDTCR	WDIF	WDIE	WDP3	WDCE	WDE	WDP2	WDP1	WDP0	42
0x20 (0x40)	PCMSK	PCINT7	PCINT6	PCINT5	PCINT4	PCINT3	PCINT2	PCINT1	PCINT0	62
0x1F (0x3F)	Reserved	–	–	–	–	–	–	–	–	
0x1E (0x3E)	EEAR	–	EEPROM Address Register							15
0x1D (0x3D)	EEDR	EEPROM Data Register								16
0x1C (0x3C)	EEDR	–	–	EEM1	EEM0	EERIE	EEMPE	EEPE	EERE	16
0x1B (0x3B)	PORTA	–	–	–	–	–	PORTA2	PORTA1	PORTA0	58
0x1A (0x3A)	DDRA	–	–	–	–	–	DDA2	DDA1	DDA0	58
0x19 (0x39)	PINA	–	–	–	–	–	PINA2	PINA1	PINA0	58
0x18 (0x38)	PORTB	PORTB7	PORTB6	PORTB5	PORTB4	PORTB3	PORTB2	PORTB1	PORTB0	58
0x17 (0x37)	DDRB	DDB7	DDB6	DDB5	DDB4	DDB3	DDB2	DDB1	DDB0	58
0x16 (0x36)	PINB	PINB7	PINB6	PINB5	PINB4	PINB3	PINB2	PINB1	PINB0	58
0x15 (0x35)	GPOR2	General Purpose I/O Register 2								20
0x14 (0x34)	GPOR1	General Purpose I/O Register 1								20
0x13 (0x33)	GPOR0	General Purpose I/O Register 0								20
0x12 (0x32)	PORTD	–	PORTD6	PORTD5	PORTD4	PORTD3	PORTD2	PORTD1	PORTD0	58
0x11 (0x31)	DDRD	–	DDD6	DDD5	DDD4	DDD3	DDD2	DDD1	DDD0	58
0x10 (0x30)	PIND	–	PIND6	PIND5	PIND4	PIND3	PIND2	PIND1	PIND0	58
0x0F (0x2F)	USIDR	USI Data Register								145
0x0E (0x2E)	USISR	USISIF	USIOIF	USIPF	USIDC	USICNT3	USICNT2	USICNT1	USICNT0	146
0x0D (0x2D)	USICR	USISIE	USIOIE	USIWM1	USIWM0	USICS1	USICS0	USICLK	USITC	147
0x0C (0x2C)	UDR	UART Data Register (8-bit)								130
0x0B (0x2B)	UCSRA	RXC	TXC	UDRE	FE	DOR	UPE	U2X	MPCM	130
0x0A (0x2A)	UCSRB	RXCIE	TXCIE	UDRIE	RXEN	TXEN	UCSZ2	RXB8	TXB8	132
0x09 (0x29)	UBRRH	UBRRH[7:0]								134
0x08 (0x28)	ACSR	ACD	ACBG	ACO	ACI	ACIE	ACIC	ACIS1	ACIS0	150
0x07 (0x27)	Reserved	–	–	–	–	–	–	–	–	
0x06 (0x26)	Reserved	–	–	–	–	–	–	–	–	
0x05 (0x25)	Reserved	–	–	–	–	–	–	–	–	
0x04 (0x24)	Reserved	–	–	–	–	–	–	–	–	
0x03 (0x23)	UCSRC	–	UMSEL	UPM1	UPM0	USBS	UCSZ1	UCSZ0	UCPOL	133
0x02 (0x22)	UBRRH	–	–	–	–	UBRRH[11:8]				134
0x01 (0x21)	DIDR	–	–	–	–	–	–	AIN1D	AIN0D	151
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
<b>ARITHMETIC AND LOGIC INSTRUCTIONS</b>					
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	Rd,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
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
SBIW	Rd,K	Subtract Immediate from Word	$Rdh:Rdl \leftarrow Rdh:Rdl - K$	Z,C,N,V,S	2
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	$Rd \leftarrow 0xFF - Rd$	Z,C,N,V	1
NEG	Rd	Two's Complement	$Rd \leftarrow 0x00 - Rd$	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	$Rd \leftarrow Rd \bullet (0xFF - K)$	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	$Rd \leftarrow 0xFF$	None	1
<b>BRANCH INSTRUCTIONS</b>					
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
<b>BIT AND BIT-TEST INSTRUCTIONS</b>					
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



