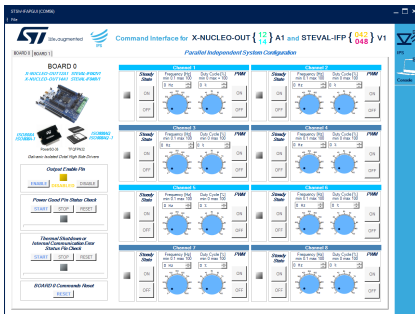


Demonstration firmware for NUCLEO-F401RE enabling STSW-IFAPGUI on X-NUCLEO-OUT12A1 and X-NUCLEO-OUT14A1 expansion boards



Features

- Full control of the X-NUCLEO-OUT12A1 and X-NUCLEO-OUT14A1 expansion boards via the STSW-IFAPGUI graphical user interface
- Control of:
 - output channel switching frequency and duty cycle configuration
 - visualization of diagnostic signals (power good and common over-temperature / communication error diagnostics)
 - both Regular Mode and Daisy Chain Mode management

Description

The STSW-OUT12F4 firmware runs on the NUCLEO-F401RE development board and allows controlling the X-NUCLEO-OUT12A1 or X-NUCLEO-OUT14A1 expansion boards using the STSW-IFAPGUI graphical user interface.

The STSW-OUT12F4 contains the software routines that enable the USB-based communication between the NUCLEO-F401RE and the system where the STSW-IFAPGUI runs, and the control of the X-NUCLEO-OUT12A1 or X-NUCLEO-OUT14A1.

The firmware can control a single expansion board or two stacked X-NUCLEO-OUT12A1 (or X-NUCLEO-OUT14A1) configured in parallel independent or daisy chaining mode.

The STSW-IFAPGUI is based on a common engine and several plug-ins designed to communicate through the USB connection with the application layer running on the NUCLEO-F401RE development board stacked with the expansion board.

Product summary	
Demonstration firmware for NUCLEO-F401RE enabling STSW-IFAPGUI on X-NUCLEO-OUT12A1 and X-NUCLEO-OUT14A1 expansion boards	STSW-OUT12F4
Industrial digital output expansion board based on ISO808A for STM32 Nucleo	X-NUCLEO-OUT12A1
Industrial digital output expansion board based on ISO808A-1 for STM32 Nucleo	X-NUCLEO-OUT14A1
STM32 Nucleo-64 development board with STM32F401RE MCU	NUCLEO-F401RE
Graphical user interface for the industrial IPS and IO-Link transceiver evaluation boards based on STM32 Nucleo	STSW-IFAPGUI
Applications	Industrial Safety Industrial Tools

1 Control of the expansion board (single or dual) by IFAPGUI

1.1 System identification

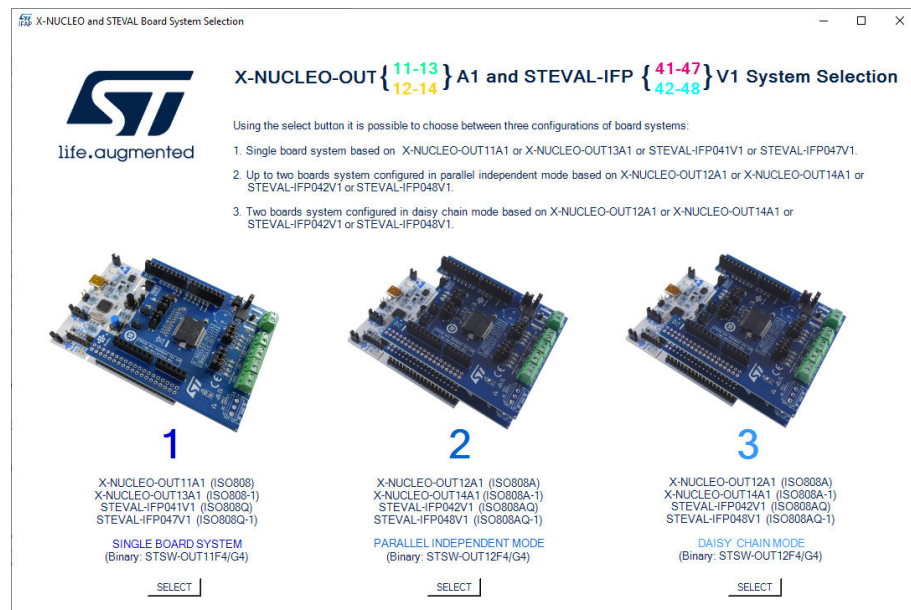
- Step 1.** Stack the expansion system (single X-NUCLEO-OUT12A1/X-NUCLEO-OUT14A1, or combined as parallel independent / daisy chain) through the Arduino connectors on the NUCLEO-F401RE board flashed with the STSW-OUT12F4 firmware.
- Step 2.** Connect the complete system (expansion + Nucleo) to your PC or laptop USB port through a mini-USB cable.
The STM32 is supplied via USB (3.3 V) and the flashed firmware starts running.
Press the black button on the NUCLEO-F401RE board to reset the firmware.
- 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 1. 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 2. System configuration selection panel



