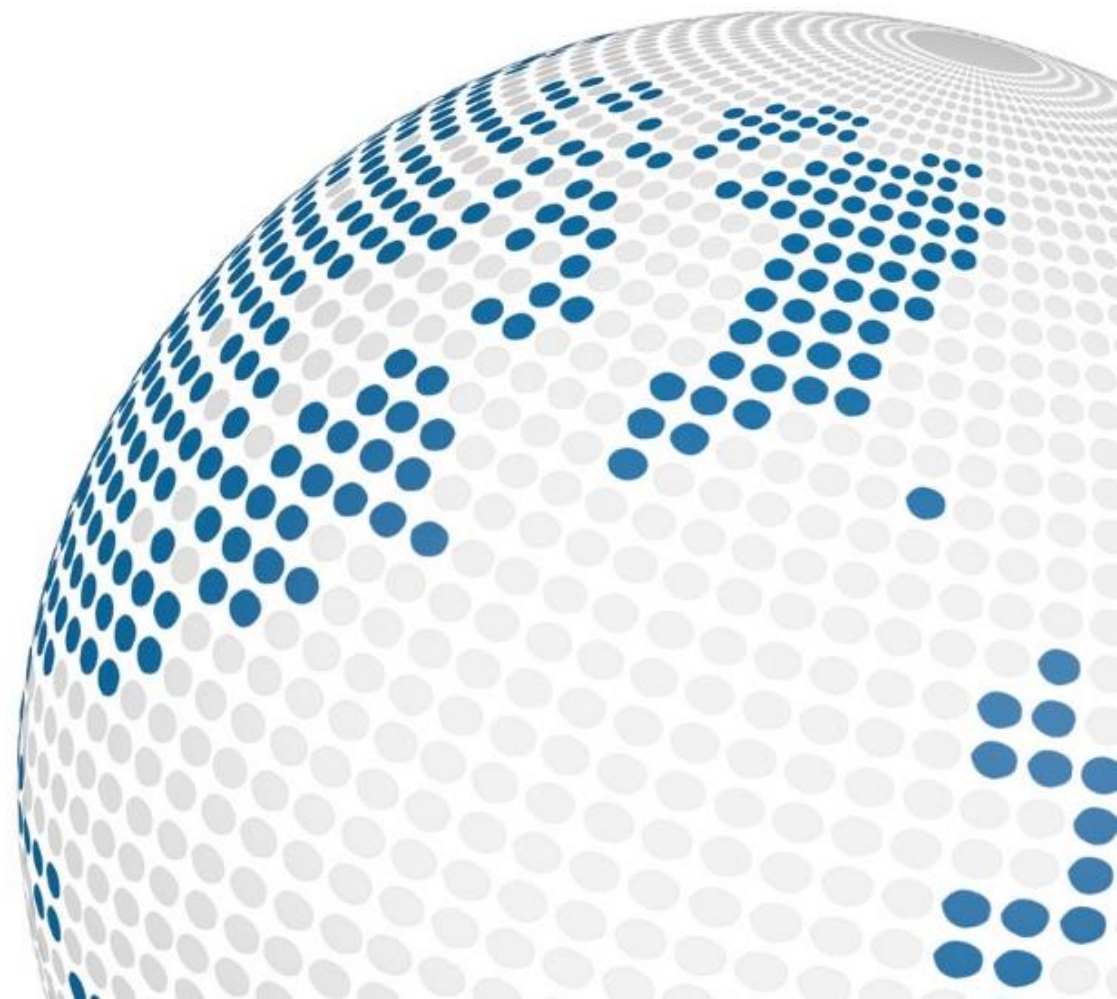


Product Document

ams

Shaping the world with sensor solutions

Kumud Dey
June 2020



AS7030B Design-in Guidelines

Overview

Power supply Scheme

IO Signals

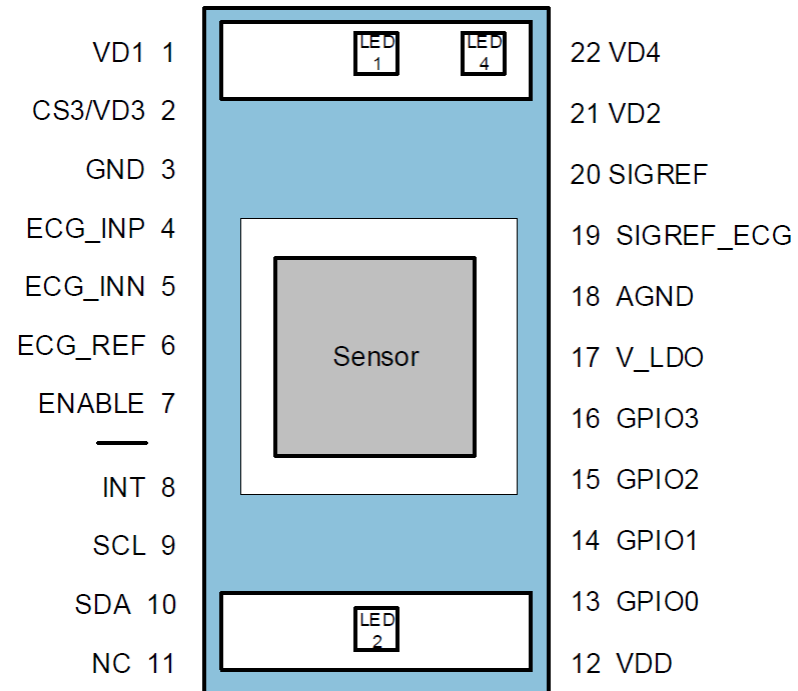
PPG Signal

ECG

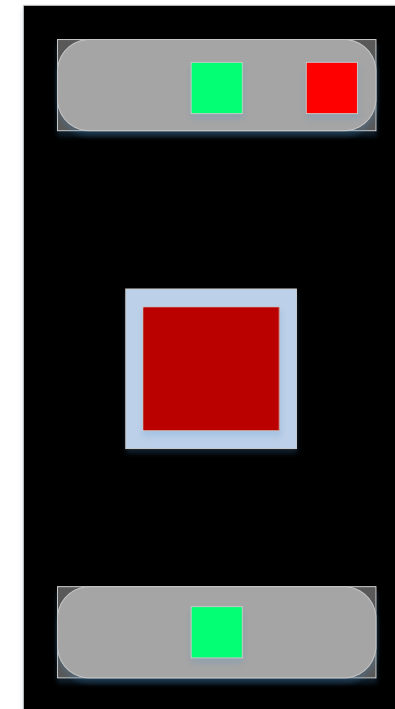
Optical-Mechanical Integration

AS7030B

Overview



AS7030B
Pin Description

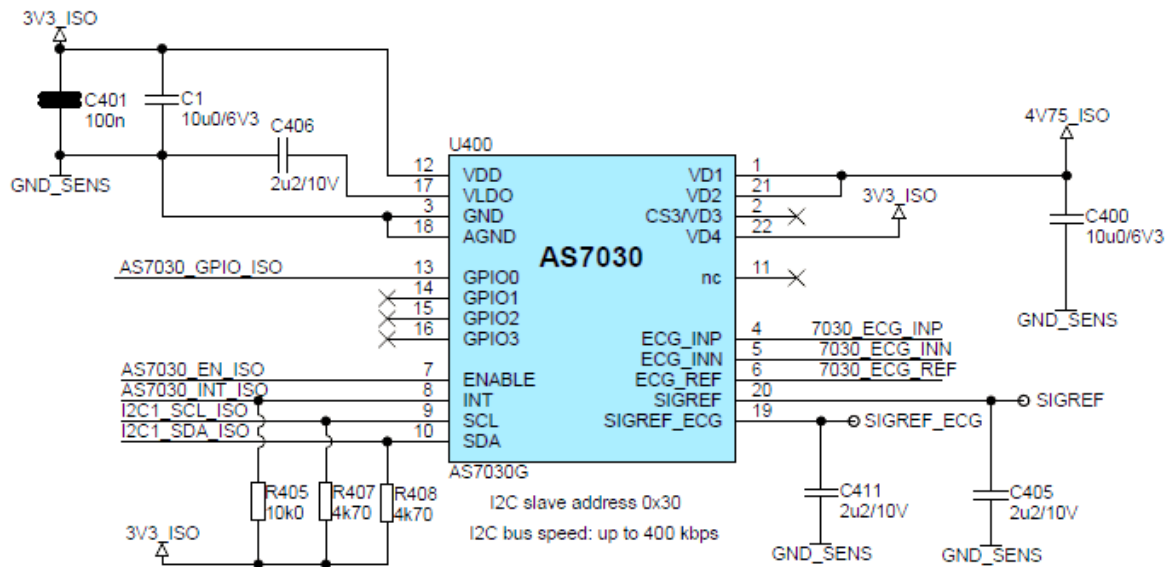


AS7030B
3D-TopView

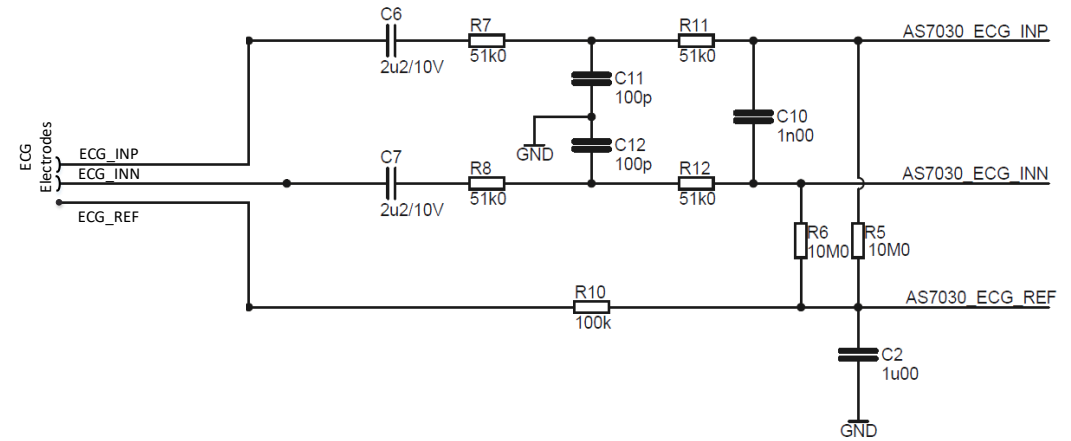
AS7030B

Recommended design

