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# Products and solutions for PLCs and smart I/Os



# Key products for PLCs and industrial I/Os

## INTRODUCTION

The programmable logic controller has evolved over the decades into a reliable, highly configurable, and safe device that interfaces human operators with 24V industrial buses.



The following ST product families open new application possibilities for designers through state-of-the-art technologies:

- Smart industrial input
- Smart industrial output
- I/Os for safe-ready automation
- MCUs and MPUs
- Devices for serial connectivity
- Protections
- Power management

We focus on helping our customers develop their applications with key products and reference designs. ST also provides supporting software packages like the [TouchGFX](#) software framework for developing HMIs and the [X-CUBE-STL](#) self-test library to address safety applications (SIL2 and SIL3) with STM32 microcontrollers.

# Product highlights

ST offers a full range of industrial grade ICs covered by our 10-year longevity commitment plan.



Input current limiters or current limiter terminations provide interfaces for 24V analog devices such as sensors, as well as 4-20mA digital logic devices running on 3.3V supplies. The [CLT03-2Q3](#) addresses 1- or 2-channel applications, even without any power supply. For IEC 61131-2 standard type 1 and 3 devices, this IC in a QFN 4.0 x 2.0 mm package offers high-side, low-side, and reverse polarity compatibility with 60V tolerance for safe-ready applications.

Regarding outputs, the following ICs feature robust and reliable performance for driving any kind of load (inductive, resistive, or capacitive).

The [ISO808](#) product family consists of eight galvanic isolated octal high-side drivers with different output ratings (0.7A or 1.0A), control input interfaces (parallel or serial), and packages (PowerSO-36 or TFQFPN32). It extends the intelligent power switch portfolio alongside the ISO8200 family.

The ICs are intended for driving any industrial load, with one side connected to ground (high-side switch). Each IC has two independent galvanic isolated voltage domains: VCC for the process stage and VDD for the control logic stage. The two stages communicate through the galvanic isolation channel using an ST proprietary protocol.

The ICs are suitable for 12 V and 24 V applications, with a wide 9.2 V to 36 V operating voltage range for the process stage and a breakdown voltage up to 45 V on the supply pin.

These ICs ensure 4kV galvanic isolation between the power and logic sides, so you do not need optocouplers in your design, which means you can reduce PCB space and cost. The SPI microcontroller interface (with daisy chaining), fast demagnetization of inductive loads, and comprehensive diagnostics and protections render these ICs ideal for PLC and remote I/O management in smart industry scenarios. The ICs are designed to meet IEC 61000-4-2/-4/-5/-8 and are certified UL1577 and UL508.

The high efficiency [IPS2050H](#), [IPS2050H-32](#), [IPS2050HQ](#), and [IPS2050HQ-32](#) high-side switches feature extensive diagnostics and smart driving for any kind of load with one side connected to ground. They have 2-channel capability and are suitable for applications with up to 2.4 A ([IPS2050H/HQ](#)) or 5.6 A ([IPS2050H-32/HQ-32](#)) steady state operating current. Their 8 to 60V operating supply voltage range can be aligned with various safety requirements. The choice of PowerSSO-24 and QFN48L packages ensures greater design flexibility.

Choosing the right microcontroller is a critical aspect of factory automation design. STM32 MCUs range from mainstream to ultralow power families, and the range also includes MPUs.

