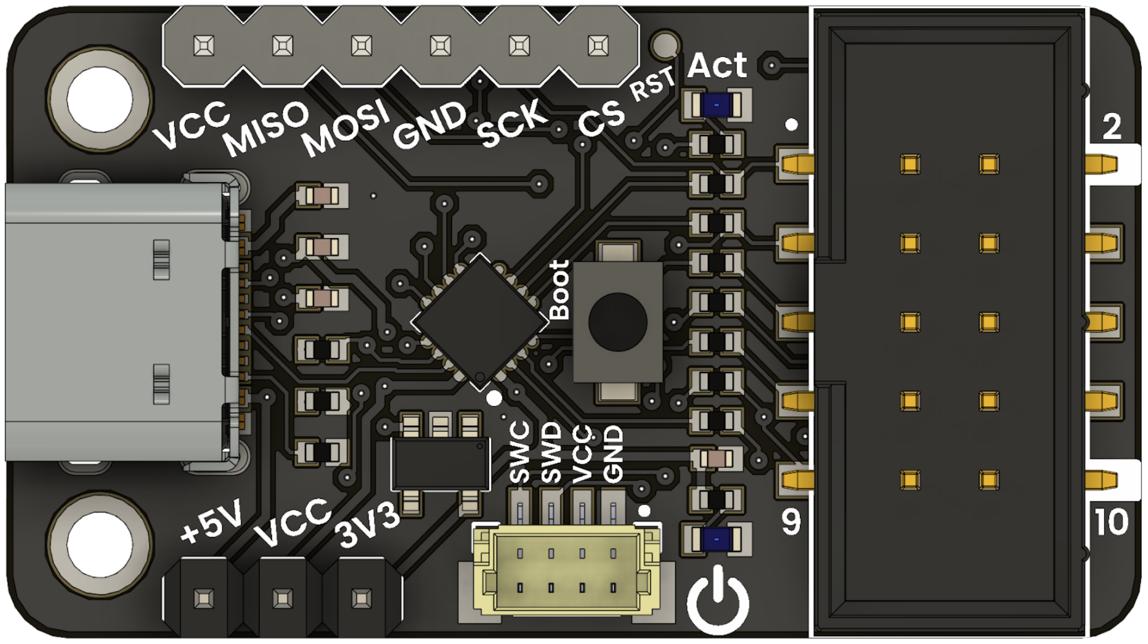


CH552 USB Multi-Protocol Programmer User Guide and Technical Reference

Release 0.0.1

Cesar Bautista

May 26, 2025

Contents

Note: This documentation is actively evolving. For the latest updates and revisions, please visit the project's GitHub repository.

CH552 USB Multi-Protocol Programmer

The **CH552 USB Multi-Protocol Programmer** is a compact and cost-effective device designed for embedded systems development, testing, and debugging. It supports multiple hardware architectures including **AVR**, **ARM Cortex-M (CMSIS-DAP)**, and **CPLD (MAX II)**, making it ideal for a wide range of applications such as firmware development, educational labs, and low-volume production environments.

This programmer is built around the **CH552 microcontroller**, which is based on the enhanced **8051 architecture**. It offers native USB support and a range of digital interfaces (GPIO, SPI, I2C, UART), enabling seamless communication between the host system and the target hardware.

Microcontroller Core

The programmer integrates a **CH552 microcontroller** with the following characteristics:

- 8051-based enhanced core, up to 24 MHz.
- Native USB 2.0 Full-Speed device.
- Multiple GPIO pins for signal control and mapping.
- SPI, I2C, and UART interfaces for protocol bridging.
- Low power consumption and small form factor.

Features

- **Multi-architecture support**: Compatible with AVR (ISP), ARM Cortex-M (CMSIS-DAP), and CPLD (JTAG).
- **In-System Programming (ISP)**: Flash microcontrollers without desoldering.
- **Real-time debugging**: Step-through and breakpoint debugging with OpenOCD and PyOCD.
- **JTAG boundary-scan**: For CPLD configuration and board testing.
- **Configurable GPIOs**: Adaptable for use as JTAG, SWD, or ISP lines.
- **USB 2.0 interface**: Direct connection to host PC using USB CDC or HID.
- **Toolchain compatibility**: Works with avrdude, OpenOCD, PyOCD, urJTAG, and others.
- **Cross-platform support**: Compatible with Linux and partially supported on Windows.

