User manual

EV-VNH90xxAQ motor driver

Introduction

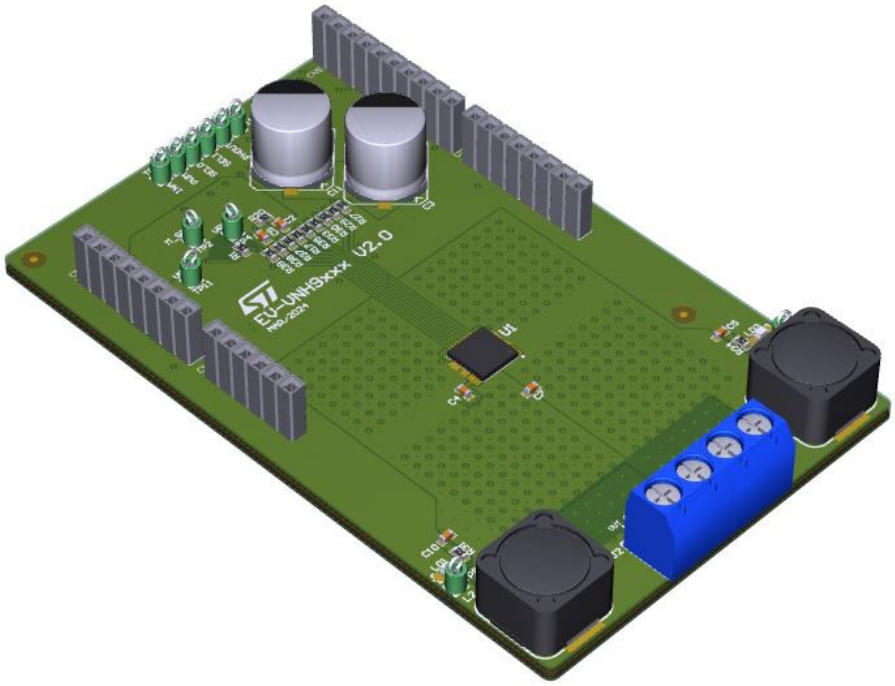
This document describes the specifications for the EV-VNH90xxAQ easy board, which can be connected to the EV-SPC582B to create a full bridge motor driver evaluation tool intended for a wide range of automotive applications. To simplify the evaluation of VNH90xxAQ devices, a GUI has been developed to facilitate the management of VNH90xxAQ inputs, monitor H-Bridge status, and provide current sensing and fault diagnostic feedback. Collectively, this solution provides a powerful and flexible tool for managing motor operations.

1 Quick start

The EV-VNH90xxAQ evaluation board simplifies the integration of ST VIPower M0-9 DC motor drivers into your prototype circuitry. This preassembled board includes the VNH90xxAQ, and the essential electrical components as recommended in the device datasheet. This setup allows for direct connections to the load, power supply, and microcontroller, eliminating the need for additional external component design and connections.

When used with the EV-SPC582B board (available on st.com), it forms a comprehensive evaluation tool for assessing the performance of EV-VNH90xxAQ motor drivers

Figure 1. EV-VNH90xxAQ board



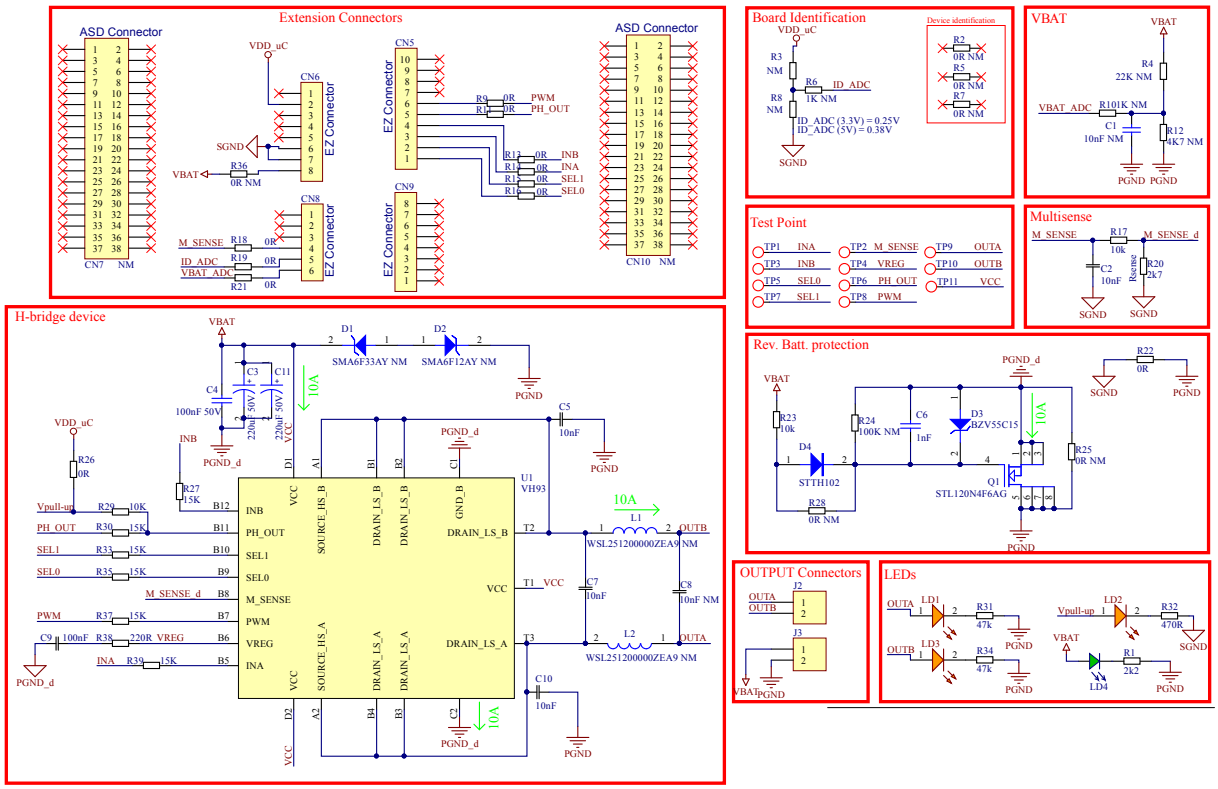
1.1 Getting started

Follow the sequence below to configure the system and launch the application:

1. Check the jumpers position of the EV-SPC582B board in the user manual (available on www.st.com)
2. Connect the EV-SPC582B board to a PC through USB cable "type A to mini B"
3. If the EV-SPC582B board must be programmed execute this step otherwise skip it:
   – Download firmware STSW-EV-VNH9xxx (available on www.st.com) and program the board as described in Section 2.3: FW Download.
4. Disconnect USB cable
5. Stack EV-VNH9030AQ on top of EV-SPC582B (as shown in chapter 2.4)
6. Install the GUI as described on STSW-EV-VNH9xxx (available on www.st.com)
7. Power supply (as shown in Section 2.4: System connections)
   a. Supply MCU as described in the EV-SPC582B user manual
   b. Apply V_{CC} < V_{CC}max. between V_{BAT} and P_{GND} in the EV-VNH90xxAQ board
8. Connect using USB cable PC <-> EV-SPC582B (as shown on Section 2.4: System connections)
9. Run GUI (see features in Section 2.5: RUN GUI (graphical user interface))

2 Hardware, schematic

Figure 2. **VNH90xxAQ evaluation board schematic**



2.1 VNH90xxAQ product Family

2.1.1 Features

Type	$R_{DS(on)}$. per leg	I_{OUT}
VNH9030AQ	30 mΩ	35 A
VNH9045AQ	45 mΩ	23 A
VNH9090AQ	82 mΩ	15 A

- AEC-Q100 qualified
- ISO 26262 ready
- CMOS compatible inputs
- Undervoltage shutdown
- Overvoltage clamp
- Thermal shutdown
- Cross-conduction protection
- Current and power limitation
- Very low standby power consumption
- Protection against loss of ground and loss of V_{CC}
- PWM operation up to 25 kHz
- Multisense monitoring functions
  - Analog motor current feedback
  - Chip temperature monitoring
- Multisense diagnostic functions
  - Output short to ground detection
  - Thermal shutdown indication
  - OFF-state open-load detection
  - High-side power limitation indication
  - Low-side overcurrent shutdown indication
  - Output short to V_{CC} detection
- Output protected against short to ground and short to V_{CC}
- Standby mode
- Half bridge operation
- Pin to pin compatibility among the whole family

2.1.2 Application

- Motor control automotive applications supplied by 12 V board-net

2.1.3 Description

VNH90xxAQ is a full bridge motor driver intended for a wide range of automotive applications. The device incorporates a dual monolithic high-side driver and two low-side switches. Both switches are designed using ST proprietary VIPower M09 technology that allows it to integrate efficiently on the same die a true power MOSFET with an intelligent signal/protection circuitry.

The three dies are assembled in a QFN 6x6 package equipped with three exposed islands for optimized dissipation performances.

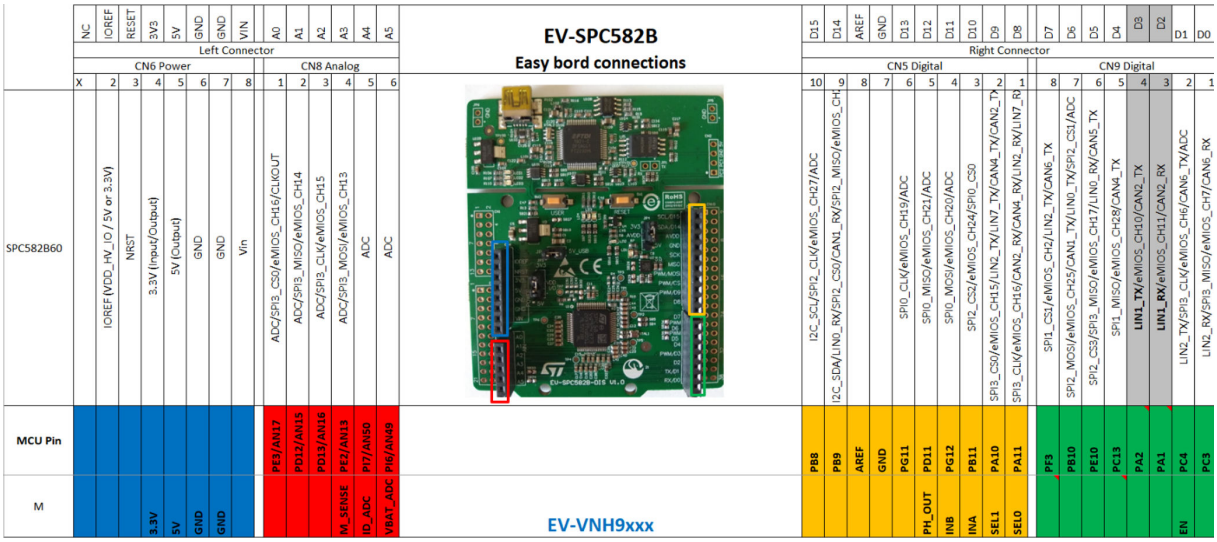
This package is specifically designed for the harsh automotive environment and offers improved thermal performance thanks to exposed die pads.

The input signals INA and INB can directly interface the microcontroller to select the motor direction and the brake condition. Two selection pins (SEL0 and SEL1) are available to address to the microcontroller the information available on the multisense pin and Phase_OUT pin. The Multisense pin allows it to monitor the motor current by delivering a current proportional to the motor current value and also provides the diagnostic feedback. The Phase_OUT pin provides feedback of OUT status confirming the motor is driven properly. The PWM, up to 25 kHz, allows controlling the speed of the motor in all possible conditions or selecting the brake to GND condition. In all cases, a low-level state on the PWM pin turns off both the LSA and LSB switches.

2.2 Easy board connectors

The following figure shows the connectors pins of the EV-VNH9xxx easy board and the correspondent pins used to manage them in the EV-SPC582B.

