

**SmartMCD™ TB9M001FTG**  
**BOARD**

USER MANUAL

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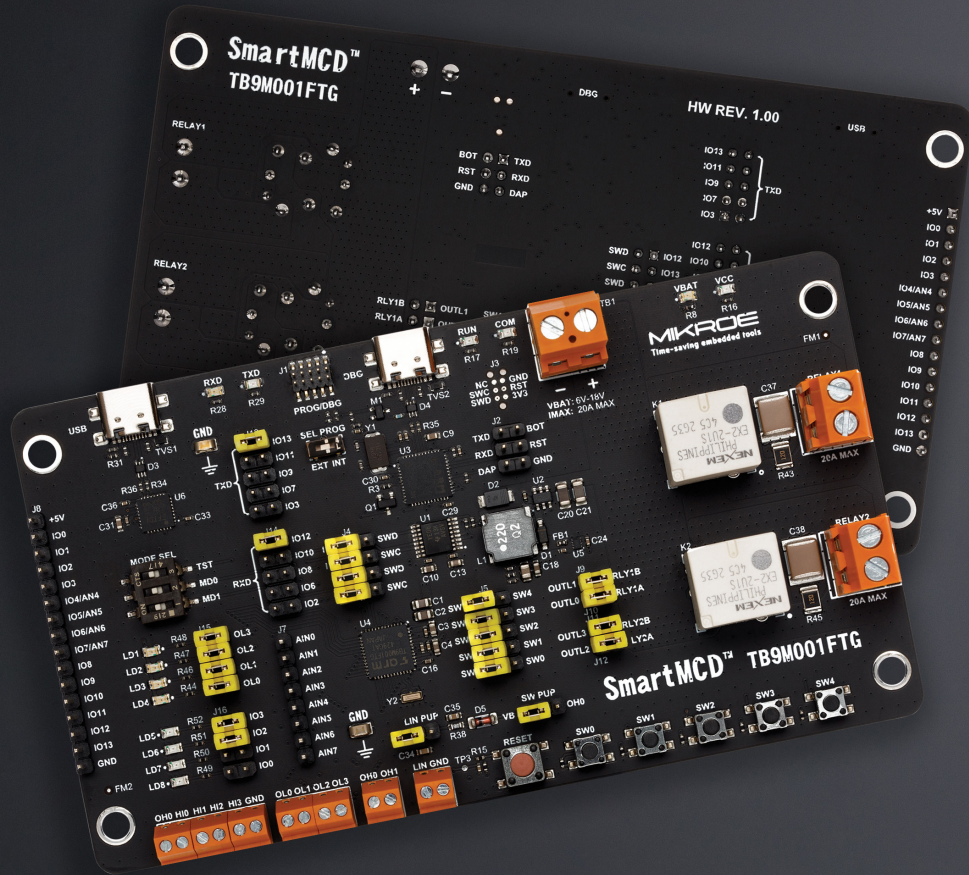
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Figure: SmartMCD™ TB9M001FTG board front and back view



**The SmartMCD™ TB9M001FTG board** offers an advanced solution for evaluation and control of brushed DC motors and high-current automotive loads. At the core of the board is the TB9M001FTG (U1), an automotive-grade relay driver IC with integrated low-side and high-side driver outputs, relay control functionality, and multiple general-purpose and analog interfaces, making it well suited for body electronics, motor control, and power management applications.

The board supports control of two high-current brushed DC motor channels through onboard solid-state relays rated up to 20A per channel, driven directly by the TB9M001FTG low-side driver outputs. In addition to relay-based motor control, the board exposes dedicated low-side (OLO-OL3) and high-side (OHO-OH1) driver outputs, enabling flexible connection and control of external loads and power stages. Power is supplied through a wide

input voltage range from 6V to 18V, with onboard DC-DC and LDO regulation providing stable 5V and 3.3V rails for internal circuitry and peripheral devices. The SmartMCD™ TB9M001FTG board also features comprehensive programming and debugging options, including an onboard CMSIS-DAP compliant debug unit as well as support for external SWD programmers

Multiple connectivity and user interaction options are provided, including USB-to-UART communication, LIN interface support, configurable switches, push buttons, LED indicators, analog inputs, and Hall sensor monitoring terminals. The board's compact design, measuring 130mm (x) 73mm, includes all circuits needed for motor control and switches for operational testing.

# 1. Key Silicon Features

At its core, the SmartMCD™ board uses the **TB9M001FTG IC**.

The TB9M001FTG is an integrated IC with a microcontroller unit (MCU) for automotive applications, which incorporates an Arm® Cortex®-M0 Processor, a relay driver, and a LIN transceiver. This IC features a power supply system that operates at vehicle battery voltage levels, making it suitable for DC motor applications using external relays. It also includes large-capacity code flash and data flash memory, allowing it to function as a LIN-controlled secondary device. The TB9M001FTG can be configured to transition to Standby mode in the Idle state to reduce power consumption.

