Quick-start guide for XENSIV™ PAS CO2 Shield2Go

About this document

Scope and purpose

This user manual serves as a starting guide and will focus on the setup and communication of the XENSIV™ PAS CO2 Shield2Go. Main focus will be the hardware along with a quick example of how to set up communication and start basic measurement with the provided software library using the XMC 2Go, the Arduino Due and the Arduino Uno in combination with the my IoT adapter.

Intended audience

Application engineers, system engineers and makers.

Order information

Sales Name: **SHIELD_PASCO2_SENSOR**

SP-No: **SP005569590**

Opn: **SHIELDPASCO2SENSORTOBO1**

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1 Introduction

The XENSIV™ PAS CO2 sensor is a real carbon dioxide (CO_2) sensor in an unprecedentedly small form factor. Designed on the basis of a unique photoacoustic spectroscopy (PAS) concept, the sensor saves more than 75 percent space compared to existing commercial real CO_2 sensors. Its direct ppm readings, SMD capability and simple design allow for quicker and easier integration into customers' systems in low- and high-volume applications alike.

The photoacoustic principle can be traced back to over 100 years ago, first discovered by Alexander Graham Bell in 1880. The photoacoustic effect involves the formation of sound waves (pressure changes) following light absorption in a material sample. The sound signal is quantified by detectors such as microphones. In order to obtain this effect, the light intensity must vary. A PAS gas sensor is based on the principle that gases absorb light in a specific wavelength of the infrared spectrum. CO_2 molecules, for example, have strong absorption in the λ = 4.2 µm wavelength.

The XENSIV™ PAS CO2 sensor module integrates, on the same PCB, the PAS transducer, a microcontroller for signal processing, algorithms and a MOSFET. As depicted in the block diagram, the PAS transducer includes: i) a proprietary infrared emitter with blackbody radiation, which is periodically chopped by the MOSFET; ii) a narrow-band optical filter passing the CO_2 specific wavelength λ = 4.2 µm, significantly improving the sensor selectivity compared to other gases, including humidity; and iii) Infineon's high-SNR (signal-to-noise ratio) MEMS microphone XENSIV™ IM69D130, detecting the pressure changes generated by the CO_2 molecules. All the components are developed and designed in-house in accordance with Infineon's high-quality guidelines. The sensor therefore benefits from Infineon's illustrious record of accomplishments in MEMS design and acoustic capabilities, resulting in it being best-in-class for price/performance.

The XENSIV™ PAS CO2 sensor is ideal for smart-home and building automation as well as various indoor air quality IoT devices such as air purifiers, thermostats, weather stations and personal assistants. The sensor enables end users to track, understand and improve the air quality surrounding them in a timely and highly energy-efficient manner.

Figure 1 XENSIV™ PAS CO2 sensor

Introduction

1.1 Shield2Go platform

Infineon's Shield2Go boards are equipped with one featured Infineon IC and provide a standardized form factor and pin layout for fast orientation. All boards come with solderless connectors allowing designers to stack the boards instead of soldering them. This makes the Shield2Go boards simple, reusable and flexible. In addition, each Shield2Go comes with a dedicated and free software library for Arduino. The Shield2Go boards are compatible with Arduino Uno with Infineon's My IoT adapter. This combination of flexible hardware components and accompanying software speeds up the prototyping process. Engineers and makers can develop customized system solutions by freely selecting and combining Shield2Go boards in multiple ways based on their needs and use cases. Learn more about the Shield2Go approach and the available portfolio on the dedicated product page.

https://www.infineon.com/cms/en/tools/landing/infineon-for-makers/shield-2go-my-iot/

The My IoT adapter board is also part of the evaluation environment that acts as the gateway to external hardware - such as the popular hardware platforms like Arduino, Raspberry Pi or Espressif Wi-Fi Chips -, making it possible to combine the Shield2Go boards into systems easily and flexibly. The adapter offers multiple sockets which allow free and flexible combination of various Shield2Go boards. Thereby, users do not have to care about pin allocation, level shifting or system integration.

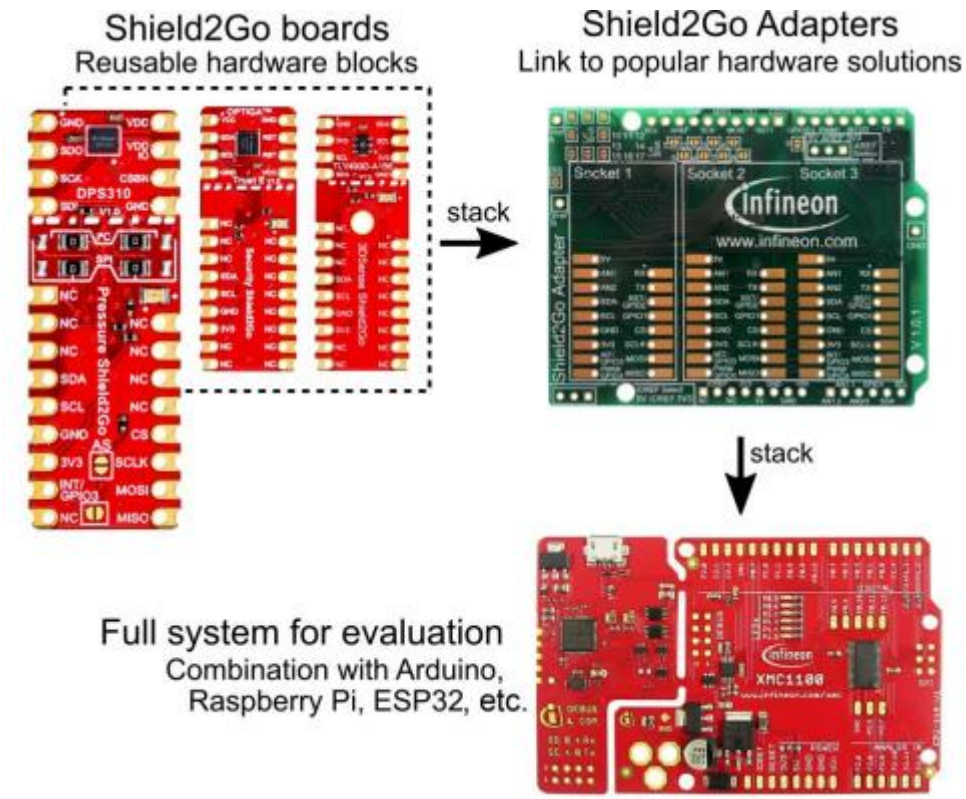

Figure 2 Combining Shield2Go board and My IoT adapter to a system

More and detailed information can be found on the dedicated My IoT product page.

https://www.infineon.com/cms/en/product/evaluation-boards/my-iot-adapter/

1.2 XENSIV™ PAS CO2 Shield2Go

The XENSIV™ PAS CO2 Shield2Go includes every necessary component to fully supply the XENSIV™ PAS CO2 with all the available features enabled and optimized. The necessary stable 12 V supply for the IR emitter is generated on board with a boost converter and also additionally an LDO for the 3.3 V supply is integrated on board which reduces the required supplies to a single 5 V supply. If user wants to use their own design it is possible to break apart the head which only consists of the XENSIV™ PAS CO2 module with all the pins routed out on castellated pads to easily mount the XENSIV™ PAS CO2 to the other PCBs. PWM and INT functionality is also covered in both cases. Please refer to the programming guide and register map for full detailed description and examples.

https://www.infineon.com/dgdl/Infineon-programming_guide_PAS_CO2_evaluationkit-ApplicationNotes-v02_00-EN.pdf?fileId=5546d4627600a6bc0176041139e77780

https://www.infineon.com/dgdl/Infineon-Registermap_description_PASCO2_MA2-ApplicationNotes-v02_00-EN.pdf?fileId=5546d4627600a6bc017604238d967785

