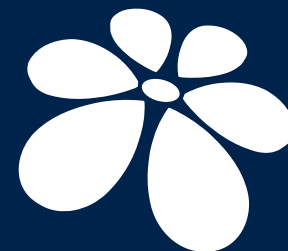




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# Quick Start Guide X-NUCLEO-OUT05A1

Industrial digital output expansion board based on  
IPS1025H for STM32 Nucleo



**STM32** Open  
Development  
Environment

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# X-NUCLEO-OUT05A1 expansion board

## Hardware overview 1/2

### Hardware Description

The X-NUCLEO-OUT05A1 industrial digital output expansion board for STM32 Nucleo provides a powerful and flexible environment for the evaluation of the driving and diagnostic capabilities of the IPS1025H (single high-side smart power solid state relay) in a digital output module connected to 2.5 A (max.) industrial loads.

The X-NUCLEO-OUT05A1 interfaces with the microcontroller on the STM32 Nucleo via 5 kV optocouplers driven by GPIO pins and Arduino UNO R3 (default configuration) and ST morpho (optional, not mounted) connectors. The expansion board can be connected to either a NUCLEO-F401RE or NUCLEO-G431RB development board.

It is also possible to evaluate a system composed by up to four stacked X-NUCLEO-OUT05A1 expansion boards.

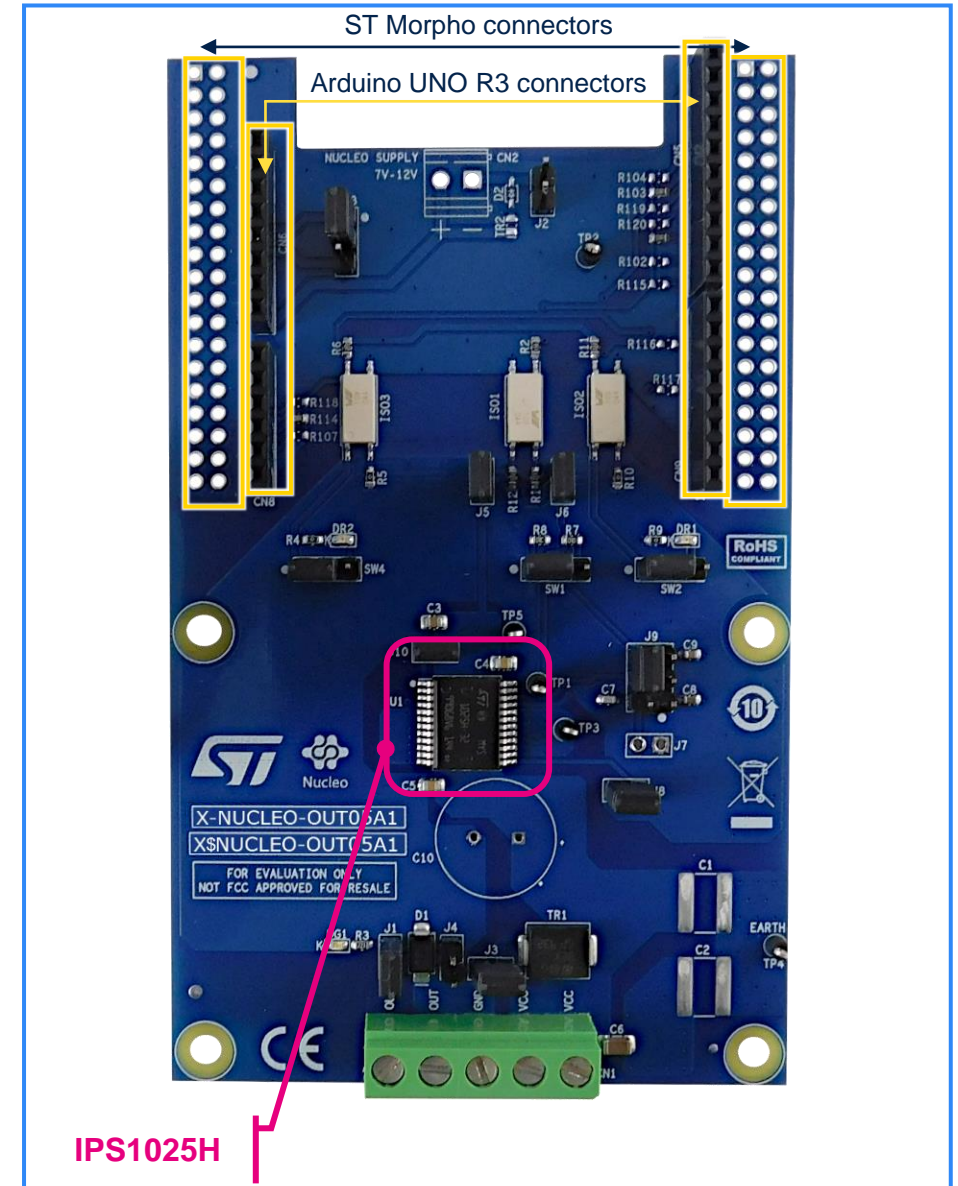
### Main Features:

- 4 X-NUCLEO-OUT05A1 expansion boards allows you to evaluate a four-channel digital output module with 2.5 A (max.) capability each
- Operating range up to 60 V/2.5 A
- Low power dissipation ( $R_{ON(MAX)} = 25\text{ m}\Omega$ )
- Fast decay for inductive loads
- Smart driving of capacitive load
- Under-voltage lock-out
- Overload and over-temperature protections
- PowerSSO24 package

### Key Products on the Nucleo expansion board:

#### IPS1025H

High Efficiency Single High Side Switch with extended diagnostic and smart driving for capacitive loads



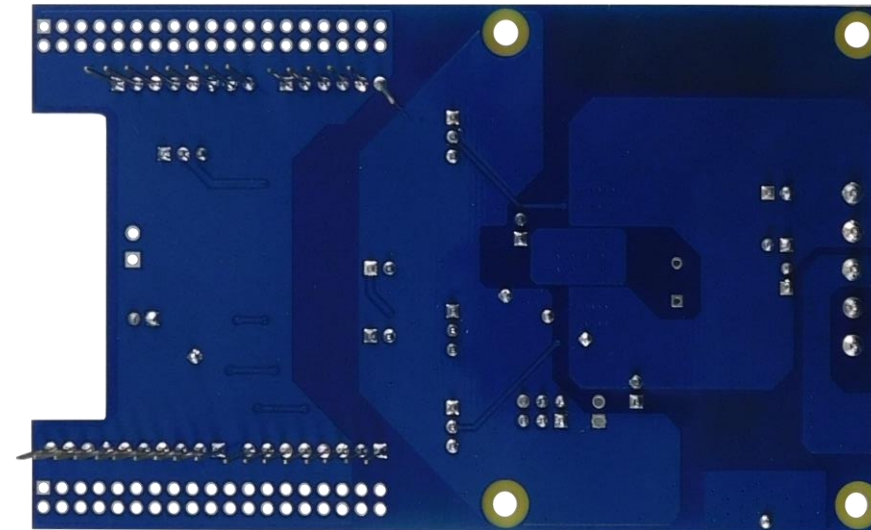
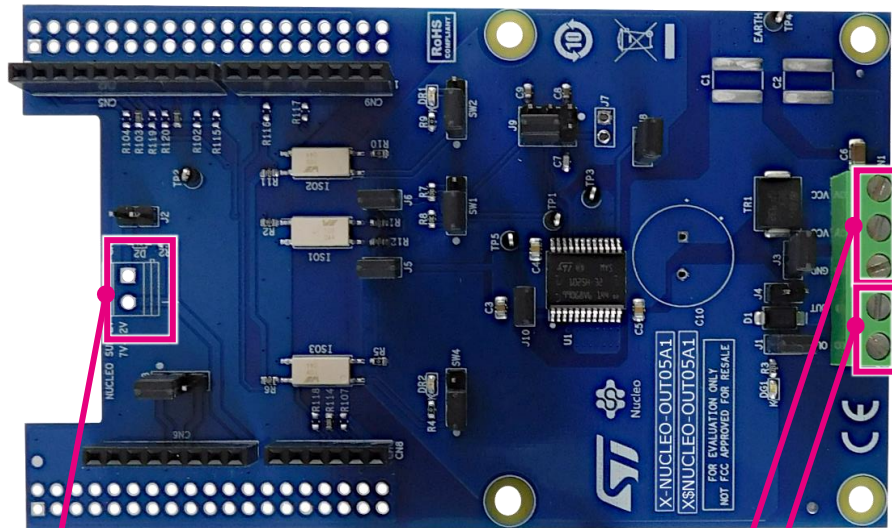