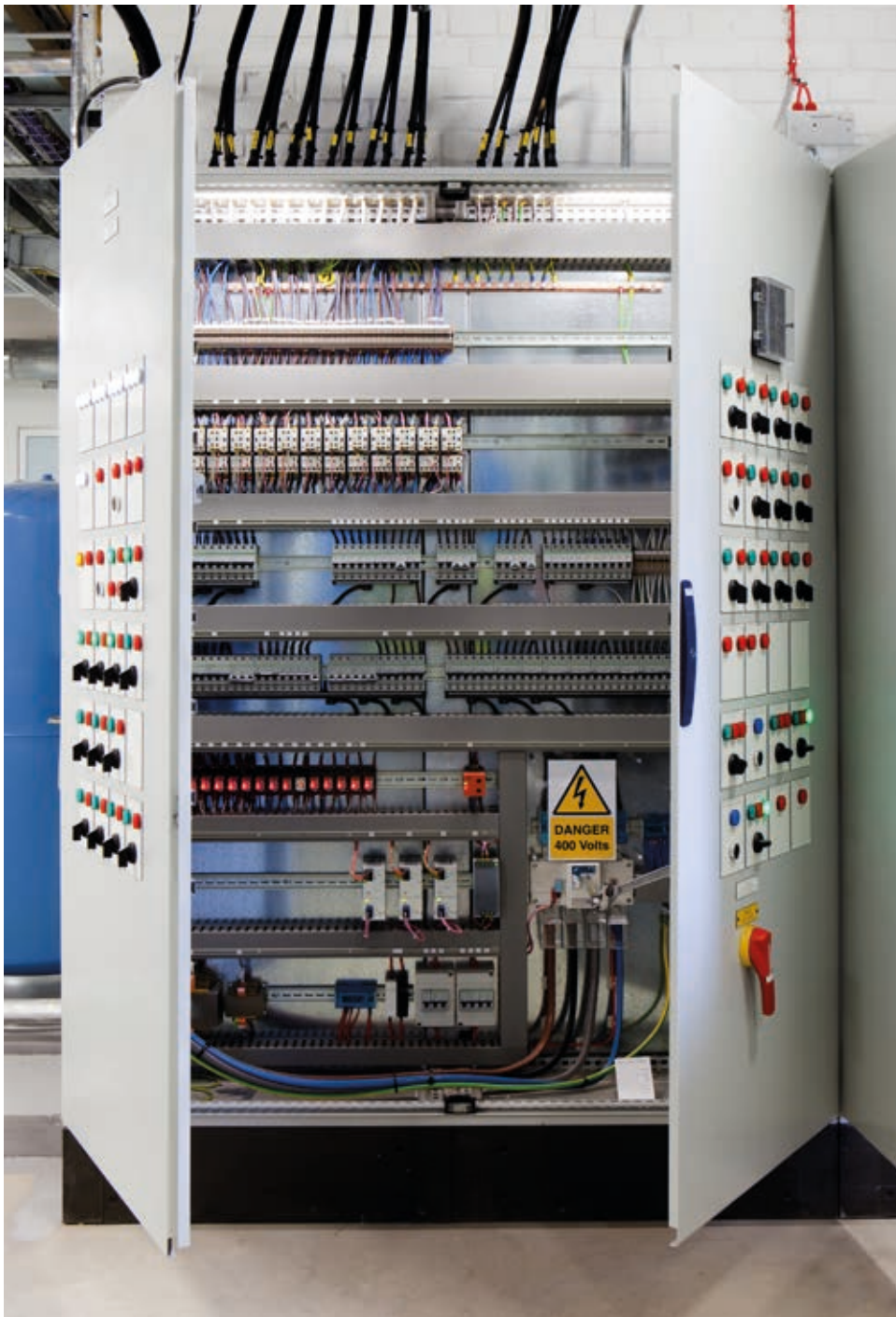




The [STM32H7](#) high-performance MCU is ideal for high-end PLC applications. It features a DSP with DP-FPU Arm® Cortex® M7 MCU, 2 MB of flash memory, a 480 MHz CPU, and provisions for RAM, L1 cache, and external memory to handle any factory floor application.

The microcontroller allows sophisticated HMI interfaces with an LCD-TFT controller up to XGA resolution and Chrom-ART graphical hardware accelerator. It is complete with over 20 timers and watchdogs, over 150 I/O ports, advanced embedded power management with USB and voltage regulators, and tens of communication peripherals from on-board serial communication to CAN, USB, and an Ethernet MAC interface.

STM32 also distinguishes itself for its massive ecosystem of development tools, resources, and community, available at [www.st.com](http://www.st.com).



## EVALUATION BOARDS AND REFERENCE DESIGNS FOR PLCs AND INDUSTRIAL I/Os

The following evaluation boards are based on the latest products for factory automation, with the mission profiles for PLCs, industrial I/O, and safety.

Sales code	Core devices	Brief description
<a href="#">STEVAL-PLC001V1</a>	STM32F746, CLT03-2Q3 CLT01-38SQ7, IPS4260L, ISO8200AQ	New design for industrial PLC and I/O applications featuring a powerful HMI interface with TouchGFX software.
<a href="#">STEVAL-SILPLC01</a>	STM32H723, CLT03-2Q3, IPS160HF, L7987L, IS0SD61	Evaluation board for factory automation applications that meet the safety integrity level (SIL) requirements.
<a href="#">STEVAL-IFP035V1</a>	CLT03-2Q3	Industrial digital input evaluation board on CLT03-2Q3 in a QLN16L package.
<a href="#">STEVAL-IFP040V1</a>	IPS1025HF	Industrial digital output expansion board based on IPS1025HF in a QFN48L package.
<a href="#">STEVAL-IFP043V1</a>	IPS2050H	Industrial digital output expansion board based on IPS2050H in a QFN48L package.
<a href="#">STEVAL-IFP044V1</a>	IPS2050H-32	Industrial digital output expansion board based on IPS2050H-32 in a QFN48L package.
<a href="#">STEVAL-IFP045V1</a>	IPS1025H	Industrial digital output expansion board based on IPS1025H in a QFN48L package.
<a href="#">STEVAL-IFP046V1</a>	IPS1025H-32	Industrial digital output expansion board based on IPS1025H-32 in a QFN48L package.
<a href="#">STEVAL-FSM01M1</a>	IPS160HF, IPS161HF, CLT03-2Q3	Fail-safe module evaluation board for factory automation
<a href="#">X-NUCLEO-OUT02A1</a>	ISO8200AQ	Industrial digital output expansion board based on ISO8200AQ for STM32 Nucleo.
<a href="#">X-NUCLEO-OUT03A1 (X-NUCLEO-OUT04A1)</a>	IPS2050H (IPS2050H-32)	Industrial digital output expansion board based on IPS2050H (IPS2050H-32) for STM32 Nucleo.
<a href="#">X-NUCLEO-OUT05A1 (X-NUCLEO-OUT06A1)</a>	IPS1025H (IPS1025H-32)	Industrial digital output expansion board based on IPS1025H (IPS1025H-32) for STM32 Nucleo.
<a href="#">X-NUCLEO-OUT08A1 (X-NUCLEO-OUT10A1)</a>	IPS160HF (IPS161HF)	Industrial digital output expansion board based on IPS160HF (IPS161HF) for STM32 Nucleo.
<a href="#">X-NUCLEO-OUT11A1</a>	ISO808	Industrial digital output expansion board based on ISO808.
<a href="#">X-NUCLEO-OUT12A1</a>	ISO808A	Industrial digital output expansion board based on ISO808A.
<a href="#">X-NUCLEO-OUT13A1</a>	ISO808-1	Industrial digital output expansion board based on ISO808-1.
<a href="#">X-NUCLEO-OUT14A1</a>	ISO808A-1	Industrial digital output expansion board based on ISO808A-1.
<a href="#">X-NUCLEO-OUT15A1</a>	IPS1025HF (PowerSSO 24 package)	Industrial digital output expansion board based on IPS1025HF for STM32 Nucleo.
<a href="#">X-NUCLEO-PLC01A1</a>	VNI8200XP, CLT01-38SQ7	Industrial input/output expansion board based on VNI8200XP and CLT01-38SQ7 for STM32 Nucleo.