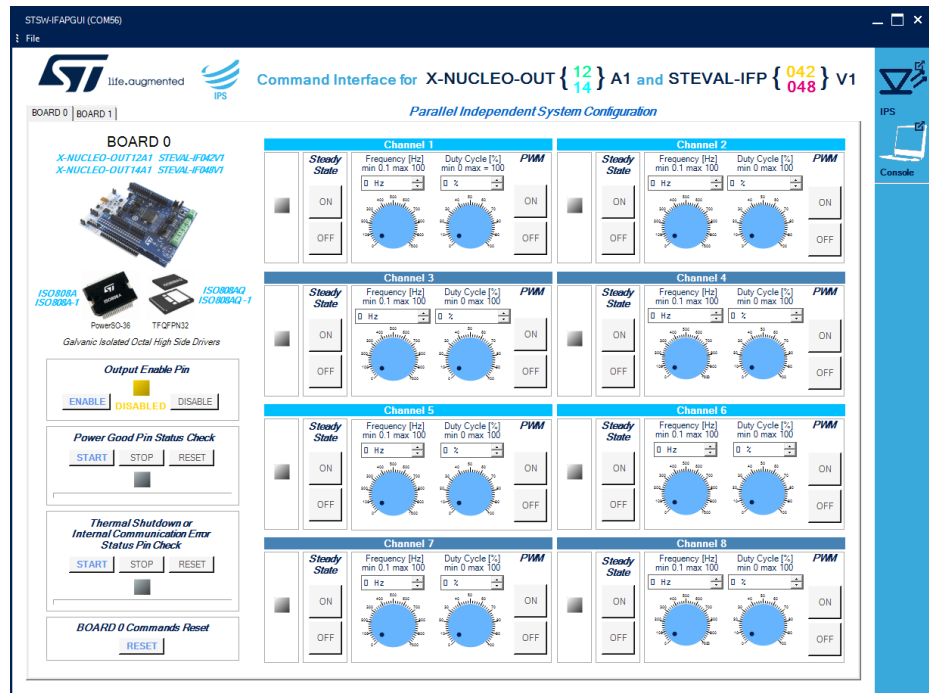
Ignore option [1] (specifically dedicated to ISO808 family driven by parallel interface, instead of SPI interface) and select option [2] (for Single or Parallel Independent) or [3] (Daisy Chaining) according to your system configuration.

1.2 Regular mode (Parallel Independent)

This mode allows the control of a single expansion board or the control of two stacked expansion boards but not configured in daisy chaining.