Advantages

- **Compact design**: Suitable for breadboards and embedded setups.
- **Versatility**: One device for multiple programming and debugging protocols.
- **Open-source firmware**: Fully customizable and community-supported.
- **Cost-effective**: Inexpensive alternative to commercial debuggers and programmers.
- **Linux-friendly**: No need for proprietary drivers on Linux systems.
- **Ideal for education**: Can be used in microcontroller courses and workshops.

Limitations

- **External power required**: Cannot supply power to high-current target boards.
- **Learning curve**: Requires knowledge of protocols like CMSIS-DAP, JTAG, or AVR ISP.
- **Firmware updates**: May require reflashing to support new features or targets.
- **Partial Windows support**: Some tools may require manual setup or driver adjustments.

Compatibility

CMSIS-DAP (ARM Cortex-M)

- Fully compatible with CMSIS-DAP v2.0 protocol.
- Supported by OpenOCD and PyOCD.
- Tested with:
  - STM32F0
  - RP2040 (Raspberry Pi Pico)
  - PY32 series
  - Other Cortex-M0/M3/M4 devices

AVR ISP

- Works with avrdude using USBasp-like interface.
- Supports:
  - ATmega328P
  - ATtiny85
  - ATmega2560
  - Other classic 8-bit AVR microcontrollers

CPLD JTAG

- Supports Intel (formerly Altera) MAX II series.
- Compatible with JTAG tools like urJTAG or openFPGALoader.
- JTAG signals exposed via GPIO (TDI, TDO, TCK, TMS).

Use Cases

- Firmware flashing and in-system programming.
- Debugging embedded applications with CMSIS-DAP.
- Educational labs and training environments.
- Low-cost production line programming.
- Boundary-scan tests for hardware bring-up.
- CPLD configuration and prototyping.

Resources

- Firmware: [https://github.com/wagiminator/CH552-DAPLink{]}(https://github.com/wagiminator/CH552-DAPLink)
- CH552 Datasheet: Available from WCH official website.
- Tools:
  - OpenOCD, PyOCD
  - avrdude
  - urJTAG, openFPGALoader
- Community support: GitHub issues, Reddit, Hackaday, forums.

CHAPTER
ONE

GENERAL INFORMATION

The **CH552 USB Multi-Protocol Programmer** is a compact and versatile development tool designed for high-precision embedded system applications. It supports a broad range of protocols and device architectures, including **AVR**, **ARM (CMSIS-DAP)**, and **CPLD (MAX II)**. Its USB connectivity enables direct interfacing with standard development environments, enabling:

- In-system programming (ISP)
- Step-through debugging
- Boundary-scan testing (JTAG)
- Flash memory operations

Compatible with popular platforms such as **STM32**, **RP2040**, and **PY32**, this programmer integrates configurable GPIO lines, multi-protocol headers, and streamlined power delivery—making it ideal for rapid prototyping and field diagnostics.

1.1 Supported Architectures

- **AVR** — via ISP (SPI configuration)
- **ARM Cortex-M** — via CMSIS-DAP and SWD
  - **RP2040**
  - **PY32**
  - **STM32**
- **CPLD/FPGA (MAX II)** — via JTAG

All protocols are exposed via labeled headers or JST connectors, allowing fast, solderless prototyping.

This device connects to a host system via USB and allows the user to program and debug various microcontrollers and programmable logic devices.

1.2 Supported Interfaces

- **JTAG**, for full-chip debugging and boundary scan
- **SWD**, for ARM Cortex-M series
- **SPI**, for flash and peripheral programming
- **UART**, for serial bootloaders and communication
- **GPIO**, for bit-banging or peripheral testing

Table 1.1: Interface and Signal Overview

Interface	Description	Signals / Pins	Typical Use
JTAG	Standard boundary-scan and debug interface	TCK, TMS, TDI, TDO, nTRST	Full chip programming, in-circuit test, debug
SPI	High-speed serial peripheral interface	MOSI, MISO, SCK, CS	Flash memory programming, peripheral data exchange
SWD	ARM's two-wire serial debug and programming interface	SWCLK, SWDIO	Cortex-M programming & step-through debugging
JST Header	Compact connector for power + single-wire debug signals	SWC (SWCLK), SWD (SWDIO), VCC, GND	Quick-connect to target board for SWD and power

1.3 Sections GPIO Pin Distribution

The CH552 USB Multi-Protocol Programmer features a set of GPIO pins that can be configured for various protocols, including JTAG, SWD, and ISP. These GPIOs are mapped to specific functions in the firmware, allowing users to adapt the programmer for different applications.

