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Atmel 8-bit AVR Microcontroller with 2/4/8K Bytes In-System Programmable Flash

ATtiny25/V / ATtiny45/V / ATtiny85/V
Summary

Features

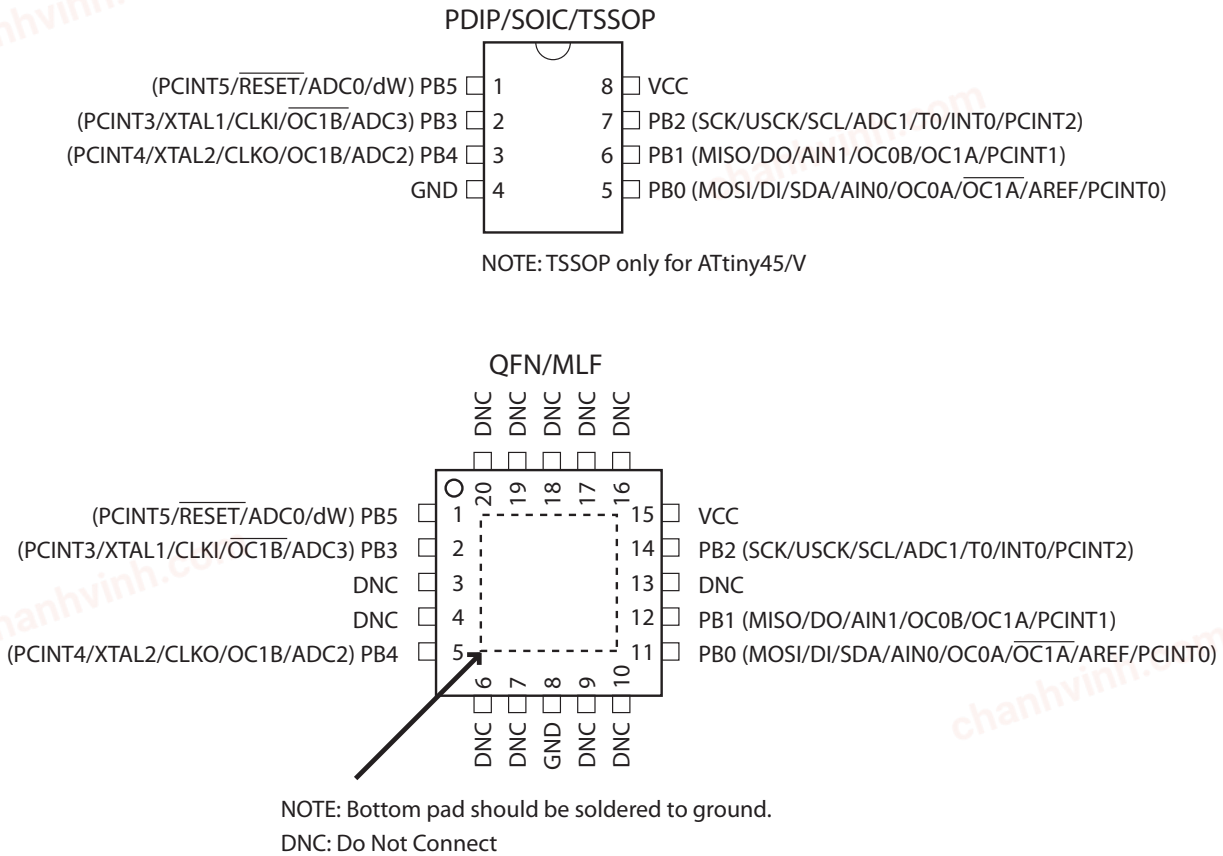
- High Performance, Low Power AVR® 8-Bit Microcontroller
- Advanced RISC Architecture
  - 120 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
- Non-volatile Program and Data Memories
  - 2/4/8K Bytes of In-System Programmable Program Memory Flash
    - Endurance: 10,000 Write/Erase Cycles
  - 128/256/512 Bytes In-System Programmable EEPROM
    - Endurance: 100,000 Write/Erase Cycles
  - 128/256/512 Bytes Internal SRAM
  - 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, 20-pad QFN/MLF, and 8-pin TSSOP (only ATtiny45/V)
- Operating Voltage
  - 1.8 - 5.5V for ATtiny25V/45V/85V
  - 2.7 - 5.5V for ATtiny25/45/85
- Speed Grade
  - ATtiny25V/45V/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: 300 µA
  - Power-down Mode:
    - 0.1 µA at 1.8V

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1. Pin Configurations

Figure 1-1. Pinout ATtiny25/45/85



1.1 Pin Descriptions

1.1.1 VCC

Supply voltage.

1.1.2 GND

Ground.

1.1.3 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.

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Port B also serves the functions of various special features of the ATtiny25/45/85 as listed in “Alternate Functions of Port B” on page 60.

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

1.1.4 $\overline{\text{RESET}}$

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 and provided the reset pin has not been disabled. The minimum pulse length is given in Table 21-4 on page 165. Shorter pulses are not guaranteed to generate a reset.

The reset pin can also be used as a (weak) I/O pin.