AS7030B design



Recommended ECG Signal Filter Design

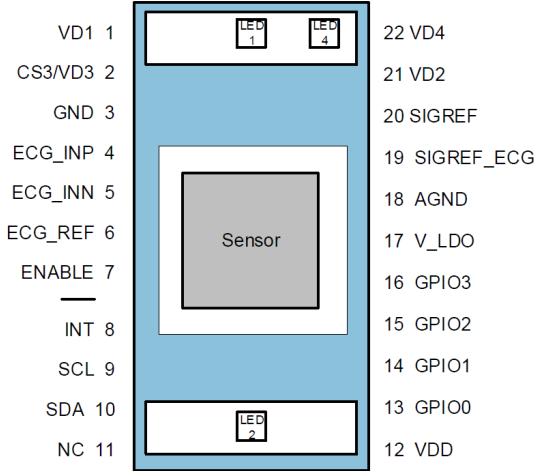
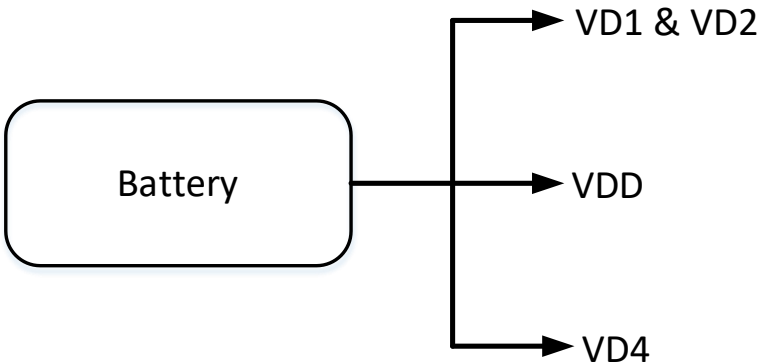


Power Supply Scheme

Pin description

- Battery supply

AS7030B Bluetooth eval kit gets the power from the battery.
The 3.7V coming from the battery is supplied to the green LEDs, IR LED, and the AS7030B VDD.



Pin No.	Pin Name	Description	Recommended Voltage [V]	Decoupling Capacitor [F]
1	VD1	Supply Voltage for LED D1 (Green LED)	3V7	10u to GND
2	VD3	Connection to current sink 3 (GND)	NC, If not in use	-