[X-NUCLEO-OUT05A1](#)



[X-NUCLEO-PLC01A1](#)



[STEVAL-PLC001V1](#)

# STEVAL-PLC001V1 all-in-one PLC reference design

The [STEVAL-PLC001V1](#) is a 12 input/12 output PLC evaluation board with a powerful HMI for easy manipulation of the following industrial I/Os products and features:

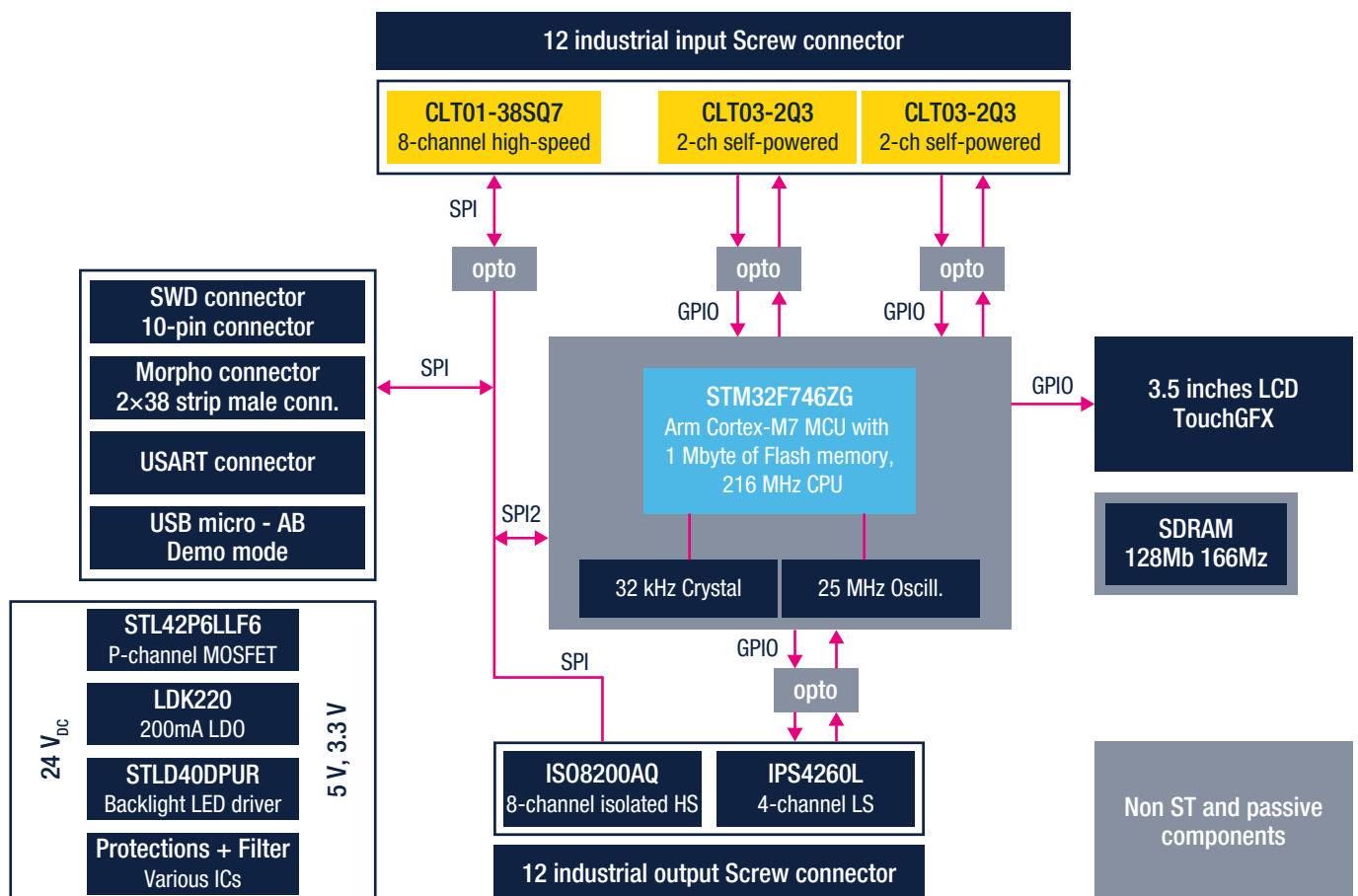
- [CLT01-38SQ7](#): managing 8 input lines ensuring protection and serialized state transfer
- [CLT03-2Q3](#): managing the remaining 4 inputs from 2 ICs, each with two independent, isolated channels
- [ISO8200AQ](#): 8 outputs in high-side configuration with 4 kV galvanic isolation embedded and SPI microcontroller interface
- [IPS4260L](#): 4 low-side channels with smart solid-state relay features.