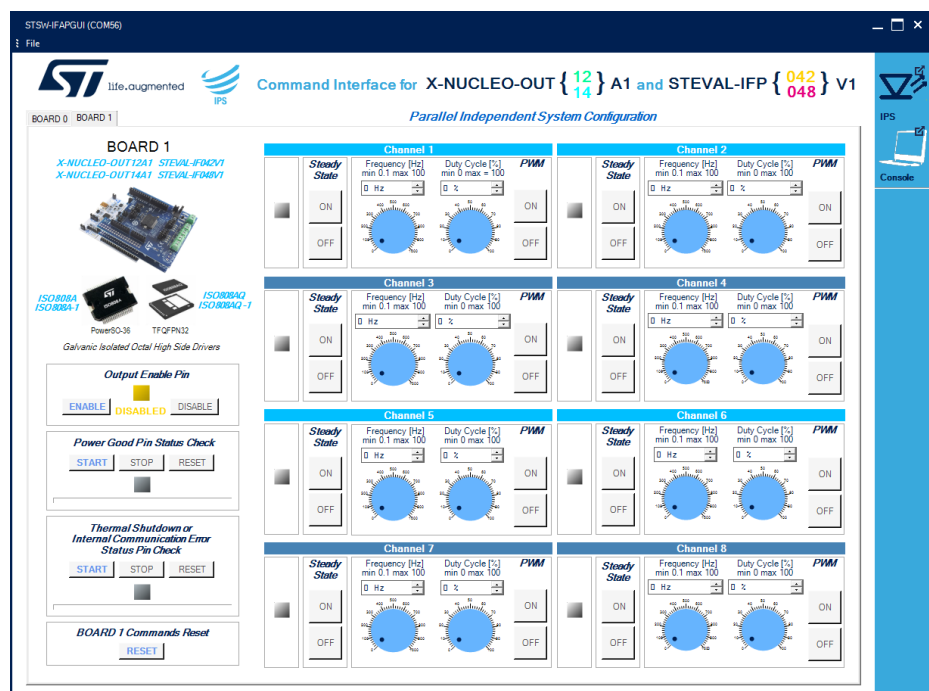
Step 1. Select [2] **PARALLEL INDEPENDENT MODE** and the STSW-IFAPGUI appears on the screen.

Figure 3. STSW-IFAPGUI main control panel BOARD 0



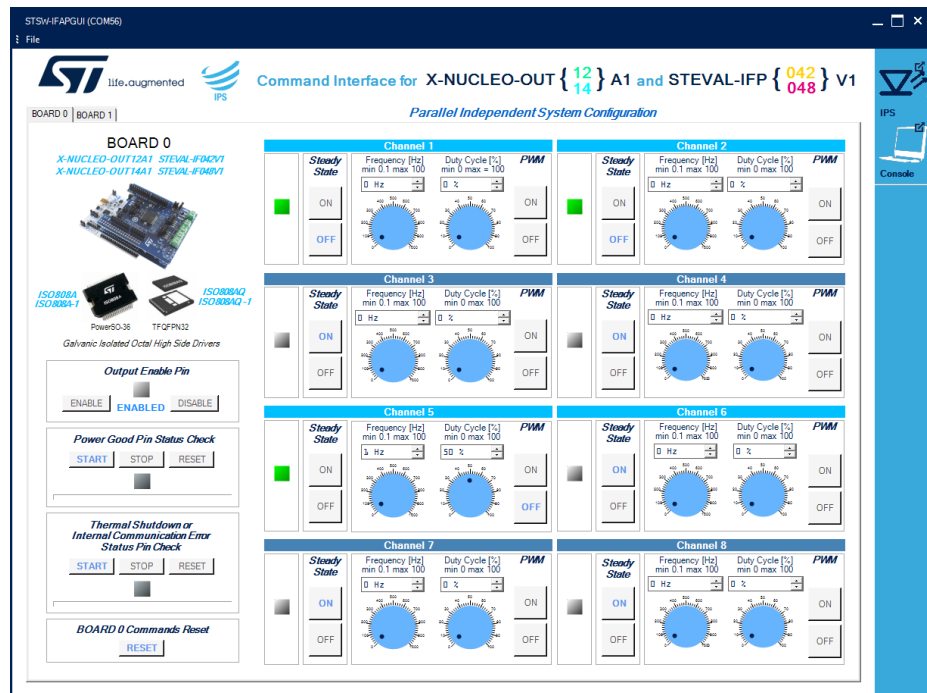
If present in your configuration, the second board panel is enabled (see next figure).

Figure 4. STSW-IFAPGUI main control panel BOARD 1



- Step 2.** If more than one board is present in your system, you can select the proper board to send the commands to: use the tab BOARD 0 | BOARD 1 in the top left side of the GUI to select the board. Then use the dedicated section of the GUI for the desired channel of ISO808A (or ISO808A-1) to:
- manage channel steady state (the left part in each channel section)
 - manage channel PWM settings (the right part in each channel section)
- Use the bottom left side of the GUI to:
- enable/disable outputs, properly setting the Output Enable pin
 - enable/disable and reset diagnostic pin and Power Good polling activities
 - reset all channel features to OFF state for the selected board
- 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.** Select the desired switching frequency and duty cycle of the desired output channel through the [Pulse Width Modulation] controls in the right part of desired channel section.
- Step 5.** The desired output channel steady state can be activated/deactivated by clicking on the [ON/OFF] buttons in the left part of the desired channel section in the [STEADY STATE] sub-section.
- Step 6.** Click on the [START] button in the [Thermal shutdown or Internal Communication Error Status Pin Check] area on the bottom left side of the GUI to monitor the on/off status on the FAULT pin on ISO808A (or ISO808A-1).
You can stop monitoring the fault status by clicking on the [STOP] button in the same section. Press the [RESET] button to reset the fault status.
- Step 7.** Click on [Enable] button in Output Enable Pin section to drive the output pins. Click on [Disable] in the same section to turn off all output pins.
- Step 8.** Click on [RESET] button in Command Reset section to reset any channel setting and also the diagnostic pins status monitoring.

