Graphical user interface for STGAP4S

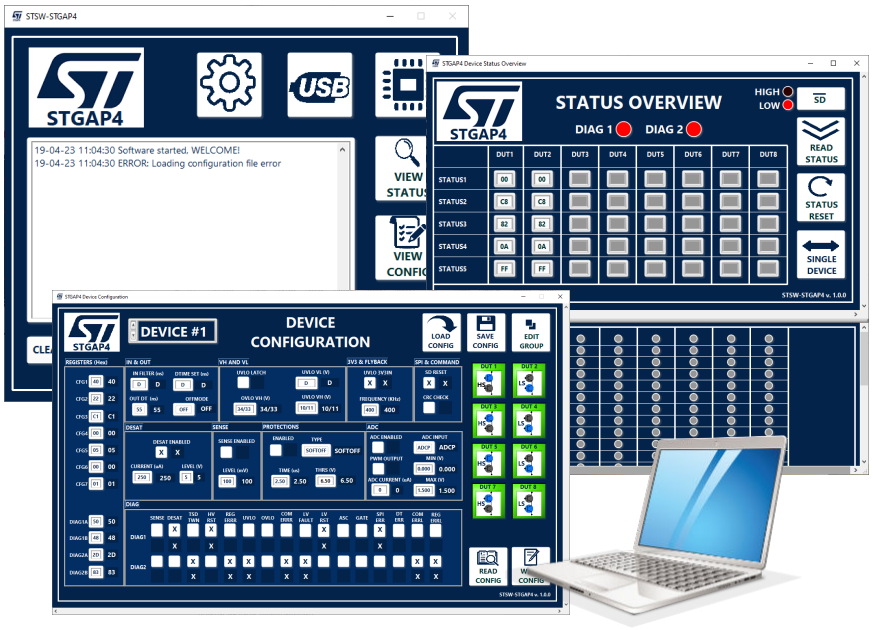
Introduction

The STGAP4S is an advanced galvanically isolated single gate driver for IGBTs and SiC MOSFETs provided with a wide set of features that are configurable through an SPI interface.

The STSW-STGAP4 is a PC user-friendly graphical user interface that allows to configure and monitor up to eight STGAP4S devices on EVALSTGAP4S boards connected through an SPI daisy chain to the microcontroller board STEVAL-PCC009V2.

A simple USB connection allows the GUI to communicate with the microcontroller board.

The user interface offers an outlook of all the registers of the STGAP4S devices connected, providing an easy view of the device status and diagnostics, and allows the configuration of all the available features. The configuration values can be saved in a file that can be recalled at any time.



1 Environment setup

1.1 Software tools required

The following software tools are required:

1. STSW-STGAP4 toolset, including the:
   – Installer folder of the user interface application (containing the STSW-STGAP4_Setup.exe)
   – Firmware file for the microcontroller board (STSW-STGAP4_FW.hex)
2. Programming software STM32CubePrg (download available from STMicroelectronics website).

1.2 Hardware tools required

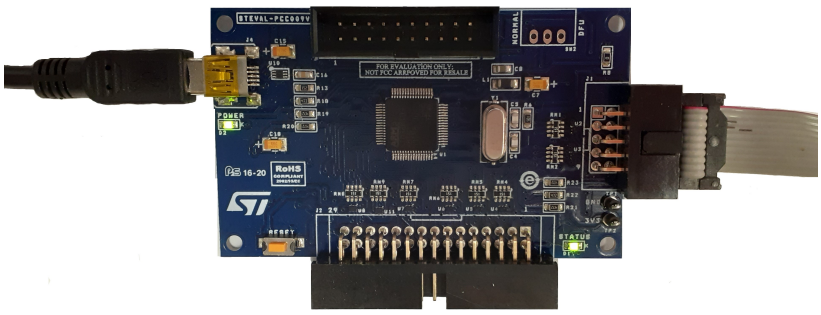
The following hardware tools are required:

1. The ST-LINK/V2 tool, for STM32 microcontroller programming, shown in Figure 1.

Figure 1. ST-LINK/V2 tool for microcontroller programming

2. The microcontroller board STEVAL-PCC009V2, shown in Figure 2.

Figure 2. Microcontroller board STEVAL-PCC009V2

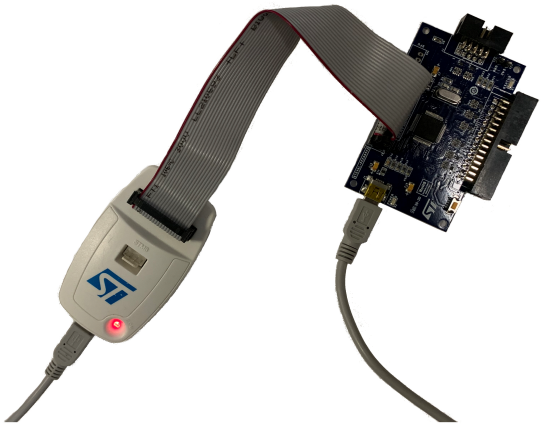


1.3 STEVAL- PCC009V2 firmware programming

If it is the first run, the STEVAL-PCC009V2 must be programmed with the dedicated firmware file (STSW STGAP4_FW.hex) included in the toolset.

Connect the ST-LINK/V2 programmer to the STEVAL-PCC009V2 board through the dedicated cable as shown in Figure 3.

Figure 3. ST-LINK/V2 connection to STEVAL-PCC009V2 board

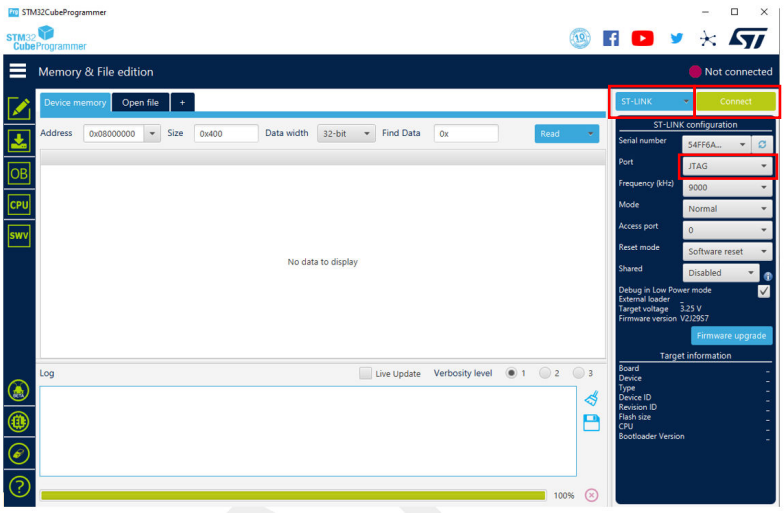


If the STM32 Cube programmer is not already installed on the selected PC, launch the installer file downloaded from the STMicroelectronics website and follow the automatic procedure for software installation.

Start the software and from the main panel check that the “ST-LINK” and “JTAG” port are selected.

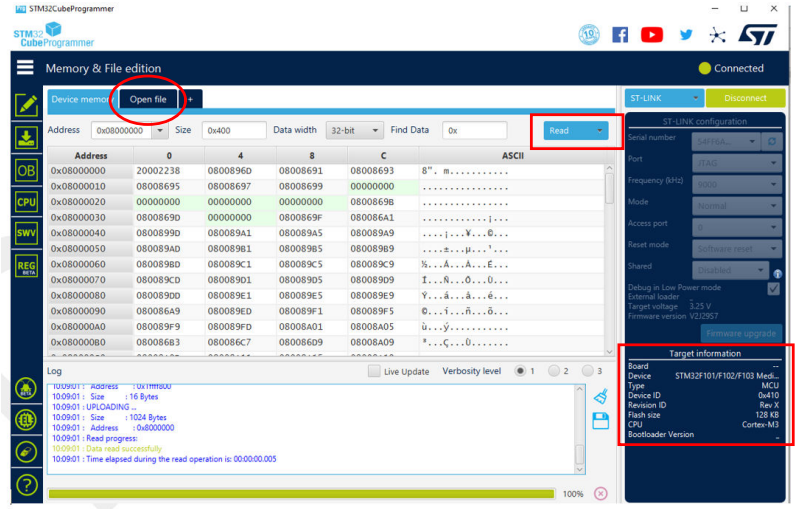
Click the “Connect” button and, if everything is ok, the software automatically recognizes the microcontroller connected. Check among the target information that the device is “STM32F103”.