The core of the system is the STM32F746 high-performance MCU with 32-bit ARM® Cortex®-M7 CPU with FPU, Chrom-ART Accelerator, and DSP instructions. The HMI is managed by the embedded TouchGFX software framework with the following features:

- I/O play mode
- Ladder logic
- Product show

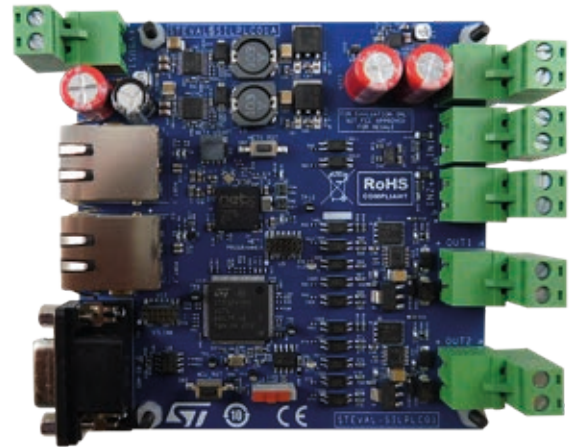
The [STSW-PLC001](#) companion software package, freely available on [www.st.com](http://www.st.com), allows experimenting with these advanced features.



# STEVAL-SILPLC01: safety-ready industrial PLC evaluation board

The **STEVAL-SILPLC01** features a powerful data processing unit that is based on the **STM32H723VG** microcontroller with Arm® Cortex®-M7 core, multiprotocol Ethernet real-time communication at a data rate of 100 Mbps, opto and galvanic isolation between the MCU side and digital actuation, and protections to improve the EMC robustness.

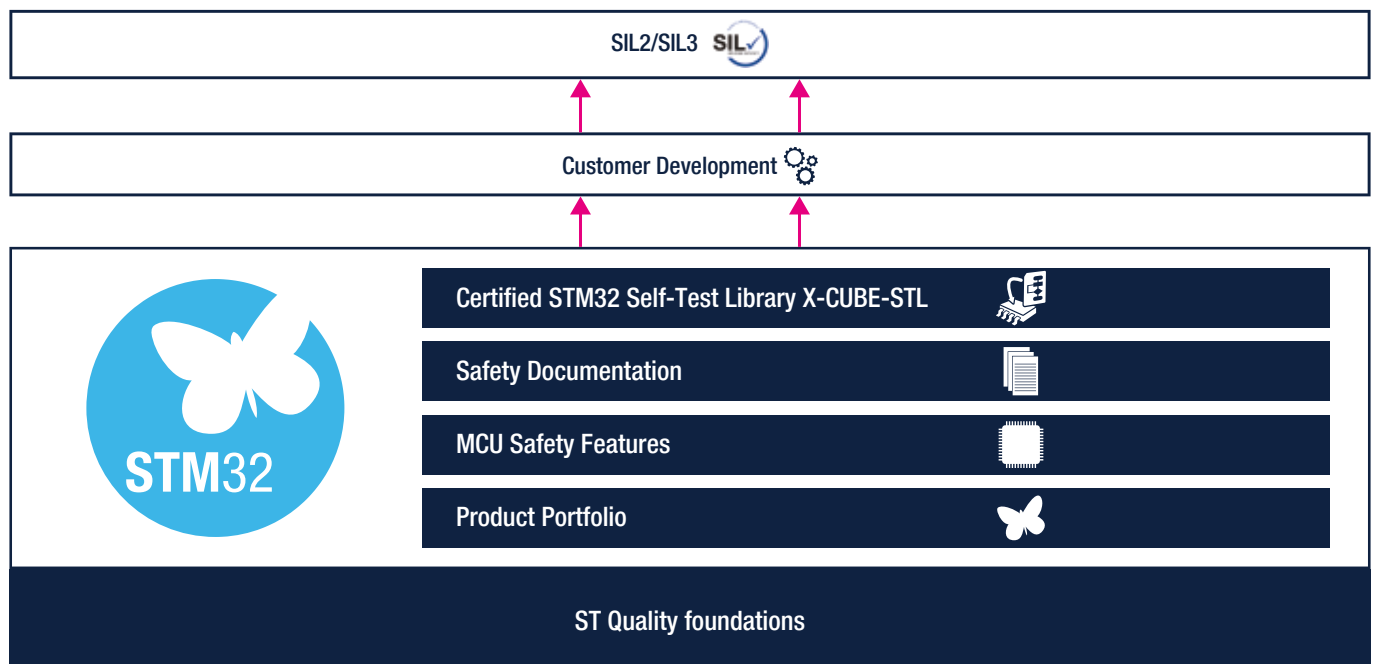
To meet the IEC61508 standard and other functional safety standards (EN 62061, EN/ISO 13849-1, and EN ISO 13849-2), both the hardware and the software include several safety mechanisms. These include circuits for detecting and offering protection against failure events such as short-circuits, undervoltage, overvoltage, and overtemperature. Another example is an output architecture to allow load driving according to the 1oo2 architecture established by the IEC61508, with redundancy capability on the output port.



