

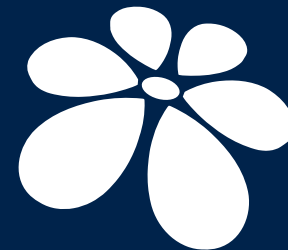


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# Quick Start Guide X-NUCLEO-DO40A1

Industrial digital output expansion board based on  
IPS4140HQ for STM32 Nucleo

V. 1.0



**STM32 Open  
Development  
Environment**

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STM32 Open Development Environment: Overview

# X-NUCLEO-DO40A1 expansion board

## Hardware overview 1/2

### Hardware Description

The X-NUCLEO-DO40A1 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 IPS4140HQ (Quad High Side Switch, with per-channel diagnostic, overload and overtemperature protections) in a digital output module connected to 4x0.7 A industrial loads.

The galvanic isolation between the logic side and process side of the system is guaranteed by the isolation embedded in the STISO621. The expansion board can be connected to either a NUCLEO-F401RE or NUCLEO-G431RB development board.

By default, the application board is configured with the onboard LDO40LPU33 enabled to provide the VISO\_P rail from the 24V industrial supply. The VISO\_P rail is used both to pull-up the four open drain per-channel diagnostic pins of IPS4140HQ, and to supply the secondary side of the STISO621. Then on board TVS (U2) protects the whole application from surge pulse on the process side supply rail of the board (VCC) from the industrial supply rail.

The four onboard green LEDs allow the visual detection of the output stage activation/deactivation.

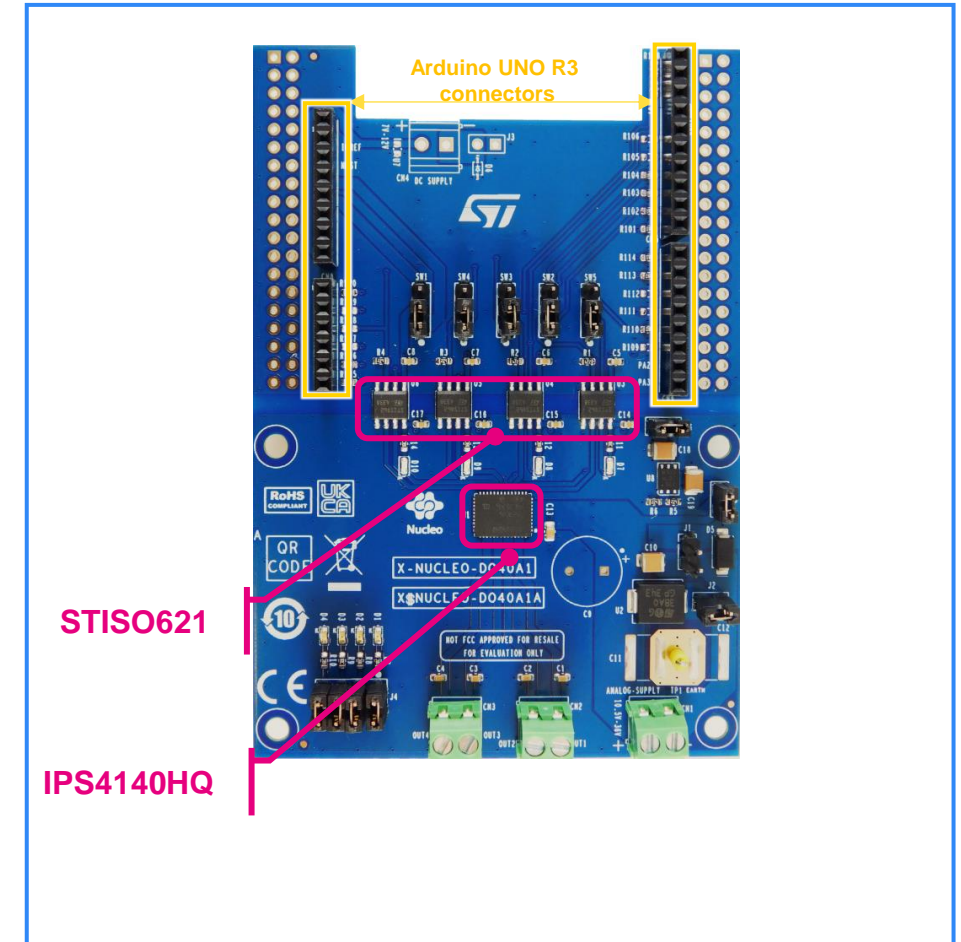
The four onboard red LEDs allow the visual detection of the overtemperature per-channel diagnostic.

The four driving signals, as well as the four diagnostic signals are available on the Arduino connectors and controlled/monitored through the companion X-CUBE-IPS software package.