Figure 4. STM32 cube programmer – main panel



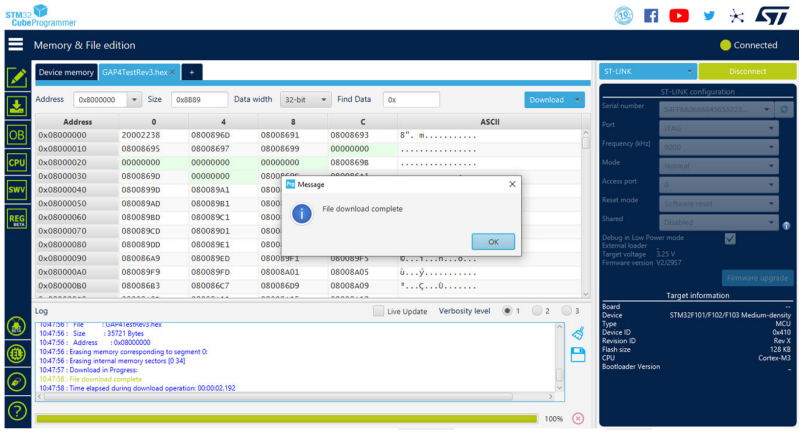
Click the “Open file” button and select the firmware file “STSW-STGAP4_FW.hex”. Click the “Download” button to program the microcontroller board.

Figure 5. **STM32 cube programmer – download panel**



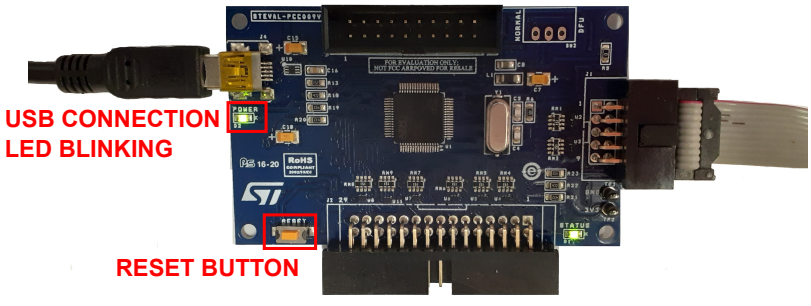
At the end, a message shows the result of the download operation.

Figure 6. **STM32 cube programmer – message of download completed**



If the programming operation is successfully completed, reset the microcontroller board clicking the reset button and check that the LED below the USB connector starts to blink, see Figure 7.

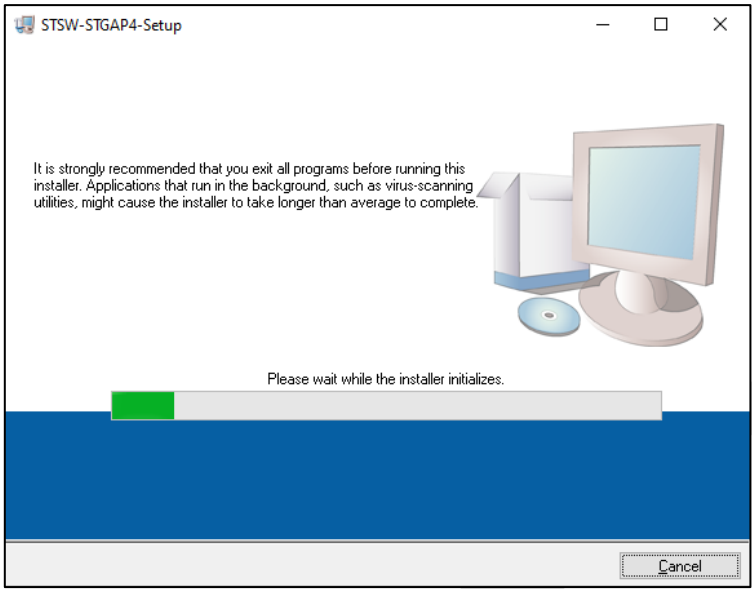
Figure 7. **STEVAL-PCC009V2 USB connection LED and reset button**



1.4 STSW-STGAP4 GUI software installation

Click on the installer file “STSW-STGAP4_Setup.exe” and follow the procedure to install the software.

Figure 8. Software installation



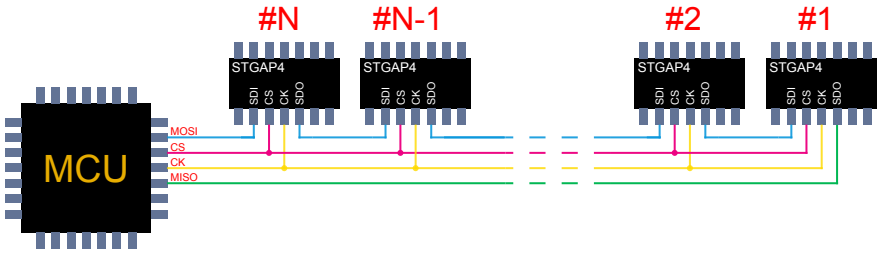
At the end of the installation, a shortcut link is available on the PC desktop:

Figure 9. GUI software shortcut link

1.5 Hardware connection

The STSW-STGAP4 GUI allows the configuration and monitoring of up to eight devices connected through an SPI daisy chain. The software enumerates the devices according to the data return order to the microcontroller board assigning the #1 to the first returned data.

Figure 10. Device enumeration in SPI daisy chain



The STEVAL-PCC009V2 can be used in combination with the EVALSTGAP4S or any other board with the STGAP4S devices connected in daisy chain. For details about the connection of the EVALSTGAP4S, refer to the related user manual. In Figure 11 an example with a single EVALSTGAP4S is shown while Figure 12 reports the devices enumeration when four EVALSTGAP4S are connected together composing an eight-device daisy chain.

Figure 11. Single board connection – two devices daisy chain

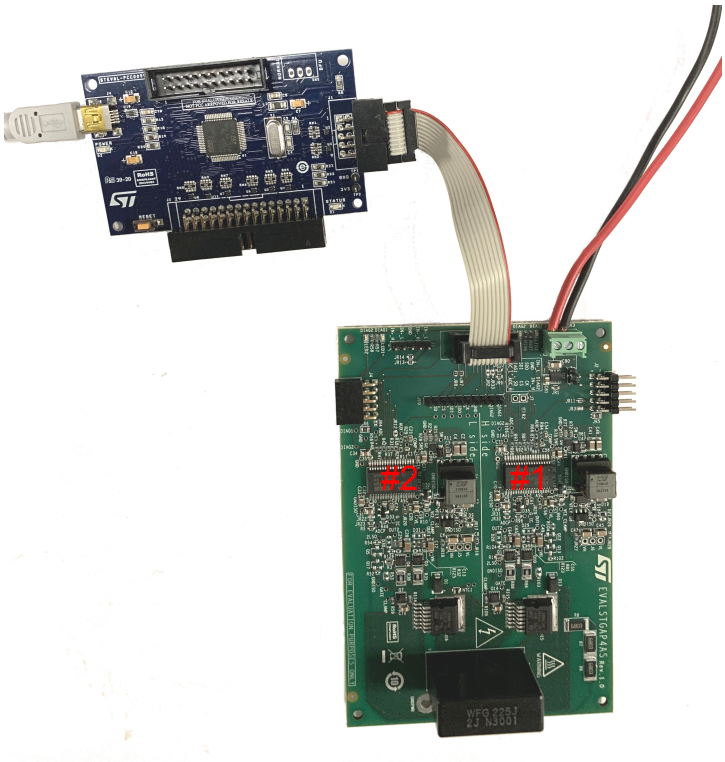
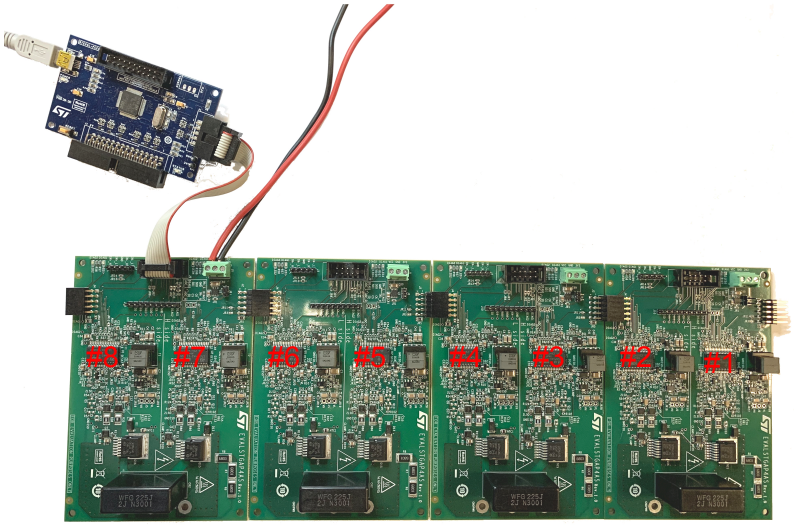