Mnemonics	Operands	Description	Operation	Flags	#Clocks
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
<b>DATA TRANSFER INSTRUCTIONS</b>					
MOV	Rd, Rr	Move Between Registers	$Rd \leftarrow Rr$	None	1
MOVW	Rd, Rr	Copy Register Word	$Rd+1:Rd \leftarrow Rr+1:Rr$	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
LPM	Rd, Z	Load Program Memory	$Rd \leftarrow (Z)$	None	3
LPM	Rd, Z+	Load Program Memory and Post-Inc	$Rd \leftarrow (Z), Z \leftarrow Z + 1$	None	3
SPM		Store Program Memory	$(Z) \leftarrow R1:R0$	None	-
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
<b>MCU CONTROL INSTRUCTIONS</b>					
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

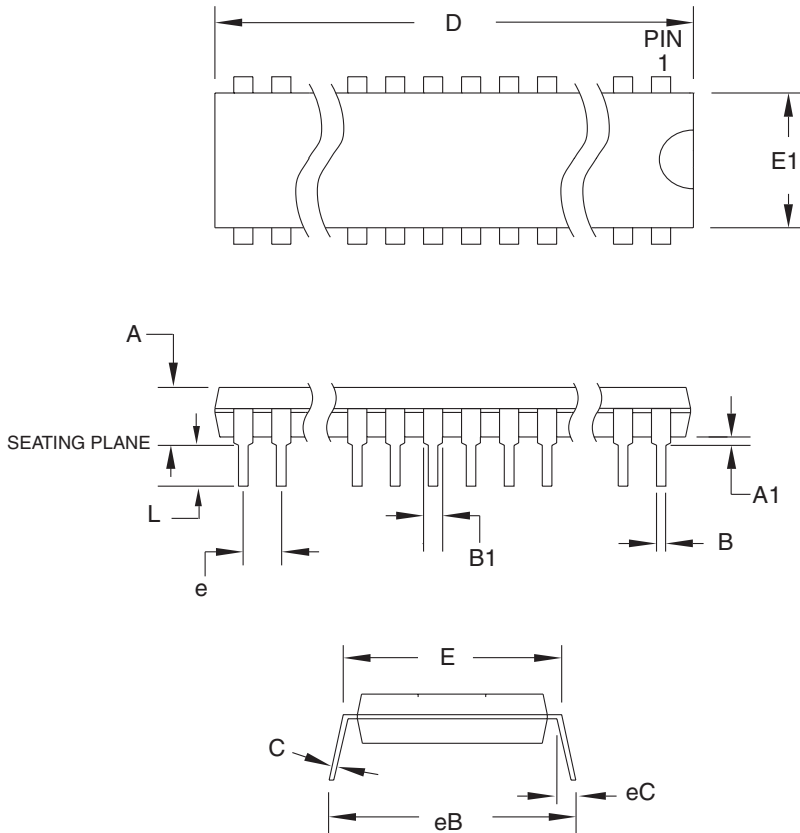
Speed (MHz) <sup>(3)</sup>	Power Supply	Ordering Code	Package <sup>(1)</sup>	Operation Range
10	1.8 - 5.5V	ATtiny2313V-10PI ATtiny2313V-10PU <sup>(2)</sup> ATtiny2313V-10SI ATtiny2313V-10SU <sup>(2)</sup> ATtiny2313V-10MU <sup>(2)</sup>	20P3 20P3 20S 20S 20M1	Industrial (-40°C to 85°C)
20	2.7 - 5.5V	ATtiny2313-20PI ATtiny2313-20PU <sup>(2)</sup> ATtiny2313-20SI ATtiny2313-20SU <sup>(2)</sup> ATtiny2313-20MU <sup>(2)</sup>	20P3 20P3 20S 20S 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 82 on page 181 and Figure 83 on page 181.

