Getting started with the graphical user interface for the industrial IPS boards for STM32 Nucleo

Introduction

The STSW-IFAPGUI is the common graphic user interface designed to facilitate the control of the intelligent power switch (IPS) expansion boards for STM32 Nucleo.

The GUI works in combination with the firmware running on the STM32 Nucleo development board connected to your laptop/PC via USB cable.

The following table lists in the first column the demonstration firmware that the STSW-IFAPGUI is able to automatically detect. A demonstration firmware runs on a STM32 Nucleo and controls the related expansion or evaluation board included in the third column.

Table 1. Demonstration Firmware

Demonstration Firmware	STM32 NUCLEO	Associated Boards
STSW-OUT1F4	NUCLEO-F401RE	X-NUCLEO-OUT01A2
STSW-OUT1G4	NUCLEO-G431RB	
STSW-OUT02	NUCLEO-F401RE NUCLEO-F446RE	X-NUCLEO-OUT02A1
STSW-OUT3F4	NUCLEO-F401RE	X-NUCLEO-OUT03A1, X-NUCLEO-OUT04A1, STEVAL-IFP043V1, STEVAL-IFP044V1
STSW-OUT3G4	NUCLEO-G431RB	
STSW-OUT3D8F4	NUCLEO-F401RE	STDES-OUT03DO8, STDES-OUT04DO8
STSW-OUT3D8G4	NUCLEO-G431RB	
STSW-OUT5F4	NUCLEO-F401RE	X-NUCLEO-OUT05A1, X-NUCLEO-OUT06A1
STSW-OUT5G4	NUCLEO-G431RB	
STSW-OUT5D4F4	NUCLEO-F401RE	STDES-OUT05DO4, STDES-OUT06DO4
STSW-OUT5D4G4	NUCLEO-G431RB	
STSW-OUT7F4	NUCLEO-F401RE	X-NUCLEO-OUT07A1
STSW-OUT7G4	NUCLEO-G431RB	
STSW-OUT8F4	NUCLEO-F401RE	X-NUCLEO-OUT08A1, X-NUCLEO-OUT10A1
STSW-OUT8G4	NUCLEO-G431RB	
STSW-OUT9F4	NUCLEO-F401RE	X-NUCLEO-OUT09A1, X-NUCLEO-OUT19A1
STSW-OUT9G4	NUCLEO-G431RB	
STSW-OUT11F4	NUCLEO-F401RE	X-NUCLEO-OUT11A1, X-NUCLEO-OUT13A1, STEVAL-IFP041V1, STEVAL-IFP047V1
STSW-OUT11G4	NUCLEO-G431RB	
STSW-OUT12F4	NUCLEO-F401RE	X-NUCLEO-OUT12A1, X-NUCLEO-OUT14A1, STEVAL-IFP042V1, STEVAL-IFP048V1
STSW-OUT12G4	NUCLEO-G431RB	
STSW-OUT15F4	NUCLEO-F401RE	X-NUCLEO-OUT15A1, STEVAL-IFP040V1
STSW-OUT15G4	NUCLEO-G431RB	
STSW-OUT16F4	NUCLEO-F401RE	X-NUCLEO-OUT16A1, X-NUCLEO-OUT17A1
STSW-OUT16G4	NUCLEO-G431RB	
STSW-DO40F4	NUCLEO-F401RE	X-NUCLEO-DO40A1, X-NUCLEO-DO41A1

Demonstration Firmware	STM32 NUCLEO	Associated Boards
STSW-DO40G4	NUCLEO-G431RB	X-NUCLEO-DO40A1, X-NUCLEO-DO41A1

The GUI is available free of charge on www.st.com.

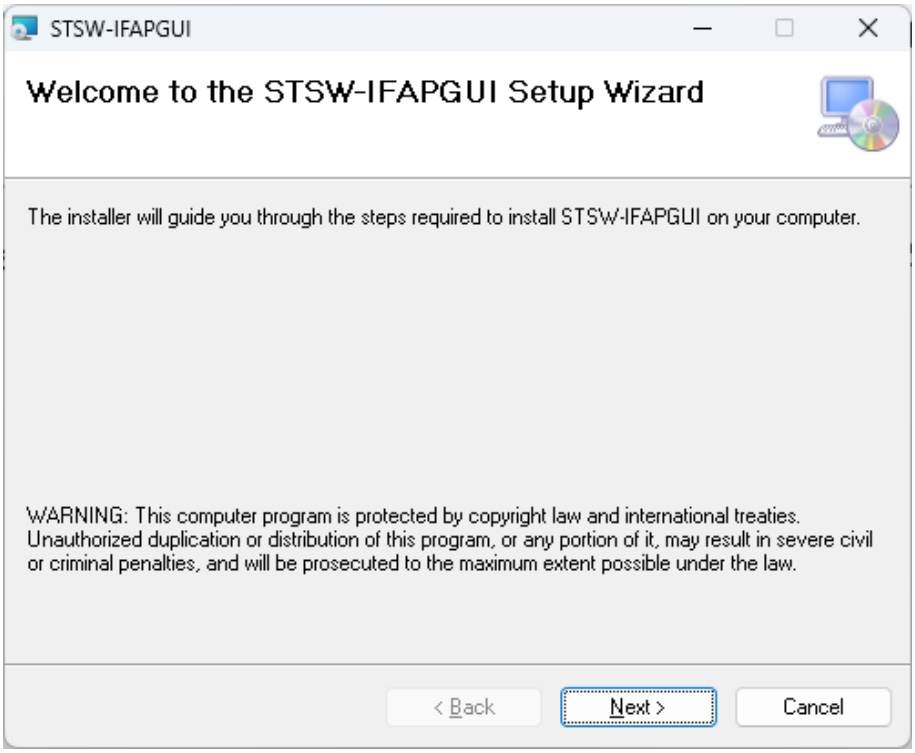
1 Software installation

The STSW-IFAPGUI software is designed to run on Microsoft® Windows.
To install the GUI:

Step 1. Run the setup.exe included in the package

Step 2. Follow the installation instructions

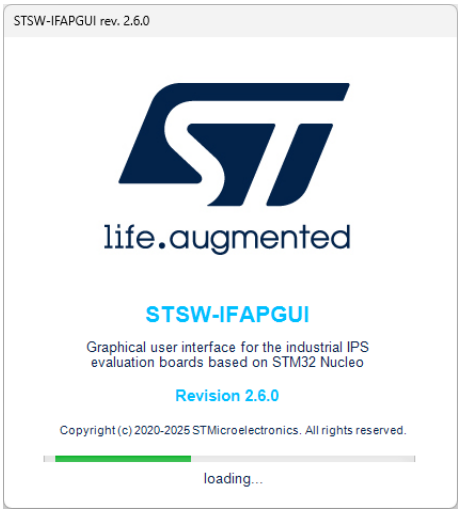
Figure 1. STSW-IFAPGUI installation guide



2 Running the graphical user interface

After launching the STSW-IFAPGUI, a splash screen appears during the application components loading.

Figure 2. STSW-IFAPGUI COM - splash screen



If a valid firmware is detected a COM port is opened for communication and the user can verify the detected firmware and then can request to launch the proper main control panel for the connected expansion board.

2.1 X-NUCLEO-OUT01A2 expansion board

2.1.1 How to control the expansion board

This application scenario is based on the default configuration of the on-board switch and resistors of the X-NUCLEO-OUT01A2

Step 1. Stack the X-NUCLEO-OUT01A2 on top of the NUCLEO-F401RE flashed with the STSW-OUT1F4 firmware (or NUCLEO-G431RB flashed with the STSW-OUT1G4 firmware), through the Arduino® UNO R3 connectors.

Step 2. Connect the two stacked boards to your PC or laptop USB port through a mini-USB cable (for NUCLEO-F401RE) or micro-USB cable (for NUCLEO-G431RB). The STM32 is supplied via USB (3.3 V) and the flashed firmware starts running.

Step 3. Connect the load and supply the power stage of the X-NUCLEO-OUT01A2 with a 24 V rail via the CN1 connector.

Step 4. Launch the STSW-IFAPGUI. When the application starts, the firmware running on the STM32 is automatically detected and a COM port is opened for communication.

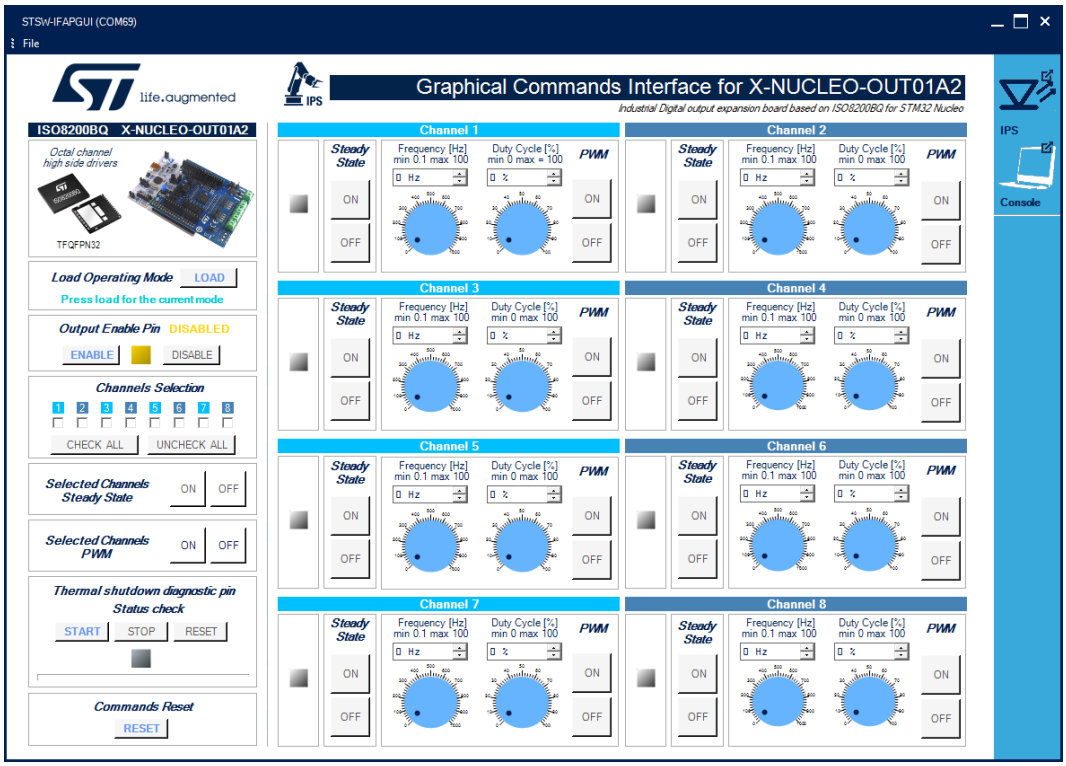
Figure 3. STSW-IFAPGUI COM - port opened

Step 5. Click on the GUI STM32 Nucleo icon after it turns blue and after firmware identification the logo will be green.

Figure 4. STSW-IFAPGUI identification complete

Step 6. The STSW-IFAPGUI appears on the screen.

Figure 5. STSW-IFAPGUI main control panel



Step 7. Use the Command Interface. The main panel is divided into:

- eight channel control sections, one for each channel
- load operating mode section.
- the outputs enable section.
- channels selection section
- selected channels steady state on/off
- selected channels PWM on/off
- a diagnostic section
- commands reset section.

All the buttons with blue text are related to the currently active functions.

- Use the [**LOAD**] button in the [**Load Operating Mode**] section to load the control mode (Direct or Synchronous) set for ISO8200BQ.

Figure 6. STSW-IFAPGUI Load Operating Mode Section

Figure 7. STSW-IFAPGUI Direct Control Mode detected

- Use the [**Output Enable Pin**] section to enable the outputs for ISO8200BQ. At the startup the outputs and all commands into the channels control section are disabled.

Figure 8. STSW-IFAPGUI output enable section

When the output has been enabled the [**Output Enable Pin**] section will change:

Figure 9. STSW-IFAPGUI output enabled

The channel control sections are used to switch on or off the channels in steady state and PWM mode.

- Use the Channel [**Steady State**] GUI section to manage the channel steady state for ISO8200BQ. The [**ON**] and [**OFF**] buttons are used to turn a channel on or off respectively. The [**ON**] button for each channel is enabled at the startup. When a channel is on in steady state mode the green LED corresponding to that channel will be on, the [**OFF**] button will be enabled, and the [**ON**] button disabled. When a channel is turned on in steady state mode it will not be possible to use the PWM mode. To use the PWM, the steady state of the channel must first be switched off.
- Use the channel [**PWM**] GUI section to manage the channel PWM settings and to power on or off the channel input in PWM mode. The [**ON**] button starting the PWM will be enabled when both the frequency and the duty cycle values for the channel have been selected through the dedicated controls and the steady mode is off for the channel. The PWM on will be signalized by the green LED blinking according to the frequency and duty cycle chosen. Use the [**OFF**] button to stop the PWM function. The following figures show a detailed view of the GUI Channel section functions.

Figure 10. **STSW-IFAPGUI channel section, steady state enabled and ready to use**

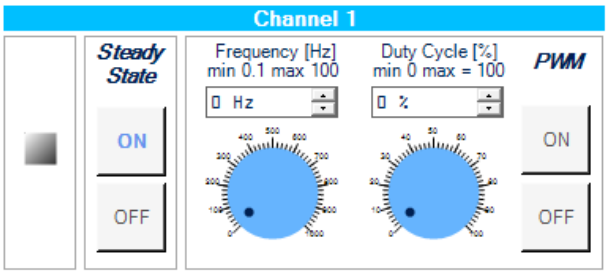


Figure 11. **STSW-IFAPGUI channel section, steady state on**

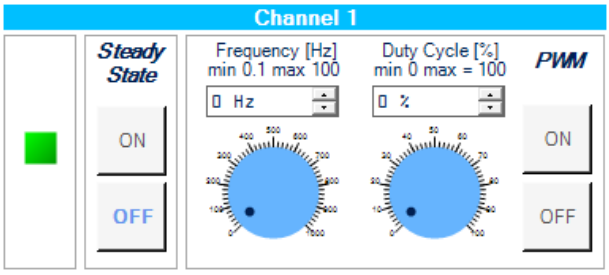
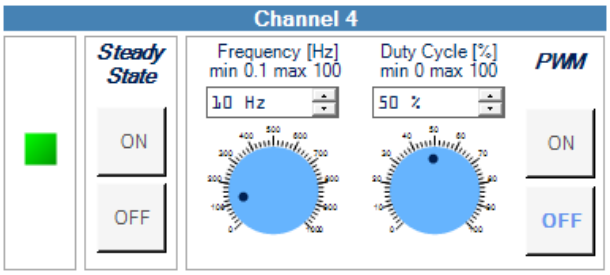


Figure 12. **STSW-IFAPGUI channel section, PWM on**



Step 8. The [**Channels Selection**] section allows you to select a set of channels to turn on or off with a single operation in steady state or PWM mode. Click on the [**CHECK ALL**] button to select all channels and on [**UNCHECK ALL**] to unselect all the channels. Furthermore, each channel can be selected individually using the related checkbox.

Figure 13. **STSW-IFAPGUI Channels Selection Section**

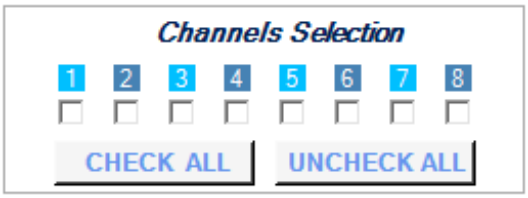
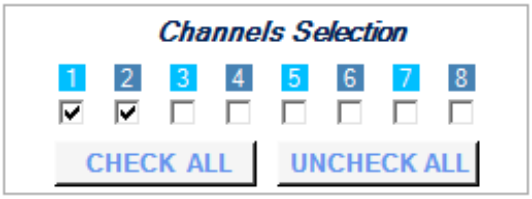


Figure 14. **STSW-IFAPGUI Channels 1 and 2 selected**



Step 9. The [**Selected Channels Steady State**] section allows you to turn on or off the selected channels in steady state mode. However, it should be specified that the command to turn on a selected channel is sent only if that channel is not currently turned on, neither in steady state nor in PWM. The channel off command is given to all selected channels turned on in steady state.

Figure 15. STSW-IFAPGUI Selected Channels Steady State section

Click on the [**ON**] or [**OFF**] button to turn on or off the selected channels.

Step 10. The [**Selected Channels PWM**] is similar the previous section but allows you to turn on or off the selected channels in PWM mode. With the same logic the command to turn on a selected channel in PWM mode is sent only if that channel is not currently turned on, neither in steady state nor in PWM. The PWM off command is given to all selected channels turned on in PWM mode. Unlike the previous case, to be able to see the output switching, you must first set the frequency and duty cycle of the channel, using the corresponding channel section as explained previously.

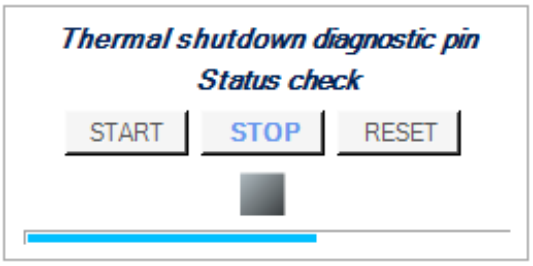
Figure 16. STSW-IFAPGUI Selected Channels PWM

Click on the [**ON**] or [**OFF**] button to turn on or off the selected channels in PWM mode.

Step 11. The diagnostic section is related to the thermal shutdown condition check. Click on the [**START**] button under [**Thermal shutdown diagnostic pin Status Check**] to monitor the on/off status of the STATUS pins for ISO8200BQ. The STATUS is a diagnostic pin at chip level. The activation of the status pin check is signalized by the bar under the diagnostic LED. When a fault condition is triggered, the red LED will light up. Click on the [**STOP**] button to stop the STATUS pin check and on the [**RESET**] button to clear the last pin condition displayed.

Figure 17. STSW-IFAPGUI status check

Figure 18. STSW-IFAPGUI status check activated



Step 12. Click on the [**RESET**] button in the [**Commands Reset**] section to stop all operations in progress, (channels switched on in steady state or PWM, status pin check activated). All frequency and duty cycle values that have been selected are also reset.

Figure 19. STSW-IFAPGUI Commands Reset section

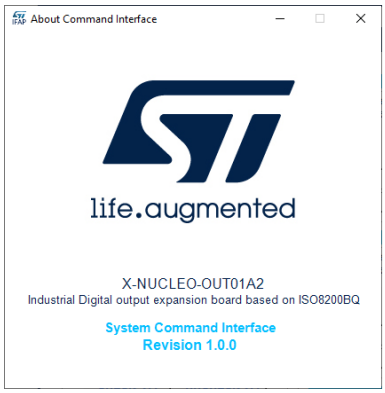
2.1.2 How to get information about the GUI

Information about the GUI revision is available by clicking at any point on title of the commands interface.

Figure 20. STSW-IFAPGUI Commands Interface Title

Then, the following window (in the example related to the first revision) appears:

Figure 21. Command interface info



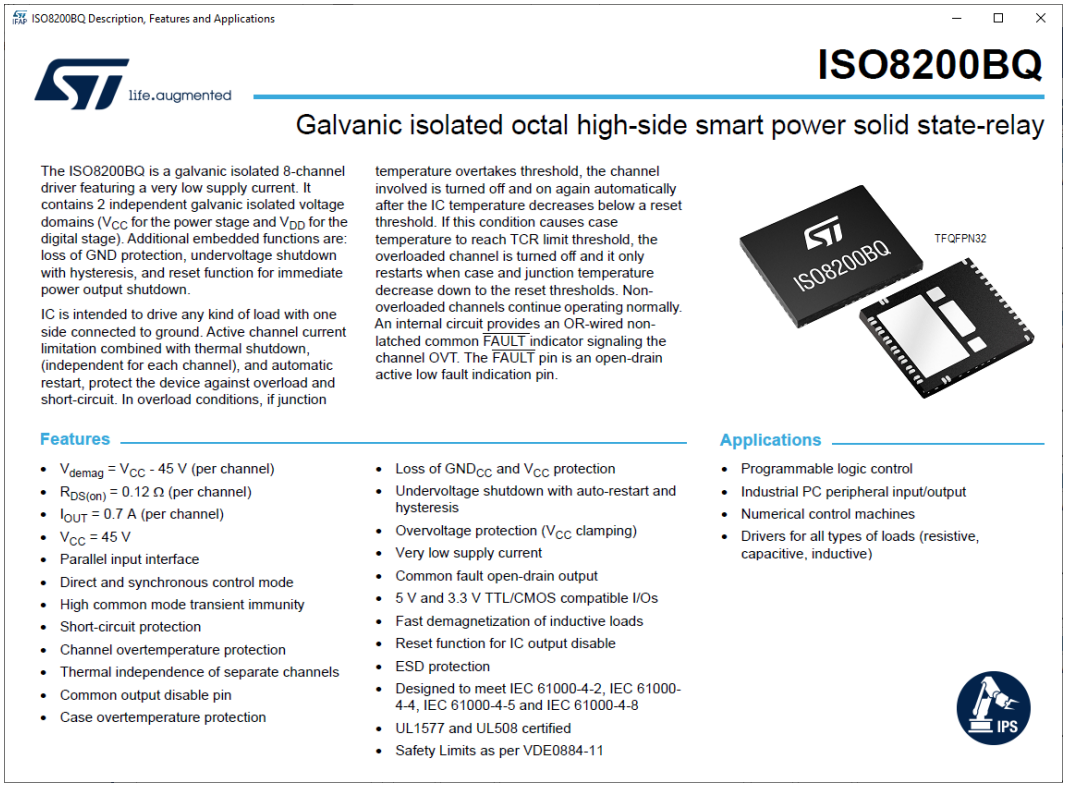
2.1.3 How to get information about the Device Features

Information about the device feature is available by clicking on device picture on the top-left part of the command interface.

Figure 22. How to get devices info

Then, the following window appears:

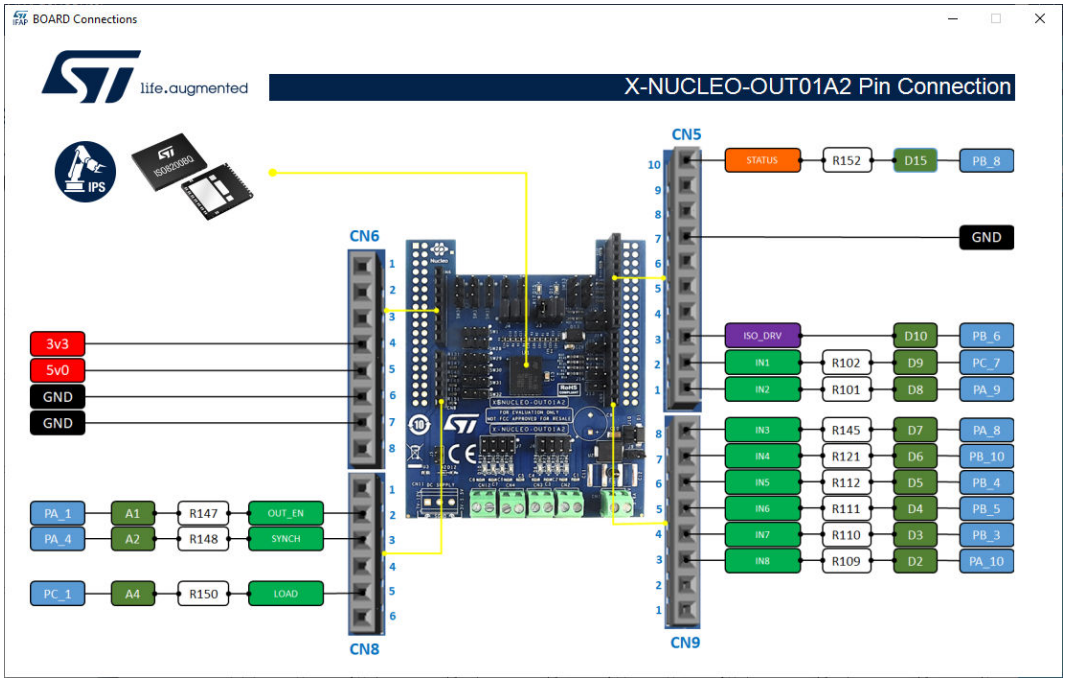
Figure 23. **Devices info**



2.1.4 Information about the pin connections

The device pin connections to the microcontroller are shown by clicking on the board image.

Figure 24. **Board Pin Connection**



2.1.5 Close the command interface

To close the command interface, use File/Close in the top-left part of the GUI.

Figure 25. **STSW-IFAPGUI close the command interface**

The command interface can be opened again by clicking on the Nucleo icon as described above.

2.2 X-NUCLEO-OUT02A1 expansion board

2.2.1 How to control a single expansion board

Step 1. Connect the STM32 Nucleo board flashed with STSW-OUT02 to the X-NUCLEO-OUT02A1 through the Arduino® UNO R3 connectors.

Step 2. Connect the stacked boards to your PC/laptop USB port through a mini-USB cable.

The STM32 is supplied by 3.3 V from the USB supply and the flashed firmware starts running.
By default, in the X-NUCLEO-OUT02A1, J8 is closed between pins 5-6 and the ISO8200AQ digital side is supplied by the same 3.3 V of the microcontroller.

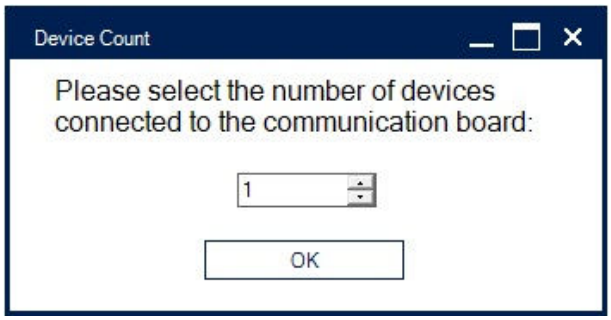
Step 3. Launch the STSW-IFAPGUI.

When the application starts, the firmware running on the STM32 is automatically detected and a COM port is opened for communication.

Step 4. Click on the GUI STM32 Nucleo icon only after it becomes blue (it is green until the firmware identification is completed).

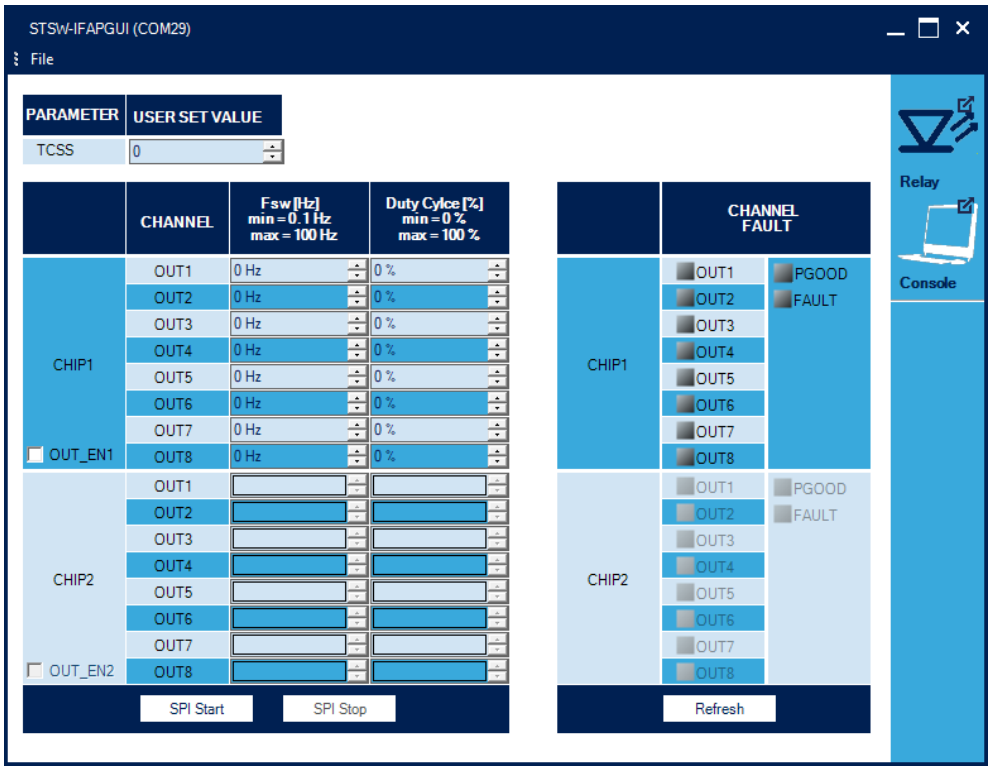
The following selection window appears.

Figure 26. **STSW-IFAPGUI selection window for the number of X-NUCLEO-OUT02A1 expansion boards to control**



Step 5. Select "1" in the **Device Count** window and then click [**OK**] to activate the control panel.

Figure 27. STSW-IFAPGUI control panel, single chip



Step 6. Supply the X-NUCLEO-OUT02A1 power stage with a 24 V rail via J1 connector.

Step 7. Click on the GUI [**Refresh**] button to align the application board and the GUI status.

Step 8. Select the desired switching frequency and duty cycle of the output channels to be activated (ON/OFF).

Note: 0 Hz stands for channel OFF; duty cycle 100% stands for channel always ON.

Step 9. Tick the OUT_EN1 to activate the ISO8200AQ output enable signal.

Step 10. Click [**Start**] to activate the SPI communication between the microcontroller and ISO8200AQ.

Now the activated output channels start switching according to the setup defined in Step 7 (green LED D5 to D12 will be driven accordingly).

When SPI is active, the right side of the GUI (fault monitoring) is automatically updated every 500 ms.

Step 11. The output channels ON/OFF status can be deactivated by unticking the OUT_EN1 or by clicking [**Stop**].

In the first case, the SPI communication between microcontroller and ISO8200AQ remains active, while in the second case the SPI communication stops.

Step 12. When the evaluation session finishes, stop the SPI communication, close the GUI, remove the 24 V from J1 and disconnect the USB cable from the STM32 Nucleo development board.

2.2.2 How to control two expansion boards

When two X-NUCLEO-OUT02A1 expansion boards are stacked (daisy chaining), follow the procedure below.

Step 1. Set the proper configuration for J6, J7 and OUT_EN signal on the twoX-NUCLEO-OUT02A1 to enable daisy chaining configuration.

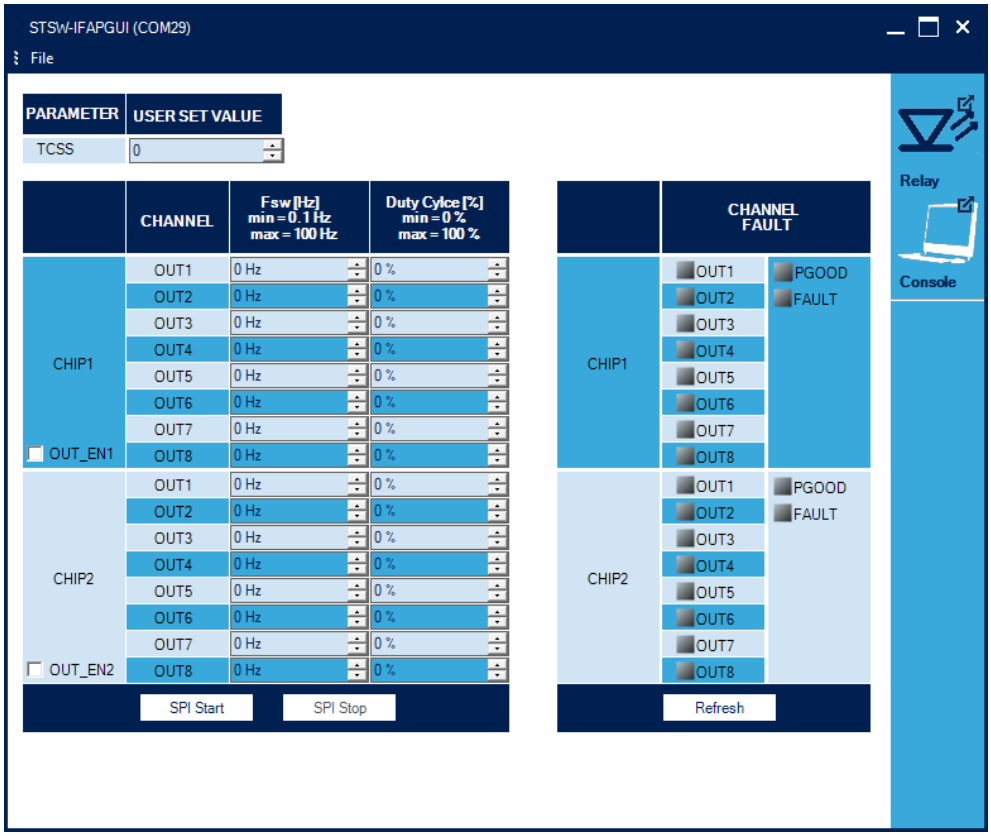
Step 2. Connect the NUCLEO-F401RE development board flashed with STSW-OUT02 to the two X-NUCLEO-OUT02A1 boards through the Arduino® UNO R3 connectors.

Step 3. Launch the STSW-IFAPGUI.
When the application starts, the firmware running on the STM32 is automatically detected and a COM port is opened for communication.

Step 4. Click on the GUI STM32 Nucleo icon only after it becomes blue (it is green until the firmware identification is completed).

Step 5. Select "2" in the **Device Count** window and then click OK to activate the control panel.

Figure 28. STSW-IFAPGUI control panel, dual chip



Step 6. Follow the steps described in Section 2.2.1 (from 6 to 12).

2.2.3 STSW-IFAPGUI control panel for X-NUCLEO-OUT02A1

This control panel (see Figure 27) shows three main function areas:

- Output channel activation (OUT_EN, switching frequency, duty cycle)
- SPI activation (start/stop)
- Fault monitoring (power good, common fault, per-channel thermal fault)

2.2.3.1 Output channel activation

You can set the switching frequency and duty cycle driving each output channel by editing the text boxes of this section of the GUI.

The switching frequency can be set from 0 Hz (channel always OFF) to 100 Hz.

The duty cycle can be set from 0% (channel always OFF) to 100% (channel always ON).

You can also control the ISO8200AQ output enable signal by ticking the OUE_ENx box: when ticked, the output enable pin is forced high, otherwise it is off.

Note: the output channel ON/OFF configuration set in the GUI is transferred to the ISO8200AQ only when the SPI communication is activated (see next chapter).

2.2.3.2 *SPI activation*

The ISO8200AQ output channels are controlled by the microcontroller SPI.