Figure 12. **Multiple boards daisy chain connection example**

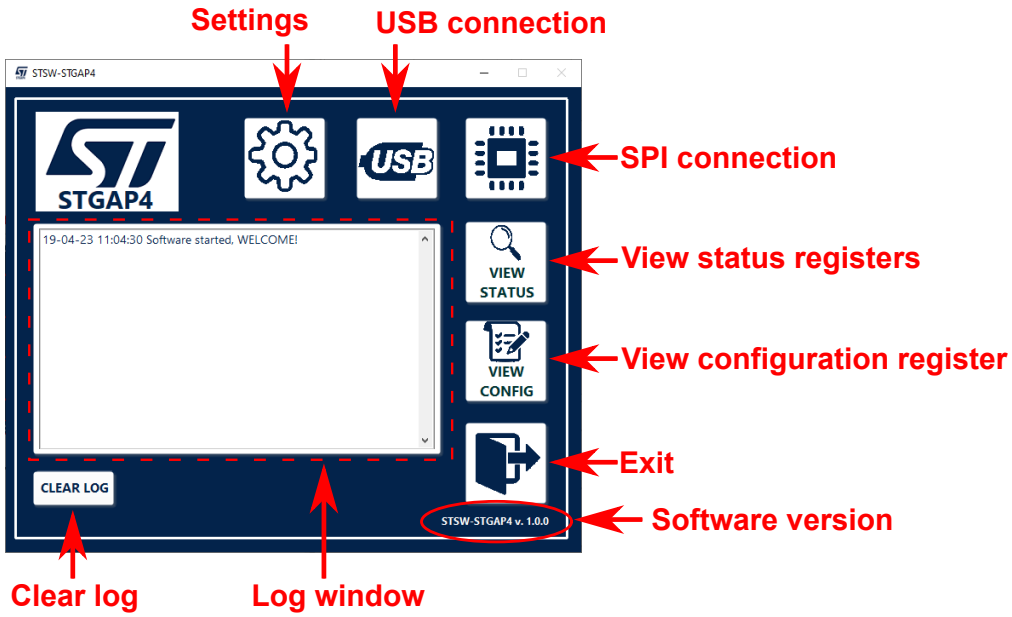


2 GUI execution

2.1 Main panel

Double clicking the software shortcut link the software is executed and the main panel appears on the screen. The main panel is shown in Figure 13:

Figure 13. Main panel



The following steps must be sequentially executed to establish the communication between the GUI and the EVALSTGAP4S:

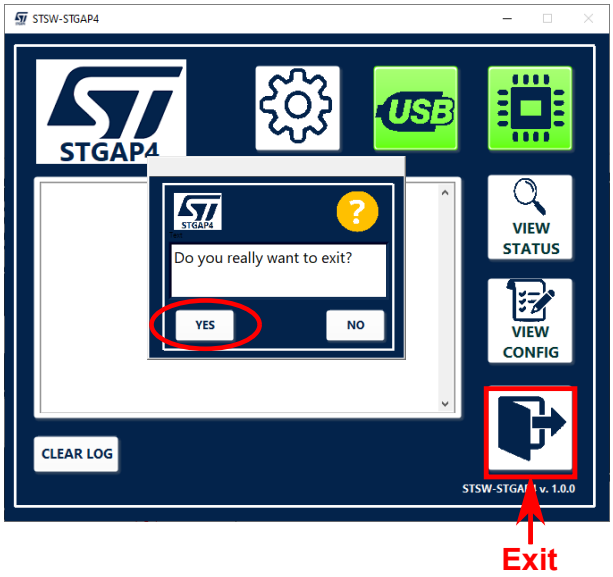
1. Configure the connection parameters: “Settings” button (see Section 2.2)
2. Start the USB communication: “USB” button (see Section 2.3)
3. Start the SPI communication: “SPI” button (see Section 2.4)

Once the communication is established the devices can be monitored using the “View status registers” panel (see Section 3) and configured using the “View configuration register” panel (see Section 4).

The outcome of each operation can be checked in the “Log windows” (see Section 2.5).

Clicking the Exit button in the Main panel a confirmation message opens and by clicking the “Yes” button the application is closed.

Figure 14. **Exit button and message**



2.2 Settings panel

Click the “Settings” button in the Main panel to open the “Settings panel” window:

Figure 15. **Settings button in the main panel**

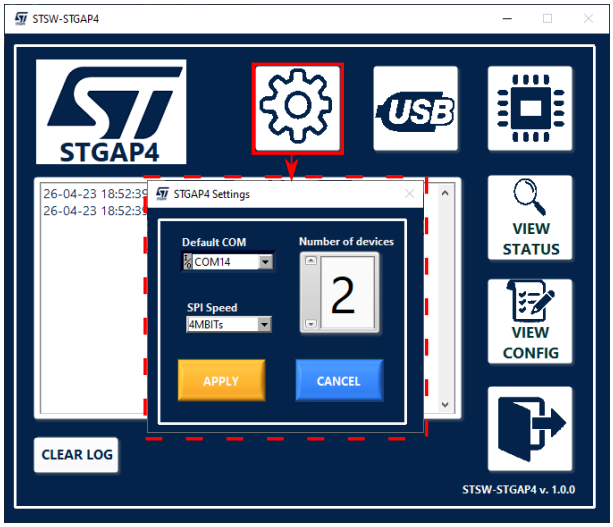
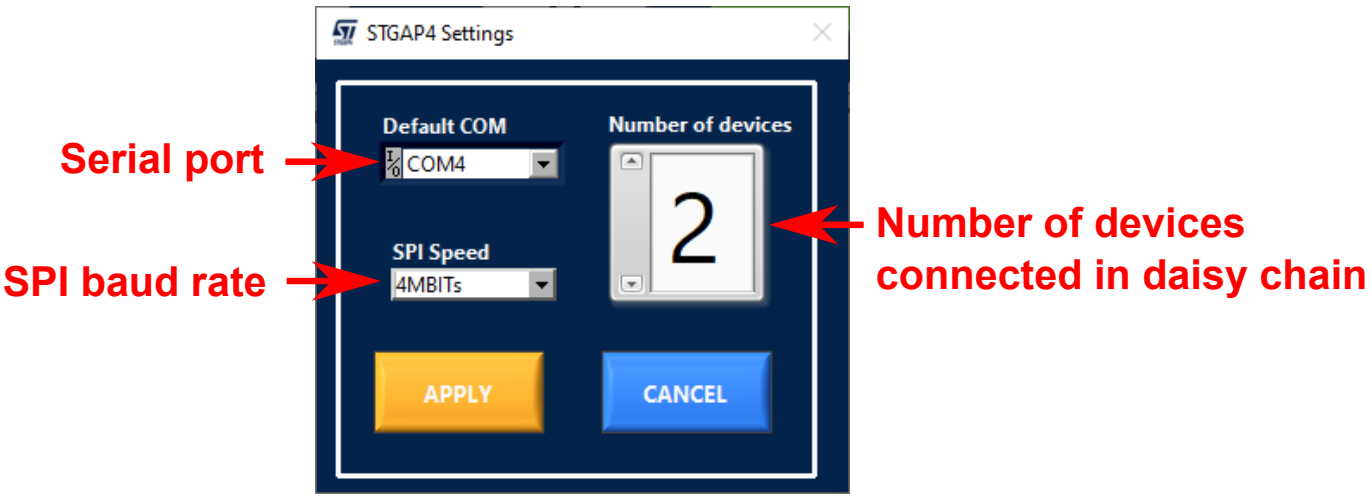


