

## Features

- High Performance, Low Power AVR<sup>®</sup> 8-Bit Microcontroller
- Advanced RISC Architecture
  - 120 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
- Non-volatile Program and Data Memories
  - 2/4/8K Byte of In-System Programmable Program Memory Flash (ATtiny25/45/85)  
Endurance: 10,000 Write/Erase Cycles
  - 128/256/512 Bytes In-System Programmable EEPROM (ATtiny25/45/85)  
Endurance: 100,000 Write/Erase Cycles
  - 128/256/512 Bytes Internal SRAM (ATtiny25/45/85)
  - Programming Lock for Self-Programming Flash Program and EEPROM Data Security
- Peripheral Features
  - 8-bit Timer/Counter with Prescaler and Two PWM Channels
  - 8-bit High Speed Timer/Counter with Separate Prescaler
    - 2 High Frequency PWM Outputs with Separate Output Compare Registers
    - Programmable Dead Time Generator
  - USI – Universal Serial Interface with Start Condition Detector
  - 10-bit ADC
    - 4 Single Ended Channels
    - 2 Differential ADC Channel Pairs with Programmable Gain (1x, 20x)
    - Temperature Measurement
  - Programmable Watchdog Timer with Separate On-chip Oscillator
  - On-chip Analog Comparator
- Special Microcontroller Features
  - debugWIRE On-chip Debug System
  - In-System Programmable via SPI Port
  - External and Internal Interrupt Sources
  - Low Power Idle, ADC Noise Reduction, and Power-down Modes
  - Enhanced Power-on Reset Circuit
  - Programmable Brown-out Detection Circuit
  - Internal Calibrated Oscillator
- I/O and Packages
  - Six Programmable I/O Lines
  - 8-pin PDIP, 8-pin SOIC and 20-pad QFN/MLF
- Operating Voltage
  - 1.8 - 5.5V for ATtiny25/45/85V
  - 2.7 - 5.5V for ATtiny25/45/85
- Speed Grade
  - ATtiny25/45/85V: 0 - 4 MHz @ 1.8 - 5.5V, 0 - 10 MHz @ 2.7 - 5.5V
  - ATtiny25/45/85: 0 - 10 MHz @ 2.7 - 5.5V, 0 - 20 MHz @ 4.5 - 5.5V
- Industrial Temperature Range
- Low Power Consumption
  - Active Mode:
    - 1 MHz, 1.8V: 450 $\mu$ A
  - Power-down Mode:
    - 0.1 $\mu$ A at 1.8V



