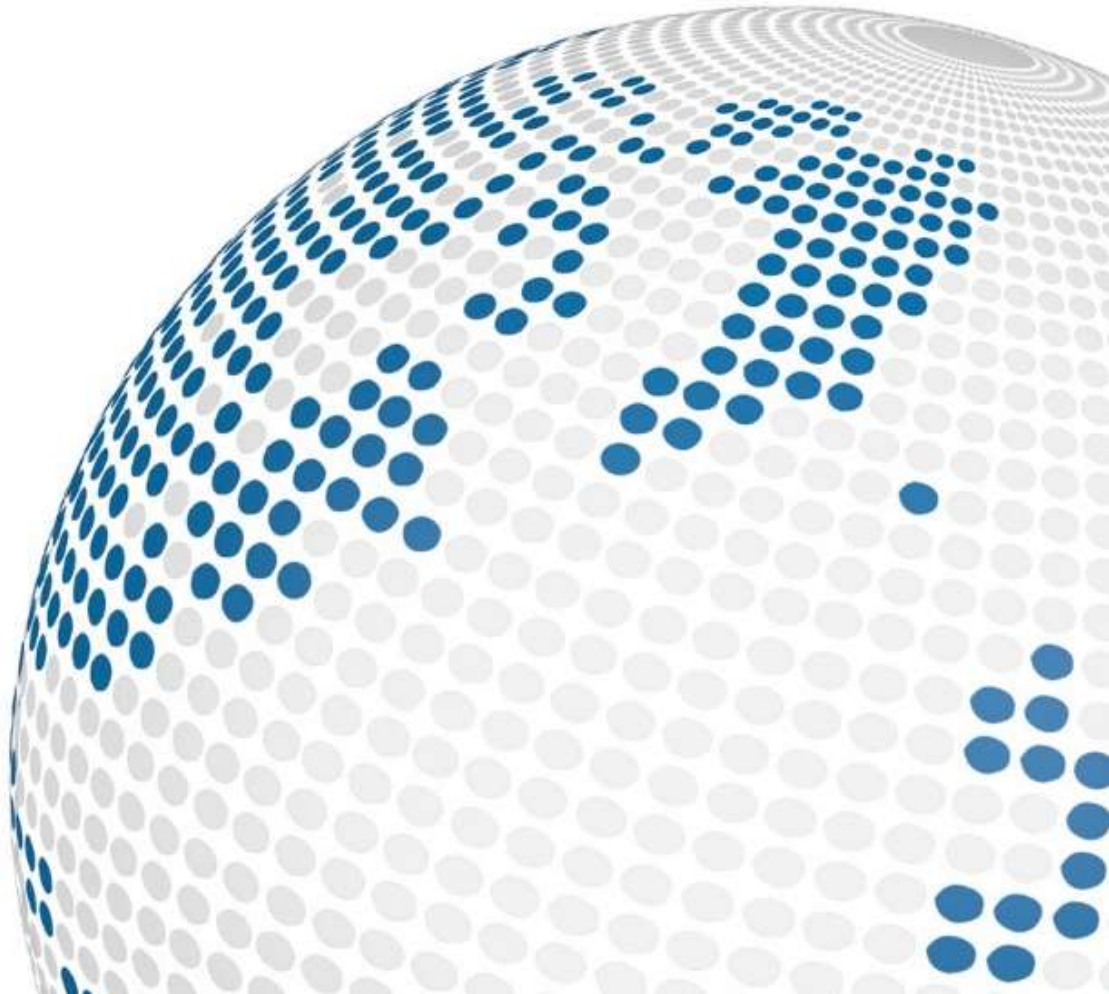
Product Document

Published by
ams OSRAM Group

ams

Shaping the world with sensor solutions

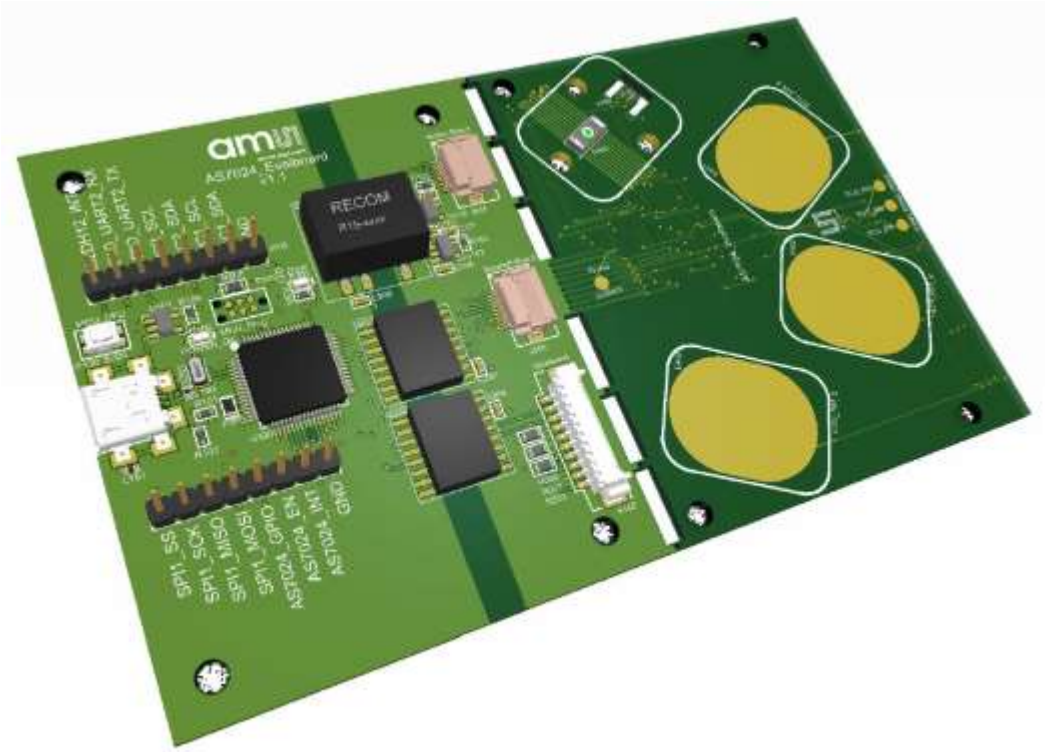
Teresa Meier
Martin Dedek
2018-06-08



AS7024 Eval Kit 1v2

User Guide

Introduction



The AS7024 Eval Kit is designed to evaluate all functions of the AS7024 biosensor and test them in various applications.

For full flexibility, biosensor (AS7024), temperature sensor (AS6200), accelerometer (LIS2DH12) and electrodes are located on the break out board, which can be used in any application and re-connected to the main board via FPC cable. There is also the option to attach different electrodes.

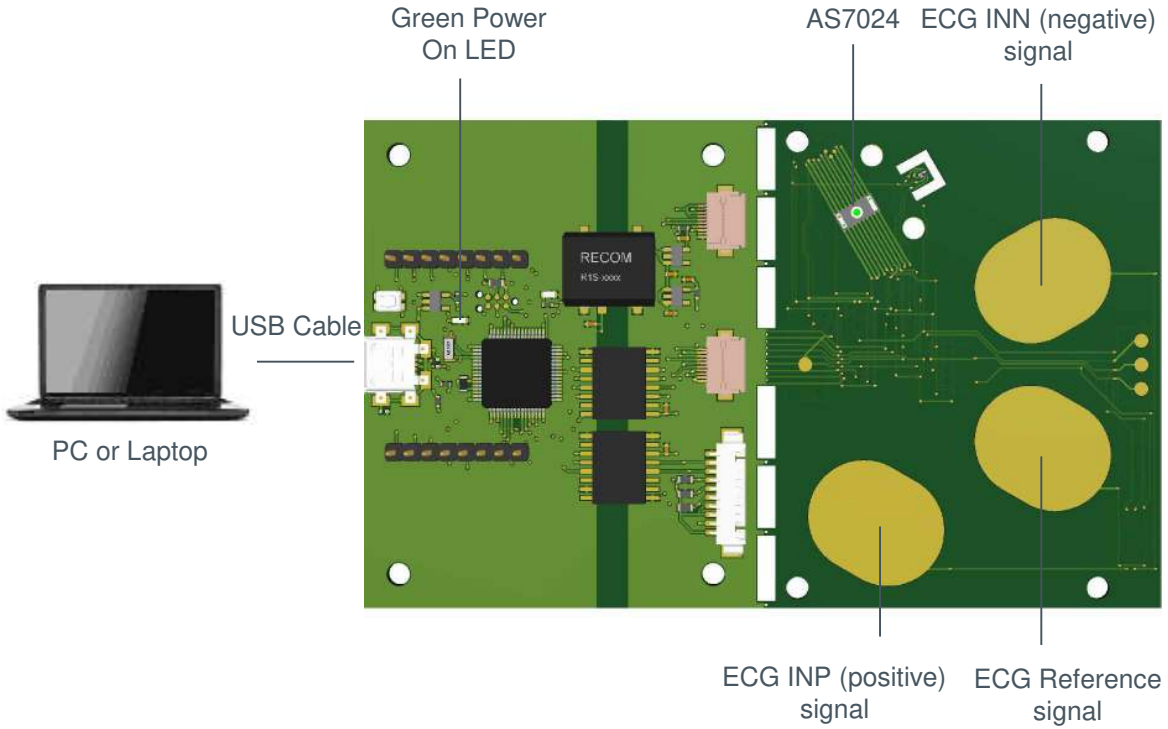
After breaking off the Board it is also possible to connect the Add-On Board with the FPC cable or the Wristband with the PicoBlade connector.

The Eval Kit works with USB connection to the PC and comes with a GUI, which enables the user to change AS7024 register settings and see measurement results.

The SDK currently containing algorithms for HRM and HRV (GSR and BP will be available in the near future) is supplied with the Eval Kit and flashed onto the STM32 ARM Cortex-M4 low power MCU.

Any signals important for development can be probed easily at the pin headers.

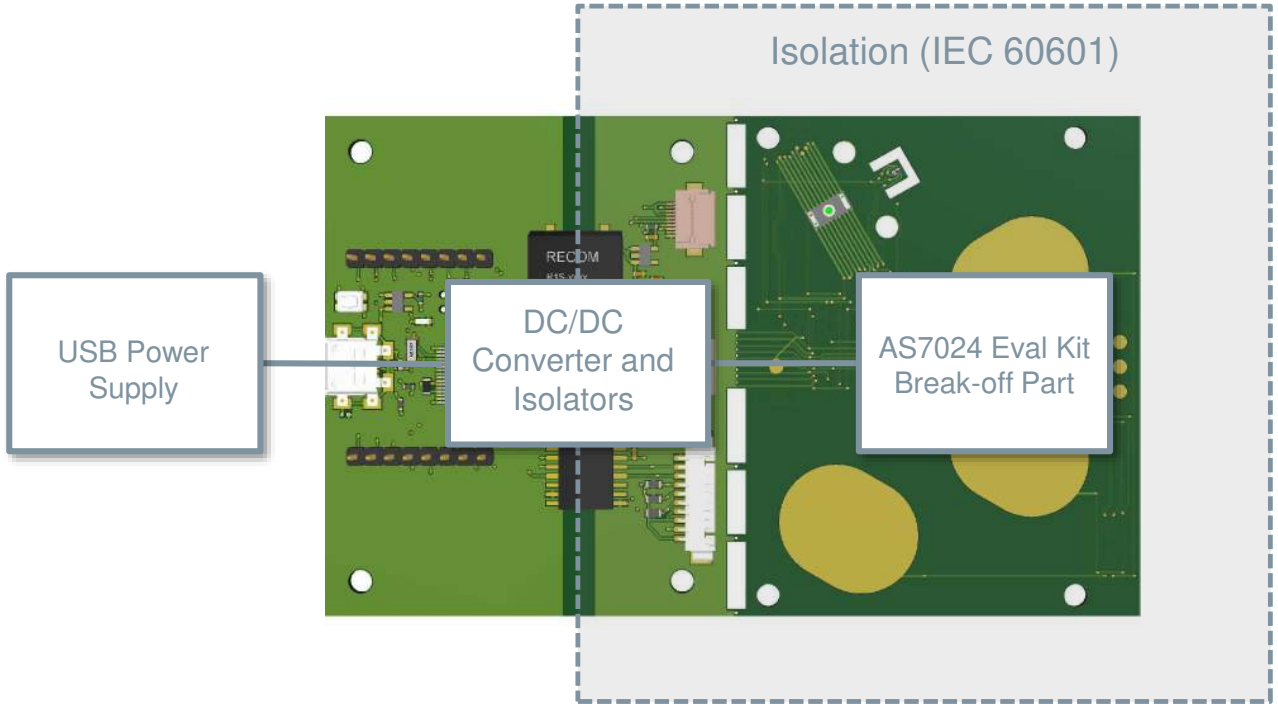
How to use



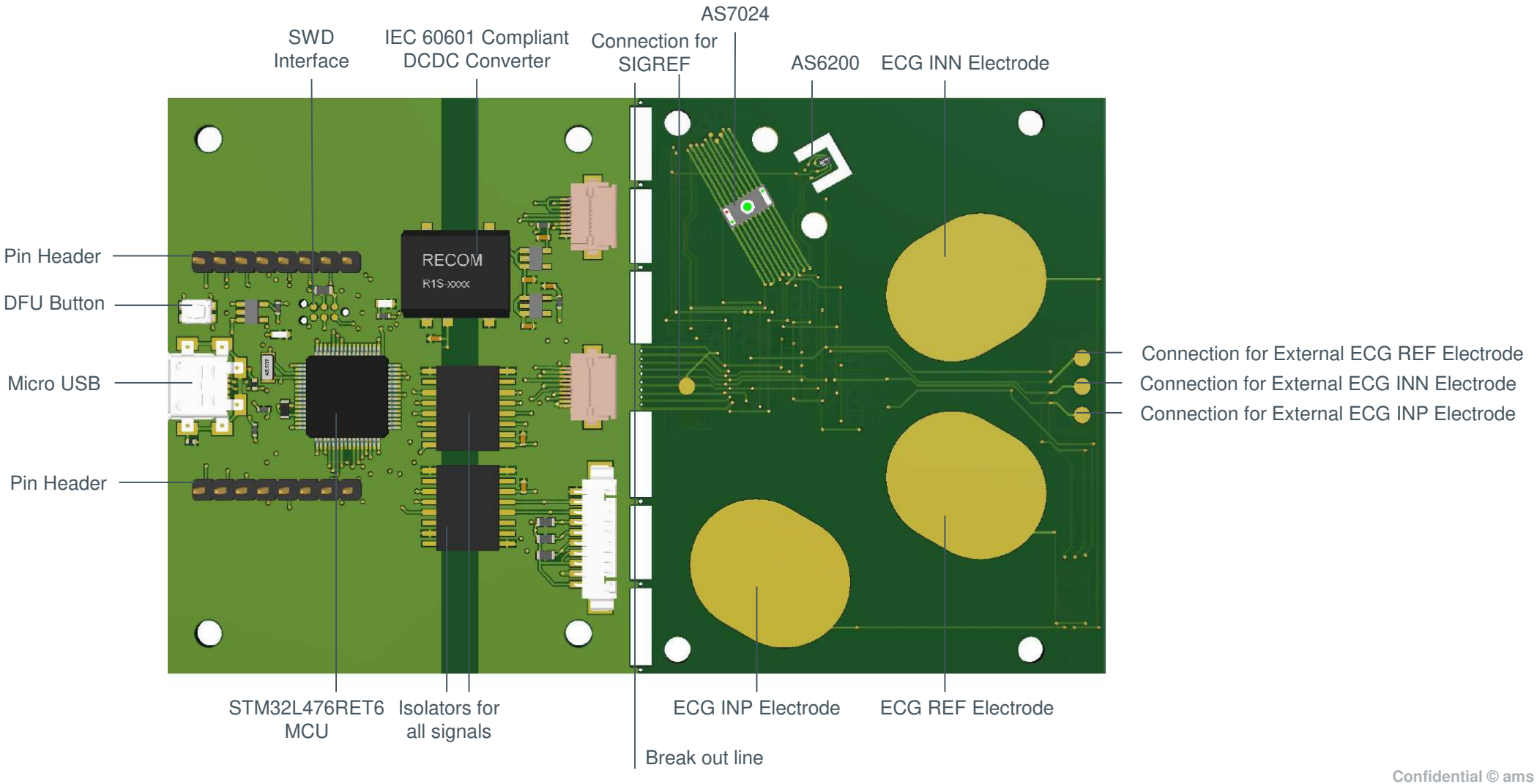
1) Install the SDK on your computer
2) Start the PC GUI
3) Connect the Micro USB to USB cable to the Eval Kit and plug it into your computer
4) The green power LED will turn ON as soon as the board is powered
5) The green AS7024 LEDs will turn on
6) Hold the ECG INP and reference electrodes with pointer and middle finger of your left hand, put the pointer finger of your right hand on the ECG INN electrode and the middle finger of your right hand on the AS7024 to measure
7) The raw pulse and ECG data will be displayed in the GUI

