

## 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 Bytes of In-System Programmable Program Memory Flash
    - Endurance: 10,000 Write/Erase Cycles
  - 128/256/512 Bytes of In-System Programmable EEPROM
    - Endurance: 100,000 Write/Erase Cycles
  - 128/256/512 Bytes of Internal SRAM
  - Data retention: 20 years at 85°C / 100 years at 25°C
  - Programming Lock for Self-Programming Flash & EEPROM Data Security
- Peripheral Features
  - One 8-Bit and One 16-Bit Timer/Counter with Two PWM Channels, Each
  - 10-bit ADC
    - 8 Single-Ended Channels
    - 12 Differential ADC Channel Pairs with Programmable Gain (1x / 20x)
  - Programmable Watchdog Timer with Separate On-chip Oscillator
  - On-Chip Analog Comparator
  - Universal Serial Interface
- Special Microcontroller Features
  - debugWIRE On-chip Debug System
  - In-System Programmable via SPI Port
  - Internal and External Interrupt Sources: Pin Change Interrupt on 12 Pins
  - Low Power Idle, ADC Noise Reduction, Standby and Power-Down Modes
  - Enhanced Power-on Reset Circuit
  - Programmable Brown-Out Detection Circuit
  - Internal Calibrated Oscillator
  - On-Chip Temperature Sensor
- I/O and Packages
  - Available in 20-Pin QFN/MLF & 14-Pin SOIC and PDIP
  - Twelve Programmable I/O Lines
- Operating Voltage:
  - 1.8 – 5.5V for ATtiny24V/44V/84V
  - 2.7 – 5.5V for ATtiny24/44/84
- Speed Grade
  - ATtiny24V/44V/84V
    - 0 – 4 MHz @ 1.8 – 5.5V
    - 0 – 10 MHz @ 2.7 – 5.5V
  - ATtiny24/44/84
    - 0 – 10 MHz @ 2.7 – 5.5V
    - 0 – 20 MHz @ 4.5 – 5.5V
- Industrial Temperature Range: -40°C to +85°C
- Low Power Consumption
  - Active Mode (1 MHz System Clock): 300 µA @ 1.8V
  - Power-Down Mode: 0.1 µA @ 1.8V



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

ATtiny24/44/84

Preliminary

Summary

ATtiny24/44 not  
recommended for  
new designs. Use:

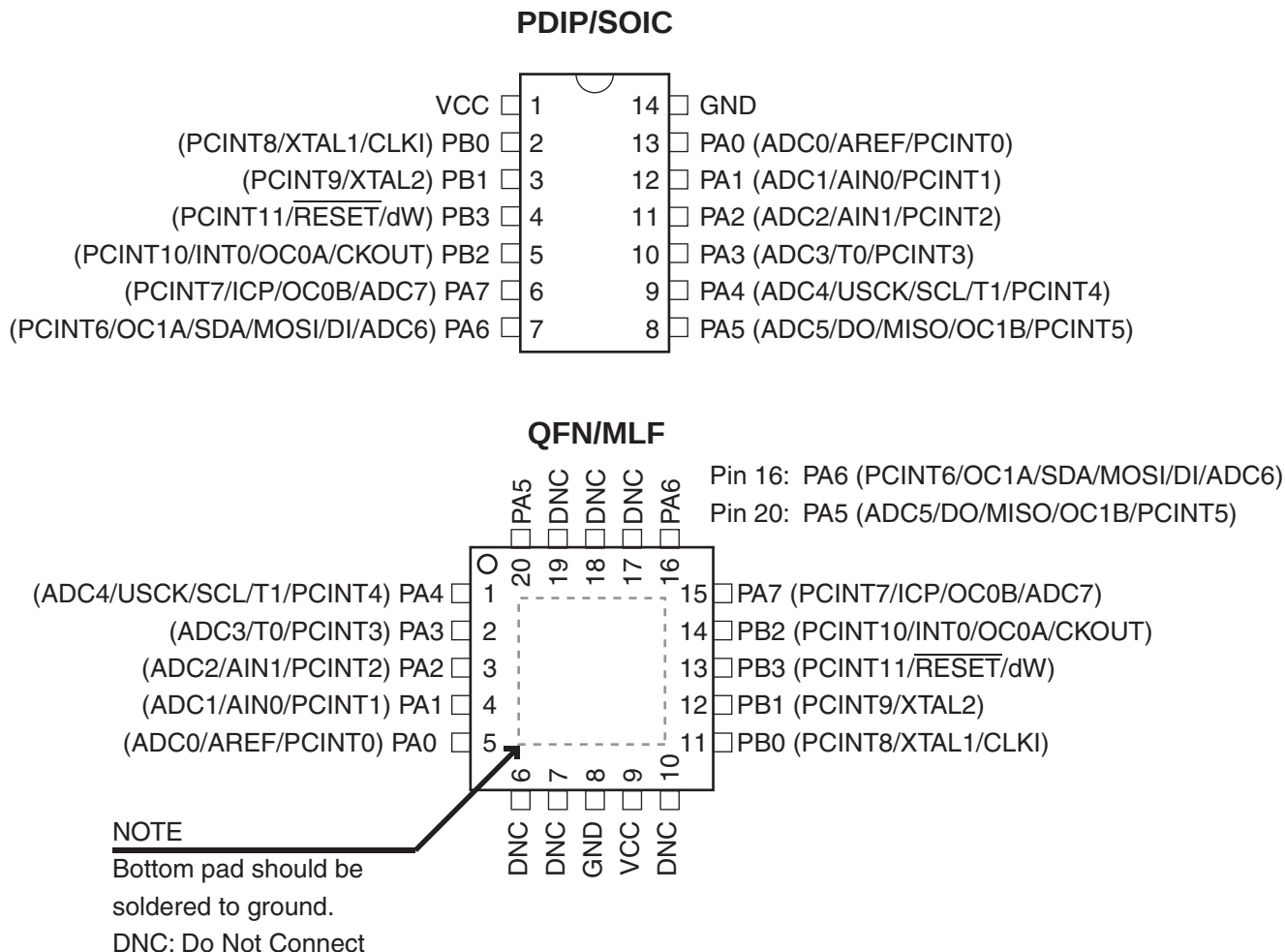
ATtiny24A  
ATtiny44A

Rev. 8006HS-AVR-10/09



## 1. Pin Configurations

Figure 1-1. Pinout ATtiny24/44/84



### 1.1 Pin Descriptions

#### 1.1.1 VCC

Supply voltage.