- 192KB Code Flash
- 16KB Data Flash
- 12KB ROM
- 16KB SRAM
- Operating frequency up to 40 MHz

For the complete list of IC features, please refer to the **TB9M001FTG datasheet**.

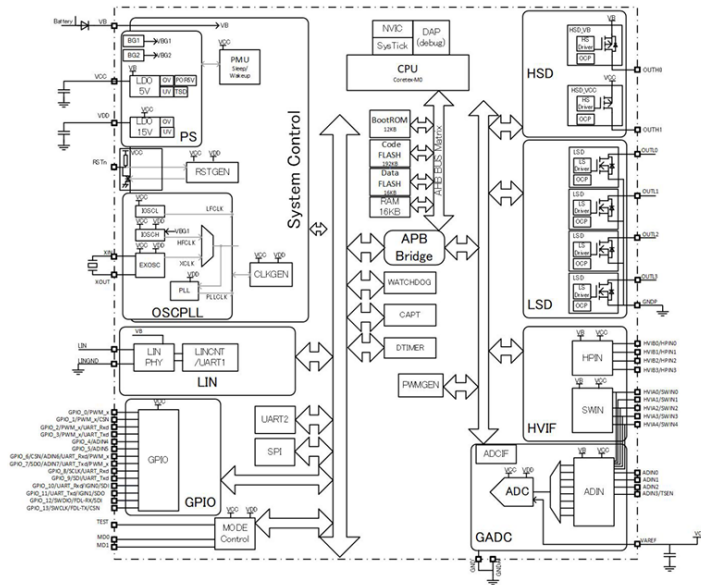


Figure 1: TB9M003FG MCU block diagram

# 2. Relay Control Driver

The SmartMCD TB9M001FTG board provides RELAY 1 and RELAY 2 terminals **[1]** designed for high-current load control, such as brushed DC motors, supporting up to 20A maximum per channel. Mechanical relays mounted on the board (K1 and K2) are used to reliably switch high-current loads. The relay control functionality is managed through the low-side driver output pins of the TB9M001FTG (U1). In addition to the relay outputs, the board exposes four dedicated low-

side driver output signals on the OL0 to OL3 terminals **[2]**. These terminals provide direct access to the TB9M001FTG low-side driver outputs, enabling flexible control of external loads. Similarly, two high-side driver output signals from the TB9M001FTG are available on the OH0 and OH1 terminals **[3]**. These high-side driver outputs support applications requiring direct supply-side switching, further extending the board's motor control and power management capabilities.

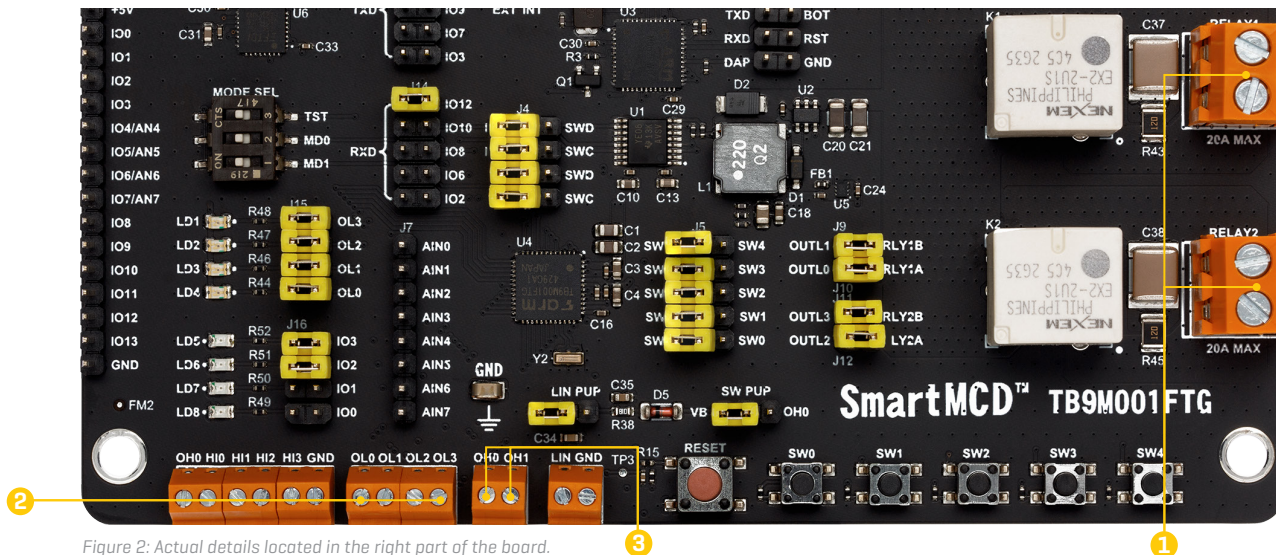


Figure 2: Actual details located in the right part of the board.