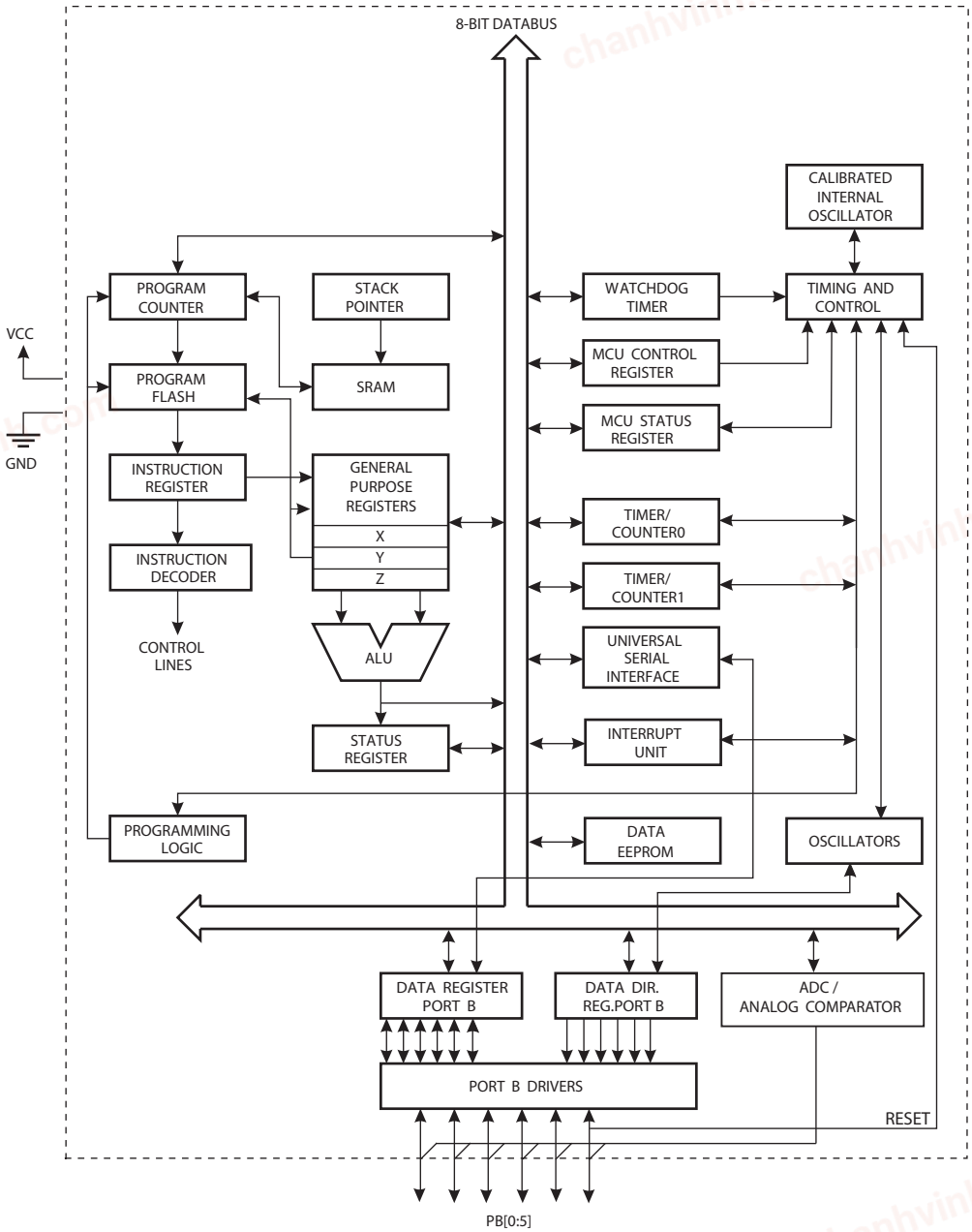
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2. Overview

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 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 bytes 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. Idle mode stops the CPU while allowing the SRAM, Timer/Counter, ADC, Analog Comparator, and Interrupt system to continue functioning. Power-down mode saves the register contents, disabling all chip functions until the next Interrupt or Hardware Reset. 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 and Evaluation kits.

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3. About

3.1 Resources

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

3.2 Code Examples

This documentation contains simple code examples that briefly show how to use various parts of the device. These code examples assume that the part specific header file is included before compilation. Be aware that not all C compiler vendors include bit definitions in the header files and interrupt handling in C is compiler dependent. Please confirm with the C compiler documentation for more details.

For I/O Registers located in the extended I/O map, “IN”, “OUT”, “SBIS”, “SBIC”, “CBI”, and “SBI” instructions must be replaced with instructions that allow access to extended I/O. Typically, this means “LDS” and “STS” combined with “SBRS”, “SBRC”, “SBR”, and “CBR”. Note that not all AVR devices include an extended I/O map.

3.3 Capacitive Touch Sensing

Atmel QTouch Library provides a simple to use solution for touch sensitive interfaces on Atmel AVR microcontrollers. The QTouch Library includes support for QTouch® and QMatrix® acquisition methods.

Touch sensing is easily added to any application by linking the QTouch Library and using the Application Programming Interface (API) of the library to define the touch channels and sensors. The application then calls the API to retrieve channel information and determine the state of the touch sensor.

The QTouch Library is free and can be downloaded from the Atmel website. For more information and details of implementation, refer to the QTouch Library User Guide – also available from the Atmel website.

3.4 Data Retention

Reliability Qualification results show that the projected data retention failure rate is much less than 1 PPM over 20 years at 85°C or 100 years at 25°C.