The GPIO pin distribution is defined within the CH552 firmware, supporting flexible assignment for various protocols. The firmware configures the specific mapping of GPIOs to protocols, such as SPI, JTAG, or SWD, based on the loaded configuration. Users can alter the pin distribution by modifying the firmware source code to suit their application requirements.

1.3.1 Protocol ISP – In-System Programming

Compatible with **AVR** microcontrollers, this protocol allows programming and debugging via the SPI interface. The programmer can be used to flash firmware directly into the target device's memory.

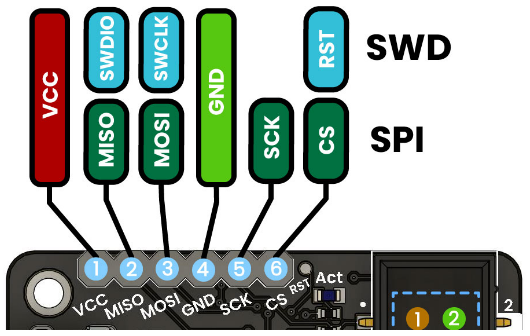


Table 1.2: Pinout

PIN	GPIO	I/O
MOSI	1.5	I/O
MISO	1.6	I/O
CS	3.0	I/O
SCK	1.7	I/O

1.4 Protocol JTAG

Compatible with **CPLD** and **FPGA** devices, this protocol allows programming and debugging via the JTAG interface. The programmer can be used to flash firmware directly into the target device's memory.

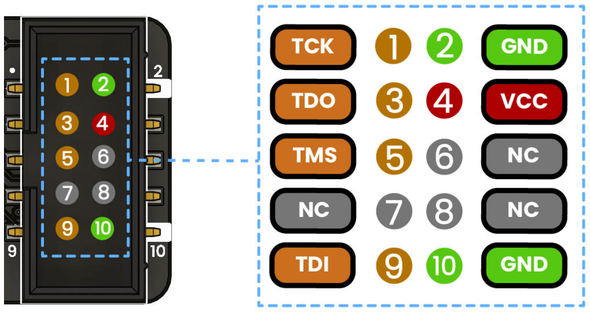


Fig. 1.1: Pinout diagram for CH552 Programmer (JTAG interface)

Table 1.3: Pinout

PIN	GPIO	I/O
TCK	1.7	I/O
TMS	3.2	I/O
TDI	1.5	I/O
TDO	1.6	I/O

Table 1.4: Pinout NC - Not Connected

PIN	GPIO	I/O
NC 6	3.4	I/O
NC 7	3.3	I/O
NC 8	1.4	I/O

1.5 Protocol SWD

Compatible with **ARM Cortex-M** microcontrollers, this protocol allows programming and debugging via the SWD interface. The programmer can be used to flash firmware directly into the target device's memory.

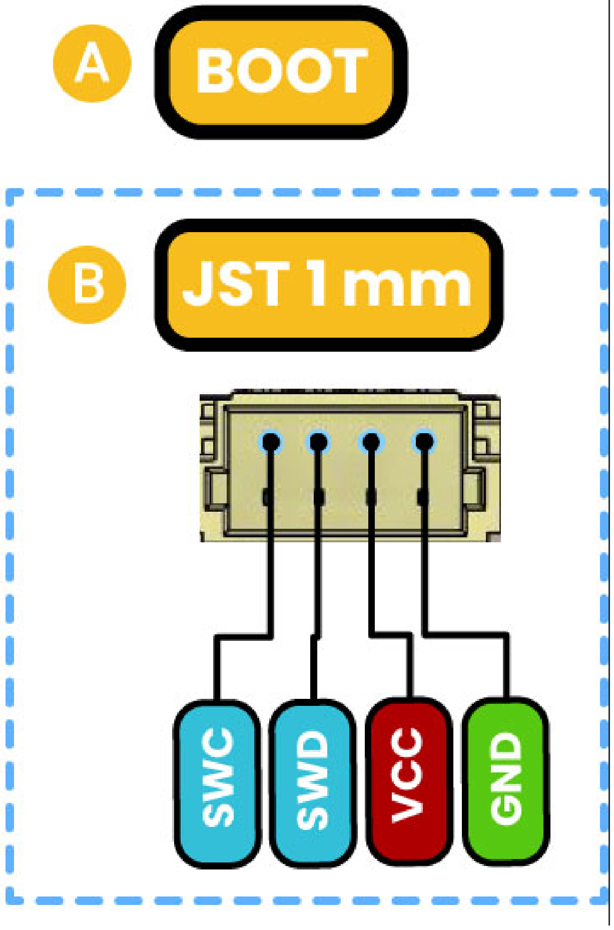


Fig. 1.2: SWD Pinout(JTAG interface)