#### 1.1.2 GND

Ground.

#### 1.1.3 Port B (PB3...PB0)

Port B is a 4-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 except PB3 which has the  $\overline{\text{RESET}}$  capability. To use pin PB3 as an I/O pin, instead of RESET pin, program ('0') RSTDISBL fuse. 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 ATtiny24/44/84 as listed in [Section 10.2 “Alternate Port Functions” on page 58](#).

#### **1.1.4     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 20-4 on page 177](#). Shorter pulses are not guaranteed to generate a reset.

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

#### **1.1.5     Port A (PA7...PA0)**

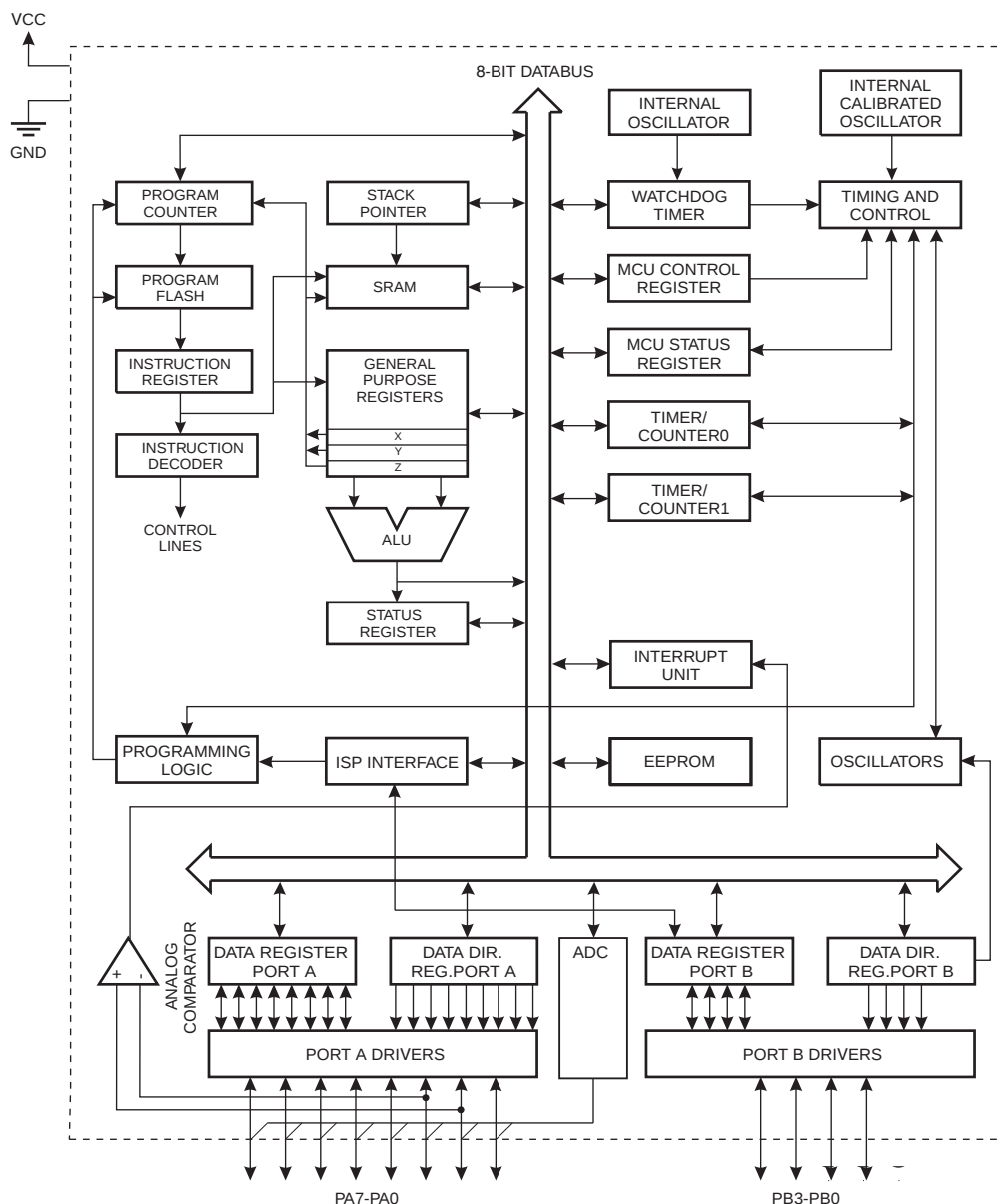
Port A is a 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port A output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port A pins that are externally pulled low will source current if the pull-up resistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Port A has alternate functions as analog inputs for the ADC, analog comparator, timer/counter, SPI and pin change interrupt as described in [“Alternate Port Functions” on page 58](#).