The firmware integrates our **X-CUBE-STL** package for the development of safe-ready applications and certified by TÜV Rheinland, able to detect permanent failures affecting the STM32H7 CPU, RAM, and flash memory during normal operation.

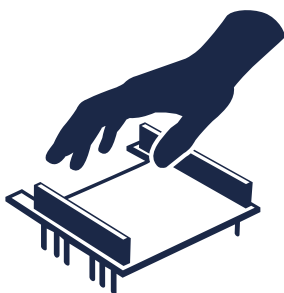
The hardware is designed to meet the SIL standards. It is officially assessed by TÜV Italia (TÜV SUD Group) in compliance with SIL 2/PL d requirements in accordance with IEC 61508, EN 62061, EN ISO 13849-1, and EN ISO 13849-2 standards.

## ACHIEVING SIL2/3 WITH STM32





# Expansion boards to facilitate industrial I/O module and PLC designs



Expansion boards allow designers to stack various hardware options on an STM32 Nucleo development board with suitable microcontroller and software as they shape the application mission profile.

The following boards feature the latest ST ICs for PLC and industrial I/O applications.

The [STEVAL-IFP045V1](#) (pictured here on a [NUCLEO-F401RE](#) development board) is an industrial digital output expansion board based on the [IPS1025H](#) in a QFN48L package.

The STEVAL-IFP045V1 can interface with the microcontroller on a [NUCLEO-F401RE](#) or [NUCLEO-G431RB](#) via 5 kV optocouplers driven by GPIO pins and Arduino R3 connectors.

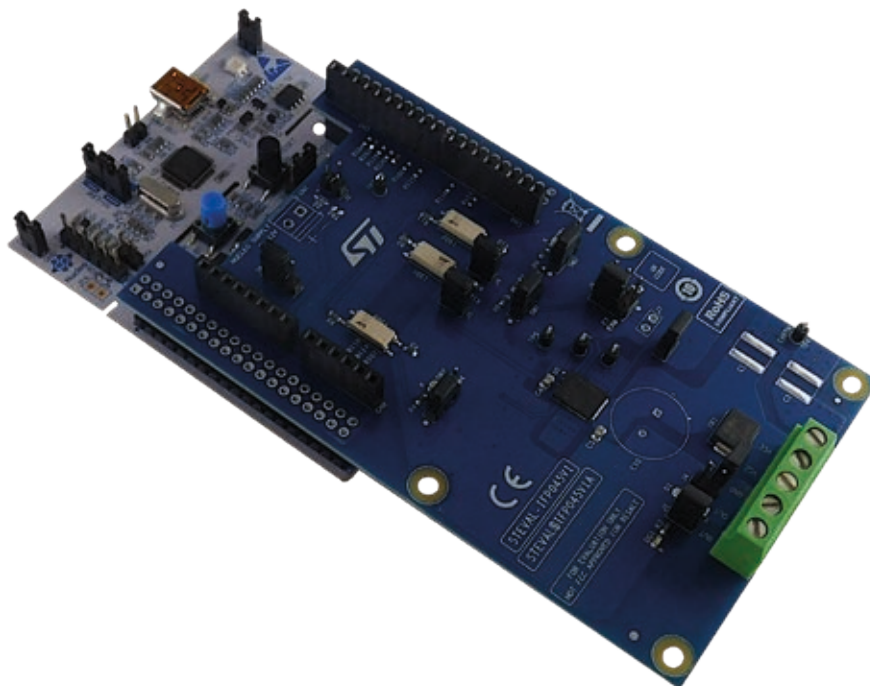
You can also evaluate a system with up to four stacked STEVAL-IFP045V1 expansion boards to evaluate a quad-channel digital output module.

It provides a powerful and flexible environment for evaluating 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 industrial loads.

The IPS1025H/HQ and IPS1025H-32/HQ-32 are single high-side switch ICs able to drive capacitive, resistive, or inductive loads with one side connected to ground.

The very low  $R_{DS(ON)}$  ( $\leq 25 \text{ m}\Omega$  up to  $T_J = 125^\circ\text{C}$ ) makes the IC suitable for applications with up to 2.4 A (IPS1025H/HQ) or 5.6 A (IPS1025H-32/HQ-32) steady-state operating current.

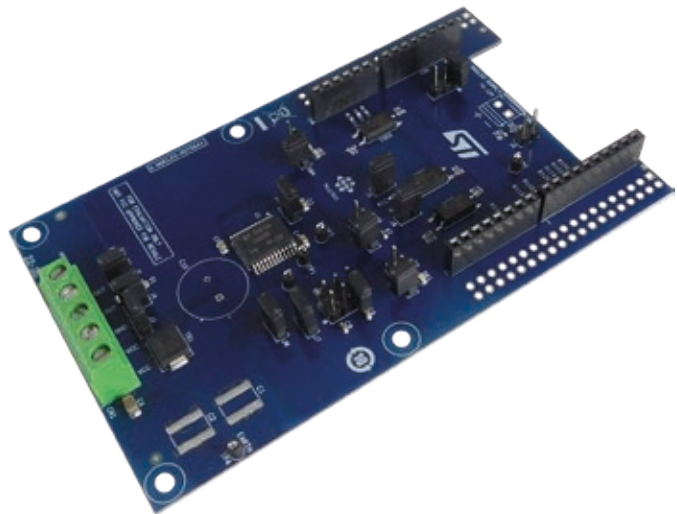
This family of ICs features 14 J single pulse avalanche energy.