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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	page 8
0x3E	SPH	–	–	–	–	–	–	SP9	SP8	page 11
0x3D	SPL	SP7	SP6	SP5	SP4	SP3	SP2	SP1	SP0	page 11
0x3C	Reserved	–								
0x3B	GIMSK	–	INT0	PCIE	–	–	–	–	–	page 51
0x3A	GIFR	–	INTF0	PCIF	–	–	–	–	–	page 52
0x39	TIMSK	–	OCIE1A	OCIE1B	OCIE0A	OCIE0B	TOIE1	TOIE0	–	pages 81, 102
0x38	TIFR	–	OCF1A	OCF1B	OCF0A	OCF0B	TOV1	TOV0	–	page 81
0x37	SPMCSR	–	–	RSIG	CTPB	RFLB	PGWRT	PGERS	SPMEN	page 145
0x36	Reserved	–								
0x35	MCUCR	BODS	PUD	SE	SM1	SM0	BODSE	ISC01	ISC00	pages 37, 51, 64
0x34	MCUSR	–	–	–	–	WDRF	BORF	EXTRF	PORF	page 44,
0x33	TCCR0B	FOC0A	FOC0B	–	–	WGM02	CS02	CS01	CS00	page 79
0x32	TCNT0	Timer/Counter0								page 80
0x31	OSCCAL	Oscillator Calibration Register								page 31
0x30	TCCR1	CTC1	PWM1A	COM1A1	COM1A0	CS13	CS12	CS11	CS10	pages 89, 100
0x2F	TCNT1	Timer/Counter1								pages 91, 102
0x2E	OCR1A	Timer/Counter1 Output Compare Register A								pages 91, 102
0x2D	OCR1C	Timer/Counter1 Output Compare Register C								pages 91, 102
0x2C	GTCCR	TSM	PWM1B	COM1B1	COM1B0	FOC1B	FOC1A	PSR1	PSR0	pages 77, 90, 101
0x2B	OCR1B	Timer/Counter1 Output Compare Register B								page 92
0x2A	TCCR0A	COM0A1	COM0A0	COM0B1	COM0B0	–		WGM01	WGM00	page 77
0x29	OCR0A	Timer/Counter0 – Output Compare Register A								page 80
0x28	OCR0B	Timer/Counter0 – Output Compare Register B								page 81
0x27	PLLCSR	LSM	–	–	–	–	PCKE	PLLE	PLOCK	pages 94, 103
0x26	CLKPR	CLKPCE	–	–	–	CLKPS3	CLKPS2	CLKPS1	CLKPS0	page 32
0x25	DT1A	DT1AH3	DT1AH2	DT1AH1	DT1AH0	DT1AL3	DT1AL2	DT1AL1	DT1AL0	page 107
0x24	DT1B	DT1BH3	DT1BH2	DT1BH1	DT1BH0	DT1BL3	DT1BL2	DT1BL1	DT1BL0	page 107
0x23	DTPS1	-	-	-	-	-	-	DTPS11	DTPS10	page 106
0x22	DWDR	DWDR[7:0]								page 140
0x21	WDTCR	WDIF	WDIE	WDP3	WDCE	WDE	WDP2	WDP1	WDP0	page 45
0x20	PRR	–				PRTIM1	PRTIM0	PRUSI	PRADC	page 36
0x1F	EEARH								EEAR8	page 20
0x1E	EEARL	EEAR7	EEAR6	EEAR5	EEAR4	EEAR3	EEAR2	EEAR1	EEAR0	page 21
0x1D	EEDR	EEPROM Data Register								page 21
0x1C	EECR	–	–	EEPM1	EEPM0	EERIE	EEMPE	EEPE	EERE	page 21
0x1B	Reserved	–								
0x1A	Reserved	–								
0x19	Reserved	–								
0x18	PORTB	–	–	PORTB5	PORTB4	PORTB3	PORTB2	PORTB1	PORTB0	page 64
0x17	DDRB	–	–	DDB5	DDB4	DDB3	DDB2	DDB1	DDB0	page 64
0x16	PINB	–	–	PINB5	PINB4	PINB3	PINB2	PINB1	PINB0	page 64
0x15	PCMSK	–	–	PCINT5	PCINT4	PCINT3	PCINT2	PCINT1	PCINT0	page 52
0x14	DIDR0	–	–	ADC0D	ADC2D	ADC3D	ADC1D	AIN1D	AIN0D	pages 121, 138
0x13	GPIOR2	General Purpose I/O Register 2								page 10
0x12	GPIOR1	General Purpose I/O Register 1								page 10
0x11	GPIOR0	General Purpose I/O Register 0								page 10
0x10	USIBR	USI Buffer Register								page 115
0x0F	USIDR	USI Data Register								page 115
0x0E	USISR	USISIF	USIOIF	USIPF	USIDC	USICNT3	USICNT2	USICNT1	USICNT0	page 115
0x0D	USICR	USISIE	USIOIE	USIWM1	USIWM0	USICS1	USICS0	USICLK	USITC	page 116
0x0C	Reserved	–								
0x0B	Reserved	–								
0x0A	Reserved	–								
0x09	Reserved	–								
0x08	ACSR	ACD	ACBG	ACO	ACI	ACIE	–	ACIS1	ACIS0	page 120
0x07	ADMUX	REFS1	REFS0	ADLAR	REFS2	MUX3	MUX2	MUX1	MUX0	page 134
0x06	ADCSRA	ADEN	ADSC	ADATE	ADIF	ADIE	ADPS2	ADPS1	ADPS0	page 136
0x05	ADCH	ADC Data Register High Byte								page 137
0x04	ADCL	ADC Data Register Low Byte								page 137
0x03	ADCSRB	BIN	ACME	IPR	–	–	ADTS2	ADTS1	ADTS0	pages 120, 137
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.

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5. 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
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

Mnemonics	Operands	Description	Operation	Flags	#Clocks
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

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6. Ordering Information

6.1 ATtiny25

Speed (MHz) [1]	Supply Voltage (V)	Temperature Range	Package [2]	Ordering Code [3]
10	1.8 – 5.5	Industrial (-40°C to +85°C) [4]	8P3	ATtiny25V-10PU
			8S2	ATtiny25V-10SU ATtiny25V-10SUR ATtiny25V-10SH ATtiny25V-10SHR
			S8S1	ATtiny25V-10SSU ATtiny25V-10SSUR ATtiny25V-10SSH ATtiny25V-10SSHR
			20M1	ATtiny25V-10MU ATtiny25V-10MUR
		Industrial (-40°C to +105°C) [5]	8S2	ATtiny25V-10SN ATtiny25V-10SNR
			S8S1	ATtiny25V-10SSN ATtiny25V-10SSNR
		Industrial (-40°C to +125°C) [6]	20M1	ATtiny25V-10MF ATtiny25V-10MFR
20	2.7 – 5.5	Industrial (-40°C to +85°C) [4]	8P3	ATtiny25-20PU
			8S2	ATtiny25-20SU ATtiny25-20SUR ATtiny25-20SH ATtiny25-20SHR
			S8S1	ATtiny25-20SSU ATtiny25-20SSUR ATtiny25-20SSH ATtiny25-20SSHR
			20M1	ATtiny25-20MU ATtiny25-20MUR
		Industrial (-40°C to +105°C) [5]	8S2	ATtiny25-20SN ATtiny25-20SNR
			S8S1	ATtiny25-20SSN ATtiny25-20SSNR
		Industrial (-40°C to +125°C) [6]	20M1	ATtiny25-20MF ATtiny25-20MFR

Notes:
1. For speed vs. supply voltage, see section 21.3 “Speed” on page 163.
2. All Pb-free, halide-free, fully green, and comply with European directive for Restriction of Hazardous Substances (RoHS).
3. Code indicators: H = NiPdAu lead finish, U/N = matte tin, R = tape & reel.
4. Can also be supplied in wafer form. Contact your local Atmel sales office for ordering information and minimum quantities.
5. For characteristics, see “Appendix A – Specification at 105°C”.
6. For characteristics, see “Appendix B – Specification at 125°C”.

Package Types	
8P3	8-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
8S2	8-lead, 0.208" Wide, Plastic Gull-Wing Small Outline (EIAJ SOIC)
S8S1	8-lead, 0.150" Wide, Plastic Gull-Wing Small Outline (JEDEC SOIC)
20M1	20-pad, 4 x 4 x 0.8 mm Body, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)

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6.2 ATtiny45

Speed (MHz) [1]	Supply Voltage (V)	Temperature Range	Package [2]	Ordering Code [3]
10	1.8 – 5.5	Industrial (-40°C to +85°C) [4]	8P3	ATtiny45V-10PU
			8S2	ATtiny45V-10SU ATtiny45V-10SUR ATtiny45V-10SH ATtiny45V-10SHR
			8X	ATtiny45V-10XU ATtiny45V-10XUR
			20M1	ATtiny45V-10MU ATtiny45V-10MUR
20	2.7 – 5.5	Industrial (-40°C to +85°C) [4]	8P3	ATtiny45-20PU
			8S2	ATtiny45-20SU ATtiny45-20SUR ATtiny45-20SH ATtiny45-20SHR
			8X	ATtiny45-20XU ATtiny45-20XUR
			20M1	ATtiny45-20MU ATtiny45-20MUR

Notes:
1. For speed vs. supply voltage, see section 21.3 “Speed” on page 163.
2. All packages are Pb-free, halide-free and fully green and they comply with the European directive for Restriction of Hazardous Substances (RoHS).
3. Code indicators:
   - H: NiPdAu lead finish
   - U: matte tin
   - R: tape & reel
4. These devices can also be supplied in wafer form. Please contact your local Atmel sales office for detailed ordering information and minimum quantities.