Safety Requirements

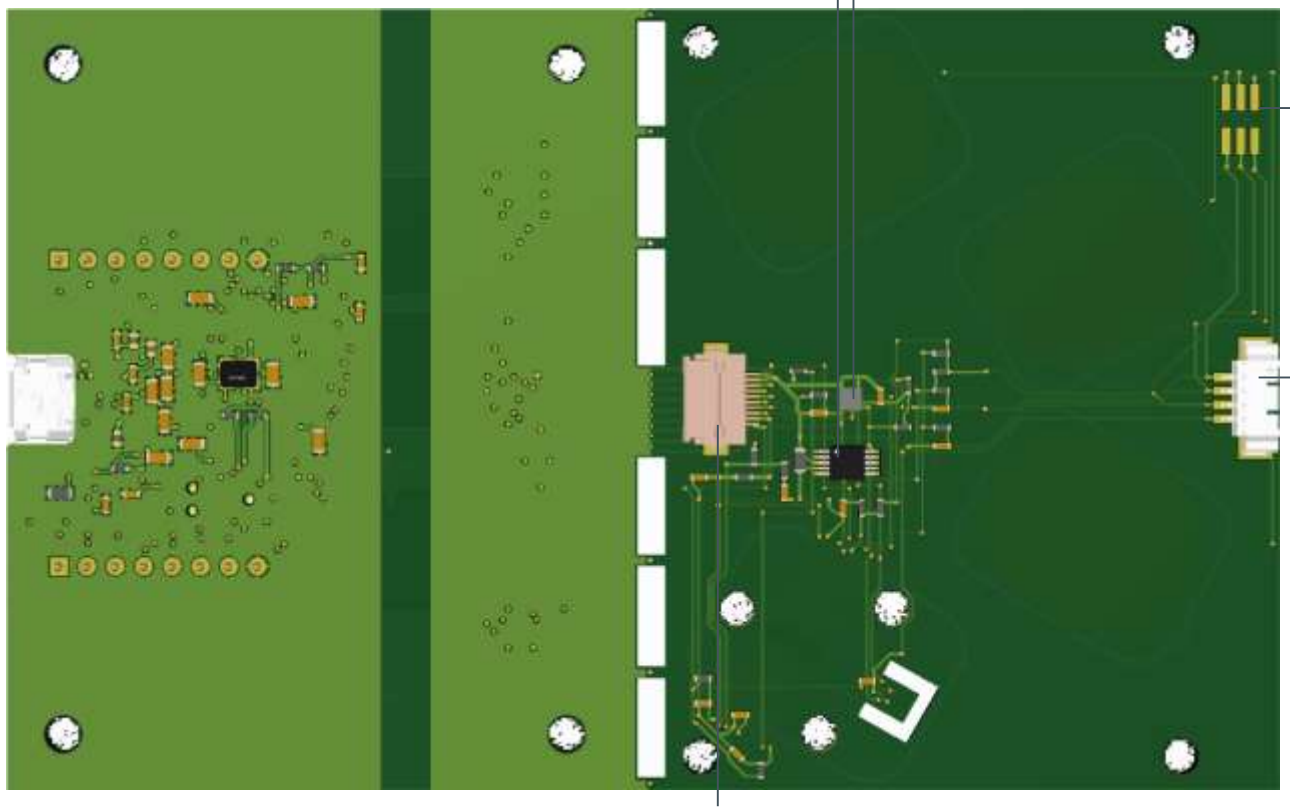
The AS7024 Eval Kit is supplied by USB connection to the PC. In order to avoid a direct connection from the electrodes to the power grid, an IEC 60601 compliant RECOM DCDC converter (R0.25S-0505/H) is assembled on the board as well as isolator ICs for any other signals, which means that there is no physical connection between the break out part of the board and the power grid.



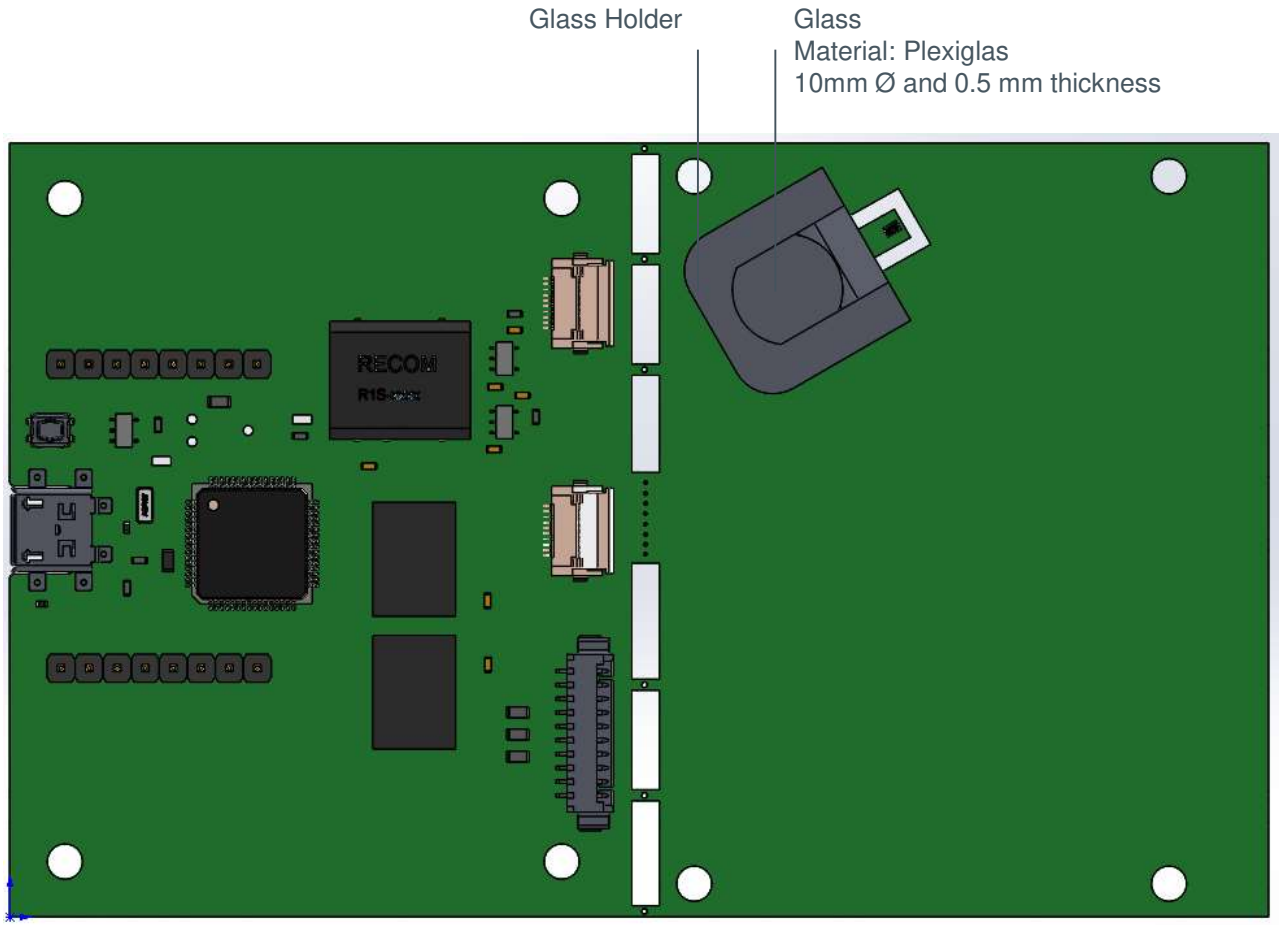
Buildup Top Side



Buildup Bottom Side



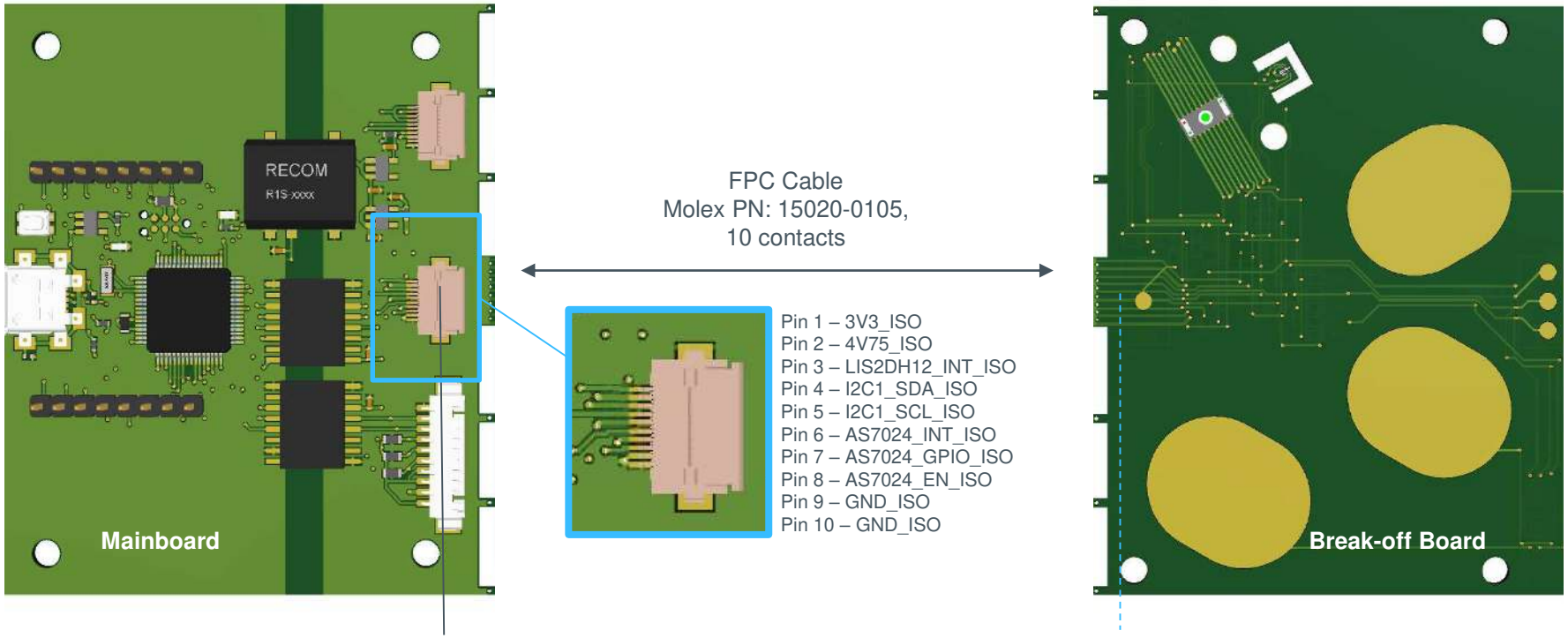
Glass Holder



1) Mount glass holder on PCB

2) Insert glass into holder

Break-off Board



Connector for Break-off Board
Hirose PN: FH12-10S-0.5SH(55),
Bottom contact, 10 contacts

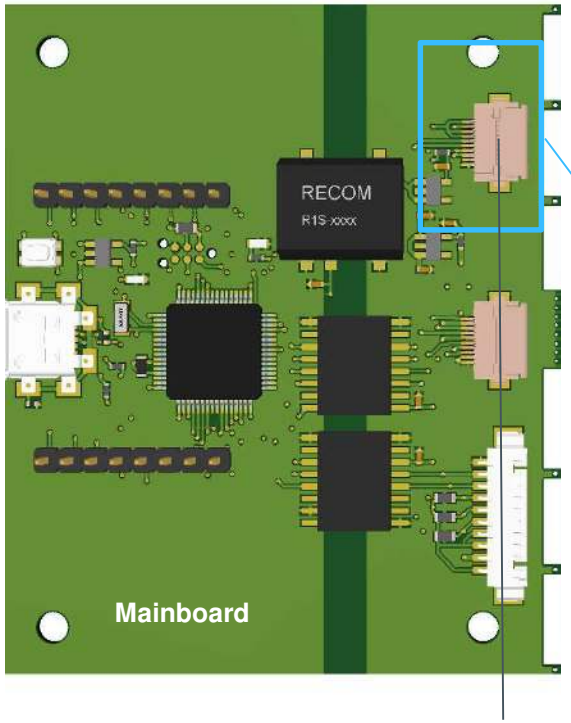
Connector for Break-off Board (on rear side)
Hirose PN: FH12A-10S-0.5SH(55),
Top contact, 10 contacts

1) Break off the board at the break out line

2) Connect the mainboard to the Break-off Board (connector on rear side) by the FPC cable

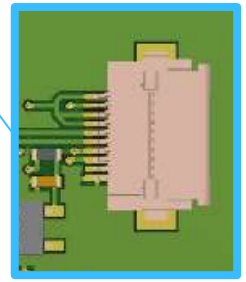
3) It is *not* required to twist the cable, since one connector is a bottom contact connector and the other one is a top contact connector

Add-On Board



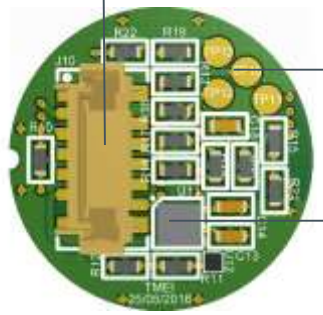
Connector for Add-On Board
Hirose PN: FH12-10S-0.5SH(55),
Bottom contact, 10 contacts

FPC Cable
Molex PN: 15020-0105,
10 contacts



Pin 1 – 3V3_ISO
Pin 2 – 4V75_ISO
Pin 3 – 3V3_ISO
Pin 4 – 3V3_ISO
Pin 5 – I2C1_SDA_ISO
Pin 6 – I2C1_SCL_ISO
Pin 7 – AS7024_INT_ISO
Pin 8 – AS7024_GPIO_ISO
Pin 9 – AS7024_EN_ISO
Pin 10 – GND_ISO

Connector for FPC cable
Hirose FH12-10S-0.5SV(55),
Vertical orientation, 10 contacts