Figure 3. Connectors

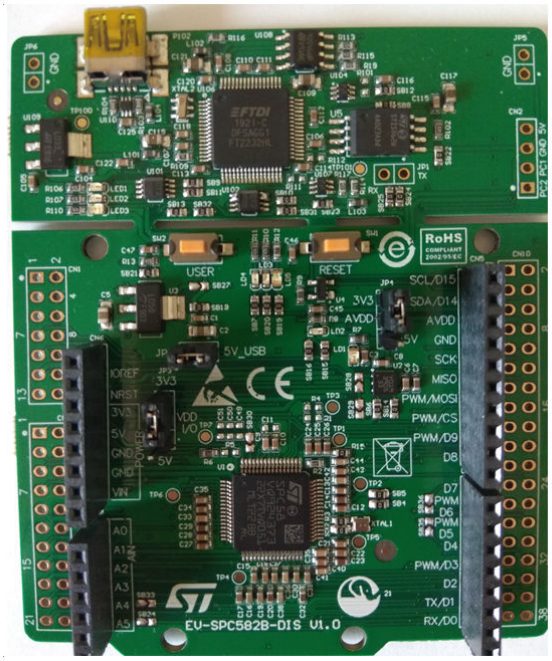


2.3 FW Download

EV-SPC582B board configuration

1. Put jumper on JP3 and JP4 on the right side (5 V)
2. Connect USB cable for board communication and programming.

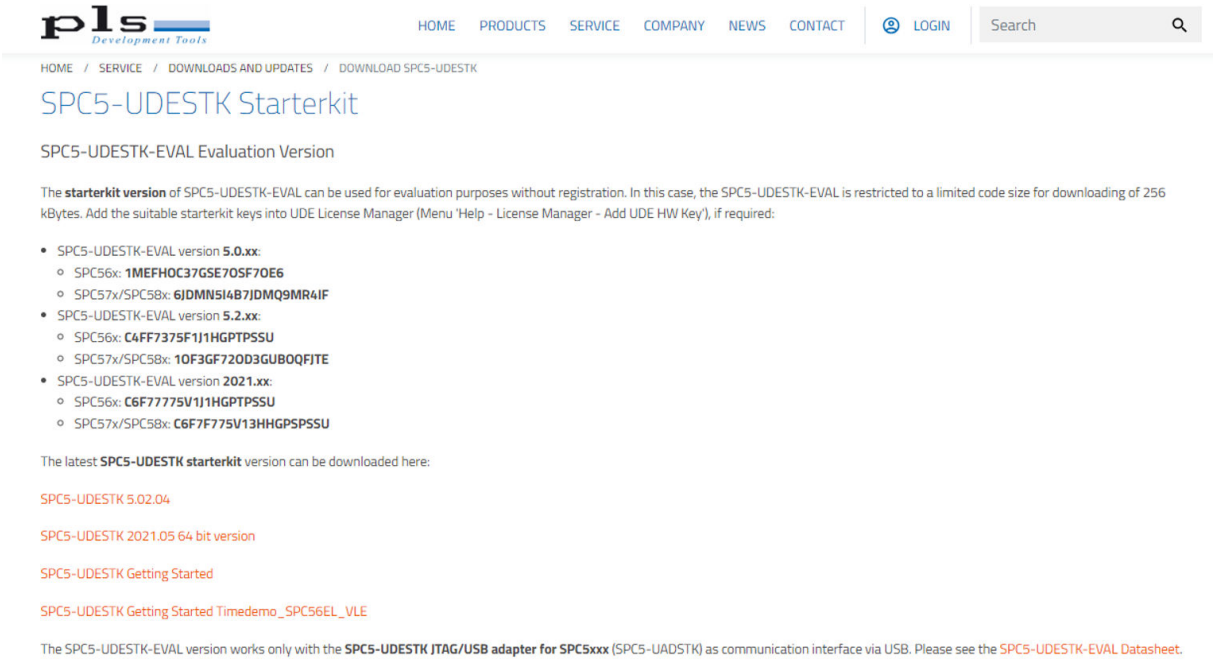
Figure 4. EV-SPC582B



2.3.1 UDE driver installation

Download tool: Go to https://www.pls-mc.com/service/downloads/download-spc5-udestk/

Figure 5. Download tool shema

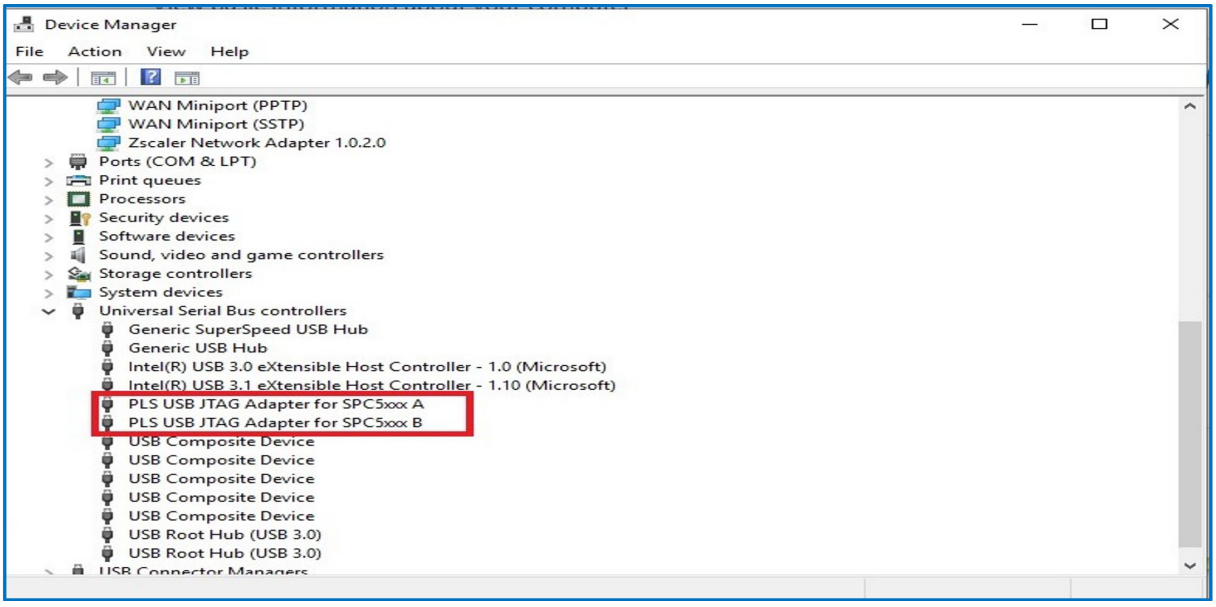


Click, download, and install the UDE tool SPC5-UDESTK 2021.05 64-bit version

2.3.2 Driver installation check

If driver installation is finished, connect the USB cable to the EV-SPC582B and open the device manager in Windows OS:

Figure 6. Driver installation

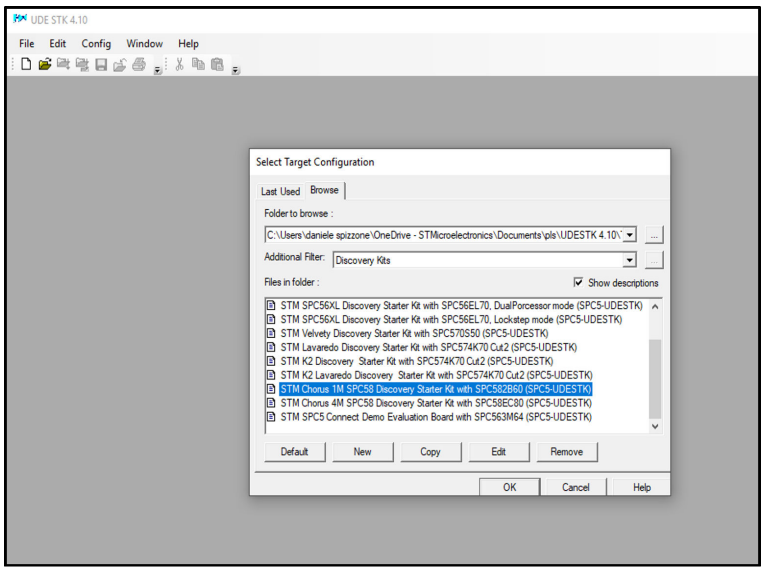


This two PLS controllers must have been recognized if everything went well.

2.3.3 Programming EV-SPC582B (new workspace creation)

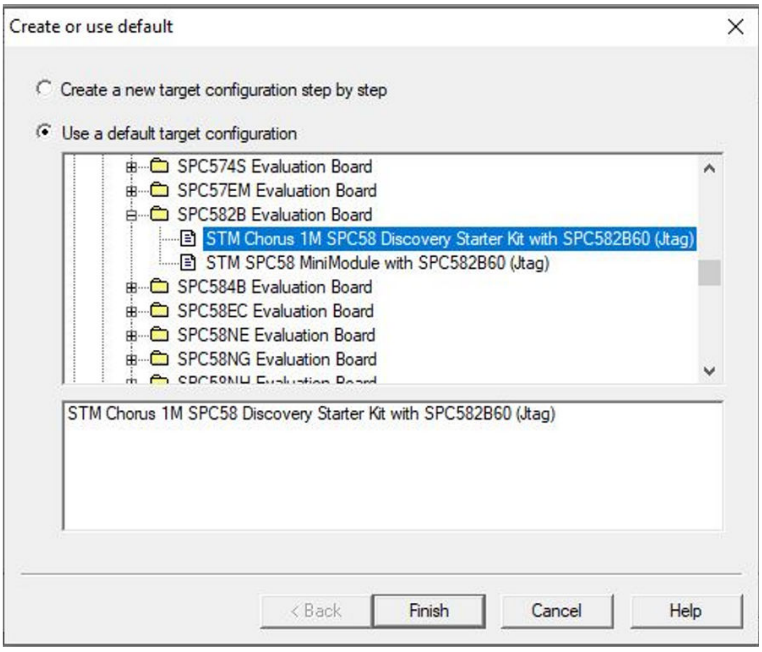
1. Plug USB cable to SPC582B
2. Execute UDE STK tool
3. Create a new workspace: go to File/New workspace
4. Configure the workspace: Click on default

Figure 7. New workspace creation



5. Configure the workspace:
   – Select use a default target configuration
   – Select STMicroelectronics chorus 1M SPC58 discovery starter kit
6. Click finish

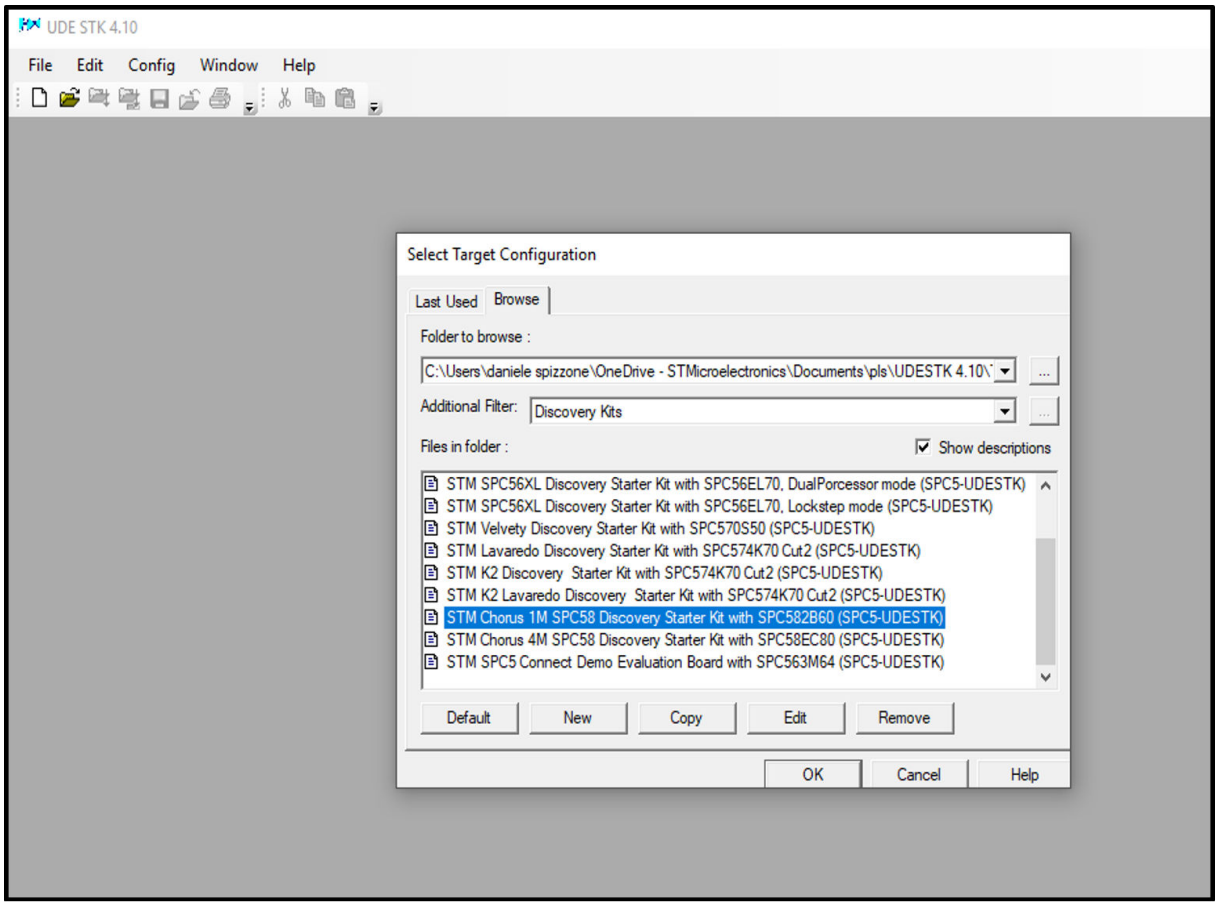
Figure 8. Programming



2.3.4 New workspace creation

1. Configure the workspace:
   - Additional filter: Discovery kits
   - Select STMicroelectronics chorus 1M SPC58 discovery starter kit
2. Click OK to finish