Package Types	
8P3	8-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
8S2	8-lead, 0.208" Wide, Plastic Gull-Wing Small Outline (EIAJ SOIC)
8X	8-lead, 4.4 mm Wide, Plastic Thin Shrink Small Outline Package (TSSOP)
20M1	20-pad, 4 x 4 x 0.8 mm Body, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)

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6.3 ATtiny85

Speed (MHz) [1]	Supply Voltage (V)	Temperature Range	Package [2]	Ordering Code [3]
10	1.8 – 5.5	Industrial (-40°C to +85°C) [4]	8P3	ATtiny85V-10PU
			8S2	ATtiny85V-10SU ATtiny85V-10SUR ATtiny85V-10SH ATtiny85V-10SHR
			20M1	ATtiny85V-10MU ATtiny85V-10MUR
20	2.7 – 5.5	Industrial (-40°C to +85°C) [4]	8P3	ATtiny85-20PU
			8S2	ATtiny85-20SU ATtiny85-20SUR ATtiny85-20SH ATtiny85-20SHR
			20M1	ATtiny85-20MU ATtiny85-20MUR

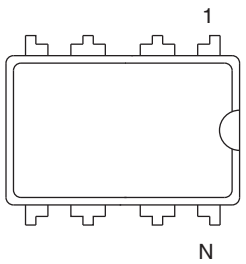
Notes:
1. For speed vs. supply voltage, see section 21.3 “Speed” on page 163.
2. All packages are Pb-free, halide-free and fully green and they comply with the European directive for Restriction of Hazardous Substances (RoHS).
3. Code indicators:
   - H: NiPdAu lead finish
   - U: matte tin
   - R: tape & reel
4. These devices can also be supplied in wafer form. Please contact your local Atmel sales office for detailed ordering information and minimum quantities.

Package Types	
8P3	8-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)
8S2	8-lead, 0.208" Wide, Plastic Gull-Wing Small Outline (EIAJ SOIC)
20M1	20-pad, 4 x 4 x 0.8 mm Body, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF)

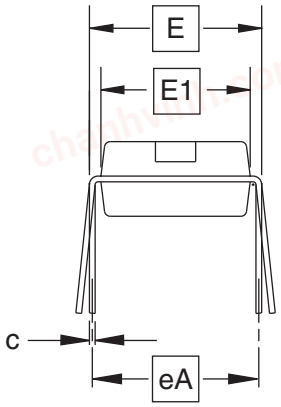
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7. Packaging Information

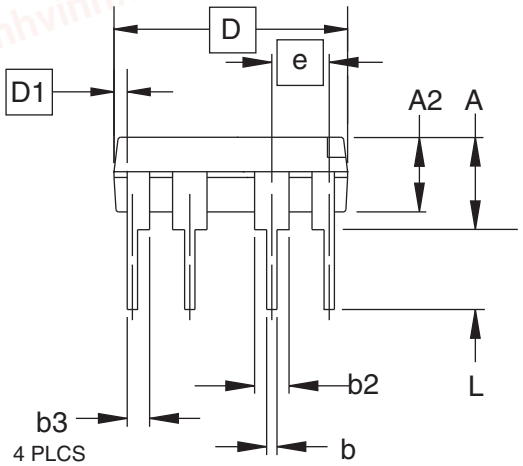
7.1 8P3



Top View



End View



Side View

COMMON DIMENSIONS
(Unit of Measure = inches)

SYMBOL	MIN	NOM	MAX	NOTE
A			0.210	2
A2	0.115	0.130	0.195	
b	0.014	0.018	0.022	5
b2	0.045	0.060	0.070	6
b3	0.030	0.039	0.045	6
c	0.008	0.010	0.014	
D	0.355	0.365	0.400	3
D1	0.005			3
E	0.300	0.310	0.325	4
E1	0.240	0.250	0.280	3
e	0.100 BSC			
eA	0.300 BSC			4
L	0.115	0.130	0.150	2

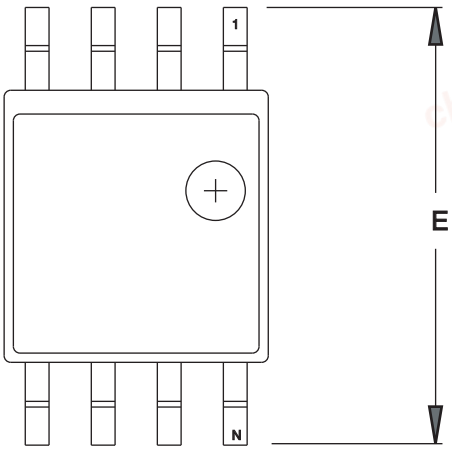
Notes:
1. This drawing is for general information only; refer to JEDEC Drawing MS-001, Variation BA for additional information.
2. Dimensions A and L are measured with the package seated in JEDEC seating plane Gauge GS-3.
3. D, D1 and E1 dimensions do not include mold Flash or protrusions. Mold Flash or protrusions shall not exceed 0.010 inch.
4. E and eA measured with the leads constrained to be perpendicular to datum.
5. Pointed or rounded lead tips are preferred to ease insertion.
6. b2 and b3 maximum dimensions do not include Dambar protrusions. Dambar protrusions shall not exceed 0.010 (0.25 mm).