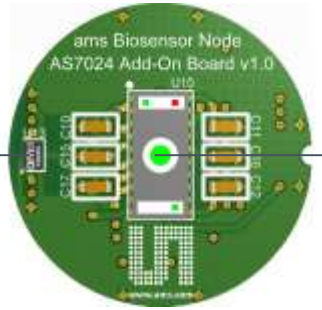


Test points to connect
external electrodes

Accelerometer
LIS2DH12

BOTTOM SIDE

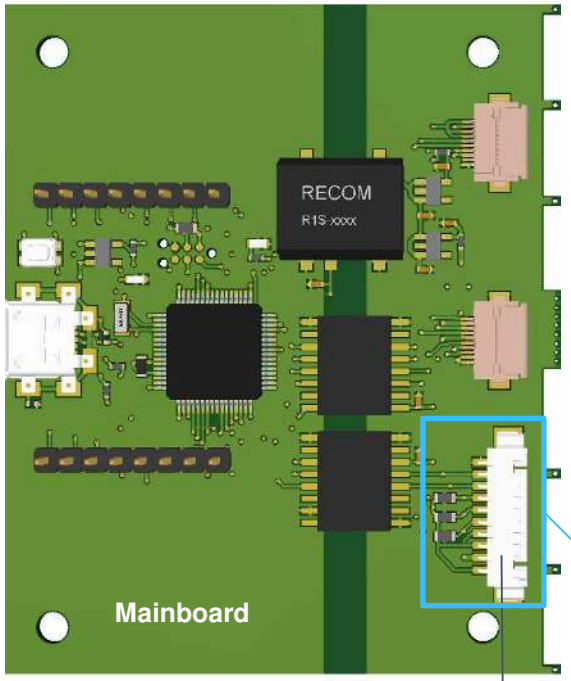
Temperature sensor
AS6200



AS7024

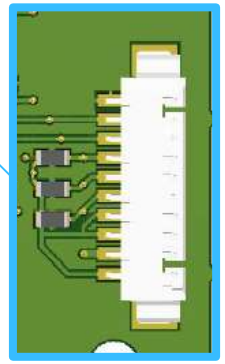
TOP SIDE

Wristband



Connector for Wristband
Molex PN: 53261_1071,
10 contacts

Connect the Wristband to the
mainboard with the
red custom cable,
10 contacts



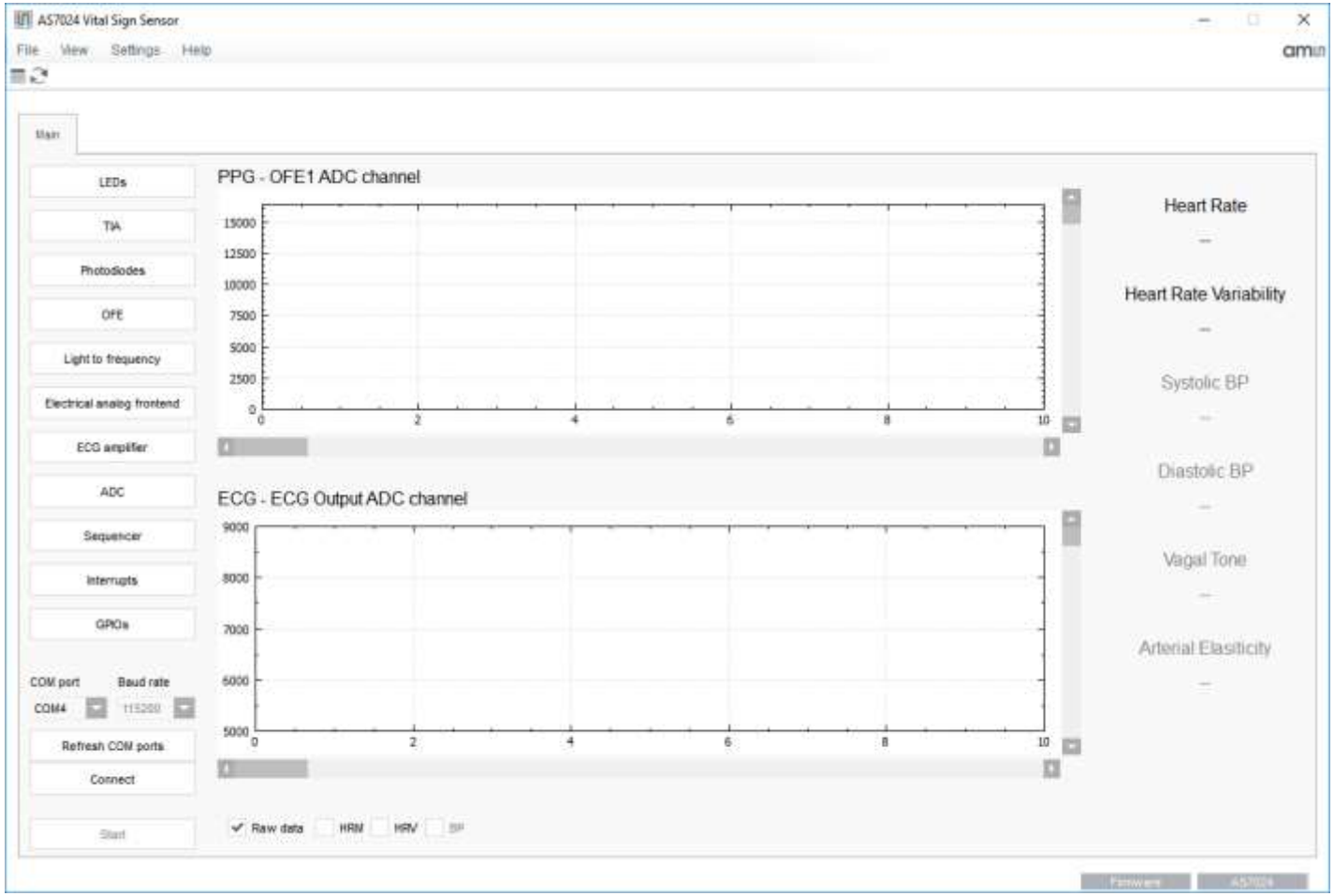
Pin 10 – GND_ISO
Pin 9 – AS7024_EN_ISO
Pin 8 – AS7024_GPIO_ISO
Pin 7 – AS7024_INT_ISO
Pin 6 – I2C1_SCL_ISO
Pin 5 – I2C1_SDA_ISO
Pin 4 – 3V3_ISO
Pin 3 – 3V3_ISO
Pin 2 – 4V75_ISO
Pin 1 – 3V3_ISO

AS7024

The Wristband also includes the accelerometer
(LIS2DH12) and 2 x AS6200

AS7024 PC Software

Working with the software



1) Connect the evaluation board to your computer using a Micro USB cable – the board will register as virtual COM board in Windows.
2) The green power LED will turn ON as soon as the board is powered
3) Select the correct COM port in the in the selection box in the lower left corner of the application. If no COM ports are listed click on “Refresh COM ports” button
4) Use the “Connect” button to start up a connection to your board. The two status fields in the bottom status bar will turn green upon successful connection
5) After pressing the “Start” button the measurement of PPG and ECG starts.
6) Touch the ECG INP and reference electrodes with index and middle finger of your left hand, put the index finger of your right hand on the ECG INN electrode and the middle finger of your right hand on the AS7024 to measure

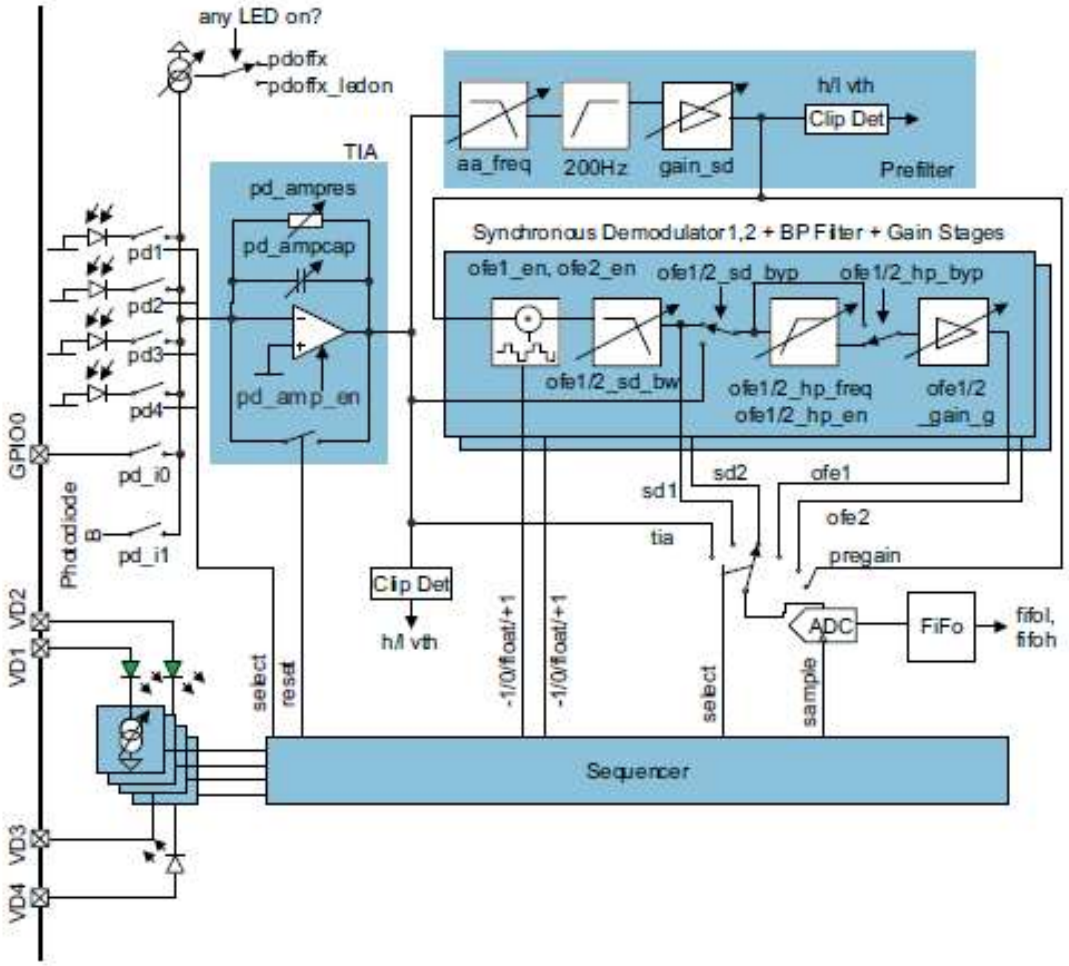
AS7024 PC Software

AS7024 Configuration Settings

At power up the board starts with default a configuration:

- The two green LEDS - LED1(VD1) and LED2(VD2) are enabled, the LED current set to 50 mA
- Sequencer period set to 2000 microseconds
- Photodiode Trans-Impedance amplifier (TIA) is on and used
- All filters are on and used
- ADC is set to measure only the optical front end 1 after the gain stage (ofe1)

The individual settings of each of the AS7024 blocks can be viewed/changed in the dedicated configuration sub menu (see next slides)



AS7024 PC Software

Sub Menu Selection

AS7024 Configuration settings

LEDs -> Datasheet pg. 14 ff.

TIA -> Datasheet pg. 29 ff.

Photodiodes -> Datasheet pg. 24 ff.

OFE -> Datasheet pg. 34 ff.

Light to frequency -> Datasheet pg. 54 ff.

Electrical analog frontend -> Datasheet pg. 61 ff.

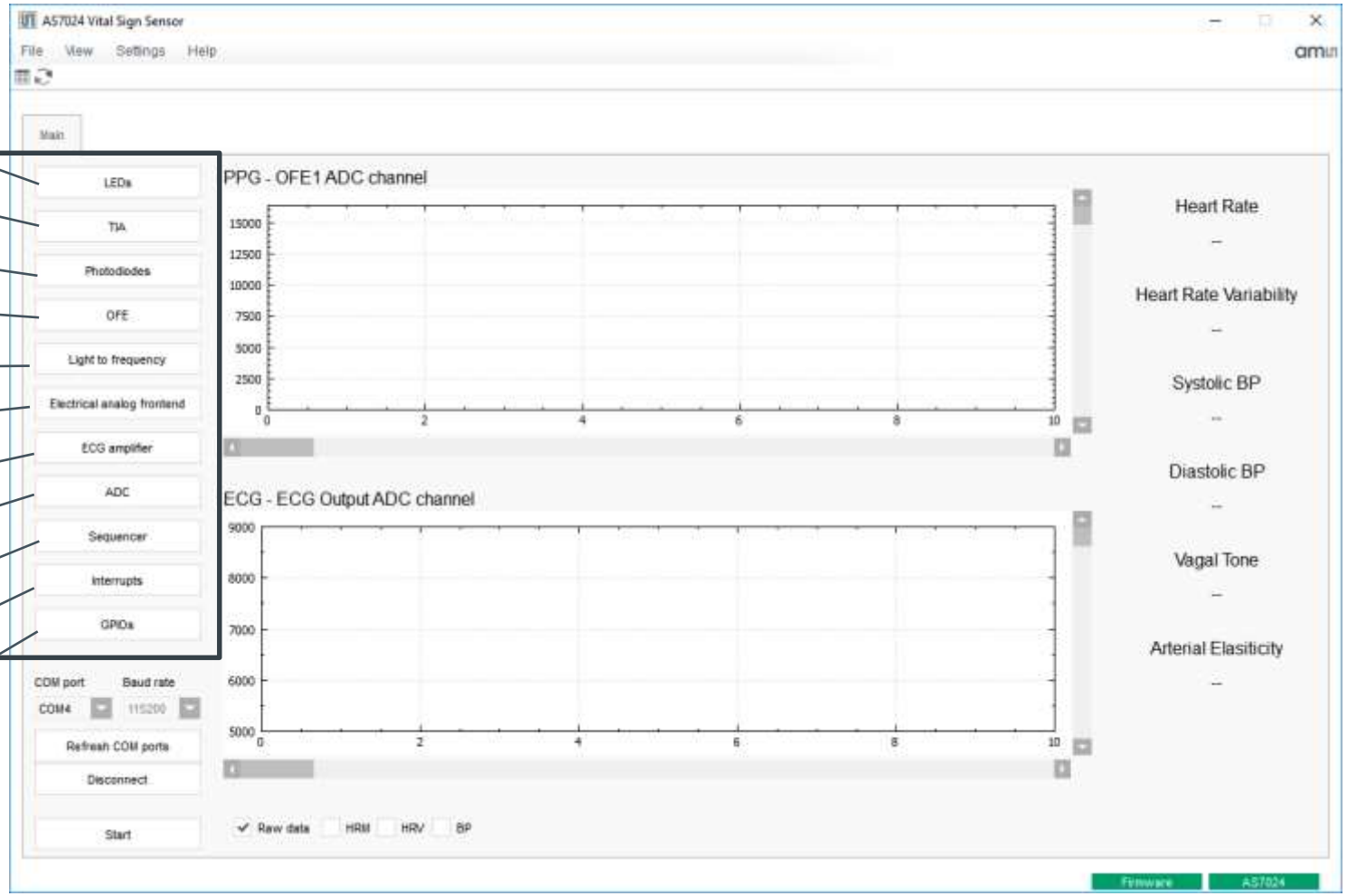
ECG amplifier -> Datasheet pg. 70 ff.

ADC -> Datasheet pg. 75 ff.

Sequencer -> Datasheet pg. 35 ff.

Interrupts -> Datasheet pg. 84 ff.

GPIOs -> Datasheet pg. 84 ff.