# X-NUCLEO-OUT05A1 expansion board

## Hardware overview 2/2

Top view

Bottom view



Alternate  
Nucleo supply

Analog supply

OUT

# X-CUBE-IPS software package

## SW architecture overview

### Software Description :

The X-CUBE-IPS expansion software package for STM32Cube runs on the STM32 microcontroller and includes a driver to control the expansion boards hosting Intelligent Power Switches ICs.

The software provides an affordable and easy-to-use solution for the development of single, dual, quad and octal digital output modules for 0.7A, 1.0A, 2.5 A and 5.7A applications, letting you easily evaluate the driving and diagnostic capabilities of the Intelligent Power Switches.

The expansion is built on STM32Cube software technology to ease portability across different STM32 microcontrollers. It is compatible with NUCLEO-F401RE or NUCLEO-G431RB development boards.

### Key Features:

- Sample application to evaluate a single channel digital output module by stacking X-NUCLEO-OUT05A1 or X-NUCLEO-OUT06A1. The software also uses a PWM timer to generate the periodic patterns on the output channel for the expansion boards.
- Sample application to interact with the STSW-IFAPGUI PC Software.

### Applications & demonstrations

Smart Driving Example

### Hardware Abstraction

STM32Cube Hardware Abstraction Layer (HAL)

### Hardware

STM32 Nucleo/STEVAL expansion boards

Nucleo

OUT03A1, OUT04A1, OUT05A1, OUT06A1, OUT08A1,  
OUT09A1, OUT10A1, OUT11A1, OUT12A1, OUT13A1,  
OUT14A1, OUT15A1, OUT19A1

STM32 Nucleo developer boards  
NUCLEO-F4/G4

Latest info available at [www.st.com](http://www.st.com)  
**X-CUBE-IPS**

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# Demo Example: Bill Of Material

HW pre-requisites

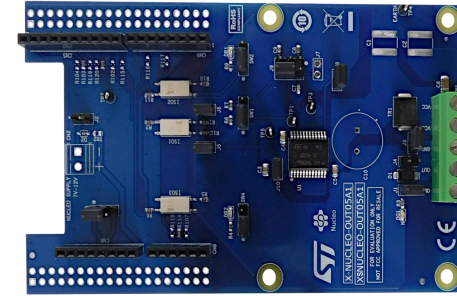
- 1x *description* expansion board (X-NUCLEO-OUT05A1)
- 1x STM32 Nucleo development board of **NUCLEO-F401RE, NUCLEO-G431RB**
- 1x USB type A to mini-B cable (for NUCLEO-F401RE)  
or  
1x USB type A to micro-B cable (for NUCLEO-G431RB)
- 1x Laptop/PC with Windows 7, 8 or above



A to mini-B  
USB Cable



A to micro-B  
USB Cable

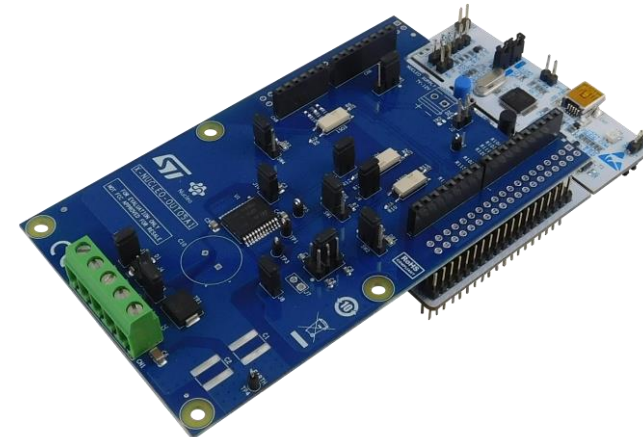


X-NUCLEO-OUT05A1

+





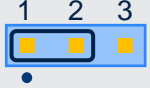
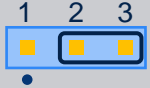
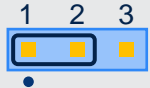
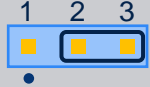
NUCLEO-F401RE or  
NUCLEO-G431RB



