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## Getting started with the FP-IND-IODSNS1 STM32Cube function pack for IO-Link industrial sensor node

### Introduction

FP-IND-IODSNS1 is an STM32Cube function pack which lets you enable IO-Link communication between P-NUCLEO-IOD02A1 kit and an IO-Link master through the L6364Q transceiver mounted on the X-NUCLEO-IOD02A1.

The function pack integrates an IO-Link demo-stack and the management of the industrial sensors mounted on the X-NUCLEO-IKS02A1.

FP-IND-IODSNS1 also includes the IODD file to be uploaded to your IO-Link master.

The software included in the package can be used in three integrated development environments (IDEs): IAR, KEIL and STM32CubeIDE.

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### Related links

*Visit the [STM32Cube ecosystem web page on www.st.com](http://www.st.com) for further information*

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# 1 FP-IND-IODSNS1 software expansion for STM32Cube

## 1.1 Overview

FP-IND-IODSNS1 is an STM32 ODE function pack and expands STM32Cube functionality.

The software package enables the IO-Link data transfer of industrial sensors on the X-NUCLEO-IKS02A1 to an IO-Link Master connected to the X-NUCLEO-IOD02A1.

The key package features are:

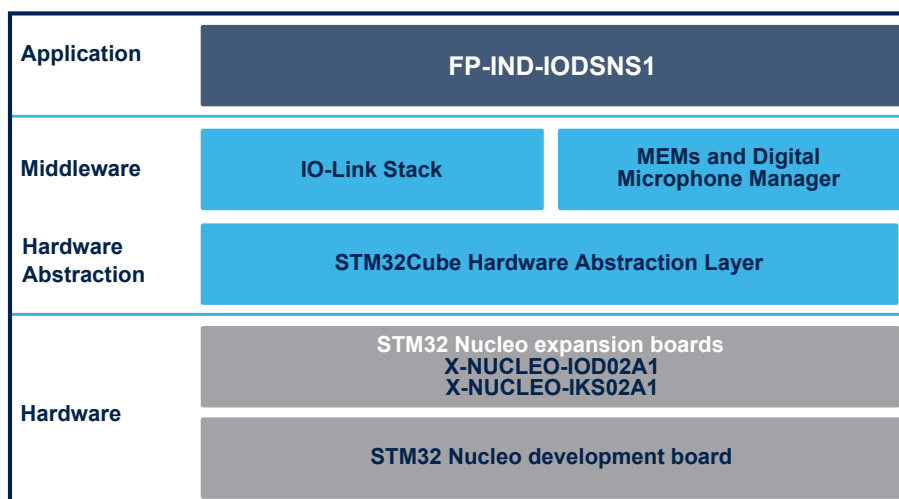
- Firmware package to build IO-Link device applications for STM32L452RE-based boards
- Middleware libraries featuring IO-Link device mini-stack for L6364Q and MEMS plus digital microphone management
- Ready-to-use binary for IO-Link device sensor data transmission
- Easy portability across different MCU families, thanks to STM32Cube
- Free, user-friendly license terms

## 1.2 Architecture

The application software accesses the X-NUCLEO-IKS02A1 and the X-NUCLEO-IOD02A1 expansion boards through the following software layers:

- the **STM32Cube HAL layer**, which provides a simple, generic, multi-instance set of application programming interfaces (APIs) to interact with the upper application, library and stack layers. It has generic and extension APIs and is directly built around a generic architecture and allows successive layers like the middleware layer to implement functions without requiring specific hardware configurations for a given microcontroller unit (MCU). This structure improves library code reusability and guarantees an easy portability on other devices.
- the **board support package (BSP)** layer, which supports all the peripherals on the STM32 Nucleo except the MCU. This limited set of APIs provides a programming interface for certain board-specific peripherals like the LED, the user button, etc. This interface also helps in identifying the specific board version.

Figure 1. FP-IND-IODSNS1 software architecture



## 1.3 Folder structure

Figure 2. FP-IND-IODSNS1 package folder structure



The following folders are included in the software package:

- **\_htmresc:** contains graphics for html documents
- **Documentation:** contains a compiled HTML help file generated from the source code detailing the software components and APIs (one for each project).
- **Drivers:** contains the HAL drivers and the board-specific drivers for each supported board or hardware platform, including those for the on-board components, and the CMSIS vendor-independent hardware abstraction layer for the ARM Cortex-M processor series.
- **Middlewares:** libraries and protocols featuring IO-Link mini-stack and sensors management.
- **Projects:** contains the sample application implementing an Industrial IO-Link multi-sensor node. This application is provided for the [NUCLEO-L452RE](#) platform with three development environments: IAR Embedded Workbench for ARM, MDK-ARM software development environment and [STM32CubeIDE](#).