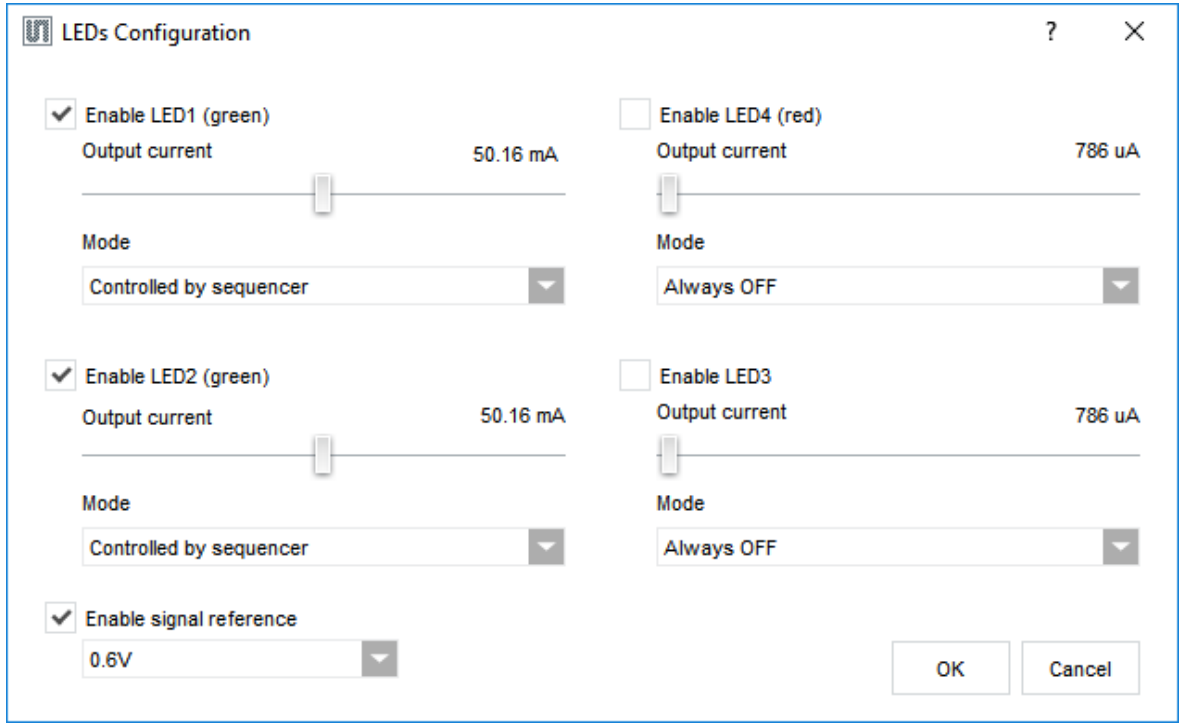


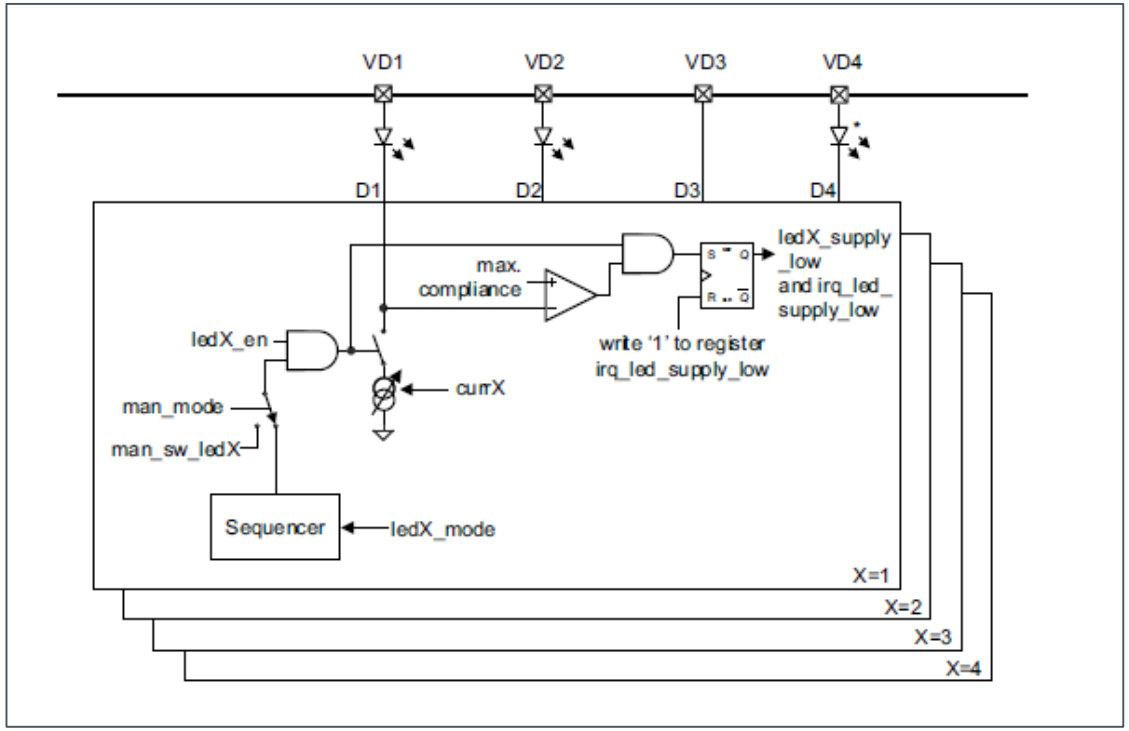
To enter the submenus press the corresponding button

AS7024 PC Software

LEDs Configuration

LED current and LED mode can be set in the “LEDs configuration” window. It is recommended to configure the current only when the output is not active as there is no latch implemented to keep the 10 bits consistent. New values are applied directly and immediately.



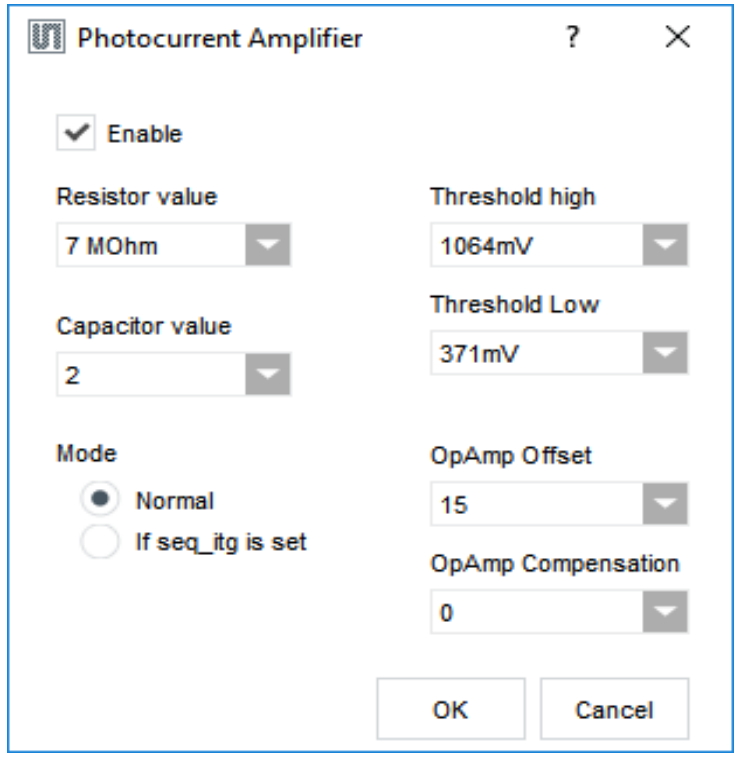


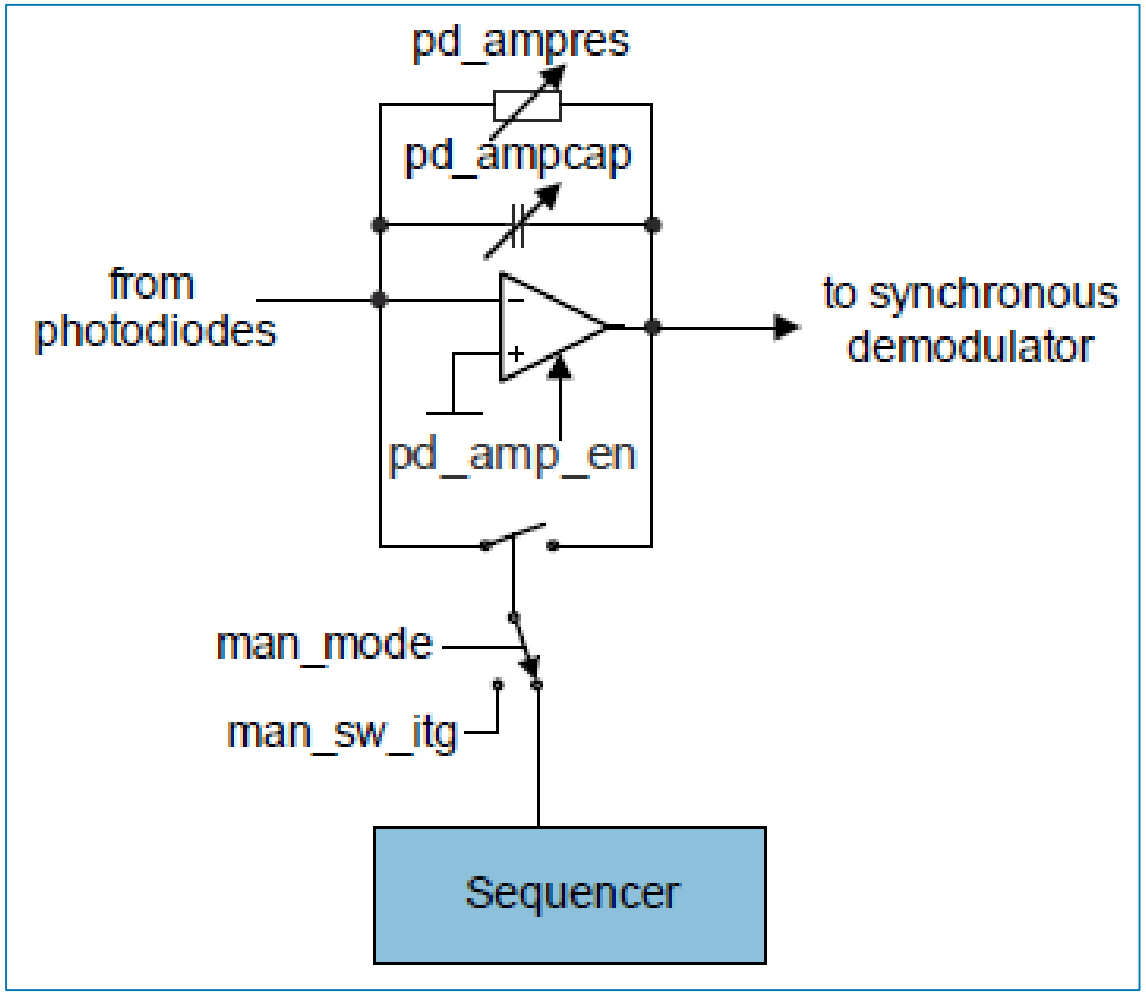
AS7024 PC Software

TIA Configuration

The TIA has to be configured according to the information in the AS7024 datasheet (table in figure 30).

It is recommended to **always** set “OpAmp Offset” to 15.

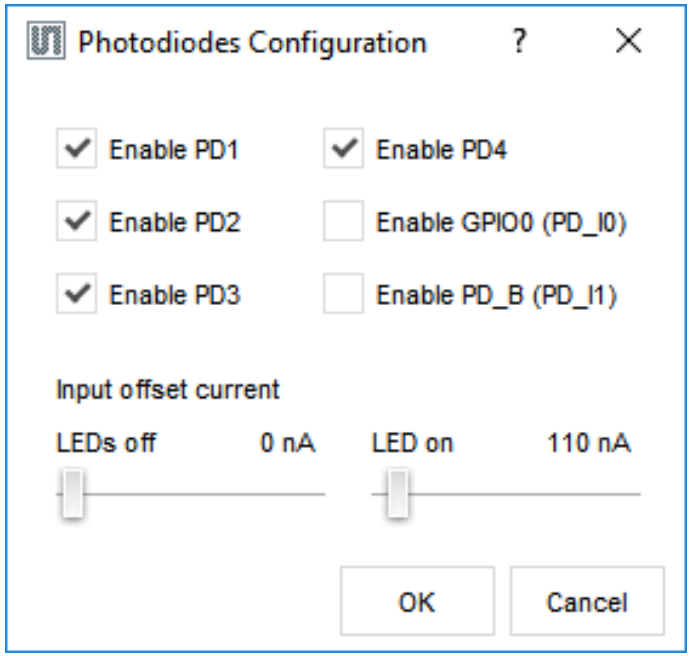


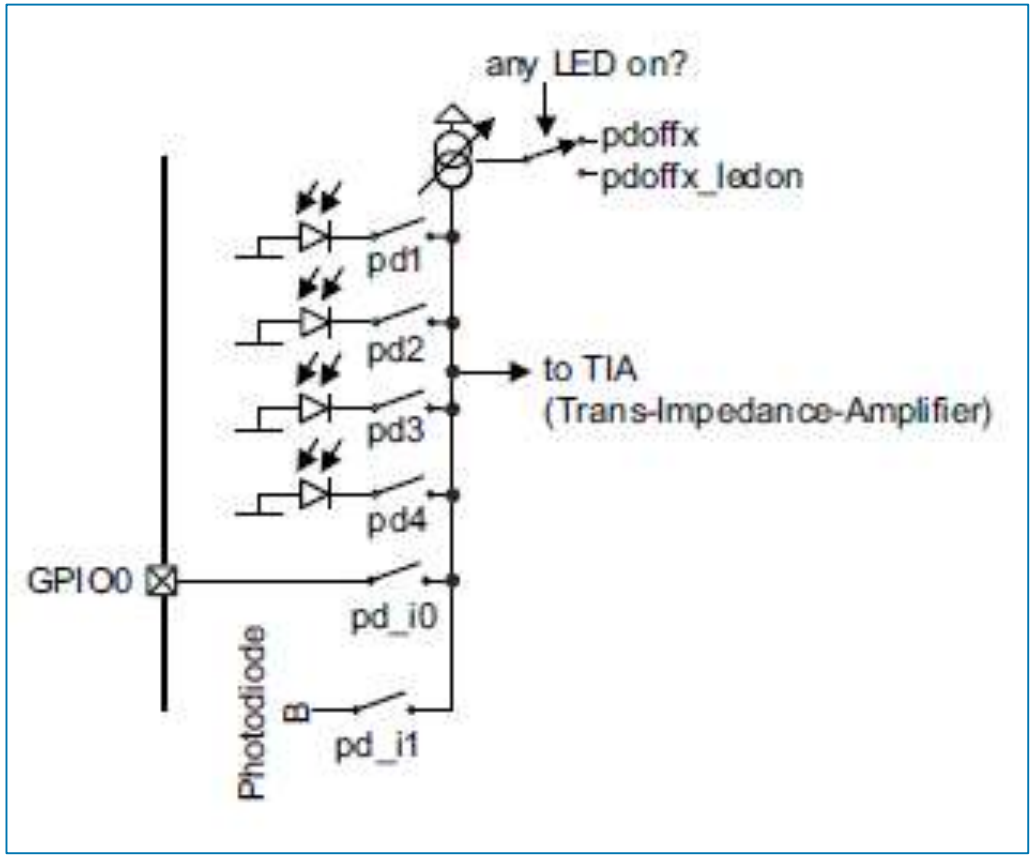


AS7024 PC Software

Photodiodes Configuration

Select the photodiodes which to connect to the TIA input. The offset current is optional, this allows cancellation of constant light sources like sunlight. Default for the input offset current is 0 for both – LEDs off and any LED on.
For an external photodiode or any other sensor with (low) current output, the pins GPIO0 and GPIO1 can be used as input.
The sequencer controls the diodes – see diode_ctrl described in register MAN_SEQ_CFG.





AS7024 PC Software

OFE Configuration

Synchronous demodulator

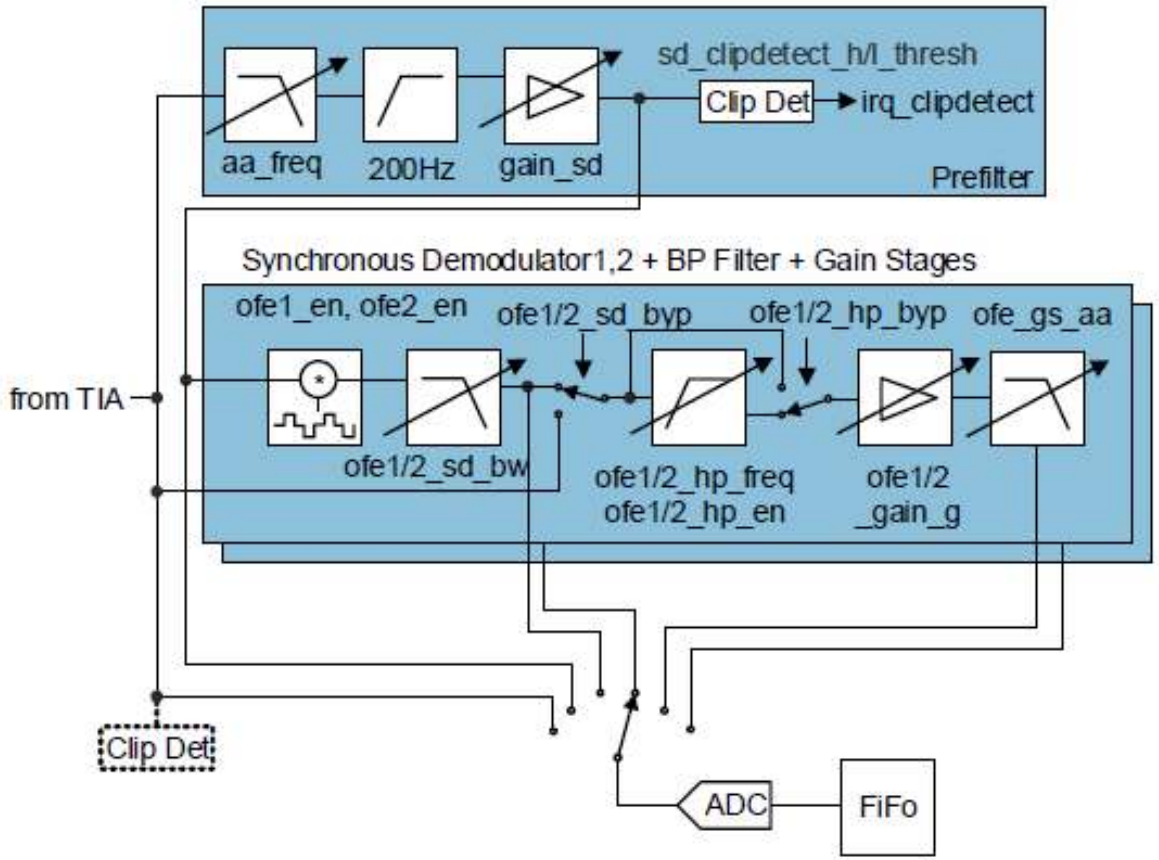
The AS7024 has two optional synchronous demodulators that can be used to detect small optical signals in the presence of large unwanted noise (ambient light). They have an input filer (the Prefilter block on the schematics - high pass at 200Hz, adjustable low pass) and a 2nd order adjustable output low pass (ofe_gs_aa). The demodulator itself multiplies the signal by +1 / 0 / -1 with a timing which is controlled by the sequencer.