# 3. Power Supply

The main power supply, which ranges from 6V to 18V (typically 12V with maximum current of 20A), is provided to the TB9M001FTG [U1] via the TB1 [1] terminal. This power supply also feeds the entire inverter circuit and the step-down DC-DC converter, the MCP16331 [U2]. The presence of active external power can be visually confirmed by a red VBAT LED [2] located near the connector. The TB9M001FG generates its own 5V supply, which can be used for external components up to 100mA, so the MCP16331 is responsible for converting the VBAT power supply to 5V, which is then used to power various ICs and components around the TB9M001FG [U1]. Additionally, the 5V power supply is further regulated to 3.3V via an LDO regulator, the NCP186 [U5], which primarily supplies the TMPM067FW [U3] MCU for programming purposes. Similar to the VBAT LED indicating the presence of external power, a green LED labeled VCC indicates the successful generation and activation of the 3.3V power supply.

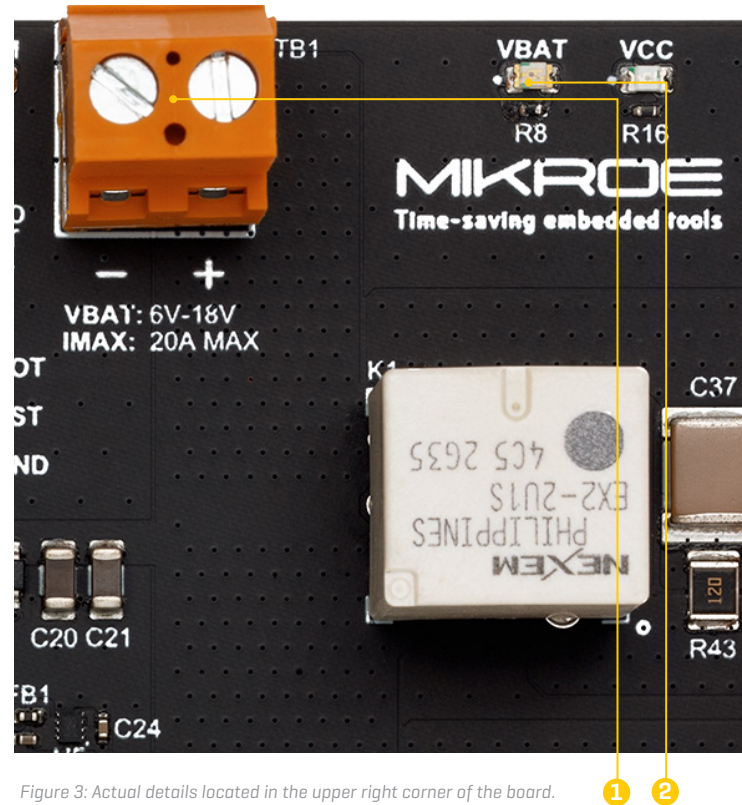


Figure 3: Actual details located in the upper right corner of the board.

# 4. MCU Programming

The program/debug switch [SEL PROG] **[1]** allows you to select the source for programming and debugging the TB9M001FTG [U1]. When set to the INT position, it enables programming and debugging via the onboard MCU, the

TMPM067FW [U3]. Alternatively, setting it to the EXT position allows for programming and debugging through the SWD connector [J1]. **[2]**

## 4.1 Programming with onboard debug unit

SmartMCD™ board uses Toshiba's TMPM067FW [U3] as the onboard Debug Unit. It is compliant with an on-board emulator standard called CMSIS-DAP. The CMSIS-DAP is the interface firmware for a Debug Unit that connects the Debug Port to USB. Debuggers, which execute on a host computer, connect via USB to the Debug Unit and the Device running the application software. The Debug Unit connects via SWD to the target Device. Once the SmartMCD™ board is powered up and the DBG USB connector is connected to the PC, the onboard debug unit takes a few seconds to initialize. After initializing the on-board CMSIS-DAP, two LEDs, RUN [LD11] and COM [LD12], blink once.