Package Type	
<b>20P3</b>	20-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
<b>20S</b>	20-lead, 0.300" Wide, Plastic Gull Wing Small Outline Package (SOIC)
<b>20M1</b>	20-pad, 4 x 4 x 0.8 mm Body, Quad Flat No-Lead/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



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TITLE

20P3, 20-lead (0.300"/7.62 mm Wide) Plastic Dual  
Inline Package (PDIP)

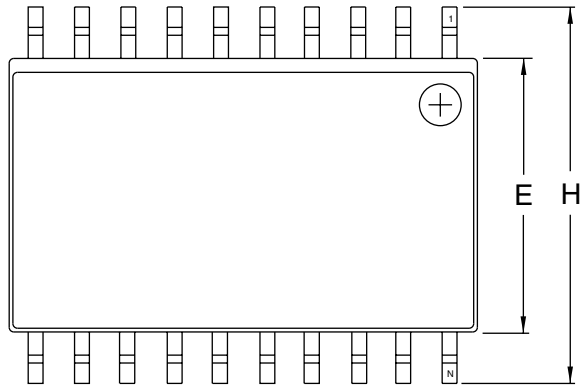
DRAWING NO.

20P3

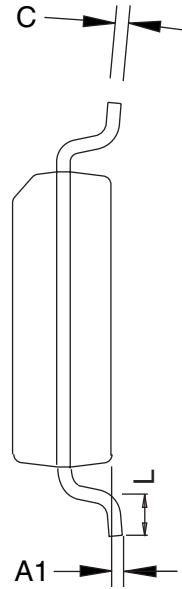
REV.

C

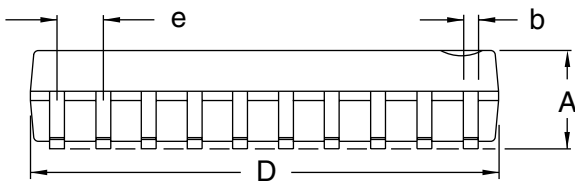




Top View



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.