3	GND	Power Supply ground	connect to GND	-
12	VDD	Supply Voltage for AS7030	3V7	2.2u to GND
17	V_LDO	1.9V output voltage. Connect 2.2uF capacitor to GND	connect to GND	2.2u to GND
18	AGND	Analog Ground. Connect to low noise GND	connect to GND	-
21	VD2	Supply Voltage for LED D2 (Green LED)	3V7	10u to GND
22	VD4	Supply Voltage for LED D4 (IR LED)	3V7	10u to GND

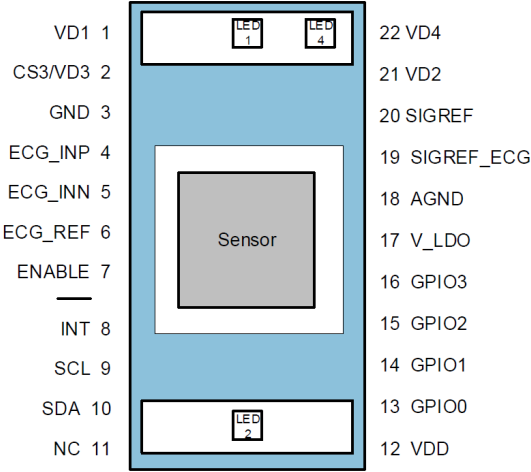
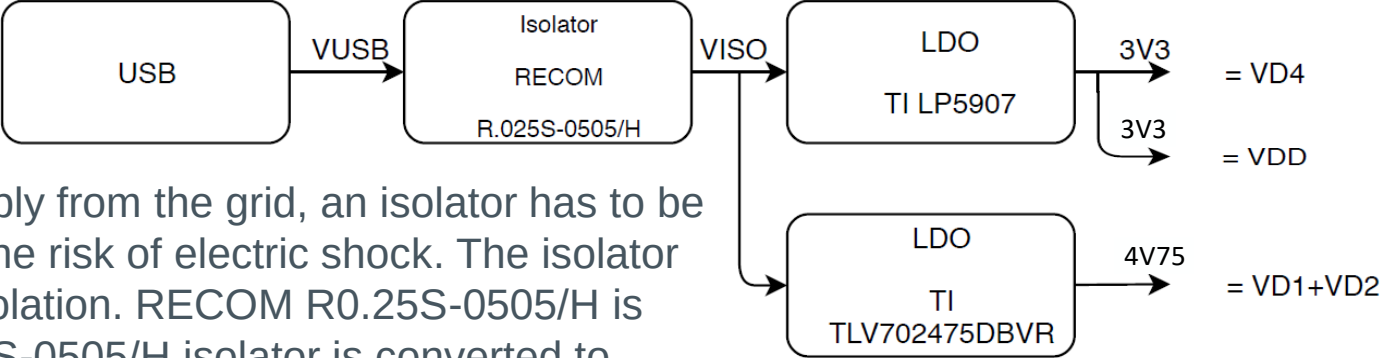
*Recommended design Schematics on Page 4