NUCLEO  
stacked solution

# Hardware setup

## Jumpers' configuration

J1		to drive the DG1 green LED (OUT)
		To disable the path to DG1
SW2		to route FLT1 signal from device to MCU only
		to drive the DR1 red LED only
SW4		to route FLT2 signal from device to MCU only
		to drive the DR2 red LED only



# Demo Example: software tools

## SW pre-requisites

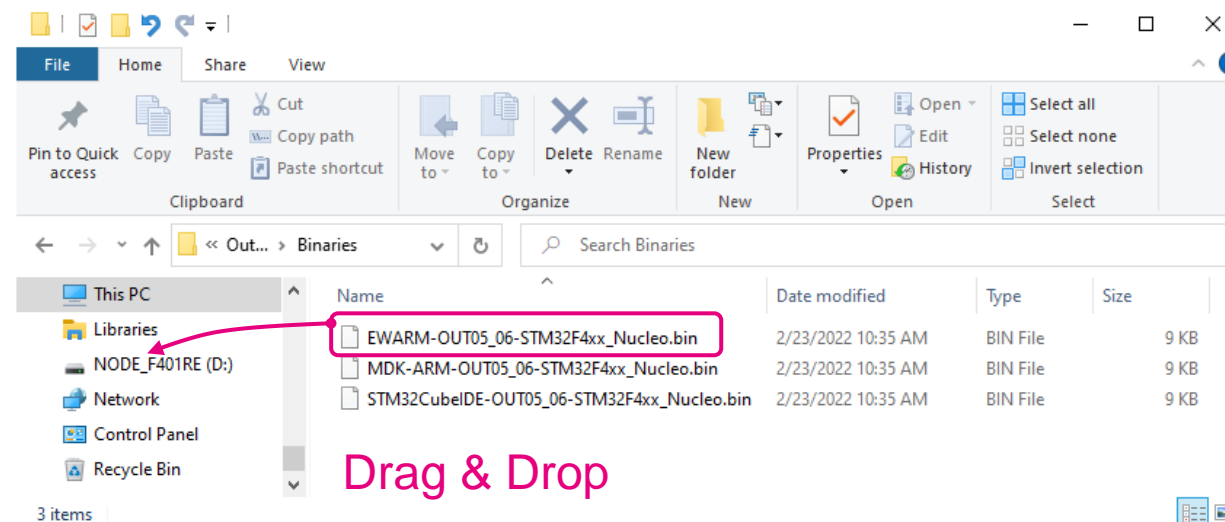
- STM32CubeProg: All-in-one multi-OS software tool for programming STM32 products or STSW-LINK009: ST-LINK/V2-1 (NUCLEO-F401RE), ST-LINK/V3 (NUCLEO-G431RB) USB driver
- X-CUBE-IPS: software package including the application examples for NUCLEO-F401RE, NUCLEO-G431RB to be associated with the X-NUCLEO-OUT03A1, X-NUCLEO-OUT04A1, X-NUCLEO-OUT05A1, X-NUCLEO-OUT06A1, X-NUCLEO-OUT08A1, X-NUCLEO-OUT09A1, X-NUCLEO-OUT10A1, X-NUCLEO-OUT11A1, X-NUCLEO-OUT12A1, X-NUCLEO-OUT13A1, X-NUCLEO-OUT14A1, X-NUCLEO-OUT15A1, X-NUCLEO-OUT19A1

# Demo Examples for different operating modes

X-NUCLEO-OUT05A1 comes with 2 demo FW binary sets (per nucleo board)