**8-bit AVR<sup>®</sup>  
Microcontroller  
with 2/4/8K  
Bytes In-System  
Programmable  
Flash**

**ATtiny25/V  
ATtiny45/V  
ATtiny85/V**

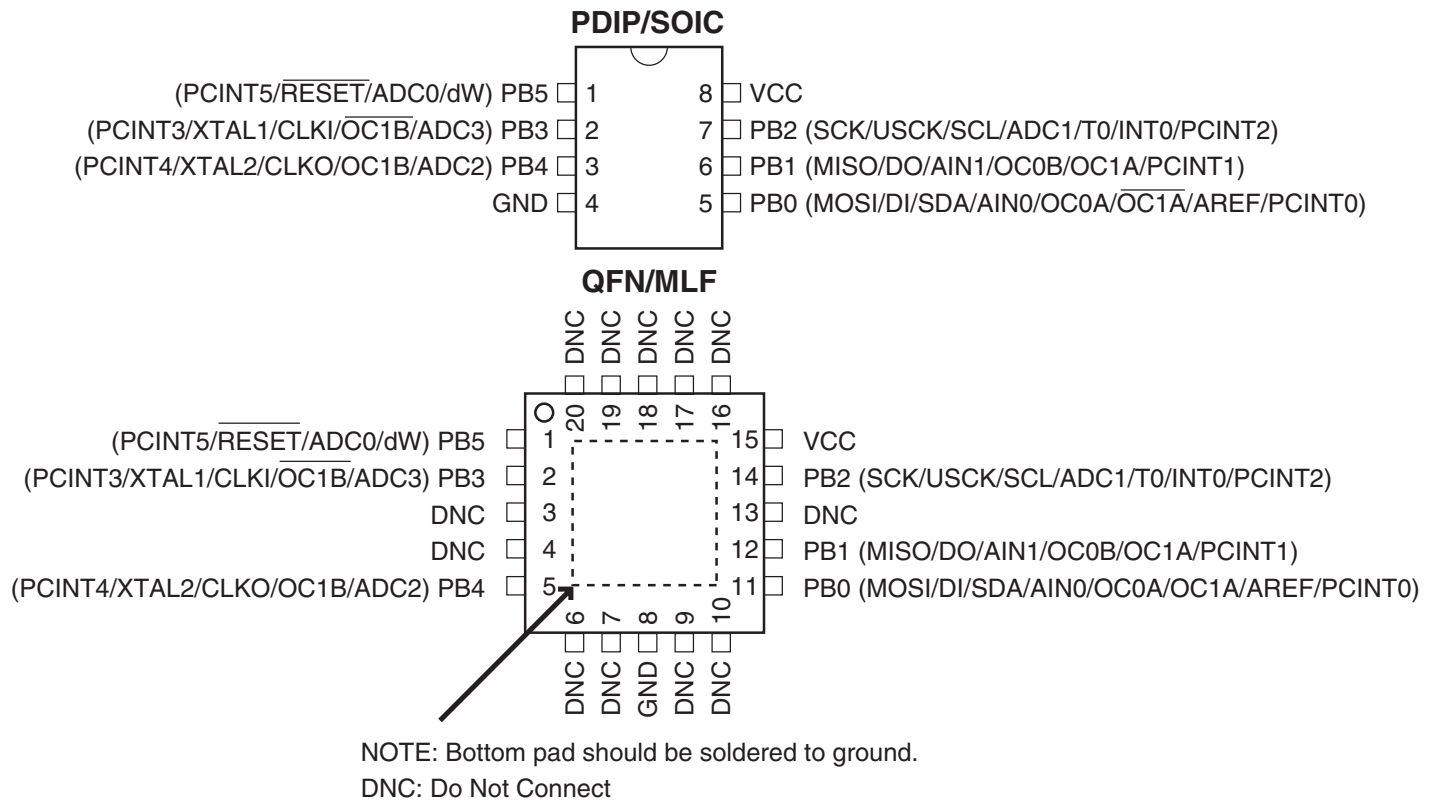
**Preliminary  
Summary**

2586GS-AVR-05/06



# 1. Pin Configurations

Figure 1-1. Pinout ATtiny25/45/85



## 1.1 Disclaimer

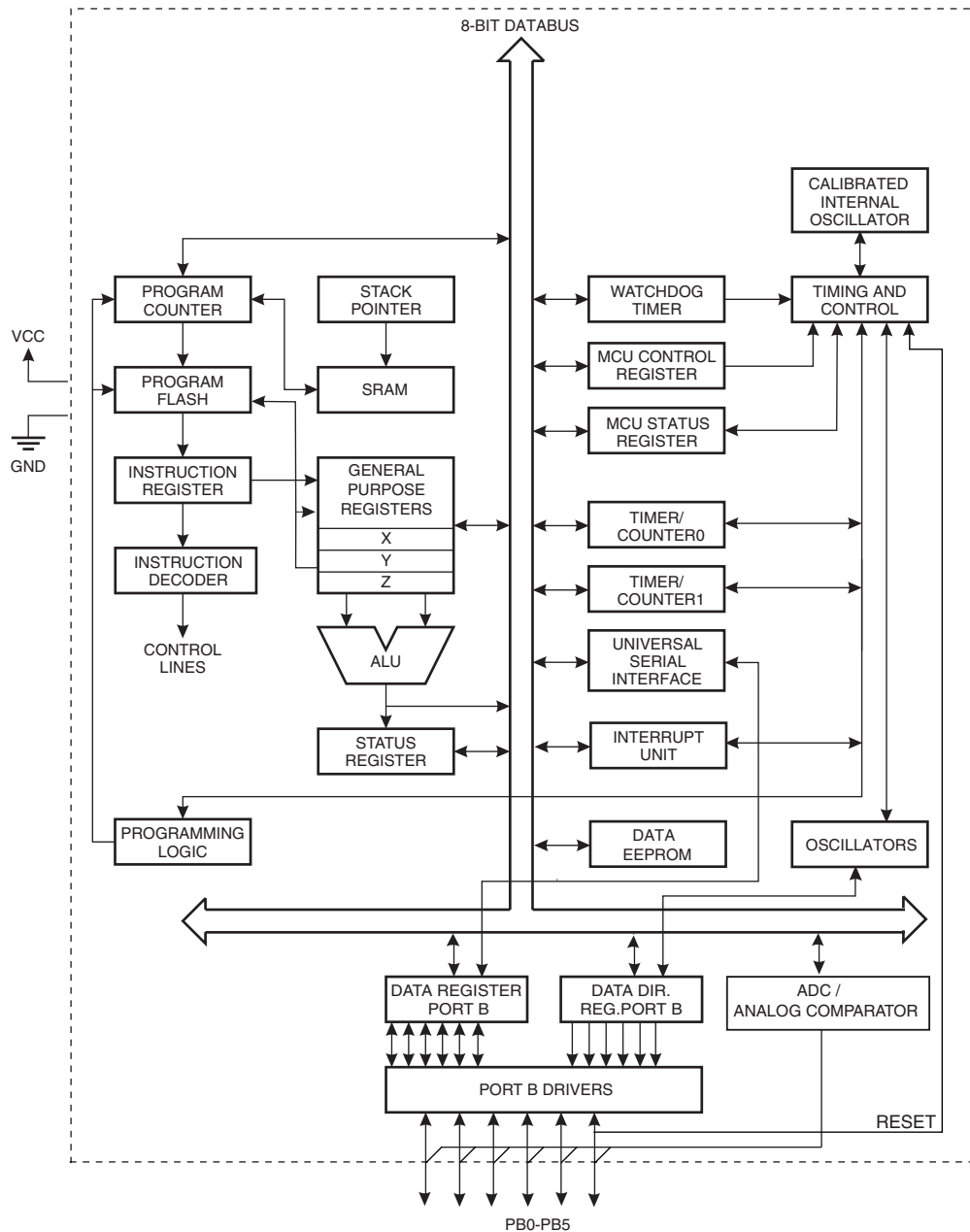
Typical values contained in this data sheet are based on simulations and characterization of other AVR microcontrollers manufactured on the same process technology. Min and Max values will be available after the device is characterized.

## 2. Overview

The ATtiny25/45/85 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 ATtiny25/45/85 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

### 2.1 Block Diagram

Figure 2-1. 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 ATtiny25/45/85 provides the following features: 2/4/8K byte of In-System Programmable Flash, 128/256/512 bytes EEPROM, 128/256/256 bytes SRAM, 6 general purpose I/O lines, 32 general purpose working registers, one 8-bit Timer/Counter with compare modes, one 8-bit high speed Timer/Counter, Universal Serial Interface, Internal and External Interrupts, a 4-channel, 10-bit ADC, 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/Counter, ADC, Analog Comparator, and Interrupt system to continue functioning. The Power-down mode saves the register contents, disabling all chip functions until the next Interrupt or Hardware Reset. The ADC Noise Reduction mode stops the CPU and all I/O modules except ADC, to minimize switching noise during ADC conversions.