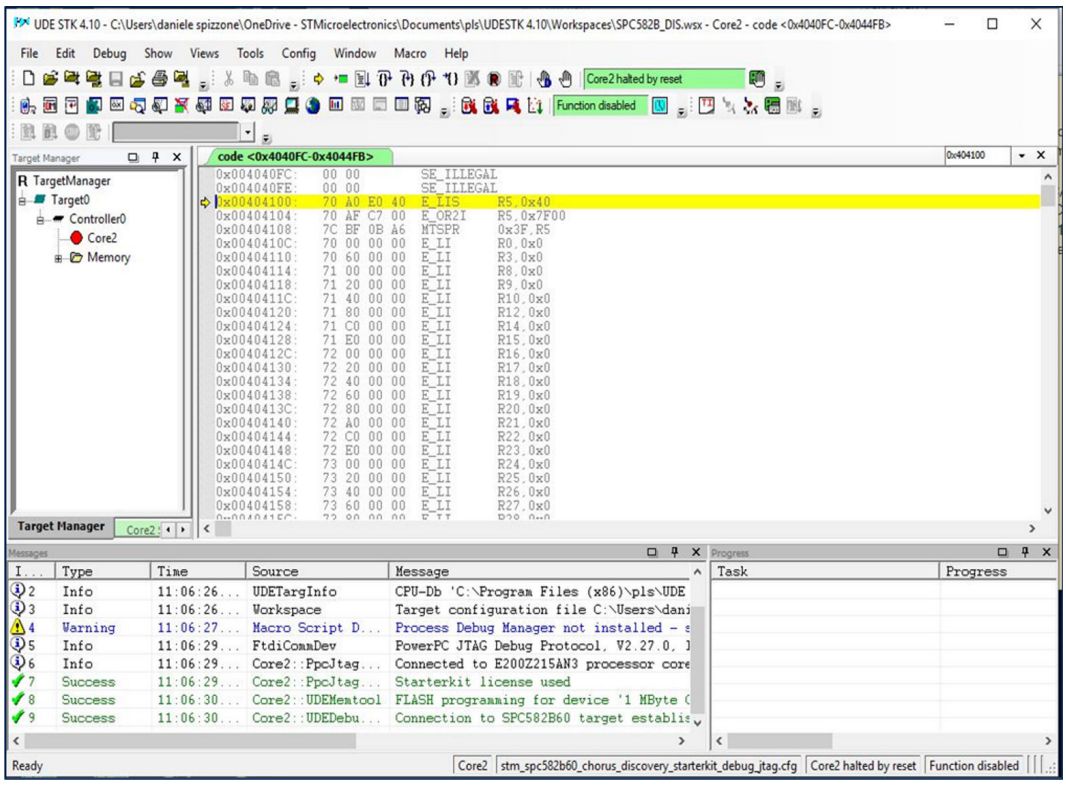
Figure 9. New workspace creation



2.3.5 Check connection

If the workspace was correctly created and the USB channel recognized, a success message in the messages box should appear.

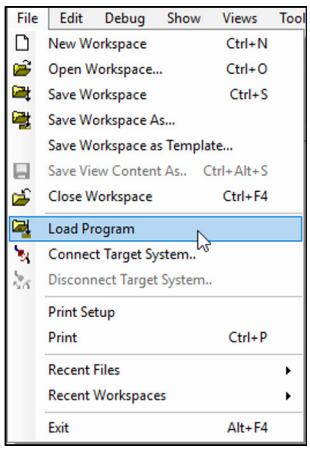
Figure 10. Check connection



2.3.6 Load .elf file

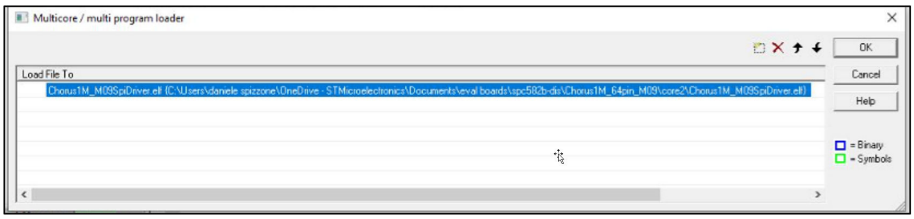
1. Click on File/Load program
2. Browse and select the .elf file to be loaded
   Figure x: Elf file