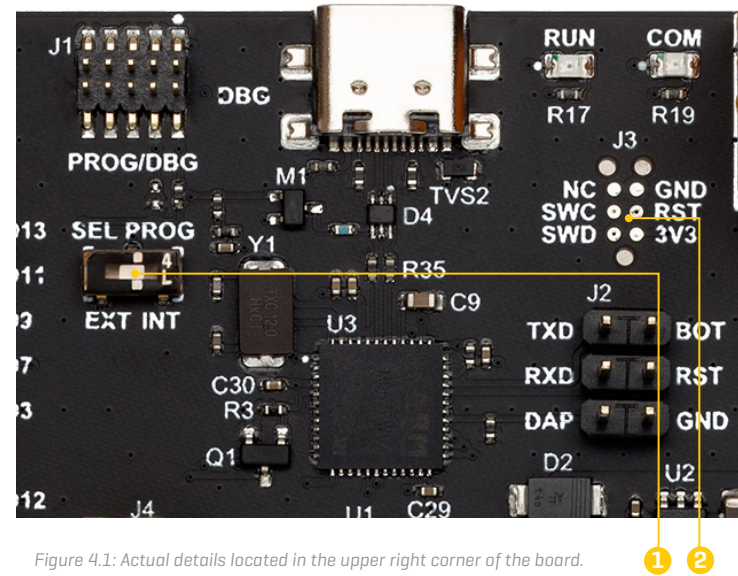
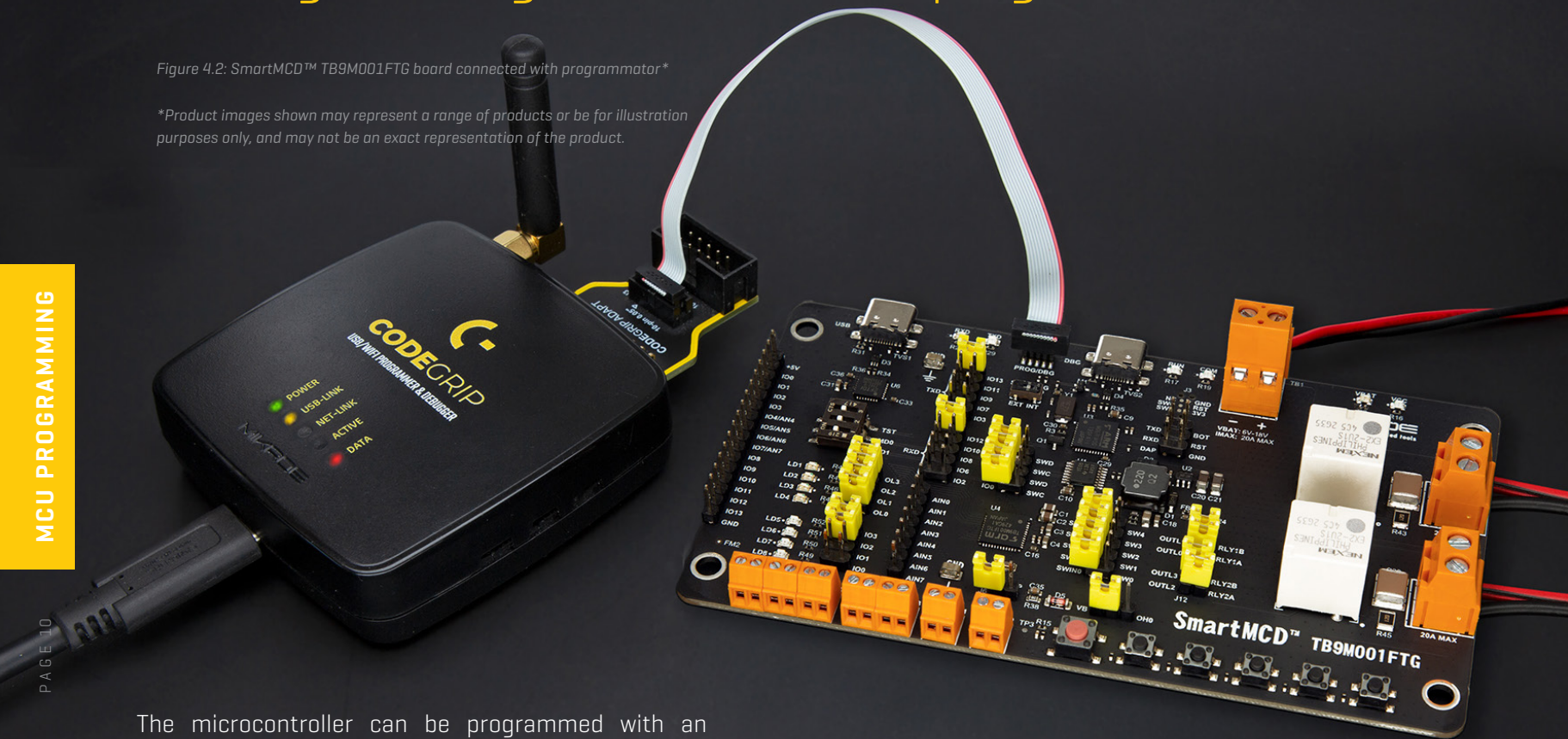


Figure 4.1: Actual details located in the upper right corner of the board.

## 4.2 Programming with an external programmer

Figure 4.2: SmartMCD™ TB9M001FTG board connected with programmer\*

\*Product images shown may represent a range of products or be for illustration purposes only, and may not be an exact representation of the product.



The microcontroller can be programmed with an external programmer and supported software. The external programmer is connected to the development board via a 2x5 PROG/DBG connector soldered on the J1 connector pads.

Please check if the programmer pinout and the 2x5 pin header pinout are compatible before usage. A corresponding adapter might be needed based on the programmer/debugger tool pinout.