The [X-NUCLEO-OUT06A1](#) provides a powerful and flexible environment for evaluating the driving and diagnostic capabilities of the [IPS1025H-32](#) single high-side smart power solid-state relay in a digital output module connected to 5.7 A industrial loads.

The expansion board interfaces with the microcontroller on the STM32 Nucleo via 5 kV optocouplers driven by GPIO pins and Arduino® UNO R3 connectors.



The expansion board can be connected to a [NUCLEO-F401RE](#) or [NUCLEO-G431RB](#) development board. It is also possible to evaluate a system with up to four stacked [X-NUCLEO-OUT06A1](#) expansion boards to evaluate a quad-channel digital output module.



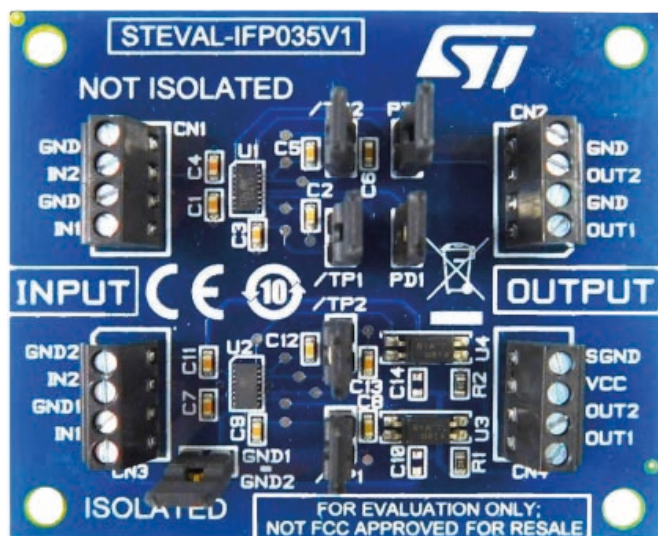
The [X-NUCLEO-OUT15A1](#) exposes the driving and diagnostic capabilities of the [IPS1025HF](#) single high-side, smart power, solid-state relay in a digital output module connected to 2.5 A industrial loads.

This expansion board interfaces with the microcontroller on the STM32 Nucleo via 5 kV optocouplers driven by the GPIO pins and Arduino® UNO R3 connectors.

The [X-NUCLEO-OUT15A1](#) can be connected to a [NUCLEO-F401RE](#) or a [NUCLEO-G431RB](#) development board. You can also evaluate a system with an [X-NUCLEO-OUT05A1](#) stacked on an [X-NUCLEO-OUT15A1](#) expansion board.

Supplying the [X-NUCLEO-OUT05A1](#) through the main supply rail and the [X-NUCLEO-OUT15A1](#) through the output of the [X-NUCLEO-OUT05A1](#), you can evaluate a single-channel digital output for safety systems. The process stages of the two expansion boards are cascaded. The load connected to the [X-NUCLEO-OUT15A1](#) output can be supplied only when both cascaded systems are operating properly.

The [STEVAL-IFP035V1](#) embeds two independent [CLT03-2Q3](#) self-powered digital input current limiters, one with two channels capable of isolated driving via opto-coupler (low-/high-side, reverse functionality), and one with nonisolated 3.3V (high side reverse blocking) digital input terminations to perform standalone evaluation. The test pulse feature can also be evaluated.

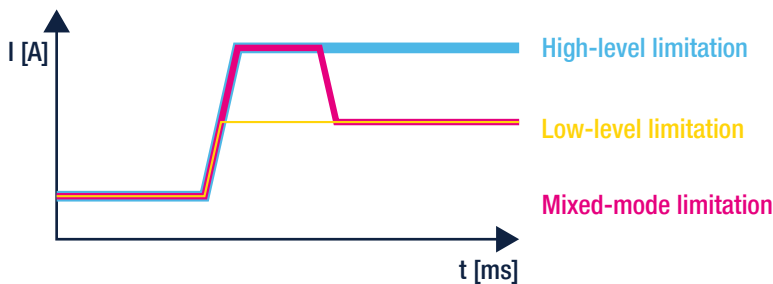


# Design tips

The CLT and IPS families for industrial input and industrial output management, together with specific STM32 MCUs for industrial applications, offers the developer a high degree of design flexibility to fulfill application requirements.

Designers will certainly appreciate the smart load management feature in our new IPS families [IPS2050H](#) (and [IPS2050H-32](#)) and equivalent single-channel [IPS1025H](#) (also [IPS1025H-32](#), [IPS1025HF](#), and respective QFN packages).

These two families of devices have three configurable operation modes to determine how the IC reacts to an overload event. The IC can be configured to limit the current and reduce power dissipation and component stress (low-level limitation indicated by the gray line below), or set to a higher current limitation level to allow loads with inrush currents (high-level limitation, blue line).