High Pass Filter

Two optional high pass filters can be used to remove DC-components from the signal and allow further amplification - four cutoff frequencies can be chosen.

Gain Stage

Two optional gain stage can be used to amplify the signal after the DC-component has been removed.

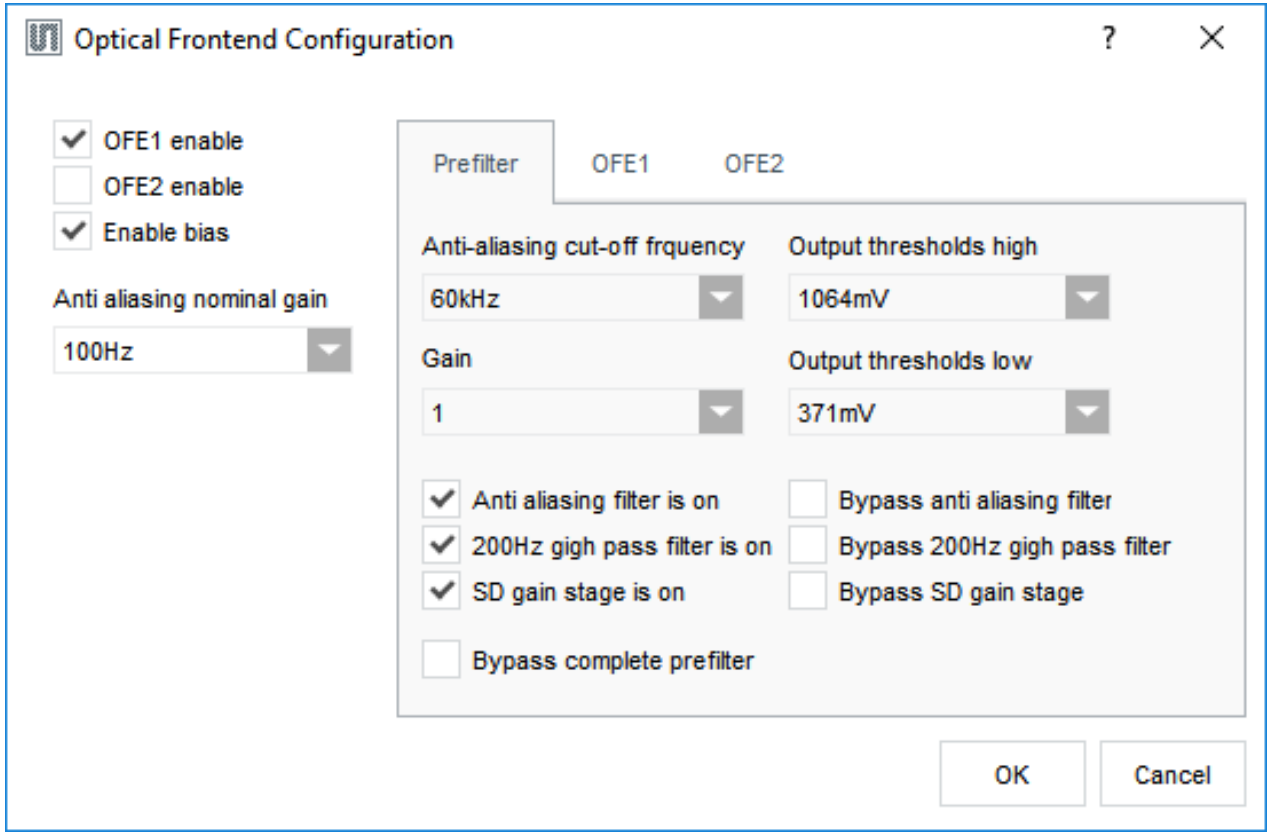


AS7024 PC Software

OFE Configuration

Check OFE1 and/or OFE2 check box to enable the corresponding OFE block shown on the previous slide.

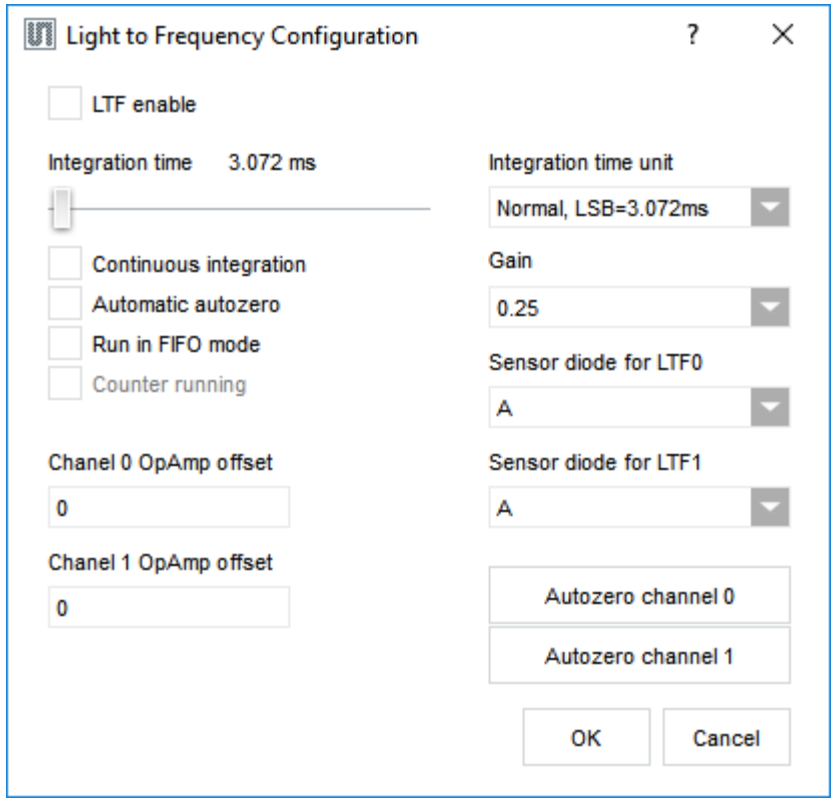
The “Prefilter” tab is setting the configuration of the input filters of the two synchronous demodulators. For reference, please see OFE_CFGA, OFE_CFGB, OFE_CFGC and OFE_CFGD register descriptions in the AS7024 datasheet.

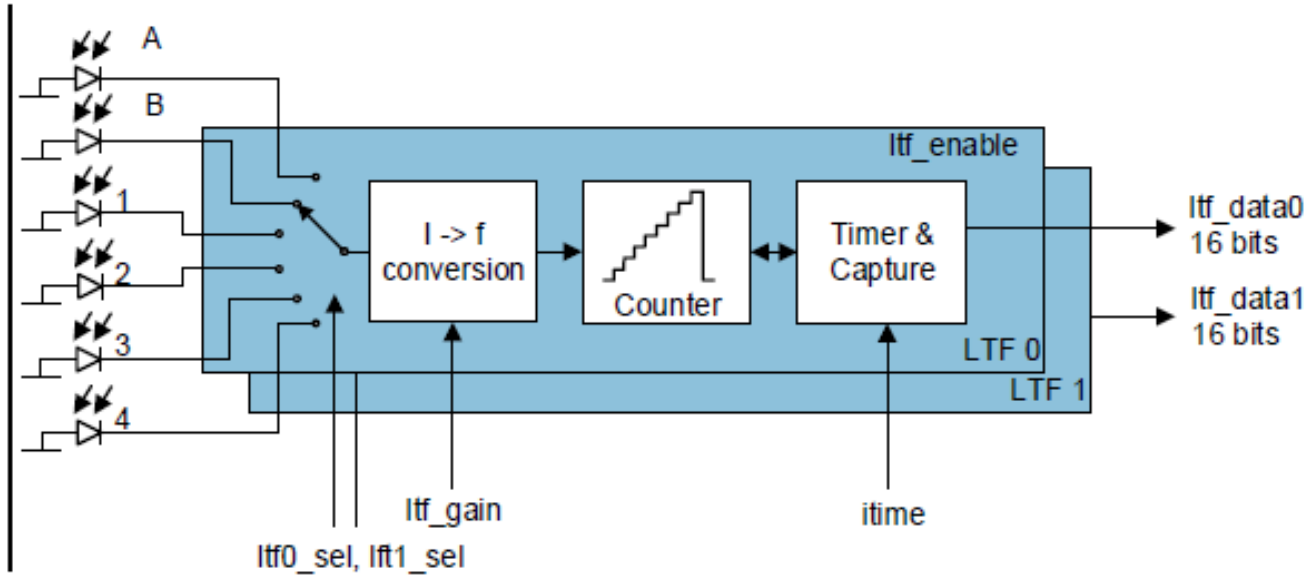


AS7024 PC Software

Light to Frequency Configuration

Light to frequency can be used to convert a light source into a frequency signal. Several settings can be done. For details check the AS7024 datasheet.
The following registers can be shown/configured in the dialog: ITIME, LTF_CONFIG, LTF_SEL and LTF_GAIN. **When selecting sensor diodes for LTF0/LTF1, make sure the selected diode is not connected to the TIA at the same time (its checkbox in the "Photodiodes" window should be unchecked), currently the SW will not take care of that**.

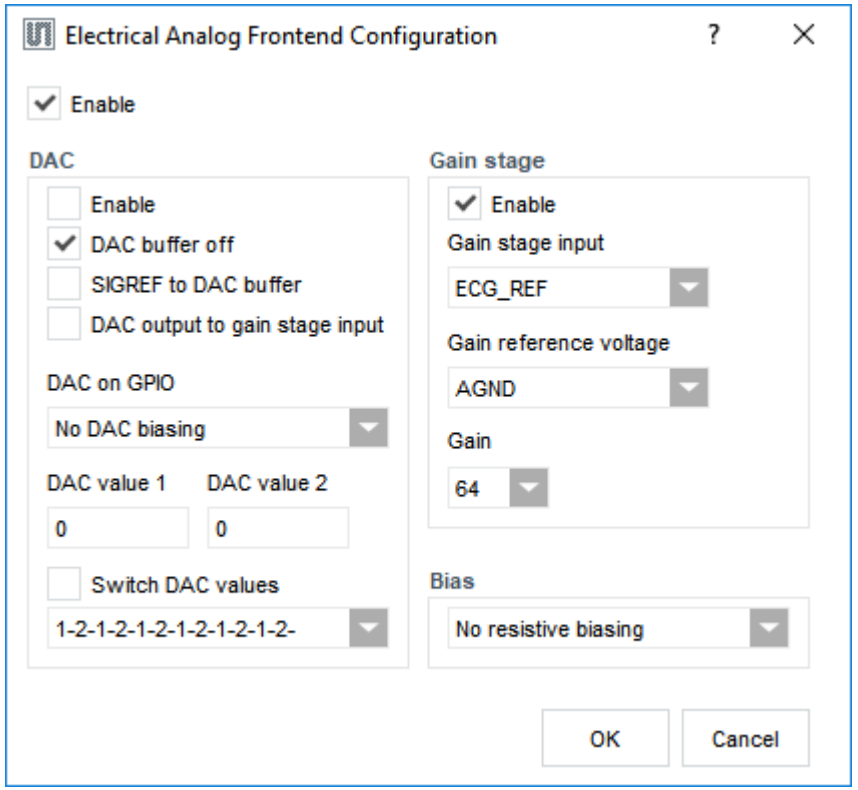


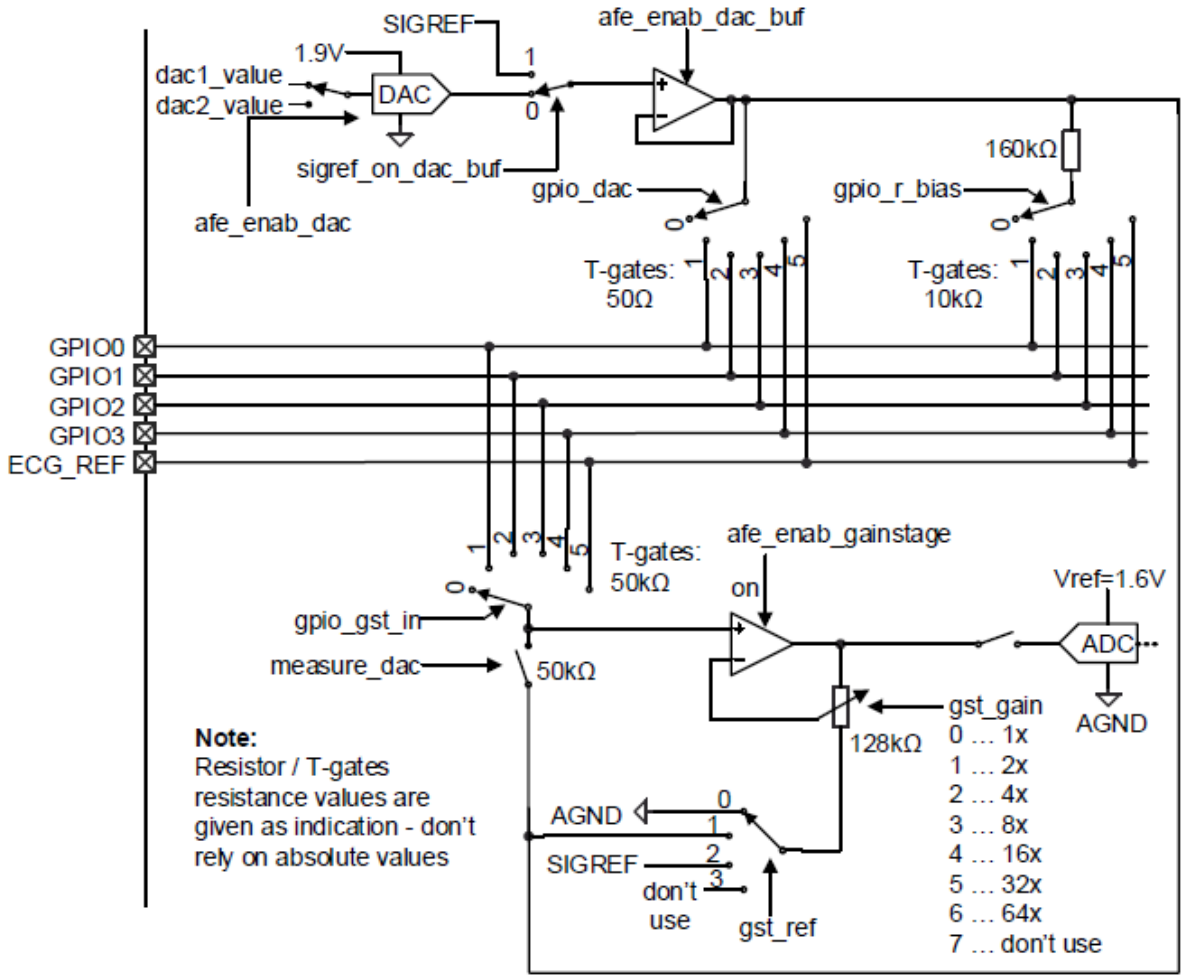


AS7024 PC Software

Electrical Analog Frontend Configuration

The electrical analog front end consists of three identical signal paths with independent settings of bias condition, gain and offset.
Here the EAF_CFG, EAF_GST, EAF_BIAS, EAF_DAC and EAF_DAC_CFG registers are set.