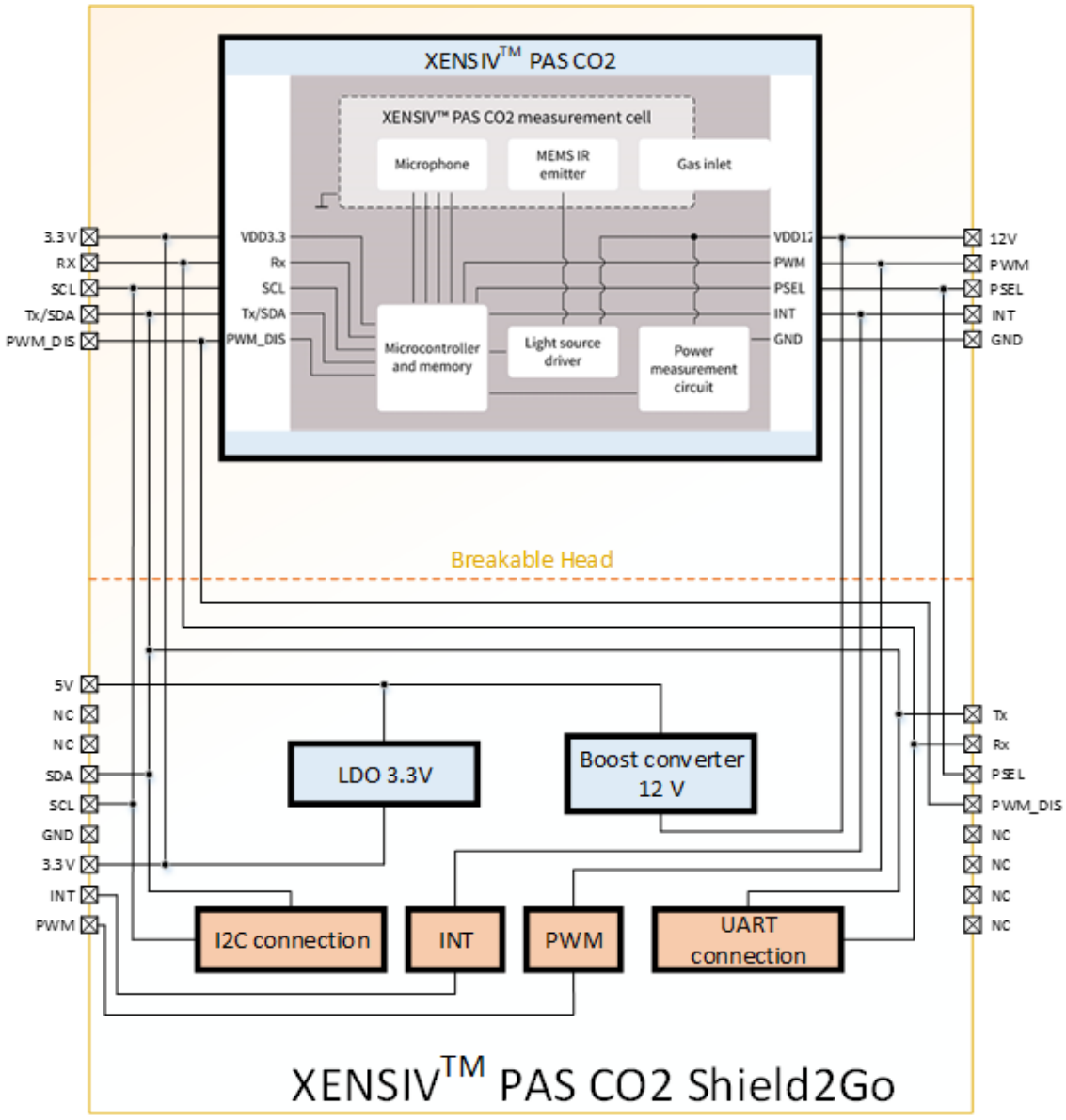

Figure 3 Block diagram of XENSIV™ PAS CO2 Shield2Go

Introduction

Two communication interfaces are available. By default, the I²C interface is configured but with a simple rearrangement from the pull-up resistor R5 to pull-down resistor R6 can the UART interface be selected. To fully disable the I²C interface and the connected pull-up resistors on the SDA/Tx and SCL lines solder jumpers can be cut and disconnected. Figure 4 is showing the two positions the resistor can take depending on desired interface and also above the solder jumpers for isolating the pull-up resistors R8 and R9.

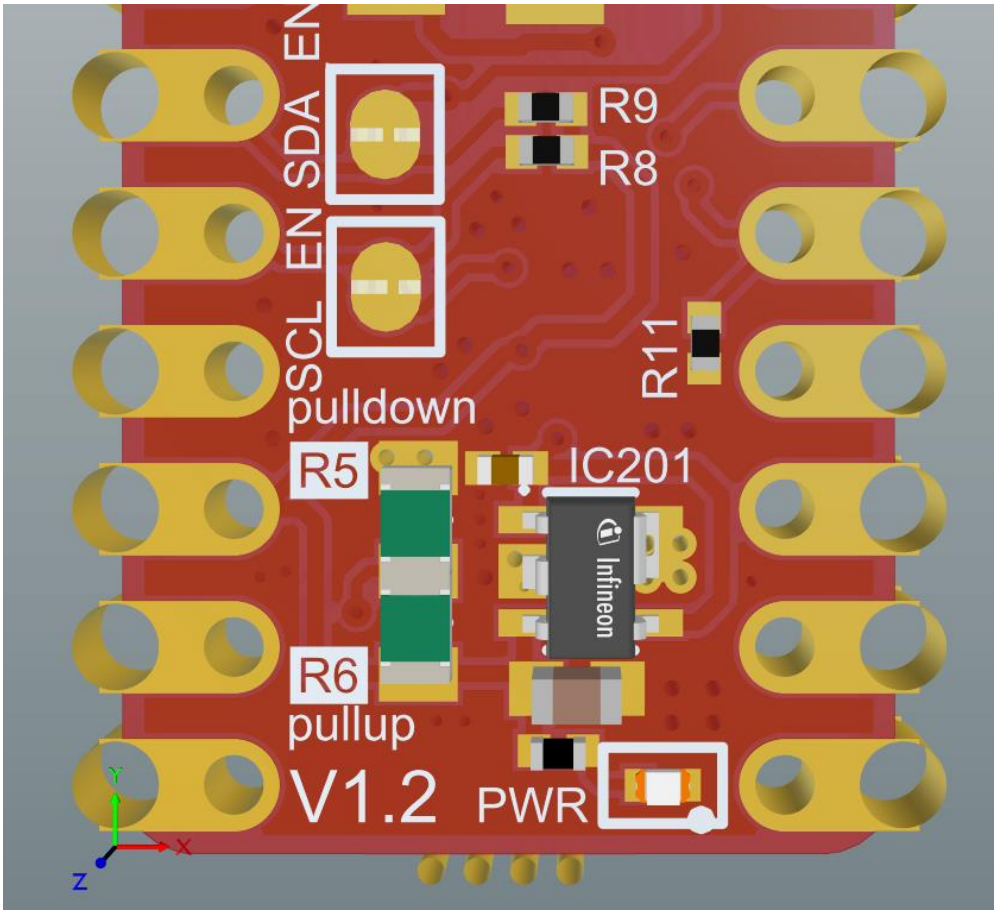

Figure 4 Selecting communication interface on the XENSIV™ PAS CO2 Shield2Go

Introduction

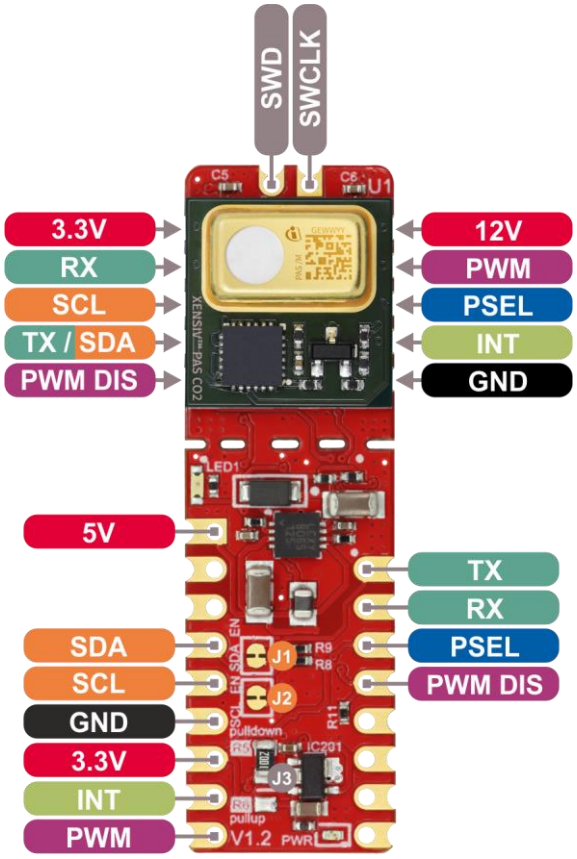

Figure 5 Pinout XENSIV™ PAS CO2 Shield2Go

Table 1 Pin descriptions of body part

Pin	Symbol	Type	Function
1	VDD5	Power supply (5 V)	5 V step up to 12 V power supply for the IR emitter
2	NC	NC	Not connected
3	NC	NC	Not connected
4	P11: SDA	Input/Output	I²C data pin (3.3 V domain)
5	P10: SCL	Input/Output	I²C clock pin (3.3 V domain)
6	GND	Ground	Ground
7	VDD3V3	Power supply (3.3 V)	3.3 V digital power supply
8	P9: INT	Output	Interrupt output pin (3.3 V domain)
9	P8: PWM	Output	PWM output pin (3.3 V domain)
10	P7: TX	Input/Output	UART transmitter pin (3.3 V domain)
11	P6: RX	Input	UART receiver pin (3.3 V domain)
12	P5: RST	Input	Communication interface select input pin (3.3 V domain)[1)]
13	P4: GPIO1	Input	PWM disable input pin (3.3 V domain)[2)]
14	NC	NC	Not connected
15	NC	NC	Not connected
16	NC	NC	Not connected
17	NC	NC	Not connected

Introduction

Table 2 Pin descriptions of head part

Pin	Symbol	Type	Function
1	VDD	Power supply (3.3 V)	3.3 V digital power supply
2	RX	Input	UART receiver pin (3.3 V domain)
3	SCL	Input/Output	I²C clock pin (3.3 V domain)
4	TX_SDA	Input/Output	UART transmitter pin/I²C data pin (3.3 V domain)
5	PWM_DIS	Input	PWM disable input pin (3.3 V domain)[2)]
6	GND	Ground	Ground
7	INT	Output	Interrupt output pin (3.3 V domain)
8	PSEL	Input	Communication interface select input pin (3.3 V domain)[1)]
9	PWM	Output	PWM output pin (3.3 V domain)
10	VDD12	Power supply (12 V)	12 V power supply for the IR emitter

[1)] High level selects UART and low level selects I²C. It is recommended to the user to hard wire the pin to VDD or GND, depending on the wanted interface.