The device is manufactured using Atmel's high density non-volatile memory technology. The On-chip ISP Flash allows the Program memory to be re-programmed In-System through an SPI serial interface, by a conventional non-volatile memory programmer or by an On-chip boot code running on the AVR core.

The ATtiny25/45/85 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.

## 2.2 Pin Descriptions

### 2.2.1 VCC

Supply voltage.

### 2.2.2 GND

Ground.

### 2.2.3 Port B (PB5..PB0)

Port B is a 6-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 ATtiny25/45/85 as listed on [page 59](#).

On the ATtiny25 device the programmable I/O ports PB3 and PB4 (pins 2 and 3) are exchanged in the ATtiny15 compatibility mode for supporting the backward compatibility with ATtiny15.

### 2.2.4 $\overline{\text{RESET}}$

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 9-1 on page 37](#). Shorter pulses are not guaranteed to generate a reset.

### **3. Resources**

A comprehensive set of development tools, application notes and datasheets are available for download on <http://www.atmel.com/avr>.



## 4. Register Summary

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Page
0x3F	SREG	I	T	H	S	V	N	Z	C	<a href="#">page 7</a>
0x3E	SPH	–	–	–	–	–	–	SP9	SP8	<a href="#">page 10</a>
0x3D	SPL	SP7	SP6	SP5	SP4	SP3	SP2	SP1	SP0	<a href="#">page 10</a>
0x3C	Reserved	–	–	–	–	–	–	–	–	
0x3B	GIMSK	–	INT0	PCIE	–	–	–	–	–	<a href="#">page 52</a>
0x3A	GIFR	–	INTF0	PCIF	–	–	–	–	–	<a href="#">page 53</a>
0x39	TIMSK	–	OCIE1A	OCIE1B	OCIE0A	OCIE0B	TOIE1	TOIE0	–	<a href="#">page 83/page 104</a>
0x38	TIFR	–	OCF1A	OCF1B	OCF0A	OCF0B	TOV1	TOV0	–	<a href="#">page 83</a>
0x37	SPMCSR	–	–	–	CTPB	RFLB	PGWRT	PGERS	SPMEN	<a href="#">page 149</a>
0x36	Reserved	–	–	–	–	–	–	–	–	
0x35	MCUCR	BODS	PUD	SE	SM1	SM0	BODSE	ISC01	ISC00	<a href="#">page 36, page 52, page 62,</a>
0x34	MCUSR	–	–	–	–	WDRF	BORF	EXTRF	PORF	<a href="#">page 42,</a>
0x33	TCCR0B	FOC0A	FOC0B	–	–	WGM02	CS02	CS01	CS00	<a href="#">page 81</a>
0x32	TCNT0	Timer/Counter0								<a href="#">page 82</a>
0x31	OSCCAL	Oscillator Calibration Register								<a href="#">page 27</a>
0x30	TCCR1	CTC1	PWM1A	COM1A1	COM1A0	CS13	CS12	CS11	CS10	<a href="#">page 90, page 102</a>
0x2F	TCNT1	Timer/Counter1								<a href="#">page 92, page 103</a>
0x2E	OCR1A	Timer/Counter1 Output Compare Register A								<a href="#">page 92, page 104</a>
0x2D	OCR1C	Timer/Counter1 Output Compare Register C								<a href="#">page 93, page 104</a>
0x2C	GTCCR	TSM	PWM1B	COM1B1	COM1B0	FOC1B	FOC1A	PSR1	PSR0	<a href="#">page 86, page 91, page</a>
0x2B	OCR1B	Timer/Counter1 Output Compare Register B								<a href="#">page 93</a>
0x2A	TCCR0A	COM0A1	COM0A0	COM0B1	COM0B0	–	–	WGM01	WGM00	<a href="#">page 78</a>
0x29	OCR0A	Timer/Counter0 – Output Compare Register A								<a href="#">page 82</a>
0x28	OCR0B	Timer/Counter0 – Output Compare Register B								<a href="#">page 82</a>
0x27	PLLCSR	LSM	–	–	–	–	PCKE	PLLE	PLOCK	<a href="#">page 95, page 105</a>
0x26	CLKPR	CLKPCE	–	–	–	CLKPS3	CLKPS2	CLKPS1	CLKPS0	<a href="#">page 30</a>
0x25	DT1A	DT1AH3	DT1AH2	DT1AH1	DT1AH0	DT1AL3	DT1AL2	DT1AL1	DT1AL0	<a href="#">page 110</a>
0x24	DT1B	DT1BH3	DT1BH2	DT1BH1	DT1BH0	DT1BL3	DT1BL2	DT1BL1	DT1BL0	<a href="#">page 111</a>
0x23	DTPS1	–	–	–	–	–	–	DTPS11	DTPS10	<a href="#">page 110</a>
0x22	DWDR	DWDR[7:0]								<a href="#">page 146</a>
0x21	WDTCR	WDIF	WDIE	WDP3	WDCE	WDE	WDP2	WDP1	WDP0	<a href="#">page 44</a>
0x20	PRR	–	–	–	–	PRTIM1	PRTIM0	PRUSI	PRADC	<a href="#">page 33</a>
0x1F	EEARH	–	–	–	–	–	–	–	EEAR8	<a href="#">page 16</a>
0x1E	EEARL	EEAR7	EEAR6	EEAR5	EEAR4	EEAR3	EEAR2	EEAR1	EEAR0	<a href="#">page 16</a>
0x1D	EEDR	EEPROM Data Register								<a href="#">page 16</a>
0x1C	ECCR	–	–	ECPM1	ECPM0	EERIE	EEMPE	EEPE	EERE	<a href="#">page 17</a>
0x1B	Reserved	–	–	–	–	–	–	–	–	
0x1A	Reserved	–	–	–	–	–	–	–	–	
0x19	Reserved	–	–	–	–	–	–	–	–	
0x18	PORTB	–	–	PORTB5	PORTB4	PORTB3	PORTB2	PORTB1	PORTB0	<a href="#">page 66</a>
0x17	DDRB	–	–	DDB5	DDB4	DDB3	DDB2	DDB1	DDB0	<a href="#">page 66</a>
0x16	PINB	–	–	PINB5	PINB4	PINB3	PINB2	PINB1	PINB0	<a href="#">page 66</a>
0x15	PCMSK	–	–	PCINT5	PCINT4	PCINT3	PCINT2	PCINT1	PCINT0	<a href="#">page 53</a>
0x14	DIDR0	–	–	ADC0D	ADC2D	ADC3D	ADC1D	AIN1D	AIN0D	<a href="#">page 126, page 143</a>
0x13	GPOR2	General Purpose I/O Register 2								<a href="#">page 9</a>
0x12	GPOR1	General Purpose I/O Register 1								<a href="#">page 9</a>
0x11	GPOR0	General Purpose I/O Register 0								<a href="#">page 9</a>
0x10	USIBR	USI Buffer Register								<a href="#">page 120</a>
0x0F	USIDR	USI Data Register								<a href="#">page 119</a>
0x0E	USISR	USISIF	USIOIF	USIPF	USIDC	USICNT3	USICNT2	USICNT1	USICNT0	<a href="#">page 120</a>
0x0D	USICR	USISIE	USIOIE	USIWM1	USIWM0	USICS1	USICS0	USICLK	USITC	<a href="#">page 121</a>
0x0C	Reserved	–	–	–	–	–	–	–	–	
0x0B	Reserved	–	–	–	–	–	–	–	–	
0x0A	Reserved	–	–	–	–	–	–	–	–	
0x09	Reserved	–	–	–	–	–	–	–	–	
0x08	ACSR	ACD	ACBG	ACO	ACI	ACIE	–	ACIS1	ACIS0	<a href="#">page 124</a>
0x07	ADMUX	REFS1	REFS0	ADLAR	REFS2	MUX3	MUX2	MUX1	MUX0	<a href="#">page 139</a>
0x06	ADCSRA	ADEN	ADSC	ADATE	ADIF	ADIE	ADPS2	ADPS1	ADPS0	<a href="#">page 140</a>
0x05	ADCH	ADC Data Register High Byte								<a href="#">page 142</a>
0x04	ADCL	ADC Data Register Low Byte								<a href="#">page 142</a>
0x03	ADCSRB	BIN	ACME	IPR	–	–	ADTS2	ADTS1	ADTS0	<a href="#">page 124, page 142</a>
0x02	Reserved	–	–	–	–	–	–	–	–	
0x01	Reserved	–	–	–	–	–	–	–	–	
0x00	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 operation 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.