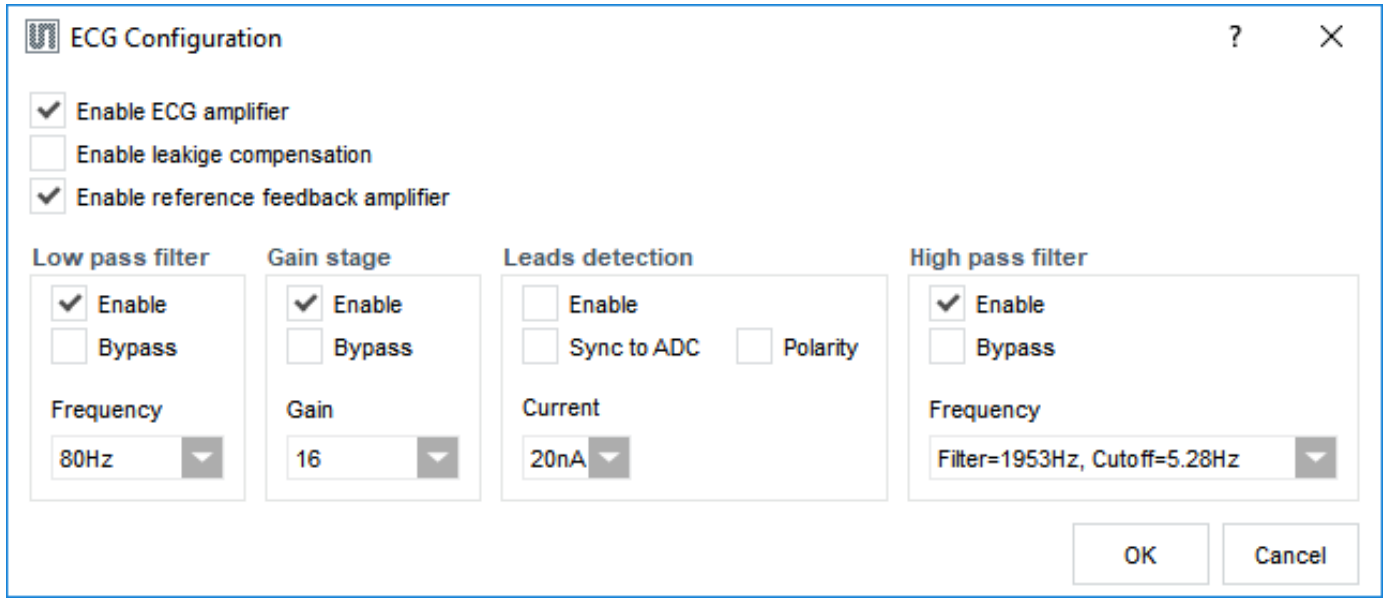


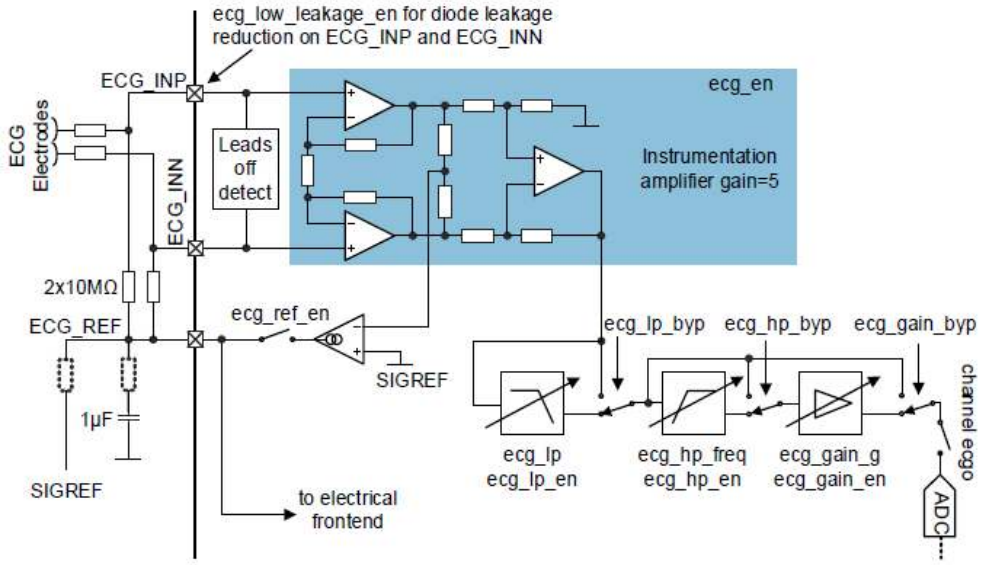


AS7024 PC Software

ECG Amplifier Configuration

The ECG (electrocardiography) amplifier is a high impedance, low noise instrumentation amplifier with analog circuitry to band pass filter the signal and amplify it before converting it with the ADC.
The ECG signal can be used independently or together with PPG in further computation. (eg. Blood pressure)



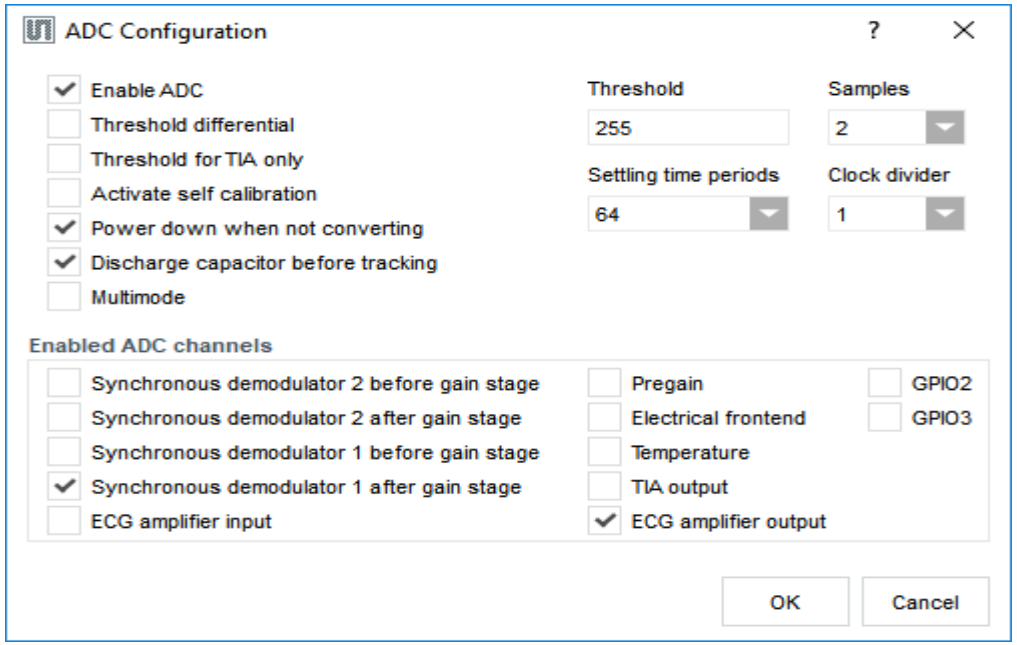


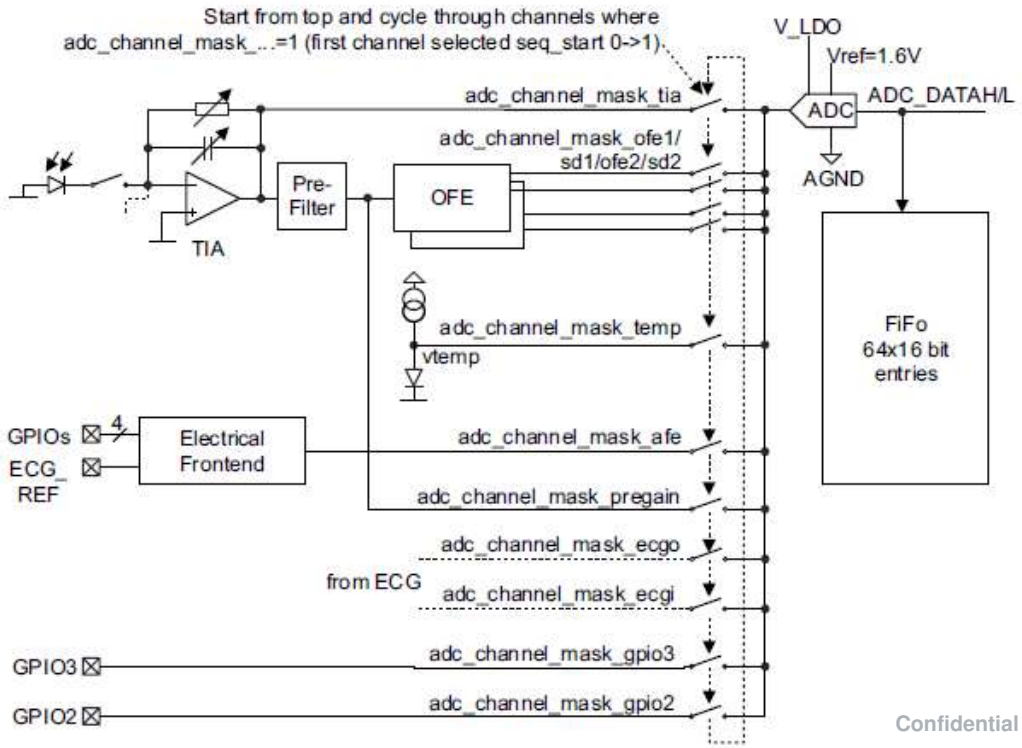
AS7024 PC Software

ADC Configuration

The ADC is a 14bit successive-approximation register (SAR) type. It supports 14bit with conversion time up to 50ksps.
At the output of the ADC converter a digital threshold can be enabled. If the output of the ADC exceeds the threshold adc_threshold, it triggers an interrupt. This mechanism can be used to identify if an object is in proximity of the sensor and then to interrupt the host. In cases where no object is detected, the host can be sleeping therefore reducing power consumption of the system.

For detailed description of the threshold calculation see the register ADC_THRESHOLD and ADC_THRESHOLD_CFG description.

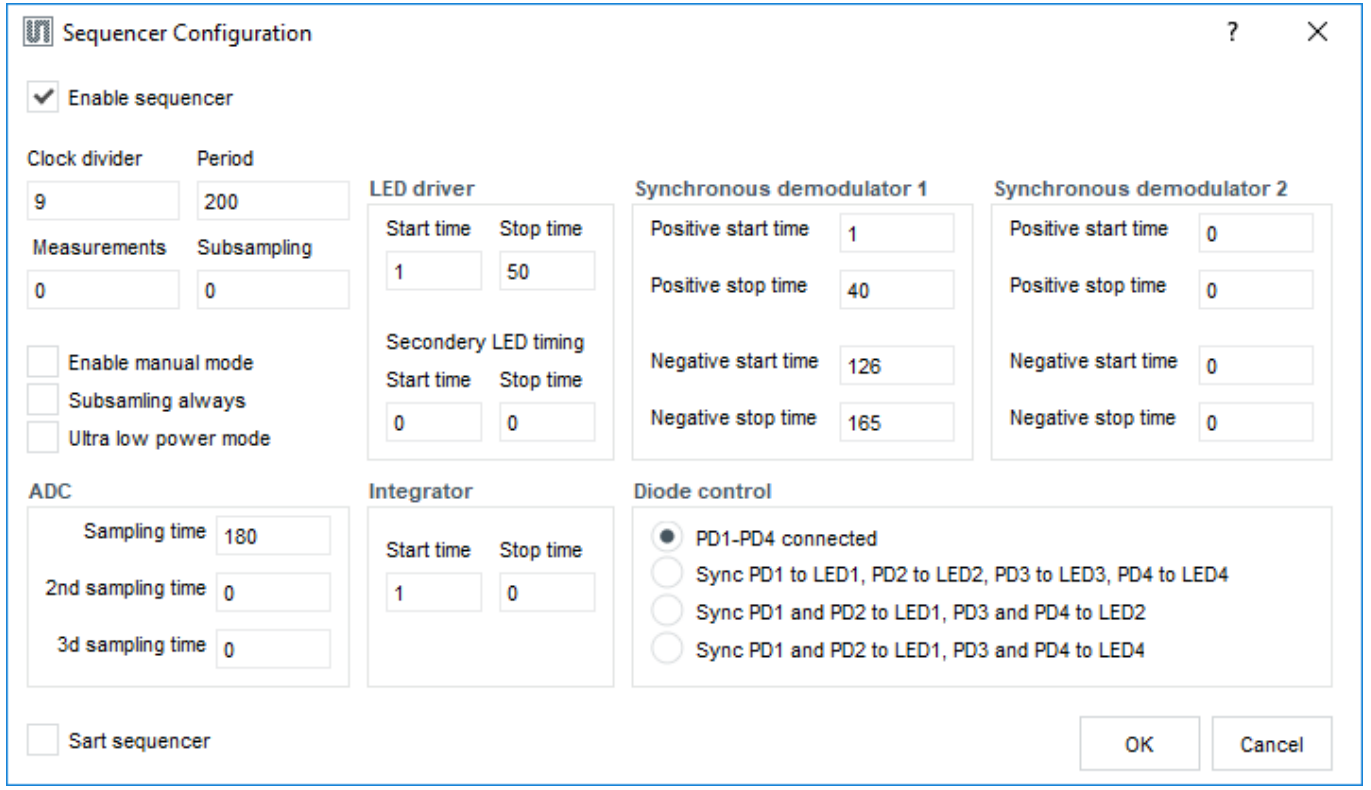




AS7024 PC Software

Sequencer Configuration

In order to synchronize the LED-currents, the integration time and the ADC-sampling time, a built in sampling Sequencer is used.
The sequencer generates the 8 bit-timings based on a 1µs clock. The input clock can be pre-scaled with the “Clock divider” (SEQ_DIV register). The sequencer will trigger the ADC do a measurement of its enabled channels (configured in the “ADC Configuration” dialog) with a period of (Period * (Clock divider +1) * 1µs. For the default configuration this gives a period of 2000 µs.

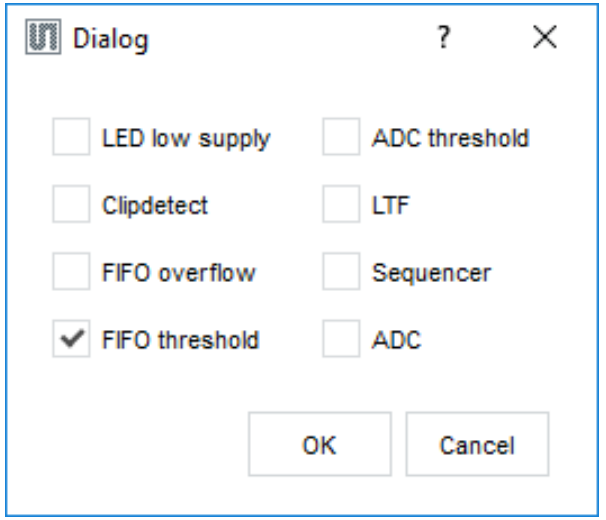


AS7024 PC Software

Interrupts Configuration

An interrupt output pin INT can be used to interrupt the host.
The following interrupt sources can be selected:

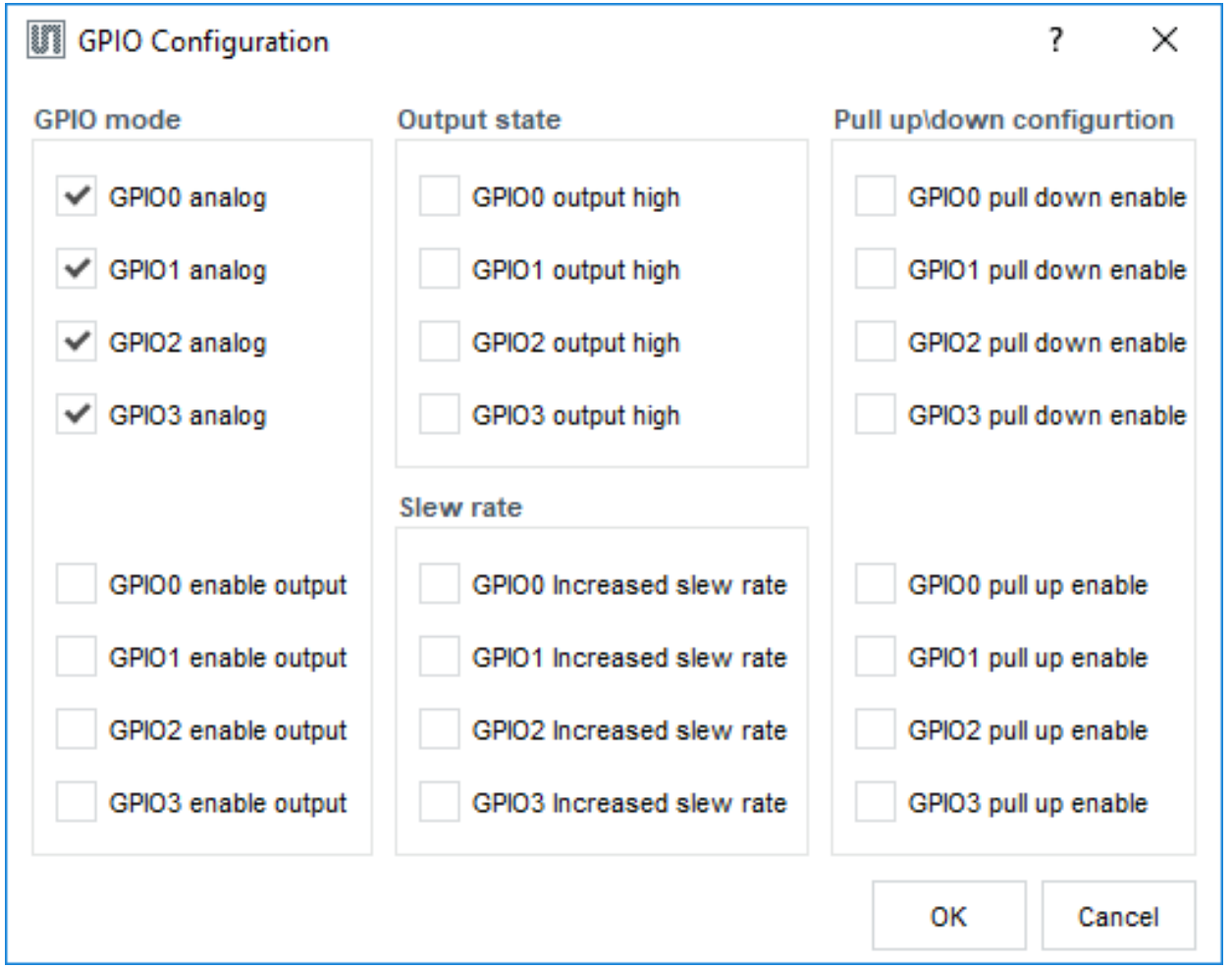
- ADC: End of ADC conversion
- Sequencer: End of sequencer sequence reached.
- LTF: A light-to-frequency conversion is finished.
- ADC threshold: ADC threshold triggered – see ADC threshold.
- FIFO threshold: FIFO almost full (default is each sample triggers an interrupt)
- FIFO overflow: FIFO overflow (error condition, data is lost
- Cipdetect: TIA output and/or SD output exceeded threshold– see details in CLIPSTATUS
- LED supply low: led supply low comparator triggered – see details in LEDSTATUS