Figure 16. **Settings panel**



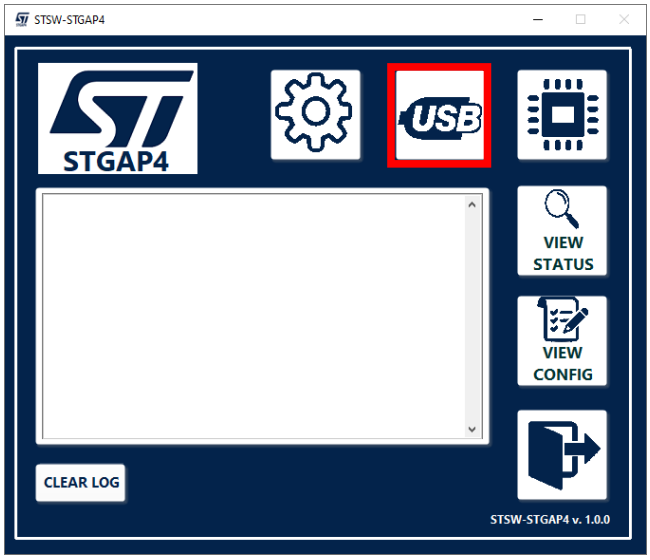
The following parameters must be configured:

- **Number of devices connected in the SPI daisy chain:** this parameter must be exactly matched to the number of STGAP4S devices in the chain otherwise the communication fails. The software can manage up to 8 devices. Refer to the EVALSTGAP4S user manual for the hardware setup.
- **Default COM serial port:** it is the default serial port (virtual COM port) used by the USB connection. When the USB connection is started (see Section 2.3) the software firstly checks the connection with the STEVAL-PCC009V2 microcontroller board using the indicated COM port. In case the connection fails the software automatically tests all the other available ports trying to find the connection with STEVAL-PCC009V2.
- **SPI speed baud rate:** it is the SPI communication baud rate. The maximum value allowed using the STEVAL-PCC009V2 microcontroller board is 4Mbit/s. It is suggested to use the maximum value to allow the configuration of the STGAP4S devices in the chain within the configuration timer (refer to the STGAP4S datasheet for the value and details).

2.3 USB connection

Click the USB connection button in the Main panel to establish the communication between the GUI software and the STEVAL-PCC009V2 microcontroller board.

Figure 17. USB connection button in the main panel



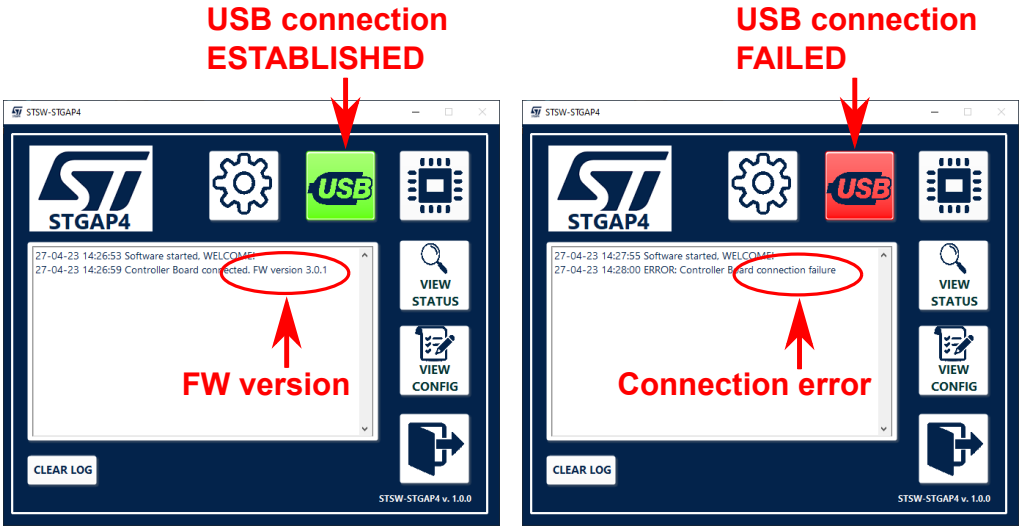
The software starts to ping all the COM ports available in the PC beginning from the “Default COM” indicated in the Settings panel (see Section 2.2). This operation ends in two cases:

- as soon as the communication with the microcontroller board is successfully established and in this case the USB connection button is highlighted in green
- if no communication can be established after checking all the available COM ports and in this case the USB connection button is highlighted in red

The Log window shows the result of the USB connection operation, and when successful, the firmware version installed on the controller board is displayed.

If the communication cannot be established check the USB cable and if the STEVAL-PCC009V2 microcontroller board is correctly programmed.

Figure 18. USB connection

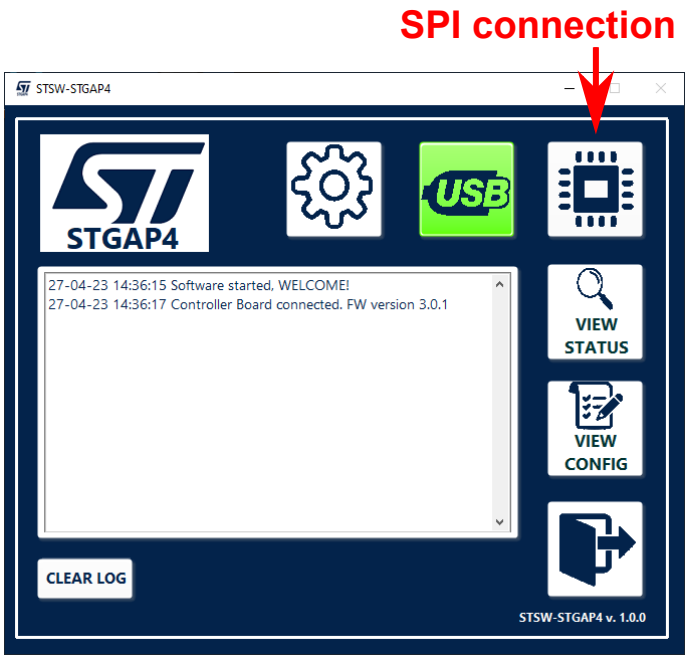


2.4 SPI connection

Once the USB communication is established, the controller board is ready to be connected to the STGAP4S devices in the SPI chain. Before proceeding check that the EVALSTGAP4S is correctly connected to the STEVAL-PCC009V2 microcontroller board through the dedicated flat cable (see Section 1.5 and the EVALSTGAP4S user manual for details).

Click the SPI connection button in the Main panel to establish the communication between the STEVAL-PCC009V2 microcontroller board and the STGAP4 devices in the SPI chain.

Figure 19. SPI connection button in the main panel



If the SPI communication is successfully established, the SPI connection button is highlighted in green and the LED of the microcontroller board controller board are fixed on.

If the SPI communication fails, the SPI connection button is highlighted in red, and the controller SPI connection LEDs start to blink. In this case, check the SPI connection flat cable, the EVALSTGAP4S power supply and setup (refer to EVALSTGAP4S user manual for details).