01/09/02

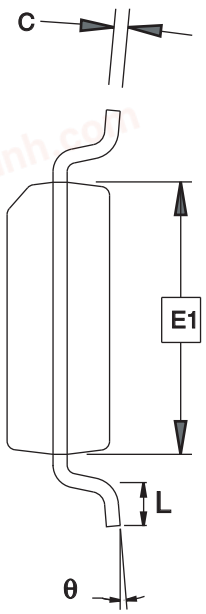
	TITLE	DRAWING NO.	REV.
2325 Orchard Parkway San Jose, CA 95131	**8P3**, 8-lead, 0.300" Wide Body, Plastic Dual In-line Package (PDIP)	8P3	B

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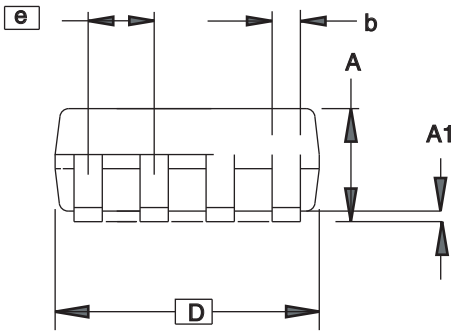
7.2 8S2



TOP VIEW



END VIEW



SIDE VIEW

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	4
C	0.15		0.35	4
D	5.13		5.35	
E1	5.18		5.40	2
E	7.70		8.26	
L	0.51		0.85	
θ	0°		8°	
e	1.27 BSC			3

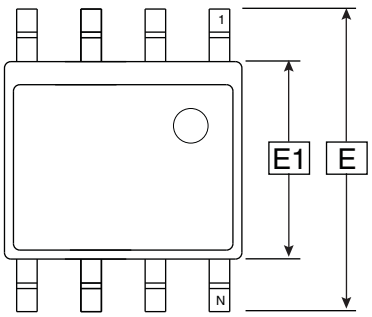
Notes: 1. This drawing is for general information only; refer to EIAJ Drawing EDR-7320 for additional information.
2. Mismatch of the upper and lower dies and resin burrs aren't included.
3. Determines the true geometric position.
4. Values b,C apply to plated terminal. The standard thickness of the plating layer shall measure between 0.007 to .021 mm.

4/15/08

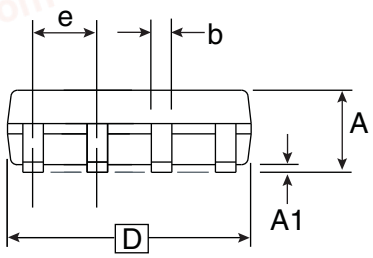
Package Drawing Contact: packagedrawings@atmel.com	TITLE	GPC	DRAWING NO.	REV.
	8S2, 8-lead, 0.208" Body, Plastic Small Outline Package (EIAJ)	STN	8S2	F

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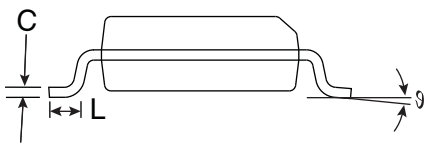
7.3 S8S1



Top View



Side View



End View

COMMON DIMENSIONS
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
E	5.79		6.20	
E1	3.81		3.99	
A	1.35		1.75	
A1	0.1		0.25	
D	4.80		4.98	
C	0.17		0.25	
b	0.31		0.51	
L	0.4		1.27	
e	1.27 BSC			
θ	0°		8°	

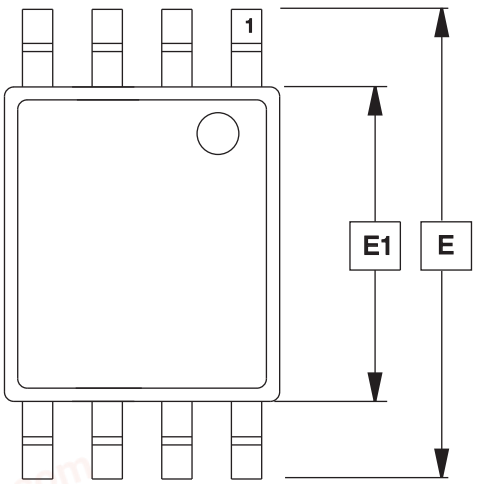
Notes: 1. This drawing is for general information only; refer to JEDEC Drawing MS-012 for proper dimensions, tolerances, datums,etc.

7/28/03

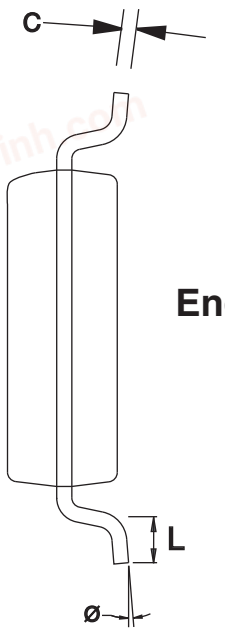
2325 Orchard Parkway San Jose, CA 95131	**TITLE** **S8S1**, 8-lead, 0.150" Wide Body, Plastic Gull Wing Small Outline (JEDEC SOIC)	**DRAWING NO.** S8S1	**REV.** A

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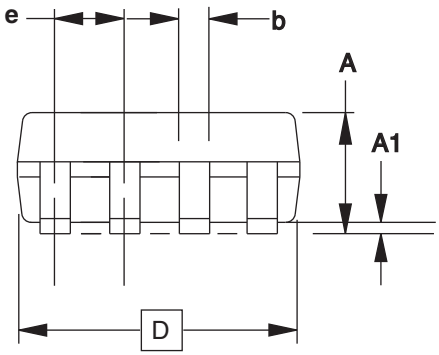
7.4 8X



Top View



End View



Side View

COMMON DIMENSIONS
(Unit of Measure = mm)

SYMBOL	MIN	NOM	MAX	NOTE
A	1.05	1.10	1.20	
A1	0.05	0.10	0.15	
b	0.25	–	0.30	
C	–	0.127	–	
D	2.90	3.05	3.10	
E1	4.30	4.40	4.50	
E	6.20	6.40	6.60	
e	0.65 TYP			
L	0.50	0.60	0.70	
ø	0°	–	8°	

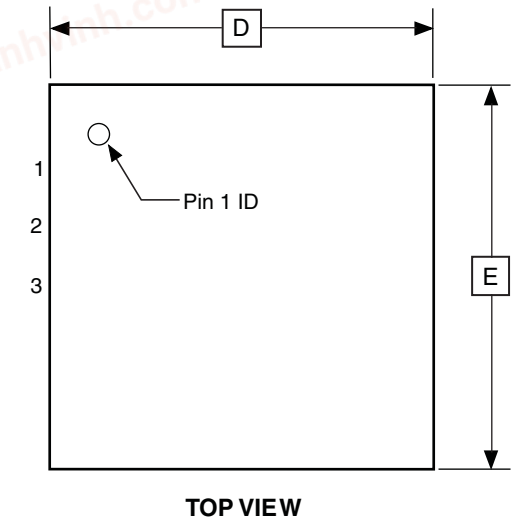
Note: These drawings are for general information only. Refer to JEDEC Drawing MO-153AC.