AS7024 PC Software

GPIOs Configuration

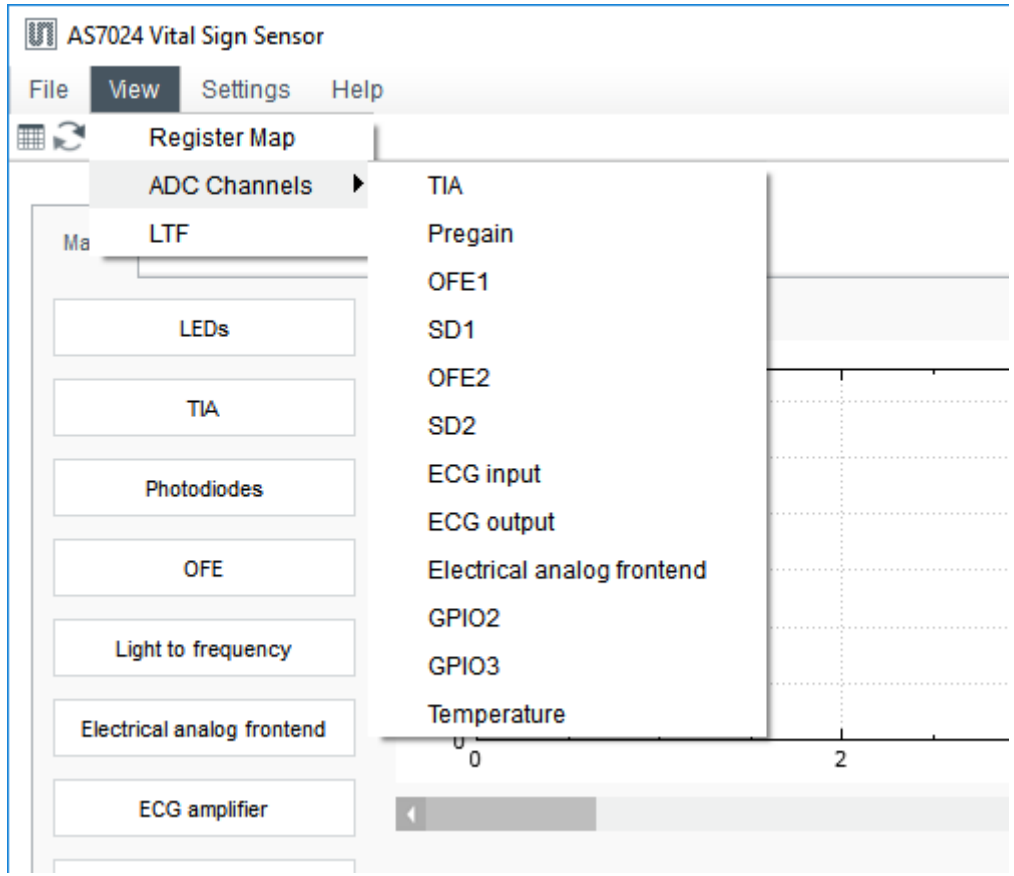
To set a GPIO to analog mode check the check box from the “GPIO mode” group box. If left unchecked, then the GPIO is a digital output or input, depending on the state of the “GPIOx enable output” check boxes - unchecked means the pin is digital input. If the pin is set as digital output, it’s state can be set via the corresponding check box in the “Output state” group box.



AS7024 PC Software

Additional ADC channels and Light-to-Frequency data display

To display a data plot of an ADC channel other than OFE1 and ECG Output, click on menu “View → ADC Channels” and then on the desired ADC channel.
For Light-to-Frequency data output, click on “View → LTF”.
A separate plot window will open.

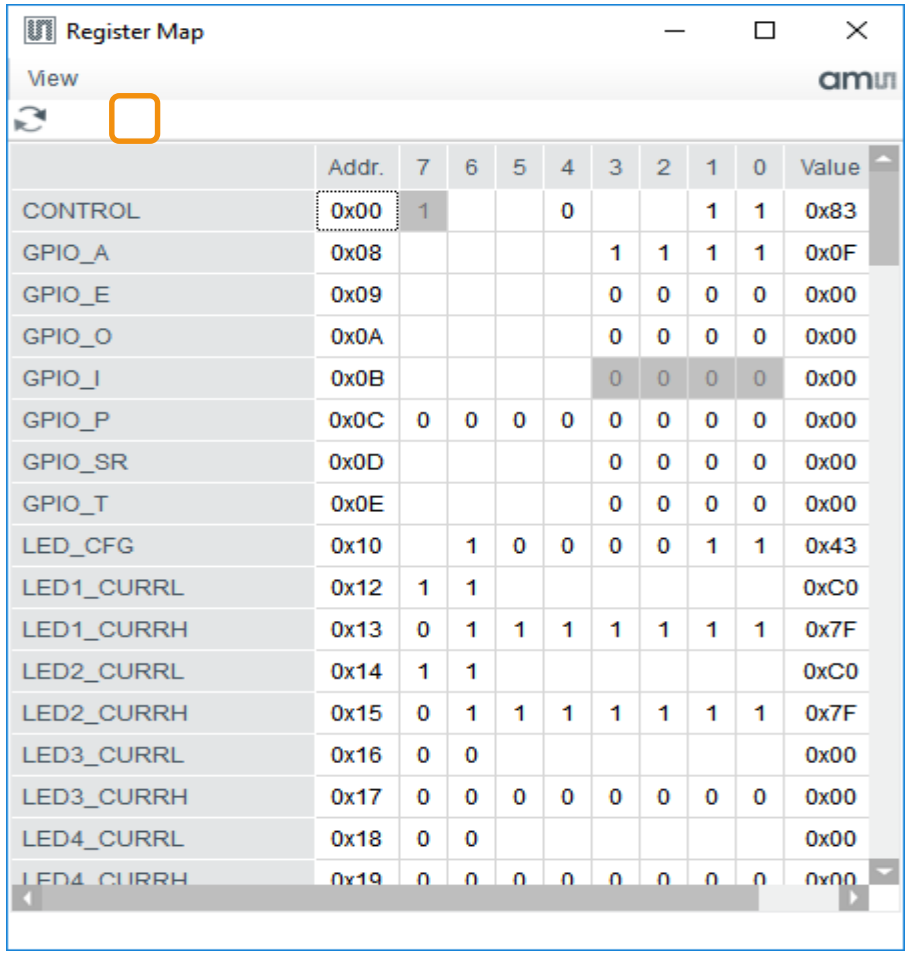


AS7024 PC Software

Register map

The “Register Map” window is used to view/change the contents of the complete set of AS7024 user register. To open it, click on the “View → Register Map” menu.

Changing a register value can be done either by modifying its value in the relevant “Value” field or by toggling a bit by clicking on the relevant bit cell. Changing a value in the register map will not update the current selection in the configuration windows of the GUI. Also, a change in any of the configuration windows will not trigger an automatic update of the already opened register map window. To update the values, click on the refresh button marked with the orange rounded rectangle on the “Register Map” picture on the right.

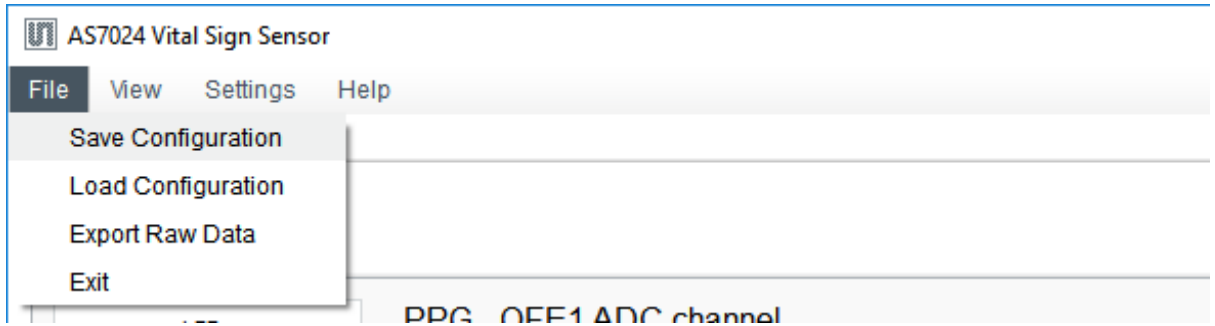


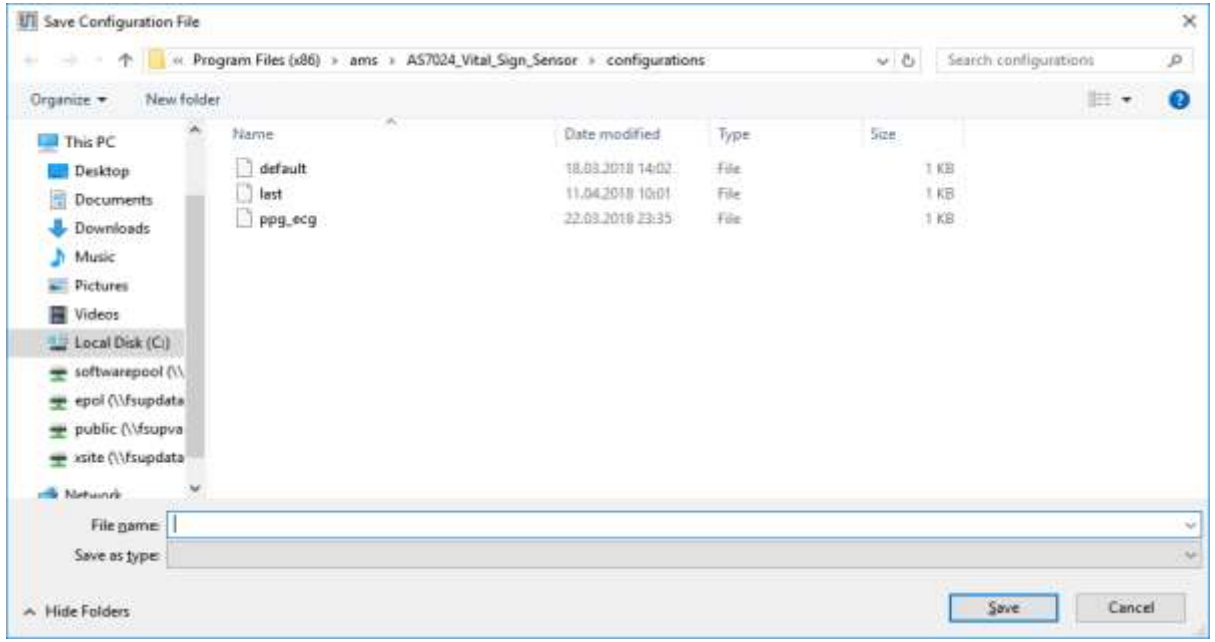
	Addr.	7	6	5	4	3	2	1	0	Value
CONTROL	0x00	1			0			1	1	0x83
GPIO_A	0x08					1	1	1	1	0x0F
GPIO_E	0x09					0	0	0	0	0x00
GPIO_O	0x0A					0	0	0	0	0x00
GPIO_I	0x0B					0	0	0	0	0x00
GPIO_P	0x0C	0	0	0	0	0	0	0	0	0x00
GPIO_SR	0x0D					0	0	0	0	0x00
GPIO_T	0x0E					0	0	0	0	0x00
LED_CFG	0x10		1	0	0	0	0	1	1	0x43
LED1_CURRL	0x12	1	1							0xC0
LED1_CURRH	0x13	0	1	1	1	1	1	1	1	0x7F
LED2_CURRL	0x14	1	1							0xC0
LED2_CURRH	0x15	0	1	1	1	1	1	1	1	0x7F
LED3_CURRL	0x16	0	0							0x00
LED3_CURRH	0x17	0	0	0	0	0	0	0	0	0x00
LED4_CURRL	0x18	0	0							0x00
LED4_CURRH	0x19	0	0	0	0	0	0	0	0	0x00

AS7024 PC Software

Saving current configuration settings to a file

The current configuration settings can be exported to a file. To do this, click on the “File → Save Configuration” menu. This will open the “Save Configuration File” dialog box on the second picture on the right. Enter file name and choose the file location, then click “Save”.





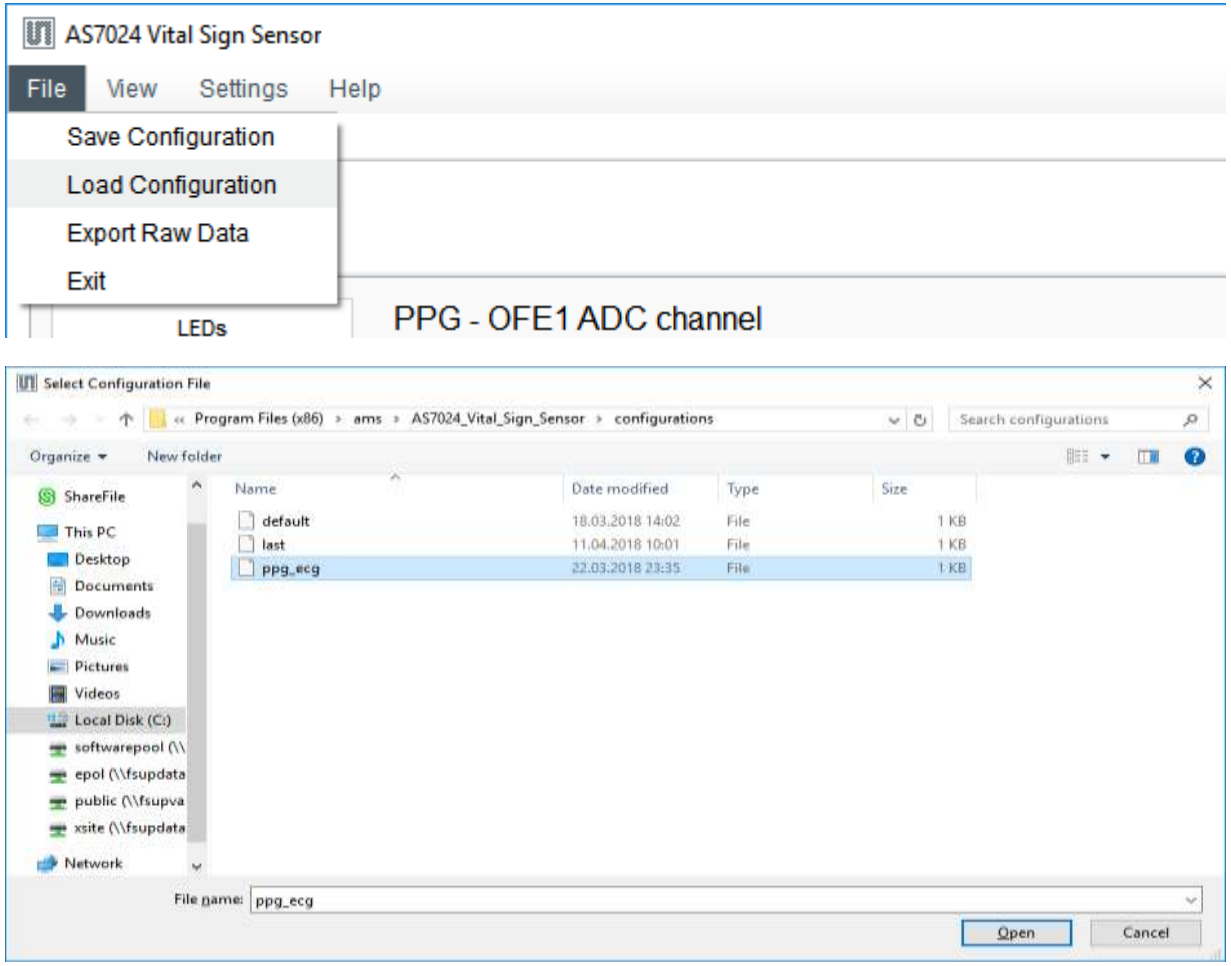
AS7024 PC Software

Loading configuration settings from file

To load a previously exported configuration settings, click on the “File → Load Configuration” menu. This will open the “Select Configuration File” dialog box. Select the configuration file from which to load settings and click “Open” button.