**NOTE**

# 5. Connectivity

Serial communication with the TB9M001FTG [U1] can be achieved through an external USB hosting device connected to the USB Type-C **[1]** connector located in the upper left corner [USB]. The USB signals [USB-D\_P, USB-D\_N] are converted to UART serial data signals [UART-TX, UART-RX] by the USB-UART controller, the FT232 [U6], enabling serial communication with the TB9M001FTG [U1]. To protect the USB signals [USB-D\_P, USB-D\_N] from electrostatic discharge, an ESD protection diode [D3] is used.

The transmit serial data [UART-TX] from the USB-UART controller, the FT232 [U6], can be routed to IO3, IO7, IO9, IO11, or IO13 of the TB9M001FTG [U1] by placing the appropriate jumper on the J13 header **[2]**. When serial data is transmitted, the TXD **[3]** illuminates. Similarly, the receive serial data [UART-RX] from the USB-UART controller, the FT232 [U6], can be connected to IO2, IO6, IO8, IO10, or IO12 of the TB9M001FTG [U1] by placing the corresponding jumper on the J14 **[4]** header. The RXD **[5]** lights up when serial data is received.

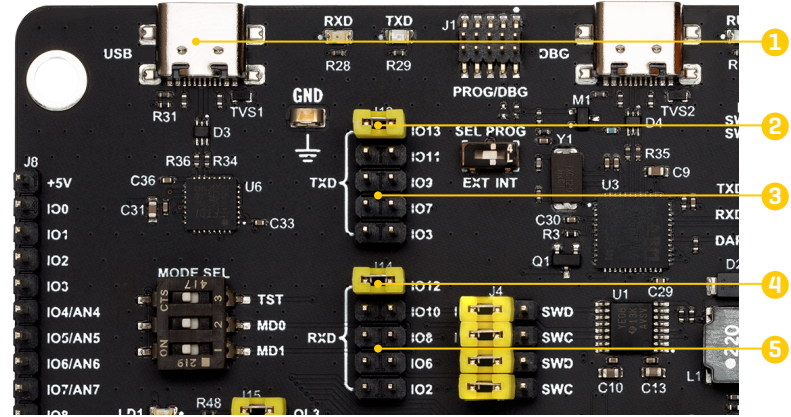


Figure 5.1: Actual details located in the upper left corner of the board.

LIN [Local Interconnect Network] communication is possible through the LIN connector **[6]** [TB2]. To ensure reliable communication and minimize interference, a bypass capacitors [C34 and C35] **[7]** is included in the circuit. This capacitor helps to reduce the amount of noise generated during LIN communication, enhancing signal integrity and overall performance.

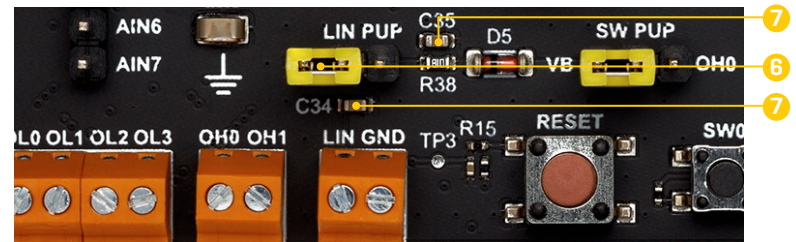


Figure 5.2: Actual details located in the lower left corner of the board.

# 6. Onboard Settings

## 6.1 Switches

The start mode selection switch (MODE SEL) **(1)** is used to choose the activation mode of the TB9M001FTG [U1]. Upon resetting, the mode is determined based on the settings of the MDO and MD1 switches. The available modes are Normal, Flash Download, and Debug. When both MDO and MD1 switches are OFF, the IC operates in Normal mode. The IC enters Flash Download mode if MD1 is ON and MDO is OFF. Conversely, the IC switches to Debug mode when MD1 is OFF and MDO is ON.