[2)] If a communication interface is used by the application, it is recommended to hard-wire pin PWM_DIS to GND. Note: In this case the device will start in continuous mode and not idle mode which needs to be considered when changing the measurement period.

Note: PSEL and PWM_DIS are both by default connected to GND on board of XENSIV™ PAS CO2 Shield2Go.

2 Software and library integration

2.1 Setting up Arduino IDE

1. Install Arduino IDE. If you are new to Arduino, please download the program and install it first. https://www.arduino.cc/en/software
2. Install the library. In the Arduino IDE, go to the menu Sketch > Include library > Manage libraries. Type pas-co2-sensor and install the library.

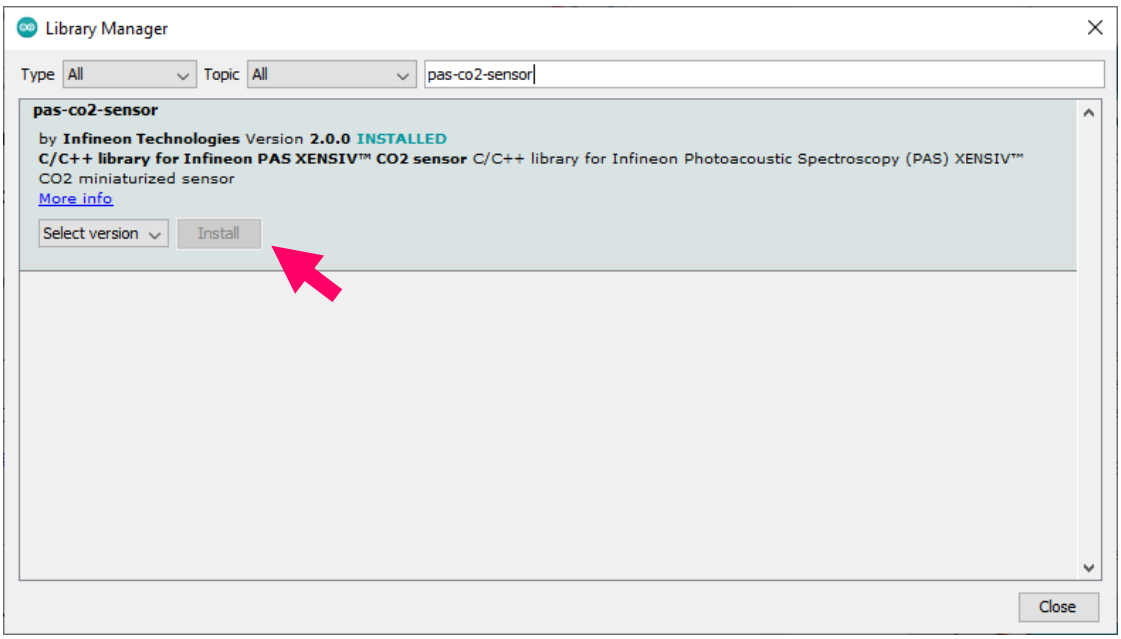

Figure 6 Installing library in the Arduino library manager

3. In case of using XMC boards as microcontroller, install board package. The official Arduino boards are already available in the Arduino software, but other third-party boards as the Infineon XMC MCU based need to be explicitly included. Follow the instructions in section 3 “Quick start with XMC 2Go” to add the XMC board family to Arduino.

2.2 Library overview

The core library is C based and provides a platform-independent driver for the XENSIV™ PAS CO2 sensor. It provides full access to all features of the sensor. The driver consists of 4 files.

Table 3 Core C driver

Source code	Description
xensiv_pasco2_ver.h	Contains the exact version of the XENSIV™ PAS CO2 sensor
xensiv_pasco2_regs.h	Contains the register definitions for interacting with the XENSIV™ PAS CO2 sensor
xensiv_pasco2.h	Contains full functions for interacting with the XENSIV™ PAS CO2 sensor
xensiv_pasco2.c	Contains full functions for interacting with the XENSIV™ PAS CO2 sensor

Software and library integration

Full documentation and overview to the driver can be found on the GitHub.

https://github.com/Infineon/sensor-xensiv-pasco2

And the documentation with detail explanation for all macros, enumerations and functions can be found here:

https://infineon.github.io/sensor-xensiv-pasco2/html/group__group__board__libs.html

The Arduino library is using this core C driver with a C++ wrapper to follow the ecosystem design pattern so that Arduino users find in this library what they are used to.

Table 4 Arduino library

Source code	Description
pas-co2-pal-ino.cpp	Target platform-specific implementation
pas-co2-platf-ino.hpp	Default board definition and selection by conditional compiling
pas-co2-ino.hpp	Contains functions for interacting with the XENSIV™ PAS CO2 sensor adapted from the core driver
pas-co2-ino.cpp	Contains functions for interacting with the XENSIV™ PAS CO2 sensor adapted from the core driver

The Arduino library includes 6 examples which the user can modify and use as a reference.

Table 5 Arduino examples

Example	Description
alarm-notification	Readout of the sensor CO2 concentration based on threshold crossing and synched via hardware interrupt
device-id	Readout of the sensor devices product and revision identifiers
single-shot-mode	Readout of the sensor CO2 concentration value using single shot measurement mode
continuous-mode	Readout of the sensor CO2 concentration value using continuous measurement mode
forced-compensation	Set CO2 reference offset using forced compensation
early-notification	Readout of the sensor CO2 concentration based on early notification synched via hardware interrupt

Full documentation of the Arduino library can be found on the GitHub.

https://github.com/Infineon/arduino-pas-co2-sensor

3 Quick start with XMC 2Go

The XMC 2Go is designed to evaluate the capabilities of the XMC1100 Microcontroller and the powerful, free of charge tool chain DAVE™. Thanks to the standardized form factor of the XENSIV™ PAS CO2 Shield2Go it is directly compatible with the XMC 2Go and can be used easily used in combination by plugging the XENSIV™ PAS CO2 Shield2Go on top of the XMC 2Go. But one important thing to consider is that the 5 V supply for the XENSIV™ PAS CO2 Shield2Go is not provided by the XMC 2Go and therefore needs to be supplied externally.