4/14/05

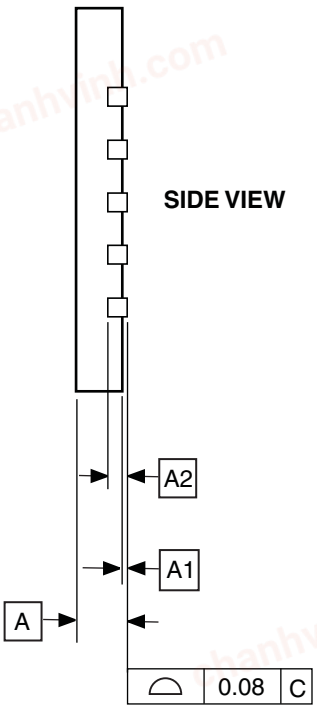
2325 Orchard Parkway San Jose, CA 95131	**TITLE** **8X**, 8-lead, 4.4 mm Body Width, Plastic Thin Shrink Small Outline Package (TSSOP)	**DRAWING NO.** 8X	**REV.** A

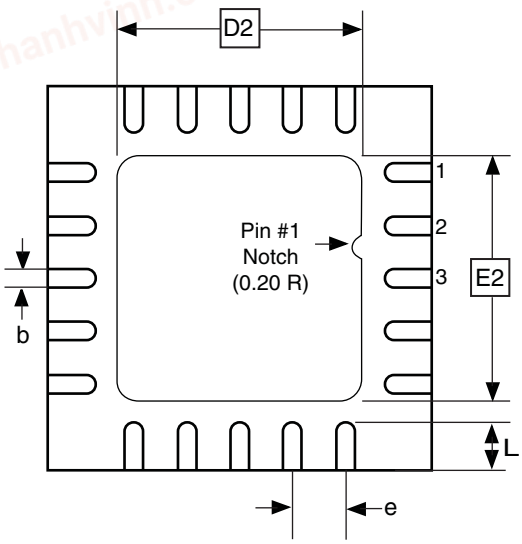
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7.5 20M1



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	B

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8. Errata

8.1 Errata ATtiny25

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

8.1.1 Rev D – F

No known errata.

8.1.2 Rev B – C

- **EEPROM read may fail at low supply voltage / low clock frequency**

1. **EEPROM read may fail at low supply voltage / low clock frequency**

   Trying to read EEPROM at low clock frequencies and/or low supply voltage may result in invalid data.

   Problem Fix/Workaround

   Do not use the EEPROM when clock frequency is below 1MHz and supply voltage is below 2V. If operating frequency can not be raised above 1MHz then supply voltage should be more than 2V. Similarly, if supply voltage can not be raised above 2V then operating frequency should be more than 1MHz.

   This feature is known to be temperature dependent but it has not been characterised. Guidelines are given for room temperature, only.

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 F – G

No known errata

8.2.2 Rev D – E

- **EEPROM read may fail at low supply voltage / low clock frequency**

1. **EEPROM read may fail at low supply voltage / low clock frequency**

   Trying to read EEPROM at low clock frequencies and/or low supply voltage may result in invalid data.

   Problem Fix/Workaround

   Do not use the EEPROM when clock frequency is below 1MHz and supply voltage is below 2V. If operating frequency can not be raised above 1MHz then supply voltage should be more than 2V. Similarly, if supply voltage can not be raised above 2V then operating frequency should be more than 1MHz.

   This feature is known to be temperature dependent but it has not been characterised. Guidelines are given for room temperature, only.

8.2.3 Rev B – C

- **PLL not locking**
- **EEPROM read from application code does not work in Lock Bit Mode 3**
- **EEPROM read may fail at low supply voltage / low clock frequency**
- **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. **EEPROM read may fail at low supply voltage / low clock frequency**

   Trying to read EEPROM at low clock frequencies and/or low supply voltage may result in invalid data.

   Problem Fix/Workaround

   Do not use the EEPROM when clock frequency is below 1MHz and supply voltage is below 2V. If operating frequency can not be raised above 1MHz then supply voltage should be more than 2V. Similarly, if supply voltage can not be raised above 2V then operating frequency should be more than 1MHz.

   This feature is known to be temperature dependent but it has not been characterised. Guidelines are given for room temperature, only.

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 COM1A[1:0] and COM1B[1:0] control bits, see table 14-4 in the data sheet. The problem has been fixed for Tiny45 rev D.

8.2.4 Rev A

- **Too high power down power consumption**
- **DebugWIRE looses communication when single stepping into interrupts**
- **PLL not locking**
- **EEPROM read from application code does not work in Lock Bit Mode 3**
- **EEPROM read may fail at low supply voltage / low clock frequency**

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 looses communication when single stepping into interrupts**
When receiving an interrupt during single stepping, debugwire will loose

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. **EEPROM read may fail at low supply voltage / low clock frequency**
Trying to read EEPROM at low clock frequencies and/or low supply voltage may result in invalid data.

Problem Fix/Workaround
Do not use the EEPROM when clock frequency is below 1MHz and supply voltage is below 2V. If operating frequency can not be raised above 1MHz then supply voltage should be more than 2V. Similarly, if supply voltage can not be raised above 2V then operating frequency should be more than 1MHz.

This feature is known to be temperature dependent but it has not been characterized. Guidelines are given for room temperature, only.

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8.3 Errata ATtiny85

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

8.3.1 Rev B – C

No known errata.

8.3.2 Rev A

- **EEPROM read may fail at low supply voltage / low clock frequency**

1. **EEPROM read may fail at low supply voltage / low clock frequency**

   Trying to read EEPROM at low clock frequencies and/or low supply voltage may result in invalid data.

   Problem Fix/Workaround

   Do not use the EEPROM when clock frequency is below 1MHz and supply voltage is below 2V. If operating frequency can not be raised above 1MHz then supply voltage should be more than 2V. Similarly, if supply voltage can not be raised above 2V then operating frequency should be more than 1MHz.

   This feature is known to be temperature dependent but it has not been characterised. Guidelines are given for room temperature, only.

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9. Datasheet Revision History

9.1 Rev. 2586Q-08/13

1. “Bit 3 – FOC1B: Force Output Compare Match 1B” description in “GTCCR – General Timer/Counter1 Control Register” on page 90 updated: PB3 in “compare match output pin PB3 (OC1B)” corrected to PB4.

9.2 Rev. 2586P-06/13

1. Updated description of “EEARH – EEPROM Address Register” and “EEARL – EEPROM Address Register” on page 20.

9.3 Rev. 2586O-02/13

Updated ordering codes on page 11, page 12, and page 13.