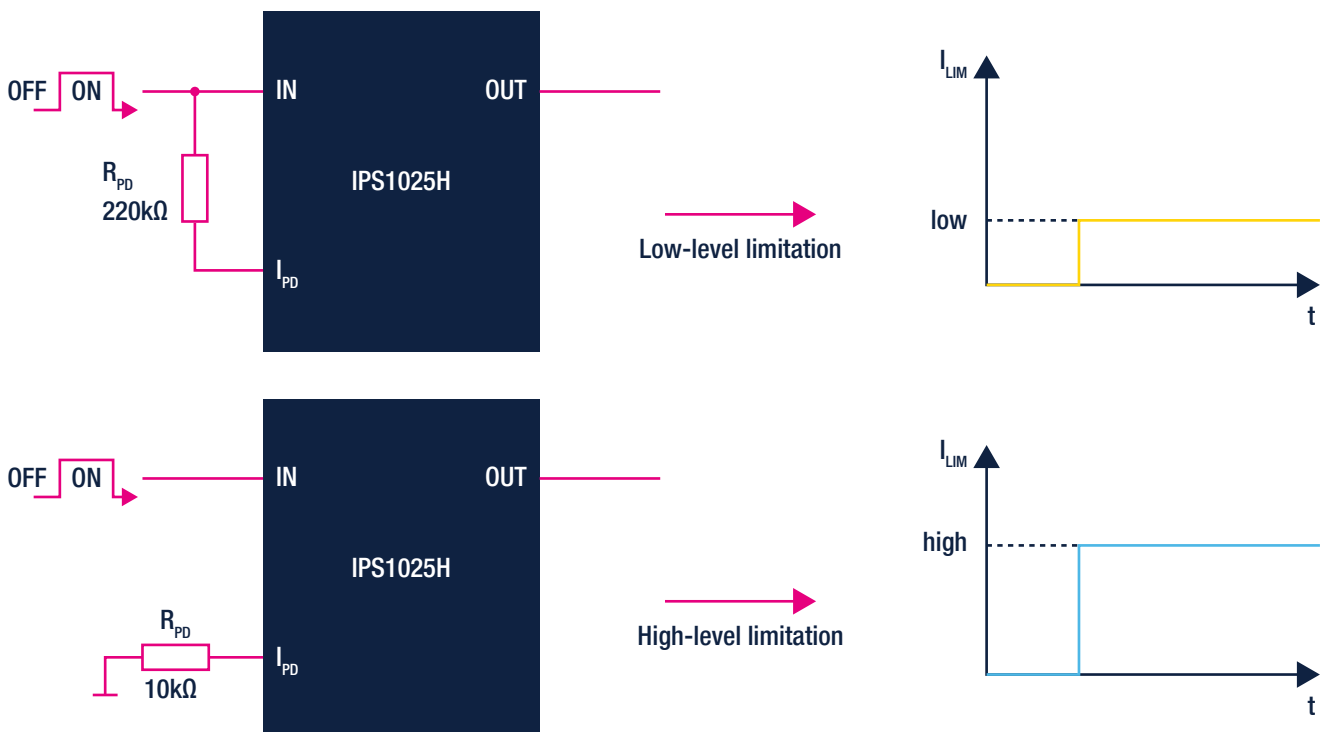
The mixed limitation mode (magenta line) combines the benefits of both high-level and low-level limitation. In this mode, the IC allows an initial high-level current before dropping to low-level limitation after a certain time (from 100  $\mu$ s to 100 ms).

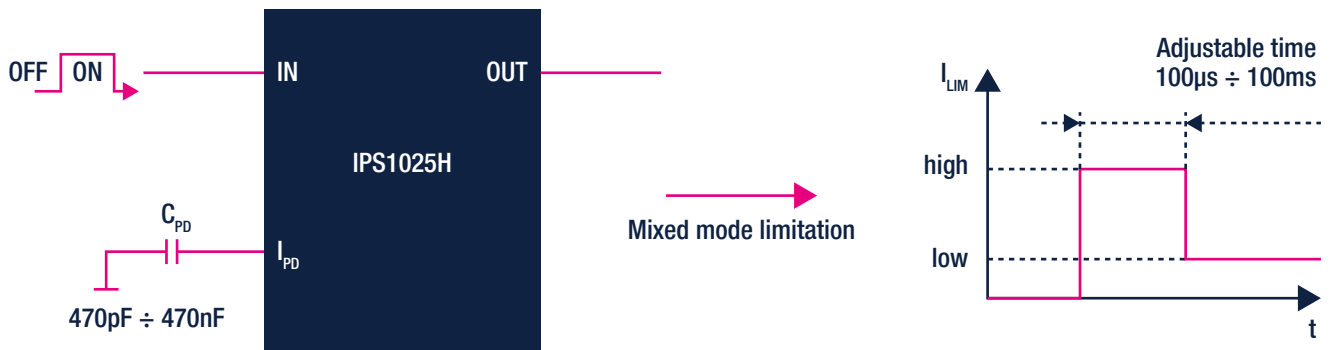
Using the IPS1025H as our example, the 3 modes can be implemented through the IN and IPD pins of the IC. We can set these two pins through external resistors and capacitors, but the most interesting option is to dynamically drive these pins with a microcontroller.