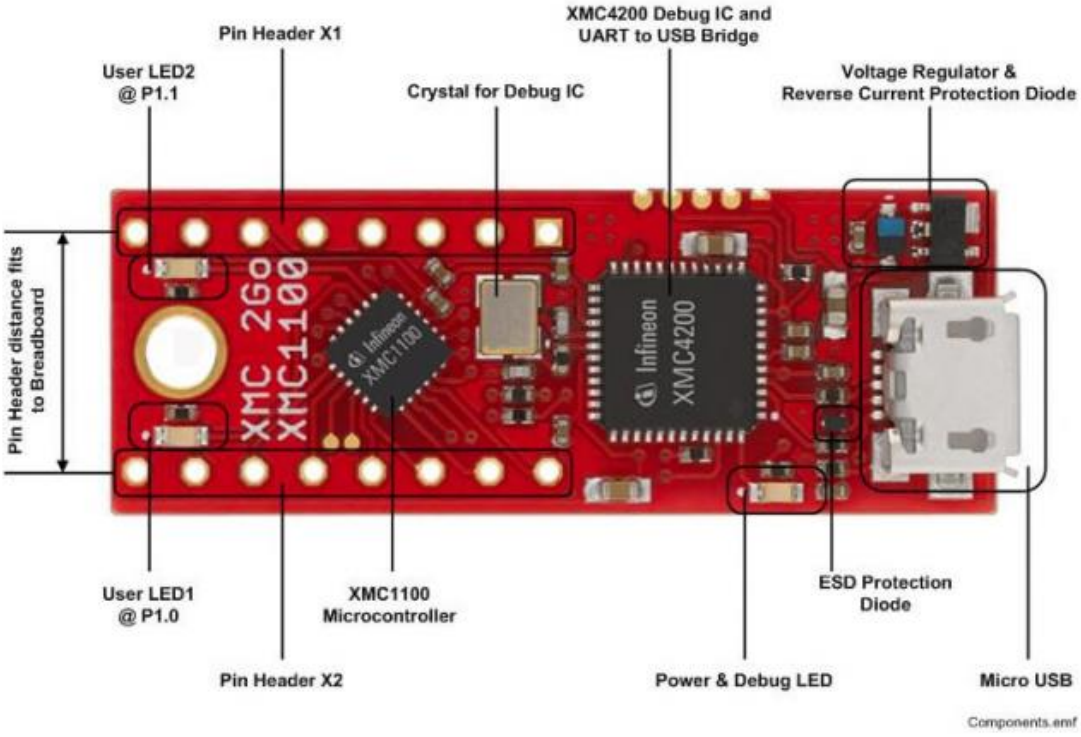

Figure 7 XMC 2Go Kit board overview

Table 6 Features of the XMC 2Go Kit with XMC1100

Topic	Features
Processor	XMC1100 microcontroller (ARM® Cortex™-M0 based) in a 4 x 4 mm VQFN-24 package
Flash	64 kB
RAM	16 kB
Clock Generation	Internal Oscillator
Frequencies	32 MHz CPU clock, 64 MHz Timer clock
Dimensions	14.0 x 38.5 mm
Power Supply	from USB via Debug probe (J-Link) or 3.3V external power
Connectors	Two 8-pin header (pin pitch: 2.54 mm ≙0.1” / between rows: 10.16 mm ≙0.4”) Pin header fits to breadboard
Debugger	On-Board J-Link Debugger supports • Serial Wire Debug (SWD, ARM Standard) • Single Pin Debug (SPD) • UART-to-USB bridge (virtual COM)

Peripherals	Mapped to pin header X1/X2: • 2 Channel USIC (UART, SPI, I2C, I2S, LIN) • 6 Channel Analog to Digital Converter (12-Bit resolution) • External Interrupts (via ERU) • 4 x 16-Bit Timer Others: • Real Time Clock • Random Number Generator
Others	2 User LEDs @ P1.0 and P1.1

More and detailed information can be found on the dedicated XMC 2Go product page.

https://www.infineon.com/cms/de/product/evaluation-boards/kit_xmc_2go_xmc1100_v1/

3.1 Step by step CO2 concentration readout example

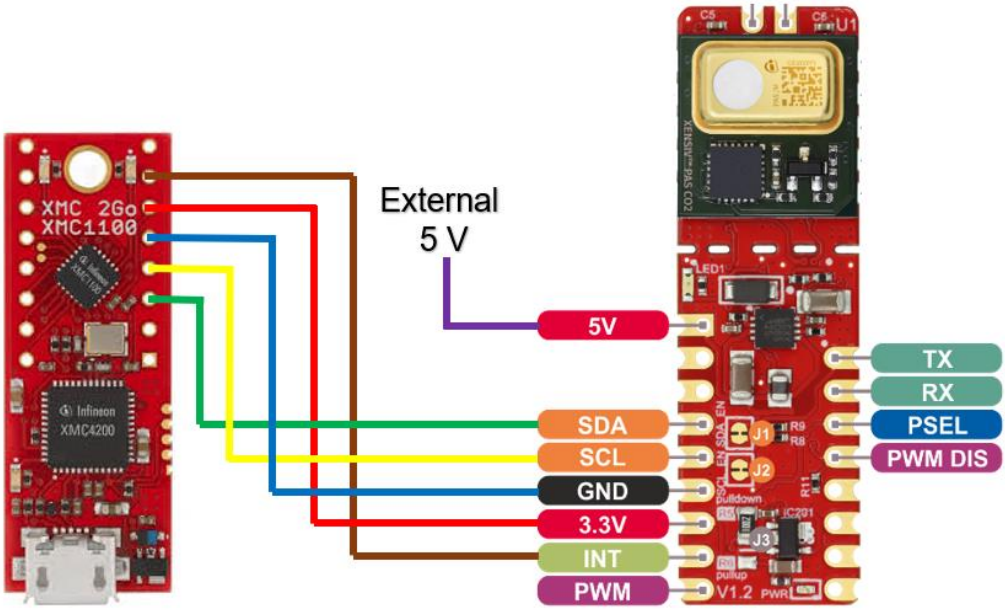

Figure 8 XENSIV™ PAS CO2 Shield2Go I²C interface connection to XMC 2Go

Table 7 Pin connections

Position	Symbol	Connection to the XMC 2Go
1	VDD5	Not available on XMC 2Go, 5 V power supply needs to be supplied externally
2	NC	Not connected
3	NC	Not connected
4	P11: SDA	I²C data pin (3.3 V domain)
5	P10: SCL	I²C clock pin (3.3 V domain)

6	GND	Ground
7	VDD3V3	3.3 V power supply
8	P9: INT	Digital pin D9
9	P8: PWM	Not connected (in this case)
10	P7: TX	Not connected (in this case)
11	P6: RX	Not connected (in this case)
12	P5: RST (PSEL)	Not connected (in this case)
13	P4: GPIO1 (PWM_DIS)	Not connected (in this case)
14	NC	Not connected
15	NC	Not connected
16	NC	Not connected
17	NC	Not connected

Figure 8 is just to visualize the connection because the XENSIV™ PAS CO2 Shield2Go can be simply stacked on top of the XMC 2Go via pin headers as seen in figure 9.

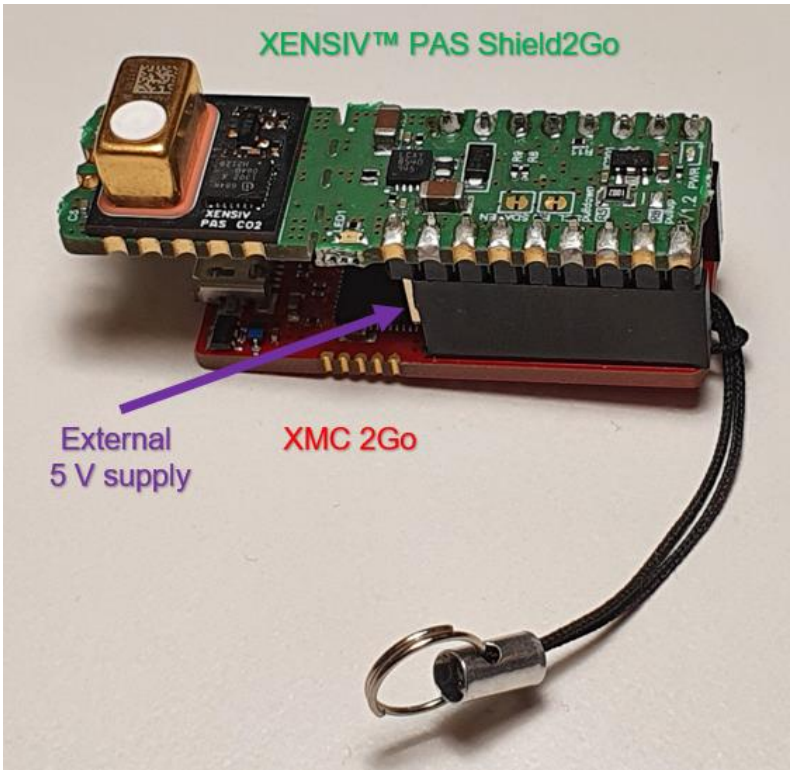

Figure 9 XENSIV™ PAS CO2 Shield2Go I²C interface connection to XMC 2Go

In order to use and program the Infineon XMC microcontrollers in the Arduino IDE, SEGGER J-Link must be installed first. Please follow the link to SEGGER J-Link and install the J-Link Software and Documentation Pack for your operating system. If you have already installed 'DAVE™ - Development Platform for XMC™ Microcontrollers', you can skip this step as the respective drivers/programs are already installed on your system.

https://www.segger.com/downloads/jlink

Quick start with XMC 2Go

Afterwards Infineon's microcontroller boards can be added to the Arduino IDE by pasting the following URL into the 'Additional Boards Manager URLs' input field under **File > Preferences**.

https://github.com/Infineon/Assets/releases/download/current/package_infineon_index.json