## 1.4 APIs

Detailed technical information with full user API function and parameter description are in a compiled HTML file in the “Documentation” folder.

## 1.5 Sample application description

The sample application is provided in the Projects folder, using the [X-NUCLEO-IOD02A1](#) with the [L6364Q](#) transceiver and the [X-NUCLEO-IKS02A1](#) with the industrial MEMS and digital microphone.

Ready-to-build projects are available for multiple IDEs. You can upload one of the binary files provided in the [FP-IND-IODSNS1](#) via [STM32 ST-LINK Utility](#), [STM32CubeProgrammer](#) or the programming feature in your IDE.

To evaluate the [FP-IND-IODSNS1](#) firmware, it is necessary to upload the IODD file to the control tool of your IO-Link Master and connect it to the [X-NUCLEO-IOD02A1](#) by a 3-wire cable (L+, L-/GND, CQ). [Section 2.3](#) shows an example where the IO-Link Master is the [P-NUCLEO-IOM01M1](#) and the related control tool is the IO-Link Control Tool developed by TEConcept (ST partner). Alternatively, you can use another IO-Link Master with the related control tool.

## 2 System setup guide

### 2.1 Hardware description

#### 2.1.1 P-NUCLEO-IOD02A1 STM32 Nucleo pack

The P-NUCLEO-IOD02A1 is an STM32 Nucleo pack composed of the X-NUCLEO-IOD02A1 and X-NUCLEO-IKS02A1 expansion boards stacked on the NUCLEO-L452RE development board.

The X-NUCLEO-IOD02A1 features an IO-Link device transceiver for the physical connection to an IO-Link master, while the X-NUCLEO-IKS02A1 features a multi-sensor board for industrial applications, and the NUCLEO-L452RE features the necessary hardware resources to run the FP-IND-IODSNS1 function pack and to control the transceiver and multi-sensor boards.

The FP-IND-IODSNS1 combines an IO-Link demo stack library (derived from X-CUBE-IOD02) with the X-CUBE-MEMS1 and features an example of IO-Link device multi-sensor node.

The P-NUCLEO-IOD02A1 can be used for evaluation purpose and as development environment.

The STM32 Nucleo pack provides an affordable and easy-to-use solution for the development of IO-Link and SIO applications, evaluation of L6364Q communication features and robustness, together with the STM32L452RET6U computation performance.

Figure 3. P-NUCLEO-IOD02A1 STM32 Nucleo pack



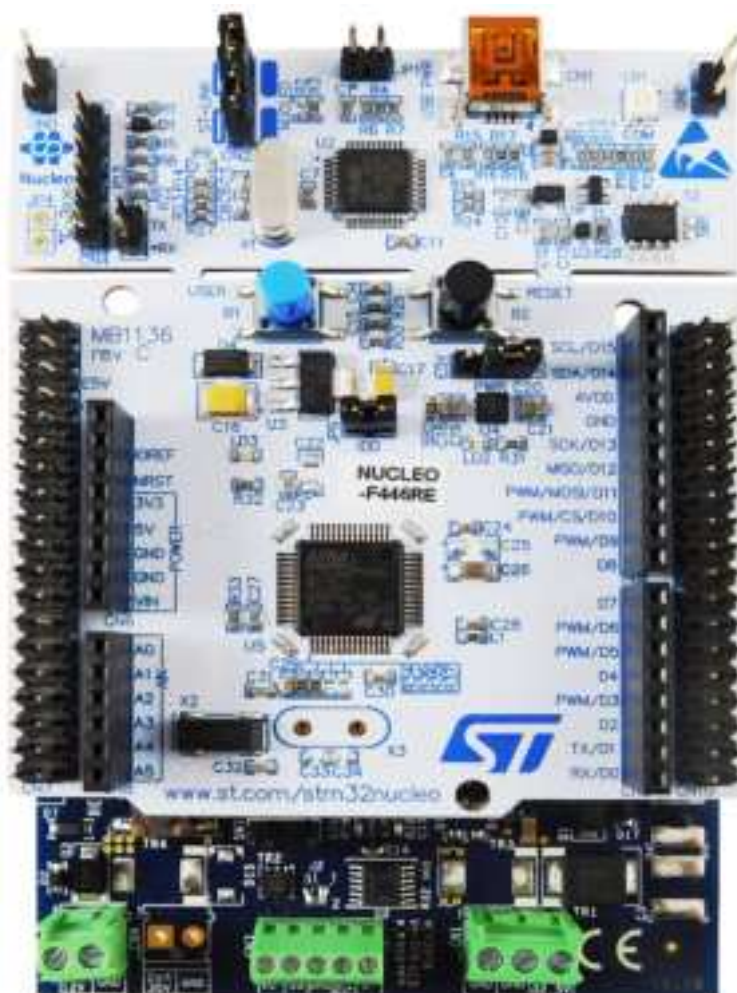
## 2.1.2 P-NUCLEO-IOM01M1 STM32 Nucleo pack