## 5. 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



## 6. Ordering Information

### 6.1 ATtiny25

Speed (MHz) <sup>(3)</sup>	Power Supply	Ordering Code	Package <sup>(1)(2)</sup>	Operational Range
10	1.8 - 5.5V	ATtiny25V-10PU ATtiny25V-10SU ATtiny25V-10MU	8P3 8S2 20M1	Industrial (-40°C to 85°C)
20	2.7 - 5.5V	ATtiny25-20PU ATtiny25-20SU ATtiny25-20MU	8P3 8S2 20M1	Industrial (-40°C to 85°C)

- Notes:
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 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 24.5 on page 167](#)

Package Type	
<b>8P3</b>	8-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
<b>8S2</b>	8-lead, 0.209" Wide, Plastic Gull-Wing Small Outline (EIAJ SOIC)
<b>20M1</b>	20-pad, 4 x 4 x 0.8 mm Body, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)

## 6.2 ATtiny45

Speed (MHz) <sup>(3)</sup>	Power Supply	Ordering Code	Package <sup>(1)(2)</sup>	Operational Range
10	1.8 - 5.5V	ATtiny45V-10PU ATtiny45V-10SU ATtiny45V-10MU	8P3 8S2 20M1	Industrial (-40°C to 85°C)
20	2.7 - 5.5V	ATtiny45-20PU ATtiny45-20SU ATtiny45-20MU	8P3 8S2 20M1	Industrial (-40°C to 85°C)

- Notes:
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 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 24.5 on page 167](#)

Package Type	
<b>8P3</b>	8-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
<b>8S2</b>	8-lead, 0.209" Wide, Plastic Gull-Wing Small Outline (EIAJ SOIC)
<b>20M1</b>	20-pad, 4 x 4 x 0.8 mm Body, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)