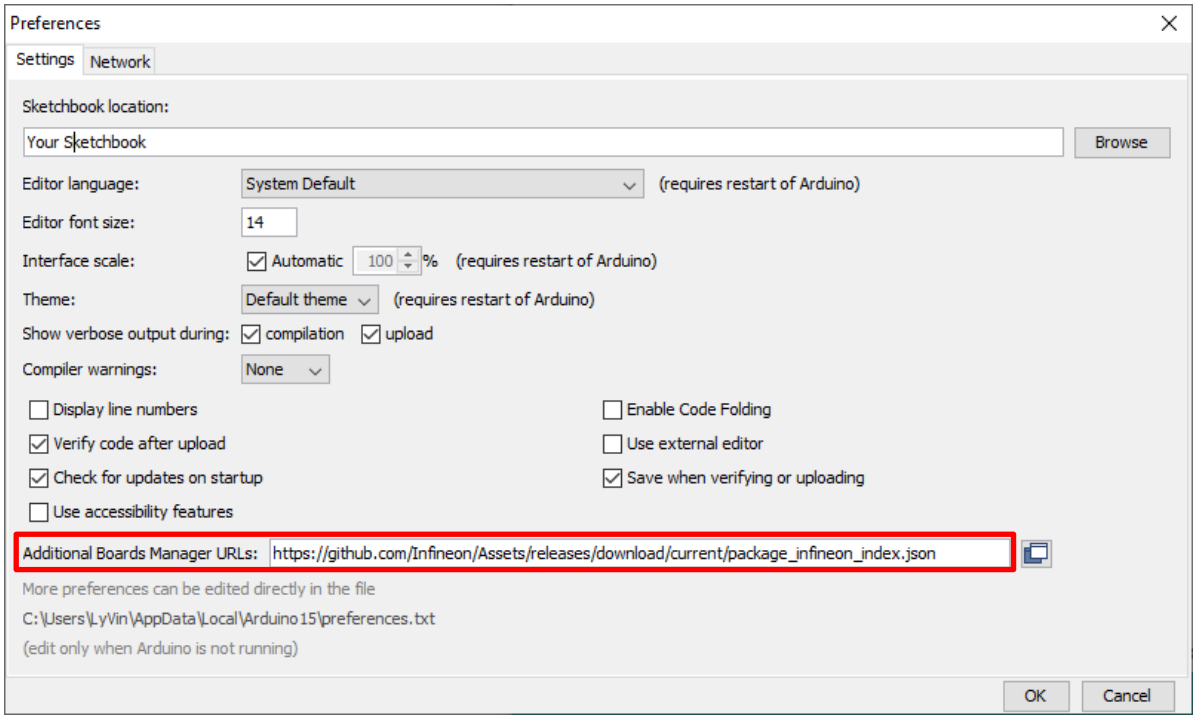

Figure 10 Adding XMC boards to the Arduino IDE in the 'Preference' section

To install the boards, please navigate to **Tools > Board > Boards Manager...** and search for XMC. You will find options to install the board files for the microcontrollers. Click "Install" to add the boards to your Arduino IDE.

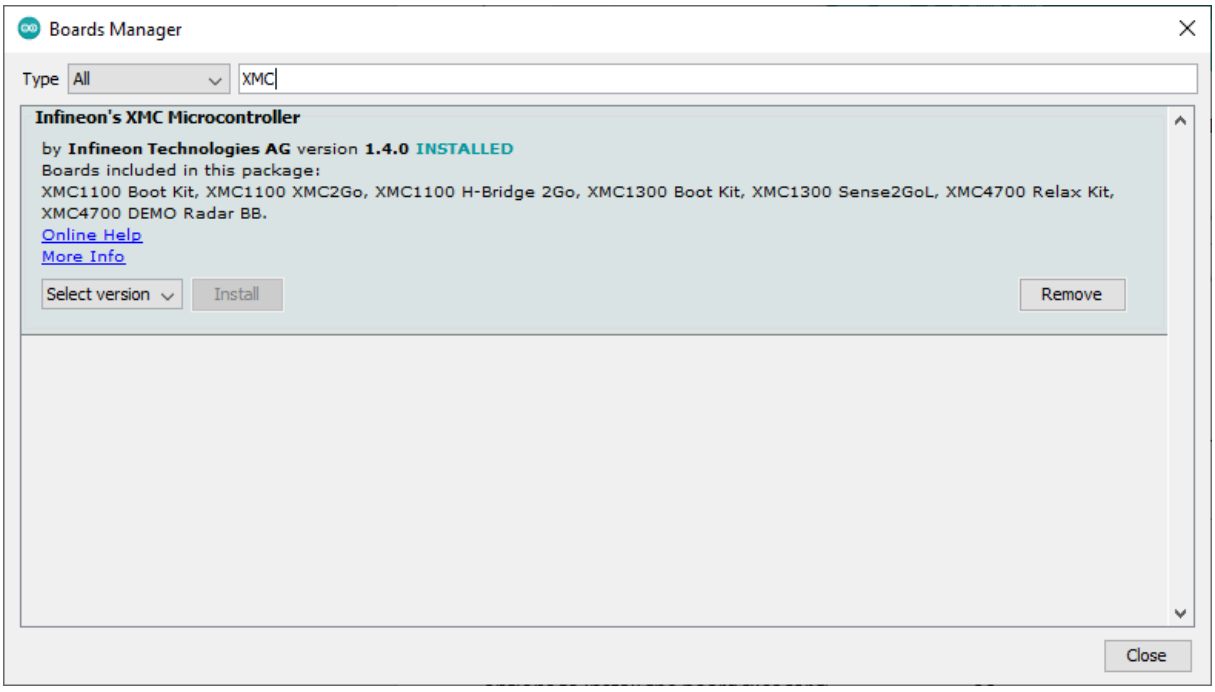

Figure 11 Installing XMC microcontroller board files

Quick start with XMC 2Go

In the boards list **Tools > Board**, the XMC microcontroller boards are added and can be used from now on. After that make sure to select the respective board (**XMC1100 XMC2Go**) and COM port in the Tools dropdown menu.

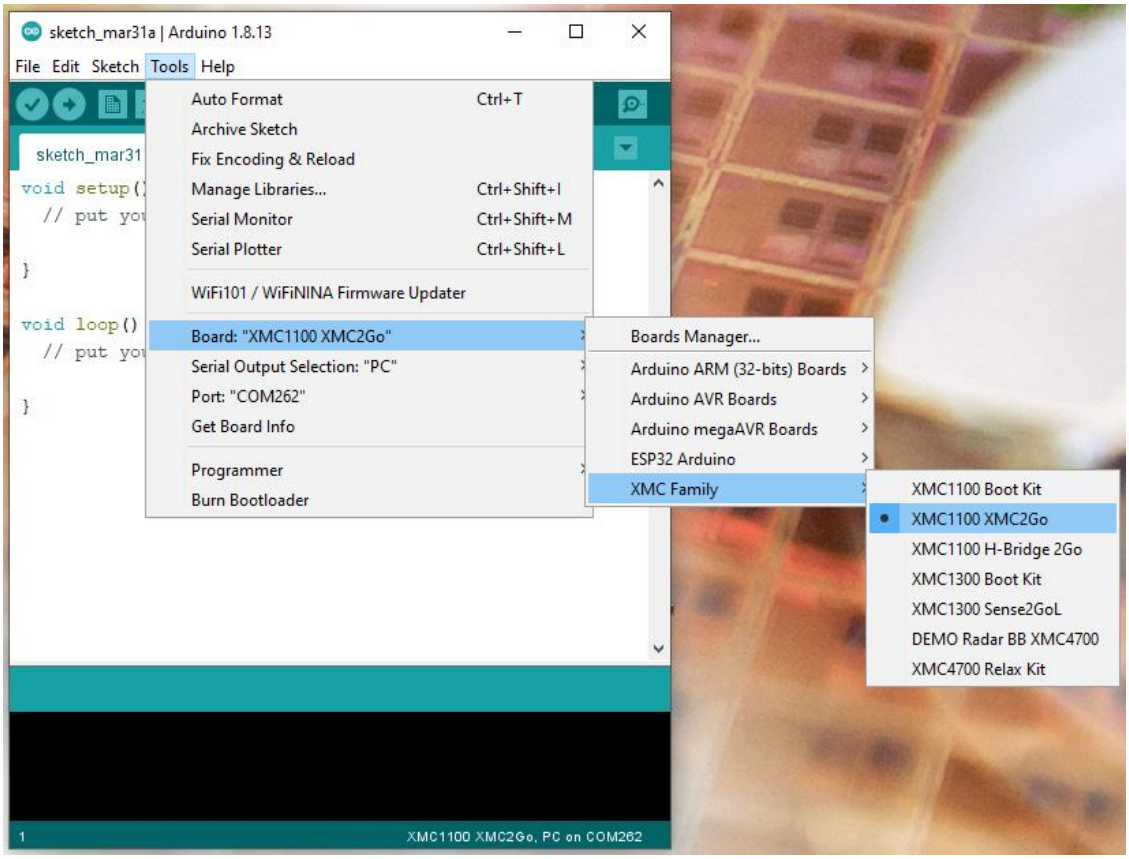

Figure 12 Selecting XMC 2Go board

Quick start with XMC 2Go

With everything ready, one of the library examples can now be opened, uploaded and run. The library examples provided can be opened in **File > Examples > pas-co2-sensor**.

