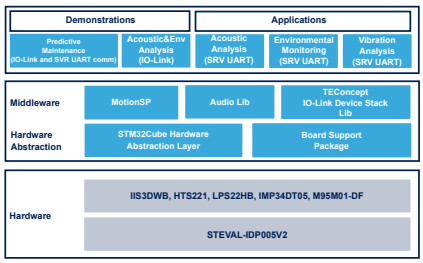
# STSW-BFA001V2

Data brief

# Software package for STEVAL- BFA001V2B multi-sensor development kit for condition monitoring and predictive maintenance




| Product summary | |
|---|---|
| Software package for STEVAL-BFA001V2B evaluation kit | STSW-BFA001V2 |
| Multi sensor predictive maintenance kit with embedded IO-Link stack v.1.1 | STEVAL-BFA001V2B |
| IO-Link communication transceiver device | L6362A |
| Capacitive digital sensor for relative humidity and temperature | HTS221 |
| Ultra-wide bandwidth, low-noise 3-axis digital accelerometer for industrial applications | IIS3DWB |
| Ultra-compact piezoresistive absolute pressure sensor | LPS22HB |
| MEMS audio sensor omnidirectional digital microphone for industrial applications | IMP34DT05 |

## Features

- Rich set of firmware examples to build applications for condition monitoring and predictive maintenance based on ultra-wide bandwidth 3D digital accelerometer, environmental and acoustic MEMS sensors
- MotionSP middleware including algorithms for advanced time and frequency domain signal processing for vibration analysis:
  - Programmable FFT size (point 256, 512, 1024, 2048)
  - Programmable FFT overlapping and averaging
  - Programmable windowing (Flat Top, Hanning, Hamming, rectangular)
  - Speed RMS moving average, acceleration max. peak
- Middleware integrating microphone algorithms for:
  - PDM to PCM conversion
  - Sound pressure
  - Audio FFT
- Third-party middleware in object format for IO-Link device stack v1.1 (provided by TEConcept GmbH):
  - IODD file (IO-Link Device Descriptor), containing device identity, parameters, process and diagnosis data and communication properties (COM3)
  - BLOB transfer support for vibration and acoustic FFT data transfer
  - Parameter configuration and event device generation for time and frequency domain setting and analysis
- Programmable thresholds for warning and alarm condition in spectral band and time domain
- Two different data output working modes:
  - Stand-alone mode connecting the kit to a PC via USB
  - IO-Link mode with main board interfaced with a generic master board
- Firmware package developed for STM32F469AI with easy portability across different MCU families
- Application example firmware to interface the node with a generic IO-Link master tool
- Dedicated PC GUI to plot the data coming from STEVAL-IDP005V2 (included in the STEVAL-BFA001V2B kit) when it is connected to the STEVAL-IDP004V2 IO-Link master multi-port evaluation board
- STSW-BFA2PREDMNT condition monitoring firmware configured to interact with STSW-IDP4PREDMNT and to allow data uploading to the cloud via the STM32MP157C-DK2 gateway (resources included in the SL-PREDMNT-E2C Solution)

## Description

The STSW-BFA001V2 firmware package has been developed to enable and speed up development of solutions for industrial predictive maintenance based on condition monitoring.

The software runs on the high performance STM32F469AI, ARM® Cortex®-M4, 32-bit microcontroller and includes drivers for sensor devices (HTS221, LPS22HB, IIS3DWB, IMP34DT05) and M95M01-DF.

| Product summary | |
|---|---|
| High-performance advanced line, ARM Cortex-M4 core with DSP and FPU, 2 Mbytes Flash, 384+4 kB of RAM, DMA controller, up to 17 timers | STM32F469AI |
| Condition monitoring cloud gateway solution, using smart sensor nodes and edge processing | SL-PREDMNT-E2C |
| Applications | Condition Monitoring / Predictive Maintenance |

It integrates middleware based on algorithms for accelerometer data signal processing to enable rotating equipment monitoring (i.e. motors, pumps and fans) in time and frequency domains.

The package also includes audio lib middleware to perform acoustic emission analysis starting from FFT and SPL (sound pressure level), and the IO-Link device stack v1.1 protocol, in object library format, which is a third party middleware for evaluation purpose with some limitations in the features.

The software comes with different applications to monitor all sensor data and output algorithm results and dedicated demonstration examples are based on programmable thresholds for warning and alarm condition in time domain and in spectral band.

The firmware package provides projects based on two types of wired communication: stand-alone mode, based on UART to USB PC communication, and IO-Link mode, based on IO-Link communication.

In stand-alone mode, the related projects support USART data output: the STEVAL-IDP005V2 (main board of STEVAL-BFA001V2B kit) is connected to a USB PC port through the STEVAL-UKI001V2 adapter and STLINK-V3MINI. In this case, a user terminal emulator like Tera Term can be used to monitor environmental, acoustic and vibration data results and log them to a PC.

In IO-Link mode, the projects include the IO-Link device stack, the STEVAL-IDP005V2 is interfaced with the IO-Link master board through M12 cable and data output can be displayed through the master interface.

Dedicated examples demonstrate device interoperability with any master tool and support BLOB transfer for vibration and acoustic FFT data, event generator for alarm and warning coming from configurable time and frequency domain thresholds and parameter configuration for MotionSP settings and thresholds (parameter custom ISDU).

The package includes also a dedicated GUI to display and store sensor data and algorithm output data when the STEVAL-IDP005V2 interfaces with the STEVAL-IDP004V2.

The application scenario also allows STEVAL-BFA001V2B and STEVAL-IDP004Vx data to be collected and processed in an edge gateway.

The gateway consists of an STM32MP157C-DK2 discovery kit running X-LINUX-PREDMNT software which includes the AWS Green Grass service and gathers all the data on the DSH-PREDMNT cloud based web application for condition monitoring and predictive maintenance. A sensor edge-to-cloud application example is included in the STSW-BFA2PREDMNT dedicated binary (IO-Link stack is not part of it).

# 1 STM32Cube development environment

STM32Cube is a combination of a full set of PC software tools and embedded software blocks running on STM32 microcontrollers and microprocessors:

- STM32CubeMX configuration tool for any STM32 device; it generates initialization C code for Cortex-M cores and the Linux device tree source for Cortex-A cores
- STM32CubeIDE integrated development environment based on open-source solutions like Eclipse or the GNU C/C++ toolchain, including compilation reporting features and advanced debug features
- STM32CubeProgrammer programming tool that provides an easy-to-use and efficient environment for reading, writing and verifying devices and external memories via a wide variety of available communication media (JTAG, SWD, UART, USB DFU, I2C, SPI, CAN, etc.)
- STM32CubeMonitor family of tools (STM32CubeMonRF, STM32CubeMonUCPD, STM32CubeMonPwr) to help developers customize their applications in real-time
- STM32Cube MCU and MPU packages specific to each STM32 series with drivers (HAL, low-layer, etc.), middleware, and lots of example code used in a wide variety of real-world use cases
- STM32Cube expansion packages for application-oriented solutions

## Revision history

**Table 1. Document revision history**

| Date | Version | Changes |
|---|---|---|
| 12-Dec-2019 | 1 | Initial release. |
| 21-May-2020 | 2 | Updated cover page features and description. |
| 17-Feb-2021 | 3 | Added references to SL-PREDMNT-E2C Solution. |