### 6.3 ATtiny85

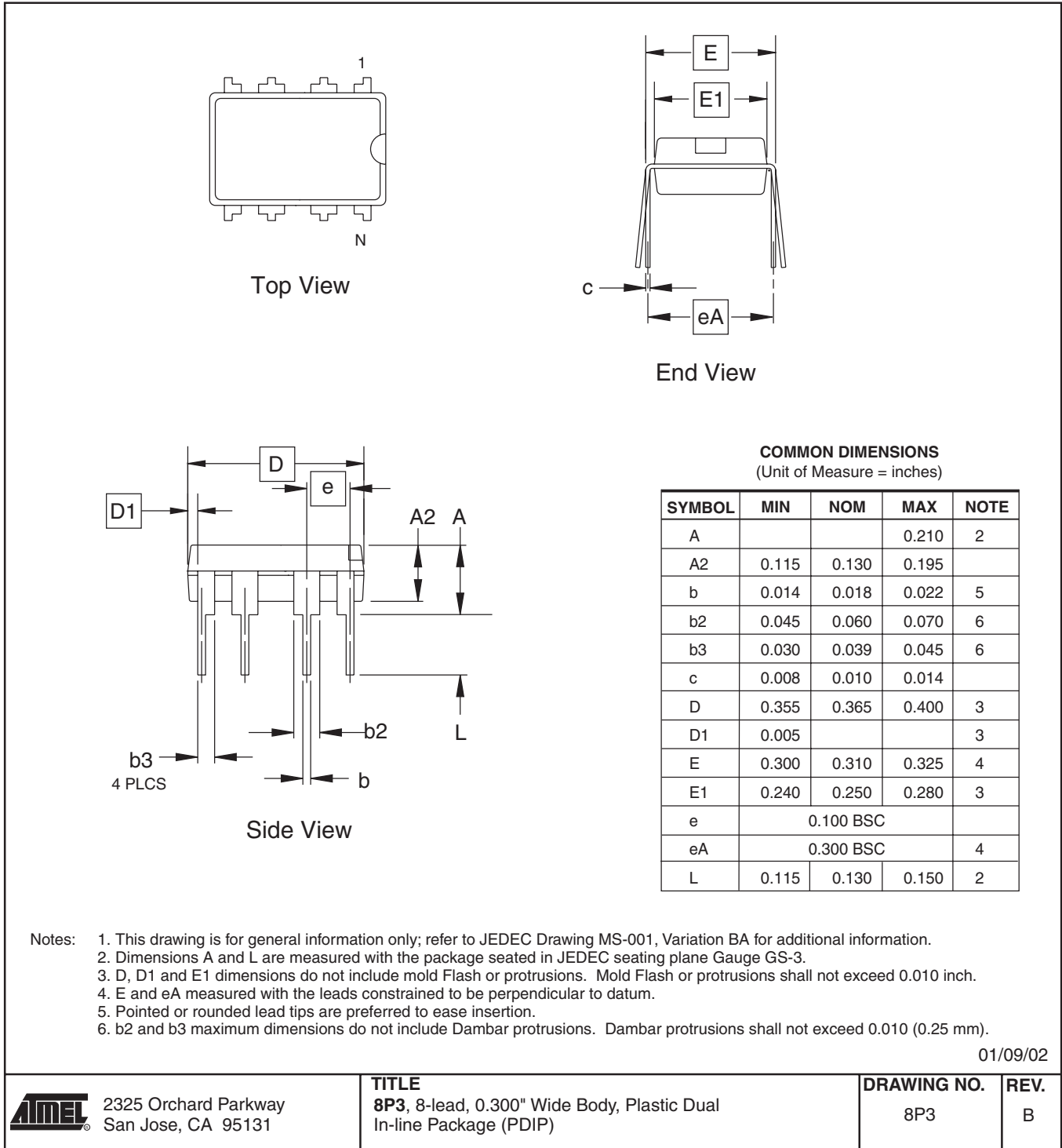
Speed (MHz) <sup>(3)</sup>	Power Supply	Ordering Code	Package <sup>(1)(2)</sup>	Operational Range
10	1.8 - 5.5V	ATtiny85V-10PU ATtiny85V-10SU ATtiny85V-10MU	8P3 8S2 20M1	Industrial (-40°C to 85°C)
20	2.7 - 5.5V	ATtiny85-20PU ATtiny85-20SU ATtiny85-20MU	8P3 8S2 20M1	Industrial (-40°C to 85°C)

- Notes:
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 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 24.5 on page 167](#)

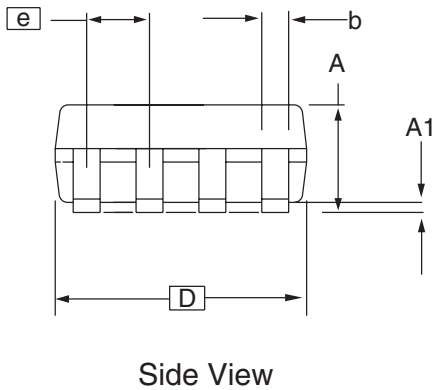
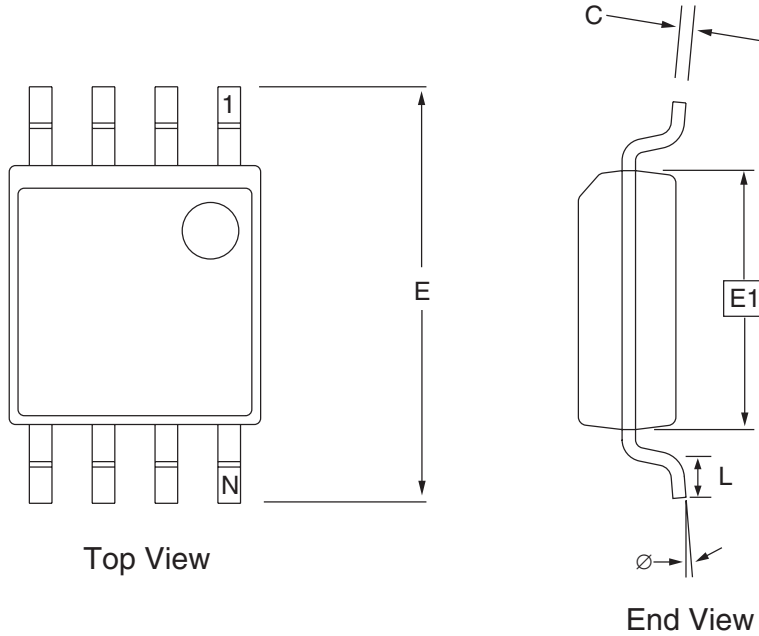
Package Type	
<b>8P3</b>	8-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
<b>8S2</b>	8-lead, 0.209" Wide, Plastic Gull-Wing Small Outline (EIAJ SOIC)
<b>20M1</b>	20-pad, 4 x 4 x 0.8 mm Body, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)