## 2. Overview

ATtiny24/44/84 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 ATtiny24/44/84 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

**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 ATtiny24/44/84 provides the following features: 2/4/8K byte of In-System Programmable Flash, 128/256/512 bytes EEPROM, 128/256/512 bytes SRAM, 12 general purpose I/O lines, 32 general purpose working registers, an 8-bit Timer/Counter with two PWM channels, a 16-bit timer/counter with two PWM channels, Internal and External Interrupts, a 8-channel 10-bit ADC, programmable gain stage (1x, 20x) for 12 differential ADC channel pairs, a programmable Watchdog Timer with internal oscillator, internal calibrated oscillator, and four 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. ADC Noise Reduction mode minimizes switching noise during ADC conversions by stopping the CPU and all I/O modules except the ADC. In Power-down mode registers keep their contents and all chip functions are disabled until the next interrupt or hardware reset. In Standby mode, the crystal/resonator oscillator is running while the rest of the device is sleeping, allowing 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 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 ATtiny24/44/84 AVR is supported with a full suite of program and system development tools including: C Compilers, Macro Assemblers, Program Debugger/Simulators and Evaluation kits.

## 3. About

### 3.1 Resources

A comprehensive set of drivers, application notes, data sheets and descriptions on development tools are available for download at <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 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.

### 3.4 Disclaimer

Typical values contained in this datasheet 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.