Figure 5. STSW-IFAPGUI in action



1.3 Daisy Chain mode

This mode is specifically designed for the system configuration with two stacked expansion boards configured in daisy chain.

Step 1. Select [3] DAISY CHAIN MODE and the STSW-IFAPGUI appears on the screen.

Figure 6. STSW-IFAPGUI main control panel Daisy Chain BOARD 0

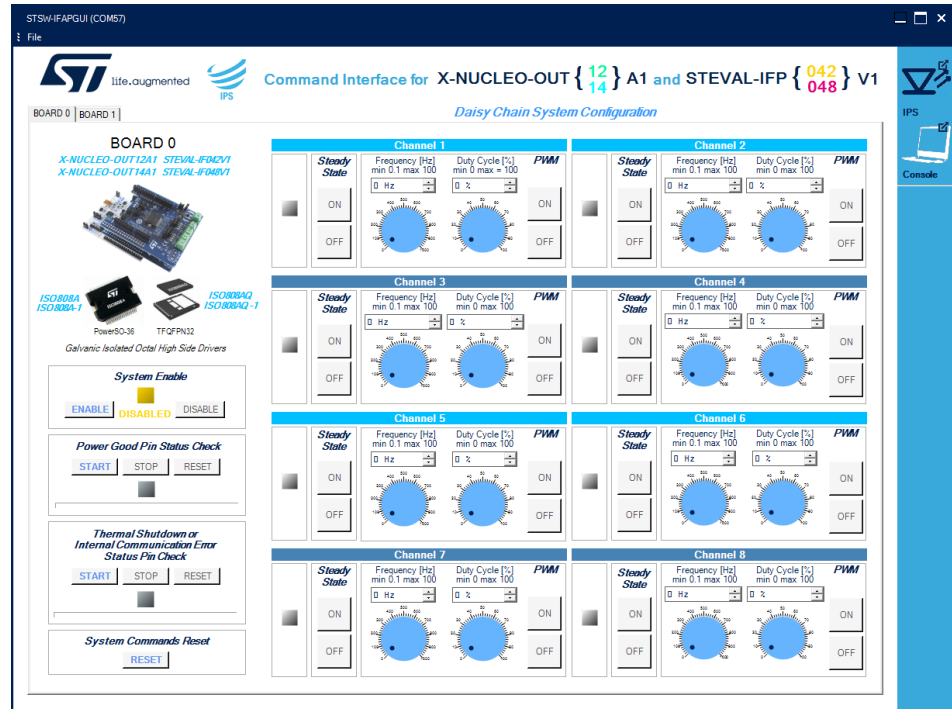
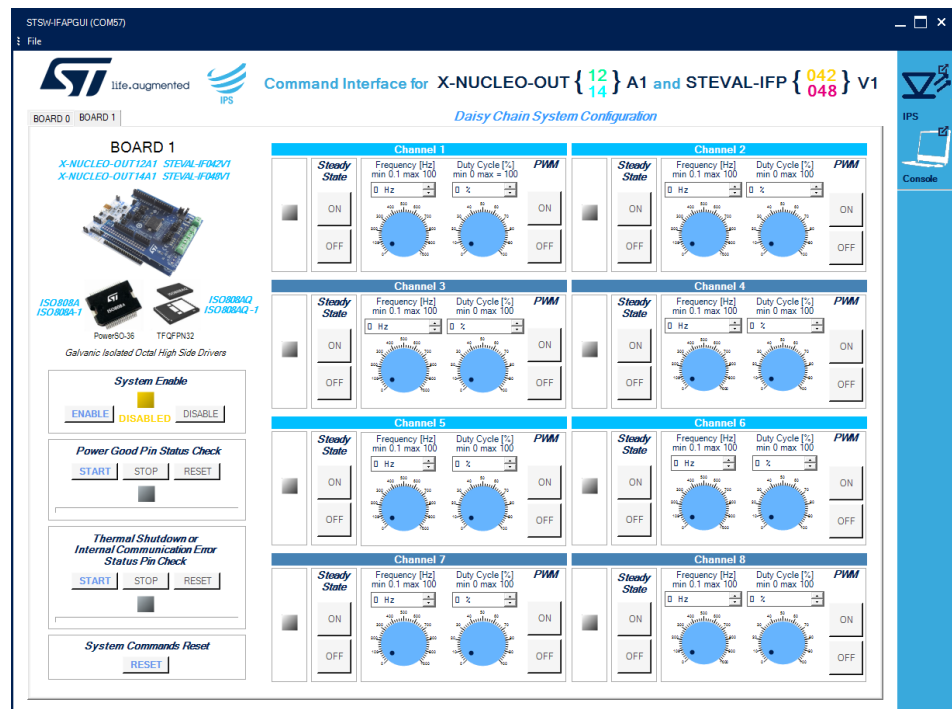