The STSW-IFAPGUI activates/deactivates the STM32 SPI interface by clicking the [**SPI Start**] or [**SPI Stop**] buttons.

Although the SPI is activated by the [**SPI Start**] button, you have to tick the GUI OUT_ENx box to enable the outputs.

2.2.3.3 *Fault monitoring*

The ISO8200AQ can report to the microcontroller a wide set of information.

Voltage drop on supply rail

The supply voltage is monitored by an embedded circuitry and the power good open drain pin is activated (forced low) when the supply voltage on J1 goes below 16.5 V.

SPI communication error (modulo-8 violation)

The internal logic controls if each SPI communication contains 8 bits on the SDI (MOSI) line. In case of violation, the common fault pin is activated (forced low).

Communication error internal to ISO8200AQ

The internal logic controls if any communication error occurs between the ISO8200AQ logic and process stage. The common fault is activated (forced low) in case of internal commutation error.

Output channel thermal fault

The common fault pin is forced low when one (or more) ISO8200AQ channel has triggered the thermal shutdown threshold. The microcontroller recognizes which channel is in thermal fault by reading the byte sent back by the ISO8200AQ through the SDO (MISO) line.

When SPI is active, the whole status information of the ISO8200AQ is automatically refreshed every 500 ms.

When SPI is not active, the status of ISO8200AQ can be showed on the GUI by clicking the [**Refresh**] button.

2.3 X-NUCLEO-OUT03A1 and X-NUCLEO-OUT04A1 expansion boards

2.3.1 How to control a single expansion board

This application scenario is based on the default configuration of the on-board switch and resistors of X-NUCLEO-OUT03A1 (or X-NUCLEO-OUT04A1).

Step 1. Stack the X-NUCLEO-OUT03A1 (or X-NUCLEO-OUT04A1) on top of the NUCLEO-F401RE flashed with the STSW-OUT3F4 firmware (or NUCLEO-G431RB flashed with STSW-OUT3G4 firmware), through the Arduino® UNO R3 connectors.

Step 2. Connect the two stacked boards to your PC or laptop USB port through a mini-USB cable (for NUCLEO-F401RE) or micro-USB cable (for NUCLEO-G431RB).

The STM32 is supplied via USB (3.3 V) and the flashed firmware starts running.

Step 3. Launch the STSW-IFAPGUI.

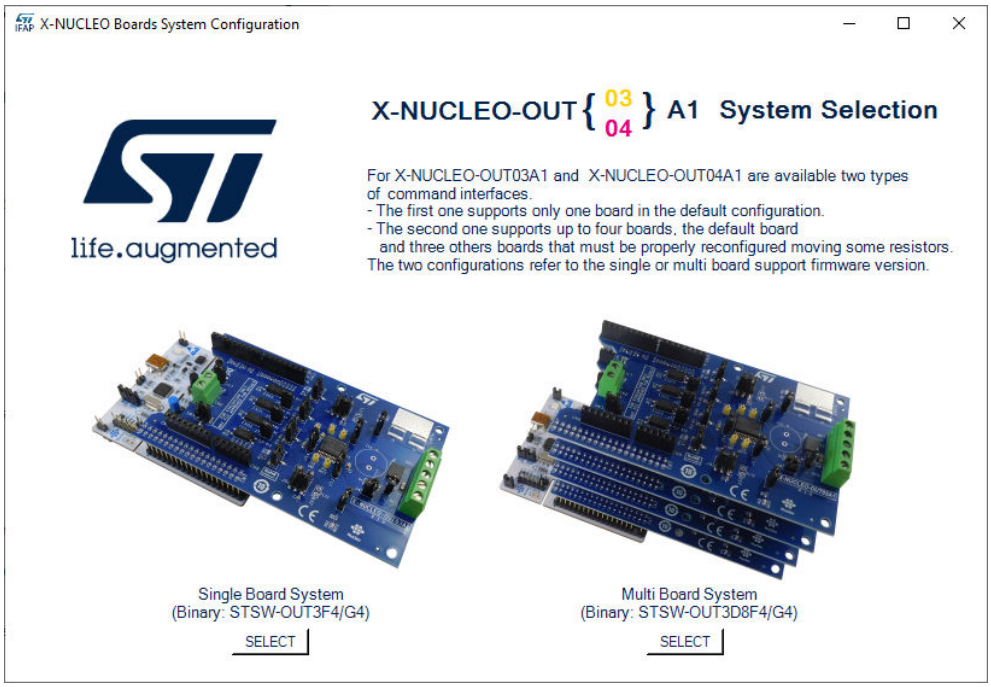
When the application starts, the firmware running on the STM32 is automatically detected and a COM port is opened for communication.

Figure 29. STSW-IFAPGUI COM - port opened

Step 4. Click on the GUI STM32 Nucleo icon after it turns blue (it remains green until the firmware identification is complete).

A popup window appears to choose the proper system configuration.

Figure 30. System configuration selection panel



Step 5. Select [**Single Board System**] and the STSW-IFAPGUI appears on the screen.

Step 6.

– Use the left side of the GUI to manage steady state (channel 1 or channel 2, or both) for IPS2050H (or IPS2050H-32).

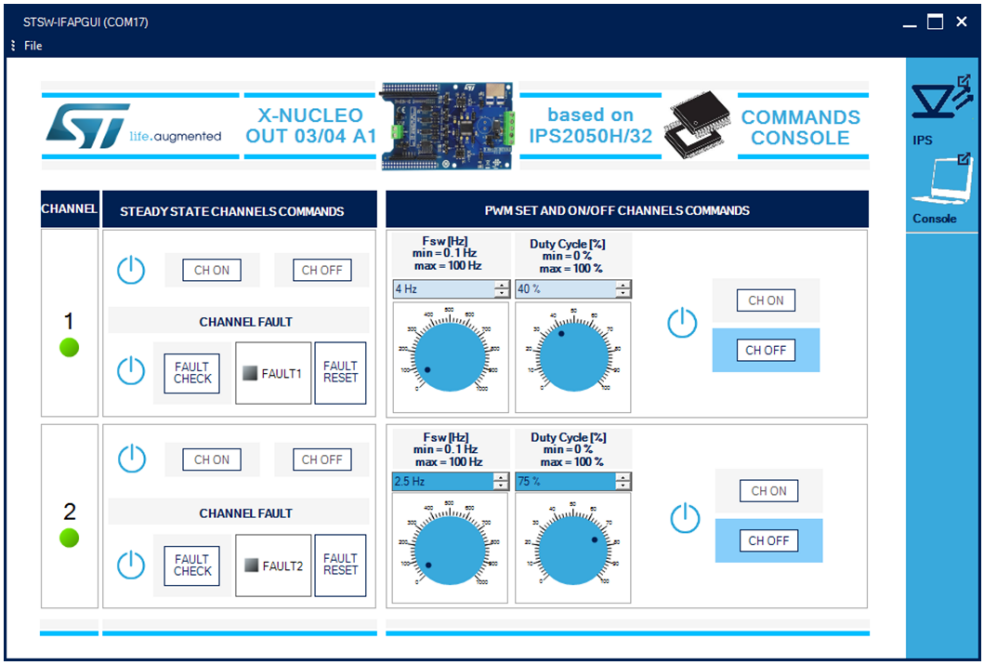
– Use the right side of the GUI to manage its PWM settings.

Step 7. Connect the load and supply the power stage of the X-NUCLEO-OUT03A1 (or X-NUCLEO-OUT04A1) with a 24 V rail via the CN1 connector.

Step 8. Select the desired switching frequency and duty cycle of the output channel through the [**PWM SET AND ON/OFF CHANNELS COMMANDS**] on the right side of the GUI.

Step 9. To activate the output channel steady state, click on [**STEADY STATE CHANNELS COMMANDS**]>[**CH ON**] on the left side of the GUI, for the desired input channel. Use [**CH OFF**] to deactivate it.

Figure 31. STSW-IFAPGUI for a single expansion board in action



Step 10. Click on the [**FAULT CHECK**] button on the left side of the GUI for the desired input channel to monitor the on/off status of the FAULT pin on IPS2050H (or IPS2050H-32) (FAULT1 for channel 1, FAULT2 for channel 2).

You can stop monitoring the per-channel fault status by clicking again on the related [**FAULT CHECK**] button.
Press [**FAULT RESET**] button to reset the channel fault status.

2.3.2 How to control up to four expansion boards

This application scenario is based on the multiboard configuration of the on-board switch and resistors of STDES-OUT03DO8 (or STDES-OUT04DO8). Details about how to configure the default board (board 0) and the additional ones (board 1, board 2, and board 3) are available in UM2863 "Getting started with X-CUBE-OUT3 industrial digital output software for STM32 Nucleo". The following table summarizes the multiboard setup.

Table 2. Configuration of a stack of four expansion boards

Board no.	IN1	IN2	FLT1	FLT2
Board 0	R101	R102	R103	R104
Board 1	R131	R132	R133	R134
Board 2	R111	R112	R113	R114
Board 3	R121	R122	R123	R124

Note: When using board 2 and board 3, two jumpers must be used to close the morpho connectors pins in the STM32 Nucleo board: CN7.35-36 and CN10.25-26 closed.

It is also possible to obtain information on the configuration of the resistance connections for each board directly through the GUI by clicking on the image that appears in the window of the respective board (see Figure 38. STSW-IFAPGUI main control panel), as shown in the following figures.

Figure 32. **Setup for board 0 (default setup)**

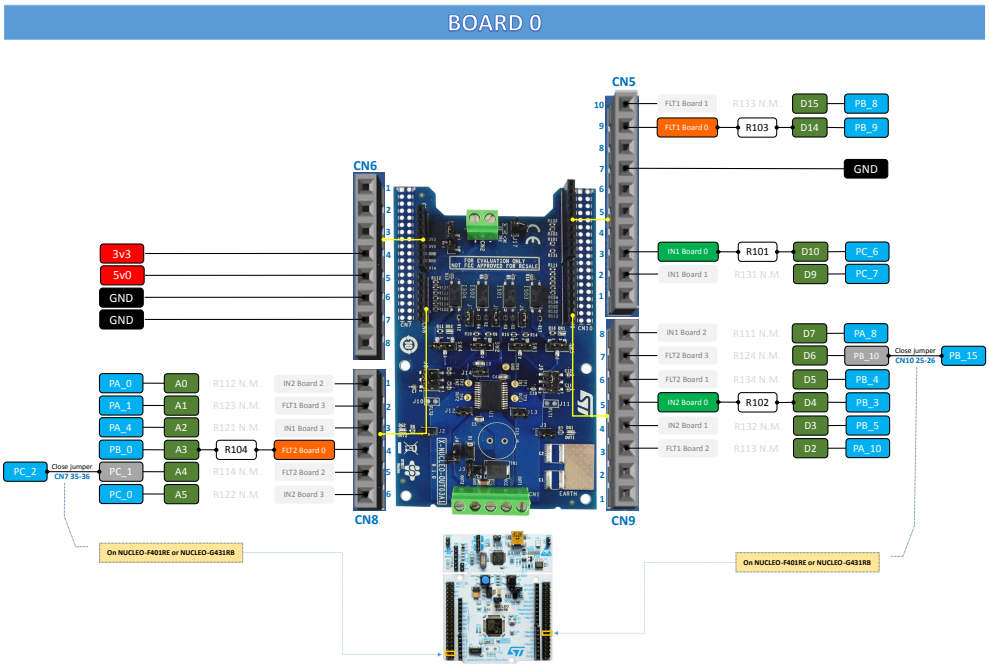


Figure 33. **Setup for board 1**

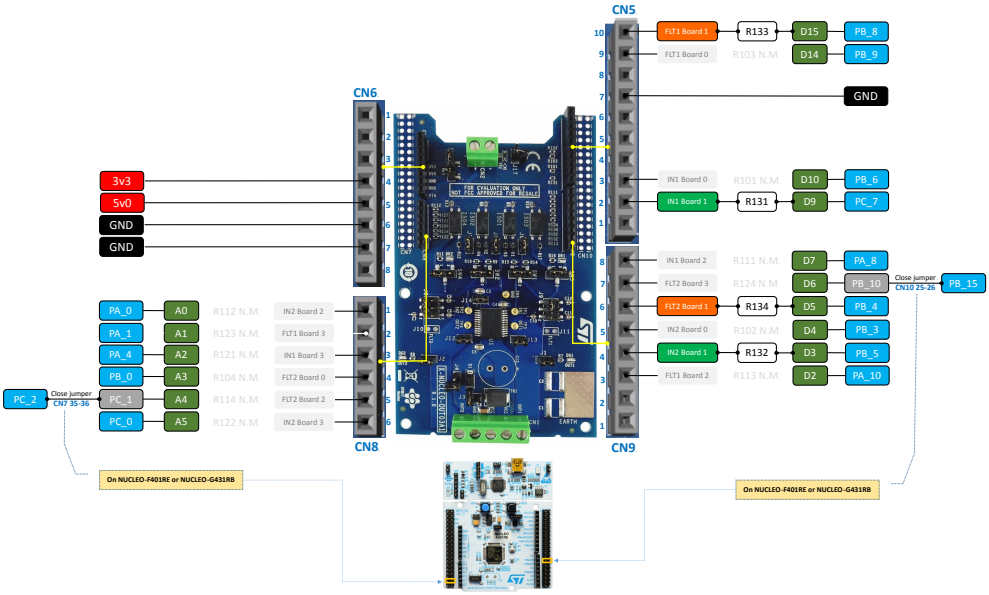


Figure 34. **Setup for board 2**

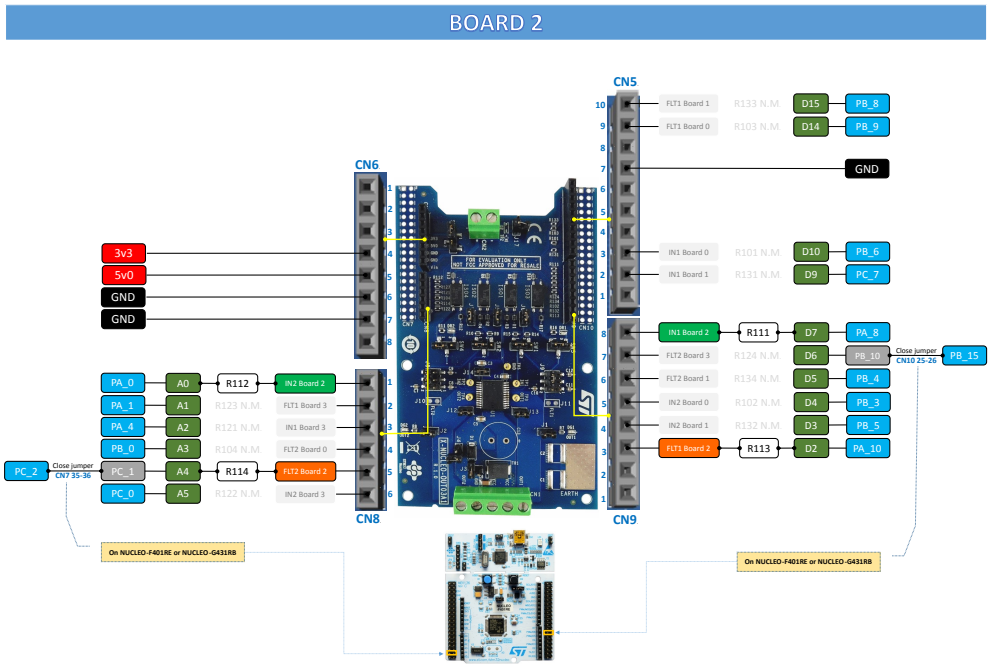
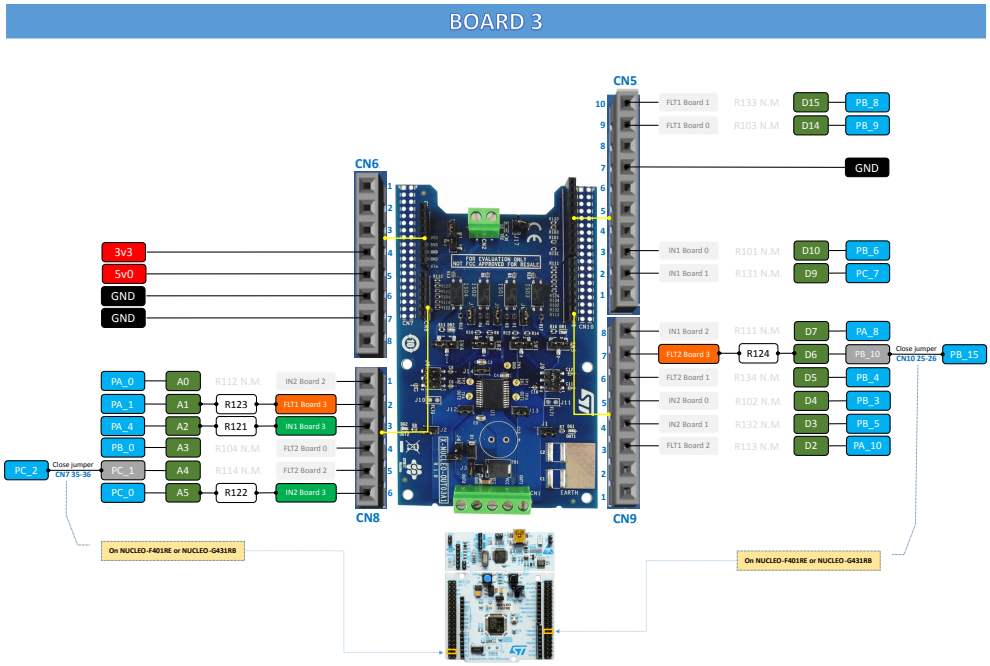


Figure 35. **Setup for board 3**



Step 1. Stack up to four X-NUCLEO-OUT03A1 (or X-NUCLEO-OUT04A1) on top of the NUCLEO-F401RE flashed with the STSW-OUT3D8F4 firmware (or NUCLEO-G431RB flashed with the STSW-OUT3D8G4 firmware), through the Arduino® UNO R3 connectors.

Step 2. Connect the stacked boards to your PC or laptop USB port through a mini-USB cable (for NUCLEO-F401RE) or micro-USB cable (for NUCLEO-G431RB).

The STM32 is supplied via USB (3.3 V) and the flashed firmware starts running.

Step 3. Launch the STSW-IFAPGUI.

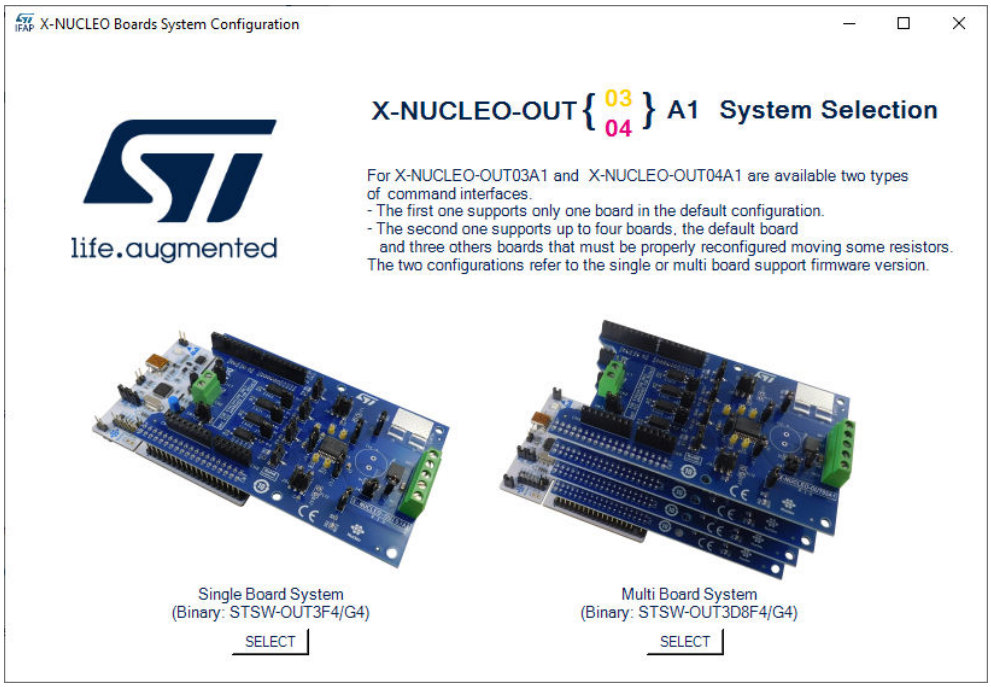
When the application starts, the firmware running on the STM32 is automatically detected and a COM port is opened for communication.

Figure 36. STSW-IFAPGUI COM - port opened

Step 4. Click on the GUI STM32 Nucleo icon after it turns blue (it remains green until the firmware identification is complete).

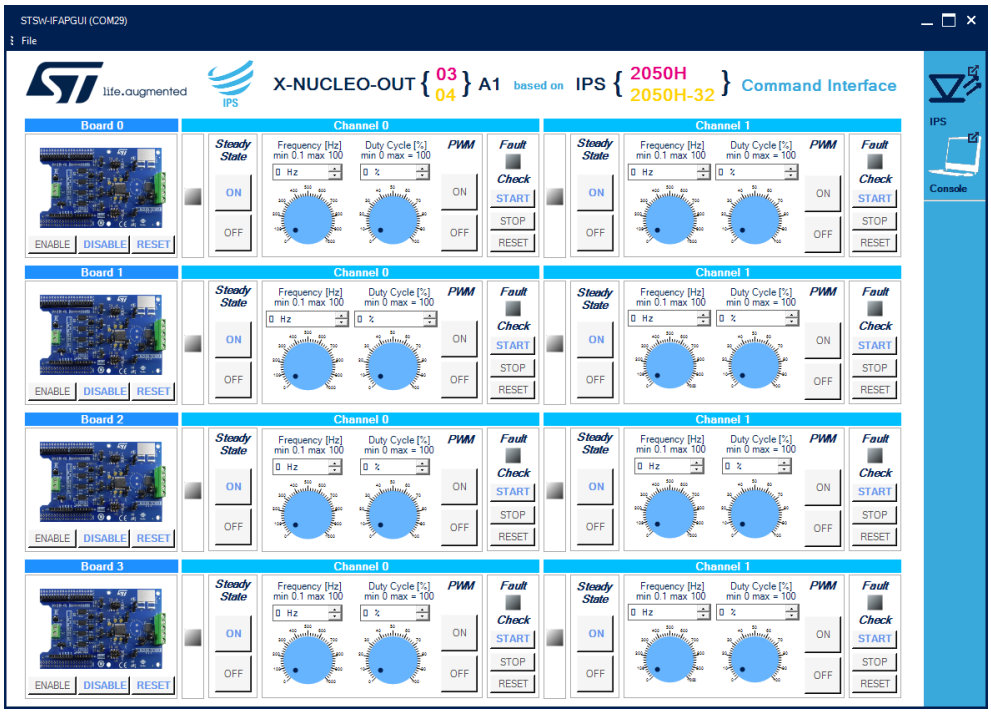
A popup window appears to choose the proper system configuration.

Figure 37. System configuration selection panel



Step 5. Select [**Multi Board System**] and the STSW-IFAPGUI appears on the screen.

Figure 38. STSW-IFAPGUI main control panel



Step 6. If all four boards are not physically connected, it is possible to disable the commands on the unconnected boards using the [**DISABLE**] button of the relevant boards.

By pressing the same button, you can reenable the board once connected.

Step 7. The main control panel is divided in four rows, one per each board. Each row is divided in two columns, one per each channel of the on-board device.

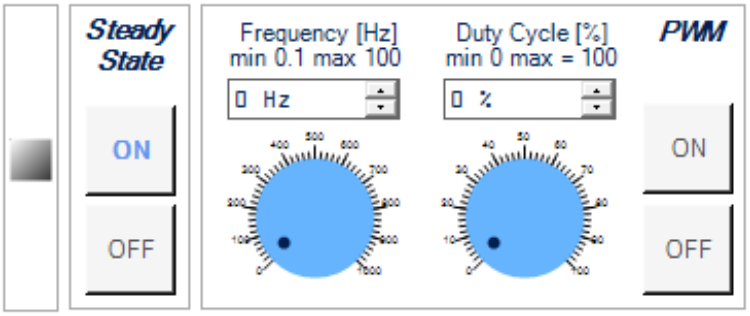
All the buttons with blue text are related to the currently active functions.
For each channel:

– Use the left part of the GUI section to manage the channel steady state for IPS2050H (or IPS2050H-32).

– Use the right part of the GUI section to manage its PWM settings.

The following figure shows a detailed view of the GUI section for each channel.

Figure 39. STSW-IFAPGUI channel section



Step 8. Connect the load and supply the power stage of the X-NUCLEO-OUT03A1 (or X-NUCLEO-OUT04A1) with a 24 V rail via the CN1 connector.

Step 9. Select the desired switching frequency and duty cycle of the output channel through the dedicated controls. Use [**ON**] and [**OFF**] buttons under [**PWM**] to start and stop the PWM function.

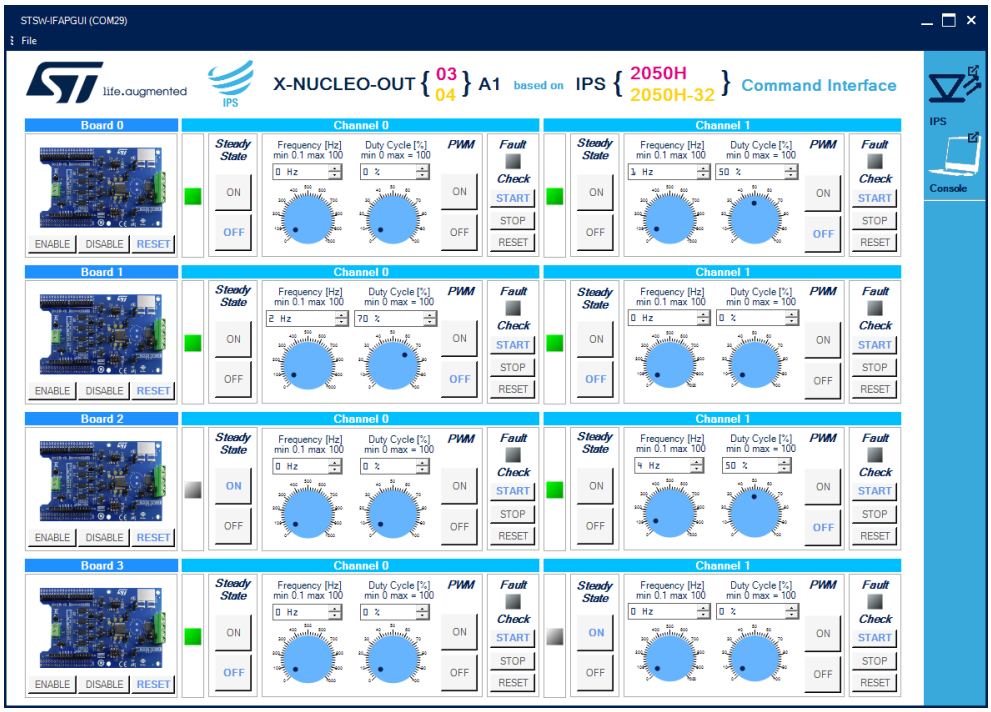
The button that starts the PWM is activated after selecting a frequency and a duty cycle.

Step 10. To activate the output channel steady state, use the [**ON**] button under [**Steady State**]. Use [**OFF**] to deactivate it.

Step 11. Click on the [**START**] button under [**Fault Check**] on the right side of the GUI channel section to monitor the on/off status on the per-channel FAULT pin on IPS2050H (or IPS2050H-32).

You can stop monitoring the fault status by clicking on the related [**STOP**] button.
Press the [**RESET**] button to reset the related fault status.

Figure 40. STSW-IFAPGUI in action



2.3.3 How to get information about the GUI

Information about the GUI revision for the multiboard configuration is available by clicking on [**Command Interface**] at the right of the title.

Then, the following window (in the example related to the first revision) appears:

Figure 41. Command interface info

2.4 X-NUCLEO-OUT05A1 and X-NUCLEO-OUT06A1 expansion boards

2.4.1 How to control a single expansion board

This application scenario is based on the default configuration of the on-board switch and resistors of the X-NUCLEO-OUT05A1 (or X-NUCLEO-OUT06A1).

Step 1. Stack the X-NUCLEO-OUT05A1 (or X-NUCLEO-OUT06A1) on top of the NUCLEO-F401RE flashed with the STSW-OUT5F4 firmware (or NUCLEO-G431RB flashed with the STSW-OUT5G4 firmware), through the Arduino® UNO R3 connectors.

Step 2. Connect the two stacked boards to your PC or laptop USB port through a mini-USB cable (for NUCLEO-F401RE) or micro-USB cable (for NUCLEO-G431RB).

The STM32 is supplied via USB (3.3 V) and the flashed firmware starts running.

Step 3. Launch the STSW-IFAPGUI.

When the application starts, the firmware running on the STM32 is automatically detected and a COM port is opened for communication.

Figure 42. STSW-IFAPGUI COM - port opened

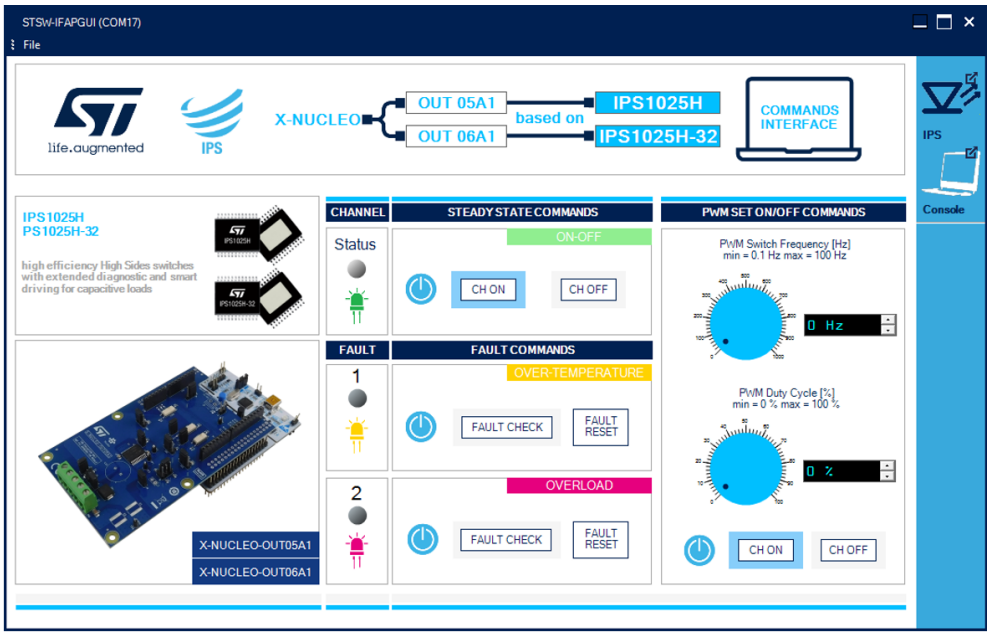
Step 4. Click on the GUI STM32 Nucleo icon after it turns blue (it remains green until the firmware identification is complete).

A popup window appears to choose the proper system configuration.

Figure 43. System configuration selection panel

Step 5. Select [**X-NUCLEO-OUT05/06A1 Single Board System**] and the STSW-IFAPGUI appears on the screen.

Figure 44. STSW-IFAPGUI main control panel



Step 6.

– Use the left side of the GUI to manage the channel steady state for the IPS1025H (or IPS1025H-32)

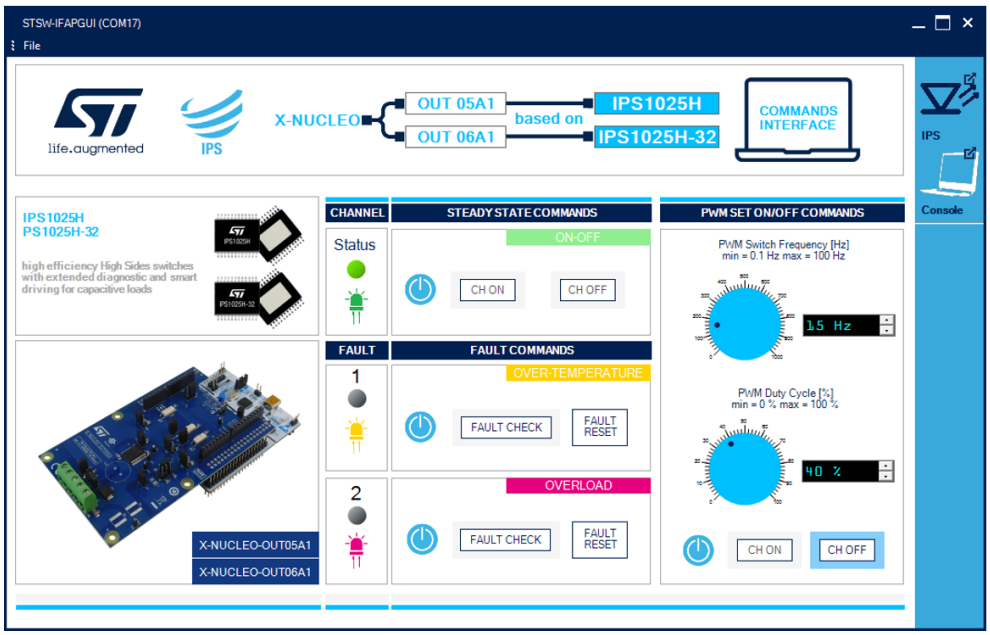
– Use the right side of the GUI to manage its PWM settings.

Step 7. Connect the load and supply the power stage of the X-NUCLEO-OUT05A1 (or X-NUCLEO-OUT06A1) with a 24 V rail via the CN1 connector.

Step 8. Select the desired switching frequency and duty cycle of the output channel through the [**PWM SET ON/OFF COMMANDS**] on the right side of the GUI.

Step 9. To activate the output channel steady state, click on the [**CH ON**] button on the left side of the GUI in the [**STEADY STATE COMMANDS**]. Use [**CH OFF**] to deactivate it.

Figure 45. STSW-IFAPGUI in action



Step 10. Click on the [**FAULT CHECK**] button on the left side of the GUI to monitor the on/off status on the desired FAULT pin on IPS1025H (or IPS1025H-32) (FAULT1 for overtemperature, FAULT2 for overload).

You can stop monitoring the fault status by clicking again on the related [**FAULT CHECK**] button. Press the [**FAULT RESET**] button to reset the related fault status.

2.4.2 How to control up to four expansion boards

This application scenario is based on the multiboard configuration of the on-board switch and resistors of STDES-OUT05DO4 (or STDES-OUT06DO4). The following table summarizes the multiboard setup.