MDO	MD1	IC
OFF	OFF	Normal
OFF	ON	Flash Download
ON	OFF	Debug Mode

Figure 6.1: Activation modes of TB9M001FTG

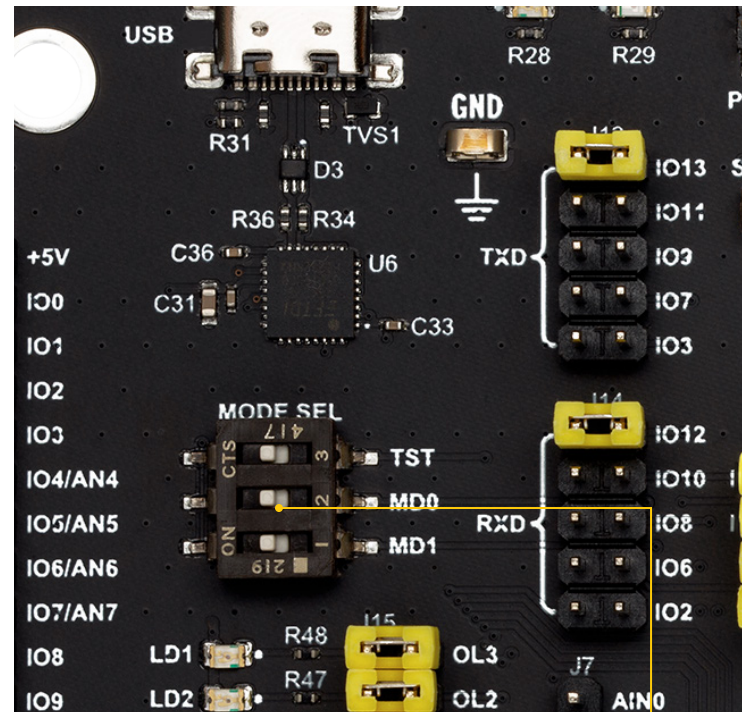


Figure 6.2: Actual details located in the center left corner of the board.

## 6.2 Headers, Jumpers and Connectors

Some of the pins on the TB9M001FTG [U1] are multiplexed, with their assignments determined by the software configuration after startup. The J8 1x16 pin header [1] provides additional connections and can be used to connect from IO0 to IO13 pins of the TB9M001FTG [U1], as well as to the 5V power supply and GND for testing purposes. This board includes the J7 header [2], which provides access to eight analog input pins of the TB9M001FTG, labeled AIN0 through AIN7. These pins are directly connected to the microcontroller's analog input channels and can be used for interfacing with external analog signals such as sensors, potentiometers, or other voltage-based inputs.

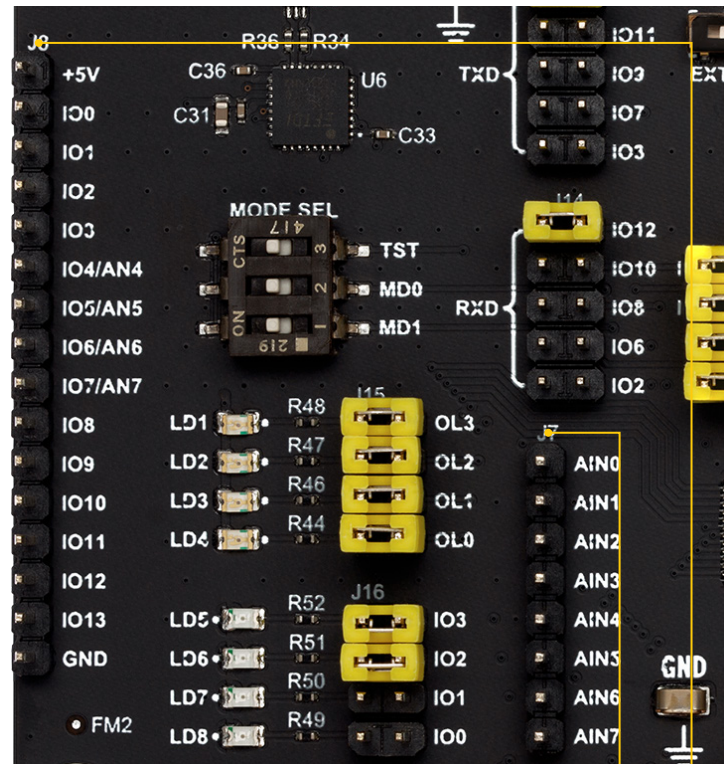


Figure 6.2: Actual details located in the center left corner of the board.

## 6.3 Buttons

The SmartMCD TB9M001FTG board is equipped with a RESET button and a set of five user-configurable buttons labeled SW0 through SW4. The RESET button [3] generates a hardware reset signal for the TB9M001FTG [U1], allowing the device to be returned to its default operating state. In addition to the RESET button, the board features five user-

configurable buttons [4], SW0 to SW4, which are connected as switch inputs to the TB9M001FTG. These buttons can be freely assigned by the application software and used for user interaction, mode selection, parameter adjustment, or triggering specific firmware functions during development and testing.

## 6.4 LED Indicators

The SmartMCD TB9M001FTG board features a set of user-configurable LED indicators located on the right side of the board [5], labeled LD1 through LD8. The first group consists of four red LEDs, LD1 to LD4, which are connected to the OUTL0 to OUTL3 pins on the header J15. These pins function as low-side driver outputs, and the corresponding

LEDs provide a direct visual indication of their active state. The second group includes four green LEDs, LD5 to LD8, connected to the IO0 to IO3 pins on the header J16 [6]. These pins operate as general-purpose I/O [GPIO] pins, allowing the LEDs to reflect their logical states during firmware execution