Figure 7. STSW-IFAPGUI main control panel Daisy Chain BOARD 1



Step 2. In Daisy Chain the system must be composed of two boards: you can select the proper board, whose status you want to change, using the tab **BOARD 0 | BOARD 1** in the top left side of the GUI.

Note: *output stage is 16-bit wide, so any change in input state must be sent to the system with a 2-bytes SPI write operation.*

After selecting the board to modify, use the dedicated section of the GUI for the desired channel of ISO808A (or ISO808A-1) to:

- manage channel steady state (the left part in each channel section)
- manage channel PWM settings (the right part in each channel section)

Use the bottom left side of the GUI to:

- enable/disable outputs, properly setting the Output Enable pin (common for the two boards)
- enable/disable and reset diagnostic pin and Power Good polling activities
- reset all channel features to OFF state for the whole system

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. Select the desired switching frequency and duty cycle of the desired output channel through the **[Pulse Width Modulation]** controls in the right part of desired channel section

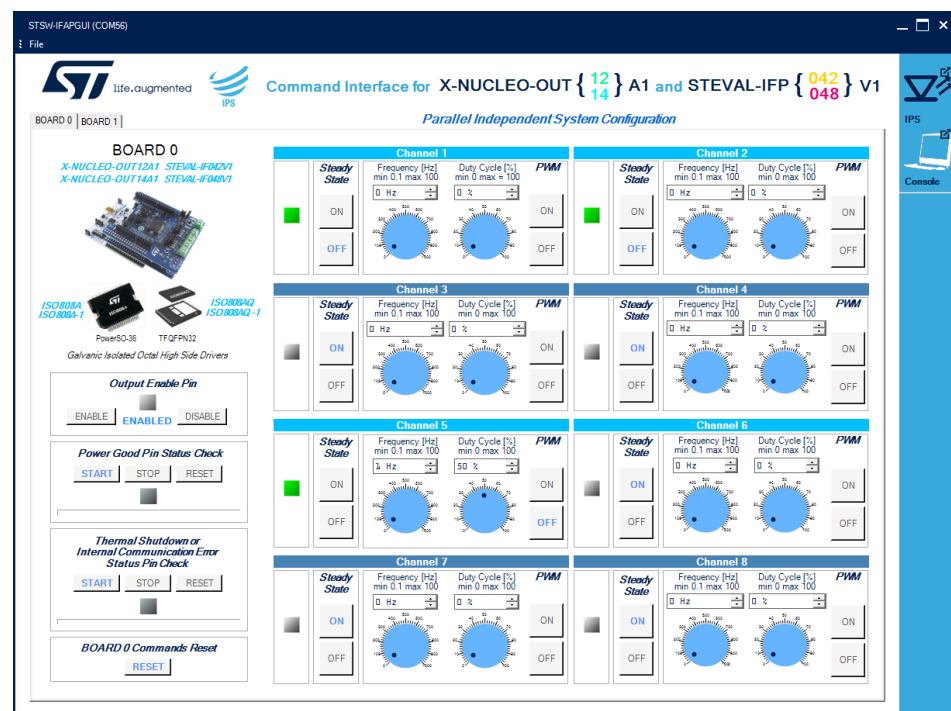
Step 5. The desired output channel steady state can be activated/deactivated by clicking on the **[ON/OFF]** buttons in the left part of the desired channel section in **[STEADY STATE]** sub-section.