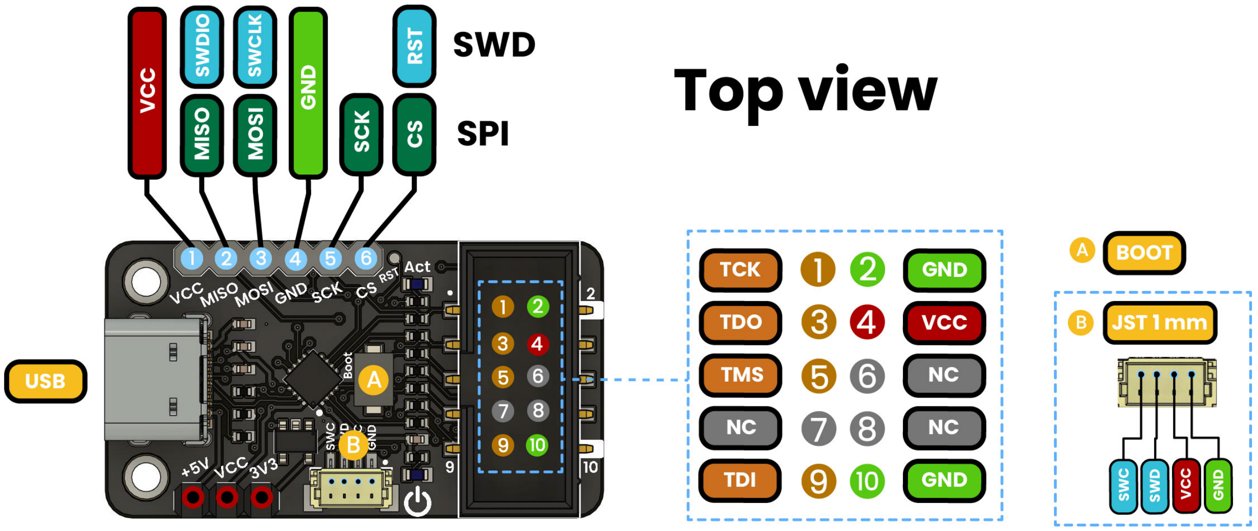
Table 1.5: Pinout

PIN	GPIO	I/O
SWCLK	1.7	I/O
SWDIO	1.6	I/O

Note: GPIO numbers refer to the CH552 internal ports. Ensure correct firmware pin mapping before connecting external devices.

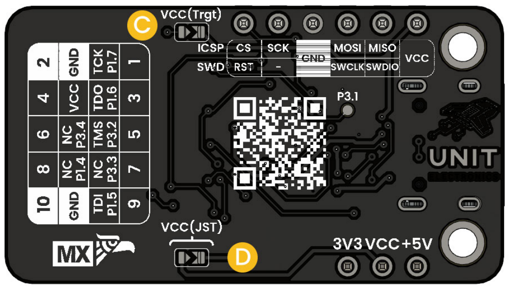
UNIT Universal USB Programmer

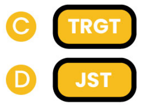
Top view



VCC is selected using a Switch, choosing between 3V3 or 5V.
The VCC value (3V3 or 5V) depends on the supply voltage of the microconroller to be programmed.