Power Supply Scheme

Pin description

- **USB supply with Isolator**

In case the AS7030B is supplied by USB or voltage supply from the grid, an isolator has to be used in the power path as well as signal path, to avoid the risk of electric shock. The isolator must be medically approved and provide at least 3kV isolation. RECOM R0.25S-0505/H is recommended. The 5V coming from the RECOM R0.25S-0505/H isolator is converted to 4V75 by an TLV702475DBVR LDO to supply the green LEDs. and the AS7030B VDD. TI LP5907 with fixed output voltage is recommended as LDO that converts the 5V from the RECOM R0.25S-0505/H isolator to 3V3 for the IR LED and the AS7030B VDD. Optionally only one LDO with 3V7 output can be used for sensor power supply (page 5)



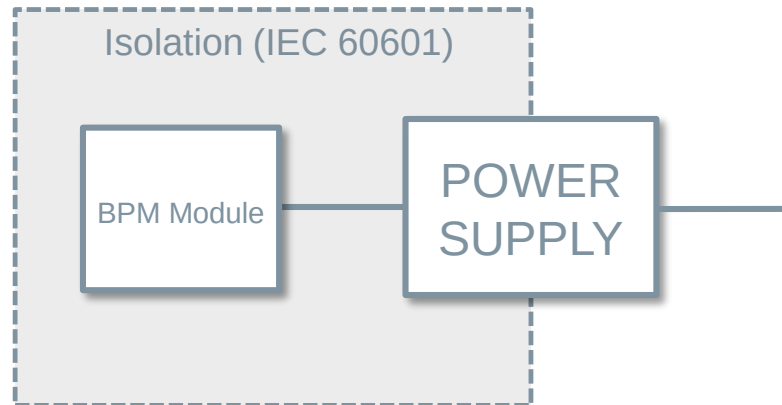
Pin No.	Pin Name	Description	Recommended Voltage [V]	Decoupling Capacitor [F]
1	VD1	Supply Voltage for LED D1 (Green LED)	4V75	10u to GND
2	VD3	Connection to current sink 3 (GND)	connect to GND	-
3	GND	Power Supply ground	connect to GND	-
12	VDD	Supply Voltage for AS7030	2V7 - 5V5	2.2u to GND
17	V_LDO	1.9V output voltage. Connect 2.2uF capacitor to GND	connect to GND	2.2u to GND
18	AGND	Analog Ground. Connect to low noise GND	connect to GND	-
21	VD2	Supply Voltage for LED D2 (Green LED)	4V75	10u to GND
22	VD4	Supply Voltage for LED D4 (IR LED)	3V3	10u to GND

*Recommended design Schematics on Page 4

Safety Requirements

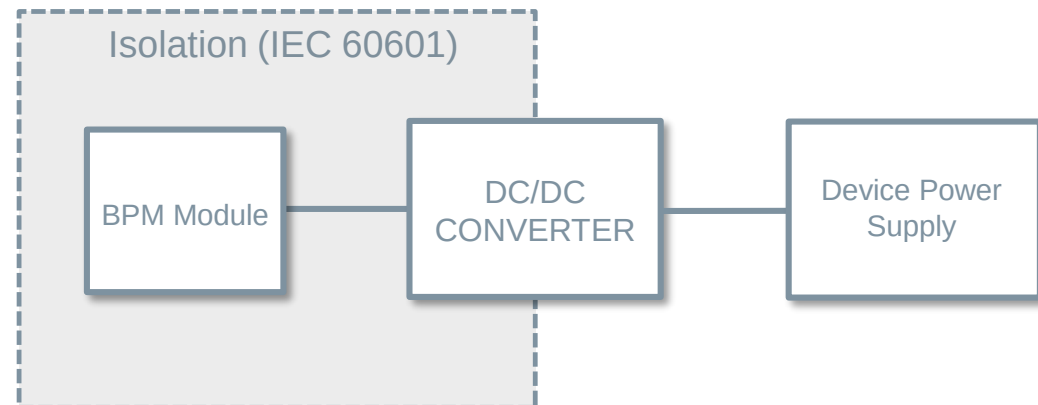
USB with Isolator

The power supply used to power the BPM Module must be IEC 60601 certified, if the end device is connected to a wall plug, in order to guarantee isolation from the electricity network when touching the electrodes.



Application option 1:

Device internal power supply compliant to IEC 60601 with separated ground.