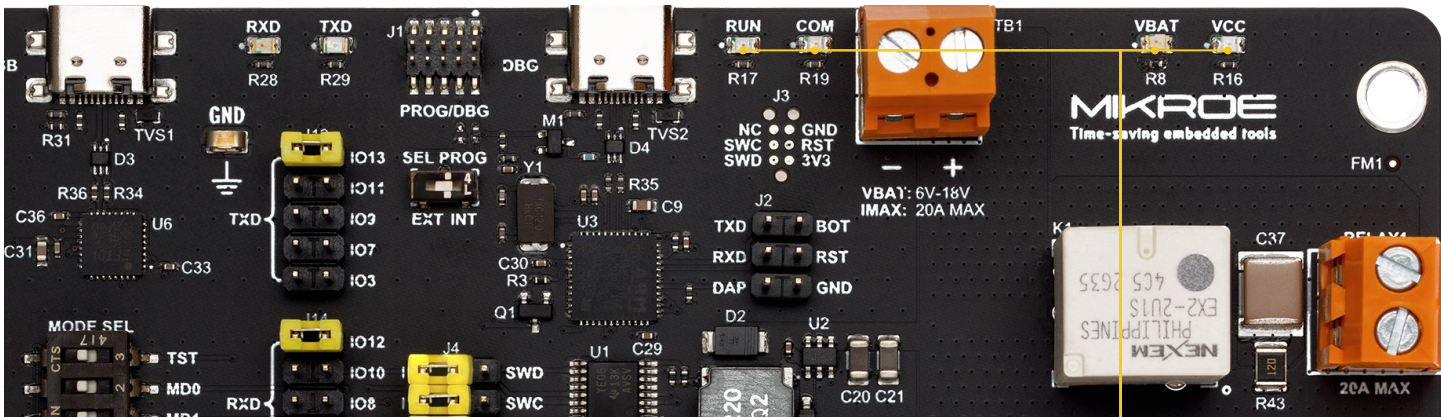


Figure 6: Position of Switches, Buttons, Headers, Jumpers, Connectors and LED Indicators

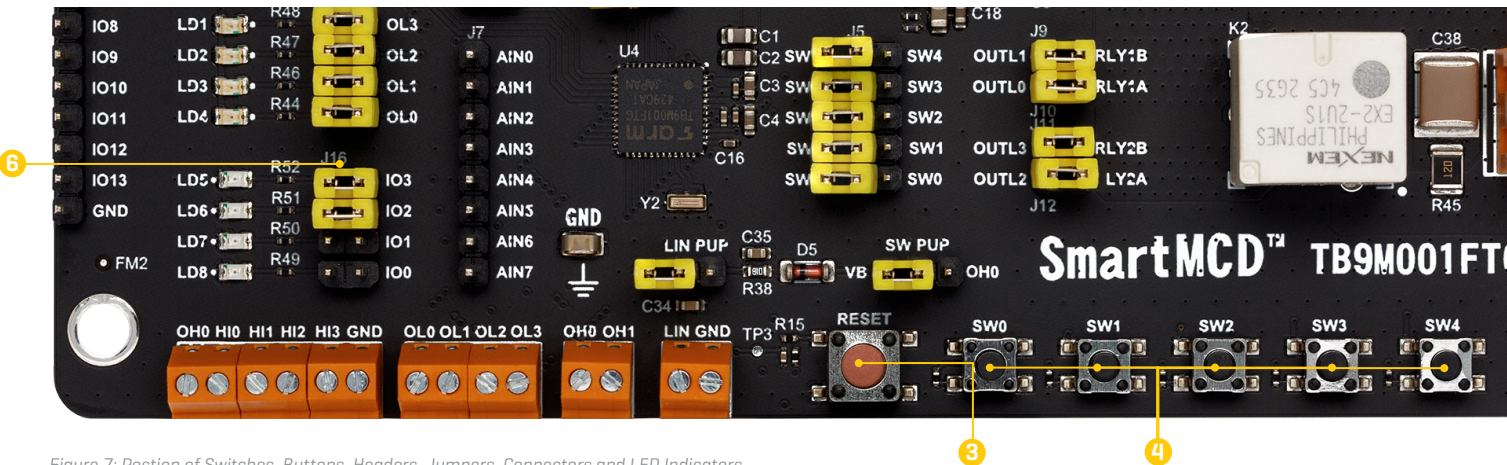


Figure 7: Position of Switches, Buttons, Headers, Jumpers, Connectors and LED Indicators

# 7. SmartMCD™ board Peripherals

The SmartMCD TB9M001FTG board provides H10 to H13 terminals [1] for Hall sensor input. These terminals are implemented as a 4-pin monitor input interface and are intended for input signal observation only. The H10 to H13 inputs allow connection of Hall sensor output signals for monitoring and evaluation purposes.