Figure 11. Load .Elf



3. Click OK

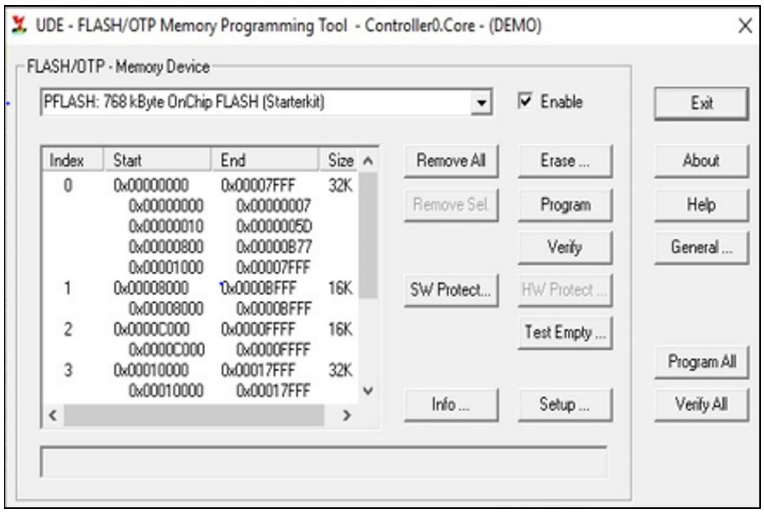
Figure 12. Click OK



2.3.7 Program .elf file

1. Click program all

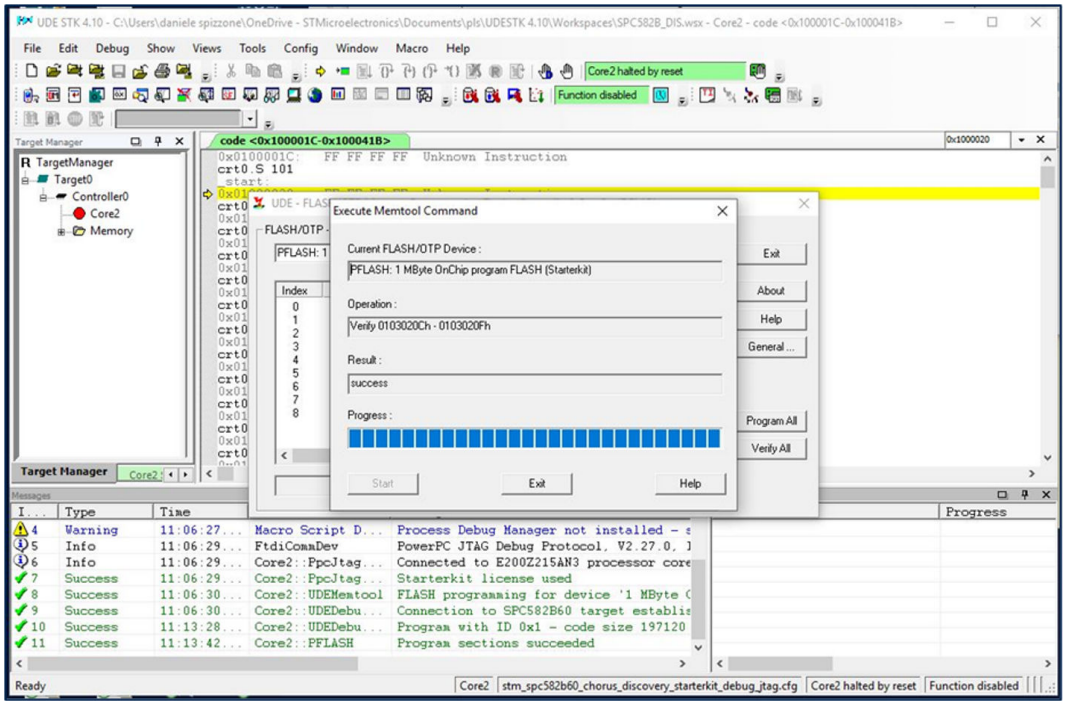
Figure 13. Program .elf



2.3.8 Check the programming result

1. If the board was programmed correctly a success message appears
2. Press exit and save workspace changes for the future use

Figure 14. Check



2.4 System connections

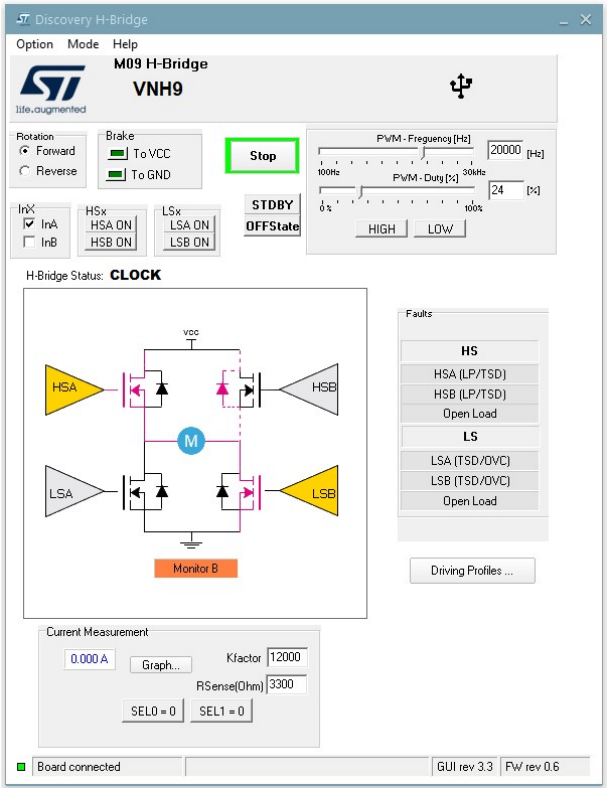
To ensure a successful launch of the GUI, please verify the following connections:

1. Ensure the USB connection between the PC and the EV-SPC582B is secure
2. Confirm that the 12 V power supply is properly connected between V_{CC} and GND connectors on the EV-VNH90xxAQ
3. Verify that the load is connected to the OUTA and OUTB connectors on the EV-VNH9xxx.

2.5 RUN GUI (graphical user interface)

For detailed information, please refer to STSW-EV-VNH9xxx (available on www.st.com).

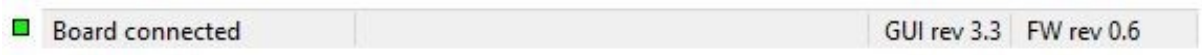
Figure 15. Clockwise



2.5.1 Check connection

After checking the connection and the power supply is ON check on the status bar below:

Figure 16. Check connection



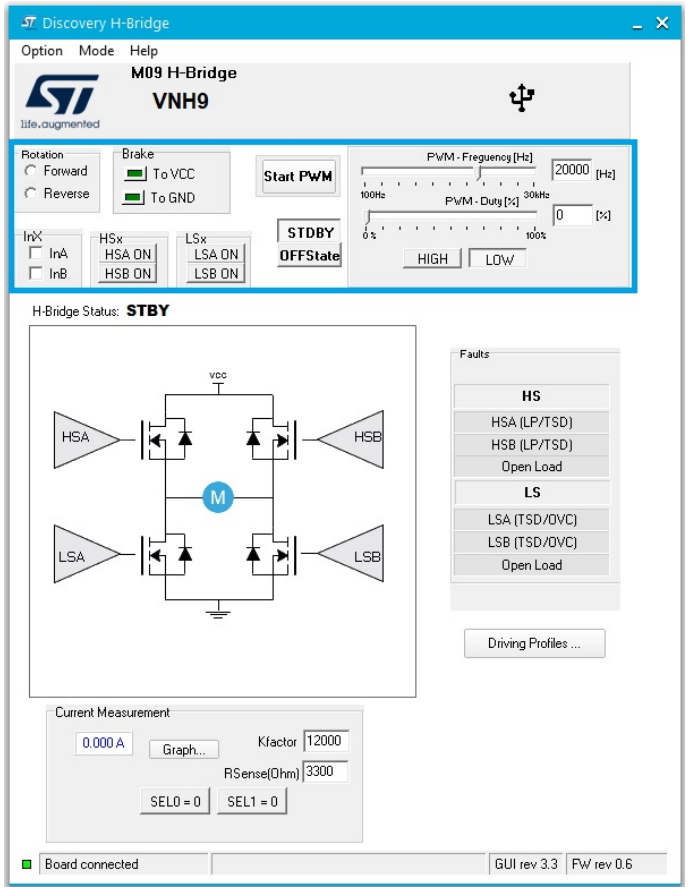
If the boards are connected and the communication is running well, this bar shows connection status (green light), GUI revision, and firmware revision.