Bottom view





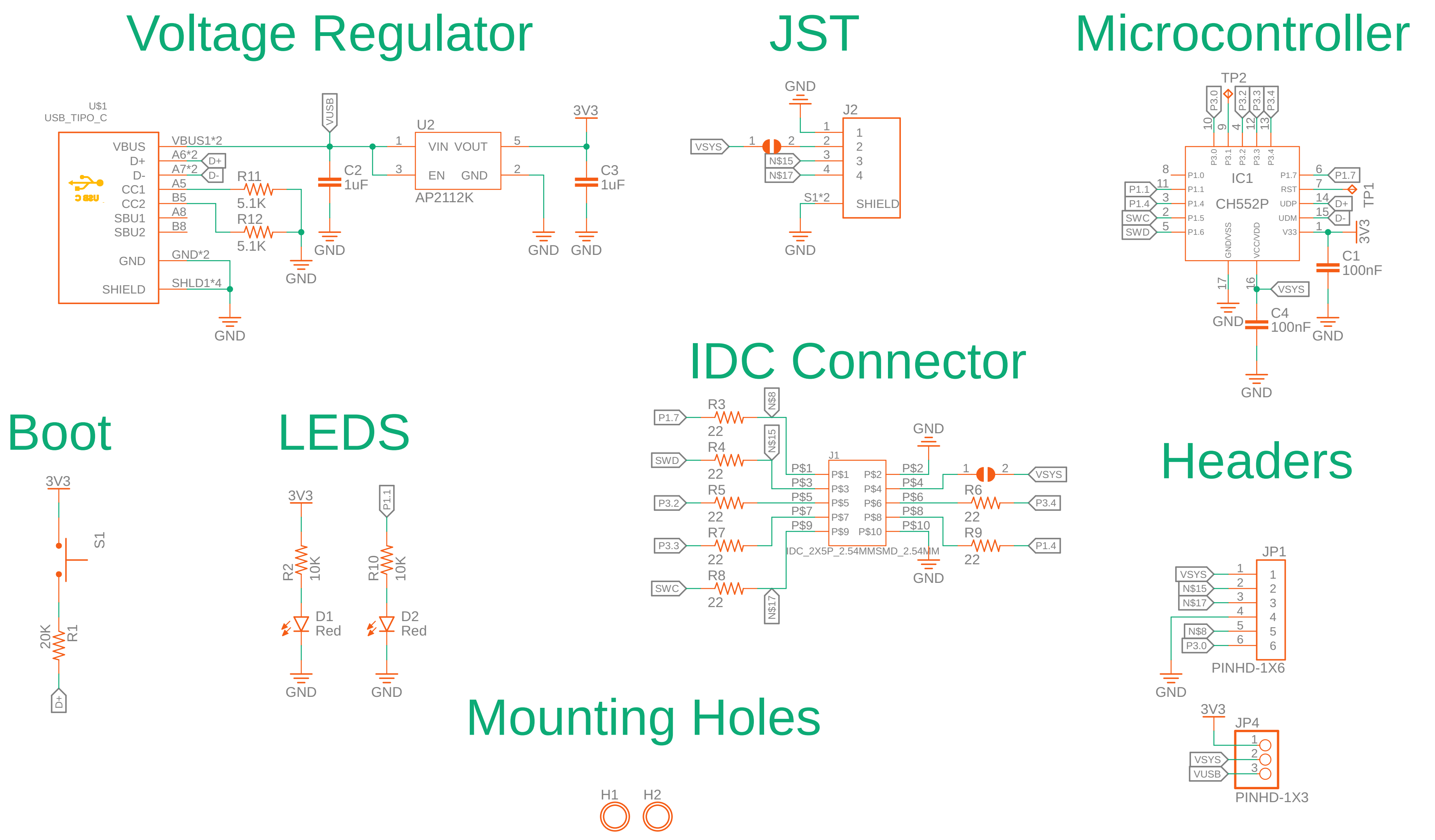
Description:

🟥 Supply voltage	⬛ No conection	🟦 SWD
🟩 GND	🟩 SPI	
🟨 Components	🟧 JTAG	

APPENDIX A: SCHEMATICS

THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF UNIT ELECTRONICS. ANY REPRODUCTION IN PART OR WHOLE IS STRICTLY PROHIBITED WITHOUT WRITTEN PERMISSION.

PROPRIETARY



Title: CH552 USB Multi-Protocol Programmer		UNIT ELECTRONICS
SKU: UE0090	REV1.0	
Last date time: 02/05/2025 11:40 a. m.	SHEET: 1 of 1	
File:	Sheet description:	Author:Alberto Villanueva

CHAPTER TWO

AVR GUIDE

2.1 Introduction to AVR Microcontrollers

AVR (Advanced Virtual RISC) is a family of microcontrollers originally developed by Atmel, now part of Microchip Technology. Renowned for their simplicity, low power consumption, and ease of use, AVR microcontrollers are widely adopted in embedded systems, including Arduino boards and other DIY electronics projects.