Table 3. Configuration of a stack of four expansion boards

Board no.	IN1	FLT1	FLT2
Board 0	R101	R103	R114
Board 1	R102	R104	R117
Board 2	R115	R116	R107
Board 3	R120	R119	R118

To get information about the resistance connection configuration for each board directly through the GUI, click on the image that appears in the window of the respective board (see Figure 52. STSW-IFAPGUI main control panel), as shown in the following figures.

Figure 46. **Setup for board 0 (default setup)**

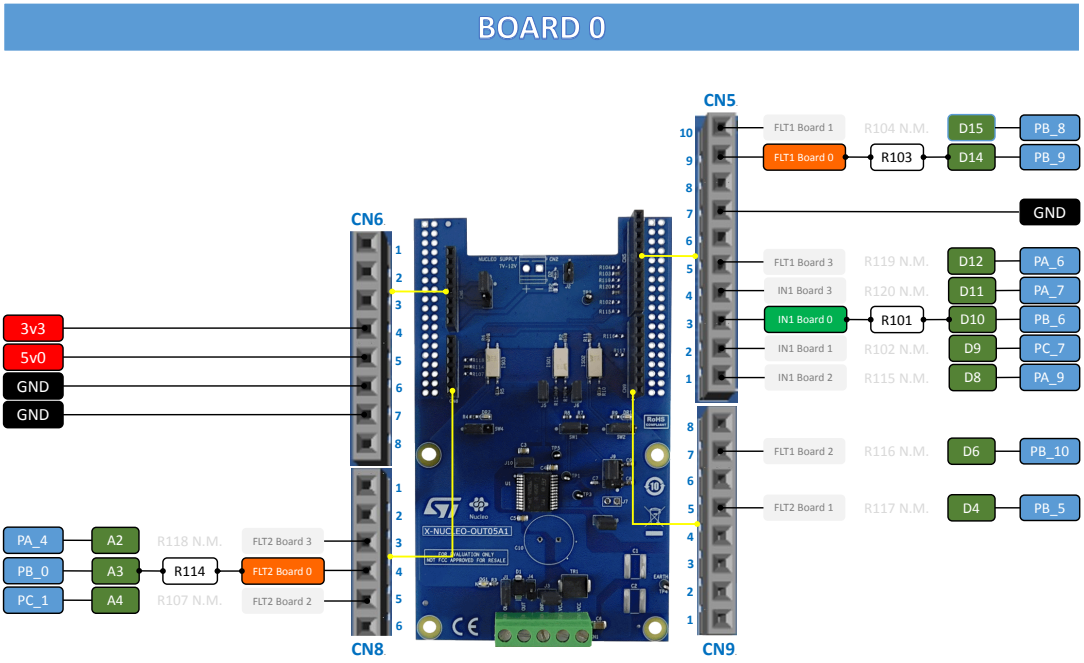


Figure 47. **Setup for board 1**

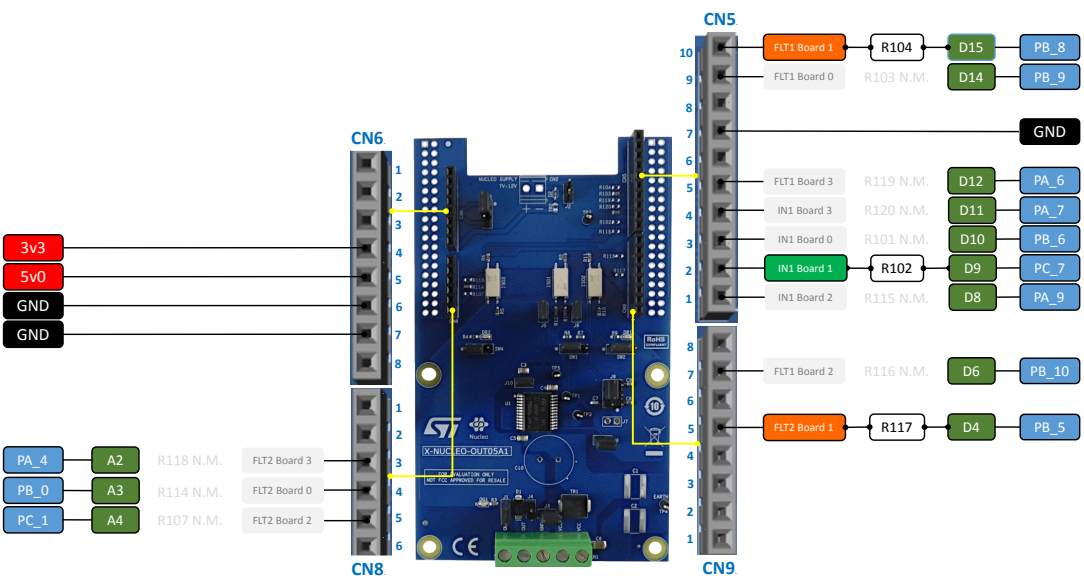


Figure 48. **Setup for board 2**

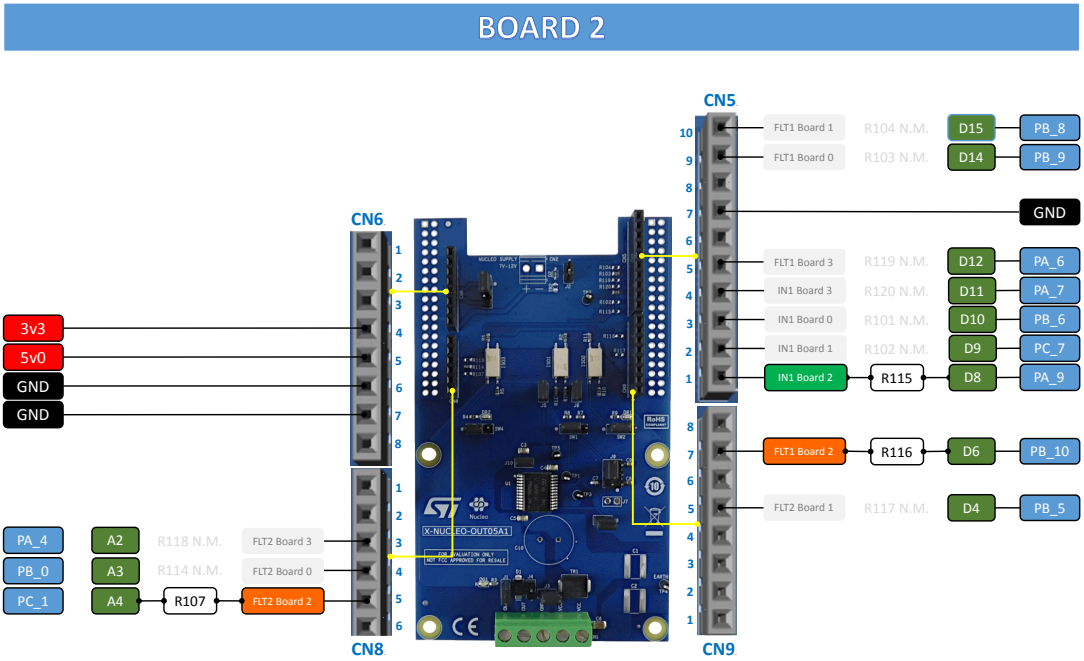
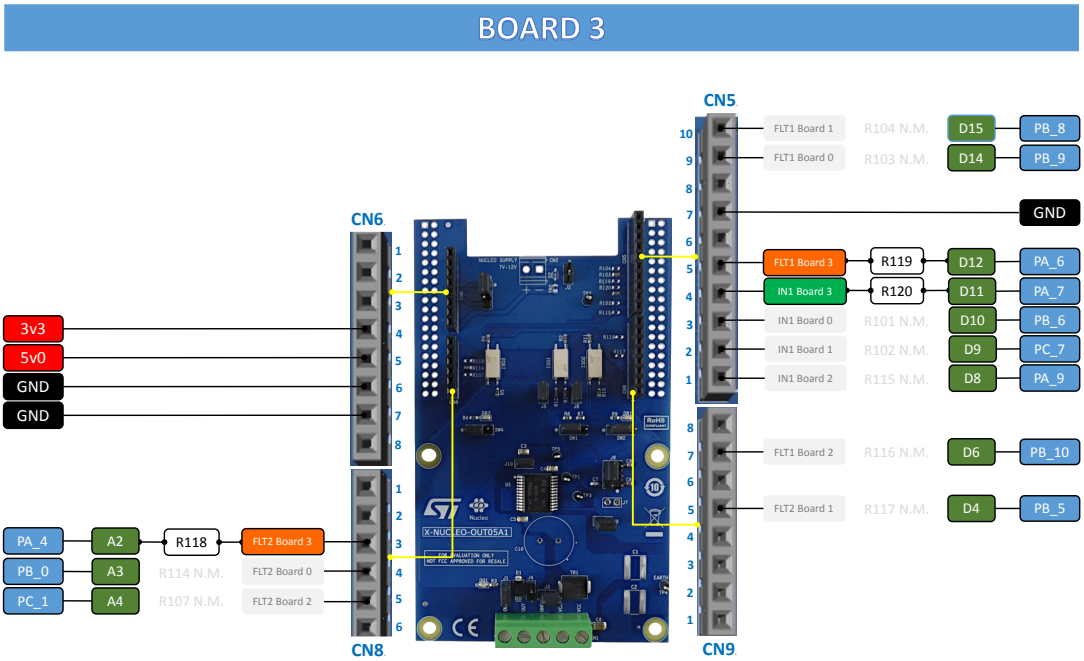


Figure 49. **Setup for board 3**



Step 1. Stack up to four X-NUCLEO-OUT05A1 (or X-NUCLEO-OUT06A1) on top of the NUCLEO-F401RE flashed with the STSW-OUT5D4F4 firmware (or NUCLEO-G431RB flashed with the STSW-OUT5D4G4 firmware), through the Arduino® UNO R3 connectors.

Step 2. Connect the stacked boards to your PC or laptop USB port through a mini-USB cable (for NUCLEO-F401RE) or micro-USB cable (for NUCLEO-G431RB).

The STM32 is supplied via USB (3.3 V) and the flashed firmware starts running.

Step 3. Launch the STSW-IFAPGUI.

When the application starts, the firmware running on the STM32 is automatically detected and a COM port is opened for communication.

Figure 50. STSW-IFAPGUI COM - port opened

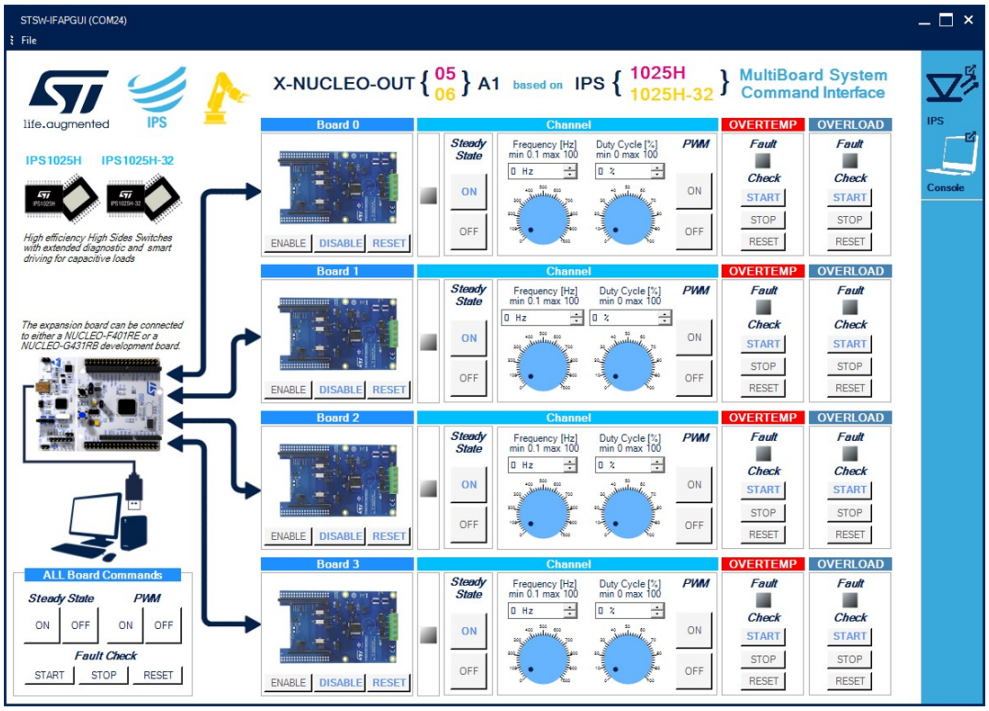
Step 4. Click on the GUI STM32 Nucleo icon after it turns blue (it remains green until the firmware identification is complete).

A popup window appears to choose the proper system configuration.

Figure 51. System configuration selection panel

Step 5. Select [**X-NUCLEO-OUT05/06A1 Multi Board System**] and the STSW-IFAPGUI appears on the screen.

Figure 52. STSW-IFAPGUI main control panel



Step 6. If all four boards are not physically connected, it is possible to disable the commands on the unconnected boards using the [**Disable**] button of the relevant boards.

By pressing the same button, you can re-enable the board once connected.

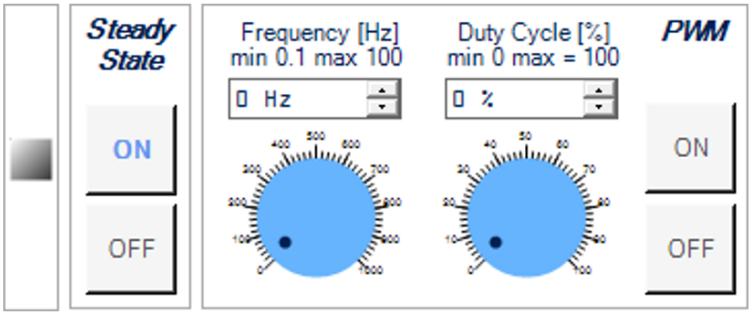
Step 7. The main control panel is divided in four rows, one per each board. Each row is divided in two columns, one per each channel of the on-board device. All the buttons with blue text are related to the currently active functions. For each channel:

– Use the left part of the GUI section to manage the channel steady state for IPS1025H (or IP1025H-32).

– Use the right part of the GUI section to manage its PWM settings.

The following figure shows a detailed view of the GUI section for each channel.

Figure 53. STSW-IFAPGUI channel section



Step 8. Connect the load and supply the power stage of the X-NUCLEO-OUT05A1 (or X-NUCLEO-OUT06A1) with a 24 V rail via the CN1 connector.

Step 9. Select the desired switching frequency and duty cycle of the output channel through the dedicated controls. Use [**ON**] and [**OFF**] buttons under [**PWM**] to start and stop the PWM function.

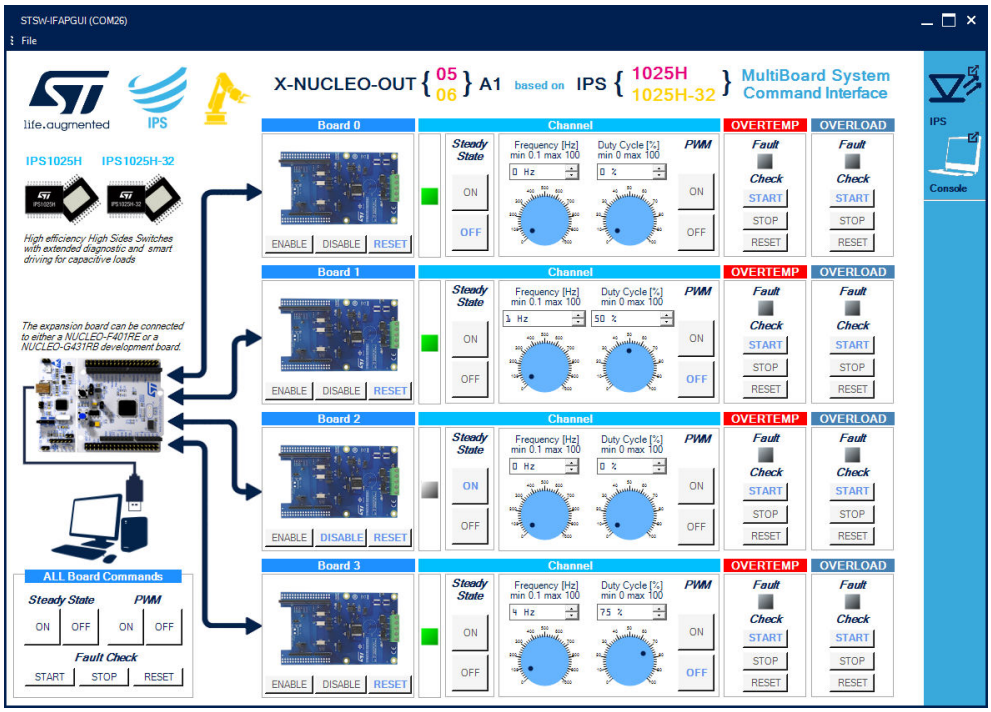
The button that starts the PWM is activated after selecting a frequency and a duty cycle.

Step 10. To activate the output channel steady state, use the [**ON**] button under [**Steady State**]. Use [**OFF**] to deactivate it.

You can stop monitoring the fault status by clicking on the related [**STOP**] button. Press the [**RESET**] button to reset the related fault status.

Step 11. Click on the [**START**] button under [**Fault Check**] on the right side of the GUI channel section to monitor the on/off status on the per-channel FAULT pins on IPS1025H (or IPS1025H-32).

Figure 54. STSW-IFAPGUI in action



2.4.3 How to get information about the GUI

Information about the GUI revision for the multiboard configuration is available by clicking on [**Command Interface**] at the right of the title.

Then, the following window (in the example related to the first revision) appears:

Figure 55. Command interface info

2.5 X-NUCLEO-OUT07A1 expansion board

2.5.1 How to control the expansion board

This application scenario is based on the default configuration of the on-board switch and resistors of the X-NUCLEO-OUT07A1.

Step 1. Stack the X-NUCLEO-OUT07A1 on top of the NUCLEO-F401RE flashed with the STSW-OUT7F4 firmware (or NUCLEO-G431RB flashed with the STSW-OUT7G4 firmware), through the Arduino® UNO R3 connectors.

Step 2. Connect the two stacked boards to your PC or laptop USB port through a mini-USB cable (for NUCLEO-F401RE) or micro-USB cable (for NUCLEO-G431RB). The STM32 is supplied via USB (3.3 V) and the flashed firmware starts running.

Step 3. Connect the load and supply the power stage of the X-NUCLEO-OUT07A1 with a 24 V rail via the CN1 connector.

Step 4. Launch the STSW-IFAPGUI. When the application starts, the firmware running on the STM32 is automatically detected and a COM port is opened for communication.

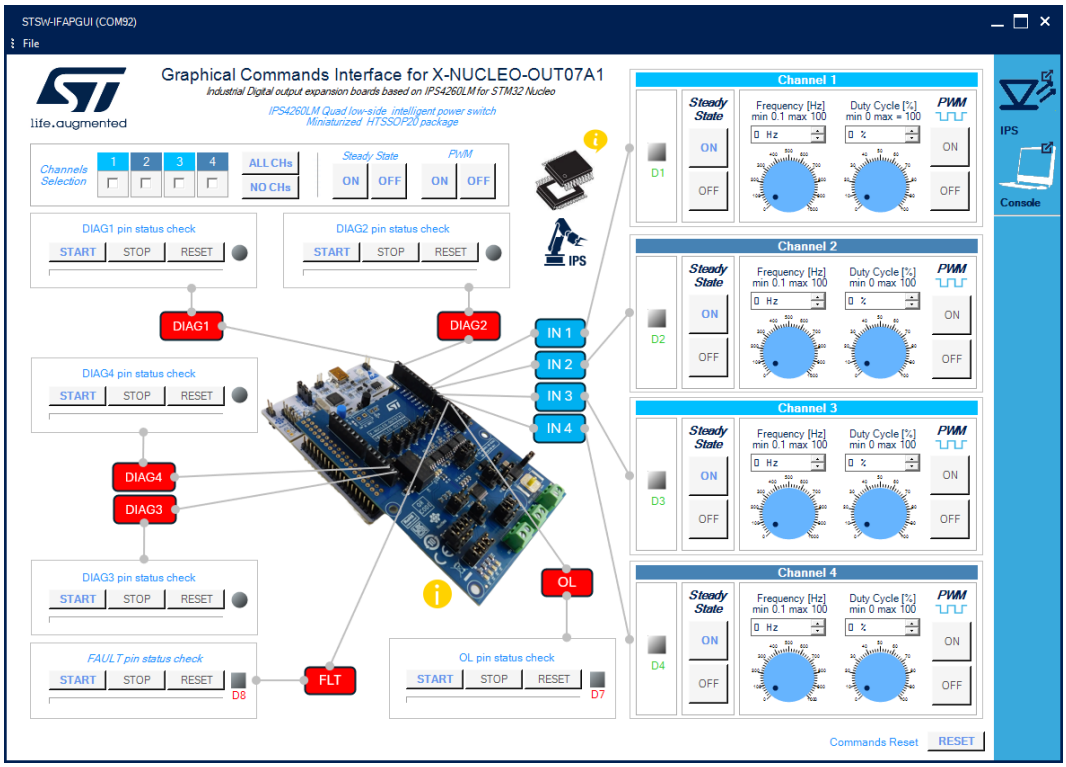
Figure 56. STSW-IFAPGUI COM - port opened

Step 5. Click on the GUI STM32 Nucleo icon after it turns blue (it remains green until the firmware identification is complete). The GUI automatically identifies the board configuration based on the information provided by the firmware.

Figure 57. STSW-IFAPGUI identification complete

Step 6. When the board identification phase has been completed the related STSW-IFAPGUI appears on the screen.

Figure 58. STSW-IFAPGUI main control panel



Step 7. The main control panel includes the sections:

- four channel control sections, one for each device channel, to control the Steady State or PWM mode.
- six diagnostic sections related to FAULT, OL device pins, and DIAG1, DIAG2, DIAG3 and DIAG4 signals
- a Channels Selection section to perform operation on the selected channels with a single click
- a Command Reset section to restore the main control panel startup status

All the buttons with blue text refer to the functions currently active, when the text is gray the function will be activated after a preliminary action, such as setting the frequency and duty cycle of the PWM.

- Use the Channel [**Steady State**] GUI section to manage the channel steady state for IPS4260LM. The [**ON**] and [**OFF**] buttons are used to turn a channel on or off respectively. The [**ON**] button for each channel is enabled at the startup. When a channel is on in steady state mode the green LED corresponding to that channel will be on, the [**OFF**] button will be enabled, and the [**ON**] button disabled. When a channel is turned on in steady state mode it will not be possible to use the PWM mode. To use the PWM, the steady state of the channel must first be switched off.

Figure 59. STSW-IFAPGUI Channel section, Steady State enabled and ready to use

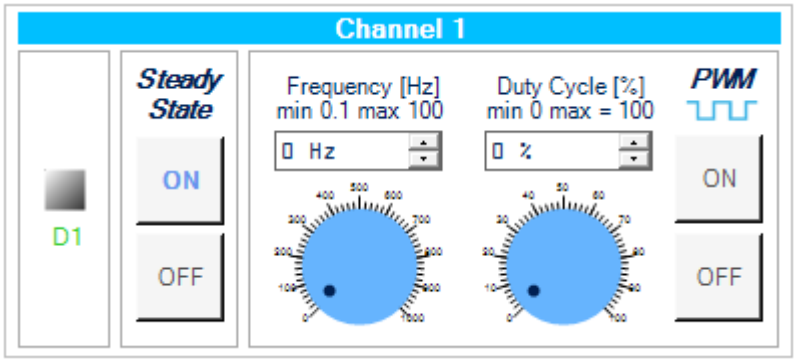
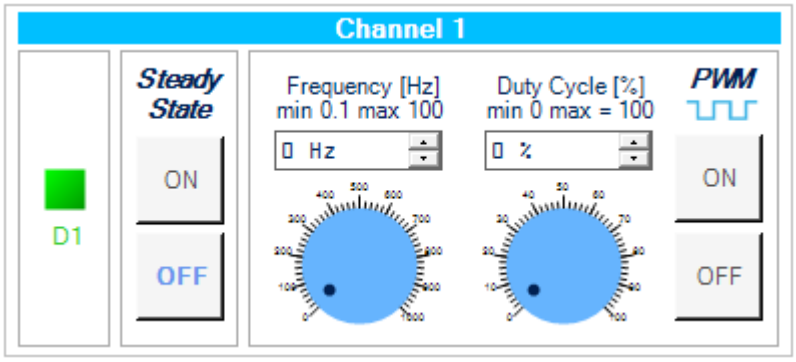
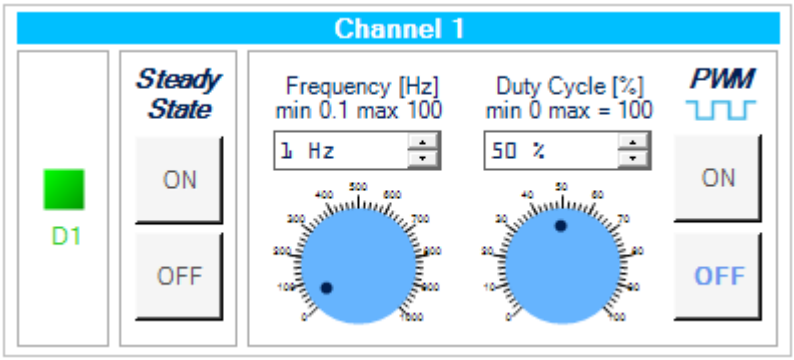


Figure 60. STSW-IFAPGUI Channel section, Steady State on



- Use the channel [**PWM**] GUI section to manage the channel PWM settings and to power on or off the channel input in PWM mode. The button [**ON**] starting the PWM will be enabled when both the frequency and the duty cycle values for the channel have been selected through the dedicated controls and the steady mode is off for the channel. The PWM on will be signalized by the green LED blinking according to the frequency and duty cycle chosen. Use the [**OFF**] button to stop the PWM function.

Figure 61. **STSW-IFAPGUI channel section, PWM ON state**



Step 8. The diagnostic sections allow you to check the status of the diagnostic pins and signals available on the board. The pins and signals that is possible to check are:

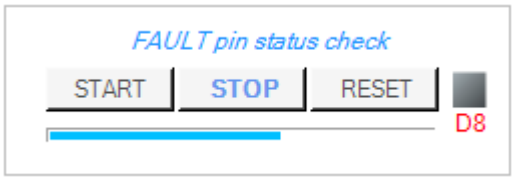
- FAULT: Cut-off and thermal shutdown pin. Common diagnostic pin both for thermal shutdown and cut-off
- OL: Cumulative power stage open load or short ground common diagnostic
- DIAG1: Channel 1 cut-off and thermal shutdown diagnostic
- DIAG2: Channel 2 cut-off and thermal shutdown diagnostic
- DIAG3: Channel 3 cut-off and thermal shutdown diagnostic
- DIAG4: Channel 4 cut-off and thermal shutdown diagnostic

Use the [**FAULT pin status check**] section to start and stop the check on the device FAULT pin.

Figure 62. STSW-IFAPGUI FAULT pin status check section

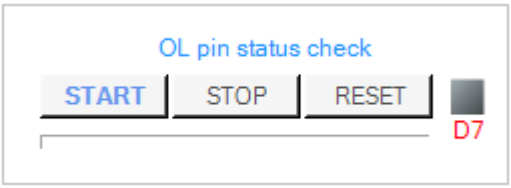
Click on the [**START**] to monitor the on/off status of the FAULT pin onIPS4260LM. The FAULT is a Common Diagnostic pin, and it is activated (forced low) for both for thermal shutdown and cut-off. When a fault condition is triggered, the red LED into the section will light up. The pin check in progress is signaled by the activation of the progress bar.

Figure 63. STSW-IFAPGUI FAULT pin status check in progress



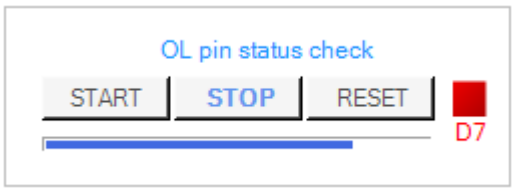
Click on the [**STOP**] button to stop the FAULT pin check and on the [**RESET**] button to clear the last pin condition which is kept displayed after the stop.
Use the [**OL pin status check**] section to start and stop the check on the device OL pin. It is the cumulative power stage open load or short ground common diagnostic, forced low when fault condition occurs.

Figure 64. STSW-IFAPGUI OL pin status check section



Click on the [**START**] to monitor the on/off status of the OL pin on IPS4260LM. The OL is a Common Diagnostic pin, and it is forced low when activated. When an OL fault condition is triggered, the red LED into the section will light up, as shown in the following figure. The pin check in progress is signaled by the activation of the progress bar.

Figure 65. **STSW-IFAPGUI OL pin status check in progress**



Click on the [**STOP**] button to stop the OL pin check and on the [**RESET**] button to clear the last pin condition which is kept displayed after the stop.
Below is a description of how to use the monitoring of the DIAG1, DIAG2, DIAG3 and DIAG signals. Since the operation is similar for all four, the operation will be explained only once by generically indicating one of the four signals with DIAGx.
Use the [**DIAGx pin status check**] section to start and stop the check of the device DIAGx diagnostic signal.

Figure 66. **STSW-IFAPGUI DIAGx signal status check section**

Click on the [**START**] to monitor the on/off status of the DIAGx signal on X-NUCLEO-OUT07A1. The DIAGx is a per-channel diagnostic pin, and it is activated (forced low) in case of thermal shutdown. When a fault condition is triggered, the red LED into the section will light up. The signal check in progress is signaled by the activation of the progress bar.

Figure 67. **STSW-IFAPGUI DIAGx signal status check in progress**

Click on the [**STOP**] button to stop the DIAGx signal status check and on the [**RESET**] button to clear the last signal condition which is kept displayed after the stop.

Step 9. Click on the [**RESET**] button in the bottom-right part of the main control panel to stop all operations in progress (channels switched on in steady state or PWM mode, diagnostic checks on going). All frequency and duty cycle values selected for the PWM are also reset.

Figure 68. **STSW-IFAPGUI Commands Reset button**

2.5.2 How to get information about the GUI

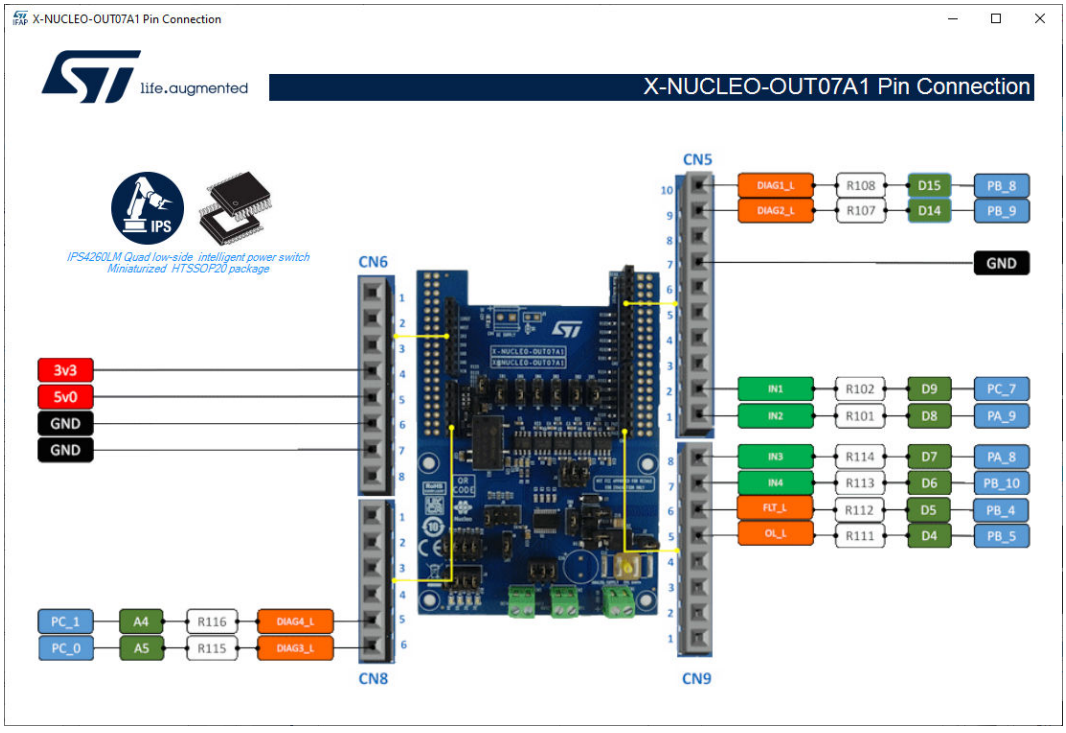
Information about the GUI revision is available by clicking on the interface title (See Figure 58. STSW-IFAPGUI main control panel). Then, the following window (in the example related to the first revision) appears:

Figure 69. Command interface info

2.5.3 Information about the pin connections

The device pin connections to the microcontroller are shown by clicking on the yellow info logo on the left of the board image (See Figure 58. STSW-IFAPGUI main control panel). The following figure shows the Board Connections window shown after the click for X-NUCLEO-OUT07A1.