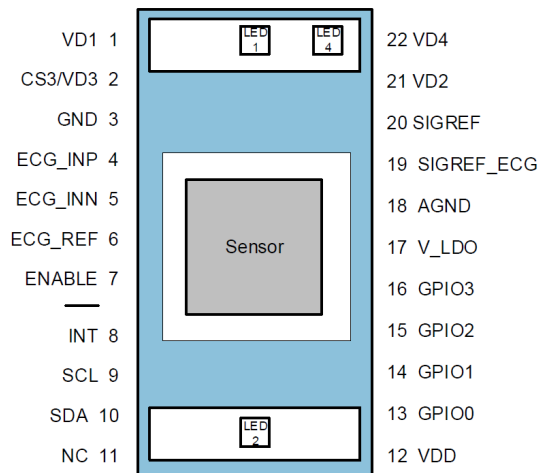
Application option 2:

Additional DC/DC-Converter (IEC 60601 certified), to power the BPM Module in the device.

IO Signals

Pin description

- After setting the pin ENABLE=1 the AS7030B registers can be accessed by the I2C interface. Before enabling any additional function (current source, TIA, ADC...) set the bit Ido_en=1 to set the internal LDO to normal mode. For operating the ADC or the sequencer enable the oscillator by setting osc_en=1.
- An interrupt output pin INT can be used to interrupt the host.
- The AS7030B includes an I2C slave using an I2C address of 0x30 (7-bit format; R/W bit has to be added) respectively 60h (8-bit format for writing) and 61h (8-bit format for reading). Fast mode (400kHz) and standard mode (100kHz) support.



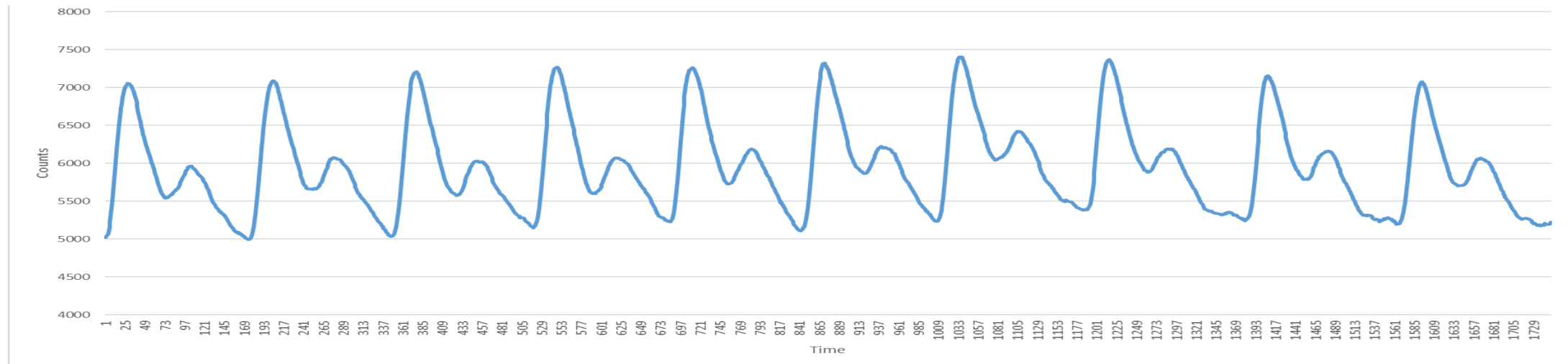
Pin No.	Pin Name	Description	Decoupling Capacitor [F]	Pull-up Resistor [Ohm]
7	ENABLE	Enable input for AS7030B. Active High. If ENABLE is not used, connect to VDD	-	10K
8	INT	Open drain interrupt output pin. Active Low	-	10k
9	SCL	I2C serial clock input terminal	-	4K7 Resistor value depends on I2C bus
10	SDA	I2C serial data I/O terminal - open drain	-	4K7 Resistor value depends on I2C bus
13	GPIO0	General purpose input/output	-	-
14	GPIO1	General purpose input/output	-	-
15	GPIO2	General purpose input/output	-	-
16	GPIO3	General purpose input/output	-	-

*Recommended design Schematics on Page 4

PPG Signal

General Information

- Make sure your fingers are warm -> a pulse signal cannot be detected on cold fingers
- Do not press the finger too hard on the sensor -> if pressed too hard, the blood flow may be disrupted and no signal can be detected

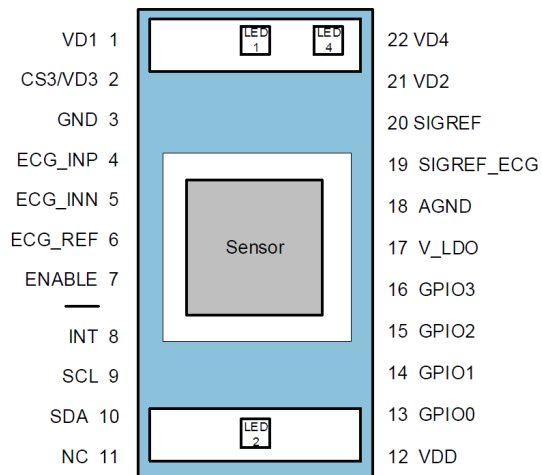


PPG signal
Counts vs Time

ECG

Pin description

- The ECG (electro cardiogram) 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 lead OFF detection can be used for detection if the user actually touches the leads. It is a circuitry to measure the capacitor and/or resistance between the two lead inputs ECG_INP and ECG_INN.