The AVR family spans a variety of models with differing specifications—such as flash memory capacity, I/O pin count, and integrated peripherals. Common examples include the **ATmega** series (e.g., `ATmega328P`, `ATmega2560`) and the **ATtiny** series (e.g., `ATtiny85`, `ATtiny2313`).

2.2 Architecture Overview

AVR microcontrollers are based on a **modified Harvard architecture**, which separates instruction and data memory. This design allows for simultaneous access and contributes to faster instruction execution and efficient memory usage.

Developers typically write code for AVR devices using **AVR Assembly** or higher-level languages like **C/C++**, supported by environments such as **Atmel Studio** or the **Arduino IDE**.

2.3 Programming with the CH552 Multi-Protocol Programmer

The **CH552 USB Multi-Protocol Programmer** provides robust support for AVR microcontrollers via the **In-System Programming (ISP)** interface. This method enables direct programming of the target microcontroller's **flash memory** and **EEPROM** without removing it from the circuit.

2.3.1 Key Advantages:

- **Non-intrusive**: Program the MCU without desoldering or removing it from the board.
- **Efficient workflow**: Ideal for development, testing, and field updates.
- **Wide compatibility**: Supports common AVR chips used in educational and commercial projects.

2.3.2 Supported Operations:

- Flash memory writing
- EEPROM access
- Fuse and lock bit configuration
- Signature verification

2.4 Getting Started

To program AVR microcontrollers using the CH552 programmer:

1. Connect the ISP header to the target board (MISO, MOSI, SCK, RESET, VCC, GND).
2. Use compatible software such as `avrdude` or the Arduino IDE with custom programmer settings.
3. Ensure proper voltage levels (typically 5V or 3.3V depending on the target device).
4. Run the programming command to flash the firmware or configure the device.

```
avrdude -p m328p -c ch552 -U␣
↪flash:w:firmware.hex
```

NOTES

CHAPTER
THREE

AVR: COMPILE AND UPLOAD CODE

3.1 Toolchain Overview

To compile and upload code to an AVR microcontroller, you'll need the **AVR-GCC** toolchain. This includes essential components such as the compiler, assembler, linker, and utilities like `avr-objcopy`.

3.2 Installation

You can download and install the AVR-GCC toolchain from the official Microchip website:

Windows

Download the installer from the Microchip website and follow the installation instructions.

- AVR-GCC Compiler for Microchip Studio

Linux

You can install the AVR-GCC toolchain using your package manager. For example, on Ubuntu:

```
sudo apt-get install avr-gcc avr-binutils␣
↪avr-libc
```

macOS

You can use Homebrew to install the AVR-GCC toolchain:

```
brew tap osx-cross/avr
brew install avr-gcc
```

Ensure the toolchain is added to your system's `PATH` environment variable for global access.

3.3 Example: Compiling a Blink Program

This example demonstrates how to compile a basic blink program for two common AVR microcontrollers:

- **ATtiny88**
- **ATmega328P**

The program toggles an LED connected to **pin PB0** every second.

3.3.1 Source File

```
#define F_CPU 16000000UL
#include <avr/io.h>
#include <util/delay.h>

int main(void) {
    DDRB |= (1 << PB0); // Set PB0 as␣
↪output
    while (1) {
        PORTB ^= (1 << PB0); // Toggle PB0
        _delay_ms(1000);
    }
}
```

3.3.2 Compilation Commands

Use the following commands to compile and generate the HEX file:

```
# For ATtiny88
avr-gcc -mmcu=attiny88 -Os -o blink.elf␣
↪blink.c
avr-objcopy -O ihex blink.elf blink.hex

# For ATmega328P
avr-gcc -mmcu=atmega328p -DF_
↪CPU=16000000UL -Os -o blink.elf blink.c
avr-objcopy -O ihex blink.elf blink.hex
```

Explanation of flags:

- `-mmcu=` specifies the target microcontroller.
- `-Os` enables size optimization.
- `-DF_CPU` sets the clock frequency used for timing functions.

3.4 Uploading with AVRDUDE

Once the `.hex` file is generated, you can upload it to the AVR microcontroller using **AVRDUDE**.