It is also possible to evaluate a system composed by a X-NUCLEO-DO40A1 stacked on other expansion boards, provided the compatibility with signals mapped on Arduino connectors.

### Main Features:

- A single expansion board allows you to evaluate a quad-channel digital output module with 0.7A per-channel capability
- Operating range up to 30 V/2.8 A
- Low power dissipation ( $R_{ON(TYP)} = 80 \text{ m}\Omega$ )
- Fast decay for inductive loads
- Rise and fall time < 25us
- Overload and over-temperature protections
- Over temperature diagnostic
- 4x green LEDs for output channel status
- 4x red LEDs for over-temperature diagnostic
- UVLO
- QFN48L 8x6mm package



Key Products on the Nucleo expansion board:

**IPS4140HQ**

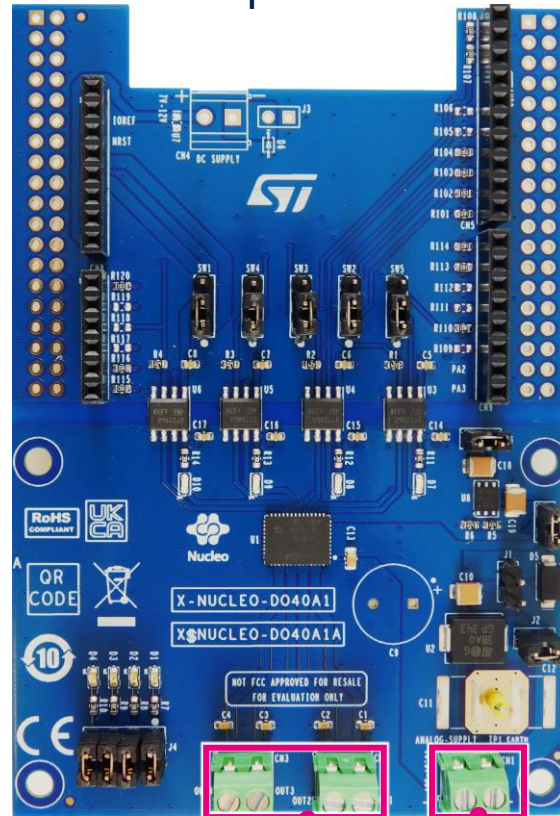
Quad High Side Switch with overload and over-temperature protections and per-channel diagnostic



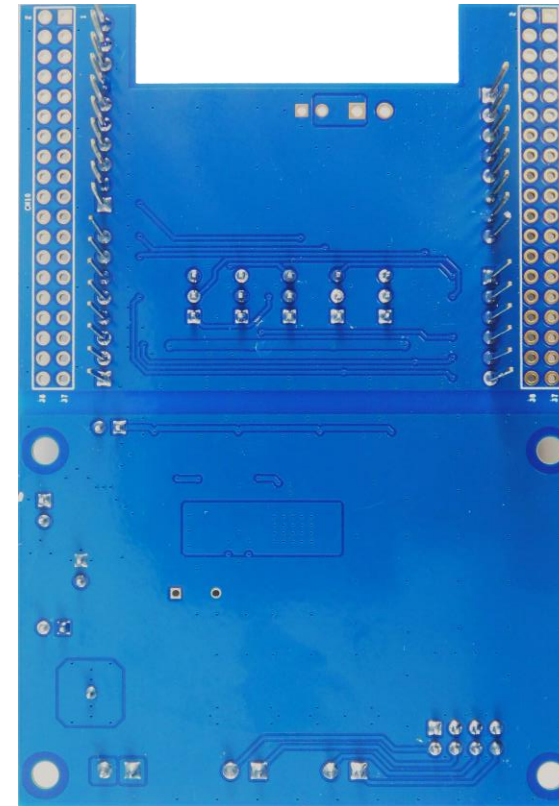
# X-NUCLEO-DO40A1 expansion board

## Hardware overview 2/2

Top view



Bottom view



Outputs

Analog  
supply

# 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 0.5A, 0.6A, 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 has been tested on NUCLEO-F401RE and NUCLEO-G431RB development boards and is also available as an STM32 Software Pack into STM32CubeMX to be compatible with any NUCLEO development board supported.

### Key Features:

- Sample application to evaluate basic digital output modules by stacking X-NUCLEO-DO40A1 and a NUCLEO development board. The software also uses a PWM timer to generate the periodic patterns on the output channel for the expansion boards.
- Up to 10kHz switching frequency of the driving signals
- Cumulative overload/over-temperature and Open Load diagnostic
- Per-channel overload diagnostic
- Sample application to interact with the STSW-IFAPGUI PC Software.