Pin No.	Pin Name	Description	Capacitors [F]	Resistors [Ohm]
4	ECG_INP	ECG amplifier positive input	2.2u in series 100p to GND 1n to ECG_INN	51k + 51k in series 10M to ECG_REF
5	ECG_INN	ECG amplifier negative input	2.2u in series 100p to GND	51k + 51k in series 10M to ECG_REF
6	ECG_REF	ECG amplifier refernce output	1u to GND	100k in series
19	SIGREF_ECG	Analog refernce output	2.2u to GND	

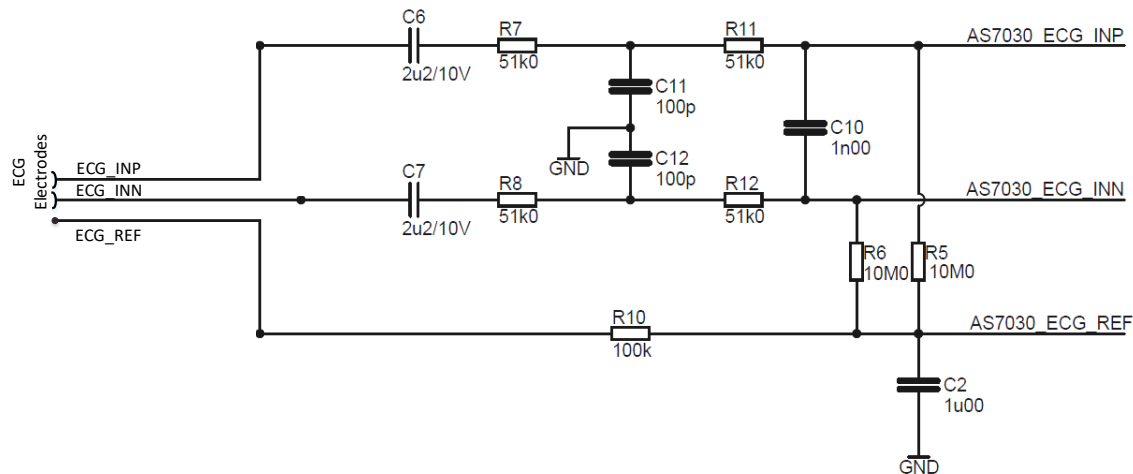
*Recommended design Schematics on Page 4

ECG

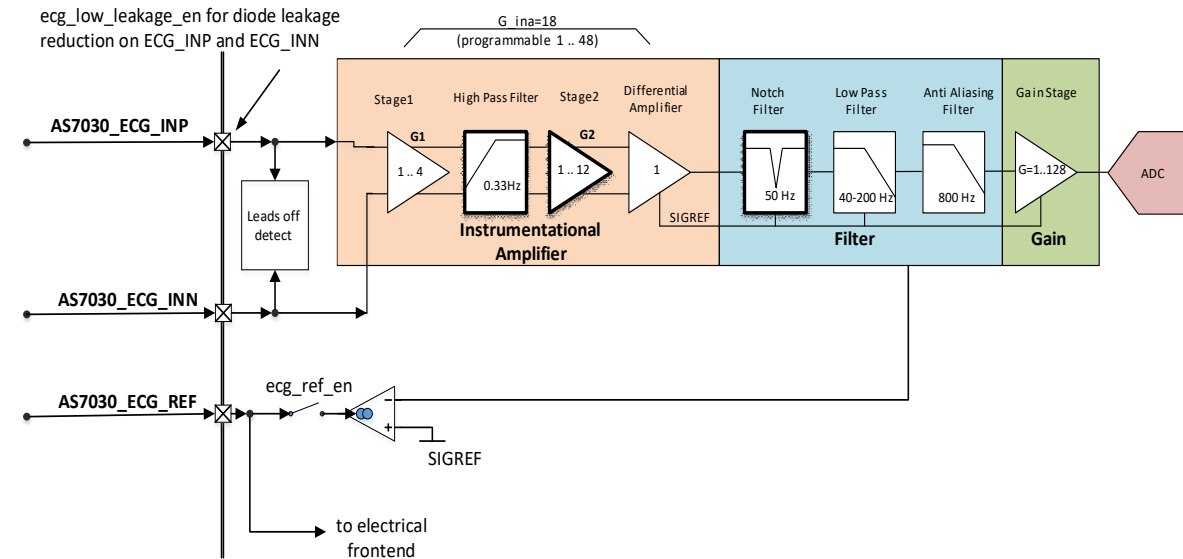
Pin description

- ECG amplifier is very sensitive to noise. Therefore, it is important to have an ECG frontend filter to reduce the noise