7. Packaging Information

7.1 8P3



7.2 8S2



**COMMON DIMENSIONS**  
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	1.70		2.16	
A1	0.05		0.25	
b	0.35		0.48	5
C	0.15		0.35	5
D	5.13		5.35	
E1	5.18		5.40	2, 3
E	7.70		8.26	
L	0.51		0.85	
Ø	0°		8°	
e	1.27 BSC			4

- Notes: 1. This drawing is for general information only; refer to EIAJ Drawing EDR-7320 for additional information.  
 2. Mismatch of the upper and lower dies and resin burrs are not included.  
 3. It is recommended that upper and lower cavities be equal. If they are different, the larger dimension shall be regarded.  
 4. Determines the true geometric position.  
 5. Values b and C apply to pb/Sn solder plated terminal. The standard thickness of the solder layer shall be 0.010 +0.010/-0.005 mm.

10/7/03

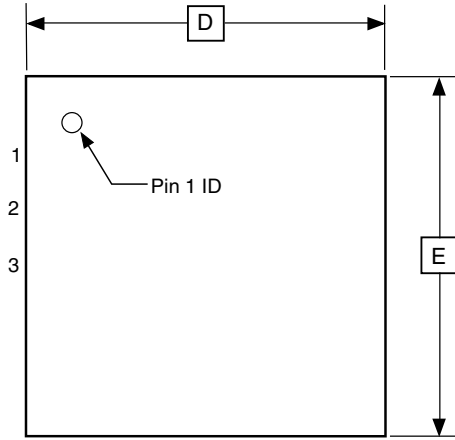
2325 Orchard Parkway  
San Jose, CA 95131

**TITLE**  
8S2, 8-lead, 0.209" Body, Plastic Small  
Outline Package (EIAJ)

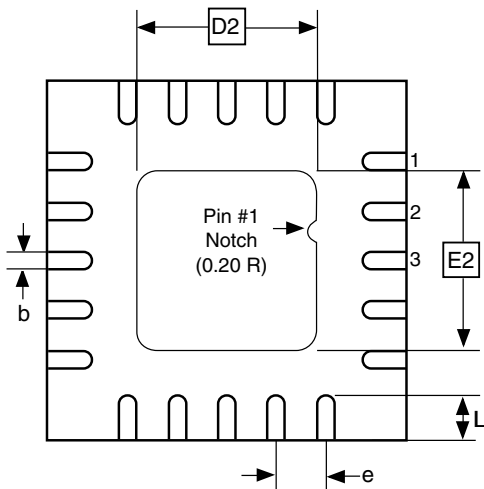
**DRAWING NO.**  
8S2

**REV.**  
C

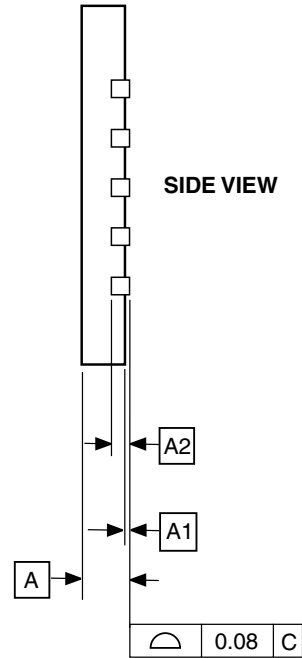
7.3 20M1



TOP VIEW



BOTTOM VIEW



SIDE 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



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



## 8. Errata

### 8.1 Errata ATtiny25

The revision letter in this section refers to the revision of the ATtiny25 device.

#### 8.1.1 Rev C

No known errata

#### 8.1.2 Rev B

- **Reading EEPROM at low frequency may not work for frequencies below 900 kHz**

1. **Reading EEPROM at low frequency may not work for frequencies below 900 kHz**

Reading data from the EEPROM at low internal clock frequency may result in wrong data read.

**Problem Fix/Workaround**

Avoid using the EEPROM at clock frequency below 900kHz.

#### 8.1.3 Rev A

Not sampled.

## 8.2 Errata ATtiny45

The revision letter in this section refers to the revision of the ATtiny45 device.

### 8.2.1 Rev E

No known errata

### 8.2.2 Rev D

- **Reading EEPROM at low frequency may not work for frequencies below 900 kHz**

#### 1. **Reading EEPROM at low frequency may not work for frequencies below 900 kHz**

Reading data from the EEPROM at low internal clock frequency may result in wrong data read.

##### **Problem Fix/Workaround**

Avoid using the EEPROM at clock frequency below 900kHz.

### 8.2.3 Rev B and C

- **PLL not locking**
- **EEPROM read from application code does not work in Lock Bit Mode 3**
- **Reading EEPROM at low frequency may not work for frequencies below 900 kHz**
- **Timer Counter 1 PWM output generation on OC1B- XOC1B does not work correctly**

#### 1. **PLL not locking**

When at frequencies below 6.0 MHz, the PLL will not lock

##### **Problem fix / Workaround**

When using the PLL, run at 6.0 MHz or higher.