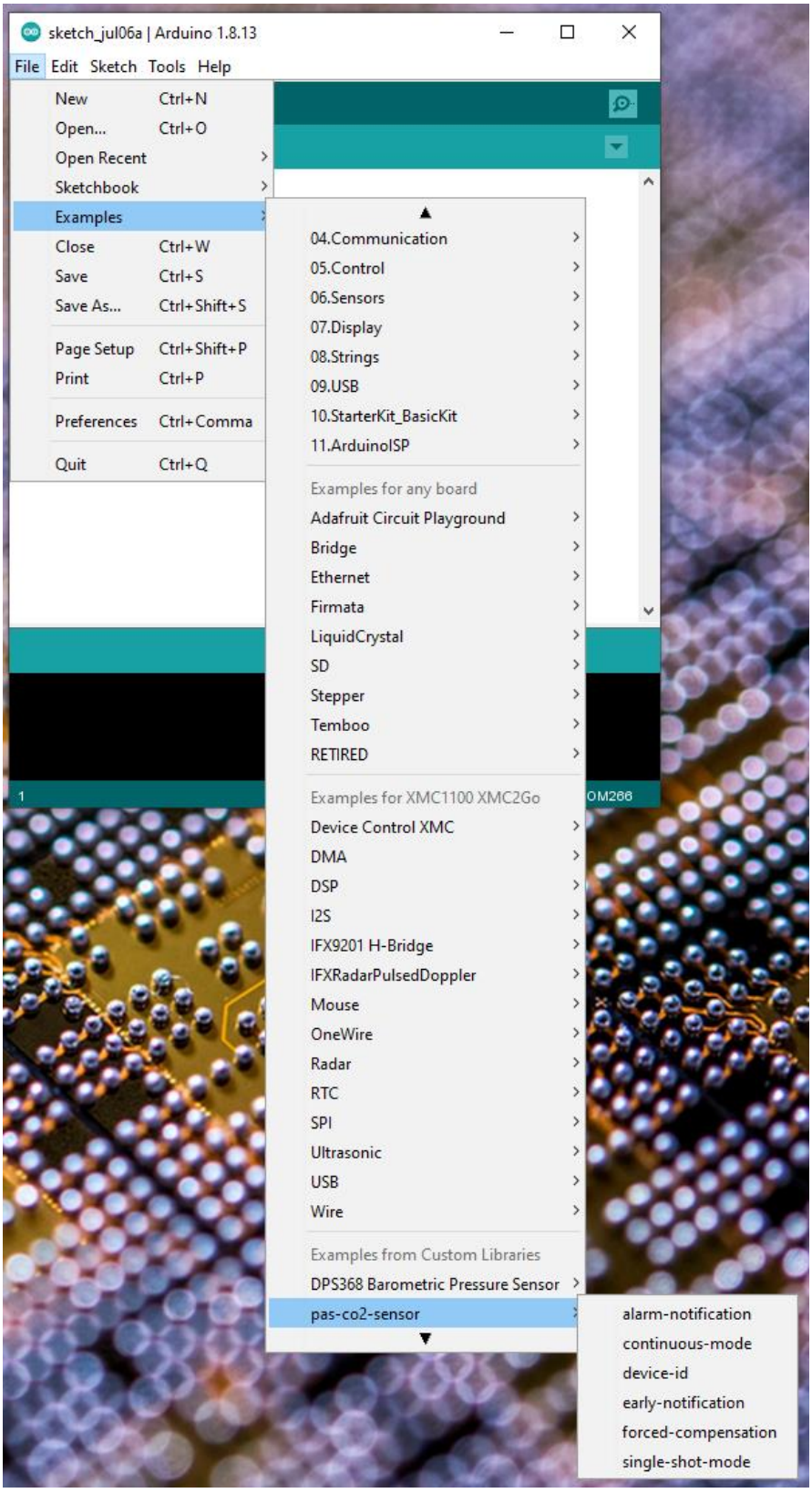

Figure 13 Arduino library examples

Quick start with XMC 2Go

In this case the serial-periodic example is used. The user can configure the I²C frequency, measurement period and reference pressure. The sensor supports both standard-mode (100 kHz) and fast-mode (400 kHz). In case of communication issues, it is recommended to lower the frequency to the standard-mode. For the measurement period the default value is 10 s and it is recommended to not go lower than that. In this example the pressure is set to 900 hPa. For correct operation, the user shall ensure that the pressure value programmed is within the specified pressure operating range of the device. This valid range of operation is 750 hPa to 1150 hPa.