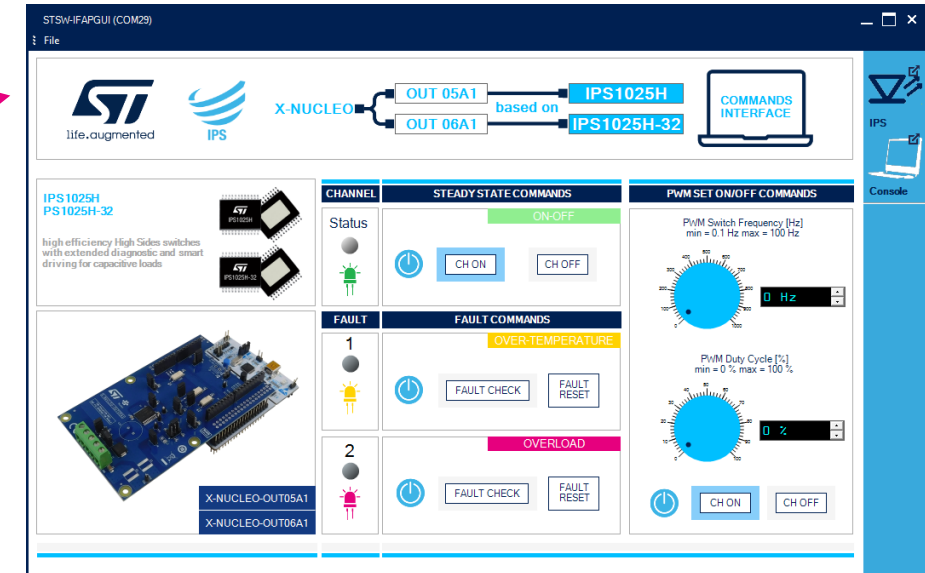
- Application example binaries for the three reference IDEs in the package X-CUBE-IPS
  - EWARM-OUT05\_06-STM32F4xx\_Nucleo.bin
  - MDK-ARM-OUT05\_06-STM32F4xx\_Nucleo.bin
  - STM32CubeIDE-OUT05\_06-STM32F4xx\_Nucleo.bin
- Application example binaries (per nucleo boards) compatible with STSW-IFAPGUI
  - STSW-OUT5F4
  - STSW-OUT5G4

Once the Nucleo board is plugged into the PC, a USB\_STORAGE like device is detected, the FW binary can be programmed into the Nucleo board by just a drag & drop operation



# Interact with the STSW-IFAPGUI

- The Firmware binaries STSW-OUT5F4.bin and STSW-OUT5G4.bin allow the interaction of the X-NUCLEO-OUT05A1 with a SW application running on PC (STSW-IFAPGUI).
- The SW app (STSW-IFAPGUI) is available for free download at the following [link](#).
- For the usage of the STSW-IFAPGUI, please refer to the document available at: <https://www.st.com/en/embedded-software/stsw-ifapgui.html#documentation>



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# Documents & related resources

All documents are available in the **DOCUMENTATION** tab of the related products webpage

## X-NUCLEO-OUT05A1:

- **DB4211:** Industrial digital output expansion board based on IPS1025H for STM32 Nucleo – **Data Brief**
- **UM2865:** Getting started with X-NUCLEO-OUT05A1 industrial digital output expansion board for STM32 Nucleo – **User Manual**
- Schematics, Gerber files, BOM

## X-CUBE-IPS

- **DB4735:** Software expansion for STM32Cube driving industrial digital output based on IPS – **Data Brief**
- **UM3035:** Getting started with X-CUBE-IPS industrial digital output software for STM32 Nucleo – **User Manual**

## STSW-IFAPGUI

- **DB3775:** Graphical user interface for the industrial IPS expansion boards for STM32 Nucleo – **Data Brief**
- **UM2509:** Getting started with the graphical user interface for the industrial IPS expansion boards for STM32 Nucleo – **User Manual**

## STSW-OUT5F4

- **DB4681:** Evaluation firmware for NUCLEO-F401RE enabling STSW-IFAPGUI on X-NUCLEO-OUT05A1 and X-NUCLEO-OUT06A1 expansion boards – **Data Brief**

## STSW-OUT5G4

- **DB4687:** Evaluation firmware for NUCLEO-G431RB enabling STSW-IFAPGUI on X-NUCLEO-OUT05A1 and X-NUCLEO-OUT06A1 expansion boards – **Data Brief**