Step 6. Click on the **[START]** button in **[Thermal shutdown or Internal Communication Error Status Pin Check]** area in the bottom left side of the GUI to monitor the on/off status on the FAULT pin on ISO808A (or ISO808A-1). You can stop monitoring the fault status by clicking on the **[STOP]** button in the same section. Press **[RESET]** button to reset the fault status.

Step 7. Click on **[Enable]** button in **Output Enable Pin** section to drive the output pins. Click on **[Disable]** in the same section to turn off all output pins

Step 8. Click on **[RESET]** button in **Command Reset** section to reset any channel setting and the diagnostic pins status monitoring.

Figure 8. STSW-IFAPGUI in action



2 Control of the expansion board (single or dual) by command line

There are three application scenarios, respectively based on:

- One board with the default on-board switches and resistors configuration of X-NUCLEO-OUT12A1 (or X-NUCLEO-OUT14A1)
- Two boards X-NUCLEO-OUT12A1 (or X-NUCLEO-OUT14A1) configured in Regular mode (parallel independent boards)
- Two boards X-NUCLEO-OUT12A1 (or X-NUCLEO-OUT14A1) configured in Daisy Chain mode

Step 1. Plug the X-NUCLEO-OUT12A1 or X-NUCLEO-OUT14A1 expansion board(s) on top of the NUCLEO-F401RE board, flashed with the STSW-OUT12F4 firmware, through the Arduino connectors.

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

Press the black button on the NUCLEO-F401RE board to reset the firmware.

Step 3. Launch the serial communication terminal application (TeraTerm in our notes). When the application starts, the serial communication must be configured as follows:

Figure 9. Tera Term: select serial communication method

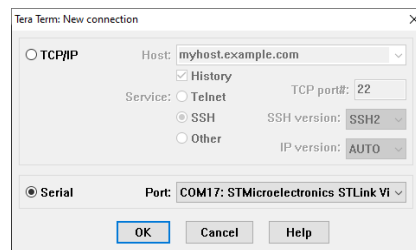


Figure 10. Tera Term: Setup / Terminal...

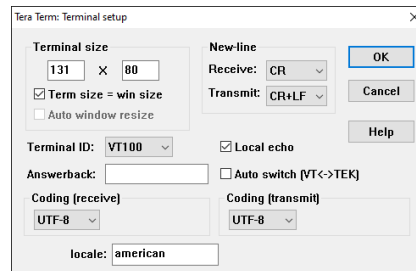
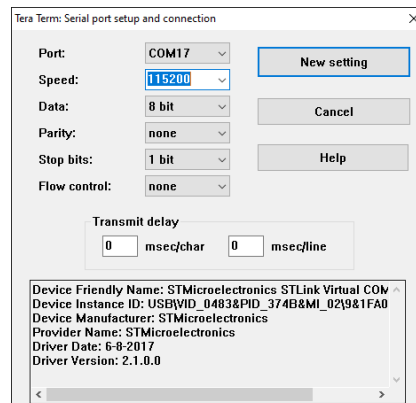
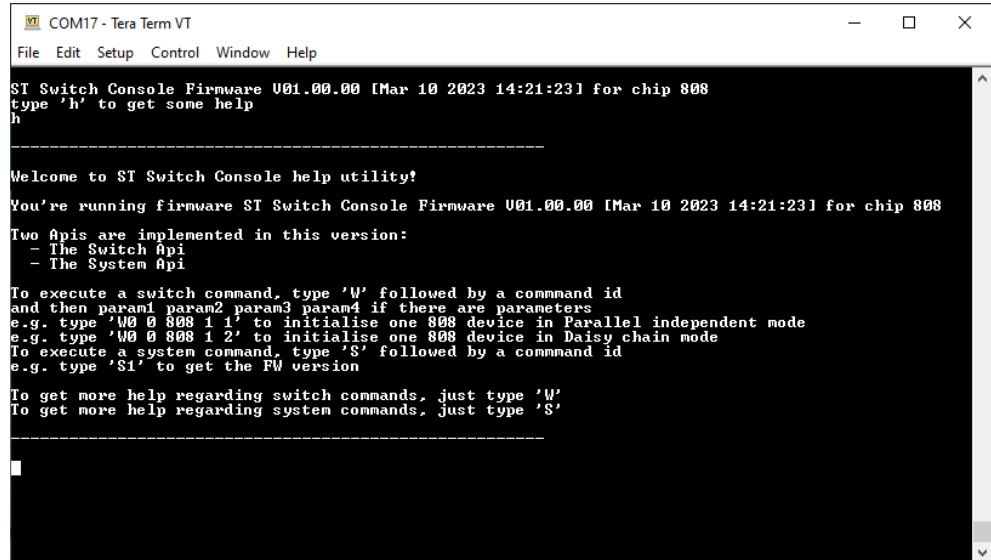