The P-NUCLEO-IOM01M1 is an STM32 Nucleo pack composed of the STEVAL-IOM001V1 and the NUCLEO-F446RE boards. The STEVAL-IOM001V1 is a single IO-Link master PHY layer (L6360) while the NUCLEO-F446RE runs an IO-Link stack rev 1.1 (developed by and property of TEConcept GmbH, license limited to 10k minutes, renewable without additional costs). IO-Link stack update is allowed exclusively by following the procedure described in UM2421 (freely available at [www.st.com](http://www.st.com)). Any other erase/overwrite of the pre-loaded stack makes impossible to restore it.

The STM32 Nucleo pack provides an affordable and easy-to-use solution for the evaluation of IO-Link applications, L6360 communication features and robustness, together with the STM32F446RET6 computation performance. The pack, hosting up to four STEVAL-IOM001V1 to build a quad port IO-Link master, can access the IO-Link physical layer and communicate with IO-Link Devices.

You can evaluate the tool via the dedicated GUI (IO-Link Control Tool®, property of TEConcept GmbH) or use it as an IO-Link master bridge accessible from the dedicated SPI interface: source code of demo project (Low-Level IO-Link Master Access Demo Application, developed by TEConcept GmbH) and API specification are available for free.

**Figure 4. P-NUCLEO-IOM01M1 STM32 Nucleo pack**



## 2.2 Hardware setup

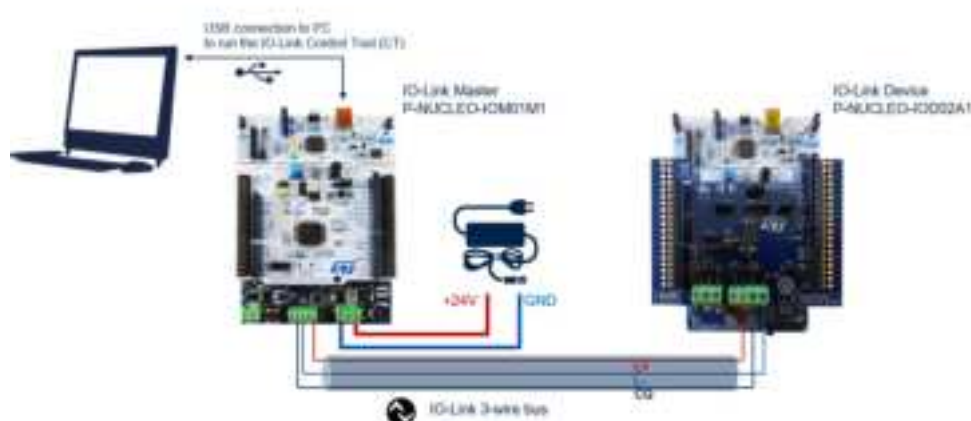
The following hardware components are needed:

1. One STM32 Nucleo pack for IO-Link device applications (order code: P-NUCLEO-IOD02A1)
2. One STM32 Nucleo pack for IO-Link master with IO-Link v1.1 PHY and stack (order code: P-NUCLEO-IOM01M1)
3. A 3-wire cable (L+, L-/GND, CQ)

## 2.3 How to control the P-NUCLEO-IOD02A1 IO-Link device through the P-NUCLEO-IOM01M1 IO-Link master

- Step 1.** Connect the P-NUCLEO-IOM01M1 and the P-NUCLEO-IOD02A1 via the 3-wire cable (L+, L-/GND and CQ- refer to the board serigraphy).
- Step 2.** Connect the P-NUCLEO-IOM01M1 to a 24 V/0.5 A power supply.  
The following figure shows how to connect the P-NUCLEO-IOM01M1 and the P-NUCLEO-IOD02A1 running the FP-IND-IODSNS1 firmware.