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

**Applications & demonstrations**

Smart Driving Example

**Hardware Abstraction**

STM32Cube Hardware Abstraction Layer (HAL)

**Hardware**

STM32 Nucleo/STEVAl expansion boards

**X-NUCLEO**

OUT01A2 , OUT02A1, OUT03A1, OUT04A1, OUT05A1, OUT06A1,  
OUT07A1, OUT08A1, OUT09A1, OUT10A1, OUT11A1, OUT12A1,  
OUT13A1, OUT14A1, OUT15A1, OUT16A1, OUT17A1, OUT19A1,  
DO40A1, DO41A1

STM32 Nucleo developer boards  
**NUCLEO-F4/G4**

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# Demo Example: Bill Of Material

HW pre-requisites

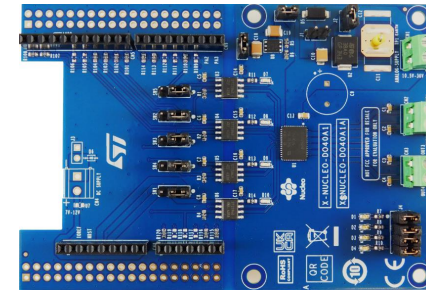
- 1x *description* expansion board:  
**X-NUCLEO-DO40A1**
- 1x STM32 Nucleo development board:  
**NUCLEO-F401RE, NUCLEO-G431RB**
- 1x USB type A to mini-B cable (for NUCLEO-F401RE)  
or  
1x USB type A to micro-B cable (for NUCLEO-G431RB)
- 1x Laptop/PC with Windows 7, 8 or above



A to mini-B  
USB Cable



A to micro-B  
USB Cable

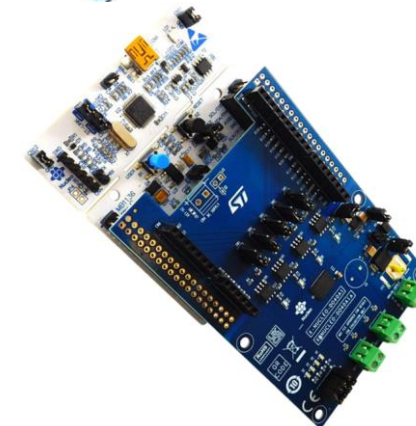


X-NUCLEO-DO40A1

+





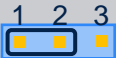
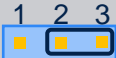








NUCLEO-F401RE or  
NUCLEO-G431RB



NUCLEO  
stacked solution

# Hardware setup

## Jumper and switches configuration

X-NUCLEO-DO40A1	VISO_L		IN1, IN2, IN3, STATUS1 = DEFAULT GPIO PORTS	IN1, IN2, IN3, STATUS1 = ALTERNATE GPIO PORTS	Disable Reverse Polarity Protection	Enable Surge Pulse Protection	Enable OUTX Status Green LEDs	Enable LDO40LPU33	Enable VISO_P
	3v3	5v0							
SW1									
SW2, SW3, SW4, SW5									
J1									
J2									
J4							   		
J5									
J6									



# Demo Example: software tools

## SW pre-requisites

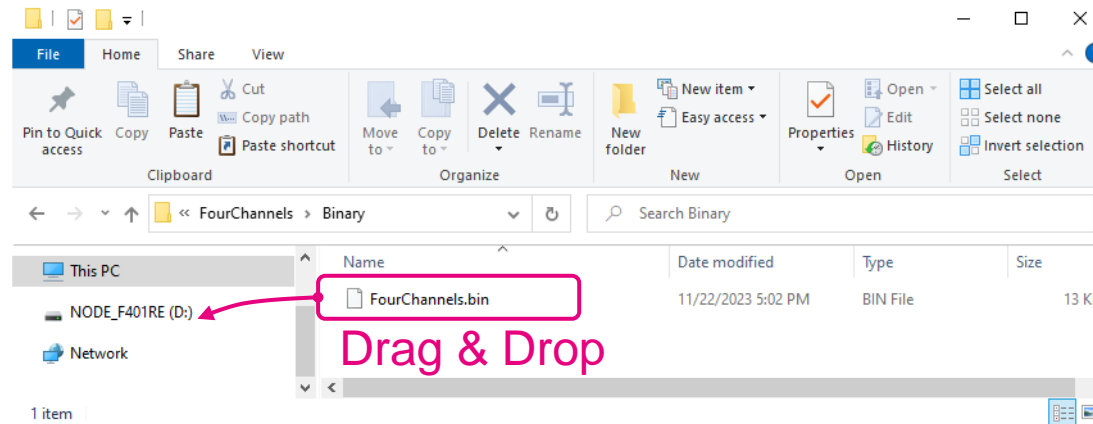
- STM32CubeProg: All-in-one multi-OS software tool for programming STM32 products or STSW-LINK009: ST-LINK/V2-1 (NUCLEO-F401RE), ST-LINK/V3 (NUCLEO-G431RB) USB driver
- X-CUBE-IPS: software package including the application examples for NUCLEO-F401RE, NUCLEO-G431RB to be associated with the:  
X-NUCLEO-OUT01A2 , X-NUCLEO-OUT02A1, X-NUCLEO-OUT03A1, X-NUCLEO-OUT04A1,  
X-NUCLEO-OUT05A1, X-NUCLEO-OUT06A1, X-NUCLEO-OUT07A1, 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-OUT16A1, X-NUCLEO-OUT17A1, X-NUCLEO-OUT19A1, X-NUCLEO-DO40A1,  
X-NUCLEO-DO41A1