#### 2. **EEPROM read from application code does not work in Lock Bit Mode 3**

When the Memory Lock Bits LB2 and LB1 are programmed to mode 3, EEPROM read does not work from the application code.

##### **Problem Fix/Work around**

Do not set Lock Bit Protection Mode 3 when the application code needs to read from EEPROM.

#### 3. **Reading EEPROM at low frequency may not work for frequencies below 900 kHz**

Reading data from the EEPROM at low internal clock frequency may result in wrong data read.

##### **Problem Fix/Workaround**

Avoid using the EEPROM at clock frequency below 900kHz.

#### 4. **Timer Counter 1 PWM output generation on OC1B – XOC1B does not work correctly**

Timer Counter1 PWM output OC1B-XOC1B does not work correctly. Only in the case when the control bits, COM1B1 and COM1B0 are in the same mode as COM1A1 and COM1A0, respectively, the OC1B-XOC1B output works correctly.

##### **Problem Fix/Work around**

The only workaround is to use same control setting on COM1B(1:0) and COM1A(1:0) control bits, see table 14-4 in the data sheet. The problem has been fixed for Tiny45 rev D.

- **Too high power down power consumption**
- **DebugWIRE loses communication when single stepping into interrupts**
- **PLL not locking**
- **EEPROM read from application code does not work in Lock Bit Mode 3**
- **Reading EEPROM at low frequency may not work for frequencies below 900 kHz**

**1. Too high power down power consumption**

Three situations will lead to a too high power down power consumption. These are:

- An external clock is selected by fuses, but the I/O PORT is still enabled as an output.
- The EEPROM is read before entering power down.
- VCC is 4.5 volts or higher.

**Problem fix / Workaround**

- When using external clock, avoid setting the clock pin as Output.
- Do not read the EEPROM if power down power consumption is important.
- Use VCC lower than 4.5 Volts.

**2. DebugWIRE loses communication when single stepping into interrupts**

When receiving an interrupt during single stepping, debugwire will lose communication.

**Problem fix / Workaround**

- When singlestepping, disable interrupts.
- When debugging interrupts, use breakpoints within the interrupt routine, and run into the interrupt.

**3. PLL not locking**

When at frequencies below 6.0 MHz, the PLL will not lock

**Problem fix / Workaround**

When using the PLL, run at 6.0 MHz or higher.

**4. EEPROM read from application code does not work in Lock Bit Mode 3**

When the Memory Lock Bits LB2 and LB1 are programmed to mode 3, EEPROM read does not work from the application code.

**Problem Fix/Work around**

Do not set Lock Bit Protection Mode 3 when the application code needs to read from EEPROM.

**5. Reading EEPROM at low frequency may not work for frequencies below 900 kHz**

Reading data from the EEPROM at low internal clock frequency may result in wrong data read.

**Problem Fix/Workaround**

Avoid using the EEPROM at clock frequency below 900kHz.

### **8.3 Errata ATtiny85**

The revision letter in this section refers to the revision of the ATtiny85 device.

#### **8.3.1 Rev B**

No known errata.

#### **8.3.2 Rev A**

- **Reading EEPROM at low frequency may not work for frequencies below 900 kHz**

1. **Reading EEPROM at low frequency may not work for frequencies below 900 kHz**

Reading data from the EEPROM at low internal clock frequency may result in wrong data read.

**Problem Fix/Workaround**

Avoid using the EEPROM at clock frequency below 900kHz.

## 9. Datasheet Revision History

### 9.1 Rev. 2586G-05/06

1. Updated "Internal PLL for Fast Peripheral Clock Generation - clkPCK" on page 23.
2. Updated "Default Clock Source" on page 24.
3. Updated "Low-frequency Crystal Oscillator" on page 26.
4. Updated "Calibrated Internal RC Oscillator" on page 26.
5. Updated "Clock Output Buffer" on page 29.
6. Updated "Power Management and Sleep Modes" on page 32.
7. Added "BOD Disable" on page 32.
8. Updated Figure 19-1 on page 124.
9. Updated "Bit 6 – ACBG: Analog Comparator Bandgap Select" on page 125.
10. Added note for Table 20-2 on page 130.
11. Updated "Register Summary" on page 197.

### 9.2 Rev. 2586F-04/06

1. Updated "Digital Input Enable and Sleep Modes" on page 56.
2. Updated Table 23-15 on page 163.
3. Updated "Ordering Information" on page 199.

### 9.3 Rev. 2586E-03/06

1. Updated Features in "Analog to Digital Converter" on page 124.
2. Updated Operation in "Analog to Digital Converter" on page 124.
3. Updated Table 20-2 on page 136.
4. Updated Table 20-6 on page 141.
5. Updated "Errata" on page 204.

### 9.4 Rev. 2586D-02/06

1. Updated Table 7-4 on page 25, Table 7-5 on page 26, Table 7-10 on page 28, Table 7-13 on page 29, Table 7-12 on page 29, Table 10-1 on page 46, Table 20-3 on page 137, Table 23-15 on page 162, Table 24-2 on page 168.
2. Updated "Timer/Counter1 in PWM Mode" on page 92.
3. Updated text "Bit 2 - TOV1: Timer/Counter1 Overflow Flag" on page 91.
4. Updated values in "DC Characteristics" on page 165.
5. Updated "Register Summary" on page 6.
6. Updated "Ordering Information" on page 10.