## 4. 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       | Page 8               |
| 0x3E (0x5E) | SPH      | –                                                 | –      | –      | –      | –       | –       | SP9     | SP8     | Page 11              |
| 0x3D (0x5D) | SPL      | SP7                                               | SP6    | SP5    | SP4    | SP3     | SP2     | SP1     | SP0     | Page 11              |
| 0x3C (0x5C) | OCR0B    | Timer/Counter0 – Output Compare Register B        |        |        |        |         |         |         |         | Page 85              |
| 0x3B (0x5B) | GIMSK    | –                                                 | INT0   | PCIE1  | PCIE0  | –       | –       | –       | –       | Page 51              |
| 0x3A (0x5A) | GIFR     | –                                                 | INTF0  | PCIF1  | PCIF0  | –       | –       | –       | –       | Page 52              |
| 0x39 (0x59) | TIMSK0   | –                                                 | –      | –      | –      | –       | OCIE0B  | OCIE0A  | TOIE0   | Page 85              |
| 0x38 (0x58) | TIFR0    | –                                                 | –      | –      | –      | –       | OCF0B   | OCF0A   | TOV0    | Page 85              |
| 0x37 (0x57) | SPMCSR   | –                                                 | –      | RSIG   | CTPB   | RFLB    | PGWRT   | PGERS   | SPMEN   | Page 157             |
| 0x36 (0x56) | OCR0A    | Timer/Counter0 – Output Compare Register A        |        |        |        |         |         |         |         | Page 84              |
| 0x35 (0x55) | MCUCR    | BODS                                              | PUD    | SE     | SM1    | SM0     | BODSE   | ISC01   | ISC00   | Pages 36, 51, and 67 |
| 0x34 (0x54) | MCUSR    | –                                                 | –      | –      | –      | WDRF    | BORF    | EXTRF   | PORF    | Page 45              |
| 0x33 (0x53) | TCCR0B   | FOC0A                                             | FOC0B  | –      | –      | WGM02   | CS02    | CS01    | CS00    | Page 83              |
| 0x32 (0x52) | TCNT0    | Timer/Counter0                                    |        |        |        |         |         |         |         | Page 84              |
| 0x31 (0x51) | OSCCAL   | CAL7                                              | CAL6   | CAL5   | CAL4   | CAL3    | CAL2    | CAL1    | CAL0    | Page 30              |
| 0x30 (0x50) | TCCR0A   | COM0A1                                            | COM0A0 | COM0B1 | COM0B0 | –       | –       | WGM01   | WGM00   | Page 80              |
| 0x2F (0x4F) | TCCR1A   | COM1A1                                            | COM1A0 | COM1B1 | COM1B0 | –       | –       | WGM11   | WGM10   | Page 108             |
| 0x2E (0x4E) | TCCR1B   | ICNC1                                             | ICES1  | –      | WGM13  | WGM12   | CS12    | CS11    | CS10    | Page 110             |
| 0x2D (0x4D) | TCNT1H   | Timer/Counter1 – Counter Register High Byte       |        |        |        |         |         |         |         | Page 112             |
| 0x2C (0x4C) | TCNT1L   | Timer/Counter1 – Counter Register Low Byte        |        |        |        |         |         |         |         | Page 112             |
| 0x2B (0x4B) | OCR1AH   | Timer/Counter1 – Compare Register A High Byte     |        |        |        |         |         |         |         | Page 112             |
| 0x2A (0x4A) | OCR1AL   | Timer/Counter1 – Compare Register A Low Byte      |        |        |        |         |         |         |         | Page 112             |
| 0x29 (0x49) | OCR1BH   | Timer/Counter1 – Compare Register B High Byte     |        |        |        |         |         |         |         | Page 112             |
| 0x28 (0x48) | OCR1BL   | Timer/Counter1 – Compare Register B Low Byte      |        |        |        |         |         |         |         | Page 112             |
| 0x27 (0x47) | DWDR     | DWDR[7:0]                                         |        |        |        |         |         |         |         | Page 152             |
| 0x26 (0x46) | CLKPR    | CLKPCE                                            | –      | –      | –      | CLKPS3  | CLKPS2  | CLKPS1  | CLKPS0  | Page 31              |
| 0x25 (0x45) | ICR1H    | Timer/Counter1 – Input Capture Register High Byte |        |        |        |         |         |         |         | Page 113             |
| 0x24 (0x44) | ICR1L    | Timer/Counter1 – Input Capture Register Low Byte  |        |        |        |         |         |         |         | Page 113             |
| 0x23 (0x43) | GTCCR    | TSM                                               | –      | –      | –      | –       | –       | –       | PSR10   | Page 116             |
| 0x22 (0x42) | TCCR1C   | FOC1A                                             | FOC1B  | –      | –      | –       | –       | –       | –       | Page 111             |
| 0x21 (0x41) | WDTCR    | WDIF                                              | WDIE   | WDP3   | WDCE   | WDE     | WDP2    | WDP1    | WDP0    | Page 45              |
| 0x20 (0x40) | PCMSK1   | –                                                 | –      | –      | –      | PCINT11 | PCINT10 | PCINT9  | PCINT8  | Page 52              |
| 0x1F (0x3F) | EEARH    | –                                                 | –      | –      | –      | –       | –       | –       | EEAR8   | Page 20              |
| 0x1E (0x3E) | EEARL    | EEAR7                                             | EEAR6  | EEAR5  | EEAR4  | EEAR3   | EEAR2   | EEAR1   | EEAR0   | Page 21              |
| 0x1D (0x3D) | EEDR     | EEPROM Data Register                              |        |        |        |         |         |         |         | Page 21              |
| 0x1C (0x3C) | EEDR     | –                                                 | –      | EEP01  | EEP00  | EERIE   | EEMPE   | EEPE    | EERE    | Page 21              |
| 0x1B (0x3B) | PORTA    | PORTA7                                            | PORTA6 | PORTA5 | PORTA4 | PORTA3  | PORTA2  | PORTA1  | PORTA0  | Page 67              |
| 0x1A (0x3A) | DDRA     | DDA7                                              | DDA6   | DDA5   | DDA4   | DDA3    | DDA2    | DDA1    | DDA0    | Page 67              |
| 0x19 (0x39) | PINA     | PINA7                                             | PINA6  | PINA5  | PINA4  | PINA3   | PINA2   | PINA1   | PINA0   | Page 68              |
| 0x18 (0x38) | PORTB    | –                                                 | –      | –      | –      | PORTB3  | PORTB2  | PORTB1  | PORTB0  | Page 68              |
| 0x17 (0x37) | DDRB     | –                                                 | –      | –      | –      | DDB3    | DDB2    | DDB1    | DDB0    | Page 68              |
| 0x16 (0x36) | PINB     | –                                                 | –      | –      | –      | PINB3   | PINB2   | PINB1   | PINB0   | Page 68              |
| 0x15 (0x35) | GPOR2    | General Purpose I/O Register 2                    |        |        |        |         |         |         |         | Page 23              |
| 0x14 (0x34) | GPOR1    | General Purpose I/O Register 1                    |        |        |        |         |         |         |         | Page 23              |
| 0x13 (0x33) | GPOR0    | General Purpose I/O Register 0                    |        |        |        |         |         |         |         | Page 23              |
| 0x12 (0x32) | PCMSK0   | PCINT7                                            | PCINT6 | PCINT5 | PCINT4 | PCINT3  | PCINT2  | PCINT1  | PCINT0  | Page 53              |
| 0x11 (0x31) | Reserved | –                                                 |        |        |        |         |         |         |         |                      |
| 0x10 (0x30) | USIBR    | USI Buffer Register                               |        |        |        |         |         |         |         | Page 125             |
| 0x0F (0x2F) | USIDR    | USI Data Register                                 |        |        |        |         |         |         |         | Page 124             |
| 0x0E (0x2E) | USISR    | USISIF                                            | USIOIF | USIPF  | USIDC  | USICNT3 | USICNT2 | USICNT1 | USICNT0 | Page 125             |
| 0x0D (0x2D) | USICR    | USISIE                                            | USIOIE | USIWM1 | USIWM0 | USICS1  | USICS0  | USICLK  | USITC   | Page 126             |
| 0x0C (0x2C) | TIMSK1   | –                                                 | –      | ICIE1  | –      | –       | OCIE1B  | OCIE1A  | TOIE1   | Page 113             |
| 0x0B (0x2B) | TIFR1    | –                                                 | –      | ICF1   | –      | –       | OCF1B   | OCF1A   | TOV1    | Page 114             |
| 0x0A (0x2A) | Reserved | –                                                 |        |        |        |         |         |         |         |                      |
| 0x09 (0x29) | Reserved | –                                                 |        |        |        |         |         |         |         |                      |
| 0x08 (0x28) | ACSR     | ACD                                               | ACBG   | ACO    | ACI    | ACIE    | ACIC    | ACIS1   | ACIS0   | Page 130             |
| 0x07 (0x27) | ADMUX    | REFS1                                             | REFS0  | MUX5   | MUX4   | MUX3    | MUX2    | MUX1    | MUX0    | Page 145             |
| 0x06 (0x26) | ADCSRA   | ADEN                                              | ADSC   | ADATE  | ADIF   | ADIE    | ADPS2   | ADPS1   | ADPS0   | Page 147             |
| 0x05 (0x25) | ADCH     | ADC Data Register High Byte                       |        |        |        |         |         |         |         | Page 149             |
| 0x04 (0x24) | ADCL     | ADC Data Register Low Byte                        |        |        |        |         |         |         |         | Page 149             |
| 0x03 (0x23) | ADCSRB   | BIN                                               | ACME   | –      | ADLAR  | –       | ADTS2   | ADTS1   | ADTS0   | Page 131, Page 149   |
| 0x02 (0x22) | Reserved | –                                                 |        |        |        |         |         |         |         |                      |
| 0x01 (0x21) | DIDR0    | ADC7D                                             | ADC6D  | ADC5D  | ADC4D  | ADC3D   | ADC2D   | ADC1D   | ADC0D   | Page 131, Page 150   |
| 0x00 (0x20) | PRR      | –                                                 | –      | –      | –      | PRTIM1  | PRTIM0  | PRUSI   | PRADC   | Page 37              |

- 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 AVR's, 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                                     | RdI,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                                     | RdI,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 ATtiny24

| Speed (MHz) | Power Supply | Ordering Code <sup>(1)</sup>                        | Package <sup>(2)</sup> | Operational Range             |
|-------------|--------------|-----------------------------------------------------|------------------------|-------------------------------|
| 10          | 1.8 - 5.5V   | ATtiny24V-10SSU<br>ATtiny24V-10PU<br>ATtiny24V-10MU | 14S1<br>14P3<br>20M1   | Industrial<br>(-40°C to 85°C) |
| 20          | 2.7 - 5.5V   | ATtiny24-20SSU<br>ATtiny24-20PU<br>ATtiny24-20MU    | 14S1<br>14P3<br>20M1   | Industrial<br>(-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.