Figure 70. Board Pin Connections



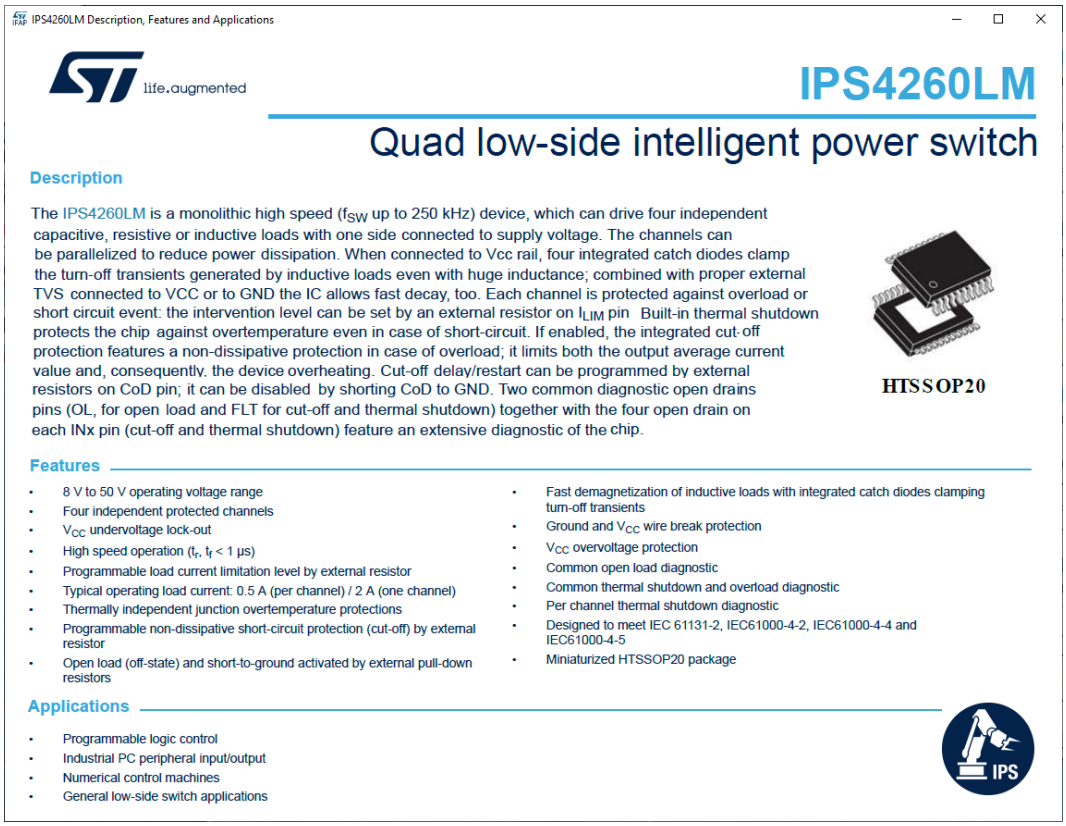
2.5.4 Information about the device

It is also possible to obtain information on the features of the device mounted on the board. Simply with a click on the device package picture (See Figure 58. STSW-IFAPGUI main control panel).

Figure 71. Get Command Interface info

Then, the following window appears:

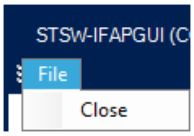
Figure 72. Device Features



2.5.5 Close the command interface

To close the command interface, use File/Close in the top-left part of the GUI.

Figure 73. STSW-IFAPGUI close the command interface



The command interface can be opened again by clicking on the Nucleo icon as described above.

2.6 X-NUCLEO-OUT08A1 and X-NUCLEO-OUT10A1 expansion boards

2.6.1 How to control a single expansion board

In this application scenario, the default X-NUCLEO-OUT08A1 (or X-NUCLEO-OUT10A1) on-board switch and resistor configuration is applied.

Step 1. Stack the NUCLEO-F401RE board flashed with the STSW-OUT8F4 firmware (or NUCLEO-G431RB flashed with STSW-OUT8G4) on the X-NUCLEO-OUT08A1 (orX-NUCLEO-OUT10A1) through the Arduino® UNO R3 connectors.

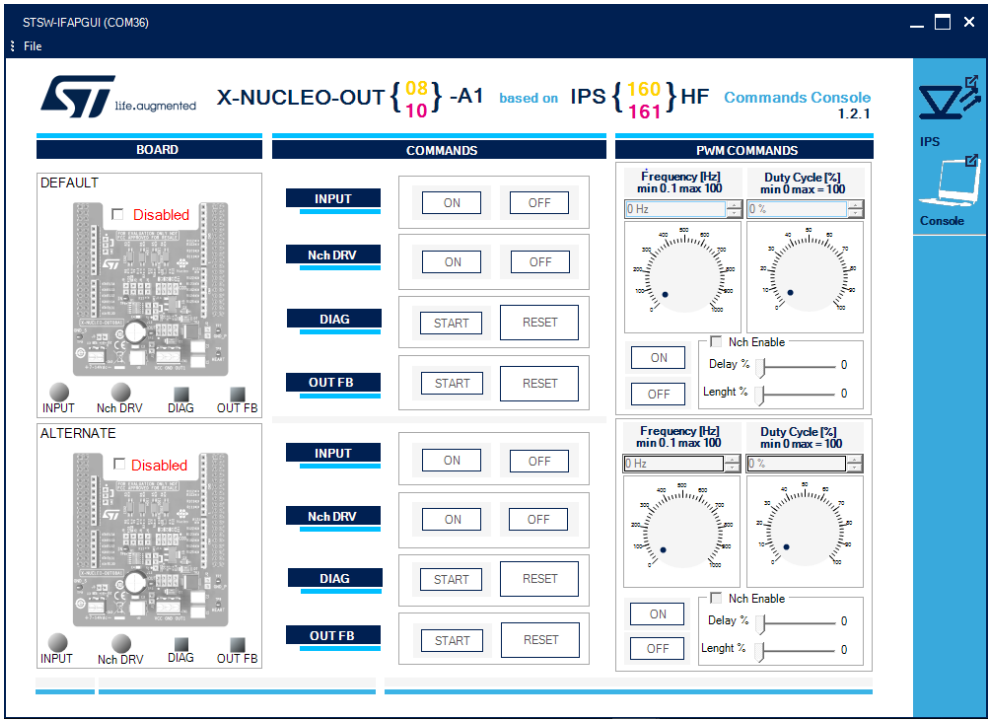
Step 2. Connect the two stacked boards to your PC/laptop USB port through a mini-USB (for NUCLEO-F401RE) or micro-USB cable (for NUCLEO-G431RB).

Step 3. Launch the STSW-IFAPGUI.

When the application starts, the firmware running on the STM32 is automatically detected and a COM port is opened for communication.

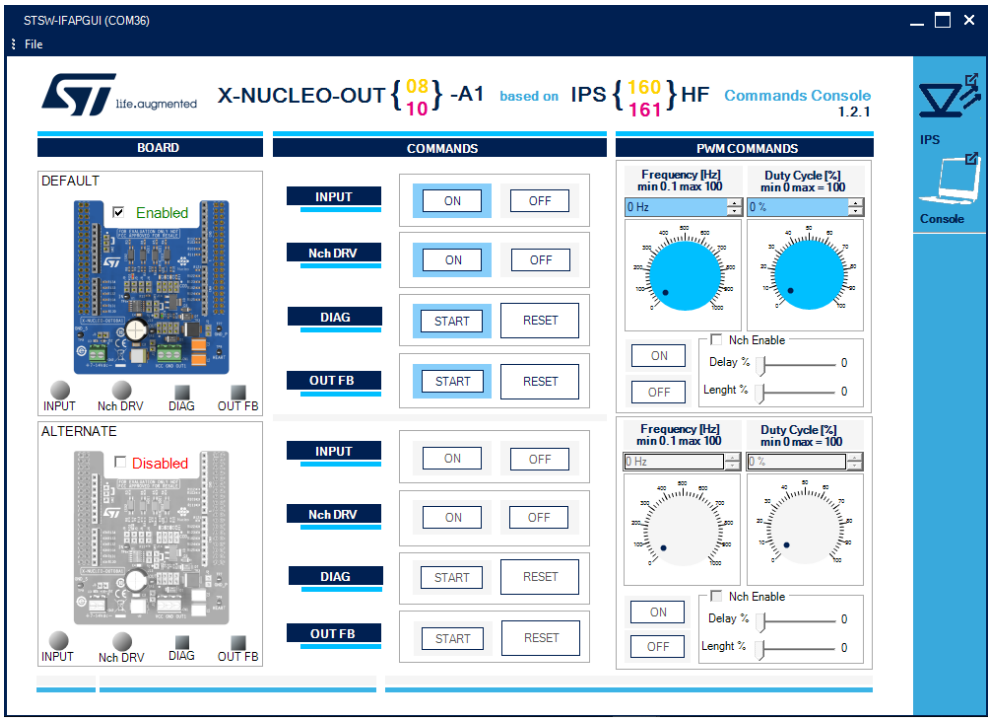
Step 4. Click on the GUI STM32 Nucleo icon after it turns blue (it remains green until the firmware identification has completed).

Figure 74. STSW-IFAPGUI main control panel



Step 5. Tick the box on the top left corner of the GUI to enable the DEFAULT board.

Figure 75. STSW-IFAPGUI single chip control panel



Step 6. Connect the load and supply the power stage of the X-NUCLEO-OUT08A1 (or X-NUCLEO-OUT10A1) with a 24 V rail via CN1 connector.

Step 7. Select the desired switching frequency and duty cycle of the output channel through the [**PWM COMMANDS**] on the top right side of the GUI.

Step 8. Click the [**ON/OFF**] button (just below the Frequency Selection area) to activate or deactivate the output channel.

*Note: The output channel steady state can be activated by clicking on the [**ON**] button on the right of the [**INPUT**] label.*

Step 9. Click on the [**START**] button on the right of the [**DIAG**] and [**OUT_FB**] labels to monitor the on/off status of the DIAG pin on IPS160HF (or IPS161HF) and the output voltage status (if activated by setting J13 appropriately).

You can stop monitoring these feedback signals by clicking on the [**STOP**] button.

Note: In some cases it may be necessary to supply the board 30 V for proper activation of the signals on the GUI.

Step 10. Use one of the following options to test Q1 and the on-board circuit for the fast discharge of high capacitive load:

– Click on the [**ON/OFF**] button on the right of the [**NchDRV**] label to activate Q1 in steady state.

– Tick the box on the left of the [**Nch Enable**] label and then select its activation delay after the output gets inactive and its activation length during the output deactivation window.

Both timing parameters are defined as a percentage of the deactivation window of the output channel by the [**Delay %**] and [**Length %**] selectors.

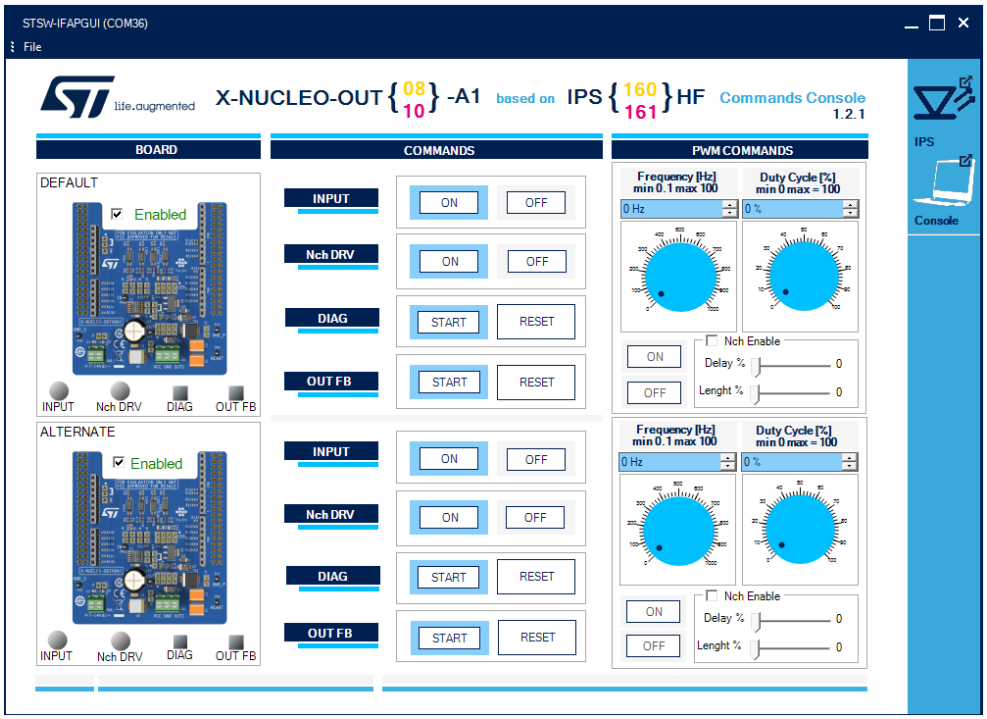
2.6.2 How to control two expansion boards

The STSW-IFAPGUI and the STSW-OUT8F4 or STSW-OUT8G4 firmware can also control two stacked shields (two X-NUCLEO-OUT08A1, or two X-NUCLEO-OUT10A1 expansion boards, or one of each).

Step 1. Configure the jumper and resistors of the second (ALTERNATE) board as described in UM2715 (for X-NUCLEO-OUT08A1) and UM2716 (for X-NUCLEO-OUT10A1), freely available on www.st.com.

Step 2. Tick the [**Enable/Disable**] boxes of the DEFAULT and ALTERNATE board on the GUI.

Figure 76. STSW-IFAPGUI dual chip control panel



The control panel of the ALTERNATE board is a clone of the DEFAULT one, so you can follow the steps described in Section 2.6.1.

2.7 X-NUCLEO-OUT09A1 and X-NUCLEO-OUT19A1 expansion boards

2.7.1 How to control the expansion board

This application scenario is based on the default configuration of the on-board switch and resistors of the X-NUCLEO-OUT09A1 (or X-NUCLEO-OUT19A1).

Step 1. Stack the X-NUCLEO-OUT09A1 (or X-NUCLEO-OUT19A1) on top of the NUCLEO-F401RE flashed with the STSW-OUT9F4 firmware (or NUCLEO-G431RB flashed with the STSW-OUT9G4 firmware), through the Arduino® UNO R3 connectors.

Step 2. Connect the two stacked boards to your PC or laptop USB port through a mini-USB cable (for NUCLEO-F401RE) or micro-USB cable (for NUCLEO-G431RB).

The STM32 is supplied via USB (3.3 V) and the flashed firmware starts running.

Step 3. Connect the load and supply the power stage of the X-NUCLEO-OUT09A1 (or X-NUCLEO-OUT19A1) with a 24 V rail via the CN1 connector.

Step 4. Launch the STSW-IFAPGUI.

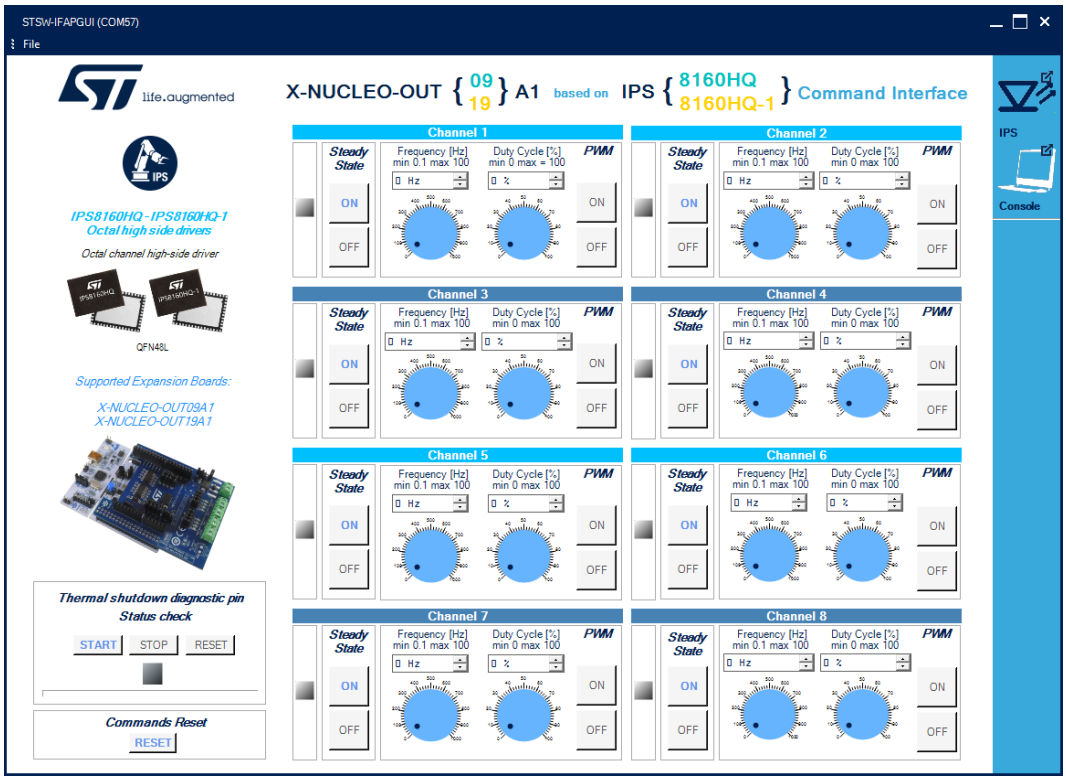
When the application starts, the firmware running on the STM32 is automatically detected and a COM port is opened for communication.

Figure 77. STSW-IFAPGUI COM - port opened

Step 5. Click on the GUI STM32 Nucleo icon after it turns blue (it remains green until the firmware Identification is complete).

Step 6. The STSW-IFAPGUI appears on the screen.

Figure 78. STSW-IFAPGUI main control panel



Step 7. The main panel is divided into:

- eight channel control sections, one for each channel
- a diagnostic section
- a command reset section

All the buttons with blue text are related to the currently active functions.
The channel control sections are used to switch on or off the channels in steady state and PWM mode.

- Use the Channel [**Steady State**] GUI section to manage the channel steady state for IPS8160HQ (or IPS8160HQ-1). The [**ON**] and [**OFF**] buttons are used to turn a channel on or off respectively. The [**ON**] button for each channel is enabled at the startup.
  When a channel is on in steady state mode the green LED corresponding to that channel will be on and the [**OFF**] button will be enabled, and the [**ON**] button disabled. When a channel is turned on in steady state mode it will not be possible to use the PWM mode. In order to use the PWM, the steady state of the channel must first be switched off.
- Use the channel [**PWM**] GUI section to manage the channel PWM settings and to power on or off the channel input in PWM mode. The [**ON**] button starting the PWM will be enabled when both the frequency and the duty cycle values for the channel have been selected through the dedicated controls and the steady mode is off for the channel. The PWM on will be signalized by the green LED blinking according to the frequency and duty cycle chosen. Use the [**OFF**] button to stop the PWM function.

The following figures show a detailed view of the GUI Channel section functions.

Figure 79. STSW-IFAPGUI channel section, Steady State enabled and ready to use

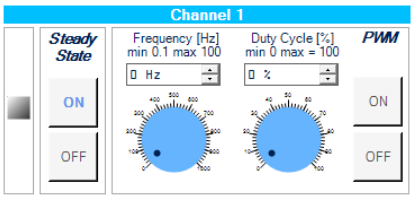


Figure 80. STSW-IFAPGUI channel section, Steady State ON

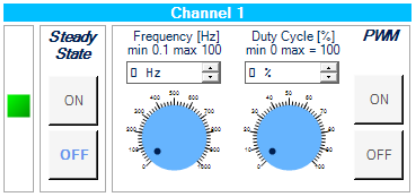
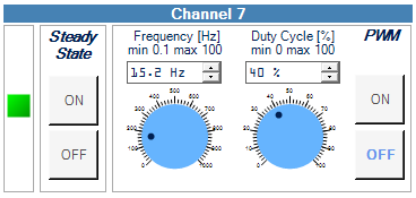


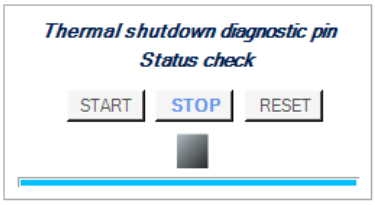
Figure 81. STSW-IFAPGUI channel section, PWM ON



Step 8. The diagnostic section is related to the thermal shutdown condition check. Click on the [**START**] button under [**Thermal shutdown diagnostic pin Status Check**] to monitor the on/off status of the STATUS pins on IPS8160HQ (or IPS8160HQ-1). The STATUS is a diagnostic pin at chip level. The activation of the status pin check is signalized by the bar under the diagnostic LED. When a fault condition is triggered, the red LED will light up. Click on the [**STOP**] button to stop the STATUS pin check and on the [**RESET**] button to clear the last pin condition displayed

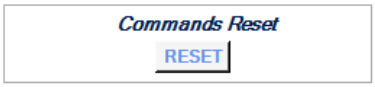
Figure 82. STSW-IFAPGUI status check

Figure 83. STSW-IFAPGUI status check activated (no fault condition triggered)



Step 9. Click on the [**RESET**] button in the [**Commands Reset**] section to stop all operations in progress (channels switched on in steady state or PWM, status pin check activated). All frequency and duty cycle values that have been selected are also reset.

Figure 84. STSW-IFAPGUI commands reset



Step 10. To close the command interface, use File/Close in the top-left part of the GUI. The command interface can be opened again by clicking on the Nucleo icon as described above.

2.7.2 How to get information about the GUI

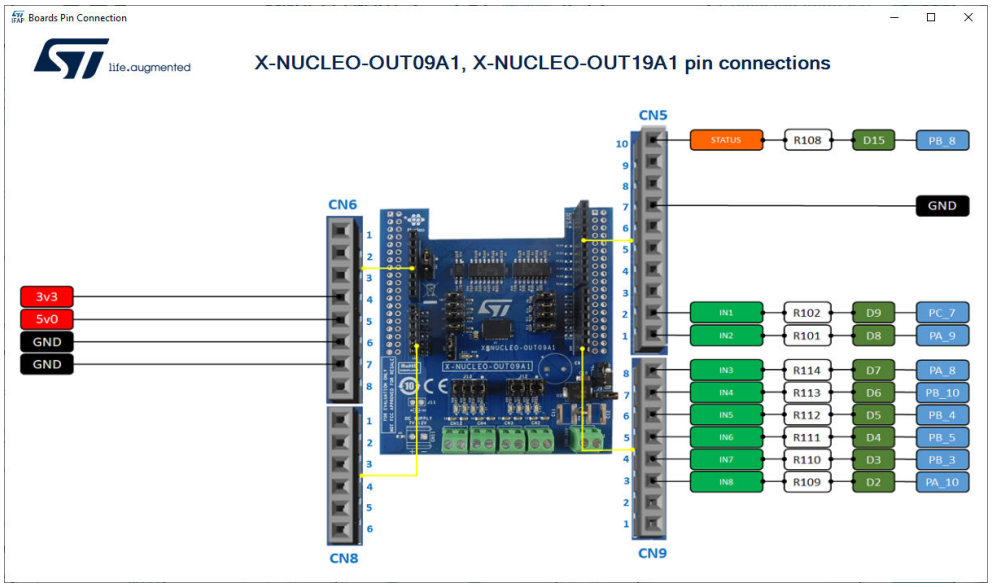
Information about the GUI revision is available by clicking on [**Command Interface**] at the right of the title. Then, the following window (in the example related to the first revision) appears:

Figure 85. Command Interface info

2.7.3 Information about the pin connections

The device pin connections to the microcontroller are shown by clicking on the board image.

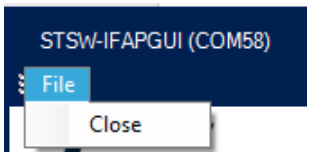
Figure 86. Board setup



2.7.4 Close the command interface

To close the command interface, use File/Close in the top-left part of the GUI.

Figure 87. STSW-IFAPGUI close the command interface



The command interface can be opened again by clicking on the Nucleo icon as described above.

2.8 X-NUCLEO-OUT11A1 and X-NUCLEO-OUT13A1 expansion boards

2.8.1 How to control the expansion board

This application scenario is based on the default configuration of the on-board switch and resistors of the X-NUCLEO-OUT11A1 (or X-NUCLEO-OUT13A1).

Step 1. Stack the X-NUCLEO-OUT11A1 (or X-NUCLEO-OUT13A1) on top of the NUCLEO-F401RE flashed with the STSW-OUT11F4 firmware (or NUCLEO-G431RB flashed with the STSW-OUT11G4 firmware), through the Arduino® UNO R3 connectors.

Step 2. Connect the two stacked boards to your PC or laptop USB port through a mini-USB cable (for NUCLEO-F401RE) or micro-USB cable (for NUCLEO-G431RB). The STM32 is supplied via USB (3.3 V) and the flashed firmware starts running.

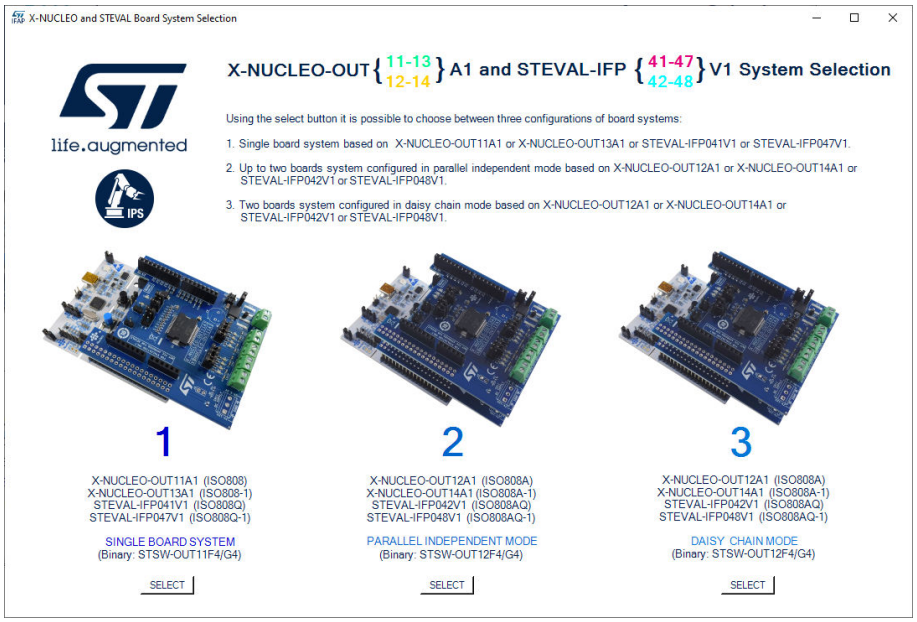
Step 3. Connect the load and supply the power stage of the X-NUCLEO-OUT11A1 (or X-NUCLEO-OUT13A1) with a 24 V rail via the CN1 connector.

Step 4. Launch the STSW-IFAPGUI. When the application starts, the firmware running on the STM32 is automatically detected and a COM port is opened for communication.

Figure 88. STSW-IFAPGUI COM - port opened

Step 5. Click on the GUI STM32 Nucleo icon after it turns blue. After the click a system selection windows are shown, because there are more than one system using device of the same 808 family.

Figure 89. System configuration selection panel

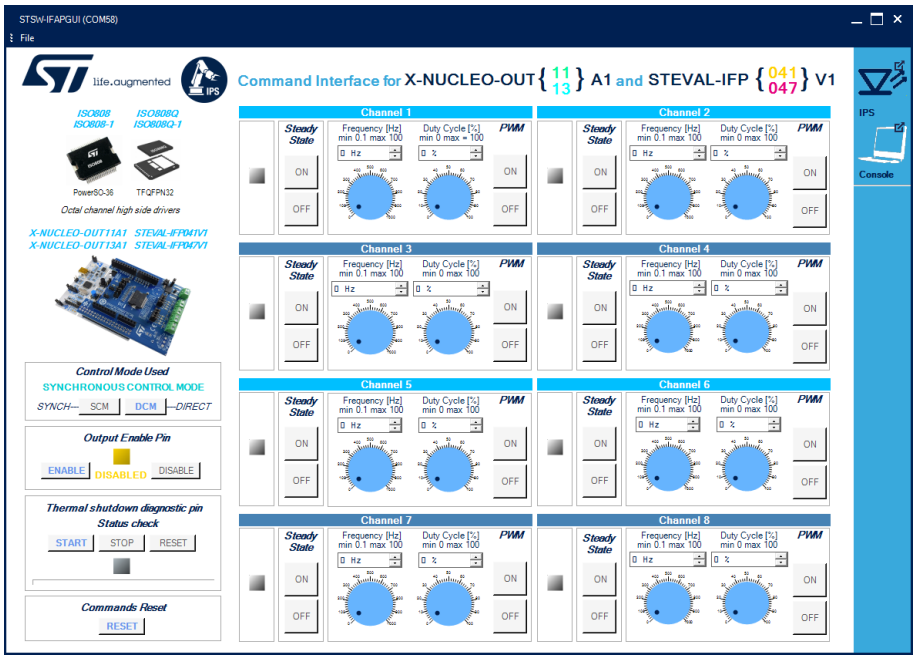


In this case the option one must be selected. It is necessary to have flashed the correct firmware (STSW-OUT11F4 or STSW-OUT11G4) in the microcontroller to avoid errors when opening the command interface, in fact if the firmware is not the correct one an error message will be shown. After the system selection and firmware identification the logo will be green.

Figure 90. STSW-IFAPGUI identification complete

Step 6. The STSW-IFAPGUI appears on the screen.

Figure 91. STSW-IFAPGUI main control panel



Step 7. Use the Command Interface.

The main panel is divided into:

- eight channel control sections, one for each channel
- control mode section
- the outputs enable section
- a diagnostic section
- commands reset section

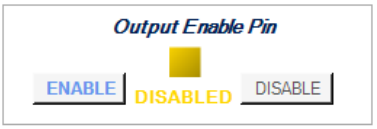
All the buttons with blue text are related to the currently active functions.

- Use the [**Control Mode Used**] section to choose the control mode state for ISO808 or ISO808-1 or ISO808Q or ISO808Q-1. The [**SCM**] button selects the Direct Control Mode, the [**DCM**] button selects the Synchronous Control Mode. At the command interface startup, the default mode is Synchronous, so the change mode to [**DCM**] button is enabled.

Figure 92. STSW-IFAPGUI control mode selection

- Use the [**Output Enable Pin**] section to enable the outputs for ISO808 or ISO808-1 or ISO808Q or ISO808Q-1. At the startup the outputs and all commands into the channels control section are disabled.

Figure 93. STSW-IFAPGUI Output Enable Pin control



The channel control sections are used to switch on or off the channels in steady state or PWM mode

- Use the Channel [**Steady State**] GUI section to manage the channel steady state for ISO808 or ISO808-1 or ISO808Q or ISO808Q-1. The [**ON**] and [**OFF**] buttons are used to turn a channel on or off respectively. The [**ON**] button for each channel is not enabled after the commands interface startup until the outputs are enabled. When a channel is on in steady state mode the green LED corresponding to that channel will be on, the [**OFF**] button will be enabled, and the [**ON**] button disabled. When a channel is turned on in steady state mode it will not be possible to use the PWM mode. In order to use the PWM, the steady state of the channel must first be switched off.
- Use the channel [**PWM**] GUI section to manage the channel PWM settings and to power on or off the channel input in PWM mode. The [**ON**] button starting the PWM will be enabled when the outputs are enabled and both the frequency and the duty cycle values for the channel have been selected through the dedicated controls and the steady mode is off for the channel. The PWM on will be signalized by the green LED blinking according to the frequency and duty cycle chosen. Use the [**OFF**] button to stop the PWM function.

The following figures show a detailed view of the GUI Channel section functions.

Figure 94. **STSW-IFAPGUI channel section, Steady State control enabled and ready to use**

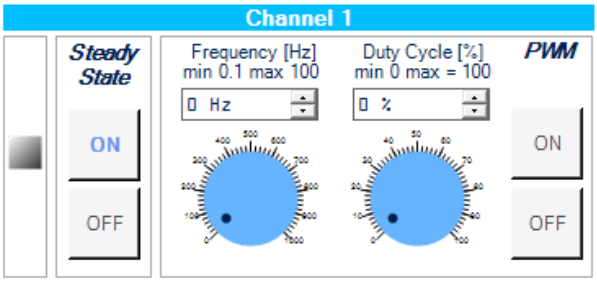


Figure 95. **STSW-IFAPGUI channel section, Steady State on**

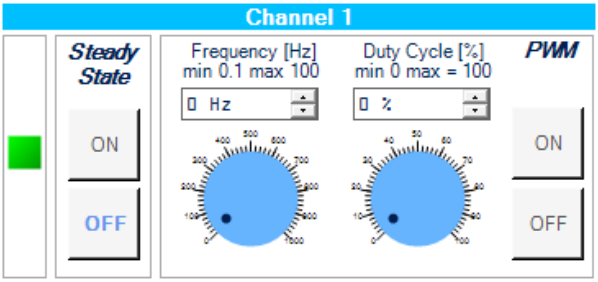
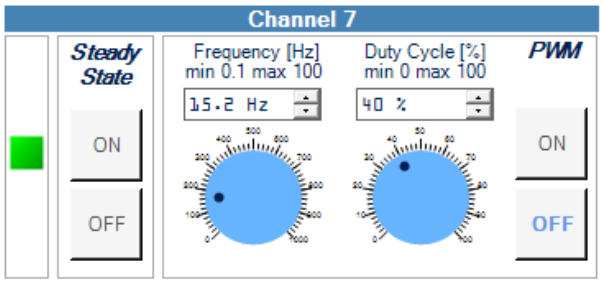


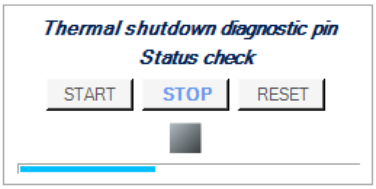
Figure 96. **STSW-IFAPGUI channel section, PWM on**



Step 8. The diagnostic section is related to the thermal shutdown condition check. Click on the [**START**] button under [**Thermal shutdown diagnostic pin Status Check**] to monitor the on/off status of the STATUS pins on ISO808 or ISO808-1 or ISO808Q or ISO808Q-1. The STATUS is a diagnostic pin at chip level. The activation of the status pin check is signalized by the bar below the diagnostic LED. When a fault condition is triggered, the red LED will light up. Click on the [**STOP**] button to stop the STATUS pin check and on the [**RESET**] button to clear the last pin condition displayed.

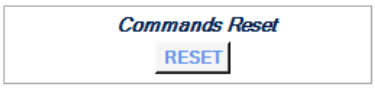
Figure 97. STSW-IFAPGUI status check before activation

Figure 98. STSW-IFAPGUI status check activated, no fault



Step 9. Click on the [**RESET**] button in the [**Commands Reset**] section to stop all operations in progress, (channels switched on in steady state or PWM, status pin check activated). All frequency and duty cycle values that have been selected are also reset.