9.4 Rev. 2586N-04/11

1. Added:
   – Section “Capacitive Touch Sensing” on page 6.
2. Updated:
   – Document template.
   – Removed “Preliminary” on front page. All devices now final and in production.
   – Section “Limitations” on page 36.
   – Program example on page 49.
   – Section “Overview” on page 122.
   – Table 17-4 on page 135.
   – Section “Limitations of debugWIRE” on page 140.
   – Section “Serial Programming Algorithm” on page 151.
   – Table 21-7 on page 166.
   – EEPROM errata on pages 19, 19, 20, 21, and 22
   – Ordering information on pages 11, 12, and 13.

9.5 Rev. 2586M-07/10

1. Clarified Section 6.4 “Clock Output Buffer” on page 31.
2. Added Ordering Codes -SN and -SNR for ATtiny25 extended temperature.

9.6 Rev. 2586L-06/10

1. Added:
   – TSSOP for ATtiny45 in “Features” on page 1, Pinout Figure 1-1 on page 2, Ordering Information in Section 6.2 “ATtiny45” on page 12, and Packaging Information in Section 7.4 “8X” on page 17
   – Table 6-11, “Capacitance of Low-Frequency Crystal Oscillator,” on page 29
   – Figure 22-36 on page 191 and Figure 22-37 on page 191, Typical Characteristics plots for Bandgap Voltage vs. V_{CC} and Temperature
   – Extended temperature in Section 6.1 “ATtiny25” on page 11, Ordering Information

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– Tape & reel part numbers in Ordering Information, in Section 6.1 “ATtiny25” on page 11 and Section 6.2 “ATtiny45” on page 12

2. Updated:
   – “Features” on page 1, removed Preliminary from ATtiny25
   – Section 8.4.2 “Code Example” on page 44
   – “PCMSK – Pin Change Mask Register” on page 52, Bit Descriptions
   – “TCCR1 – Timer/Counter1 Control Register” on page 89 and “GTCCR – General Timer/Counter1 Control Register” on page 90, COM bit descriptions clarified
   – Section 20.3.2 “Calibration Bytes” on page 150, frequencies (8 MHz, 6.4 MHz)
   – Table 20-11, “Minimum Wait Delay Before Writing the Next Flash or EEPROM Location,” on page 153, value for t_{WD_ERASE}
   – Table 20-16, “High-voltage Serial Programming Instruction Set for ATtiny25/45/85,” on page 158
   – Table 21-1, “DC Characteristics. T_A = -40°C to +85°C,” on page 161, notes adjusted
   – Table 21-11, “Serial Programming Characteristics, T_A = -40°C to +85°C, V_{CC} = 1.8 - 5.5V (Unless Otherwise Noted),” on page 170, added t_{SLIV}
   – Bit syntax throughout the datasheet, e.g. from CS02:0 to CS0[2:0].

9.7 Rev. 2586K-01/08

1. Updated Document Template.
2. Added Sections:
   – “Data Retention” on page 6
   – “Low Level Interrupt” on page 49
   – “Device Signature Imprint Table” on page 149
3. Updated Sections:
   – “Internal PLL for Fast Peripheral Clock Generation - clkPCK” on page 24
   – “System Clock and Clock Options” on page 23
   – “Internal PLL in ATtiny15 Compatibility Mode” on page 24
   – “Sleep Modes” on page 34
   – “Software BOD Disable” on page 35
   – “External Interrupts” on page 49
   – “Timer/Counter1 in PWM Mode” on page 97
   – “USI – Universal Serial Interface” on page 108
   – “Temperature Measurement” on page 133
   – “Reading Lock, Fuse and Signature Data from Software” on page 143
   – “Program And Data Memory Lock Bits” on page 147
   – “Fuse Bytes” on page 148
   – “Signature Bytes” on page 150
   – “Calibration Bytes” on page 150
   – “System and Reset Characteristics” on page 165
4. Added Figures:
   – “Reset Pin Output Voltage vs. Sink Current (V_{CC} = 3V)” on page 184
   – “Reset Pin Output Voltage vs. Sink Current (V_{CC} = 5V)” on page 185
   – “Reset Pin Output Voltage vs. Source Current (V_{CC} = 3V)” on page 185

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– “Reset Pin Output Voltage vs. Source Current (V_{CC} = 5V)” on page 186

5. Updated Figure:
   – “Reset Logic” on page 39
6. Updated Tables:
   – “Start-up Times for Internal Calibrated RC Oscillator Clock” on page 28
   – “Start-up Times for Internal Calibrated RC Oscillator Clock (in ATtiny15 Mode)” on page 28
   – “Start-up Times for the 128 kHz Internal Oscillator” on page 28
   – “Compare Mode Select in PWM Mode” on page 86
   – “Compare Mode Select in PWM Mode” on page 98
   – “DC Characteristics. T_A = -40°C to +85°C” on page 161
   – “Calibration Accuracy of Internal RC Oscillator” on page 164
   – “ADC Characteristics” on page 167
7. Updated Code Example in Section:
   – “Write” on page 17
8. Updated Bit Descriptions in:
   – “MCUCR – MCU Control Register” on page 37
   – “Bits 7:6 – COM0A[1:0]: Compare Match Output A Mode” on page 77
   – “Bits 5:4 – COM0B[1:0]: Compare Match Output B Mode” on page 77
   – “Bits 2:0 – ADTS[2:0]: ADC Auto Trigger Source” on page 138
   – “SPMCSR – Store Program Memory Control and Status Register” on page 145.
9. Updated description of feature “EEPROM read may fail at low supply voltage / low clock frequency” in Sections:
   – “Errata ATtiny25” on page 19
   – “Errata ATtiny45” on page 19
   – “Errata ATtiny85” on page 22
10. Updated Package Description in Sections:
    – “ATtiny25” on page 11
    – “ATtiny45” on page 12
    – “ATtiny85” on page 13
11. Updated Package Drawing:
    – “S8S1” on page 16
12. Updated Order Codes for:
    – “ATtiny25” on page 11

9.8 Rev. 2586J-12/06

1. Updated “Low Power Consumption” on page 1.
2. Updated description of instruction length in “Architectural Overview” .
3. Updated Flash size in “In-System Re-programmable Flash Program Memory” on page 15.
4. Updated cross-references in sections “Atomic Byte Programming” , “Erase” and “Write” , starting on page 17.
5. Updated “Atomic Byte Programming” on page 17.