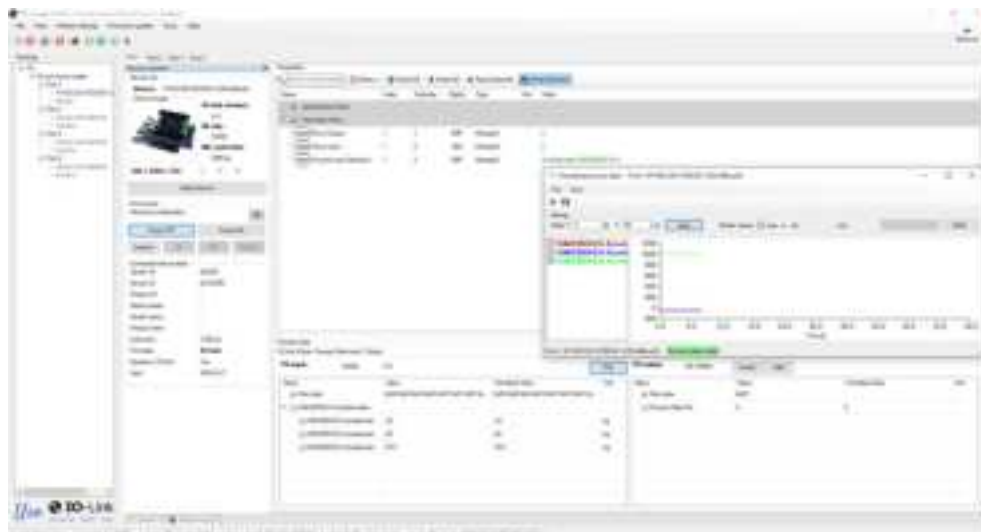
Figure 5. Terminal settings



- Step 3.** Launch the IO-Link Control Tool on your laptop/PC.
- Step 4.** Connect by mini-USB cable the P-NUCLEO-IOM01M1 running the IO-Link Control Tool to your laptop/PC.  
Next steps (5 to 13) refer to actions to be performed on the IO-Link Control Tool.
- Step 5.** Upload the P-NUCLEO-IOD02A1 IODD to the IO-Link Control Tool by clicking on **[Select device]** and following the instructions to upload the proper IODD (xml format) file available in the IODD directory of the software package.  
IODD files are provided for both COM2 (38.4 k Bd) and COM3 (230.4 k Bd) baud rates.
- Step 6.** Connect the Master by clicking on the green icon (top left corner).
- Step 7.** Click on **[Power ON]** to supply the P-NUCLEO-IOD02A1 (red LED on the X-NUCLEO-IOD02A1 blinks).
- Step 8.** Click on **[IO-Link]** to start an IO-Link Communication (green LED on X-NUCLEO-IOD02A1 blinks).  
By default, the communication with IIS2DLPC starts.
- Step 9.** Click on **[Plot]** to plot the collected data.

- Step 10.** To activate the data-exchange with another sensor, go to **[Parameter Menu]>[Process Input Selection]**, then double click on the sensor name (green text), select the desired sensor from the available choices. The sensor change will be highlighted by the sensor name which will turn blue. To finally align the Master and the Device, it is necessary to click on **[Write Selected]**. The procedure is completed when the name of the selected sensor becomes green.

Figure 6. IO-Link Control Tool view (example)



- Step 11.** When you finish your evaluation session, click on **[Inactive]** to stop IO-Link communication.
- Step 12.** Clicking on **[Power Off]** to make the IO-Link Master stop supplying the IO-Link Device.
- Step 13.** Click on **[Disconnect]** to stop the communication between IO-Link Control Tool and P-NUCLEO-IOM01M1.
- Step 14.** Disconnect the mini-USB cable and the 24 V supply from the P-NUCLEO-IOM01M1.

## 2.4 Software setup

The following software components are needed to set up a suitable development environment to create applications for IO-Link applications for NUCLEO-L452RE and L6364Q:

- FP-IND-IODSNS1 firmware and related documentation available on [www.st.com](http://www.st.com)
- One of the following development tool-chain and compilers:
  - IAR Embedded Workbench for ARM® toolchain + ST-LINK/V2
  - RealView Microcontroller Development Kit toolchain (MDK-ARM software development environment + ST-LINK/V2)
  - STM32CubeIDE + ST-LINK/V2

## Revision history

**Table 1. Document revision history**

Date	Version	Changes
04-Dec-2020	1	Initial release.
07-Mar-2024	2	Updated <a href="#">Figure 2</a> . FP-IND-IODSNS1 package folder structure. Minor text changes.

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