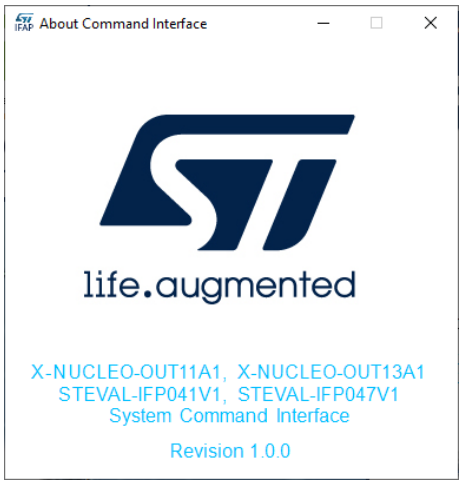
Figure 99. STSW-IFAPGUI commands reset



2.8.2 How to get information about the GUI

Information about the GUI revision for the system you are using is available by clicking on [**Command Interface**] at the left part of the title.Then, the following window (in the example related to the first revision) appears:

Figure 100. Command interface info



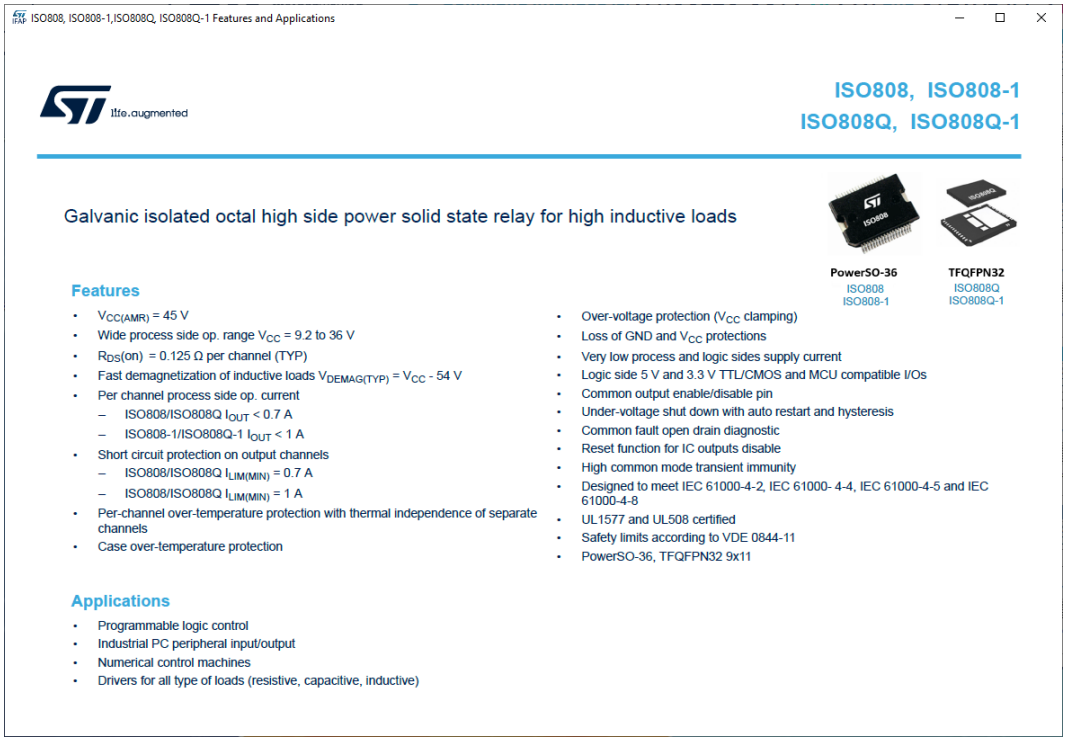
2.8.3 How to get information about the Device Features

Information about the device feature is available by clicking on devices pictures on tthe top-left part of the command interface.

Figure 101. How to get devices info

Then, the following window appears:

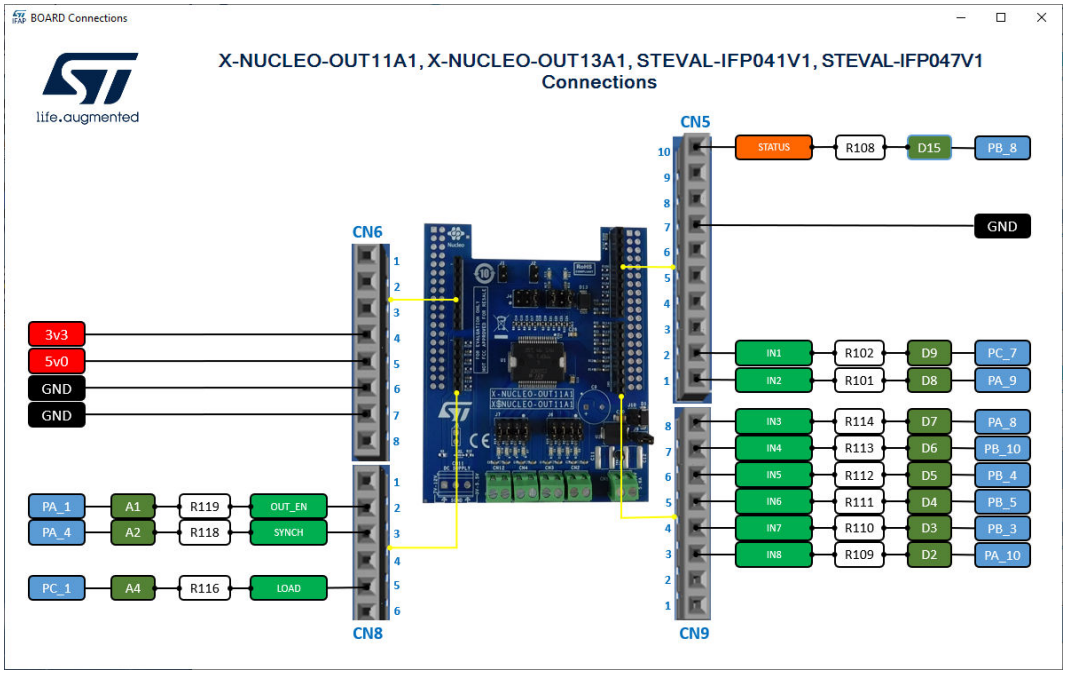
Figure 102. Devices info



2.8.4 Information about the pin connections

The device pin connections to the microcontroller are shown by clicking on the board image.

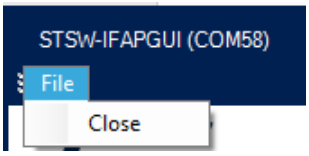
Figure 103. **Board setup**



2.8.5 Close the command interface

To close the command interface, use File/Close in the top-left part of the GUI.

Figure 104. **STSW-IFAPGUI close the command interface**



The command interface can be opened again by clicking on the Nucleo icon as described above.

2.9 X-NUCLEO-OUT12A1 and X-NUCLEO-OUT14A1 expansion boards

2.9.1 How to setup a multiboard system

This application scenario is based on the multiboard configuration using the on-board jumpers and resistors of the X-NUCLEO-OUT12A1 (or X-NUCLEO-OUT14A1).

There are two different scenarios:

- Parallel Independent Mode
- Daisy Chain Mode

In the parallel independent mode, it is possible to drive up to two boards independently to get an 8+8 channels system. The board resistors must be properly configured. The first board, called Board 0 has the default resistor configuration and you don't have to do anything. For the second, called Board 1, it is necessary to unsolder some resistor and solder them in a new position as described in the following table:

Table 4. Resistors configuration of two stacked expansion boards in Parallel Independent Mode

Board no.	SPI_CLK	DaisyChain	SPI_MISO	SPI_MOSI	SPI_SS	OUT_EN	STATUS	PGOOD
Board 0	R106	–	R105	R104	R103	R119	R108	R107
Board 1	R106	–	R105	R104	R114	R109	R113	R111

To use the command interface, it`s not necessary to have booth boards. Can be stacked on the nucleo board only one of the two X-NUCLEO, but it is necessary to refer to the board number accordingly to the resistors configuration. Furthermore, the correct jumper setup must be used:

J5 open

J3 Closed 1-2, 3-4, 5-6

J4 Closed 5-6

J6 Closed 1-2, 3-4, 5-6, 7-8 to enable active state led for OUT1-4

J7 Closed 1-2, 3-4, 5-6, 7-8 to enable active state led for OUT5-8

J9, J10 closed

J12: Closed 1-2

J13: Closed 1-2

In Daisy Chan mode the two board connections create a unique system. So, the two boards are not independent and must always be stacked together on the Nucleo board. In this case two stacked boards using Daisy Chain implement a 16 channels system.

Table 5. Configuration of a stack of two expansion boards in Daisy Chain Mode

Board no.	SPI_CLK	DaisyChain	SPI_MISO	SPI_MOSI	SPI_SS	OUT_EN	STATUS	PGOOD
Board 0	R106	R102	-	R104	R103	R119	R108	R107
Board 1	R106	R102	R105	-	R103	R119	R113	R111

The jumper setup for the Daisy Chain Mode is:

J5 open

J3 Closed 1-2, 3-4, 5-6

J4 Closed 5-6

J6 Closed 1-2, 3-4, 5-6, 7-8 to enable active state led for OUT1-4

J7 Closed 1-2, 3-4, 5-6, 7-8 to enable active state led for OUT5-8

J9, J10 closed

- **Board 0**:
  - J12: Closed 1-2
  - J13: Closed 3-4
- **Board 1**:
  - J12: Closed 3-4
  - J13: Closed 1-2

2.9.2 How to control the expansion boards

Step 1. Stack the X-NUCLEO-OUT12A1 (or X-NUCLEO-OUT14A1) on top of the NUCLEO-F401RE flashed with the STSW-OUT12F4 firmware (or NUCLEO-G431RB flashed with the STSW-OUT12G4 firmware), through the Arduino® UNO R3 connectors.

Step 2. Connect the two stacked boards to your PC or laptop USB port through a mini-USB cable (for NUCLEO-F401RE) or micro-USB cable (for NUCLEO-G431RB). The STM32 is supplied via USB (3.3 V) and the flashed firmware starts running.

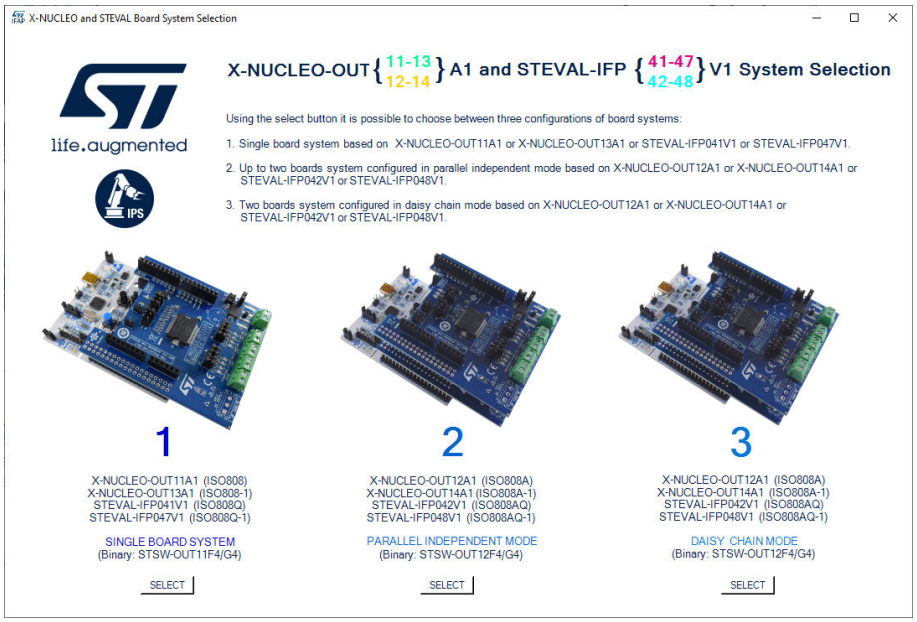
Step 3. Connect the load and supply the power stage of the X-NUCLEO-OUT12A1 (or X-NUCLEO-OUT14A1) with a 24 V rail via the CN1 connector.

Step 4. Launch the STSW-IFAPGUI. When the application starts, the firmware running on the STM32 is automatically detected and a COM port is opened for communication.

Figure 105. STSW-IFAPGUI COM - port opened

Step 5. Click on the GUI STM32 Nucleo icon after it turns blue. After the click a system selection windows are shown, because there is more than one system using device of the same 808 family.

Figure 106. System configuration selection panel



In this case there are two options selectable:

– **2**: Parallel Independent Mode

– **3**: Daisy Chain Mode

The firmware to be flashed in the microcontroller must be STSW-OU12F4 or STSW-OUT12G4, a not corrected firmware will generate an error message in command interface opening phase.
After the system selection and firmware identification the logo will be green.

Figure 107. STSW-IFAPGUI identification complete

Step 6. The STSW-IFAPGUI appears on the screen. The following figures show the command interface startup window for parallel independent and daisy chain mode.

Figure 108. STSW-IFAPGUI – parallel independent system main control panel

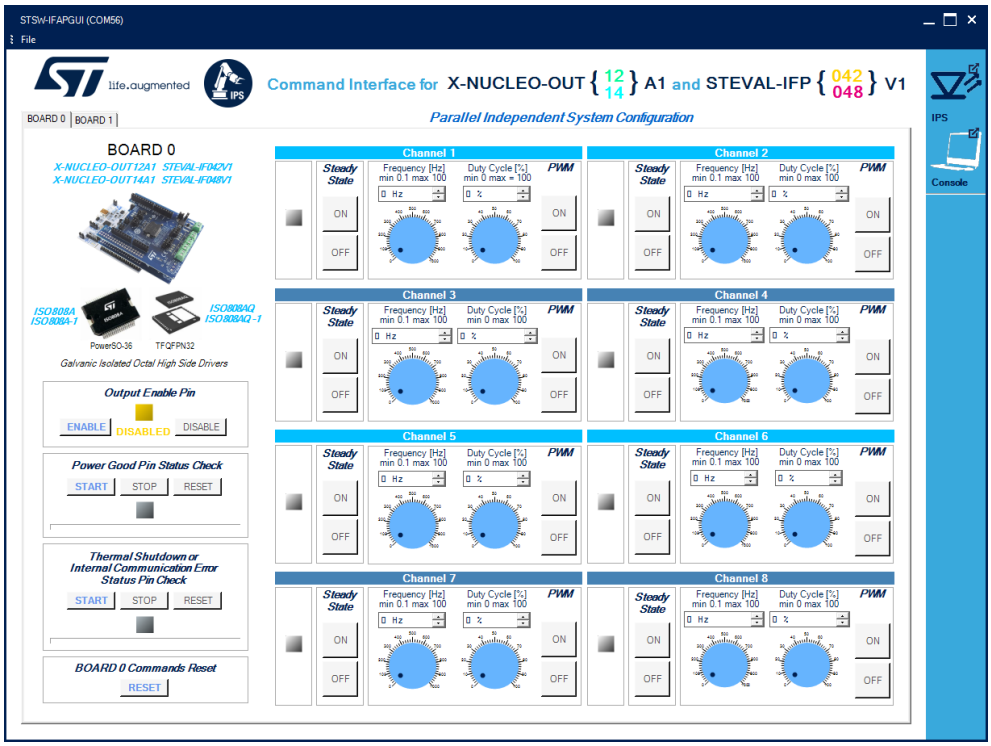
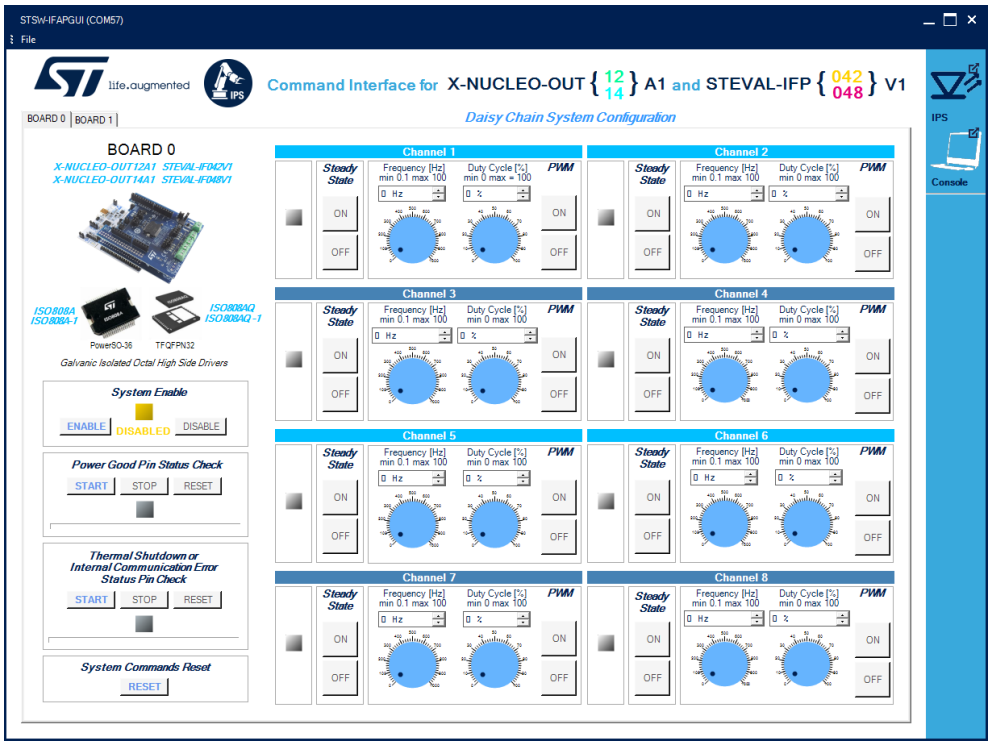


Figure 109. STSW-IFAPGUI – daisy chain system main control panel



Step 7. Use the Command Interface.

The main panel for Parallel Independent and Daisy Chain mode are quite similar. The differences using the two interfaces will be described later. The main panel contains two tabs related to Board 0 and 1 respectively. Each tab is divided into sections:
For the **Parallel Independent** Command Interface:

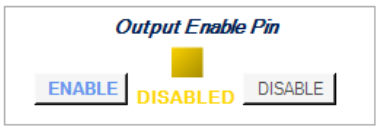
- an Output Enable Pin section.
- eight channel control sections, one for each channel.
- a diagnostic section to check the Power Good Pin.
- a diagnostic section to check the Status Pin.
- a commands reset section.

For the Daisy Chain Command Interface:

- a System Enable section.
- eight channel control sections, one for each channel.
- a diagnostic section to check the Power Good.
- a diagnostic section to check the Status Pin
- a commands reset section.

Step 8. Use the [**ENABLE**] button int the [**Output Enable Pin**] section to enable the outputs for ISO808A or ISO808A-1 or ISO808AQ or ISO808AQ-1. At the startup the outputs and all commands into the channels control section are disabled, and the yellow led will be on. After the click on the [**ENABLE**] button LED will be switched off. The two boards outputs can be enabled and disabled independently.

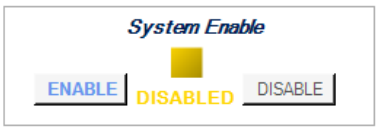
Figure 110. STSW-IFAPGUI Output Enable for Parallel Independent configuration



Daisy Chain System Configuration

Use the [**ENABLE**] button int the [**System Enable**] section to enable the outputs for ISO808A or ISO808A-1 or ISO808AQ or ISO808AQ-1. At the startup the outputs and all commands into the channels control section are disabled, and the yellow led will be on. After the click on the [**ENABLE**] button LED will be switched off. In the Daisy Chain connections, the operation on the two boards are not independent, so each enabling command on one board affects also the other. The same behavior for the disable.

Figure 111. STSW-IFAPGUI SYSTEM Enable for Daisy Chain configuration



Step 9. The command interface can be used to drive up to board in parallel independent mode and two board in daisy chain mode. To address a board, use the tab in the upper-left part of the interface.

Figure 112. STSW-IFAPGUI board selection

Step 10. Control the channel in steady state or PWM mode using the related Control sections.

– Use the Channel [**Steady State**] GUI section to manage the channel steady state for ISO808A or ISO808A-1 or ISO808AQ or ISO808AQ-1. The [**ON**] and [**OFF**] buttons are used to turn a channel on or off respectively. The [**ON**] button for each channel is not enabled at the command interface startup. To enable it will be necessary to enable the outputs using the [**Output Enable Pin**] section for a parallel independent system or the [**System Enable**] section for Daisy Chain mode.
When a channel is on in steady state mode the green LED corresponding to that channel will be on and the [**OFF**] button will be enabled, and the [**ON**] button disabled. When a channel is turned on in steady state mode it will not be possible to use the PWM mode. In order to use the PWM, the steady state of the channel must first be switched off.

– Use the channel [**PWM**] GUI section to manage the channel PWM settings and to power on or off the channel input in PWM mode. The [**ON**] button starting the PWM will be enabled when both the frequency and the duty cycle values for the channel have been selected through the dedicated controls and the steady mode is off for the channel and the system was initially enabled using the [**Output Enable Pin**] section for a parallel independent system or the [**System Enable**] section for Daisy Chain mode. The PWM on will be signalized by the green LED blinking according to the frequency and duty cycle chosen. Use the [**OFF**] button to stop the PWM function.
The following figures show a detailed view of the GUI channel section functions.

Figure 113. STSW-IFAPGUI channel section, Steady State enabled and ready to use

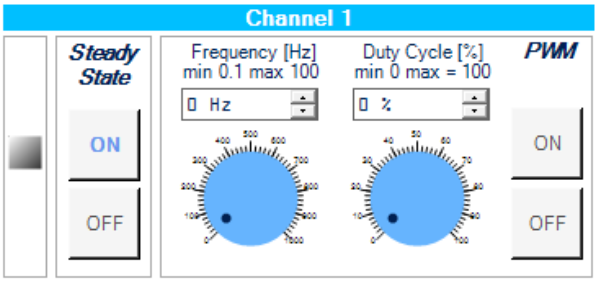


Figure 114. STSW-IFAPGUI channel section, Steady State on

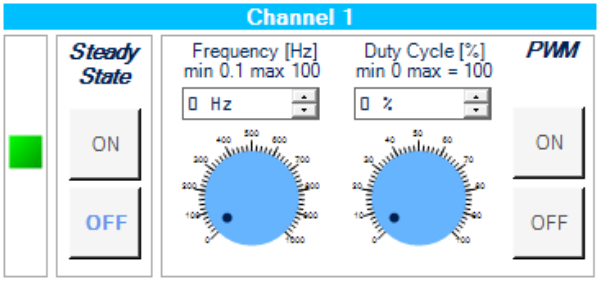
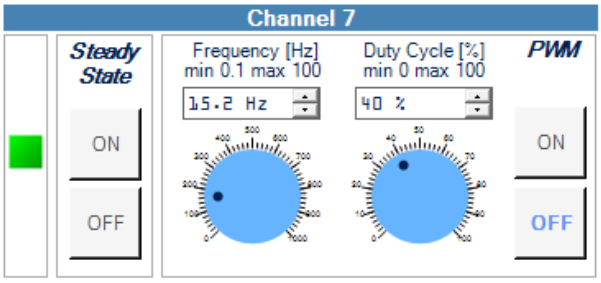


Figure 115. STSW-IFAPGUI channel section, PWM on



Step 11. Diagnostic section related to the [**Thermal Shutdown or Internal Communication Error**] condition. Click on the related [**START**] button to monitor the on/off status of the STATUS pins on ISO808A or ISO808A-1 or ISO808AQ or ISO808AQ-1. The STATUS is a diagnostic pin at chip level. The activation of the status pin check is signalized by the bar under the diagnostic LED. When a fault condition is triggered, the red LED will light up. Click on the [**STOP**] button to stop the STATUS pin check and on the [**RESET**] button to clear the last pin condition displayed.

Figure 116. STSW-IFAPGUI status check before activation

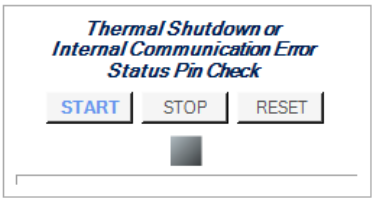
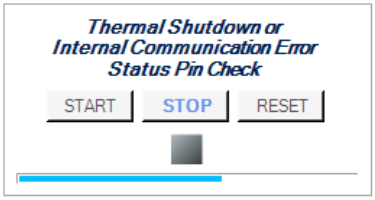


Figure 117. STSW-IFAPGUI status check activated, no fault



Step 12. A diagnostic section to check the power Good Pin.is available. Click on the [**START**] button in [**Power Good Pin Status Check**] to monitor the on/off status of the power good pin on ISO808A or ISO808A-1 or ISO808AQ or ISO808AQ-1. The STATUS is a diagnostic pin at chip level. A power good check fail condition is signalized by the red LED on into the section.

Figure 118. STSW-IFAPGUI Power Good Pin check before activation

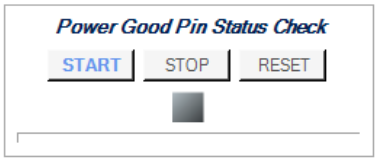
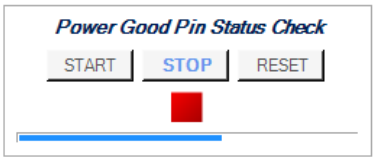


Figure 119. STSW-IFAPGUI power pood pin check activated, fail signalization



Click on the [**STOP**] button to stop the Power Good pin check and on the [**RESET**] button to clear the last pin condition displayed.

Step 13. There are dedicated sections to reset the ongoing operations and restore the command interface initial state. There are differences between parallel independent and daisy chain mode:

Parallel Independent: for the two board refers to the following sections available respectively in the BOARD 0 and 1 tabs:

Figure 120. STSW-IFAPGUI commands reset for BOARD 0 and 1

In this mode the reset works independently on the two boards.
Click on the [**RESET**] button in the [**BOARD 0 Commands Reset**] or [**BOARD 1 Commands Reset**] sections to stop all operations in progress, (channels switched on in steady state or PWM, status pin, power good check activated). All frequency and duty cycle values that have been selected are also reset. The output enable will be also switched off.
Daisy Chain: for the two board refers to the following section available in the BOARD 0 and 1 tabs:

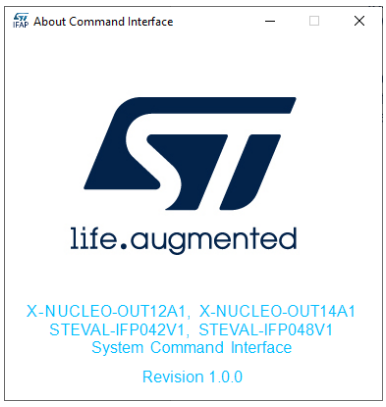
Figure 121. STSW-IFAPGUI System Commands Reset

In this mode the two boards must be considered as a unique system so the reset works on both boards simultaneously. Click on the [**RESET**] button in the [**System Commands Reset**] section to stop all operations in progress, (channels switched on in steady state or PWM, status pin, power good check activated). All frequency and duty cycle values that have been selected are also reset. The output enable will be also switched off and the system will be disabled.

2.9.3 How to get information about the GUI

Information about the GUI revision for the is available by clicking on [**Command Interface**] at the left part of the title. Then, the following window (in the example related to the first revision) appears:

Figure 122. Command Interface info



2.9.4 Information about the pin connections

The device pin connections to the microcontroller are shown by clicking on the board image.

Figure 123. **BOARD 0 setup for parallel independent mode**

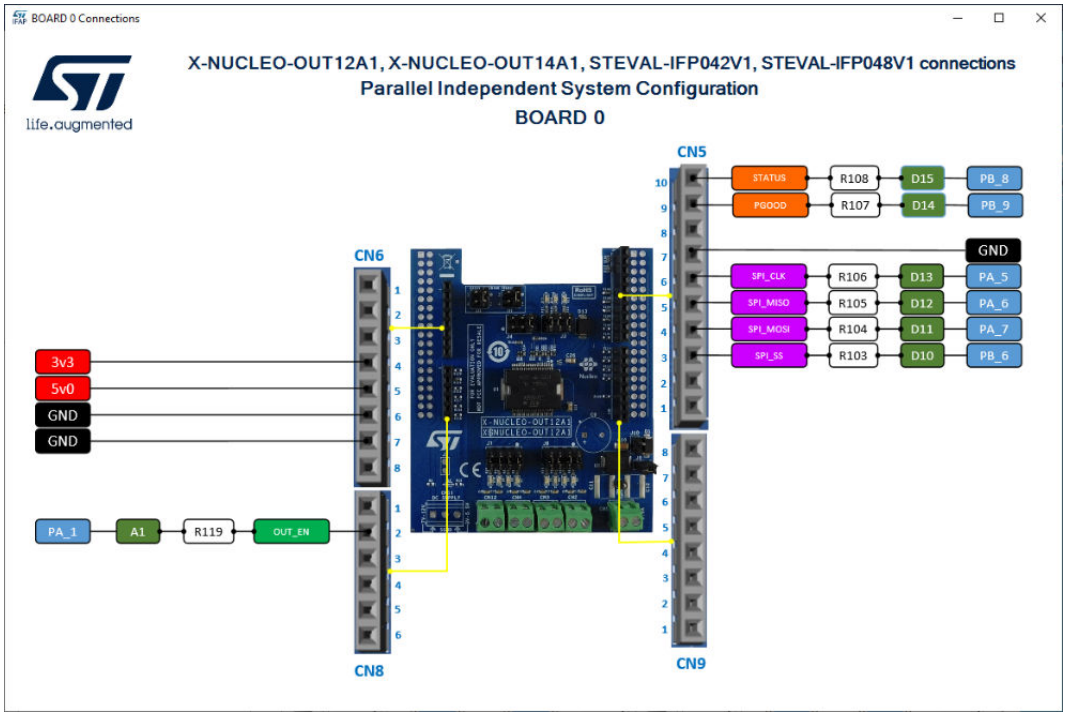


Figure 124. **BOARD 1 setup for parallel independent mode**

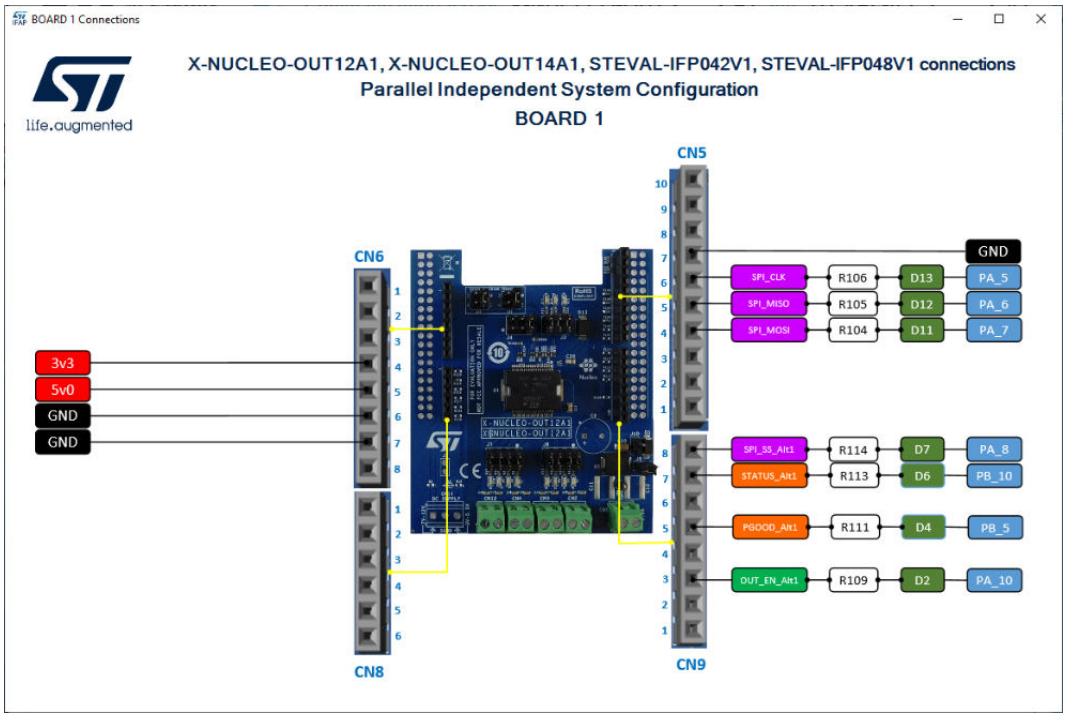


Figure 125. **BOARD 0 Setup for daisy chain mode**

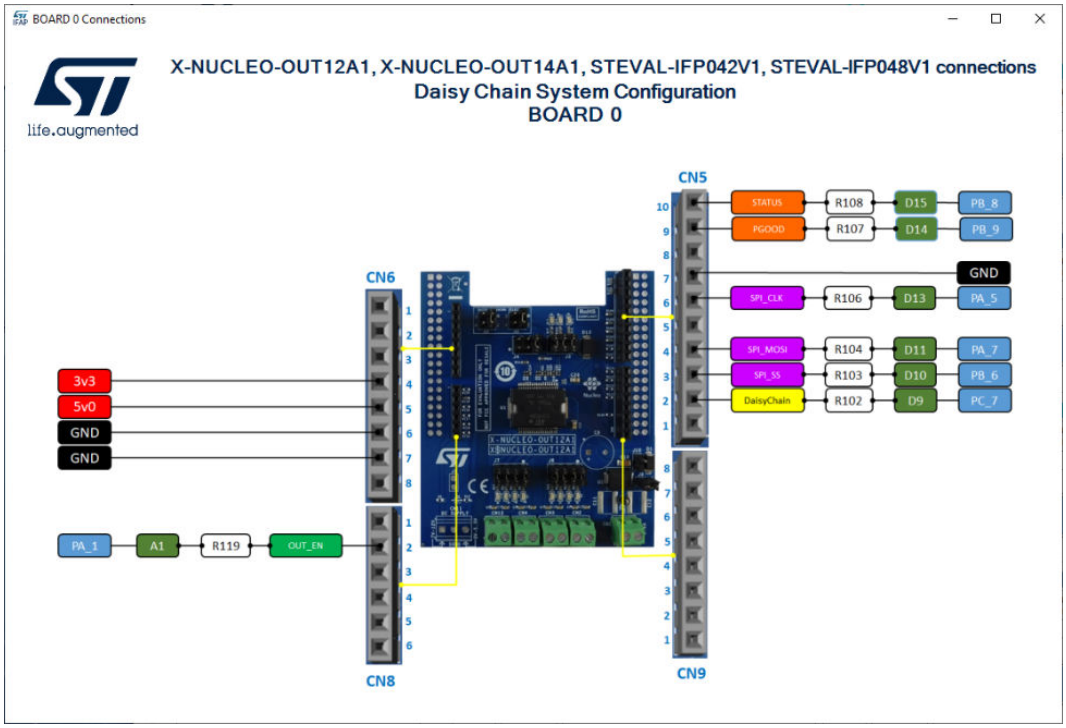
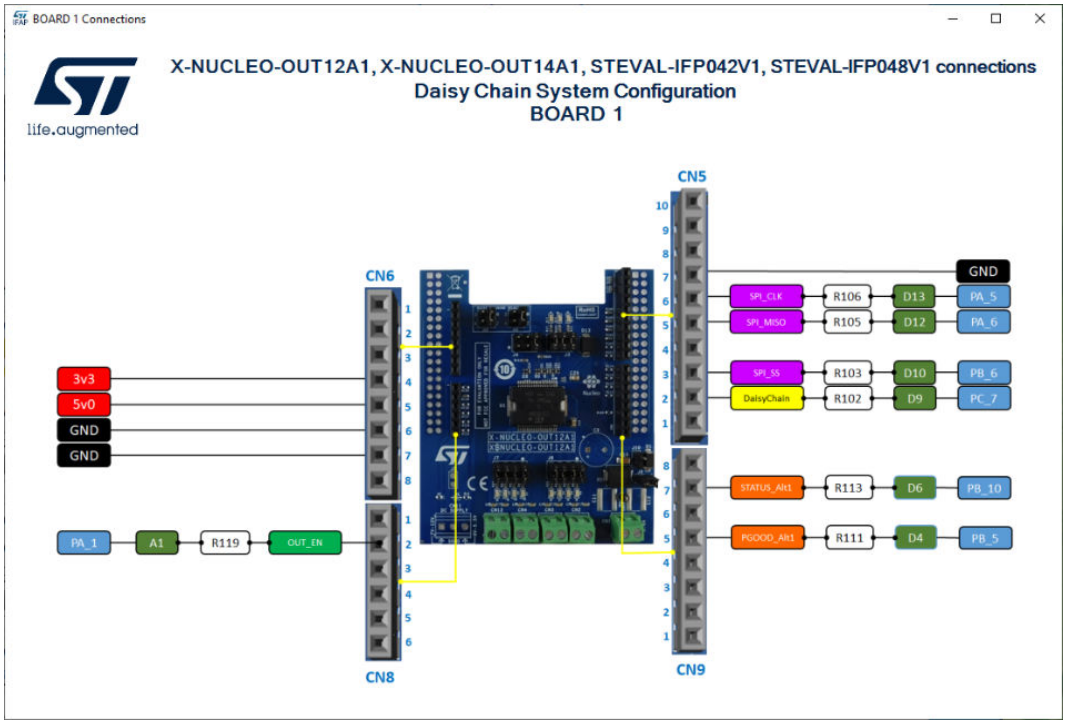


Figure 126. **BOARD 1 setup for daisy chain mode**



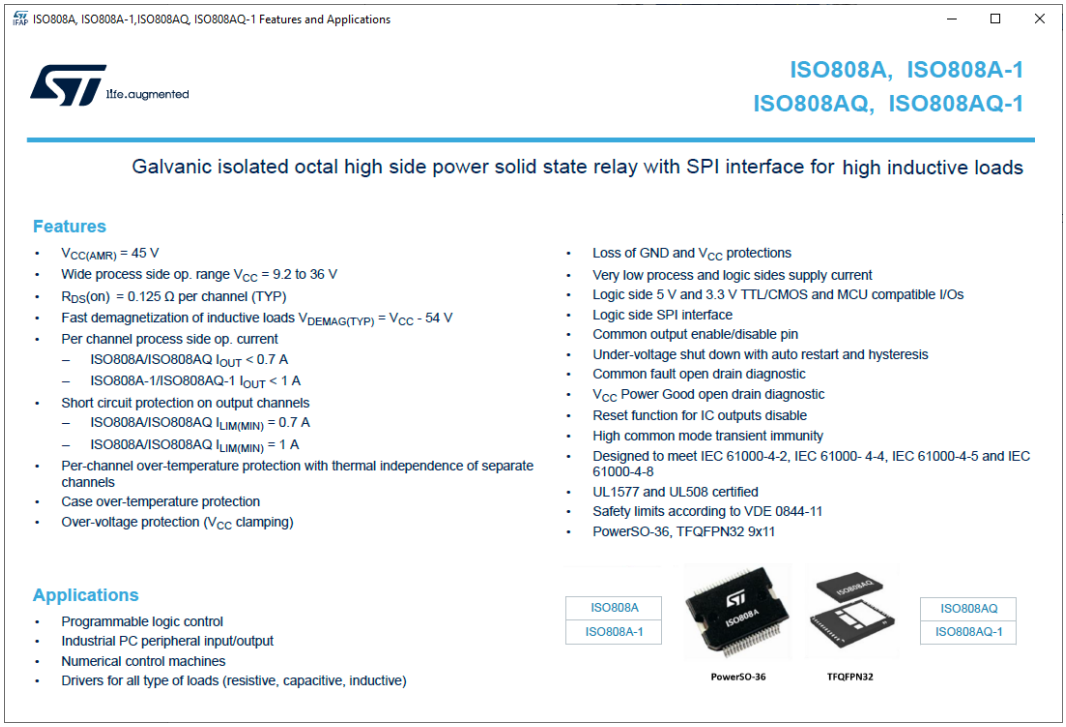
2.9.5 How to get information about the Device Features

Information about the device feature is available by clicking on devices pictures on the top-left part of the command interface.