2.5.2 MAIN control and settings

This section of the GUI enables users to manage various aspects of motor operation. Users can control the direction of load rotation by toggling between "forward" and "reverse," which adjusts the motor's rotational direction (clockwise or counterclockwise). They can also apply a braking condition by selecting either "Brake to VCC" or "Brake to GND."

Furthermore, users are able to drive each PowerMOSFET independently, as well as set the device to an off state or standby mode.

Figure 17. M09 H-Bridge



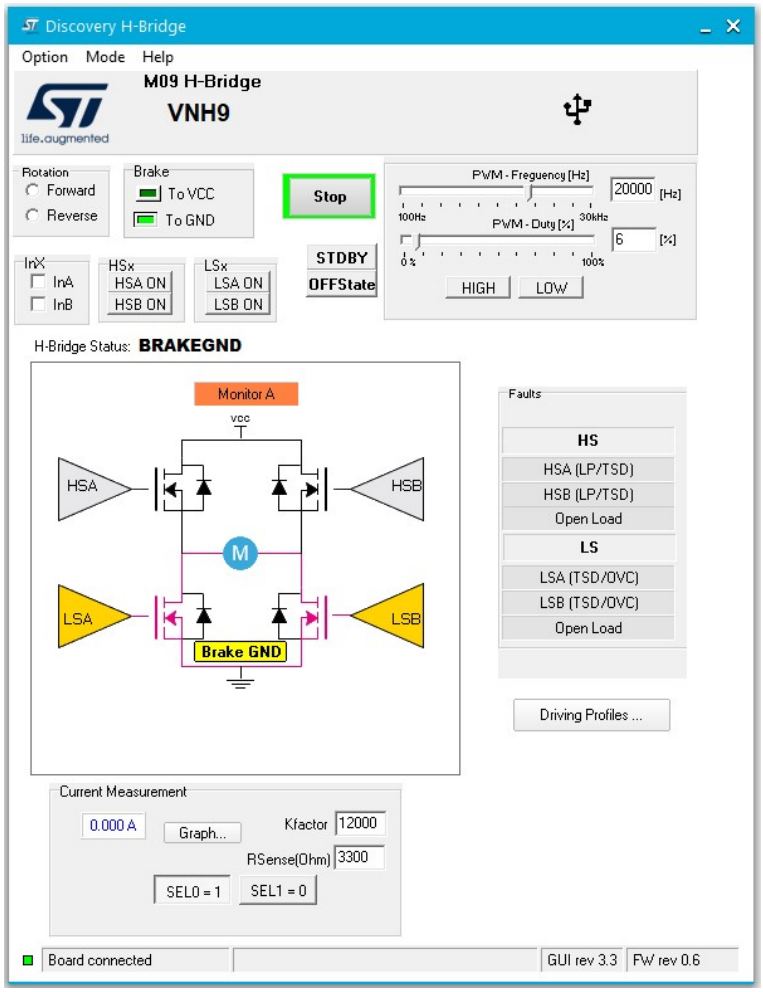
Here is an illustrative example:

1. Configure parameters: Set "Kfactor" and "RSense" in the "Current measurement" section.
2. Select rotation flag: Choose "Forward" or "Reverse" to drive the device in a clockwise or counterclockwise direction.
3. Set PWM parameters: Define the PWM frequency and duty cycle to control the low side switches.
4. Start PWM: Click on "Start PWM" to send the configuration to the EV-SPC582B.
5. Adjust States: Modify "SEL0" and "SEL1" states in the "Current measurement" section to monitor LegA or LegB.
6. Monitor activity: Click "Graph" under the "Current measurement" section to observe the H-Bridge current sense activity.

In “H-Bridge status” the user can monitor the device’s working state as it is shown in the following:

Brake to GND

Figure 18. **Brake to GND**



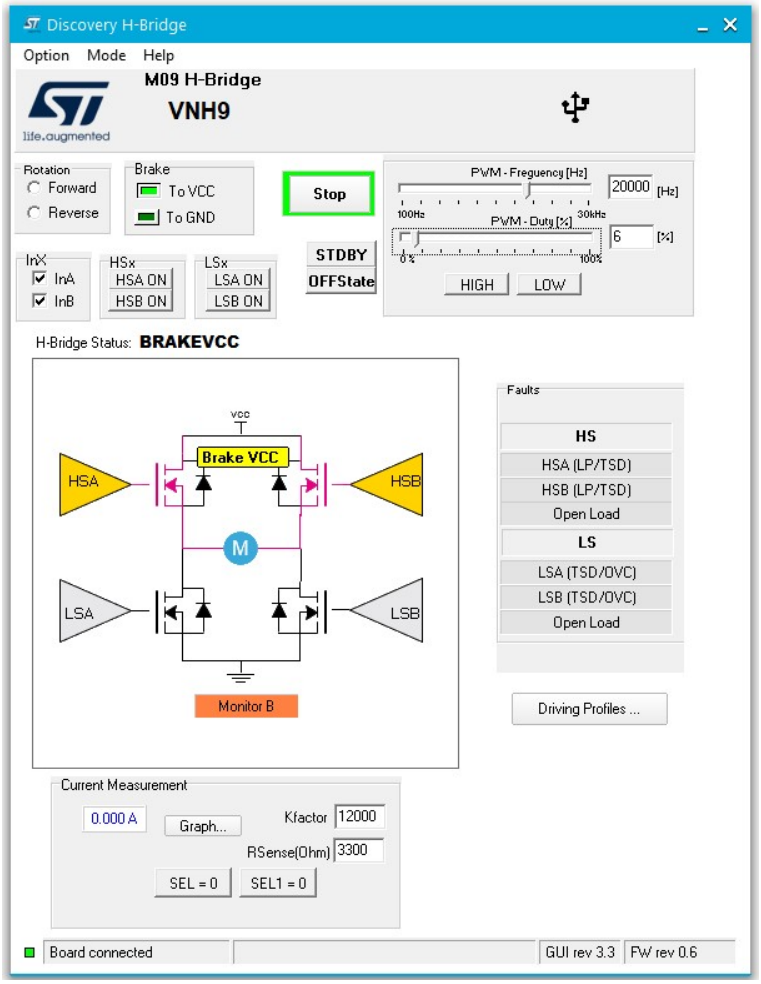
Inputs configuration:

- INA = INB = L
- PWM = H

Note: Setting the pin SEL1 = 1 and SEL0 = 0 (SEL1 = 1 and SEL0 = 1) it is possible to keep one leg in HiZ for half bridge configuration and diagnostic.