7. Updated Rev B and C, "Errata ATtiny45" on page 17.
8. All references to power-save mode are removed.
9. Updated Register Addresses.

## 9.5 Rev. 2586C-06/05

1. Updated "Features" on page 1.
2. Updated Figure 1-1 on page 2.
3. Updated Code Examples on page 19 and page 20.
4. Moved "Temperature Measurement" to Section 20.8 page 141.
5. Updated "Register Summary" on page 6.
6. Updated "Ordering Information" on page 10.

## 9.6 Rev. 2586B-05/05

1. CLKI added, instances of EEMWE/EEWE renamed EEMPE/EEPE, removed some TBD.  
Removed "Preliminary Description" from "Temperature Measurement" on page 141.
2. Updated "Features" on page 1.
3. Updated Figure 1-1 on page 2 and Figure 9-1 on page 36.
4. Updated Table 8-1 on page 32, Table 12-4 on page 62, Table 12-5 on page 62
5. Updated "Serial Programming Instruction set" on page 155.
6. Updated SPH register in "Instruction Set Summary" on page 8.
7. Updated "DC Characteristics" on page 165.
8. Updated "Ordering Information" on page 10.
9. Updated "Errata" on page 16.

## 9.7 Rev. 2586A-02/05

1. Initial revision.



## Atmel Corporation

2325 Orchard Parkway  
San Jose, CA 95131, USA  
Tel: 1(408) 441-0311  
Fax: 1(408) 487-2600

## Regional Headquarters

### Europe

Atmel Sarl  
Route des Arsenalux 41  
Case Postale 80  
CH-1705 Fribourg  
Switzerland  
Tel: (41) 26-426-5555  
Fax: (41) 26-426-5500

### Asia

Room 1219  
Chinachem Golden Plaza  
77 Mody Road Tsimshatsui  
East Kowloon  
Hong Kong  
Tel: (852) 2721-9778  
Fax: (852) 2722-1369

### Japan

9F, Tonetsu Shinkawa Bldg.  
1-24-8 Shinkawa  
Chuo-ku, Tokyo 104-0033  
Japan  
Tel: (81) 3-3523-3551  
Fax: (81) 3-3523-7581

## Atmel Operations

### Memory

2325 Orchard Parkway  
San Jose, CA 95131, USA  
Tel: 1(408) 441-0311  
Fax: 1(408) 436-4314

### Microcontrollers

2325 Orchard Parkway  
San Jose, CA 95131, USA  
Tel: 1(408) 441-0311  
Fax: 1(408) 436-4314

La Chantrerie  
BP 70602  
44306 Nantes Cedex 3, France  
Tel: (33) 2-40-18-18-18  
Fax: (33) 2-40-18-19-60

### ASIC/ASSP/Smart Cards

Zone Industrielle  
13106 Rousset Cedex, France  
Tel: (33) 4-42-53-60-00  
Fax: (33) 4-42-53-60-01

1150 East Cheyenne Mtn. Blvd.  
Colorado Springs, CO 80906, USA  
Tel: 1(719) 576-3300  
Fax: 1(719) 540-1759

Scottish Enterprise Technology Park  
Maxwell Building  
East Kilbride G75 0QR, Scotland  
Tel: (44) 1355-803-000  
Fax: (44) 1355-242-743

### RF/Automotive

Theresienstrasse 2  
Postfach 3535  
74025 Heilbronn, Germany  
Tel: (49) 71-31-67-0  
Fax: (49) 71-31-67-2340

1150 East Cheyenne Mtn. Blvd.  
Colorado Springs, CO 80906, USA  
Tel: 1(719) 576-3300  
Fax: 1(719) 540-1759

### Biometrics/Imaging/Hi-Rel MPU/ High Speed Converters/RF Datacom

Avenue de Rochepleine  
BP 123  
38521 Saint-Egreve Cedex, France  
Tel: (33) 4-76-58-30-00  
Fax: (33) 4-76-58-34-80

---

## Literature Requests

[www.atmel.com/literature](http://www.atmel.com/literature)

**Disclaimer:** The information in this document is provided in connection with Atmel products. No license, express or implied, by estoppel or otherwise, to any intellectual property right is granted by this document or in connection with the sale of Atmel products. **EXCEPT AS SET FORTH IN ATMEL'S TERMS AND CONDITIONS OF SALE LOCATED ON ATMEL'S WEB SITE, ATMEL ASSUMES NO LIABILITY WHATSOEVER AND DISCLAIMS ANY EXPRESS, IMPLIED OR STATUTORY WARRANTY RELATING TO ITS PRODUCTS INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT. IN NO EVENT SHALL ATMEL BE LIABLE FOR ANY DIRECT, INDIRECT, CONSEQUENTIAL, PUNITIVE, SPECIAL OR INCIDENTAL DAMAGES (INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOSS OF PROFITS, BUSINESS INTERRUPTION, OR LOSS OF INFORMATION) ARISING OUT OF THE USE OR INABILITY TO USE THIS DOCUMENT, EVEN IF ATMEL HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.** Atmel makes no representations or warranties with respect to the accuracy or completeness of the contents of this document and reserves the right to make changes to specifications and product descriptions at any time without notice. Atmel does not make any commitment to update the information contained herein. Atmel's products are not intended, authorized, or warranted for use as components in applications intended to support or sustain life.

© 2006 Atmel Corporation. All rights reserved. ATMEL<sup>®</sup>, logo and combinations thereof, Everywhere You Are<sup>®</sup>, AVR<sup>®</sup>, and AVR Studio<sup>®</sup> are registered trademarks or trademarks of Atmel Corporation or its subsidiaries. Other terms and product names may be trademarks of others.