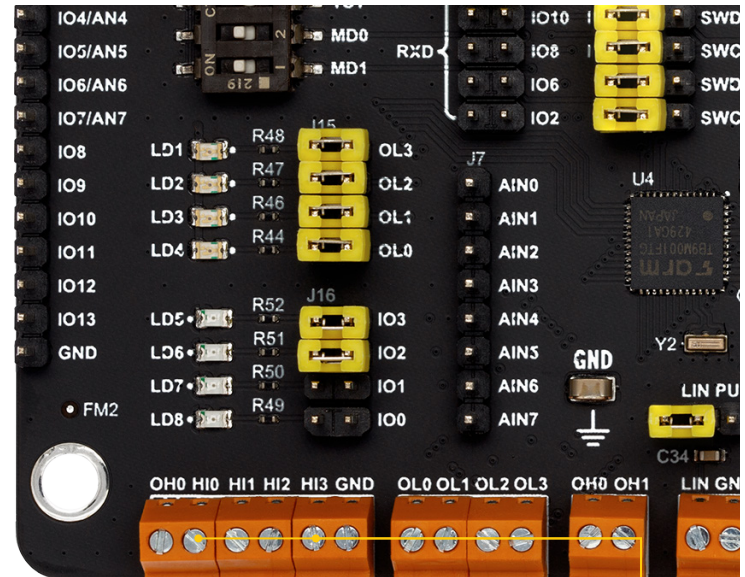


Figure 8: Actual details located in the lower left corner of the board.

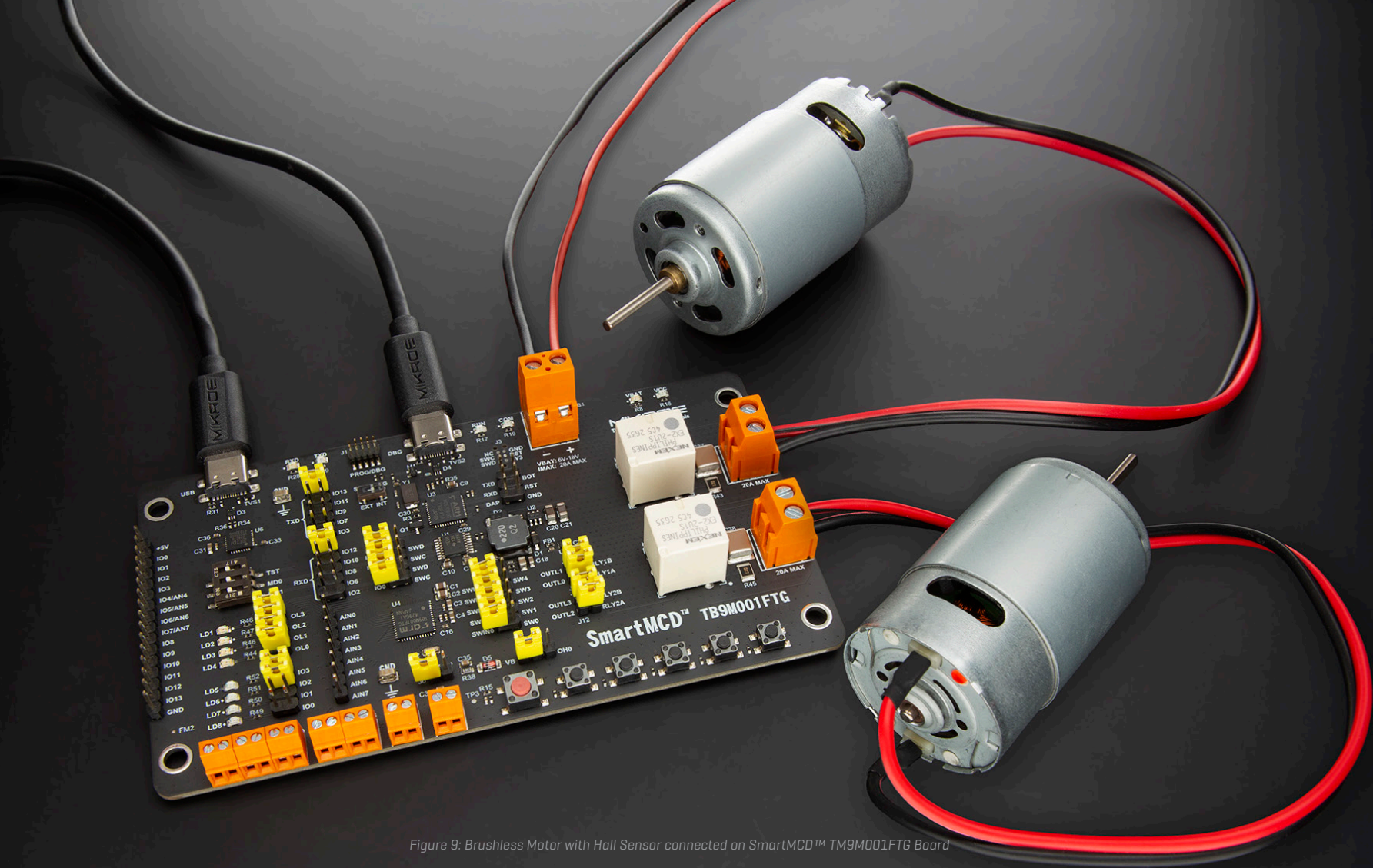


Figure 9: Brushless Motor with Hall Sensor connected on SmartMCD™ TB9M001FTG Board

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