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Introduction

Microcontrollers are the heart of countless modern devices, from tiny wearables to complex industrial controllers. Among the family of AVR microcontrollers produced by Atmel (now part of Microchip Technology), the ATtiny series stands out for its compact size, low power consumption, and versatile feature set. Whether you are a hobbyist building a simple LED project or an engineer designing a battery powered sensor, the ATtiny25, ATtiny45, and ATtiny85 offer a range of options to meet your needs. In this guide, we will walk you through the key aspects of these popular chips, dive deep into their datasheets, compare their capabilities, and provide practical tips for programming and troubleshooting.

What Are ATtiny Microcontrollers?

ATtiny25, ATtiny45, ATtiny85 Overview

The ATtiny family is a subset of the AVR microcontroller line that focuses on minimal footprint and energy efficiency. The ATtiny25, ATtiny45, and ATtiny85 share a common 8 bit RISC architecture, but they differ in flash memory size, I/O pin count, and peripheral availability. All three are available in a 28 pin PDIP package, making them easy to prototype on standard breadboards.

Key Features and Applications

Typical features across these chips include:

- 8 bit AVR core running up to 20 /MHz
- Up to 512 /bytes of Flash (ATtiny85) or 1 /kB (ATtiny25/45)
- 128 /bytes of SRAM
- Hardware serial interfaces (USART, SPI, I²C)
- Hardware timers, ADC, and PWM channels
- Low power sleep modes for battery operated devices

Because of these capabilities, ATtiny microcontrollers are ideal for:

- Simple sensor nodes and data loggers
- LED drivers and lighting control
- Wireless modules (e.g., NRF24L01) and RF transceivers
- Battery powered wearables and IoT devices
- Prototyping and educational projects

Choosing the Right ATtiny for Your Project

When selecting between ATtiny25, ATtiny45, and ATtiny85, consider:

- Memory Requirements – The ATtiny85 offers the most flash, useful for larger firmware.
- I/O Availability – ATtiny85 provides more pins and peripherals, allowing more complex interfacing.
- Power Budget – All three are low power, but the ATtiny45 and ATtiny85 have additional sleep modes that can be advantageous.
- Package Availability – All come in 28 pin PDIP, but ATtiny85 also has a 32 pin TQFP variant for more compact

designs.

Understanding the ATtiny Datasheet

Where to Find the ATmel ATtiny Datasheet

Atmel's official datasheets are freely available on the Microchip website. Search for "ATtiny25 datasheet", "ATtiny45 datasheet", or "ATtiny85 datasheet" to download the PDF. The datasheet is the definitive reference for pinouts, electrical characteristics, and programming information.

Essential Sections of the Datasheet

A typical ATtiny datasheet contains the following core sections:

- Device Overview – Summary of architecture, memory, and key features.
- Pin Description – Detailed function of each pin, including alternate functions.
- Electrical Characteristics – Voltage, current, and temperature limits.
- Memory Organization – Flash, EEPROM, and SRAM layout.
- Operating Conditions – Recommended supply voltage, temperature ranges, and power down modes.
- Programming and Bootloader Information – How to flash code via ISP.
- Peripheral Descriptions – Timers, ADC, USART, SPI, I²C, and more.

Reading the Pinout and Functionality

Each pin is listed with its primary and alternate functions. For example, pin **PB5** on the ATtiny85 is both **Reset** and a general purpose I/O. The datasheet provides a table that shows which peripheral can be assigned to each pin, making it easy to plan your PCB layout.

Decoding Electrical Characteristics

Key electrical parameters include:

- Operating Voltage – 2.7 /V to 5.5 /V for most ATtiny chips.
- Maximum Current – Typically 40 /mA per pin.
- Leakage Current – Low leakage is critical for battery powered designs.

Understanding these limits helps avoid over driving pins and ensures reliable operation across temperature extremes.

ATtiny25 Datasheet Deep Dive

Device Overview

The ATtiny25 is a 1 kB Flash microcontroller with 128 bytes of SRAM and 512 bytes of EEPROM. It runs at up to 20 /MHz and offers a single hardware serial interface (USART) and SPI.

Pin Configuration

Key pins include:

- PB0–PB2 – General purpose I/O with optional analog inputs.
- PB3 – UART TX.
- PB4 – UART RX.
- PB5 – Reset / I/O.

These pins allow simple communication with sensors and actuators.

Memory and Programming

Programming is done via In System Programming (ISP) using a 6 pin header. The ATtiny25 supports **AVRISP mkII** and **AVRISP mkIII** programmers. Flash memory is organized into 32 byte pages, enabling efficient firmware updates.

Power Management

Low power modes include:

- Idle – CPU clock stops while peripherals remain active.
- Power down – All clocks stop; only the watchdog can wake the device.
- Standby – Similar to power down but allows the oscillator to stay active.

These modes make the ATtiny25 ideal for battery operated sensors.

Typical Applications

Common use cases for ATtiny25 include:

- Simple LED drivers
- Temperature monitoring with a DS18B20 sensor
- Battery powered alarm systems

ATtiny45 Datasheet Deep Dive

Device Overview

The ATtiny45 expands on the ATtiny25 by adding 512 bytes of EEPROM and additional peripheral support, including an I²C interface.

Pin Configuration

Key pins include:

- PB0–PB5 – I/O with analog inputs on PB0–PB4.
- PB3 – UART TX.
- PB4 – UART RX.
- PB5 – Reset / I/O.

The presence of I²C on PB0 and PB1 expands communication options.

Memory and Programming

Like the ATtiny25, programming uses the ISP interface. However, the ATtiny45's larger EEPROM allows storing calibration data or user settings without overwriting the main program.

Power Management

Additional low power modes include:

- Extended Standby – Keeps the oscillator active while the CPU and peripherals are off.
- ADC Noise Reduction – Useful for analog measurements.

Typical Applications

ATtiny45 is frequently used in:

- Wireless sensor nodes with I²C sensors
- Battery powered data loggers

- Simple home automation controllers

ATtiny85 Datasheet Deep Dive

Device Overview

The ATtiny85 is the most capable of the three, offering 512 bytes of Flash, 128 bytes of SRAM, and 512 bytes of EEPROM. It supports multiple serial interfaces, including USART, SPI, and I²C.

Pin Configuration

Key pins include:

- PB0–PB5 – I/O, analog inputs on PB0–PB3.
- PB0 – I²C SDA.
- PB1 – I²C SCL.
- PB4 – USART RX.
- PB5 – Reset / I/O.

With 6 general purpose pins, the ATtiny85 offers flexibility for complex projects.

Memory and Programming

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