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# STM32 ODE Ecosystem

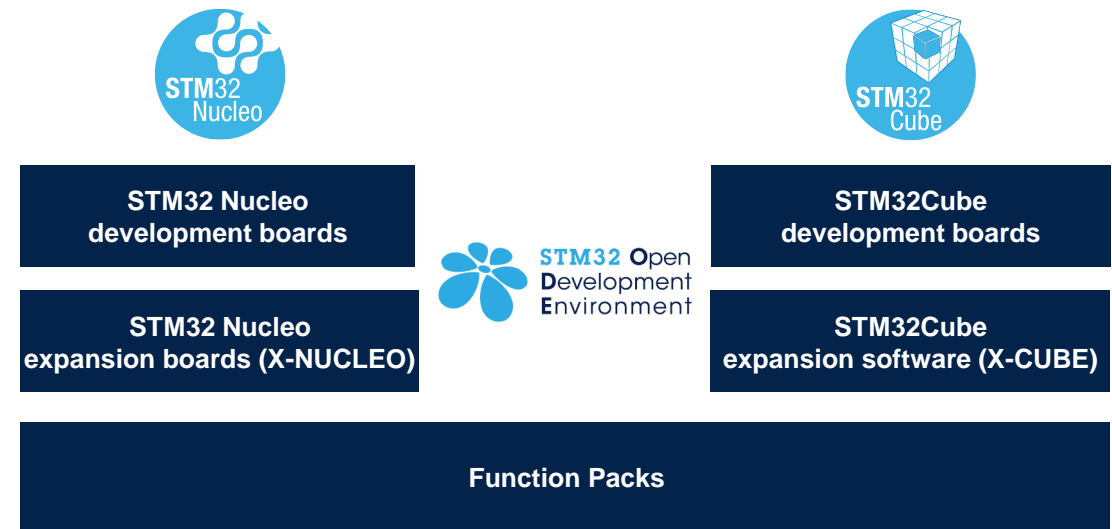
## FAST, AFFORDABLE PROTOTYPING AND DEVELOPMENT

The STM32 Open Development Environment (ODE) is an **open, flexible, easy** and **affordable** way to develop innovative devices and applications based on the STM32 32-bit microcontroller family combined with other state-of-the-art ST components connected via expansion boards. It enables fast prototyping with leading-edge components that can quickly be transformed into final designs.

The STM32 ODE includes the following five elements:

- STM32 Nucleo development boards. A comprehensive range of affordable development boards for all STM32 microcontroller series, with unlimited unified expansion capability, and with integrated debugger/programmer
- STM32 Nucleo expansion boards. Boards with additional functionality to add sensing, control, connectivity, power, audio or other functions as needed. The expansion boards are plugged on top of the STM32 Nucleo development boards. More complex functionalities can be achieved by stacking additional expansion boards
- STM32Cube software. A set of free-of-charge tools and embedded software bricks to enable fast and easy development on the STM32, including a Hardware Abstraction Layer, middleware and the STM32CubeMX PC-based configurator and code generator
- STM32Cube expansion software. Expansion software provided free of charge for use with STM32 Nucleo expansion boards, and compatible with the STM32Cube software framework
- STM32Cube Function Packs. Set of function examples for some of the most common application cases built by leveraging the modularity and interoperability of STM32 Nucleo development boards and expansions, with STM32Cube software and expansions.

The STM32 Open Development Environment is compatible with a number of IDEs including IAR EWARM, Keil MDK, mbed and GCC-based environments.



# STM32 Open Development Environment: all that you need

The combination of a broad range of expandable boards based on leading-edge commercial products and modular software, from driver to application level, enables fast prototyping of ideas that can be smoothly transformed into final designs.

To start your design:

- Choose the appropriate STM32 Nucleo development board (MCU) and expansion (X-NUCLEO) boards (sensors, connectivity, audio, motor control etc.) for the functionality you need
- Select your development environment (IAR EWARM, Keil MDK, and GCC-based IDEs) and use the free STM32Cube tools and software.
- Download all the necessary software to run the functionality on the selected STM32 Nucleo expansion boards.
- Compile your design and upload it to the STM32 Nucleo development board.
- Then start developing and testing your application.

Software developed on the STM32 Open Development Environment prototyping hardware can be directly used in an advanced prototyping board or in an end product design using the same commercial ST components, or components from the same family as those found on the STM32 Nucleo boards.