Figure 127. How to get devices info

Then, the following window appears:

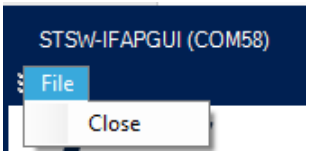
Figure 128. Devices info



2.9.6 Close the command interface

To close the command interface, use File/Close in the top-left part of the GU:.

Figure 129. STSW-IFAPGUI close the command interface



The command interface can be opened again by clicking on the Nucleo icon as described above.

2.10 X-NUCLEO-OUT15A1 expansion board

2.10.1 How to control a single expansion board

This application scenario is based on the default configuration of the on-board switch and resistors of the X-NUCLEO-OUT15A1.

Step 1. Stack the X-NUCLEO-OUT15A1 on top of the NUCLEO-F401RE flashed with the STSW-OUT15F4 firmware (or NUCLEO-G431RB flashed with the STSW-OUT15G4 firmware), through the Arduino® UNO R3 connectors.

Step 2. Connect the two stacked boards to your PC or laptop USB port through a mini-USB cable (for NUCLEO-F401RE) or micro-USB cable (for NUCLEO-G431RB).

The STM32 is supplied via USB (3.3 V) and the flashed firmware starts running.

Step 3. Launch the STSW-IFAPGUI.

When the application starts, the firmware running on the STM32 is automatically detected and a COM port is opened for communication.

Figure 130. STSW-IFAPGUI COM - port opened

Step 4. Click on the GUI STM32 Nucleo icon after it turns blue (it remains green until the firmware identification is complete).

A popup window appears to choose the proper system configuration.

Figure 131. System configuration selection panel

Step 5. Select [**X-NUCLEO-OUT15A1 Single Board System**] and the STSW-IFAPGUI appears on the screen.

Figure 132. STSW-IFAPGUI main control panel

Step 6.

– Use the bottom left side of the GUI to manage the channel steady state for the IPS1025HF.

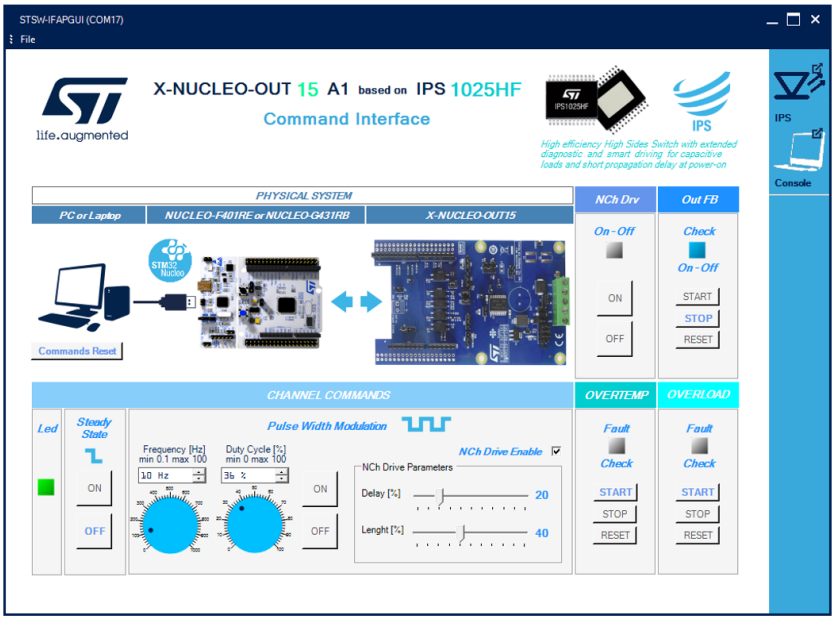
– Use the bottom right side of the GUI to manage its PWM settings.

Step 7. Connect the load and supply the power stage of the X-NUCLEO-OUT15A1 with a 24 V rail via the CN1 connector.

Step 8. Select the desired switching frequency and duty cycle of the output channel through the [**Pulse Width Modulation**] controls on the bottom right side of the GUI.

Step 9. To activate the output channel steady state, click on the [**ON**] button on the bottom left side of the GUI in the [**Steady State**] controls. Use [**OFF**] to deactivate it.

Figure 133. STSW-IFAPGUI in action



Step 10. Use the proper [**Fault Check**] [**START/STOP/RESET**] controls on the bottom right side of the GUI to monitor the on/off status on the desired FAULT pin on IPS1025HF (FAULT1 for overtemperature, FAULT2 for overload).

You can stop monitoring the fault status by clicking on the related [**STOP**] button.
Press the proper [**RESET**] button to reset the related fault status.

Step 11. Click on [**ON/OFF**] buttons in the top right side of the GUI in the [**NCh Drv**] section to activate/deactivate the output fast discharge.

Step 12. Click on [**START**], [**STOP**] and [**RESET**] buttons in the [**Out FB**] section to start, stop and reset the output feedback monitoring.

2.10.2 How to get information about the GUI

Information about the GUI revision for the current configuration is available by clicking on [**Command Interface**] just below the title.

Then, the following window (in the example related to the first revision) appears:

Figure 134. Command interface info

2.11 X-NUCLEO-OUT16A1 and X-NUCLEO-OUT17A1 expansion boards

The X-NUCLEO-OUT16A1 or X-NUCLEO-OUT17A1 boards can be used in different configurations to create single or dual board systems. The possible configurations are related to the configuration of the jumpers and switches on the used boards. In particular, the configurations that can be created are:

- Single board parallel mode
- Single board 8-bit SPI mode
- Single board 16-bit SPI mode
- Daisy Chain 8-bit SPI mode
- Daisy Chain 16-bit SPI mode

Each configuration consists of a common setting and a setting specific for the configuration (Parallel 8 Ch, SPI 8Ch 8-bit, SPI 8 Ch 16-bit, Daisy Chain 16 Ch 8-bit, Daisy Chain 16 Ch 16-bit)). The set of all possible configurations is described below:

Figure 135. Configurations

Item	Common settings	Parallel 8 Ch	SPI 8 Ch 8-bit	SPI 8 Ch 16-bit	Daisy Chain 16 Ch 8-bit	Daisy Chain 16 Ch 16-bit
SW1	Closed 1-2					
SW3	Closed 1-2					
SW17	Closed 1-2					
JP1, JP2, JP3, JP4, JP5, JP6, JP7, JP8	Closed to enable OUT1-8 output lines					
JP9	Closed					
JP10	Open					
JP11	Not mounted					
JP12	Closed					
JP13	Closed					
JP14	Open					
JP15	Closed					
JP16	Open					
JP17	Open					
JP18	Open					
JP19	Open					
JP20	Closed					
JP23	Closed					
JP24	Closed					
JP25	Closed					
JP27	Closed					
JP28	Closed 2-4					
JP29	Closed 1-2, 3-4, 5-6, 7-8 to enable active state led for OUT1-4					
JP30	Closed 1-2, 3-4, 5-6, 7-8 to enable active state led for OUT5-8					
JP31	Closed					
SW4		Closed 1-2	Closed 2-3		Closed 2-3	
SW5		Closed 1-2	Closed 2-3		Closed 2-3	
SW6 (DAISY_CHAIN/MOSI)		Closed 1-2	Closed 2-3		**Board 0** Closed 2-3	**Board 1** Closed 1-2
SW7		Closed 1-2	Closed 2-3		Closed 2-3	
SW9		Closed 1-2	Closed 2-3		Closed 2-3	
SW10		Closed 1-2	Closed 2-3		Closed 2-3	
SW11		Closed 1-2	Closed 2-3		Closed 2-3	
SW12		Closed 1-2	Closed 2-3		Closed 2-3	
SW13		Closed 1-2	Closed 2-3		Closed 2-3	
SW14		Closed 1-2	Closed 2-3		Closed 2-3	
SW15		Closed 1-2	Closed 2-3		Closed 2-3	
SW18 (SPI_MISO/DAISY_CHAIN)		Open	Closed 1-2		**Board 0** Closed 2-3	**Board 1** Closed 1-2
SW20		Closed 1-2	Closed 2-3		Closed 2-3	
JP21		Open (SEL2 L)	Closed (SEL2 H)		Closed (SEL2 H)	
JP22		Open	Open (SEL1 L)	Closed (SEL1 H)	Open (SEL1 L)	Closed (SEL1 H)

The use of the graphical interface for all these configurations will be described below.

2.11.1 Expansion board configured in parallel mode

2.11.1.1 How to control the single expansion board in parallel mode

Step 1. Stack the X-NUCLEO-OUT16A1 (or X-NUCLEO-OUT17A1) on top of the NUCLEO-F401RE flashed with the STSW-OUT16F4 firmware (or NUCLEO-G431RB flashed with the STSW-OUT16G4 firmware), through the Arduino® UNO R3 connectors.

Step 2. Connect the two stacked boards to your PC or laptop USB port through a mini-USB cable (for NUCLEO-F401RE) or micro-USB cable (for NUCLEO-G431RB). The STM32 is supplied via USB (3.3 V) and the flashed firmware starts running.

Step 3. Connect the load and supply the power stage of the X-NUCLEO-OUT16A1 (or X-NUCLEO-OUT17A1) with a 24 V rail via the CN1 connector.

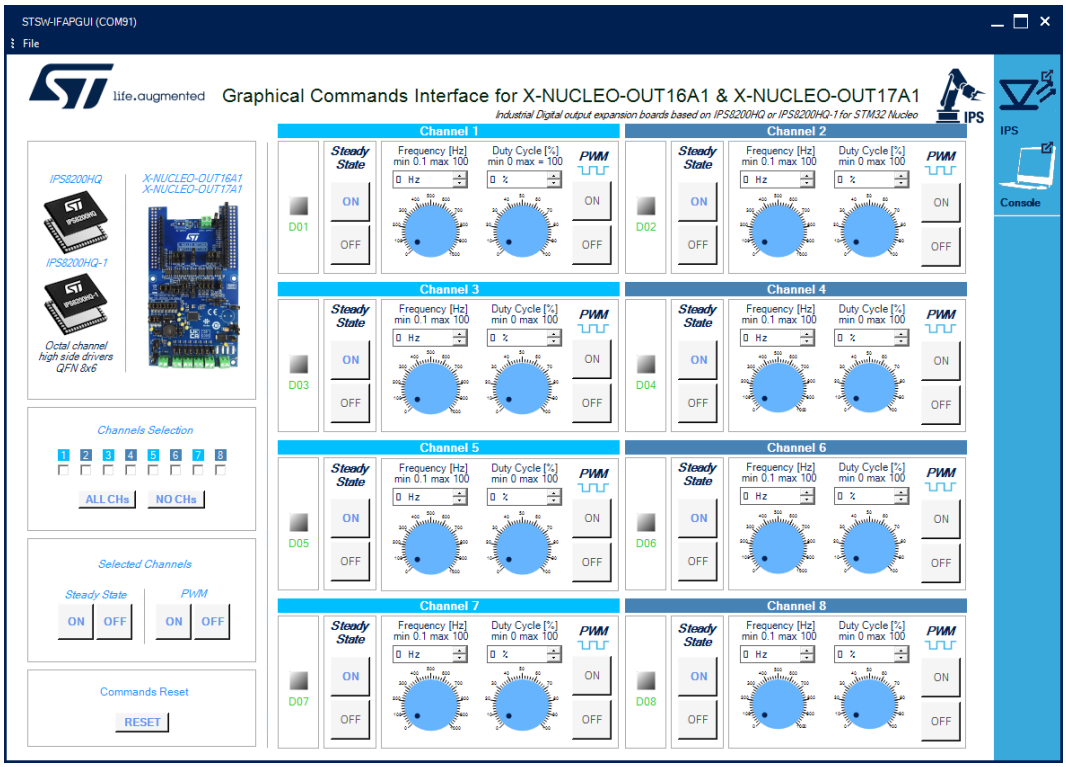
Step 4. Launch the STSW-IFAPGUI. When the application starts, the firmware running on the STM32 is automatically detected and a COM port is opened for communication.

Figure 136. STSW-IFAPGUI COM - port opened

Step 5. Click on the GUI STM32 Nucleo icon after it turns blue (it remains green until the firmware Identification is complete). The GUI automatically identifies the board configuration based on the information provided by the firmware. The firmware identifies the current configuration of the board by checking the status of the JP21 jumper. When JP21 is open the board is configured in parallel mode while JP21 closed is used for the SPI configuration.

Step 6. The STSW-IFAPGUI appears on the screen.

Figure 137. STSW-IFAPGUI main control panel



Step 7. The main panel is divided into:

- eight channel control sections, one for each channel.
- a Channel Selection section.
- a command section for the Selected Channels.
- a Command Reset section.
- board image: click on it to open a window showing the board connections.
- package image: click on it to open a window showing the device features.

All the buttons with blue text refer to the functions currently active, when the text is gray the function will be activated after a preliminary action, such as setting the frequency and duty cycle of the PWM.

- Use the Channel [**Steady State**] GUI section to manage the channel steady state for IPS8200HQ (or IPS8200HQ-1). The [**ON**] and [**OFF**] buttons are used to turn a channel on or off respectively. The [**ON**] button for each channel is enabled at the startup. When a channel is on in steady state mode the green LED corresponding to that channel will be on and the [**OFF**] button will be enabled, and the [**ON**] button disabled. When a channel is turned on in steady state mode it will not be possible to use the PWM mode. To use the PWM, the steady state of the channel must first be switched off.
- Use the channel [**PWM**] GUI section to manage the channel PWM settings and to power on or off the channel input in PWM mode. The button [**ON**] starting the PWM will be enabled when both the frequency and the duty cycle values for the channel have been selected through the dedicated controls and the steady mode is off for the channel. The PWM on will be signalized by the green LED blinking according to the frequency and duty cycle chosen. Use the [**OFF**] button to stop the PWM function.

The following figures show a detailed view of the GUI Channel section functions.

Figure 138. STSW-IFAPGUI channel section, Steady State enabled and ready to use

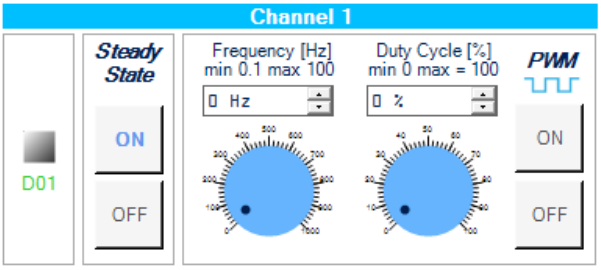


Figure 139. STSW-IFAPGUI channel section, Steady State on

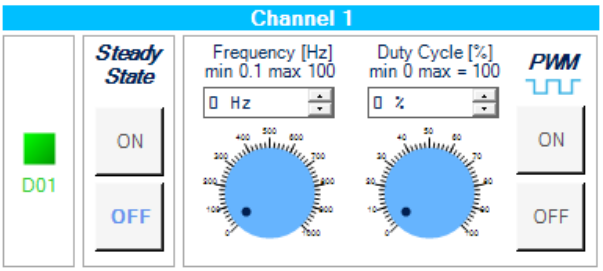
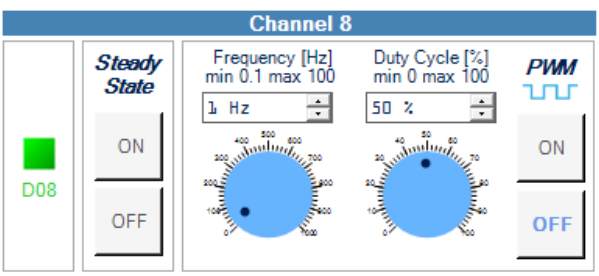
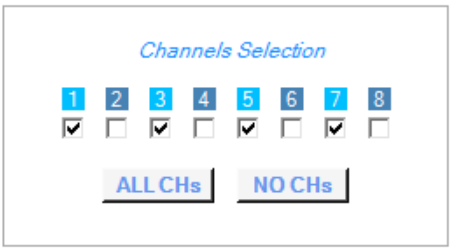


Figure 140. STSW-IFAPGUI channel section, PWM on



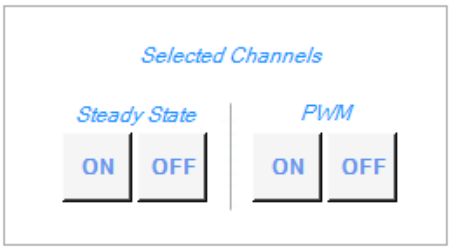
Step 8. The [**Channels Selection**] section allows you to select a group of channels to control in steady state or PWM using a single button and therefore avoiding repeating the same operation for all channels. The following figure shows an example of all odd channels selection.

Figure 141. Channels Selection section



If you want to select all channels, Click on the [**ALL CHs**] button. To deselect all the channels, click on [**NO CHs**]. After selecting the desired channels, you can control them by pressing a single button. To do this you need to use the [**Selected Channels**] section, shown in the following figure.

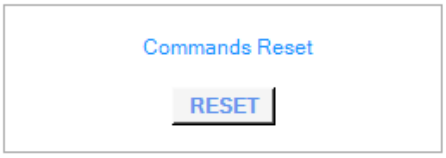
Figure 142. Selected Channels Section



Step 9. Click on the [**ON**] button in the Steady State part of the section (left side) to power on in steady state mode the selected channels. Use the [**OFF**] button to turn off the selected channels. The same behavior for the [**ON**] and [**OFF**] buttons on the PWM part of the section (right side). PWM for the selected channels will only be activated if the frequency and duty cycle have been previously set in each related channel section.

Step 10. Click on the [**RESET**] button in the [**Commands Reset**] section to stop all operations in progress, (channels switched on in steady state or PWM). All frequency and duty cycle values that have been selected are also reset.

Figure 143. STSW-IFAPGUI commands reset

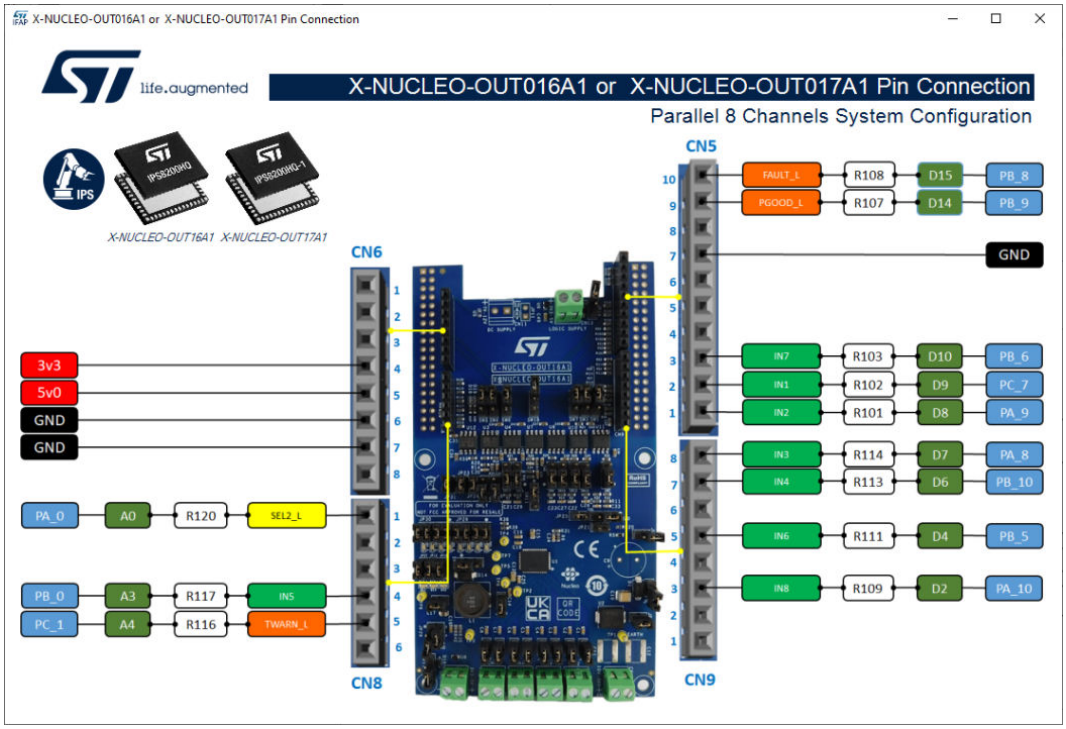


2.11.1.2 *Information about the pin connections*

The device pin connections to the microcontroller are shown by clicking on the board image.

The following figure shows the connections for the parallel system.

Figure 144. **Board pin connections**



2.11.2 Expansion board configured in 8-bit or 16-bit SPI mode.

This section shows how to control the IPS8200HQ or the IPS8200HQ-1 using the graphic interface in the case of a system with a single board configured in SPI-8 bit or SPI-16 bit. For the 8-bit case the configuration is achieved by enabling the SPI interface with SEL2=H (JP21 closed) and choosing the 8-bits with SEL1=L (JP22 open).

For the 16-bit case the configuration is achieved by enabling the SPI interface with SEL2=H (JP21 closed) and choosing the 16-bits with SEL1=H (JP22 closed).

The device configuration is automatically recognized using information from the firmware and is then opened to the correct graphical interface.

2.11.2.1 How to control a single expansion board system configuration

This application scenario is based on an X-NUCLEO-OUT16A1 (or X-NUCLEO-OUT17A1) board configured in 8-bit or 16-bit SPI mode. The operations to be done now are:

Step 1. Stack the X-NUCLEO-OUT16A1 (or X-NUCLEO-OUT17A1) on top of the NUCLEO-F401RE flashed with the STSW-OUT16F4 firmware (or NUCLEO-G431RB flashed with the STSW-OUT16G4 firmware), through the Arduino® UNO R3 connectors.

Step 2. Connect the two stacked boards to your PC or laptop USB port through a mini-USB cable (for NUCLEO-F401RE) or micro-USB cable (for NUCLEO-G431RB). The STM32 is supplied via USB (3.3 V) and the flashed firmware starts running.

Step 3. Connect the load and supply the power stage of the X-NUCLEO-OUT16A1 (or X-NUCLEO-OUT17A1) with a 24 V rail via the CN1 connector.

Step 4. Launch the STSW-IFAPGUI. When the application starts, the firmware running on the STM32 is automatically detected and a COM port is opened for communication.

Figure 145. STSW-IFAPGUI COM port opened

Step 5. Click on the GUI STM32 Nucleo icon after it turns blue. It will turn green once it has recognized the correct interface and opened it. The GUI automatically identifies the board configuration based on the jumper and switch configuration and opens the correct GUI.

Figure 146. STSW-IFAPGUI identification completed

Step 6. The STSW-IFAPGUI appears on the screen. In this phase, an interface is shown that allows you to select the physical system you want to use, i.e. a single board system or a system with two boards connected in a daisy chain.

Figure 147. STSW-IFAPGUI main control panel for 8-bit SPI configuration before single board or daisy chain selection

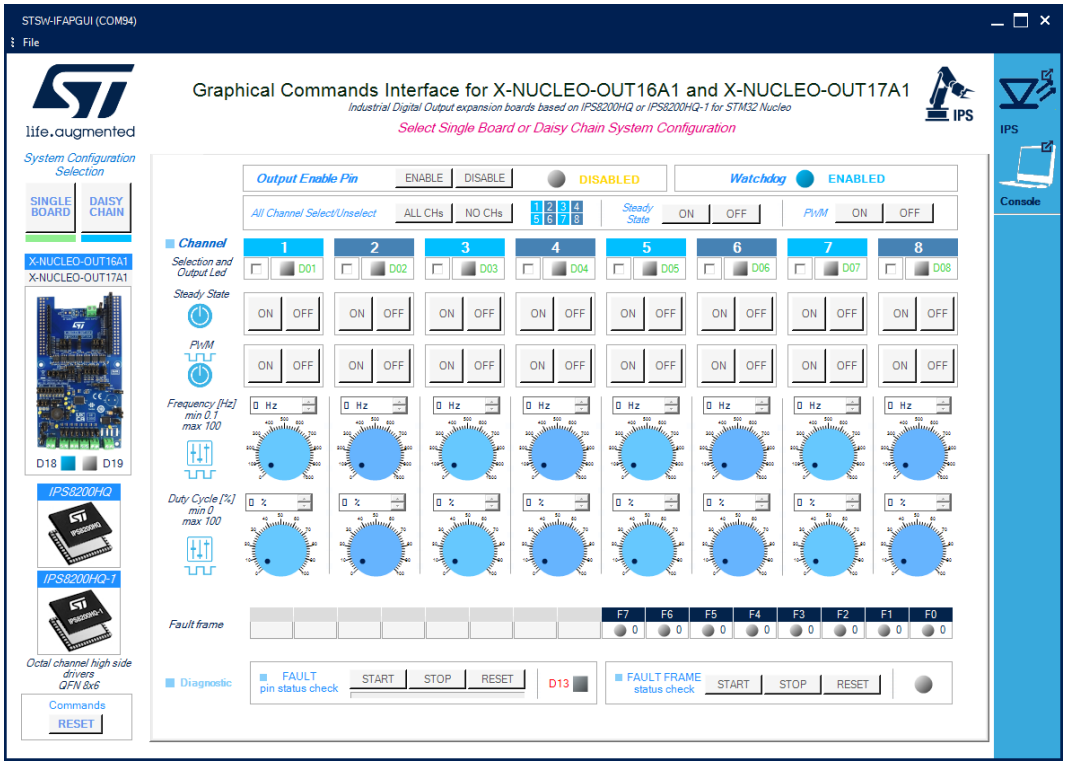
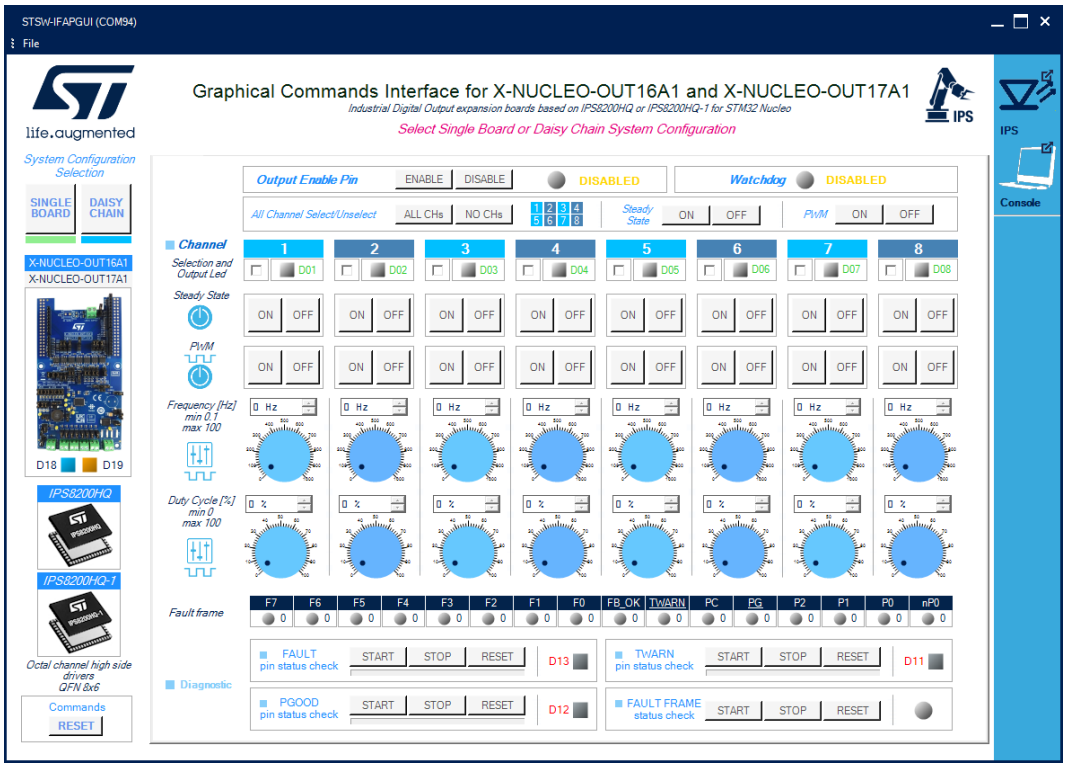
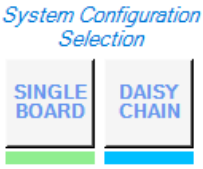


Figure 148. STSW-IFAPGUI main control panel for 16-bit SPI configuration before single board or daisy chain selection



Step 7. Use the [**SINGLE BOARD**] or [**DAISY CHAIN**] buttons to select the configuration. In this case click on [**SINGLE BOARD**]. The choice must be consistent with the physical system you are using. Otherwise, correct operation will not occur. If you make a mistake, you will need to close the main control panel and reopen it again as previously described. At this point it will be possible to make a new choice.

