BJT Tester Project - User Guide

1. Introduction

The BJT Tester project, implemented on an STM32 microcontroller, automatically detects a bipolar junction transistor (BJT), determines its type (NPN or PNP), identifies pin configuration (EBC or CBE), and calculates both static (βs) and active (βa) gains.

2. Measurement Sequence

The measurement process follows these steps:

1. A PWM-driven voltage is applied to the transistor via GPIO-controlled switches (PA6, PA7).

2. ADC readings on three channels capture voltage values at collector, emitter, and base pins.

3. The difference between collector and emitter voltages (V(C)–V(E)) is compared against a threshold to confirm transistor presence.

4. If detected, V(C)>V(E) indicates an NPN transistor; otherwise, it is PNP.

3. Pin Configuration and β Calculation

To distinguish pin order (EBC vs CBE), the tester alternates voltage application between pin pairs and compares two voltage differences: $\Delta 1$ and $\Delta 2$. If $\Delta 1 > \Delta 2$, the configuration is CBE; if $\Delta 1 \leq \Delta 2$, it is EBC. Static gain βs is calculated as βs = Ic / Ib, where Ic and Ib are derived from ADC readings and full-scale values. Active gain βa is then measured over 10 timed cycles, with results displayed on the LCD and logged over UART.

4. Hardware Components

• STM32 microcontroller with ADC and PWM capability.

• GPIO pins PA6 and PA7 for switching transistor connections.

• ADC channels: PA0, PA1, PB0 (or ADC8) for voltage sampling.

• I2C-driven LCD for real-time user interface.

• UART2 connection at 115200 baud for serial data output.

• Stable power supply (3.3V/5V) and a test socket for the BJT.

5. Software Setup

To set up the software, import the project into STM32CubeIDE, build, and flash it to the target board. Ensure HAL drivers for ADC, TIM, GPIO, I2C, and UART are enabled in the .ioc configuration. Open a serial terminal (e.g., TeraTerm) at 115200 baud to view βa measurement logs.

6. Usage Instructions

1. Connect the BJT under test to the designated ADC inputs and GPIO switch pins.

2. Power on the board. The LCD will initialize and display status messages.

3. The tester runs automatic detection and displays results on the LCD:

- “There is not BJT” if no device is detected.

- “NPN EBC”, “NPN CBE”, “PNP EBC”, or “PNP CBE” based on configuration.

4. The static gain βs appears on the second line of the LCD.

5. Active gain βa measurements are taken over 10 cycles, updating the LCD and UART output each cycle.

7. Troubleshooting

• “There is not BJT”: Verify connections and ensure correct pin alignment.

• Incorrect type detection: Adjust threshold or calibrate ADC reference.

• No LCD output: Check I2C wiring and lcd_init() functionality.

• No serial data: Confirm UART2 TX/RX mapping and terminal settings (8N1, 115200).