Consider the following settings for our example:

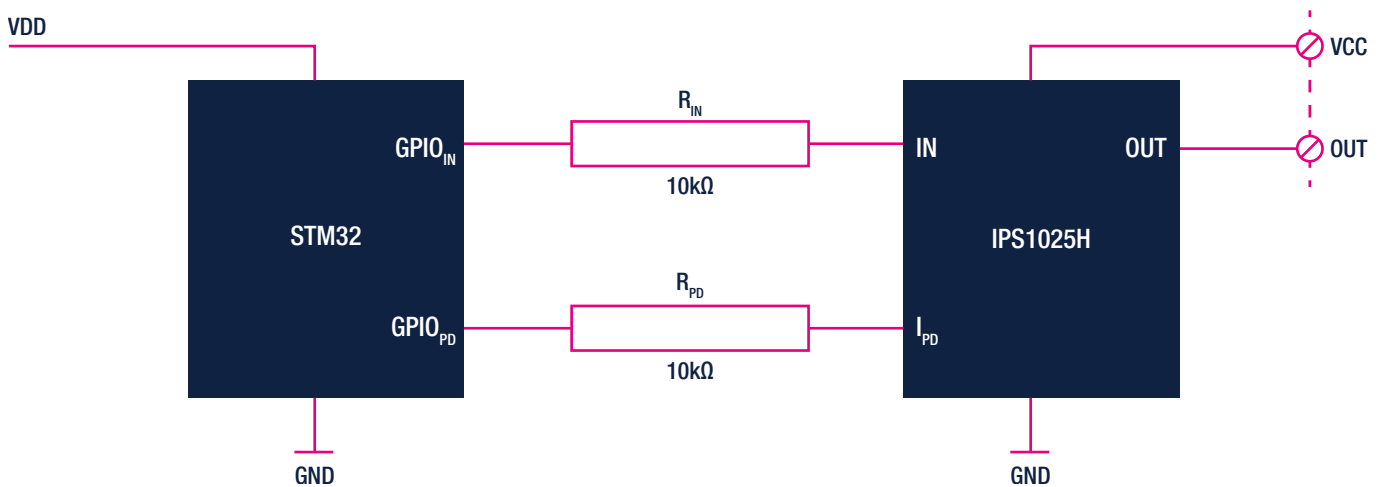
- Low-level limitation: a 220 k $\Omega$  resistor placed between IN and IPD pins
- High-level limitation: a pull-down resistor placed between IPD and ground
- Mixed-mode limitation: a pull-down capacitor placed between IPD and ground

In mixed-mode limitation, the duration of the limitation phase is determined by using different capacitor values between 470pF up to 470nF, considering  $D_{PK}[\mu s] = 215 * C_{PD}[nF]$ .





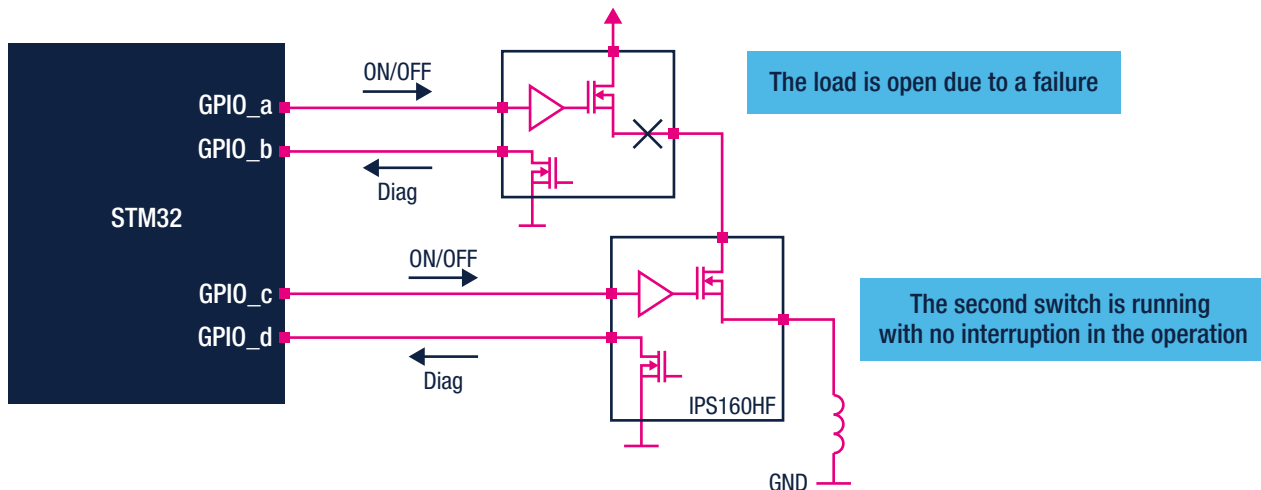
Dynamic configuration of the current limitation mode can be implemented through 2 dedicated GPIOs on the host microcontroller. This delivers excellent runtime flexibility by controlling the values on the pins via the firmware.



There are general guidelines for designing digital output (DO) modules in the industrial safety domain that are based on existing regulations like IEC61508. Some of them rely on simple circuit features like redundancy and minimal channel count (ideally one channel per module) to minimize the effects of spikes across the different lines.

In this respect, the single channel [IPS160H](#) and the faster [IPS160HF](#) implement a double PNP architecture (load connected between collector and ground) for an industrial load operating in high-side switch configuration to ensure system redundancy.

This PNP+PNP architecture allows the intervention of the second switch when the line is interrupted on the first switch. A simple MOSFET is actually sufficient for this operation, but the [IPS160H](#) and [IPS160HF](#) offer a rich set of diagnostics to determine the cause of any failures.



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Order code: **BR2303PLCIO**

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