Figure 149. STSW-IFAPGUI System configuration selection



Step 8. After the proper system configuration selection, the correct interface will appear on the screen:

Figure 150. STSW-IFAPGUI main control panel for 8-bit SPI single board configuration

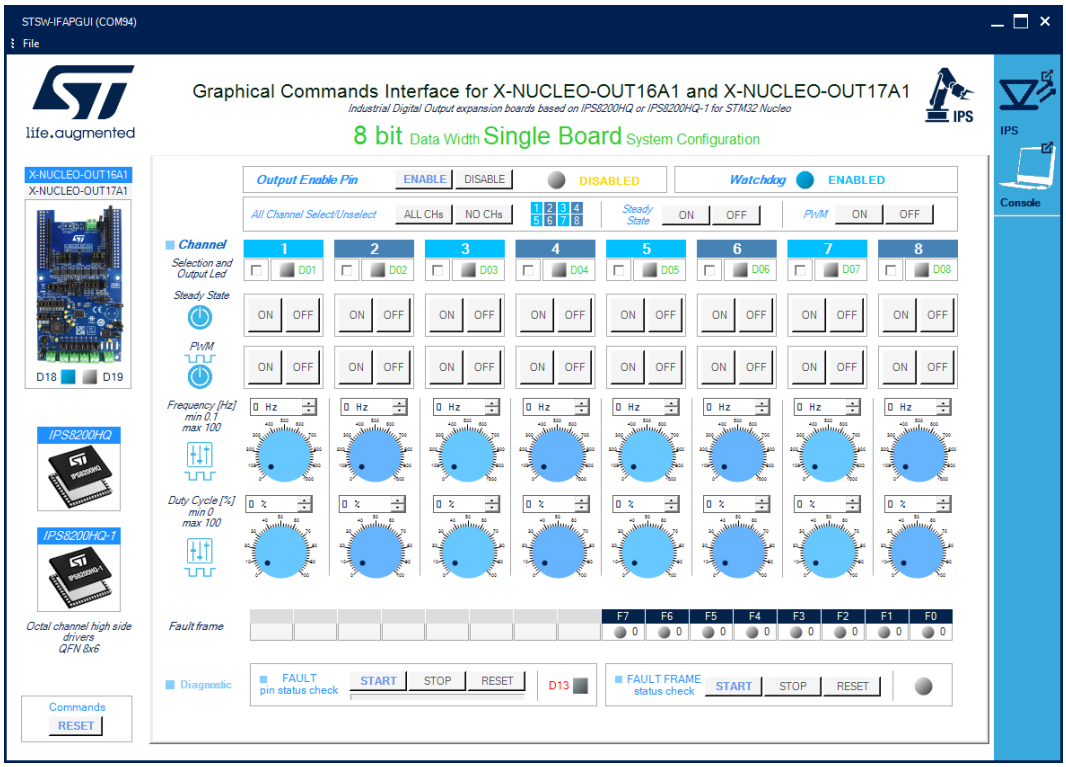
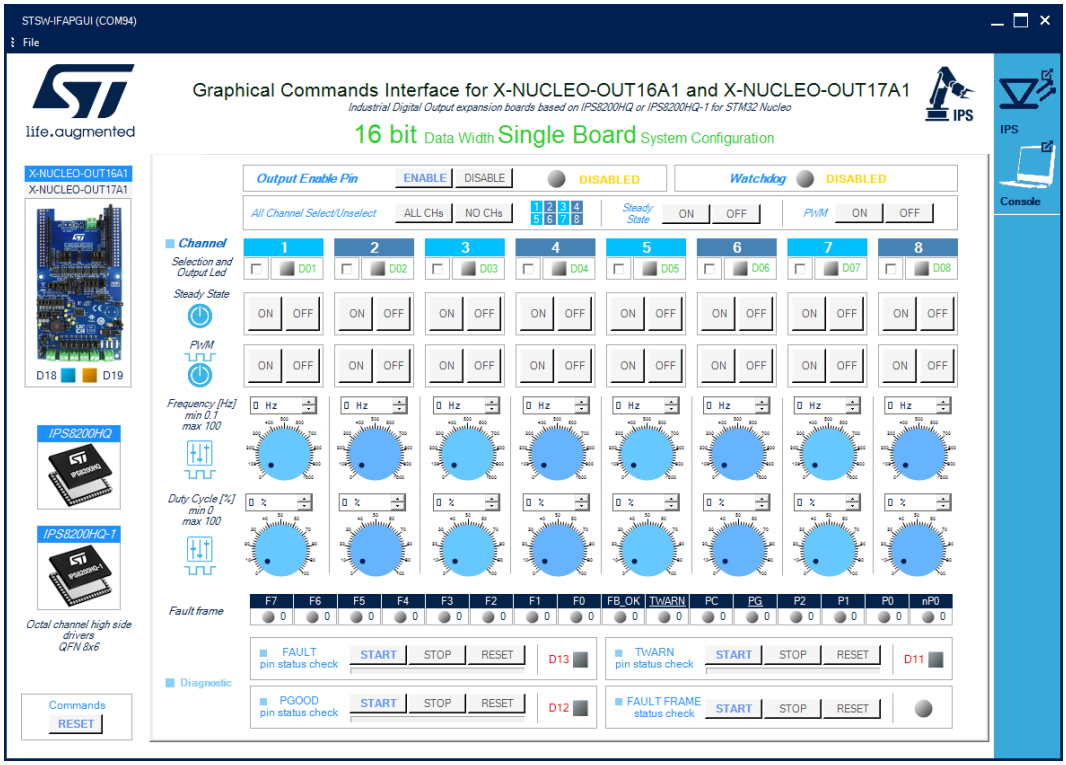


Figure 151. STSW-IFAPGUI main control panel for 16-bit SPI single board configuration



The main control panel is composed by:

- a set of columns, one for each channel. Inside each column there are the buttons to turn the channels on and off in Steady State and in PWM mode. There are also the controls used to set the frequency and duty cycle of the PWM mode. At the top of each column there is the LED that shows the status of the channel and the channel selector. On the left of the first column there is the functional description of the controls in the same row.
- the Output Enable Pin section.
- a Watchdog section (related to MCU freeze detection available in IPS8200HQ and IPS8200HQ-1).
- a Channels Selection section to perform operation on the selected channels with a single click.
- the Fault frame section to read the device register bits.
- a diagnostic section to check the FAULT pin.
- a diagnostic section to read the Fault frame.
- for the 16-bit configuration diagnostic sections for TWARN and PGOOD to check these pins.
- a command reset section.
- board image to clicking on to open a window showing the board connections.
- package images to clicking on to open a window showing the device features.

All the buttons with blue text refer to the functions currently active, when the text is gray the function will be activated after a preliminary action, such as enabling the outputs or setting the frequency and duty cycle of the PWM.

Step 9. Outputs enabling.

- First of all, it is necessary to use the [**Output Enable Pin**] section to enable the outputs of the IPS8200HQ or the IPS8200HQ-1. At the startup the outputs and all commands to power on the channels are disabled.

Figure 152. STSW-IFAPGUI Output Enable Pin section at the startup

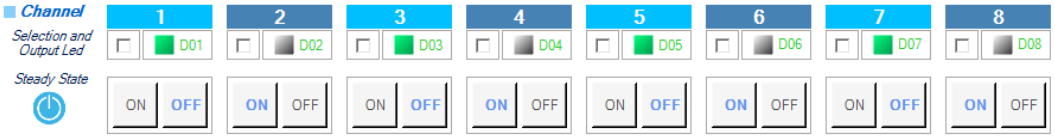
The [**ENABLE**] button enables the outputs, while the [**DISABLE**] button disables the outputs. After the click on [**ENABLE**] this is the interface answer:

Figure 153. STSW-IFAPGUI Outputs Enabled

Step 10. Use the Command Interface for Steady State and PWM.

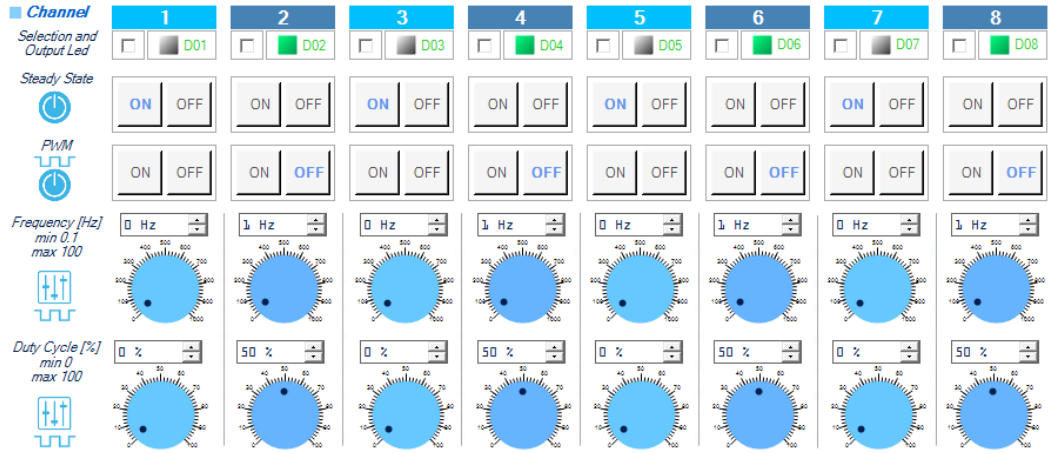
– Use the Steady State [**ON**] or [**OFF**] buttons related to the desired channel to turn on or off it in Steady State mode. The [**ON**] button for each channel is enabled after the outputs enable. When a channel is on in steady state mode the green LED corresponding to that channel will be on, the [**OFF**] button will be enabled, and the [**ON**] button disabled. When a channel is turned on in steady state mode it will not be possible to use the PWM mode. To use the PWM, the steady state of the channel must first be switched off.

Figure 154. STSW-IFAPGUI channels 1, 3, 5, 7 Steady State ON



– Use the PWM [**ON**] or [**OFF**] buttons related to the desired channel to turn on or off it in PWM mode. The [**ON**] button starting the PWM will be enabled when both the frequency and the duty cycle values for the channel have been selected through the dedicated controls and the steady mode is off for the channel. The PWM on will be signalized by the green LED blinking according to the frequency and duty cycle chosen. Use the [**OFF**] button to stop the PWM function. During the PWM, the Steady State buttons for the active channels are disabled. Turn off the PWM to have the steady state enabled on these channels. An example of channels 2, 3, 6, 8 active in PWM mode is shown below:

Figure 155. STSW-IFAPGUI channels 2, 4, 6, 8 PWM ON



Step 11. The diagnostic sections allow you to check the status of the diagnostic pins to identify the presence of thermal shutdown on one or more channels and to read the bits of the internal register to identify the channels on which it occurred.

– Use the [**FAULT pin status check**] section to start and stop the check on the device FAULT pin.

Figure 156. STSW-IFAPGUI FAULT pin status check section

Click on the [**START**] to monitor the on/off status of the FAULT pin on IPS8200HQ or IPS8200HQ-1. The FAULT is a diagnostic pin at chip level, and it is an active low fault indication pin. The condition that activates the interface signalization is the junction overtemperature of at least one channel. Only in the case of the 16-bit SPI configuration the interface is able to display a failure on this pin also when SPI communication fault event (parity check error or module-8 violation occurs).
When a fault condition is triggered, the red LED will light up. The pin check in progress is indicated by the activation of the progress bar.

Figure 157. STSW-IFAPGUI FAULT pin status check in progress

Click on the [**STOP**] button to stop the FAULT pin check and on the [**RESET**] button to clear the last pin condition which is kept displayed after the stop.

– Use the [**TWARN pin status check**] section to start and stop the check on the device TWARN pin. This section is only available when using the main control panel for the 16-bit SPI configuration. TWARN is the Case Temperature diagnostic pin, and it is activated (forced low) when a case overtemperature event occurs.

Figure 158. STSW-IFAPGUI TWARN pin status check section

Click on the [**START**] to monitor the on/off status of the TWARN pin on IPS8200HQ or IPS8200HQ-1. When the activation of the TWARM pin occurs, the red LED into the section will light up. The pin check in progress is signaled by the activation of the progress bar.

Figure 159. STSW-IFAPGUI TWARN pin status check in progress

Click on the [**STOP**] button to stop the TWARN pin check and on the [**RESET**] button to clear the last pin condition which is kept displayed after the stop.

– Use the [**PGOOD pin status check**] section to start and stop the check on the device PGOOD pin. This section is only available when using the main control panel for the 16-bit SPI configuration. PGOOD is the Power Good diagnostic pin, and it is activated (forced low) when the voltage on the VCC pin goes below V_{PGH2}.

Figure 160. **STSW-IFAPGUI PGOOD pin status check section**

Click on the [**START**] to monitor the on/off status of the PGOOD pin on IPS8200HQ or IPS8200HQ-1. When the activation of the PGOOD pin occurs, the red LED into the section will light up. The pin check in progress is signaled by the activation of the progress bar.

Figure 161. **STSW-IFAPGUI PGOOD pin status check ongoing**

Click on the [**STOP**] button to stop the PGOOD pin check and on the [**RESET**] button to clear the last pin condition which is kept displayed after the stop.

– Use the [**FAULT FRAME status check**] section to read the channel fault conditions (junction overtemperature) consisting of 8 bits. Each bit, set to '1', indicates an overtemperature condition for the corresponding channel. In the case of the 8-bit SPI configuration the entire fault frame is composed of the 8 bits just described. In the case of the 16-bit configuration, the bits that signal the junction overtemperature are the bits from position 8 to 15.

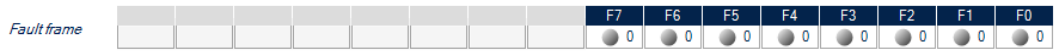
Figure 162. **STSW-IFAPGUI Fault frame section**

Click on the [**START**] button to start the read of Fault frame coming from the IPS8200HQ or IPS8200HQ-1. The [**STOP**] button ends the read. The [**RESET**] button clears the last bit sequence read from the IC. The blue LED blinking signals that the read operation is in progress.

Figure 163. **STSW-IFAPGUI Fault frame read in progress**

The read result in case of no channel fault (all bits to zero) for the SPI 8-bit configuration is shown in the following picture:

Figure 164. **STSW-IFAPGUI 8-bit SPI Fault frame, no channel fault**



The read result in case of no channel fault (all bits to zero) for the SPI 16-bit configuration is shown in the following picture:

Figure 165. **STSW-IFAPGUI 16-bit SPI Fault frame, without fault signalization**

As can be seen in this configuration, another 8 additional bits are also available, containing diagnostic and parity information. Refer to the IPS8200HQ or IPS8200HQ-1 datasheet for further information.

Step 12. The [**Watchdog**] section is useful to verify if the watchdog (MCU freeze detection feature) is enabled on the board. The blue LED indicates that the watchdog is enabled. This is an hardware configuration related to SW3 connection (1-2 WD disabled, 2-3 WD enabled) and it`s not possible to change using the interface.

Figure 166. STSW-IFAPGUI Watchdog section, case of watchdog ENABLED

Figure 167. STSW-IFAPGUI Watchdog section, case of watchdog DISABLED

– The [**All Channel Select/Unselect**] section on the top of the interface is useful to select all channels to turn on or off in Steady State or PWM mode with a single button click to avoid repeating the same operation for each channel. The selection of a single channel or a group channel is available using the checkbox on the top of each column related to a channel.

Figure 168. STSW-IFAPGUI All Channel Select/Unselect

Figure 169. STSW-IFAPGUI single channel (Ch 1) selection

The [**ALL CHs**] button selects all channels, [**NO CHs**] button deselects all channels. In the Steady State sub-section, the [**ON**] button and [**OFF**] button respectively turn on or off in Steady State mode all the selected (and not already active) channels. In the PWM sub-section, the [**ON**] button and [**OFF**] button respectively turn on or off in PWM mode all the selected (and not already active channels). In the case of PWM, the selected channels for which a frequency and duty cycle other than zero have been set will be turned on.

Step 13. Click on the [**RESET**] button in the [**Commands Reset**] section to stop all operations in progress, (channels switched on in steady state or PWM mode). All frequency and duty cycle values that have been selected are also reset.

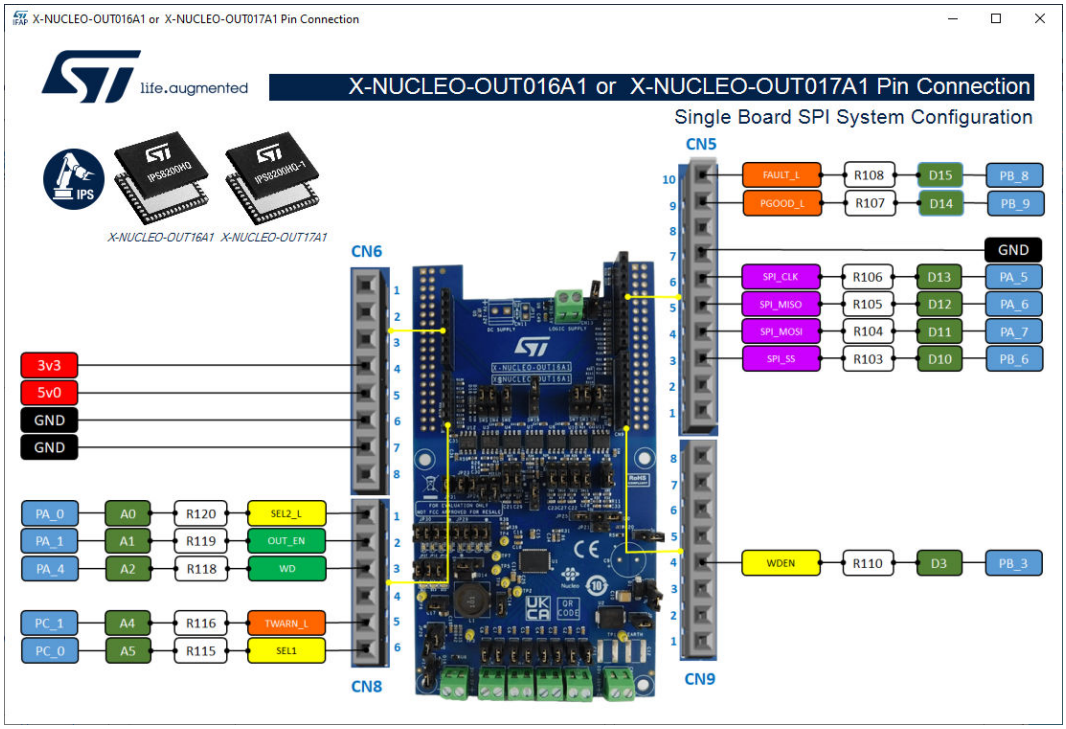
Figure 170. STSW-IFAPGUI Commands Reset

2.11.2.2 *Information about the pin connections*

The device pin connections to the microcontroller are shown by clicking on the board image.

The following figure shows the connections for the system with a single board configure SPI mode.

Figure 171. **Board Pin Connections SPI system configuration**



2.11.3 Dual Board Daisy Chain 8-bit or 16-bit SPI system

This section shows how to control the IPS8200HQ or the IPS8200HQ-1 using the graphic interface in the case of a dual board 8-bit or 16-bit SPI Daisy Chain system. The configuration is achieved using a combination of switches and jumpers described at the beginning of the paragraph dedicated to the X-NUCLEO-OUT16A1 or X-NUCLEO-OUT17A1 boards.

2.11.3.1 How to control a Daisy Chain system

This application scenario is based on the X-NUCLEO-OUT16A1 (or X-NUCLEO-OUT17A1) boards connected in daisy chain and configured in 8-bit or 16-bit SPI mode. In the following notes the two boards will be identified as board 0 the one at the beginning of the chain and board 1 the one at the end.

Step 1. Configure two X-NUCLEO-OUT16A1 (or X-NUCLEO-OUT17A1) as board 0 and board 1 and stack them on top of the NUCLEO-F401RE flashed with the STSW-OUT16F4 firmware (or NUCLEO-G431RB flashed with the STSW-OUT16G4 firmware), through the Arduino® UNO R3 connectors. Check your switch and jumper configuration carefully as they differ between the two boards.

Step 2. Connect the three stacked boards to your PC or laptop USB port through a mini-USB cable (for NUCLEO-F401RE) or micro-USB cable (for NUCLEO-G431RB). The STM32 is supplied via USB (3.3 V) and the flashed firmware starts running.

Step 3. Connect the load and supply the power stage of the two X-NUCLEO-OUT16A1 (or X-NUCLEO-OUT17A1) with a 24 V rail via the CN1 connector.

Step 4. Launch the STSW-IFAPGUI. When the application starts, the firmware running on the STM32 is automatically detected and a COM port is opened for communication.

Figure 172. STSW-IFAPGUI COM - port opened

Step 5. Click on the GUI STM32 Nucleo icon after it turns blue It will turn green when it has recognized the correct interface and opened it. The GUI automatically identifies the board configuration based on the jumper and switch configuration and opens the correct GUI.

Figure 173. STSW-IFAPGUI identification complete

Step 6. The STSW-IFAPGUI appears on the screen. In this phase, an interface is shown that allows you to select the physical system you want to use, i.e. a single board system or a system with two boards connected in a daisy chain.

Figure 174. STSW-IFAPGUI main control panel for 8-bit SPI configuration before single board or daisy chain selection

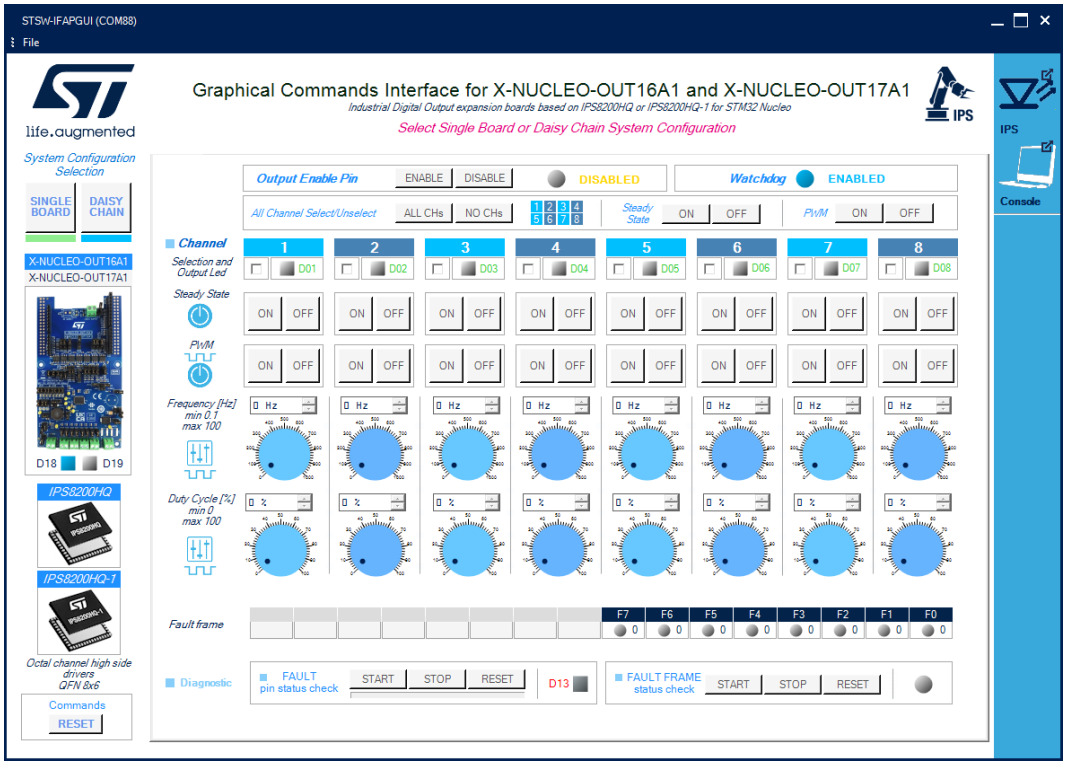
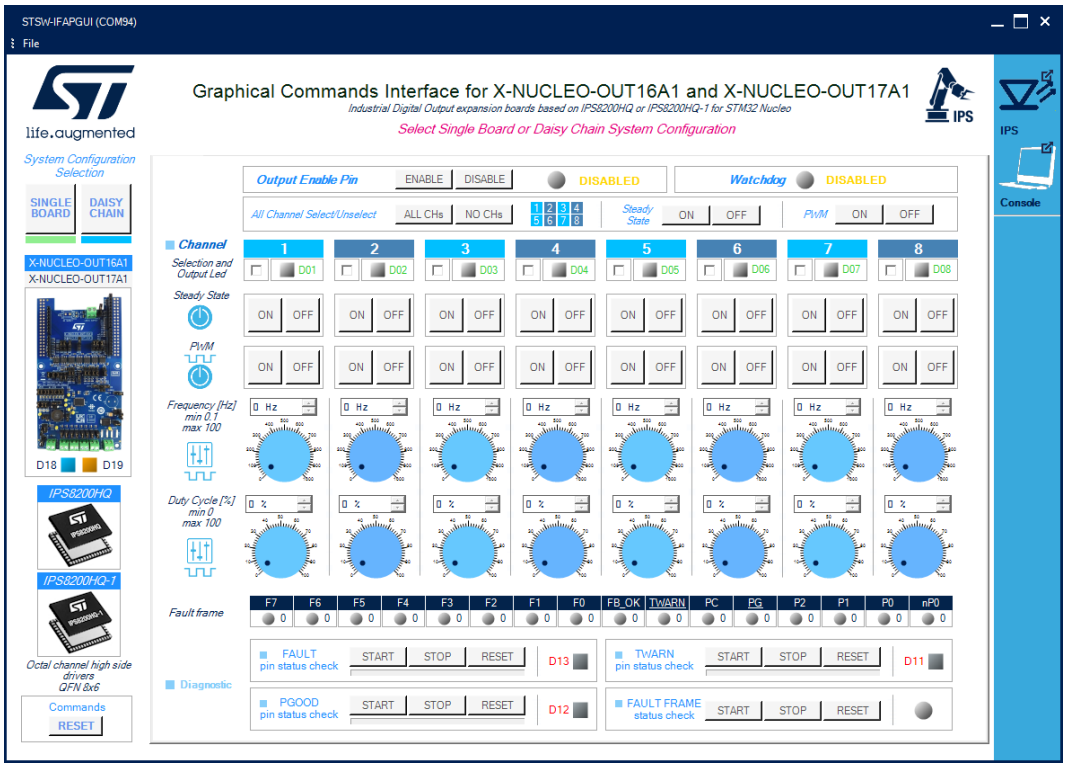
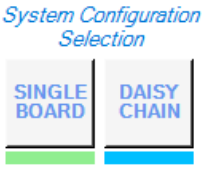


Figure 175. STSW-IFAPGUI main control panel for 16-bit SPI configuration before single board or daisy chain selection



Step 7. Use the [**SINGLE BOARD**] or [**DAISY CHAIN**] buttons to select the configuration. In this case click on [**DAISY CHAIN**]. The choice must be consistent with the physical system you are using. Otherwise, correct operation will not occur. If you make a mistake, you will need to close the main control panel and reopen it again as previously described. At this point it will be possible to make a new choice.

Figure 176. STSW-IFAPGUI System Configuration Selection



Step 8. After the System Selections, the correct interface will appear on the screen:

Figure 177. STSW-IFAPGUI main control panel for 8-bit SPI Daisy Chain configuration

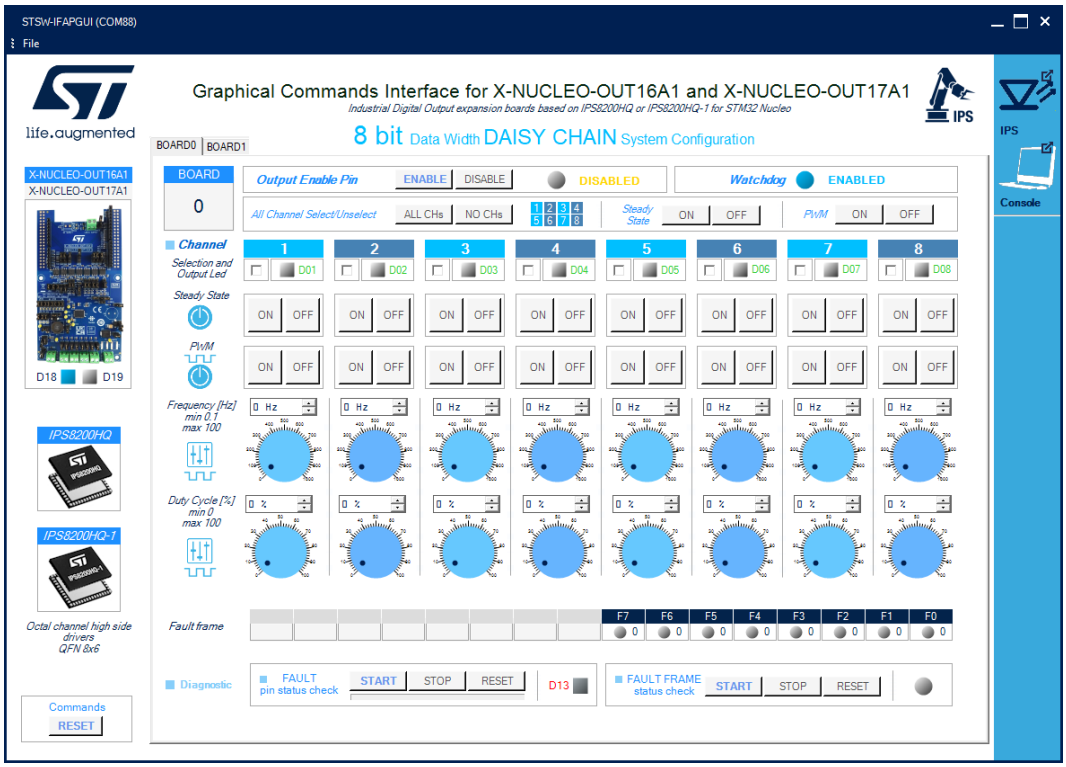
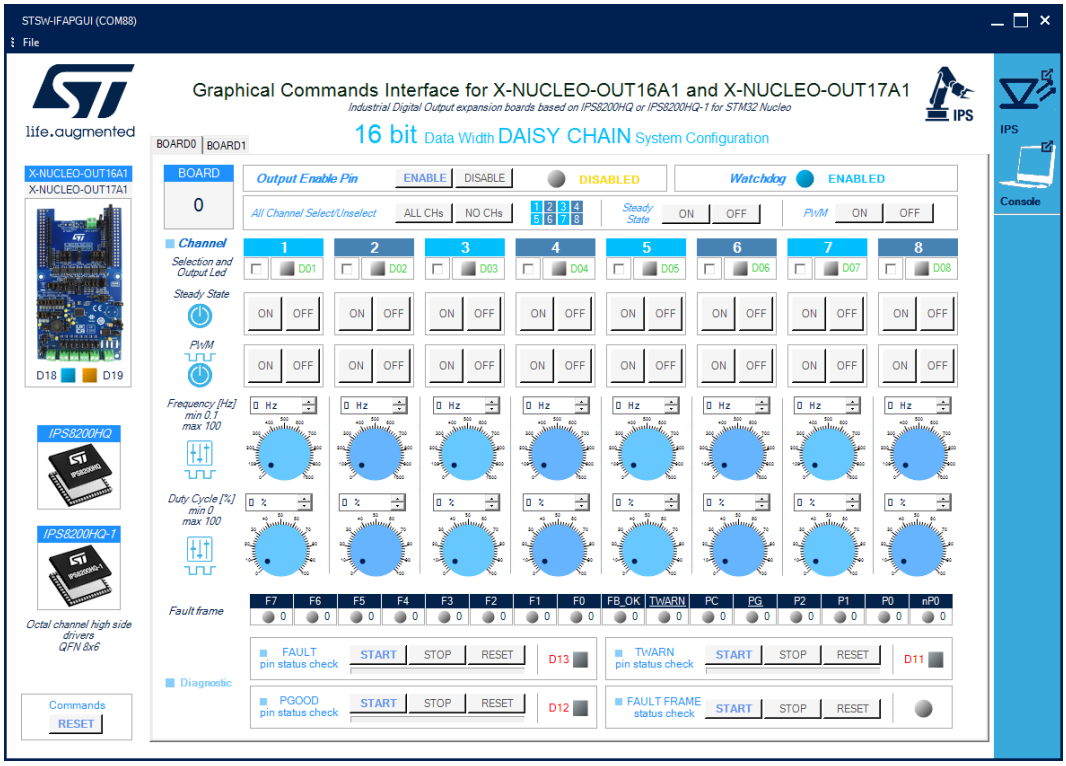


Figure 178. STSW-IFAPGUI main control panel for 16-bit SPI Daisy Chain configuration



The main panel is composed of two tabs, one for each system board. Each tab contains:

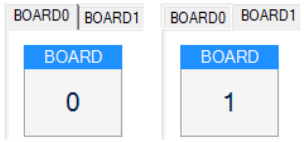
- a set of columns, one for each channel. Inside each column there are the buttons to turn the channels on and off in Steady State and in PWM mode. There are also the objects used to set the frequency and duty cycle of the PWM. At the top of each column there is the LED that shows the status of the channel and the channel selector. On the left of the first column there is the functional description of the objects in the same row.
- the Output Enable Pin Section.
- a Watchdog section (related to MCU freeze detection available in IPS8200HQ and IPS8200HQ-1).
- a Channels Selection section to perform operation on the selected channels with a single click.
- the Fault frame section to read the device register bits.
- a diagnostic section to check the FAULT pin.
- a diagnostic section to read the Fault frame.
- for the 16-bit configuration diagnostic sections for TWARN and PGOOD to check these pins.
- a command reset section.
- board image to clicking on to open a window showing the board connections.
- package images to clicking on to open a window showing the device features.

All the buttons with blue text refer to the functions currently active, when the text is gray the function will be activated after a preliminary action, such as enabling the outputs or setting the frequency and duty cycle of the PWM.

Step 9. Board 0 or Board 1 selection.

- The interface contains two tabs that can be switched to choose which of the two boards to send the commands. The following figures show how to choose one of the two boards.

Figure 179. STSW-IFAPGUI Board 0 or Board 1 selection



Step 10. Outputs enabling.

- First of all, it is necessary to use the [**Output Enable Pin**] section to enable the outputs of the IPS8200HQ or IPS8200HQ-1 for the two boards. Since in this case the two boards are a system, the enabling of the outputs can be given indifferently by one of the two boards and will be valid for the entire system. The same concept applies to the outputs disabling. At the startup the outputs and all commands to power on the channels are disabled.

Figure 180. STSW-IFAPGUI Output Enable Pin section at the startup

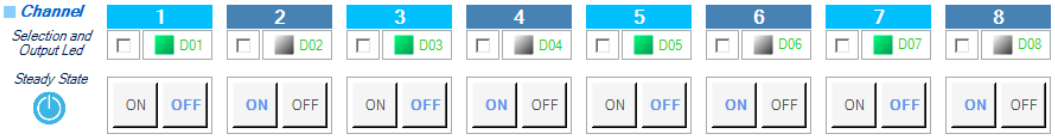
The [**ENABLE**] button enables the outputs, while the [**DISABLE**] button disables the outputs. After the click on [**ENABLE**] this is the interface answer:

Figure 181. STSW-IFAPGUI Outputs Enabled

Step 11. Use the Command Interface for Steady State and PWM.