The settings imported from the file can be reviewed in the relevant configuration windows.

If the GUI is connected to the board, the newly imported settings will be applied immediately, otherwise upon successful connection to the board.



AS7024 PC Software

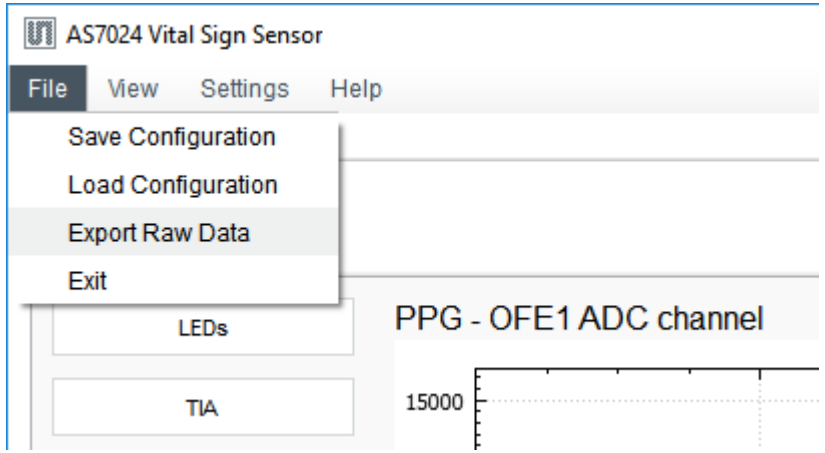
Raw data logging and exporting

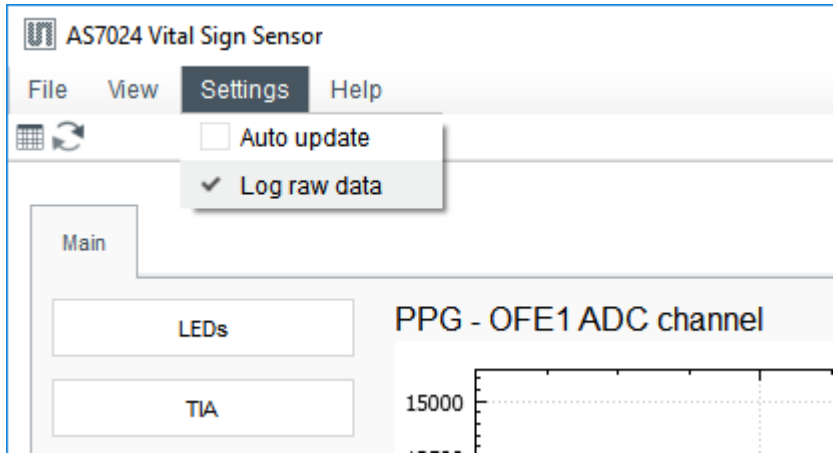
By default, during measurement the raw data from the AS7024 is logged in memory. When a measurement is stopped, this data can be exported to a comma delimited file by clicking on the “File → Export Raw Data” menu and selecting the file location and file name in the save file dialog box.

Raw data file format:

- first raw has the column captions
- first column has the timestamp in milliseconds
- columns 2nd to the last have the data from the enabled ADC channels

Raw data logging can be disabled by unchecking the “Log raw data” check box in the “Settings” menu.





Firmware Update over USB

Starting in DFU mode

In order to update the FW over USB on the AS7024 Evaluation Board the MCU has to be started in DFU mode. To do so follow the steps below:

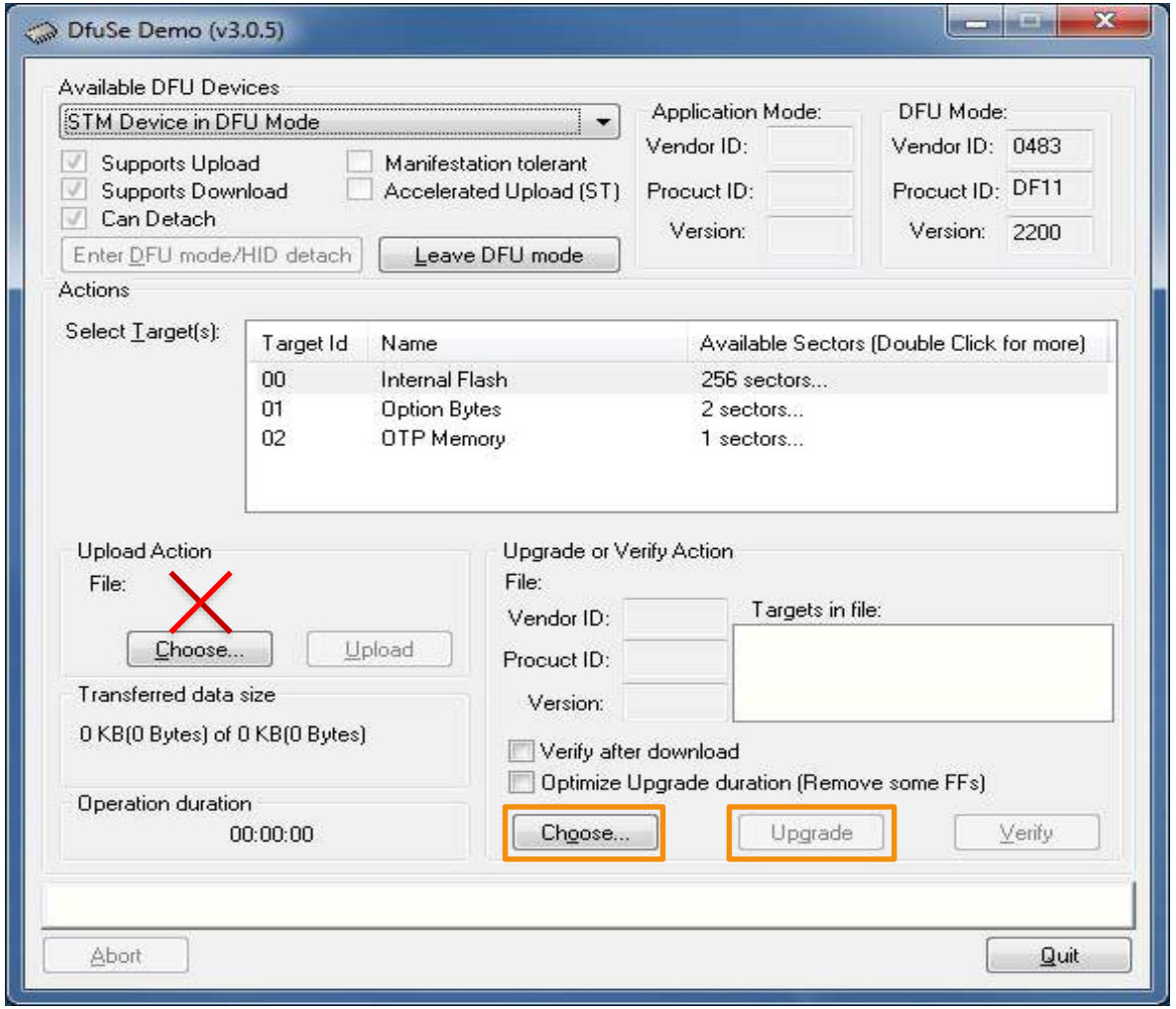
- Start the DfuSeDemo.exe from the “extras\DFU” folder located at the installation folder of the GUI (if not changed during installation should be “\Program Files (x86)\ams\AS7024_Vital_Sign_Sensor”.
- Connect a USB cable to the AS7024 Evaluation Board
- Press the button marked with yellow on the picture below
- Connect the USB cable to the computer whilst keeping the button pressed
- Release the button as soon as the device appears in the DfuSeDemo tool

Firmware Update over USB

Starting in DFU mode

If the MCU was booted in DFU mode successfully, the device will be listed and selected in the drop down menu under “Available DFU Devices”.

The next step is to flash the new FW onto the MCU. Under “Upgrade or Verify Action” press the “Choose” button.



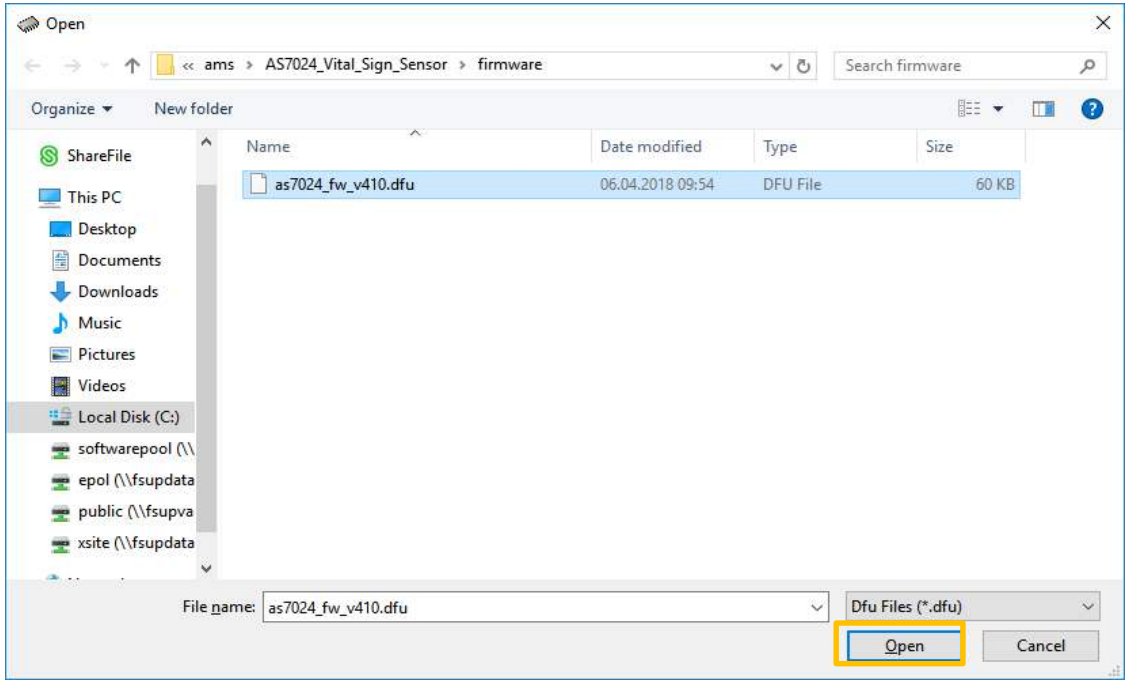
Firmware Update over USB

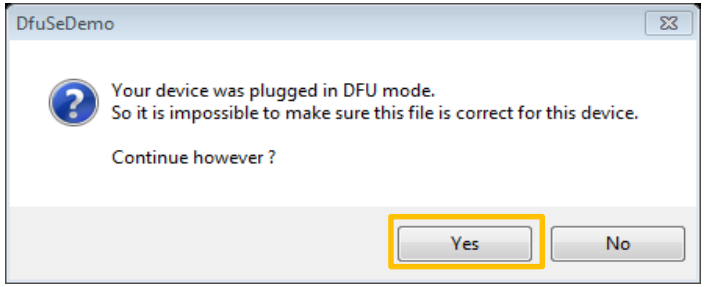
Flashing the FW onto device

Select the .dfu file containing the new FW and click on “open”.

After loading the .dfu file press the “Upgrade” button, which will be available.

The pop-up window shown in the figure below will then open. Click on “Yes” to continue.





Firmware Update over USB

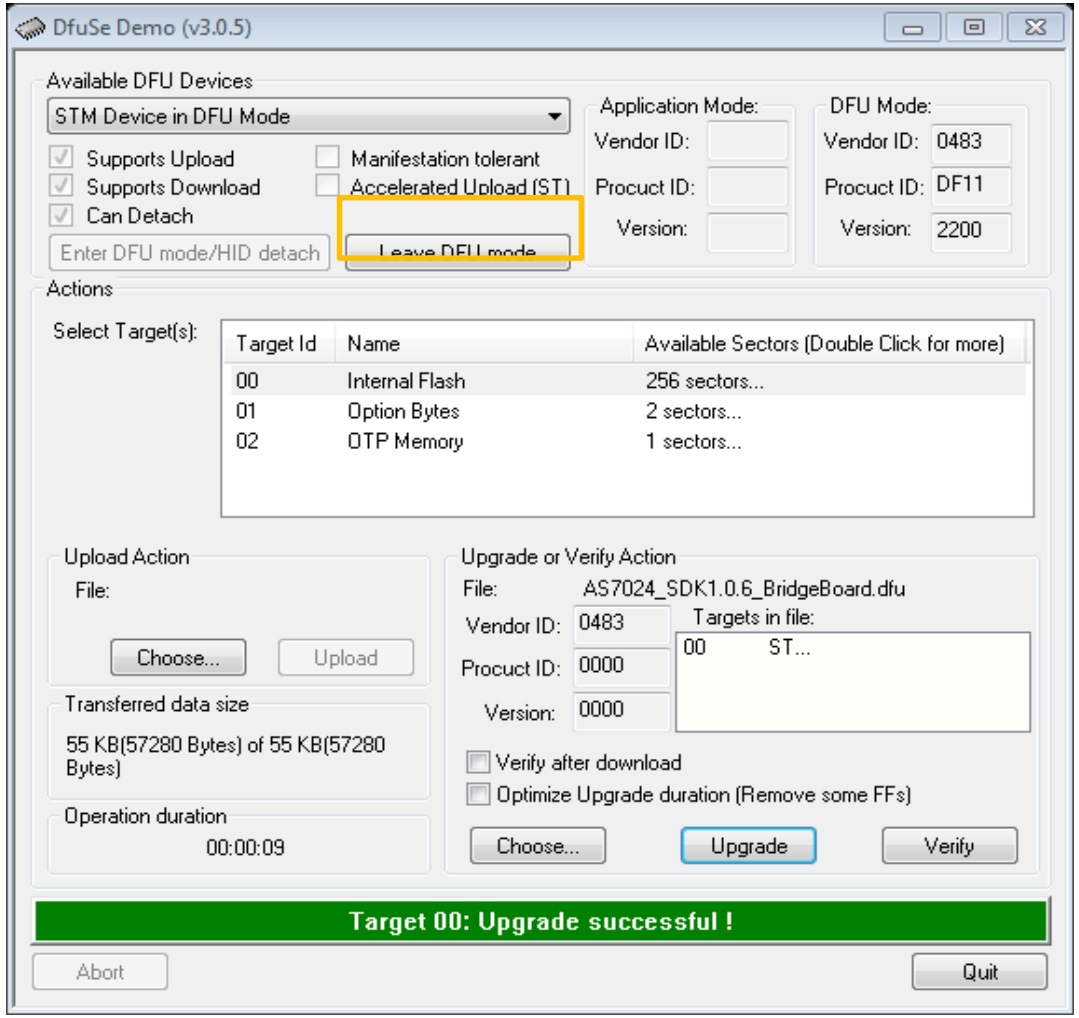
Flashing the FW onto device

The flashing will start and the progress is shown as a green bar at the bottom of the tool. The process takes only a few seconds.

When finished the message “Upgrade successful” is shown.

Last and to finish the FW update, press “Leave DFU mode”.

The AS7024 Evaluation Board is ready for use again.



Thank you!

Please visit our website
www.ams.com