Recommended ECG Frontend Filter

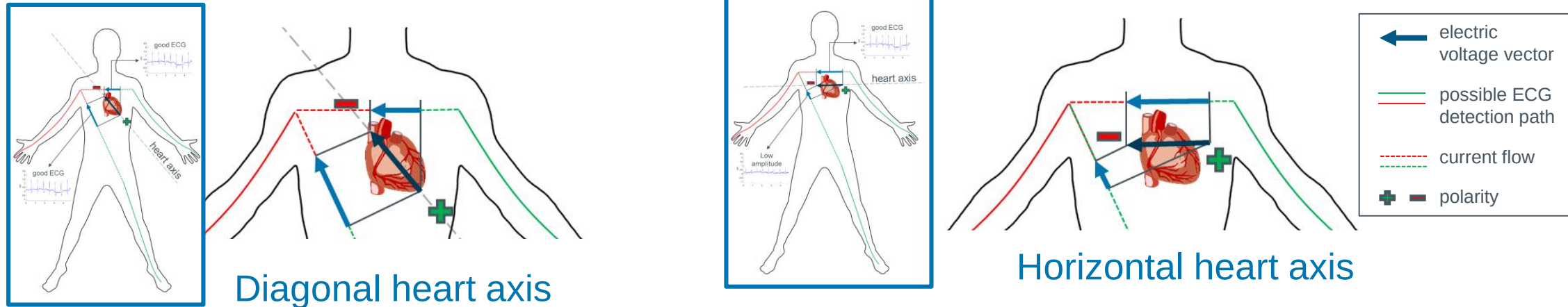


ECG Amplifier Circuit



Note: As the ECG signal lines are very sensitive to noise, it is very important to pay attention of the layout. ECG frontend filter might be changed based on the application and noise sensitivity.

ECG Signal



- ECG recording is similar to voltage measurement in batteries
- The recorded amplitude depends highly on the orientation of the electrical heart axis relatively to the recording axis of the electrodes.
- There is considerable variation of the axis orientation even in healthy people.
- A reference electrode is used to filter out pick-up noise (common mode rejection)
- Make sure the electrodes are clean and do not have any kind of fat film on them
- The ECG signal may be too weak to be detected due to dry skin
- The signal strength of the ECG signal depends on orientation of the heart axis, which varies from individual to individual and may not be detectable in some cases

Signals

- Weak signals ranging from 0.5mV to 5.0mV
- High DC component of up to +/- 300mV (electrode skin contact)
- Common-mode component up to 1.5V (potential electrodes – ground)

Noise

- Power-line interference: 50-60 Hz
- Electrode contact noise (baseline drift)
- Motion artifacts (shifts in baseline)
- Muscle contraction
- Electromagnetic interference from other electronic devices (higher frequencies)

Electrode Properties

Recommendations

Electrodes

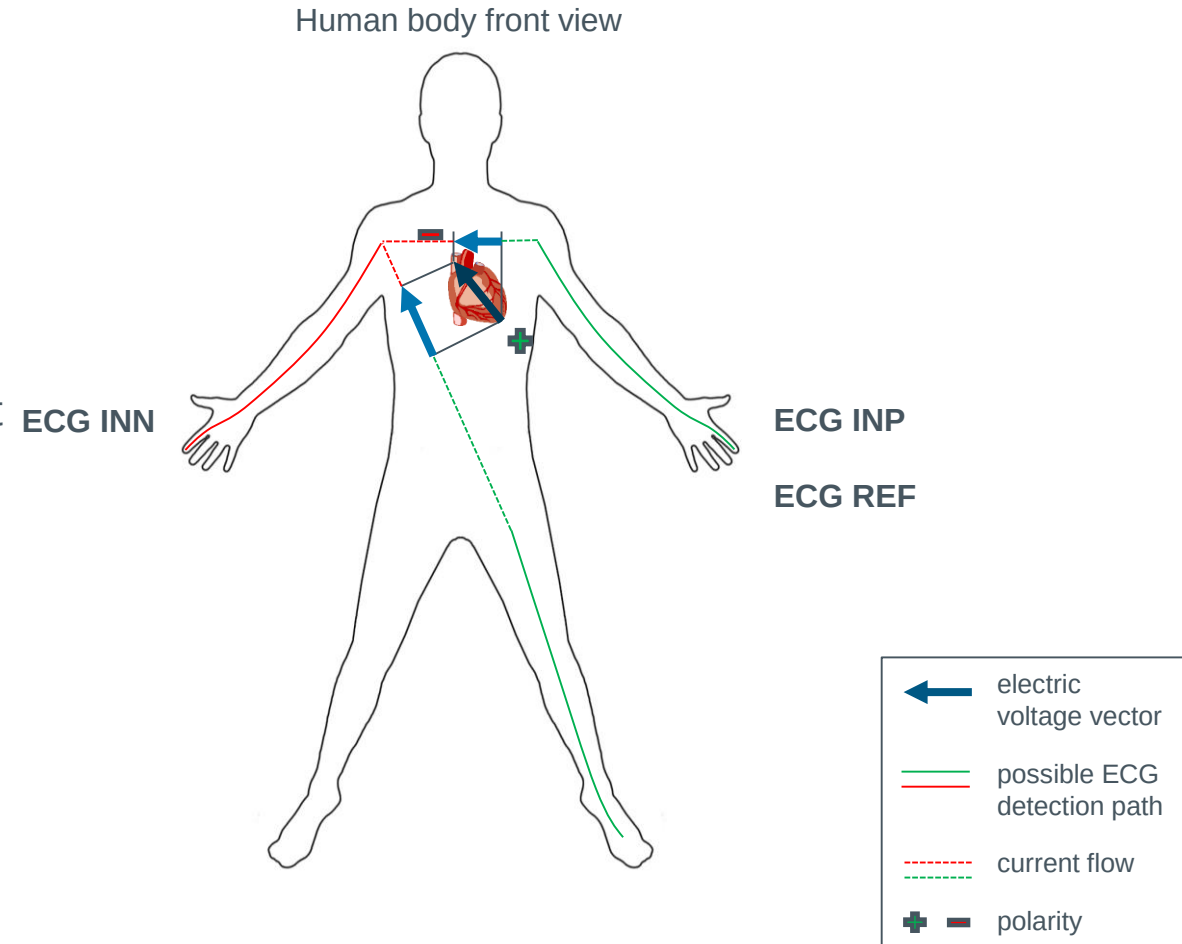
- Based on our measurements with 20 subjects, a skin-to-electrode resistance up to 350-400k Ω is recommended
- Based on this we recommend a round electrode of >14mm for each ECG contact.
- A differently shaped electrode with equivalent surface area is also possible
- A typical material to use would be stainless steel sheet electrodes (material 1.4301)