| Package Type |                                                                                   |
|--------------|-----------------------------------------------------------------------------------|
| <b>14S1</b>  | 14-lead, 0.150" Wide Body, Plastic Gull Wing Small Outline Package (SOIC)         |
| <b>14P3</b>  | 14-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)                          |
| <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 ATtiny44

| Speed (MHz) | Power Supply | Ordering Code <sup>(1)</sup>                        | Package <sup>(2)</sup> | Operational Range             |
|-------------|--------------|-----------------------------------------------------|------------------------|-------------------------------|
| 10          | 1.8 - 5.5V   | ATtiny44V-10SSU<br>ATtiny44V-10PU<br>ATtiny44V-10MU | 14S1<br>14P3<br>20M1   | Industrial<br>(-40°C to 85°C) |
| 20          | 2.7 - 5.5V   | ATtiny44-20SSU<br>ATtiny44-20PU<br>ATtiny44-20MU    | 14S1<br>14P3<br>20M1   | Industrial<br>(-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.

| Package Type |                                                                                   |
|--------------|-----------------------------------------------------------------------------------|
| <b>14S1</b>  | 14-lead, 0.150" Wide Body, Plastic Gull Wing Small Outline Package (SOIC)         |
| <b>14P3</b>  | 14-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)                          |
| <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 ATtiny84

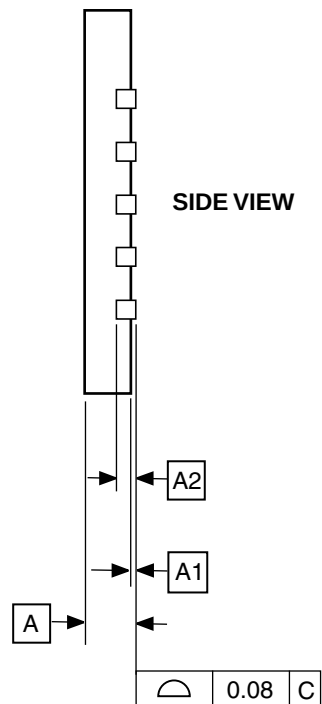
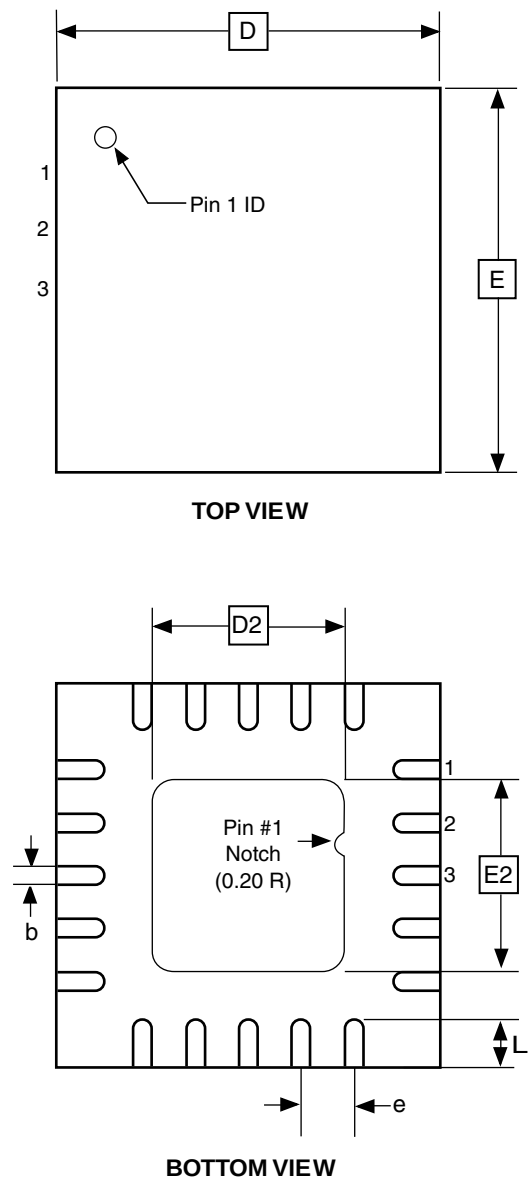
| Speed (MHz) | Power Supply | Ordering Code <sup>(1)</sup>                        | Package <sup>(2)</sup> | Operational Range             |
|-------------|--------------|-----------------------------------------------------|------------------------|-------------------------------|
| 10          | 1.8 - 5.5V   | ATtiny84V-10SSU<br>ATtiny84V-10PU<br>ATtiny84V-10MU | 14S1<br>14P3<br>20M1   | Industrial<br>(-40°C to 85°C) |
| 20          | 2.7 - 5.5V   | ATtiny84-20SSU<br>ATtiny84-20PU<br>ATtiny84-20MU    | 14S1<br>14P3<br>20M1   | Industrial<br>(-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.

| Package Type |                                                                                   |
|--------------|-----------------------------------------------------------------------------------|
| <b>14S1</b>  | 14-lead, 0.150" Wide Body, Plastic Gull Wing Small Outline Package (SOIC)         |
| <b>14P3</b>  | 14-lead, 0.300" Wide, Plastic Dual Inline Package (PDIP)                          |
| <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 20M1



**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



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**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)