3.4.1 Upload Command

```
avrdude -p m328p -c usbasp -U␣
↪flash:w:blink.hex
```

Explanation:

- `-p m328p` specifies the target device (ATmega328P).
- `-c usbasp` sets the programmer to the CH552 USB Multi-Protocol Programmer.
- `-U flash:w:blink.hex` uploads the hex file to flash memory.

Replace `m328p` with the appropriate identifier for your specific AVR device (e.g., `t88` for ATtiny88). A full list of supported devices is available in the AVRDUDE user manual.

AVR: ARDUINO IDE BOOTLOADER

4.1 Installing the Bootloader on ATMEGA328P

This guide explains how to flash the Arduino-compatible bootloader onto an **ATMEGA328** microcontroller using the **UNIT USB Multi-Protocol Programmer**. By following these steps, your ATMEGA328 can function as an **ATMEGA328P**, fully compatible with the Arduino IDE.

4.2 Required Materials

1. **UNIT Multi-Protocol Programmer**
2. **ATMEGA328P Microcontroller**

4.3 Hardware Connection

1. Use the FC cable to connect one end to the UNIT Multi-Protocol Programmer and the other to the ICSP interface of the ATMEGA328P.
2. Make sure the **MISO** pin of the programmer is aligned with **pin 1** of the ICSP header on the ATMEGA328P.

4.4 Driver Setup with Zadig

To allow USB communication between your PC and the programmer, install the required drivers using **Zadig**.

4.4.1 Step 1: Identify the COM Port

Connect the programmer to your PC and open the **Device Manager**. Under **Ports (COM & LPT)**, identify the COM port assigned to the device.

4.4.2 Step 2: Open Zadig

Launch Zadig. You should see a window like the following:

Click **Options** → **List All Devices** to display all USB interfaces:

4.4.3 Step 3: Install Drivers

Install the following two drivers:

- **picoASP Interface 0**: Install the **libusbK** driver by clicking **Replace Driver**.
- **SerialUPDI Interface 1**: Install the **USB Serial (CDC)** driver by clicking **Upgrade Driver**.

Once both drivers are installed, your UNIT Multi-Protocol Programmer is ready to flash the bootloader.

4.5 Bootloader Installation Using Arduino IDE

Open the **Arduino IDE** and follow these steps to burn the bootloader onto your ATMEGA328P.

1. **Select the Target Board**

   Navigate to **Tools** → **Board** and choose **ATMEGA328P**.

2. **Choose the Correct Port**

   Under **Tools** → **Port**, select the COM port corresponding to your programmer.

3. **Select the Programmer**

   Under **Tools** → **Programmer**, select the programmer (e.g., **USBasp** or your custom driver name).

4. **Burn the Bootloader**

   Finally, go to **Tools** → **Burn Bootloader**.

Success! Your ATMEGA328P now has a compatible Arduino bootloader installed and is ready for development.

CHAPTER FIVE

STM32 MICROCONTROLLERS

STMicontrollers is a family of 32-bit microcontrollers designed and manufactured by STMicroelectronics. They are widely used in embedded systems and IoT applications due to their low power consumption, high performance, and rich peripheral set. STM32 microcontrollers are based on the ARM Cortex-M architecture and are available in a wide range of series, each tailored to specific applications and requirements.

5.1 Getting Started with STM32

This documentation provides a comprehensive guide to getting started with STM32 microcontrollers. It includes information on setting up the development environment, installing the necessary software, and writing code for STM32 microcontrollers.

This technical documentation is a work in progress and is an adaptation of documentation from the STM32CubeIDE and STM32CubeMX software tools. It uses the ARM-GCC compiler and visual studio code as the IDE.

CHAPTER
SIX

HOW TO GENERATE AN ERROR REPORT

This guide explains how to generate an error report using GitHub repositories.

6.1 Steps to Create an Error Report

1. **Access the GitHub Repository**
   Navigate to the GitHub repository where the project is hosted.
2. **Open the Issues Tab**
   Click on the "Issues" tab located in the repository menu.
3. **Create a New Issue**
   - Click the "New Issue" button.
   - Provide a clear and concise title for the issue.
   - Add a detailed description, including relevant information such as:
     - Steps to reproduce the error.
     - Expected and actual results.
     - Any related logs, screenshots, or files.
4. **Submit the Issue**
   Once the form is complete, click the "Submit" button.

6.2 Review and Follow-Up

The development team or maintainers will review the issue and take appropriate action to address it.