Figure 11. Tera Term: Setup / Serial port...



Step 4. Press Enter and then type 'h' for help:

Figure 12. CLI help



```

COM17 - Tera Term VT
File Edit Setup Control Window Help
ST Switch Console Firmware U01.00.00 [Mar 10 2023 14:21:23] for chip 808
type 'h' to get some help
h
-----
Welcome to ST Switch Console help utility!
You're running firmware ST Switch Console Firmware U01.00.00 [Mar 10 2023 14:21:23] for chip 808
Two Apis are implemented in this version:
- The Switch Api
- The System Api
To execute a switch command, type 'W' followed by a command id
and then param1 param2 param3 param4 if there are parameters
e.g. type 'W0 0 808 1 1' to initialise one 808 device in Parallel independent mode
e.g. type 'W0 0 808 1 2' to initialise one 808 device in Daisy chain mode
To execute a system command, type 'S' followed by a command id
e.g. type 'S1' to get the FW version
To get more help regarding switch commands, just type 'W'
To get more help regarding system commands, just type 'S'
-----
    
```


Step 5. Type 'w?' for a list of commands available:

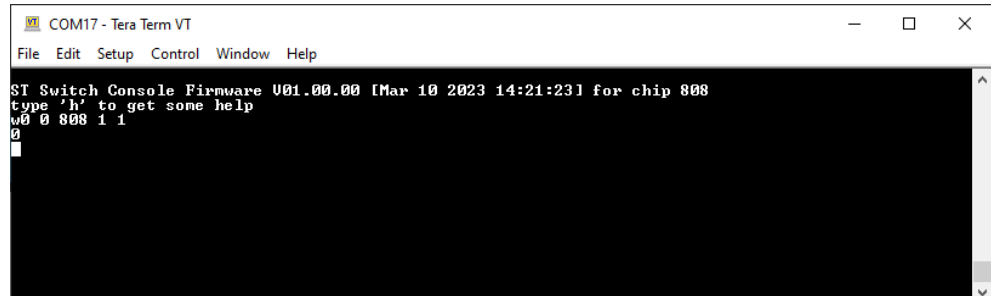
Figure 13. Command list

```

COM17 - Tera Term VT
File Edit Setup Control Window Help
ST Switch Console Firmware V01.00.00 [Mar 10 2023 14:21:23] for chip 808
type 'h' to get some help
w?
Switch API commands list:
Id: 0 IPS_SWITCH_API_INIT
w0 Instance<1B> ChipId<2B> NbDevices<1B> opMode<1B> -> Output: status<4B>
Id: 1 IPS_SWITCH_API_DEINIT
w1 Instance<1B> -> Output: status<4B>
Id: 2 IPS_SWITCH_API_READ_ID
w2 Instance<1B> -> Output: status<6B>
Id: 3 IPS_SWITCH_API_GET_FW_VERSION
w3 Instance<1B> -> Output: status<8B>
Id: 4 IPS_SWITCH_API_GET_CAPABILITIES
w4 Instance<1B> -> Output: status<5B>
Id: 5 IPS_SWITCH_API_GET_FAULT_STATUS
w5 Instance<1B> -> Output: status<5B>
Id: 6 IPS_SWITCH_API_GET_CHANNEL_STATUS
w6 Instance<1B> ChanId<1B> -> Output: status<5B>
Id: 7 IPS_SWITCH_API_SET_CHANNEL_STATUS
w7 Instance<1B> ChanId<1B> ChanStatus<1B> -> Output: status<4B>
Id: 8 IPS_SWITCH_API_GET_ALL_CHANNEL_STATUS
w8 Instance<1B> -> Output: status<5B>
Id: 9 IPS_SWITCH_API_SET_ALL_CHANNEL_STATUS
w9 Instance<1B> ChanBitmap<1B> -> Output: status<4B>
Id: 10 IPS_SWITCH_API_GET_CHANNEL_FREQ
w10 Instance<1B> ChanId<1B> -> Output: status<6B>
Id: 11 IPS_SWITCH_API_SET_CHANNEL_FREQ
w11 Instance<1B> ChanId<1B> Freq<2B> -> Output: status<4B>
Id: 12 IPS_SWITCH_API_GET_CHANNEL_DC
w12 Instance<1B> ChanId<1B> -> Output: status<5B>
Id: 13 IPS_SWITCH_API_SET_CHANNEL_DC
w13 Instance<1B> ChanId<1B> DutyCycle<1B> -> Output: status<4B>
Id: 14 IPS_SWITCH_API_GET_PWM_ENABLE
w14 Instance<1B> ChanId<1B> -> Output: status<5B>
Id: 15 IPS_SWITCH_API_SET_PWM_ENABLE
w15 Instance<1B> ChanId<1B> PwmEnable<1B> -> Output: status<4B>
Id: 17 IPS_SWITCH_API_GET_CTRL_PIN_STATUS
w17 Instance<1B> CtrlPinId<1B> -> Output: status<5B>
Id: 18 IPS_SWITCH_API_SET_CTRL_PIN_STATUS
w18 Instance<1B> CtrlPinId<1B> CtrlPinStatus<1B> -> Output: status<4B>
Id: 20 IPS_SWITCH_API_GETFAULTREGISTER
w20 Instance<1B> -> Output: status<5B>
Id: 21 IPS_SWITCH_API_QUEUECHANNELSTATUS
w21 Instance<1B> ChanId<1B> ChanStatus<1B> -> Output: status<4B>
Id: 22 IPS_SWITCH_API_QUEUEALLCHANNELSTATUS
w22 Instance<1B> ChanBitmap<1B> -> Output: status<4B>
Id: 23 IPS_SWITCH_API_SENDQUEUEDCHANNELSTATUS
w23 Instance<1B> -> Output: status<4B>
Id: 24 IPS_SWITCH_API_GETFAULTREGISTER_DAIYCHAIN
w24 Instance<1B> -> Output: status<6B>
    
```