Figure 20. SPI connection

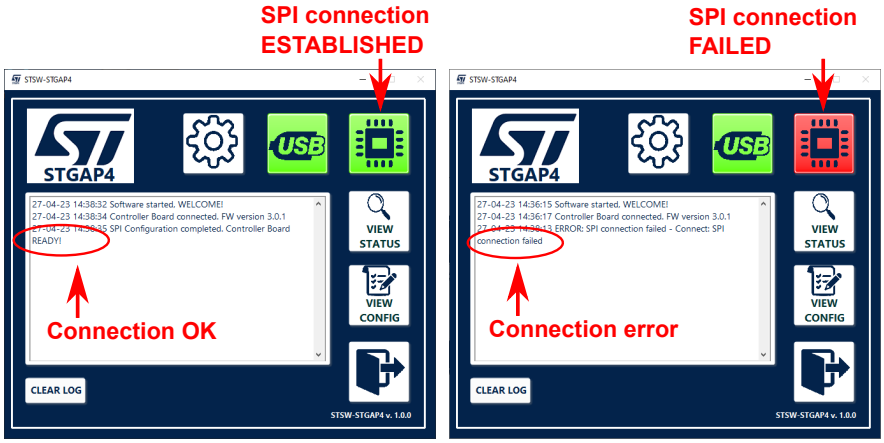


Figure 21. **STEVAL-PCC009V2 - SPI connection successful**

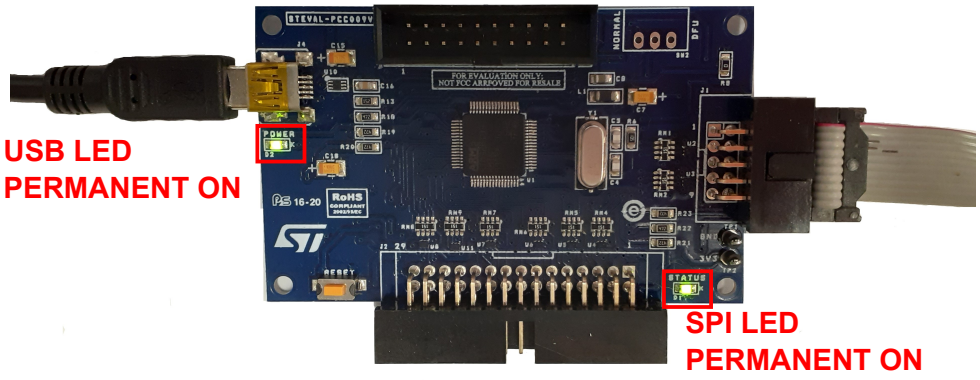
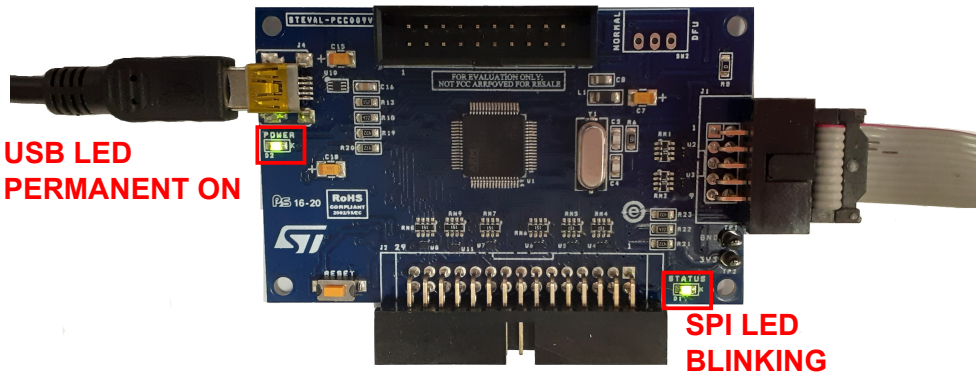
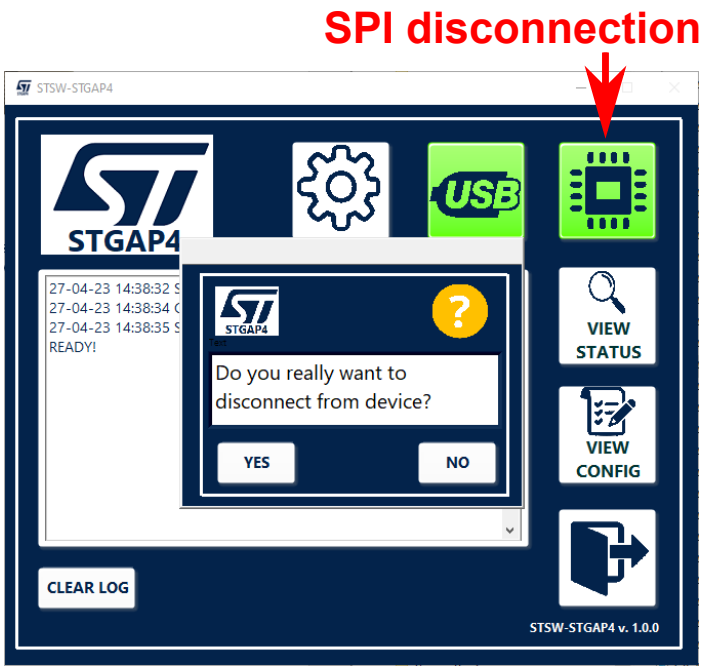


Figure 22. **STEVAL-PCC009V2 - SPI connection error**



Once the SPI connection process is successfully completed, the Settings button is locked and to change the parameters described in Section 2.2 the SPI communication must be first disconnected. The disconnection can be done by clicking the SPI communication button. A confirmation message is shown and if the “Yes” button is clicked, the disconnection is executed.

Figure 23. **SPI disconnection**

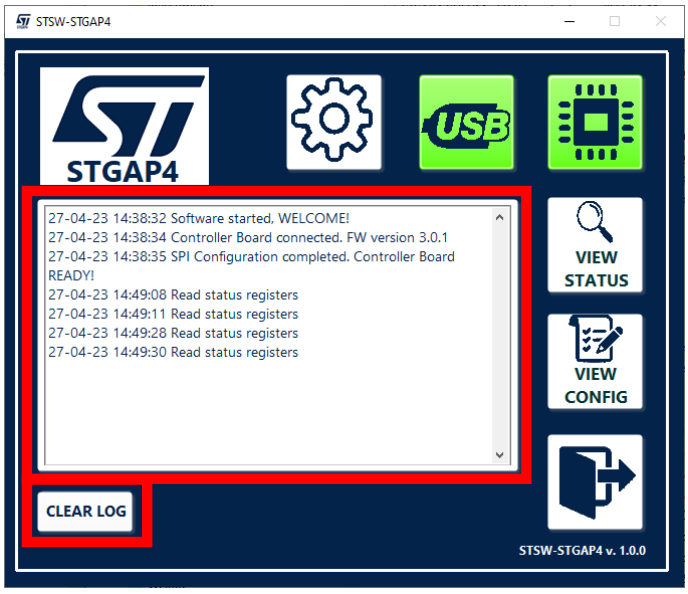


Once the SPI disconnection is executed, the Settings panel parameters can be edited (see Section 2.2).

2.5 Log window and clear log button

The Log window displays the description and the outcome of each operation done. The list can be scrolled by using the lateral bar and click the “ClearLog” button to delete all the displayed messages.

Figure 24. **Log window and clear log button**



3 View status registers panel

Once the SPI communication is successfully established (see Section 2), the user can access the STATUS registers of the STGAP4S devices clicking the View Status button.