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**TITLE**

**20S2**, 20-lead, 0.300" Wide Body, Plastic Gull Wing Small Outline Package (SOIC)

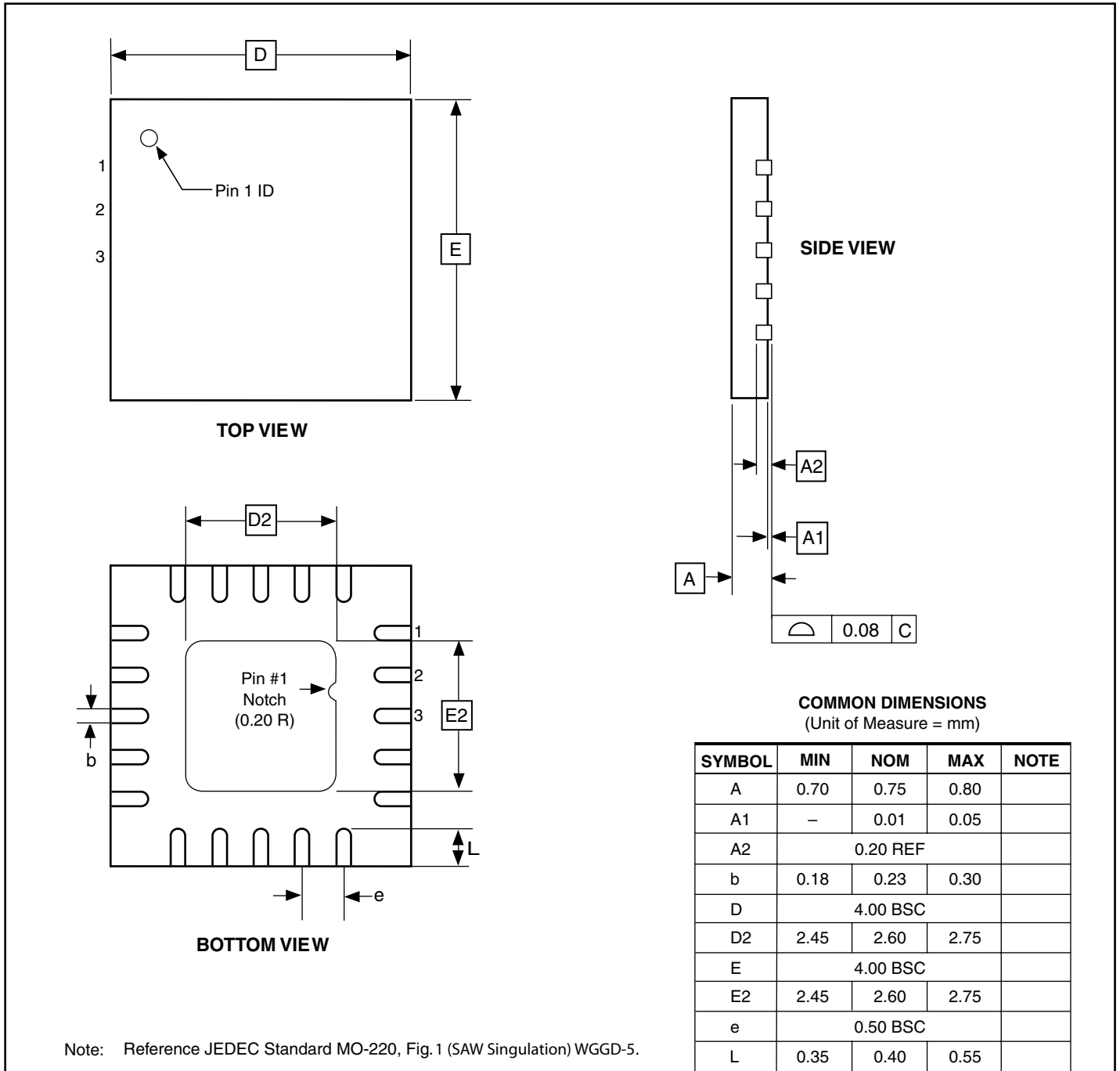
**DRAWING NO.**

20S2

**REV.**

A

## 20M1



10/27/04



2325 Orchard Parkway  
San Jose, CA 95131

**TITLE**

**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)

**DRAWING NO.**

20M1

**REV.**

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. 2514H-02/05 to Rev. 2514I-04/06

1. Updated typos.
2. Updated Figure 1 on page 2.
3. Added “Resources” on page 6.
4. Updated “Default Clock Source” on page 25.
5. Updated “128 kHz Internal Oscillator” on page 30.
6. Updated “Power Management and Sleep Modes” on page 33
7. Updated Table 3 on page 25, Table 13 on page 33, Table 14 on page 34, Table 19 on page 45, Table 31 on page 63, Table 79 on page 180.
8. Updated “External Interrupts” on page 62.
9. Updated “Bit 7..0 – PCINT7..0: Pin Change Enable Mask 7..0” on page 65.
10. Updated “Bit 6 – ACBG: Analog Comparator Bandgap Select” on page 153.
11. Updated “Calibration Byte” on page 164.
12. Updated “DC Characteristics” on page 181.
13. Updated “Register Summary” on page 6.
14. Updated “Ordering Information” on page 10.
15. Changed occurrences of OCnA to OCFnA, OCnB to OCFnB and OC1x to OCF1x.

### Changes from Rev. 2514G-10/04 to Rev. 2514H-02/05

1. Updated Table 6 on page 24, Table 15 on page 34, Table 68 on page 161 and Table 80 on page 180.
2. Changed CKSEL default value in “Default Clock Source” on page 22 to 8 MHz.
3. Updated “Programming the Flash” on page 166, “Programming the EEPROM” on page 168 and “Enter Programming Mode” on page 164.
4. Updated “DC Characteristics” on page 178.
5. MLF option updated to “Quad Flat No-Lead/Micro Lead Frame (QFN/MLF)”

### 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 53.
3. Updated “Calibration Byte” on page 161.

4. Moved Table 69 on page 161 and Table 70 on page 162 to “Page Size” on page 161.
5. Updated “Enter Programming Mode” on page 164.
6. Updated “Serial Programming Algorithm” on page 174.
7. Updated Table 78 on page 175.
8. Updated “DC Characteristics” on page 178.
9. Updated “ATtiny2313 Typical Characteristics” on page 182.
10. Changed occurrences 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.  $V_{CC}$ ” on page 181.
5. Updated “ATtiny2313 Typical Characteristics” on page 182.

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

1. Updated Table 2 on page 22.
2. Replaced “Watchdog Timer” on page 39.
3. Added “Maximum Speed vs.  $V_{CC}$ ” on page 181.
4. “Serial Programming Algorithm” on page 174 updated.
5. Changed mA to  $\mu$ A in preliminary Figure 136 on page 208.
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 SPEN 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 34 and Table 80 on page 180.
4. Updated item 5 in “Serial Programming Algorithm” on page 174.
5. Updated “Electrical Characteristics” on page 178.
6. Updated Figure 82 on page 181 and added Figure 83 on page 181.
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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