# Demo Examples for different operating modes

X-NUCLEO-DO40A1 comes with two demo FW binary sets (per nucleo board)

- Application example binaries in the package X-CUBE-IPS
  - FourChannels.bin
- Application example binaries (per nucleo boards) compatible with STSW-IFAPGUI
  - STSW-DO40F4
  - STSW-DO40G4

Once the Nucleo board is plugged into the PC, an 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-DO40F4.bin and STSW-DO40G4.bin allow the interaction of the X-NUCLEO-DO40A1 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-DO40A1

- **DB5346:** Industrial digital output expansion board based on IPS4140HQ for STM32 Nucleo – **Data Brief**
- **UM3411:** Getting started with the X-NUCLEO-DO40A1 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 evaluation boards based on STM32 Nucleo – **Data Brief**
- **UM2509:** STSW-IFAPGUI, common graphical user interface for the expansion boards of Intelligent Power Switches – **User manual**

## STSW-DO40F4

- **DB5449:** Demonstration firmware for NUCLEO-F401RE enabling STSW-IFAPGUI on X-NUCLEO-DO40A1 and X-NUCLEO-DO41A1 expansion boards – **Data Brief**
- **UM3454:** Getting started with STSW-DO40F4 demonstration firmware for NUCLEO-F401RE enabling STSW-IFAPGUI on X-NUCLEO-DO40A1 and X-NUCLEO-DO41A1 expansion boards – **User manual**

## STSW-DO40G4

- **DB5450:** Demonstration firmware for NUCLEO-G431RB enabling STSW-IFAPGUI on X-NUCLEO-DO40A1 and X-NUCLEO-DO41A1 expansion boards – **Data Brief**
- **UM3467:** Getting started with STSW-DO40G4 demonstration firmware for NUCLEO-G431RB enabling STSW-IFAPGUI on X-NUCLEO-DO40A1 and X-NUCLEO-DO41A1 expansion boards – **User manual**



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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.

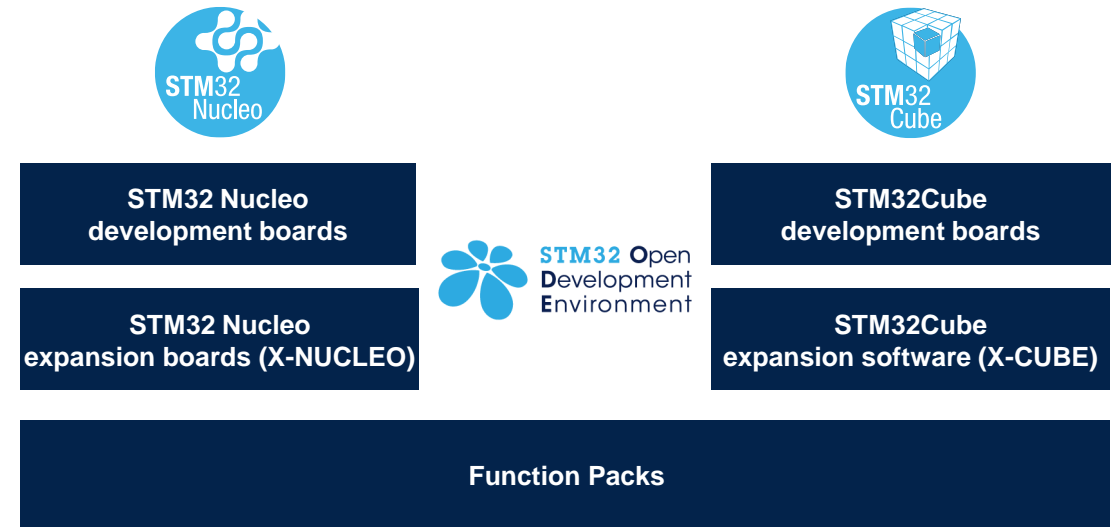
The STM32 ODE includes the following five elements:

- 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.



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# 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.