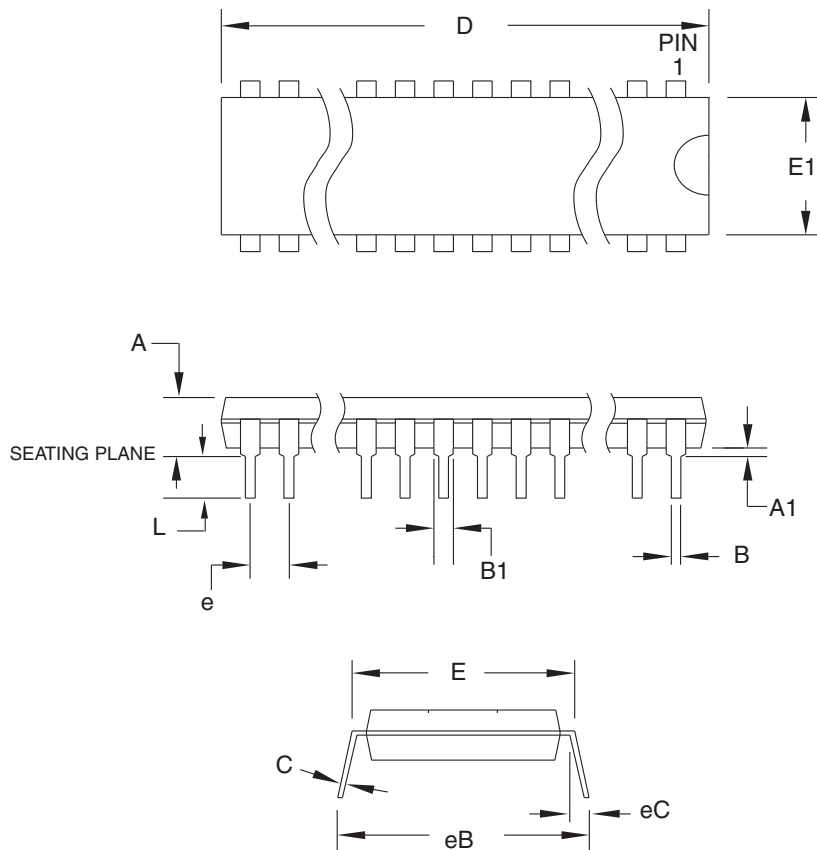
**DRAWING NO.**

20M1

**REV.**

A

## 7.2 14P3



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

| SYMBOL | MIN       | NOM | MAX    | NOTE   |
|--------|-----------|-----|--------|--------|
| A      | —         | —   | 5.334  |        |
| A1     | 0.381     | —   | —      |        |
| D      | 18.669    | —   | 19.685 | Note 2 |
| E      | 7.620     | —   | 8.255  |        |
| E1     | 6.096     | —   | 7.112  | Note 2 |
| B      | 0.356     | —   | 0.559  |        |
| B1     | 1.143     | —   | 1.778  |        |
| 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 AA.  
2. Dimensions D and E1 do not include mold Flash or Protrusion.  
Mold Flash or Protrusion shall not exceed 0.25 mm (0.010").

11/02/05



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### TITLE

**14P3**, 14-lead (0.300"/7.62 mm Wide) Plastic Dual  
Inline Package (PDIP)

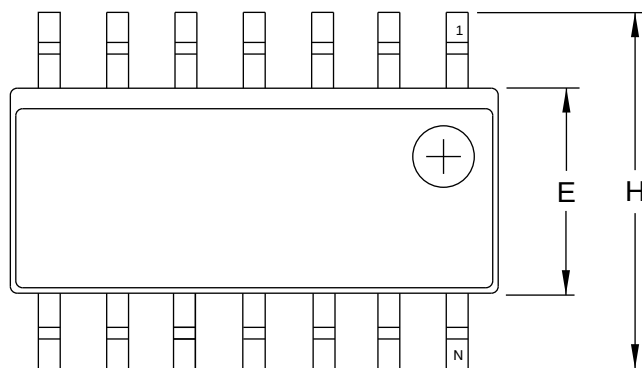
### DRAWING NO.

14P3

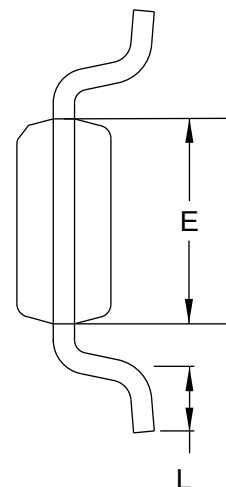
### REV.

A

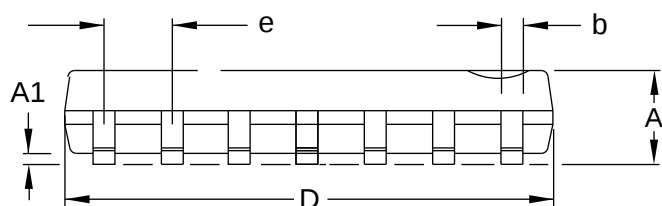
## 7.3 14S1



Top View



End View



Side View

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

| SYMBOL | MIN            | NOM | MAX         | NOTE |
|--------|----------------|-----|-------------|------|
| A      | 1.35/0.0532    | —   | 1.75/0.0688 |      |
| A1     | 0.1/0.0040     | —   | 0.25/0.0098 |      |
| b      | 0.33/0.0130    | —   | 0.5/0.02005 |      |
| D      | 8.55/0.3367    | —   | 8.74/0.3444 | 2    |
| E      | 3.8/0.1497     | —   | 3.99/0.1574 | 3    |
| H      | 5.8/0.2284     | —   | 6.19/0.2440 |      |
| L      | 0.41/0.0160    | —   | 1.27/0.0500 | 4    |
| e      | 1.27/0.050 BSC |     |             |      |

- Notes:
1. This drawing is for general information only; refer to JEDEC Drawing MS-012, Variation AB for additional information.
  2. Dimension D does not include mold Flash, protrusions or gate burrs. Mold Flash, protrusion 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.

2/5/02



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**TITLE**

**14S1**, 14-lead, 0.150" Wide Body, Plastic Gull  
Wing Small Outline Package (SOIC)

**DRAWING NO.**

14S1

**REV.**

A

## 8. Errata

The revision letters in this section refer to the revision of the corresponding ATtiny24/44/84 device.