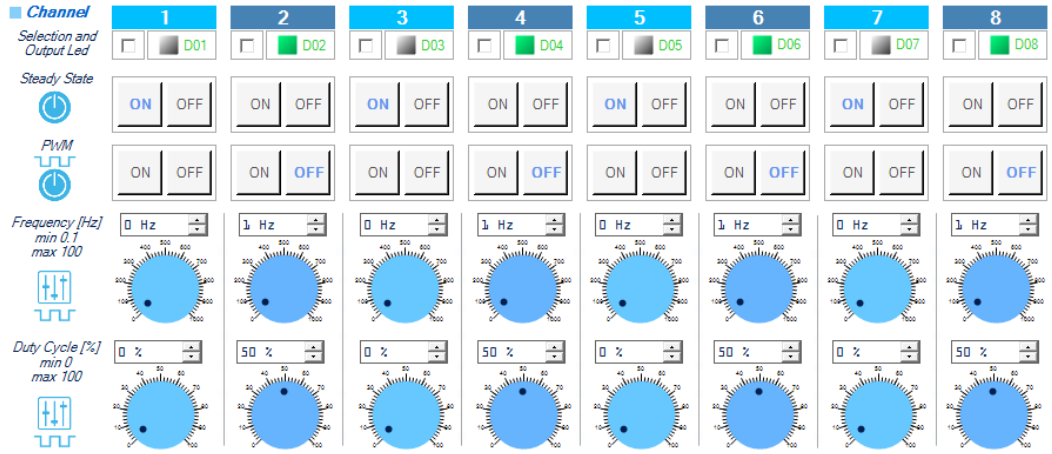
– Use the Steady State [**ON**] or [**OFF**] buttons related to the desired channel to turn on or off it in Steady State mode. The [**ON**] button for each channel is enabled after the outputs enable. When a channel is on in steady state mode the green LED corresponding to that channel will be on and the [**OFF**] button will be enabled, and the [**ON**] button disabled. When a channel is turned on in steady state mode it will not be possible to use the PWM mode. To use the PWM, the steady state of the channel must first be switched off.

Figure 182. STSW-IFAPGUI channels 1, 3, 5, 7 Steady State ON



– Use the PWM [**ON**] or [**OFF**] buttons related to the desired channel to turn on or off it in PWM mode. The [**ON**] button starting the PWM will be enabled when both the frequency and the duty cycle values for the channel have been selected through the dedicated controls and the steady mode is off for the channel. The PWM on will be signalized by the green LED blinking according to the frequency and duty cycle chosen. Use the [**OFF**] button to stop the PWM function. During the PWM the Steady State buttons for the active channels are disabled. Turn off the PWM to have the steady state enabled on these channels. An example of channels 2, 3, 6, 8 active in PWM mode is shown below.

Figure 183. STSW-IFAPGUI channels 2, 4, 6, 8 PWM ON



Step 12. The diagnostic sections allow you to check the status of the diagnostic pins to identify the presence of thermal shutdown on one or more channels and to read the bits of the internal register to identify the channels on which it occurred.

– Use the [**FAULT pin status check**] section to start and stop the check on the device FAULT pin.

Figure 184. STSW-IFAPGUI FAULT pin status check section

Click on the [**START**] to monitor the on/off status of the FAULT pin on IPS8200HQ or IPS8200HQ-1. The FAULT is a diagnostic pin at chip level, and it is an active low fault indication pin. The condition that activates the interface signalization is the junction overtemperature of at least one channel. Only in the case of the 16-bit SPI configuration the interface is able to display a failure on this pin also when SPI communication fault event (parity check error or module-8 violation occurs).
When a fault condition is triggered, the red LED will light up. The pin check in progress is indicated by the activation of the progress bar.

Figure 185. STSW-IFAPGUI FAULT pin status check ongoing

Click on the [**STOP**] button to stop the FAULT pin check and on the [**RESET**] button to clear the last pin condition which is kept displayed after the stop.

– Use the [**TWARN pin status check**] section to start and stop the check on the device TWARN pin. This section is only available when using the main control panel for the 16-bit SPI configuration. TWARN is the Case Temperature diagnostic pin, and it is activated (forced low) when a case overtemperature event occurs.

Figure 186. STSW-IFAPGUI TWARN pin status check section

Click on the [**START**] to monitor the on/off status of the TWARN pin on IPS8200HQ or IPS8200HQ-1. When the activation of the TWARM pin occurs, the red LED into the section will light up. The pin check in progress is signaled by the activation of the progress bar.

Figure 187. STSW-IFAPGUI TWARN pin status check in progress

Click on the [**STOP**] button to stop the TWARN pin check and on the [**RESET**] button to clear the last pin condition which is kept displayed after the stop.

– Use the [**PGOOD pin status check**] section to start and stop the check on the device PGOOD pin. This section is only available when using the main control panel for the 16-bit SPI configuration. PGOOD is the Power Good diagnostic pin, and it is activated (forced low) when the voltage on the VCC pin goes below V_{PGH2}.

Figure 188. **STSW-IFAPGUI PGOOD pin status check section**

Click on the [**START**] to monitor the on/off status of the PGOOD pin on IPS8200HQ or IPS8200HQ-1. When the activation of the PGOOD pin occurs, the red LED into the section will light up. The pin check in progress is signaled by the activation of the progress bar.

Figure 189. **STSW-IFAPGUI PGOOD pin status check ongoing**

Click on the [**STOP**] button to stop the PGOOD pin check and on the [**RESET**] button to clear the last pin condition which is kept displayed after the stop.

– Use the [**FAULT FRAME status check**] section to read the channel fault conditions (junction overtemperature) consisting of 8 bits. Each bit, set to '1', indicates an overtemperature condition for the corresponding channel. In the case of the 8-bit SPI configuration the entire fault frame is composed of the 8 bits just described. In the case of the 16-bit configuration, the bits that signal the junction overtemperature are the bits from position 8 to 15.

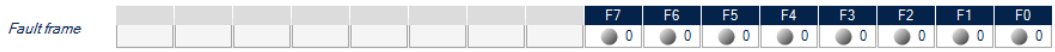
Figure 190. **STSW-IFAPGUI Fault frame section**

Click on the [**START**] button to start the read of Fault frame coming from the IPS8200HQ or IPS8200HQIPS8200HQ-1. The [**STOP**] button ends the read. The [**RESET**] button clears the last bit sequence read from the IC. The blue LED blinking signals that the read operation is in progress.

Figure 191. **STSW-IFAPGUI Fault frame read in progress**

The read result in case of no channel fault (all bits to zero) for the SPI 8-bit configuration is shown in the following picture:

Figure 192. **STSW-IFAPGUI 8-bit SPI Fault frame, no Channel fault**



The read result in case of no channel fault (all bits to zero) for the SPI 16-bit configuration is shown in the following picture:

Figure 193. **STSW-IFAPGUI 16-bit SPI Fault frame, without Channel fault signalization**

As can be seen in this configuration, another 8 additional bits are also available, containing diagnostic and parity information. Refer to the IPS8200HQ or IPS8200HQ-1 datasheet for further information.

Step 13. The [**Watchdog**] section is useful to verify if the watchdog (MCU freeze detection feature) is enabled on the board. The blue LED Indicates that the watchdog is enabled. This is a hardware configuration related to SW3 connection (1-2 WD disabled, 2-3 WD enabled) and it`s no possible to change using the interface.

Figure 194. STSW-IFAPGUI Watchdog section, case of watchdog ENABLED

Figure 195. STSW-IFAPGUI Watchdog section, case of watchdog DISABLED

– The [**All Channel Select/Unselect**] section on the top of the interface is useful to select all channels to turn on or off in Steady State or PWM mode with a single button click to avoid repeating the same operation for each channel. The selection of a single channel or a group channel is available using the checkbox on the top of each column related to a channel.

Figure 196. STSW-IFAPGUI All Channel Select/Unselect

Figure 197. STSW-IFAPGUI single channel (Ch 1) selection

The [**ALL CHs**] button selects all channels, [**NO CHs**] button deselects all channels. In the Steady State sub-section, the [**ON**] button and [**OFF**] button respectively turn on or off in Steady State mode all the selected (and not already active) channels. In the PWM sub-section, the [**ON**] button and [**OFF**] button respectively turn on or off in PWM mode all the selected (and not already active channels). In the case of PWM, the selected channels for which a frequency and duty cycle other than zero have been set will be turned on.

Step 14. Click on the [**RESET**] button in the [**Commands Reset**] section to stop all operations in progress, (channels switched on in steady state or PWM mode). All frequency and duty cycle values that have been selected are also reset

Figure 198. STSW-IFAPGUI Commands Reset

2.11.3.2 *Information about the pin connections*

The device pin connections to the microcontroller are shown by clicking on the board image. In case of the Daisy chain the connections are different for the two boards and therefore clicking on the image of the board, the connections of the board selected via one of the two tabs will be displayed.

The following figure shows the connections for Board 0 and Board 1.

Figure 199. **Board pin connections DAISY CHAIN Board 0**

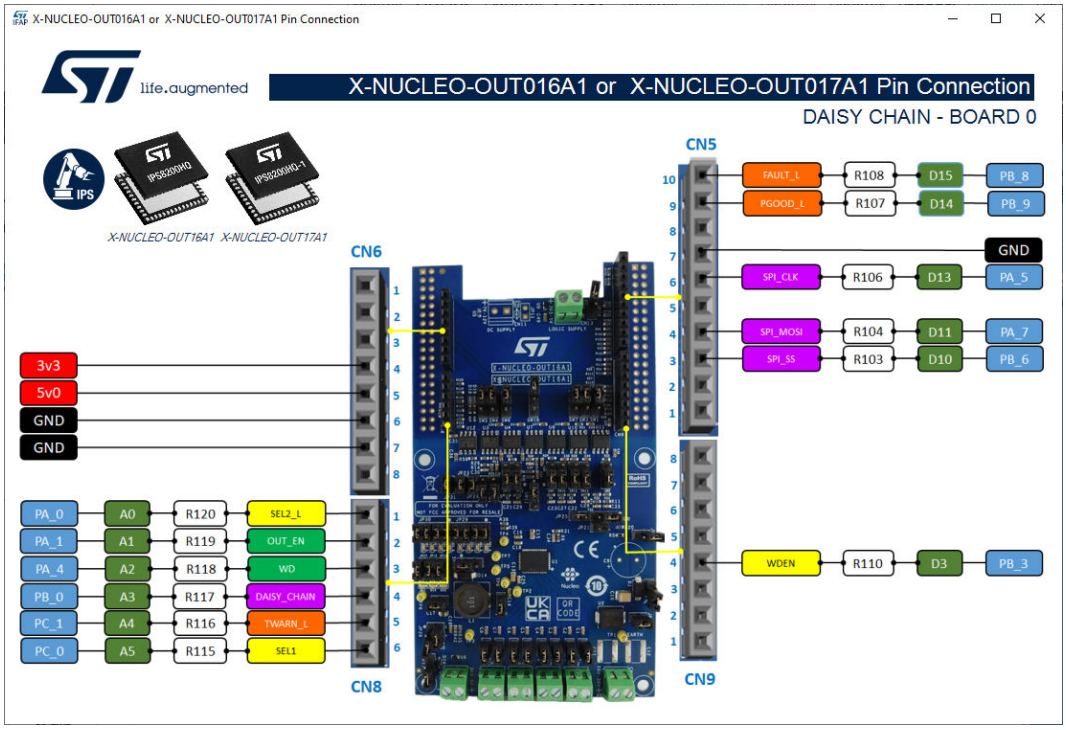
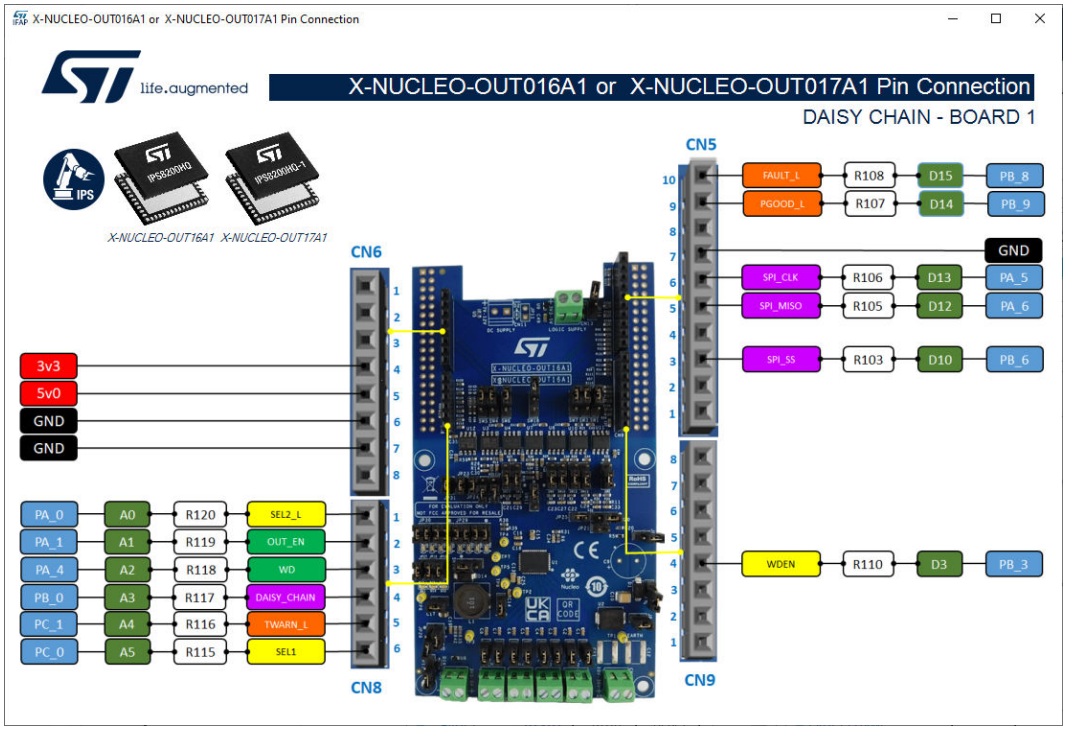


Figure 200. **Board pin Connections DAISY CHAIN Board 1**



2.11.4 How to get information about the GUI

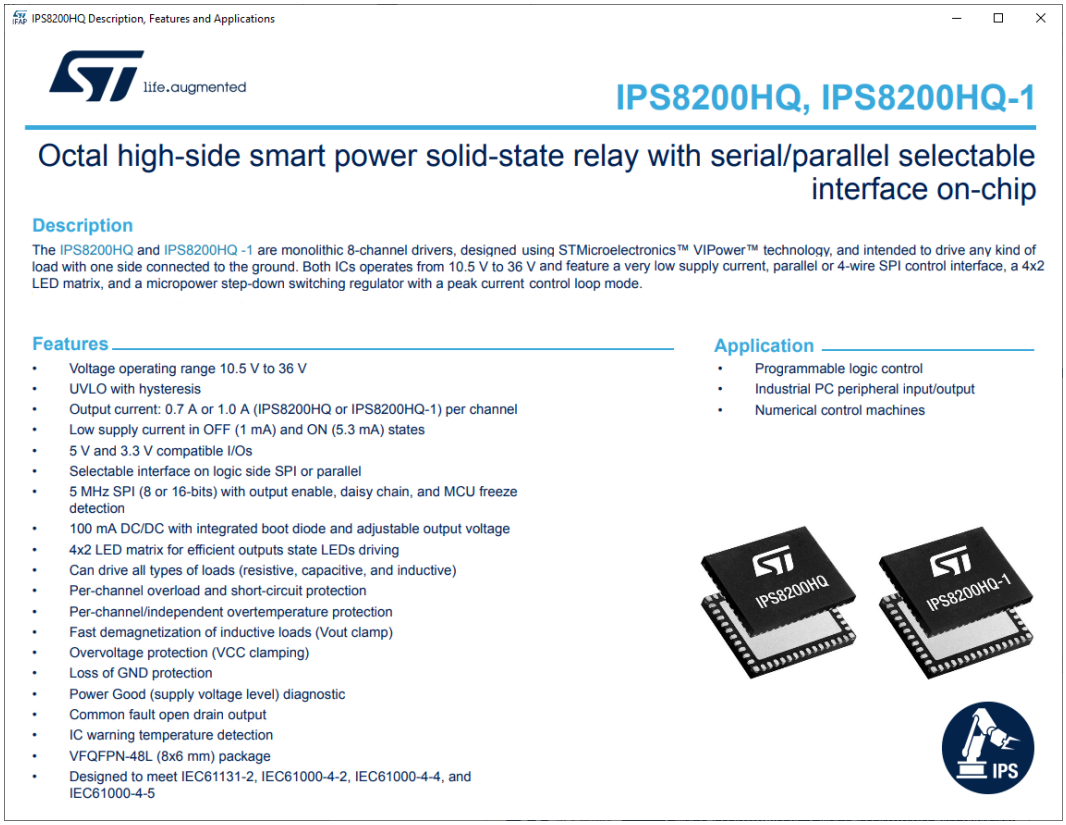
Information about the GUI revision for the is available by clicking on interface title. Then, the following window (in the example related to the first revision) appears:

Figure 201. Command Interface info

2.11.5 Information about the device

It is also possible to obtain information on the features of the device mounted on the boards, simply clicking on the image depicting the devices. The following image appears:

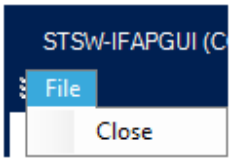
Figure 202. Device features



2.11.6 Close the command interface.

To close the command interface, use File/Close in the top-left part of the GUI.

Figure 203. **STSW-IFAPGUI close the command interface**



The command interface can be opened again by clicking on the Nucleo icon as described above.

2.12 X-NUCLEO-DO40A1 and X-NUCLEO-DO41A1 expansion boards

2.12.1 How to control the expansion board

This application scenario is based on the default configuration of the on-board switch and resistors of the X-NUCLEO-DO40A1 and X-NUCLEO-DO41A1.

Step 1. Stack the X-NUCLEO-DO40A1 (or X-NUCLEO-DO41A1) on top of the NUCLEO-F401RE flashed with the STSW-DO40F4 firmware (or NUCLEO-G431RB flashed with the STSW-DO40G4 firmware), through the Arduino® UNO R3 connectors.

Step 2. Connect the two stacked boards to your PC or laptop USB port through a mini-USB cable (for NUCLEO-F401RE) or micro-USB cable (for NUCLEO-G431RB). The STM32 is supplied via USB (3.3 V) and the flashed firmware starts running.

Step 3. Connect the load and supply the power stage of the X-NUCLEO-DO40A1 (or the X-NUCLEO-DO41A1) with a 24 V rail via the CN1 connector.

Step 4. Launch the STSW-IFAPGUI. When the application starts, the firmware running on the STM32 is automatically detected and, if a valid firmware is found, a COM port is opened for communication.

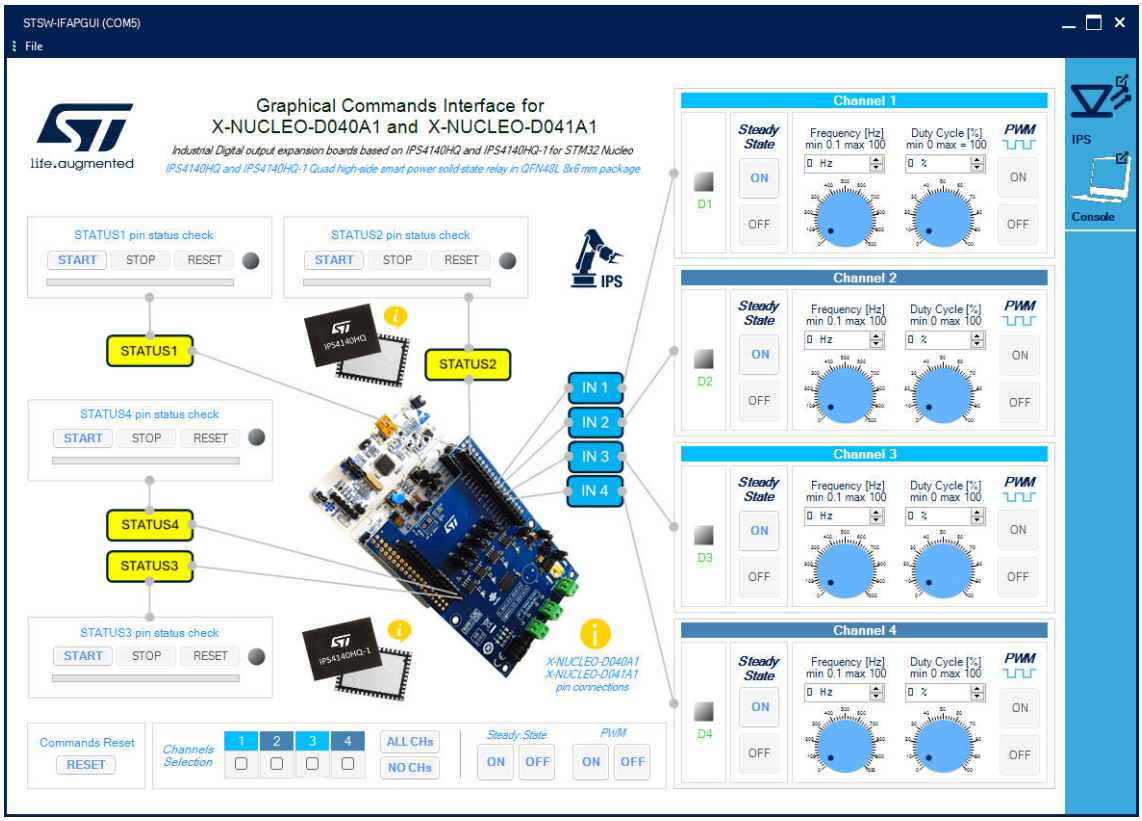
Figure 204. STSW-IFAPGUI COM - port opened

Step 5. Click on the GUI STM32 Nucleo icon after it turns blue (it remains green until the firmware identification is complete). The GUI automatically identifies the board configuration based on the information provided by the firmware.

Figure 205. STSW-IFAPGUI identification complete

Step 6. When the board identification phase has been completed the related STSW-IFAPGUI appears on the screen.

Figure 206. STSW-IFAPGUI main control panel



Step 7. The main control panel includes the sections:

– four channel control sections, one for each device channel, to control the Steady State or PWM mode.

– four diagnostic sections related to STATUS1, STATUS2, STATUS3 and STATUS4 pins

– a Channels Selection section to perform operation on the selected channels with a single click

– a Command Reset section to restore the main control panel start-up status

All the buttons with blue text refer to the functions currently active, when the text is gray the function will be activated after a preliminary action, such as setting the frequency and duty cycle of the PWM.

– Use the Channel [**Steady State**] GUI section to manage the channel steady state for IPS4140HQ (or IPS4140HQ-1). The [**ON**] and [**OFF**] buttons are used to turn a channel on or off respectively. The [**ON**] button for each channel is enabled at the start-up. When a channel is on in steady state mode the green LED corresponding to that channel will be on, the [**OFF**] button will be enabled, and the [**ON**] button disabled. When a channel is turned on in steady state mode it will not be possible to use the PWM mode. To use the PWM, the steady state of the channel must first be switched off.

Figure 207. STSW-IFAPGUI Channel section, Steady State enabled and ready to use

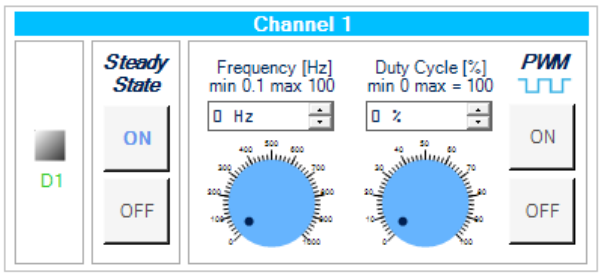
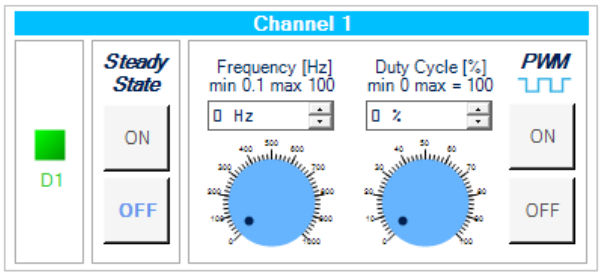
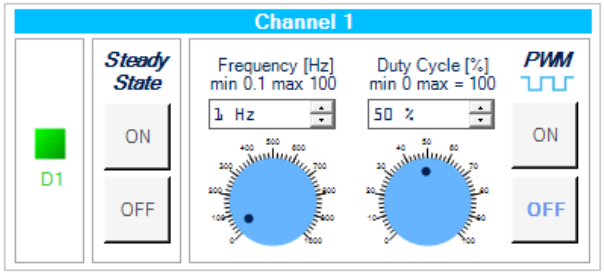


Figure 208. STSW-IFAPGUI Channel section, Steady State on



– Use the channel [**PWM**] GUI section to manage the channel PWM settings and to power on or off the channel input in PWM mode. The button [**ON**] starting the PWM will be enabled when both the frequency and the duty cycle values for the channel have been selected through the dedicated controls and the steady mode is off for the channel. The PWM on will be signalized by the green LED blinking according to the frequency and duty cycle chosen. Use the [**OFF**] button to stop the PWM function.

Figure 209. STSW-IFAPGUI channel section, PWM ON state

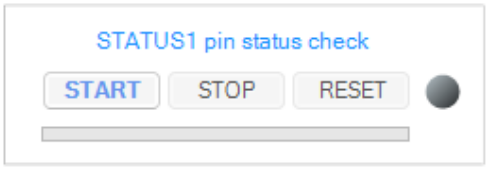


Step 8. The diagnostic sections allow you to check the status of the diagnostic pins available on the board. The pins that is possible to check are:

- STATUS1: Channel 1 per-channel over-temperature condition
- STATUS2: Channel 2 per-channel over-temperature condition
- STATUS3: Channel 3 per-channel over-temperature condition
- STATUS4: Channel 4 per-channel over-temperature condition

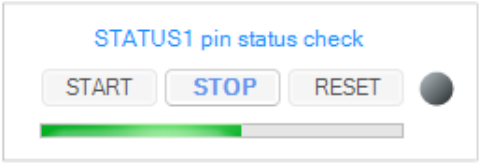
Below is a description about how to use the monitoring of the STATUS1, STATUS2, STATUS3 and STATUS4 pins. Since the operation is similar for all four, the operation will be explained only once by generically indicating one of the four pins with STATUSx.
Use the [**STATUSx pin status check**] section to start and stop the check of the device STATUSx diagnostic pin.

Figure 210. STSW-IFAPGUI STATUSx pin status check section



Click on the [**START**] to monitor the on/off status of the STATUSx pin on X-NUCLEO-DO40A1 (or X-NUCLEO-DO41A1). The STATUSx is a per-channel diagnostic pin, and it is activated (active low) in case of over-temperature condition. When an over-temperature condition is triggered, the red LED into the section will light up. The pin check in progress is signaled by the activation of the progress bar.

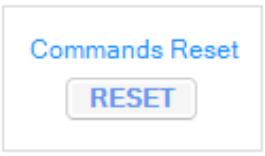
Figure 211. STSW-IFAPGUI STATUSx pin status check in progress



Click on the [**STOP**] button to stop the STATUSx pin status check and on the [**RESET**] button to clear the last pin condition which is kept displayed after the stop.

Step 9. Click on the [**RESET**] button in the bottom-left part of the main control panel to stop all operations in progress (channels switched on in steady state or PWM mode, diagnostic checks on going). All frequency and duty cycle values selected for the PWM are also reset.

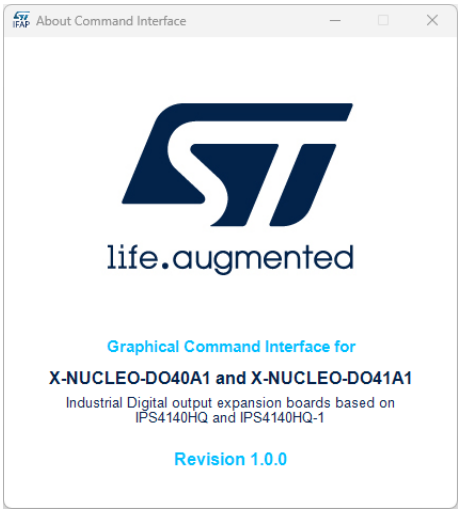
Figure 212. STSW-IFAPGUI Commands Reset button



2.12.2 How to get information about the GUI

Information about the GUI revision is available by clicking on the interface title (See Figure 206. STSW-IFAPGUI main control panel). Then, the following window (in the example related to the first revision) appears:

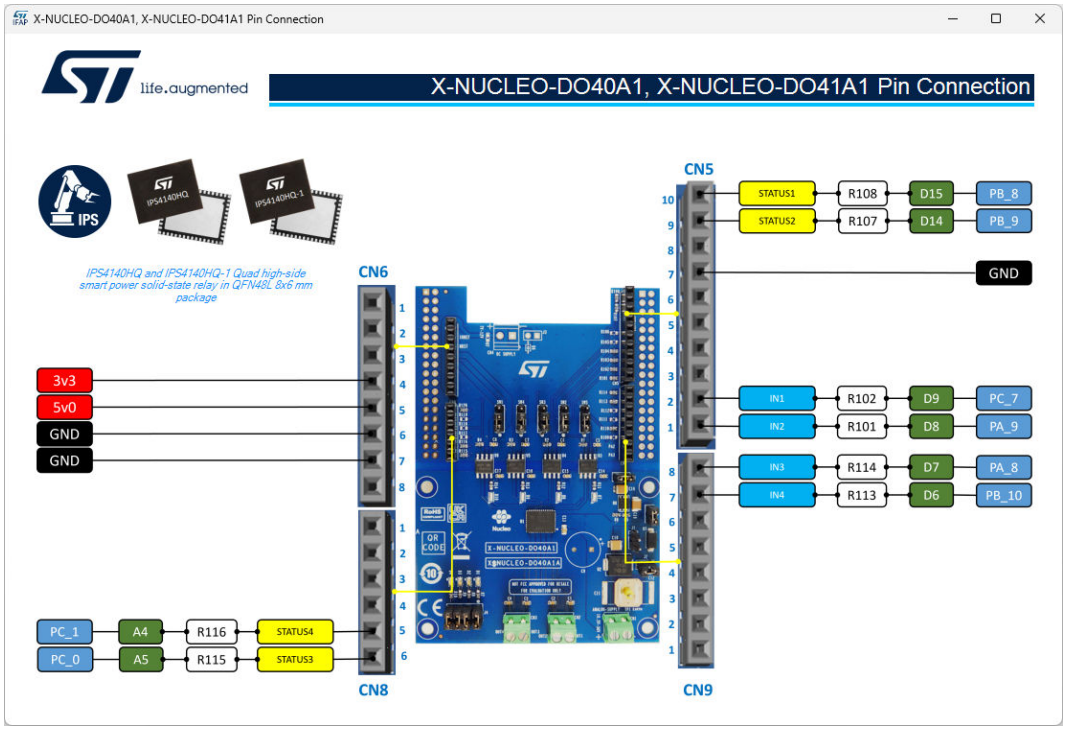
Figure 213. Command interface info



2.12.3 Information about the pin connections

The device pin connections to the microcontroller are shown by clicking on the yellow info logo on the left of the board image (See Figure 206. STSW-IFAPGUI main control panel). The following figure shows the Board Connections window shown after the click for X-NUCLEO-DO40A1 (or X-NUCLEO-DO41A1).

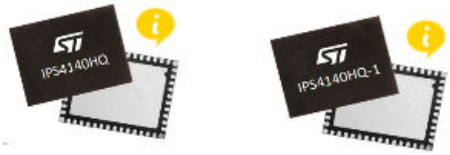
Figure 214. Board Pin Connections



2.12.4 Information about the device

It is also possible to obtain information on the features of the device mounted on the board. Simply with a click on the device package picture (See Figure 206. STSW-IFAPGUI main control panel).

Figure 215. Get Command Interface info



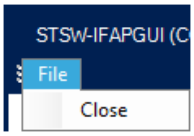
Then, the following window appears:

Figure 216. Device Features

2.12.5 Close the command interface

To close the command interface, use File/Close in the top-left part of the GUI.

Figure 217. STSW-IFAPGUI close the command interface



The command interface can be opened again by clicking on the Nucleo icon as described above.

Revision history

Table 6. **Document revision history**

Date	Version	Changes
15-Nov-2018	1	Initial release.
26-Feb-2019	2	Added references to STSW-OUT02 firmware.
17-Jun-2020	3	Added references to STSW-OUT8F4, STSW-OUT8G4, X-NUCLEO-OUT08A1 and X-NUCLEO-OUT10A1. Added Section 2.2.1 How to control a single expansion board and Section 2.2.2 How to control two expansion boards. Minor text changes.
15-Nov-2021	4	Updated Introduction. Added references to STSW-OUT3F4, STSW-OUT3G4, X-NUCLEO-OUT03A1 and X-NUCLEOOUT04A1. Added Section 2.2 X-NUCLEO-OUT03A1 and X-NUCLEO-OUT04A1 expansion boards.
06-Apr-2022	5	Updated introduction. Added references to STSW-OUT5F4, STSW-OUT5G4, STDES-OUT03DO8, STDES-OUT04DO8, STSW-OUT3D8F4, STSW-OUT3D8G4, X-NUCLEO-OUT05A1, and X-NUCLEO-OUT06A1. Updated Section 2.2.1 How to control a single expansion board. Added Section 2.2.2 How to control up to four expansion boards, Section 2.2.3 How to get information about the GUI, and Section 2.3 X-NUCLEO-OUT05A1 and X-NUCLEO-OUT06A1 expansion boards.
26-May-2022	6	Updated introduction. Added Section 2.3.2 How to control up to four expansion boards and Section 2.3.3 How to get information about the GUI. Added references to STSW-OUT5D4F4, STSW-OUT5D4G4, STDES-OUT05DO4, and STDESOUT06DO4.
22-Jun-2022	7	Updated introduction, *Section 2.4.1: How to control a single expansion board,* and *Section 2.4.2: How to control up to four expansion boards* Added *Section 2.10: X-NUCLEO-OUT15A1 expansion board, Section 2.10.1: How to control a single expansion board,* and *Section 2.10.2: How to get information about the GUI* *Section 2.11.4: How to get information about the GUI* Added references to STSW-OUT15F4, STSW-OUT15G4, and X-NUCLEO-OUT15A1.
21-Jun-2023	8	Added *Section 2.7: X-NUCLEO-OUT09A1 and X-NUCLEO-OUT19A1 expansion boards*, *Section 2.8: X-NUCLEO-OUT11A1 and X-NUCLEO-OUT13A1 expansion boards* and *Section 2.9: X-NUCLEO-OUT12A1 and X-NUCLEO-OUT14A1 expansion boards*.
24-Oct-2023	9	Updated *Section Introduction.* Added *Section 2.1: X-NUCLEO-OUT01A2 expansion board.*
04-Oct-2024	10	Added *Section 2.5: X-NUCLEO-OUT07A1 expansion board and Section 2.11: X-NUCLEO-OUT16A1 and X-NUCLEO-OUT17A1 expansion boards.*
23-Jan-2025	11	Updated Section Introduction. Added Section 2.12: X-NUCLEO-DO40A1 and X-NUCLEO-DO41A1 expansion boards.

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