Figure 25. View status button

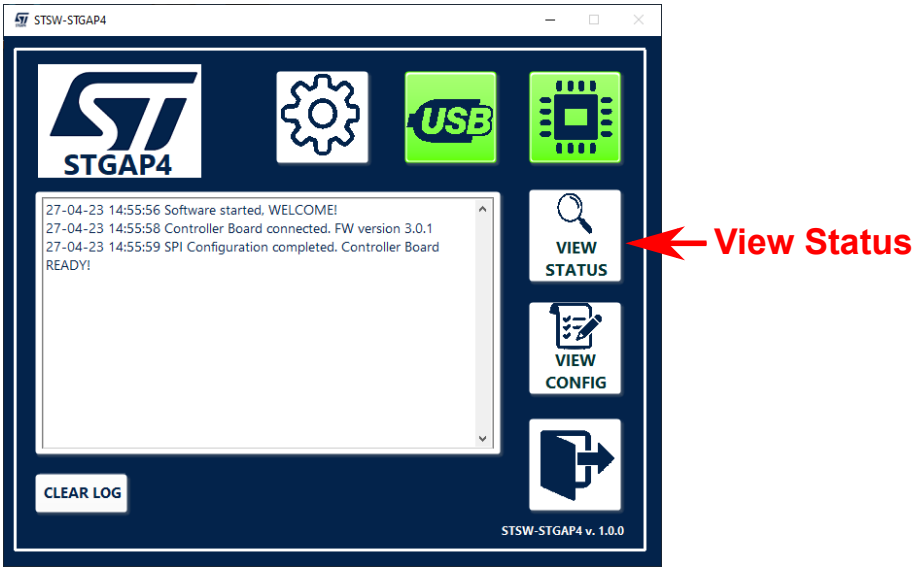
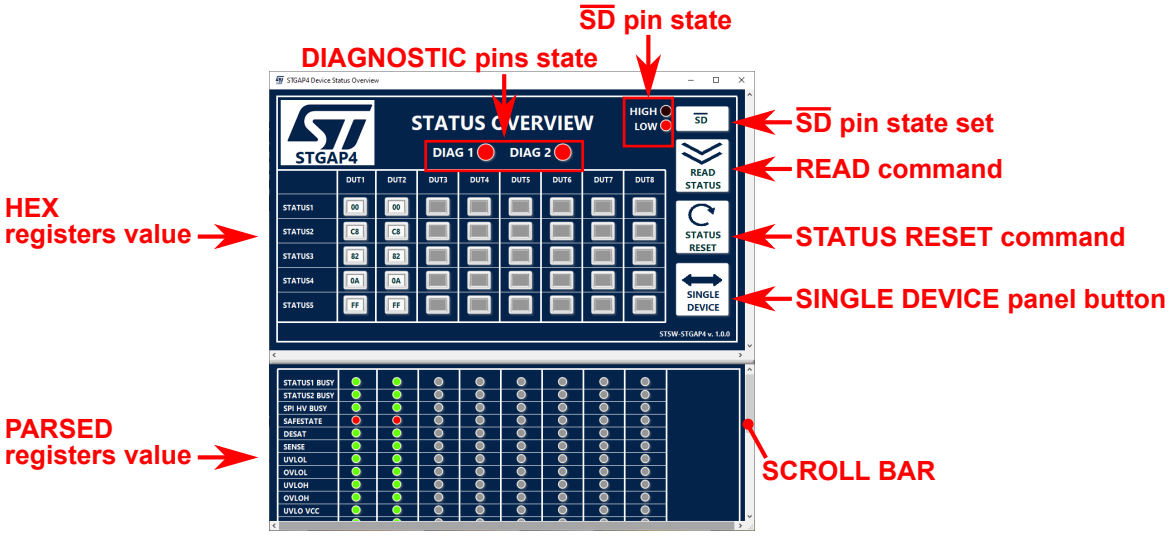


Figure 26. View status panel

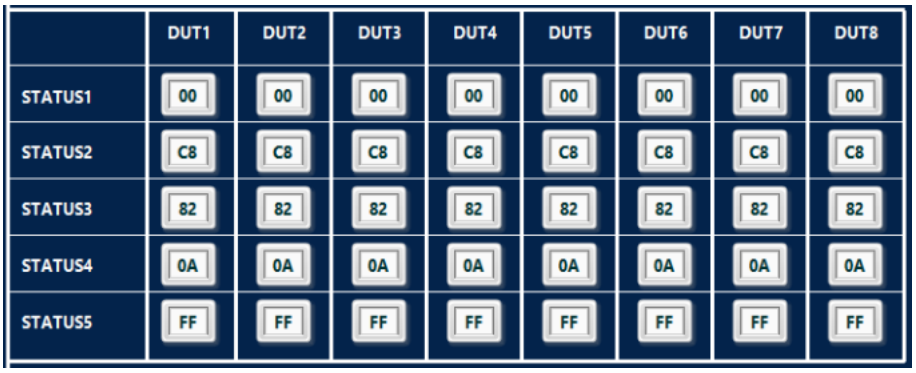


The “STATUS panel” allows to monitor the STATUS registers of all the connected devices in a single view and execute reading and reset operations. Details are given in the following sections.

3.1 Status register value

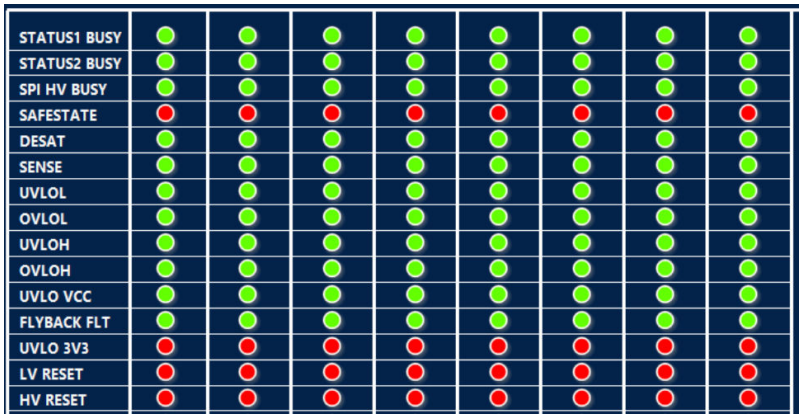
The hexadecimal value of the content of the registers is reported in the upper part of the window. Each column reports an STGAP4S device enumerated as described in Section 1.5. The number of columns highlighted corresponds to the number of the devices present in the SPI daisy chain and previously selected in the Settings panel as described in Section 2.2.

Figure 27. Hexadecimal status registers values



The same content is present in the lower part of the window where every single bit of each register is parsed for more immediate comprehension. The scroll bar can be used to go through the list.

Figure 28. Status registers parsed value



Two types of indications can be found depending on the bit purpose.

Figure 29. Bits indication

The value reported is updated when a Read Status command is executed (see Section 3.3) and at the opening of the window.

3.2 Diagnostic outputs

The panel reports the state of the open drain diagnostic outputs DIAG1 and DIAG2 that are updated in real-time. The indication is the same as the LEDs connected to the DIAGx pins in the EVALSTGAP4S, thus:

- red highlighted when the LED in the board is on, which means DIAGx is in low state
- not highlighted when the LED in the board is off, which means DIAGx is in high impedance

With more STGAP4S devices connected together, like in a single EVALSTGAP4S board, each diagnostic output shown in the panel is the cumulative (OR function) of all the devices connected. Thus, DIAG1 is the cumulative of the DIAG1 pins of all the devices connected and the same is true for DIAG2. The related indication in the panel is highlighted if at least one DIAGx output is low. Refer to EVALSTGAP4S user manual for more details.

Figure 30. DIAGx state reporting example

DIAG1 LED OFF
ALL THE DIAG1 ARE HiZ

DIAG2 LED ON
AT LEAST ONE DIAG2 IS LOW

3.3 Read status and reset status

By clicking the “Read Status” button (see Figure 26) the GUI executes the read of all the STATUS registers of all the devices connected in the SPI chain. The STATUS registers' values reported in the windows, both the hexadecimal and the parsed, are consequently updated.

By clicking the Status Reset button (see Figure 26) the GUI executes the status reset command of all the devices connected in the SPI chain. After the status reset command, the GUI executes also a read to update the value of the registers reported in the window.

3.4 Shutdown button

The “Shutdown” button controls the state of the pins of the connected devices. Clicking the button, the pin state toggles between HIGH and LOW. The state of the pins is reported highlighting the related indication in the window.

Figure 31. SD pin state toggling

After the write operation of the configuration registers (see Section 4), the pin is automatically set low.

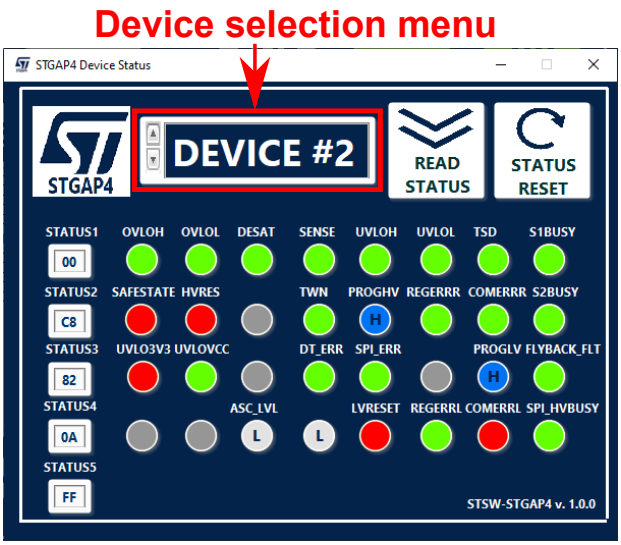
3.5 Single device status panel

Clicking the “Single device” button, the single device status panel opens.