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6. Updated “Internal PLL for Fast Peripheral Clock Generation - clkPCK” on page 24.
7. Replaced single clocking system figure with two: Figure 6-2 and Figure 6-3.
8. Updated Table 6-1 on page 25, Table 6-13 on page 30 and Table 6-6 on page 27.
9. Updated “Calibrated Internal Oscillator” on page 27.
10. Updated Table 6-5 on page 26.
11. Updated “OSCCAL – Oscillator Calibration Register” on page 31.
12. Updated “CLKPR – Clock Prescale Register” on page 32.
13. Updated “Power-down Mode” on page 35.
14. Updated “Bit 0” in “PRR – Power Reduction Register” on page 38.
15. Added footnote to Table 8-3 on page 46.
16. Updated Table 10-5 on page 63.
17. Deleted “Bits 7, 2” in “MCUCR – MCU Control Register” on page 64.
18. Updated and moved section “Timer/Counter0 Prescaler and Clock Sources”, now located on page 66.
19. Updated “Timer/Counter1 Initialization for Asynchronous Mode” on page 86.
20. Updated bit description in “PLLCSR – PLL Control and Status Register” on page 94 and “PLLCSR – PLL Control and Status Register” on page 103.
21. Added recommended maximum frequency in“Prescaling and Conversion Timing” on page 125.
22. Updated Figure 17-8 on page 129 .
23. Updated “Temperature Measurement” on page 133.
24. Updated Table 17-3 on page 134.
25. Updated bit R/W descriptions in:
“TIMSK – Timer/Counter Interrupt Mask Register” on page 81,
“TIFR – Timer/Counter Interrupt Flag Register” on page 81,
“TIMSK – Timer/Counter Interrupt Mask Register” on page 92,
“TIFR – Timer/Counter Interrupt Flag Register” on page 93,
“PLLCSR – PLL Control and Status Register” on page 94,
“TIMSK – Timer/Counter Interrupt Mask Register” on page 102,
“TIFR – Timer/Counter Interrupt Flag Register” on page 103,
“PLLCSR – PLL Control and Status Register” on page 103 and
“DIDR0 – Digital Input Disable Register 0” on page 138.
26. Added limitation to “Limitations of debugWIRE” on page 140.
27. Updated “DC Characteristics” on page 161.
28. Updated Table 21-7 on page 166.
29. Updated Figure 21-6 on page 171.
30. Updated Table 21-12 on page 171.
31. Updated Table 22-1 on page 177.
32. Updated Table 22-2 on page 177.
33. Updated Table 22-30, Table 22-31 and Table 22-32, starting on page 188.
34. Updated Table 22-33, Table 22-34 and Table 22-35, starting on page 189.
35. Updated Table 22-39 on page 192.
36. Updated Table 22-46, Table 22-47, Table 22-48 and Table 22-49.

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9.9 Rev. 2586I-09/06

1. All Characterization data moved to “Electrical Characteristics” on page 161.
2. All Register Descriptions are gathered up in seperate sections in the end of each chapter.
3. Updated Table 11-3 on page 78, Table 11-5 on page 79, Table 11-6 on page 80 and Table 20-4 on page 148.
4. Updated “Calibrated Internal Oscillator” on page 27.
5. Updated Note in Table 7-1 on page 34.
6. Updated “System Control and Reset” on page 39.
7. Updated Register Description in “I/O Ports” on page 53.
8. Updated Features in “USI – Universal Serial Interface” on page 108.
9. Updated Code Example in “SPI Master Operation Example” on page 110 and “SPI Slave Operation Example” on page 111.
10. Updated “Analog Comparator Multiplexed Input” on page 119.
11. Updated Figure 17-1 on page 123.
12. Updated “Signature Bytes” on page 150.
13. Updated “Electrical Characteristics” on page 161.

9.10 Rev. 2586H-06/06

1. Updated “Calibrated Internal Oscillator” on page 27.
2. Updated Table 6.5.1 on page 31.
3. Added Table 21-2 on page 164.

9.11 Rev. 2586G-05/06

1. Updated “Internal PLL for Fast Peripheral Clock Generation - clkPCK” on page 24.
2. Updated “Default Clock Source” on page 30.
3. Updated “Low-Frequency Crystal Oscillator” on page 29.
4. Updated “Calibrated Internal Oscillator” on page 27.
5. Updated “Clock Output Buffer” on page 31.
6. Updated “Power Management and Sleep Modes” on page 34.
7. Added “Software BOD Disable” on page 35.
8. Updated Figure 16-1 on page 119.
9. Updated “Bit 6 – ACBG: Analog Comparator Bandgap Select” on page 120.
10. Added note for Table 17-2 on page 125.
11. Updated “Register Summary” on page 7.

9.12 Rev. 2586F-04/06

1. Updated “Digital Input Enable and Sleep Modes” on page 57.
2. Updated Table 20-16 on page 158.
3. Updated “Ordering Information” on page 11.

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9.13 Rev. 2586E-03/06

1. Updated Features in “Analog to Digital Converter” on page 122.
2. Updated Operation in “Analog to Digital Converter” on page 122.
3. Updated Table 17-2 on page 133.
4. Updated Table 17-3 on page 134.
5. Updated “Errata” on page 19.

9.14 Rev. 2586D-02/06

1. Updated Table 6-13 on page 30, Table 6-10 on page 29, Table 6-3 on page 26, Table 6-9 on page 28, Table 6-5 on page 26, Table 9-1 on page 48,Table 17-4 on page 135, Table 20-16 on page 158, Table 21-8 on page 167.
2. Updated “Timer/Counter1 in PWM Mode” on page 86.
3. Updated text “Bit 2 – TOV1: Timer/Counter1 Overflow Flag” on page 93.
4. Updated values in “DC Characteristics” on page 161.
5. Updated “Register Summary” on page 7.
6. Updated “Ordering Information” on page 11.
7. Updated Rev B and C in “Errata ATtiny45” on page 19.
8. All references to power-save mode are removed.
9. Updated Register Adresses.

9.15 Rev. 2586C-06/05

1. Updated “Features” on page 1.
2. Updated Figure 1-1 on page 2.
3. Updated Code Examples on page 18 and page 19.
4. Moved “Temperature Measurement” to Section 17.12 page 133.
5. Updated “Register Summary” on page 7.
6. Updated “Ordering Information” on page 11.

9.16 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 133.
2. Updated “Features” on page 1.
3. Updated Figure 1-1 on page 2 and Figure 8-1 on page 39.
4. Updated Table 7-2 on page 38, Table 10-4 on page 63, Table 10-5 on page 63
5. Updated “Serial Programming Instruction set” on page 153.
6. Updated SPH register in “Instruction Set Summary” on page 9.
7. Updated “DC Characteristics” on page 161.
8. Updated “Ordering Information” on page 11.
9. Updated “Errata” on page 19.

9.17 Rev. 2586A-02/05

Initial revision.

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