### 8.1 ATtiny24

#### 8.1.1 Rev. D – E

No known errata.

#### 8.1.2 Rev. C

- **Reading EEPROM when system clock frequency is below 900 kHz may not work**

##### 1. **Reading EEPROM when system clock frequency is below 900 kHz may not work**

Reading data from the EEPROM at system clock frequency below 900 kHz may result in wrong data read.

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

Avoid using the EEPROM at clock frequency below 900 kHz.

#### 8.1.3 Rev. B

- **EEPROM read from application code does not work in Lock Bit Mode 3**
- **Reading EEPROM when system clock frequency is below 900 kHz may not work**

##### 1. **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.

##### 2. **Reading EEPROM when system clock frequency is below 900 kHz may not work**

Reading data from the EEPROM at system clock frequency below 900 kHz may result in wrong data read.

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

Avoid using the EEPROM at clock frequency below 900 kHz.

#### 8.1.4 Rev. A

Not sampled.

## 8.2 ATtiny44

### 8.2.1 Rev. B – D

No known errata.

### 8.2.2 Rev. A

- Reading EEPROM when system clock frequency is below 900 kHz may not work

#### 1. Reading EEPROM when system clock frequency is below 900 kHz may not work

Reading data from the EEPROM at system clock frequency below 900 kHz may result in wrong data read.

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

Avoid using the EEPROM at clock frequency below 900 kHz.

### **8.3 ATtiny84**

#### **8.3.1 Rev. A – B**

No known errata.

## 9. Datasheet Revision History

### 9.1 Rev H. 09/09

1. Updated document template. Re-arranged some sections.
2. Updated Tables:
  - “Active Clock Domains and Wake-up Sources in Different Sleep Modes” on page 33
  - “DC Characteristics” on page 174
  - “Register Summary” on page 7
3. Updated Register Description:
  - “ADMUX – ADC Multiplexer Selection Register” on page 145
4. Signature Imprint Reading Instructions updated in “Reading Device Signature Imprint Table from Firmware” on page 156.
5. Updated Section:
  - Step 1. on page 164
6. Added Table:
  - “Analog Comparator Characteristics” on page 179
7. Updated Figure:
  - “Active Supply Current vs. frequency (1 - 20 MHz)” on page 187
8. Updated Figure 21-30 on page 201 and Figure 21-33 on page 202 under “Pin Threshold and Hysteresis”.
9. Changed ATtiny24/44 device status to “Not Recommended for New Designs. Use: ATtiny24A/44A”.

### 9.2 Rev G. 01/08

1. Updated sections:
  - “Features” on page 1
  - “RESET” on page 3
  - “Overview” on page 4
  - “About” on page 6
  - “SPH and SPL — Stack Pointer Register” on page 11
  - “Atomic Byte Programming” on page 17
  - “Write” on page 17
  - “Clock Sources” on page 25
  - “Default Clock Source” on page 29
  - “Sleep Modes” on page 33
  - “Software BOD Disable” on page 34
  - “External Interrupts” on page 49
  - “USIBR – USI Data Buffer” on page 125
  - “USIDR – USI Data Register” on page 124
  - “DIDR0 – Digital Input Disable Register 0” on page 131
  - “Features” on page 132
  - “Prescaling and Conversion Timing” on page 135

- “Temperature Measurement” on page 144
  - “ADMUX – ADC Multiplexer Selection Register” on page 145
  - “Limitations of debugWIRE” on page 152
  - “Reading Lock, Fuse and Signature Data from Software” on page 155
  - “Device Signature Imprint Table” on page 161
  - “Enter High-voltage Serial Programming Mode” on page 168
  - “Absolute Maximum Ratings\*” on page 174
  - “DC Characteristics” on page 174
  - “Speed Grades” on page 175
  - “Clock Characteristics” on page 176
  - “Accuracy of Calibrated Internal RC Oscillator” on page 176
  - “System and Reset Characteristics” on page 177
  - “Supply Current of I/O Modules” on page 185
  - “ATtiny24” on page 17
  - “ATtiny44” on page 18
  - “ATtiny84” on page 19
2. Updated bit definitions in sections:
- “MCUCR – MCU Control Register” on page 36
  - “MCUCR – MCU Control Register” on page 51
  - “MCUCR – MCU Control Register” on page 67
  - “PINA – Port A Input Pins” on page 68
  - “SPMCSR – Store Program Memory Control and Status Register” on page 157
  - “Register Summary” on page 7
3. Updated Figures:
- “Reset Logic” on page 39
  - “Watchdog Reset During Operation” on page 42
  - “Compare Match Output Unit, Schematic (non-PWM Mode)” on page 95
  - “Analog to Digital Converter Block Schematic” on page 133
  - “ADC Timing Diagram, Free Running Conversion” on page 137
  - “Analog Input Circuitry” on page 140
  - “High-voltage Serial Programming” on page 167
  - “Serial Programming Timing” on page 183
  - “High-voltage Serial Programming Timing” on page 184
  - “Active Supply Current vs. Low Frequency (0.1 - 1.0 MHz)” on page 186
  - “Active Supply Current vs. frequency (1 - 20 MHz)” on page 187
  - “Active Supply Current vs.  $V_{CC}$  (Internal RC Oscillator, 8 MHz)” on page 187
  - “Active Supply Current vs.  $V_{CC}$  (Internal RC Oscillator, 1 MHz)” on page 188
  - “Active Supply Current vs.  $V_{CC}$  (Internal RC Oscillator, 128 kHz)” on page 188
  - “Idle Supply Current vs. Low Frequency (0.1 - 1.0 MHz)” on page 189
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  - “Watchdog Oscillator Frequency vs.  $V_{CC}$ ” on page 205
  - “Watchdog Oscillator Frequency vs. Temperature” on page 205
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  - “ADC Current vs.  $V_{CC}$ ” on page 207
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  - “Programming Current vs.  $V_{CC}$  (ATtiny84)” on page 210
4. Added Figures:
- “Reset Pin Output Voltage vs. Sink Current ( $V_{CC} = 3V$ )” on page 198
  - “Reset Pin Output Voltage vs. Sink Current ( $V_{CC} = 5V$ )” on page 198
  - “Reset Pin Output Voltage vs. Source Current ( $V_{CC} = 3V$ )” on page 199
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5. Updated Tables:
- “Device Clocking Options Select” on page 25
  - “Start-up Times for the Crystal Oscillator Clock Selection” on page 29
  - “Start-up Times for the Internal Calibrated RC Oscillator Clock Selection” on page 27
  - “Start-up Times for the External Clock Selection” on page 26
  - “Start-up Times for the 128 kHz Internal Oscillator” on page 27
  - “Active Clock Domains and Wake-up Sources in Different Sleep Modes” on page 33
  - “Watchdog Timer Prescale Select” on page 47
  - “Reset and Interrupt Vectors” on page 48
  - “Overriding Signals for Alternate Functions in PA7..PA5” on page 63
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  - “Overriding Signals for Alternate Functions in PA1..PA0” on page 64
  - “Port B Pins Alternate Functions” on page 65
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  - “Waveform Generation Modes” on page 110
  - “ADC Conversion Time” on page 138
  - “Temperature vs. Sensor Output Voltage (Typical Case)” on page 144
  - “DC Characteristics.  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ ” on page 174
  - “Calibration Accuracy of Internal RC Oscillator” on page 176
  - “Reset, Brown-out, and Internal Voltage Characteristics” on page 177
  - “VBOT vs. BODLEVEL Fuse Coding” on page 179