- Step 6.** Initialize the device as first action using **w0** command, in Regular mode or in Daisy Chain mode, according with current hardware configuration:

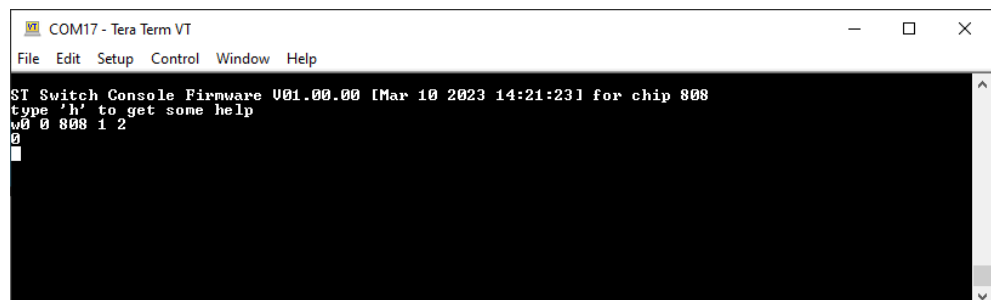
Figure 14. Device init in Regular mode



```

COM17 - Tera Term VT
File Edit Setup Control Window Help
ST Switch Console Firmware U01.00.00 [Mar 10 2023 14:21:23] for chip 808
type 'h' to get some help
w0 0 808 1 1
^
  
```

Figure 15. Device init in Daisy Chain mode



```

COM17 - Tera Term VT
File Edit Setup Control Window Help
ST Switch Console Firmware U01.00.00 [Mar 10 2023 14:21:23] for chip 808
type 'h' to get some help
w0 0 808 1 2
^
  
```

- Step 7.** Continue to interact with the device using commands from the available command list (see above).

- Note:**
- *Commands ID 7, 9 and 20 are available only in Regular mode*
 - *Commands ID 21, 22, 23 and 24 are available only in Daisy Chain mode*

Revision history

Table 1. Document revision history

Date	Revision	Changes
08-May-2023	1	Initial release.

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