The panel shows the content of the STATUS registers of the single device that has been selected in the selection menu in the top of the window, as shown in Figure 32. Like in the “View status registers” panel:

- both the hexadecimal and single parsed bit values are reported (see Section 3.2)
- a Read Status and a Reset Status button are available (see Section 3.3)

Figure 32. Single device panel



4 View configuration registers panel

Once the SPI communication is successfully established (see Section 2), the user can access the configuration registers of the STGAP4S devices clicking the “View Config” button.

Figure 33. View config button

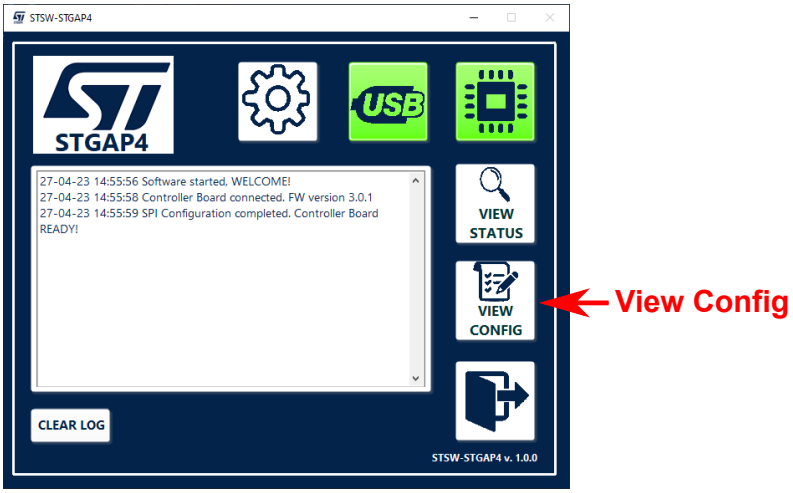
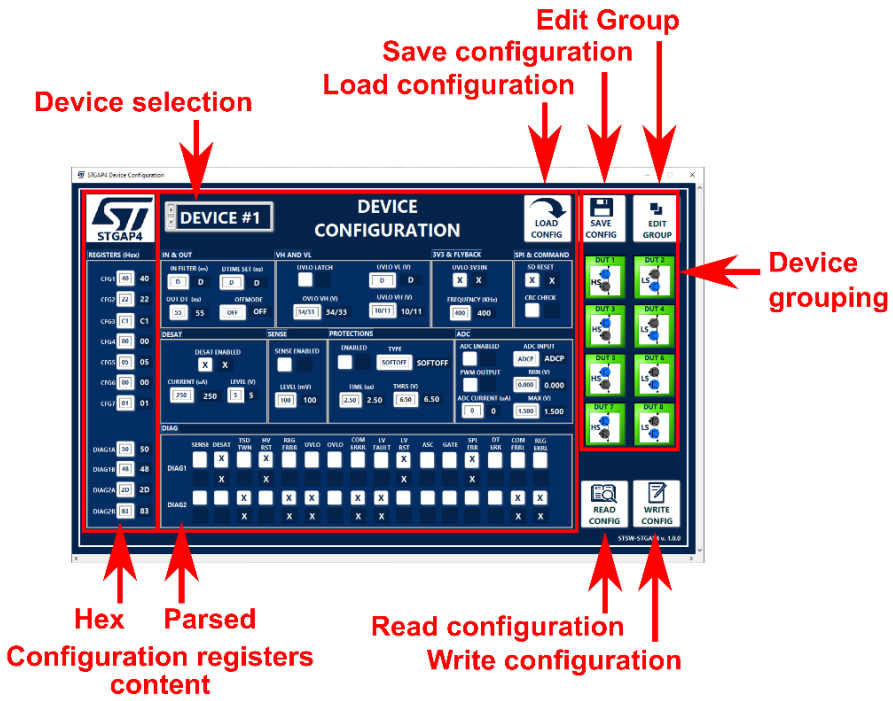


Figure 34. View config panel



The “Configuration panel” allows to read and write the configuration registers of the connected devices. Details are given in the following sections.

4.1 Device selection menu

In the “View Config” panel the content of one device at a time is shown. The device currently displayed can be selected in the “Device selection” menu in top of the window. The devices are enumerated as described in Section 1.5.

Figure 35. Device selection menu

Two virtual devices, named LS GROUP and HS GROUP, are present in the list (refer to Section 4.4 for details about the devices grouping).

4.2 Configuration registers content

The content of the configuration registers of the selected device is reported in two formats:

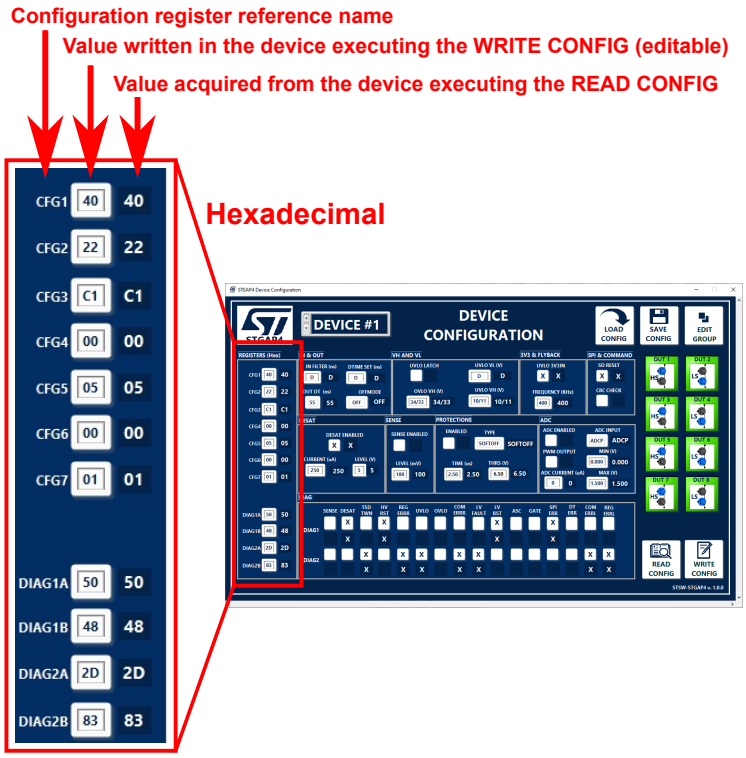
- hexadecimal value, in the left of the window
- parsed value, in the center of the windows

HEXADECIMAL VALUE

Two fields are available for each register:

- the field with a white background is editable by the user and reports the hex value that the software writes in the device when the WRITE CONFIG command is executed clicking the related button
- the field with a blue background is not editable by the user and reports the value that the software acquires from the device when the READ CONFIG command is executed clicking the related button

Figure 36. Config panel hexadecimal values



PARSED VALUE

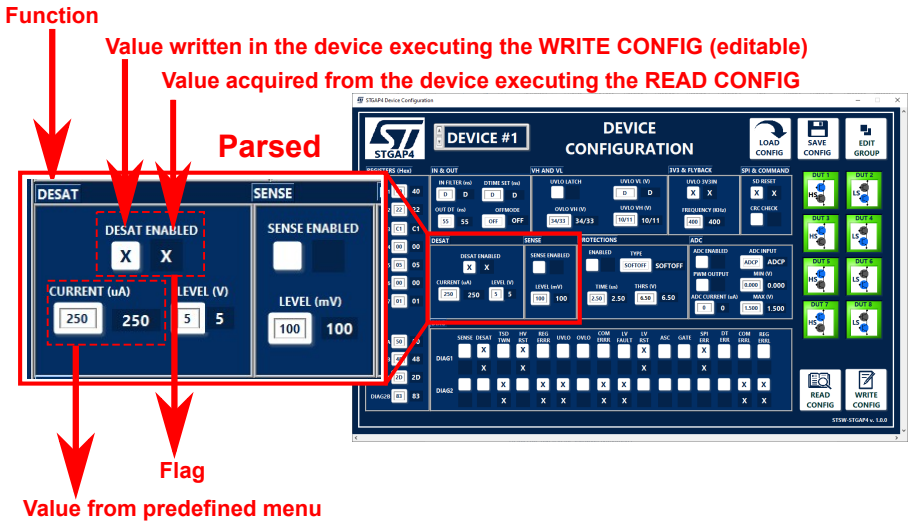
The same content present in the hexadecimal fields is parsed and reported grouped by function. When a hexadecimal value is edited, the corresponding parsed values are updated and, vice versa, changing a parsed value modifies the hexadecimal value of a register.