- “ADC Characteristics, Single Ended Channels.  $T = -40^{\circ}\text{C} - 85^{\circ}\text{C}$ ” on page 180
- “ADC Characteristics, Differential Channels (Bipolar Mode),  $T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ ” on page 182
- “Serial Programming Characteristics,  $T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ ,  $V_{CC} = 1.8 - 5.5\text{V}$  (Unless Otherwise Noted)” on page 183
- “High-voltage Serial Programming Characteristics  $T_A = 25^{\circ}\text{C}$ ,  $V_{CC} = 5\text{V}$  (Unless otherwise noted)” on page 184
- 6. Updated code examples in sections:
  - “Write” on page 17
  - “SPI Master Operation Example” on page 119
- 7. Updated “Ordering Information” in:
  - “ATtiny84” on page 13

## 9.3 Rev F. 02/07

1. Updated Figure 1-1 on page 2, Figure 8-7 on page 43, Figure 20-6 on page 184.
2. Updated Table 9-1 on page 48, Table 10-7 on page 65, Table 11-2 on page 80, Table 11-3 on page 81, Table 11-5 on page 81, Table 11-6 on page 82, Table 11-7 on page 82, Table 11-8 on page 83, Table 20-11 on page 182, Table 20-13 on page 184.
3. Updated table references in “TCCR0A – Timer/Counter Control Register A” on page 80.
4. Updated Port B, Bit 0 functions in “Alternate Functions of Port B” on page 65.
5. Updated WDTCR bit name to WDTCSR in assembly code examples.
6. Updated bit5 name in “TIFR1 – Timer/Counter Interrupt Flag Register 1” on page 114.
7. Updated bit5 in “TIFR1 – Timer/Counter Interrupt Flag Register 1” on page 114.
8. Updated “SPI Master Operation Example” on page 119.
9. Updated step 5 in “Enter High-voltage Serial Programming Mode” on page 168.

## 9.4 Rev E. 09/06

1. All characterization data moved to “Electrical Characteristics” on page 174.
2. All Register Descriptions gathered up in separate sections at the end of each chapter.
3. Updated “System Control and Reset” on page 39.
4. Updated Table 11-3 on page 81, Table 11-6 on page 82, Table 11-8 on page 83, Table 12-3 on page 109 and Table 12-5 on page 110.
5. Updated “Fast PWM Mode” on page 97.
6. Updated Figure 12-7 on page 98 and Figure 16-1 on page 133.
7. Updated “Analog Comparator Multiplexed Input” on page 129.
8. Added note in Table 19-12 on page 165.
9. Updated “Electrical Characteristics” on page 174.
10. Updated “Typical Characteristics” on page 185.

## 9.5 Rev D. 08/06

1. Updated “Calibrated Internal 8 MHz Oscillator” on page 26.
2. Updated “OSCCAL – Oscillator Calibration Register” on page 30.
3. Added Table 20-2 on page 176.
4. Updated code examples in “SPI Master Operation Example” on page 119.
5. Updated code examples in “SPI Slave Operation Example” on page 121.
6. Updated “Signature Bytes” on page 162.

## 9.6 Rev C. 07/06

1. Updated Features in “USI – Universal Serial Interface” on page 117.
2. Added “Clock speed considerations” on page 123.
3. Updated Bit description in “ADMUX – ADC Multiplexer Selection Register” on page 145.
4. Added note to Table 18-1 on page 157.

## 9.7 Rev B. 05/06

1. Updated “Default Clock Source” on page 29
2. Updated “Power Reduction Register” on page 35.
3. Updated Table 20-4 on page 177, Table 9-4 on page 42, Table 16-3 on page 145, Table 19-5 on page 161, Table 19-12 on page 165, Table 19-16 on page 171, Table 20-11 on page 182.
4. Updated Features in “Analog to Digital Converter” on page 132.
5. Updated Operation in “Analog to Digital Converter” on page 132.
6. Updated “Temperature Measurement” on page 144.
7. Updated DC Characteristics in “Electrical Characteristics” on page 174.
8. Updated “Typical Characteristics” on page 185.
9. Updated “Errata” on page 17.

## 9.8 Rev A. 12/05

Initial revision.





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