Pressure must be set between 750 hPa and 1150 hPa

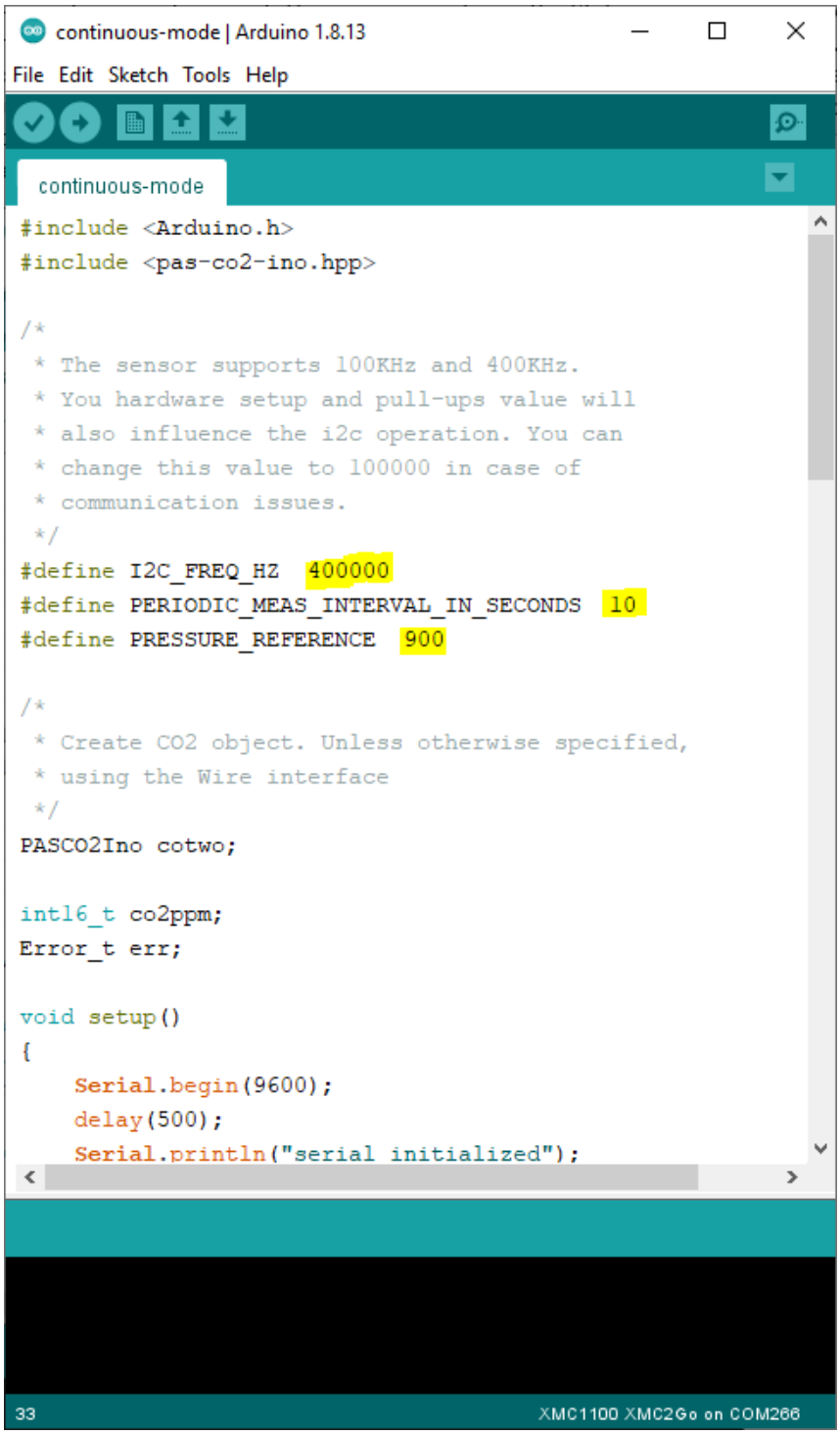

Figure 14 Arduino library example continuous-mode

Quick start with XMC 2Go

Remember to connect the 5 V pin prior to starting sensor

Ensure J-Link is installed before compiling

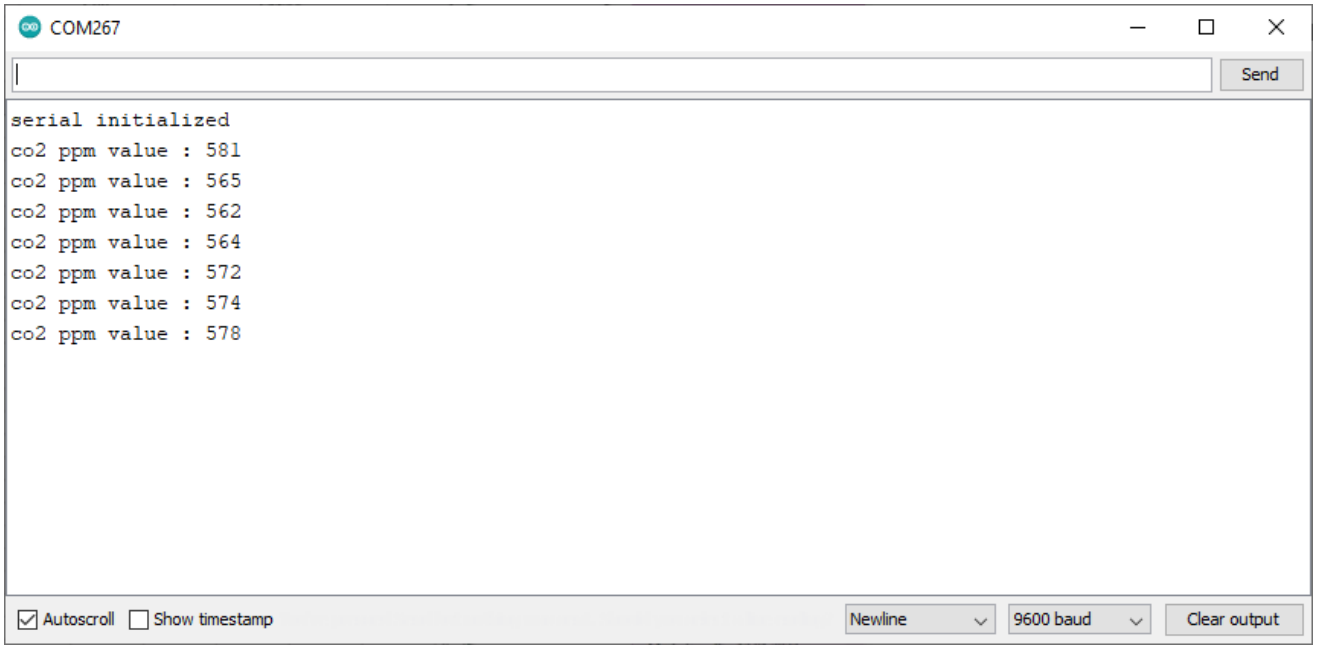

Figure 15 Serial-periodic CO2 results output

4 Quick start with Arduino Due

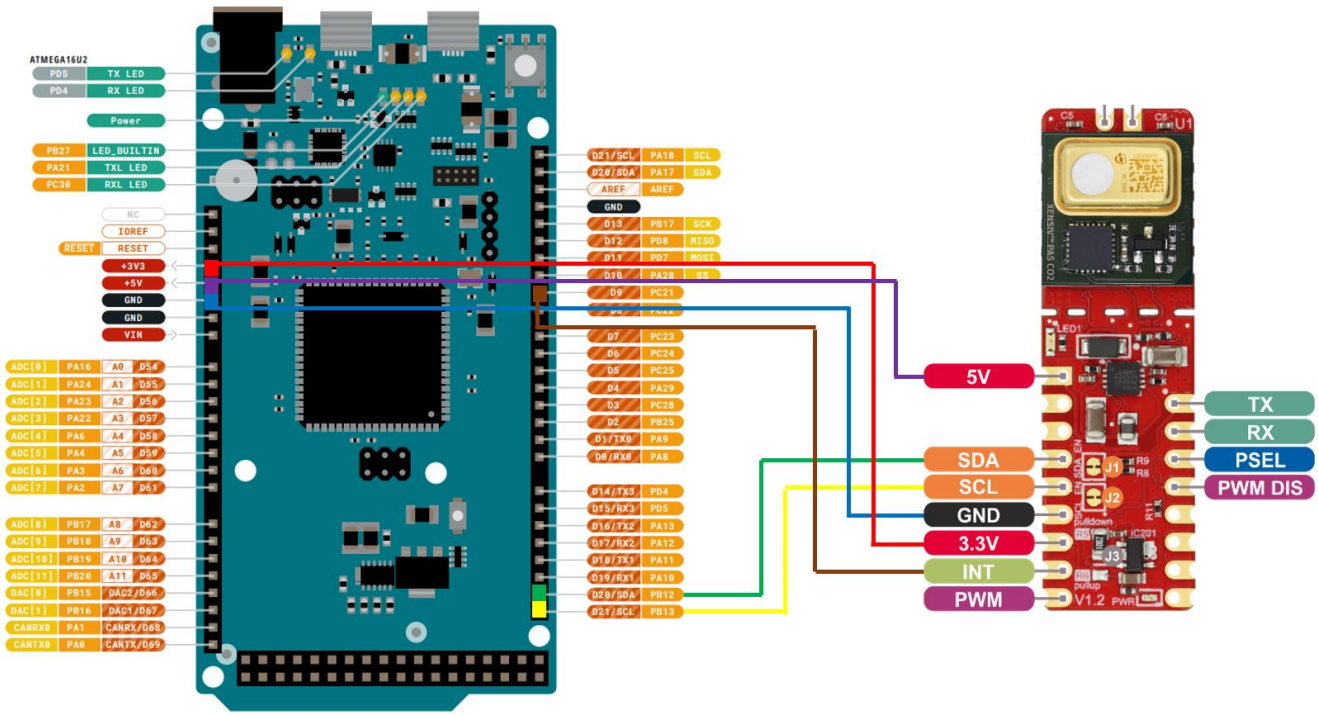

Figure 16 XENSIV™ PAS CO2 Shield2Go I²C interface connection to Arduino Due[3)]

[3)] Pinout of Arduino Due from https://content.arduino.cc/assets/Pinout-Due_latest.pdf

Table 8 Pin connections

Position	Symbol	Connection to the Arduino Due
1	VDD5	5 V power supply
2	NC	Not connected
3	NC	Not connected
4	P11: SDA	I²C data pin (3.3 V domain)
5	P10: SCL	I²C clock pin (3.3 V domain)
6	GND	Ground
7	VDD3V3	3.3 V power supply
8	P9: INT	Digital pin D9
9	P8: PWM	Not connected (in this case)
10	P7: TX	Not connected (in this case)
11	P6: RX	Not connected (in this case)
12	P5: RST (PSEL)	Not connected (in this case)
13	P4: GPIO1 (PWM_DIS)	Not connected (in this case)
14	NC	Not connected
15	NC	Not connected
16	NC	Not connected
17	NC	Not connected

Quick start with Arduino Due

Similar as with the XMC 2Go the Arduino Due board package needs to be installed first. As it is not a third-party board like the XMC 2Go, the right package “Arduino SAM Boards” (32-bit ARM® Cortex-M3) which is including the Arduino Due can be directly added with the board manager.

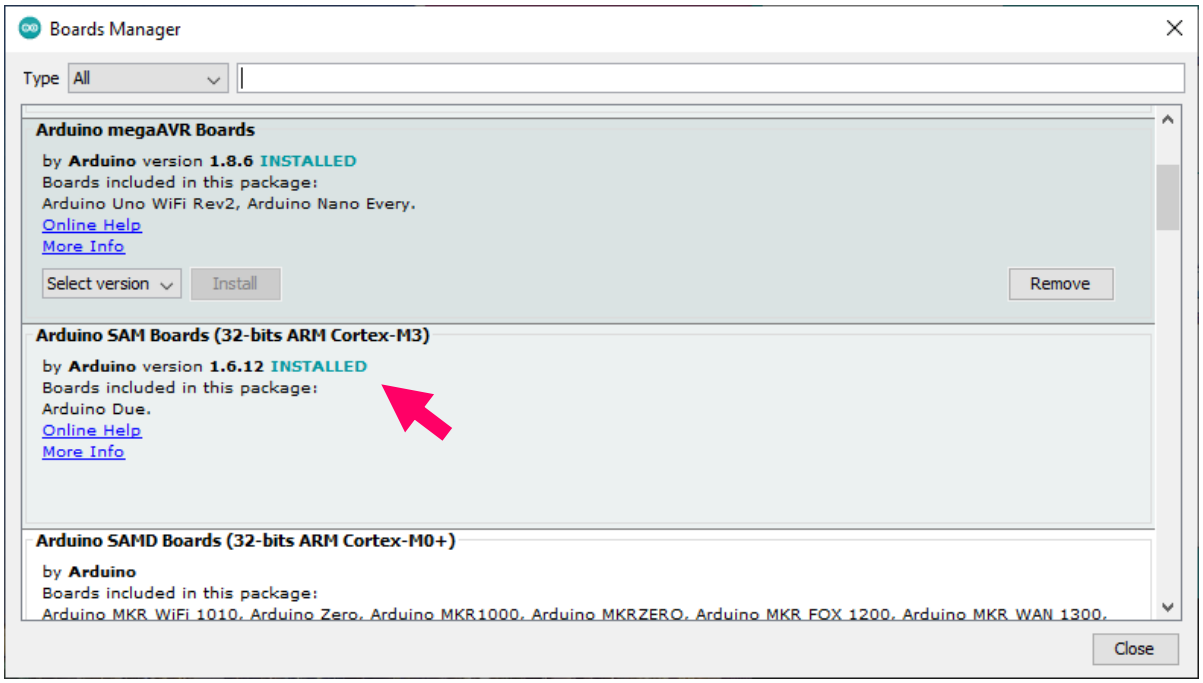

Figure 17 Arduino IDE settings: adding Arduino Due with the board manager

Afterwards the exact same steps with selecting the right board/COM port and opening, uploading and running a library example can be done as instructed previously with the XMC 2Go.