Also in this case, two types of fields can be found, a white background and a blue background, as already described for the hexadecimal values.

Two types of data can be found for the parsed values:

- numeric: the editable value must be selected from the predefined menu available clicking the related field
- flag: an X indicates that the related single bit is set “1”

Figure 37. **Config panel parsed values**



4.3 Read config and write config button

Clicking the “READ CONFIG” button (see Figure 34), the software executes the reading of all the configuration registers of all the devices connected in the SPI chain. The value currently displayed refers to the device chosen in the selection menu as described in Section 4.1.

Clicking the ”WRITE CONFIG” button (see Figure 34), the software executes the writing of all the configuration registers of the device currently selected and displayed. After the write the software automatically executes a read to check the registers content and if the values returned differ from the last values written, the device status in the grouping panel is marked red, otherwise green. Also the parameter that is not consistent, both hexadecimal and parsed values, is marked red.

In case of HS GROUP or LS GROUP selection refer to Section 4.4 for details about the groups management.

Figure 38. **Grouping panel**

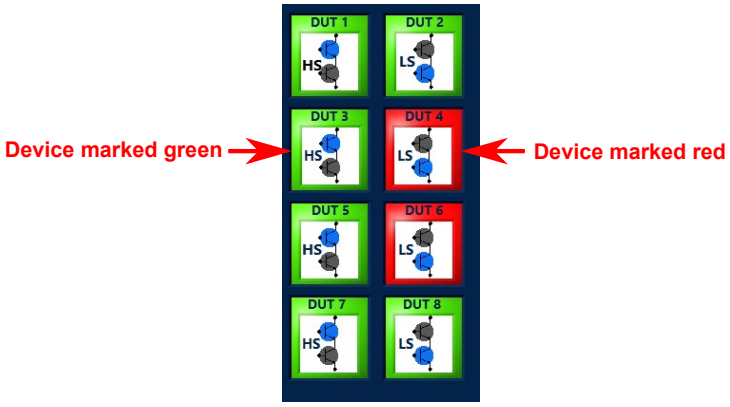
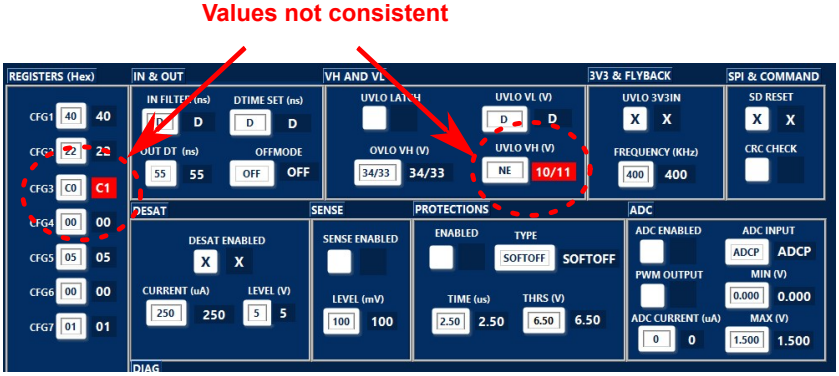


Figure 39. **Inconsistent red marked values**



4.4 Device grouping

This feature allows to write in a single shot multiple devices with the same configuration. Two groups, named LS GROUP and HS GROUP, are available in the “Device selection menu” (see Section 4.1) and each device can be independently assigned to one group or the other.

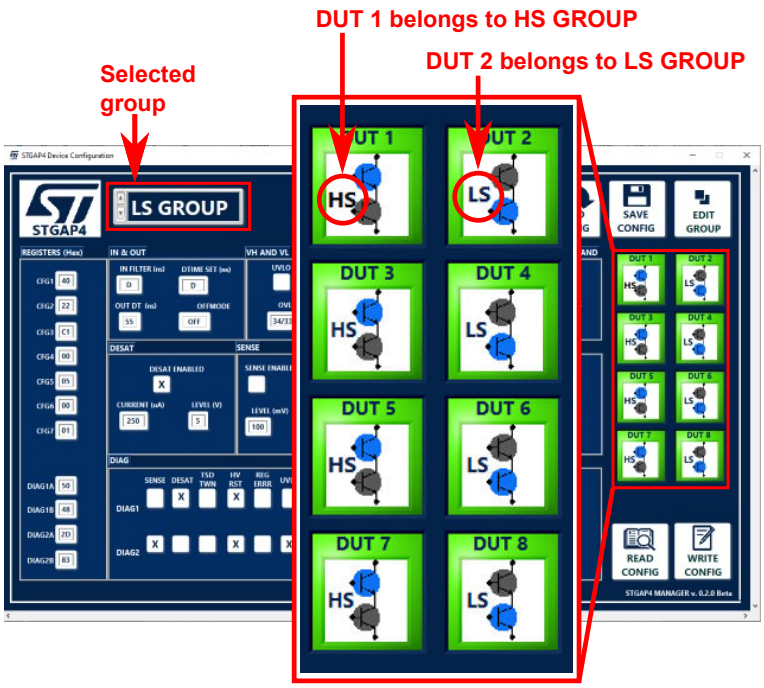
When the page of one of these two groups is selected, clicking the WRITE CONFIG button the software executes the write of the displayed parameters to all the devices that belong to that group.

The actual devices grouping is reported on the right of the View config panel and it is always displayed. This portion of the panel also shows the configuration result (green/red) as reported in Section 4.3.

If needed, after the group programming, each device can be customized accessing its own dedicated page.

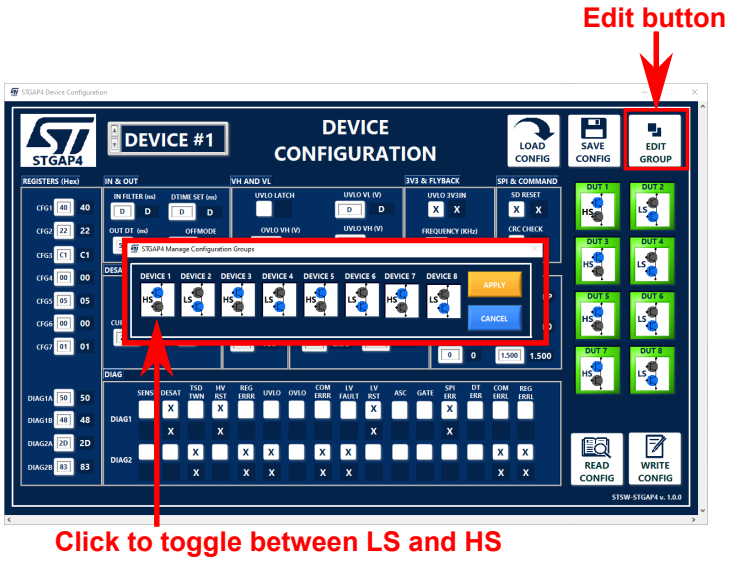
When LS GROUP or HS GROUP is selected, only the editable field (see Section 4.2) is displayed since the value currently present in the devices can be different.

Figure 40. **Actual device grouping**



The devices grouping can be edited from the dedicated panel that opens clicking the EDIT GROUP button in the View Config panel. Each device can be assigned to one of the two configuration groups (HS or LS) by clicking the device icon.

Figure 41. **Edit group panel**



The configuration of the groups does not have any effect on the hardware configuration. The graphical representation recalls a half-bridge only as an example of use of the grouping configuration. Indeed, in some inverter applications the devices configuration is differentiated depending on whether the device is a LOW-SIDE driver or a HIGH-SIDE driver.

4.5 Save and load

The configuration values can be stored in a .cfg file clicking the SAVE CONFIG button and recalled clicking the LOAD CONFIG button (see Figure 34).

Revision history

Table 1. **Document revision history**

Date	Version	Changes
24-May-2023	1	Initial release
29-Jun-2023	2	Correction of the STEVAL-PCC009V2 board name.

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