Brake to VCC

Figure 19. **Brake to VCC**



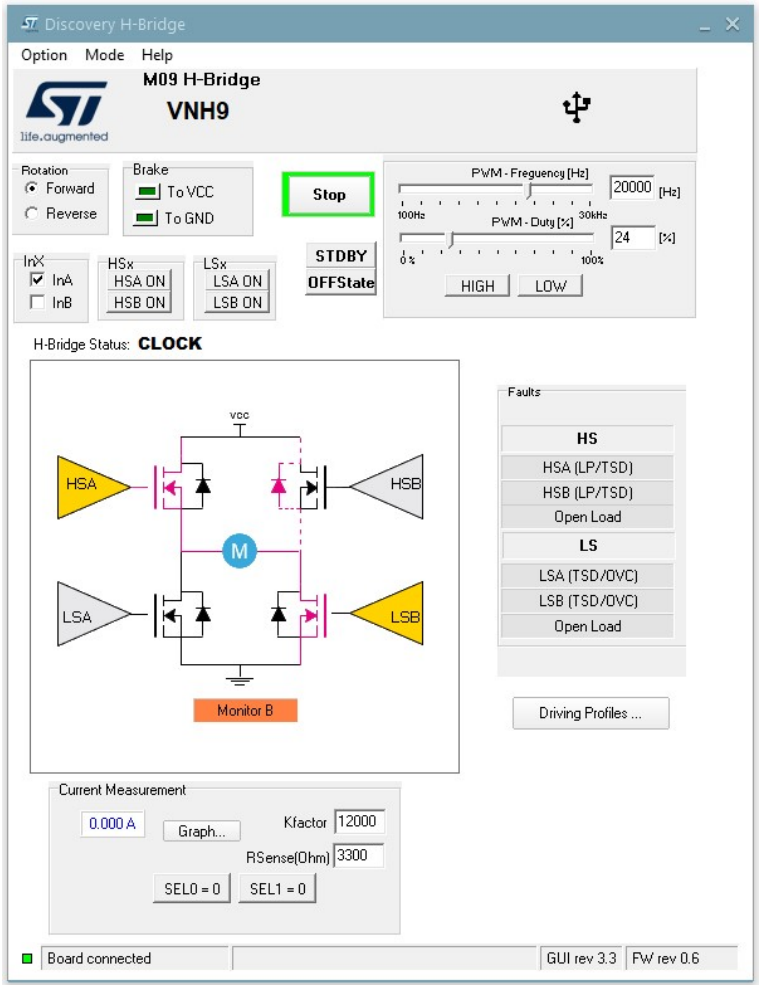
Inputs configuration:

- INA = INB = H
- PWM = L

Note: Setting the pin SEL1 = 1 and SEL0 = 0 (SEL1 = 1 and SEL0 = 1) it is possible to keep one leg in HiZ for half bridge configuration and diagnostic.

Clockwise

Figure 20. **Clockwise**



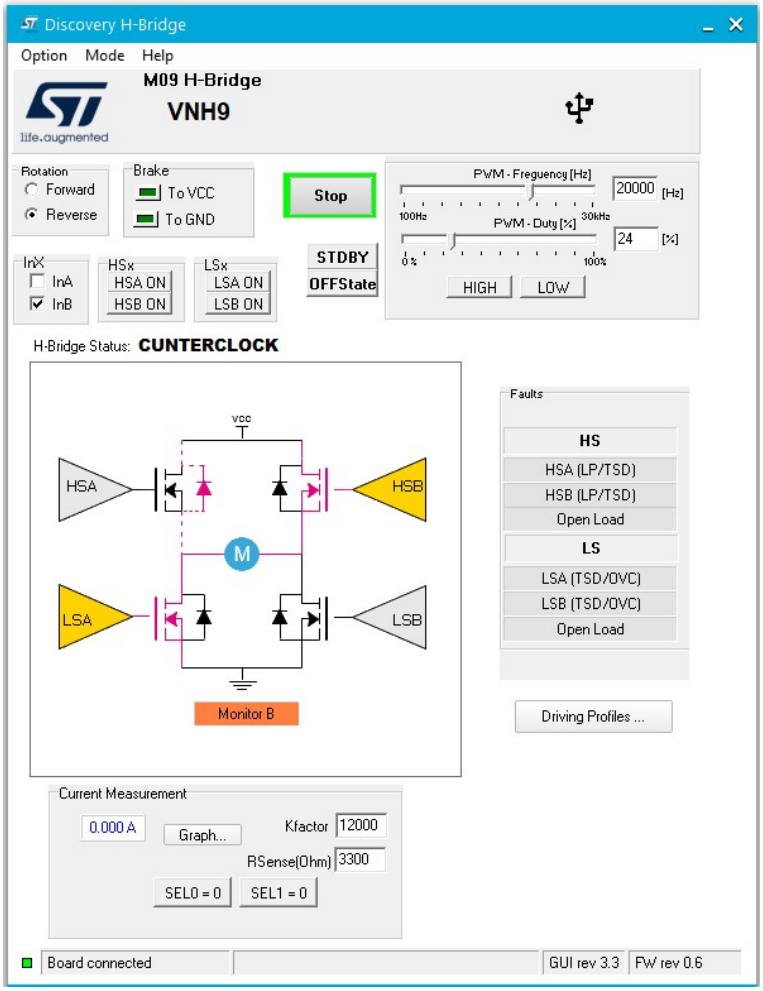
Inputs configuration

- INA = H
- INB = L
- PWM switching

Note: Correctly setting selectors it is possible to monitor current flowing through HSA.

Counterclockwise

Figure 21. **Counterclockwise**



Inputs configuration

- INA = L
- INB = H
- PWM switching

Revision history

Table 1. **Document revision history**

Date	Revision	Changes
17-Dec-2024	1	Initial release.

Contents

List of figures