5 Quick start with Arduino Uno and My IoT adapter

As introduced in section 1.2 the XENSIV™ PAS CO2 Shield2Go in combination with the My IoT adapter can be simply stacked on top of the Arduino Uno via pin headers. Pin allocation, level shifting and system integration is already covered.

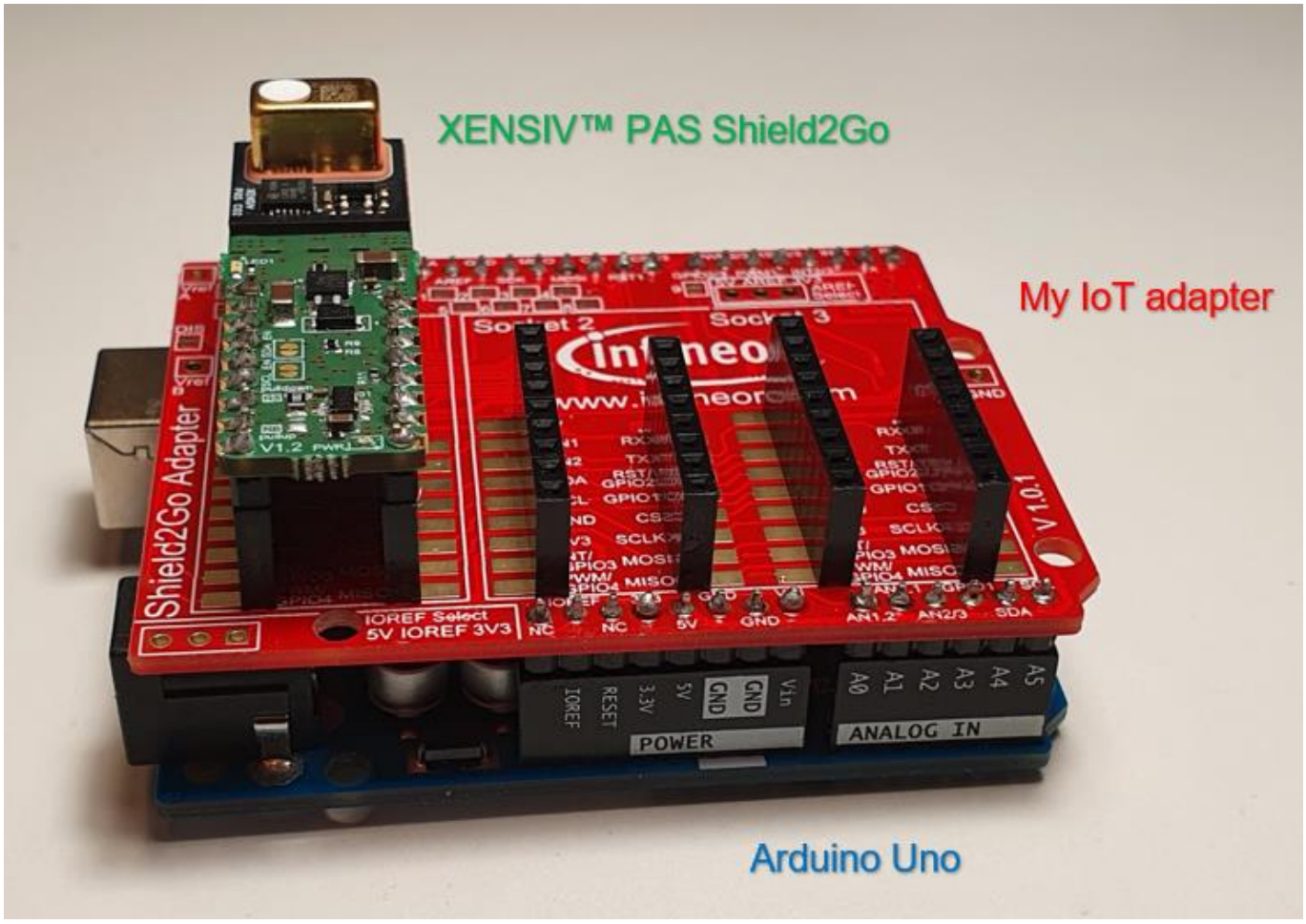

Figure 18 XENSIV™ PAS CO2 Shield2Go with My IoT adapter stacked to Arduino Uno[4)]

[4)] Pinout of Arduino Due from https://docs.arduino.cc/hardware/uno-rev3

Afterwards the exact same steps with selecting the right board/COM port and opening, uploading and running a library example can be done as instructed previously with the XMC 2Go.

In case of any technical questions please visit our community forum and have a look if similar questions are already posted or create a new one.

https://community.infineon.com/t5/CO-sensor/bd-p/CO2Sensors

6 Appendix

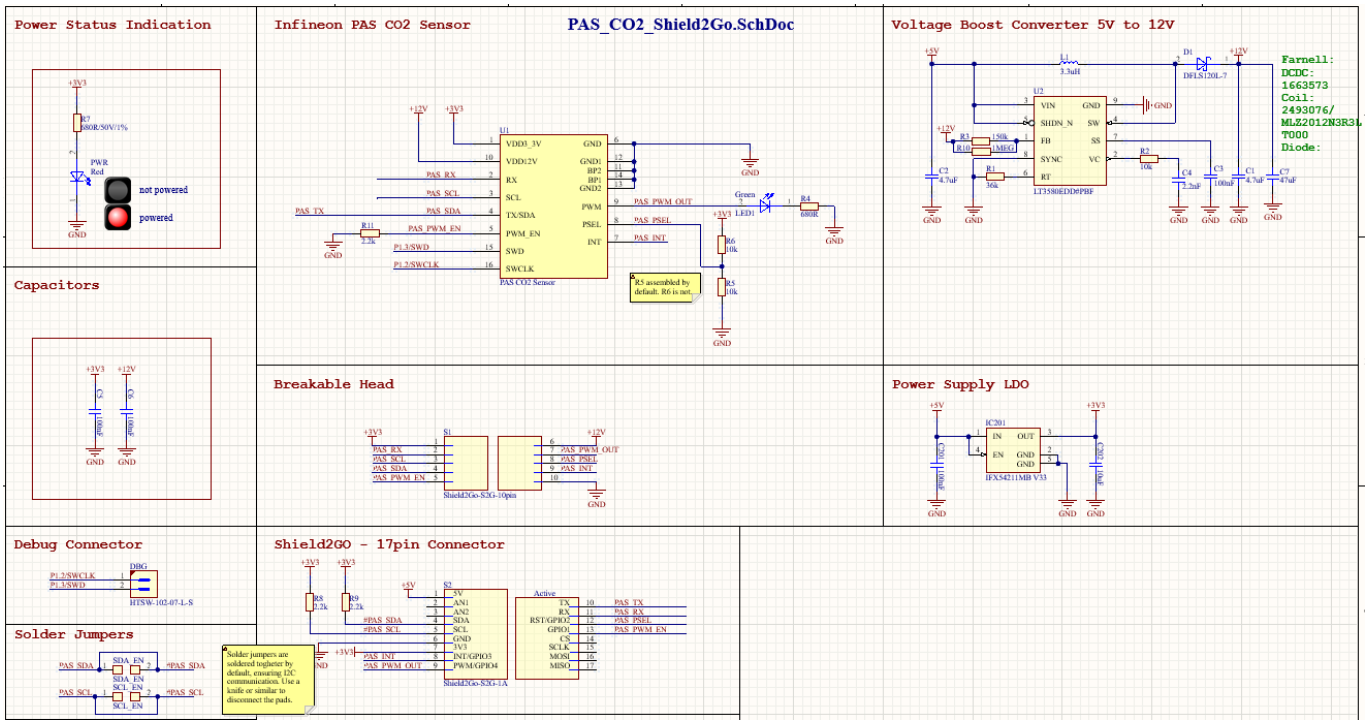

Figure 19 XENSIV™ PAS CO2 Shield2Go schematic

Revision history

Document version	Date of release	Description of changes
V 1.0	01.04.2022	Creation
V 1.1	01.07.2022	Update library overview and figures, added example using My IoT adapter
V1.2	15.08.2022	Highlighting important notes

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Edition 2022-08-15

Published by

Infineon Technologies AG

81726 Munich, Germany

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Document reference
UM_2205_PL38_2206_121720

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