Electrode Cables

- For longer electrode cables (>20cm) or in EMC polluted environments a shielded cable is highly recommended
- The shield should be connected to GND

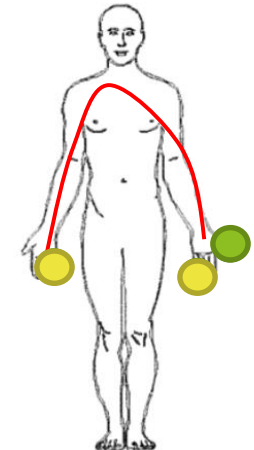
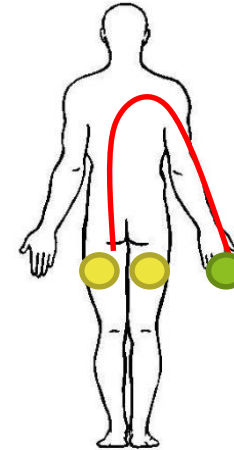
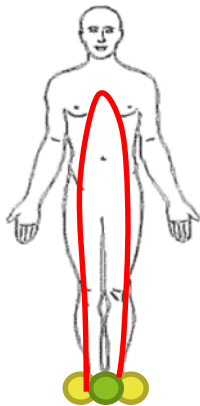
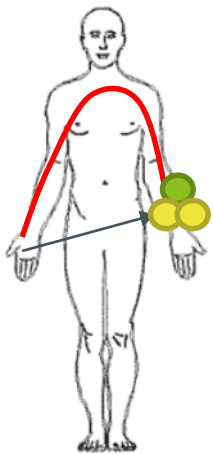
Electrode Connections

- Positive and negative electrode to detect ECG signal (across the heart)
- Reference electrode for common mode rejection
- ECG INN should be connected to the right hand of the user
- ECG INP and ECG REF should be connected to the left hand of the user
- ECG INP and ECG REF should not share an electrode but rather have individual electrodes that both connect to different parts of the left hand



Electrode Positions

For various use cases



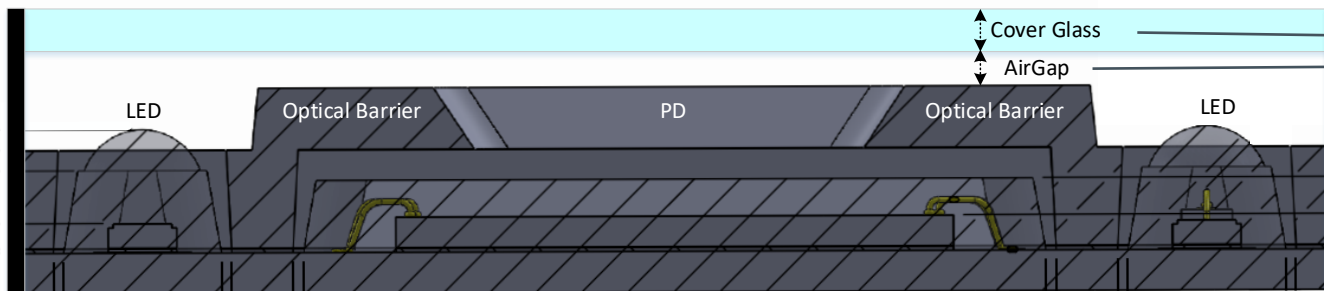
● Electrode

● PPG

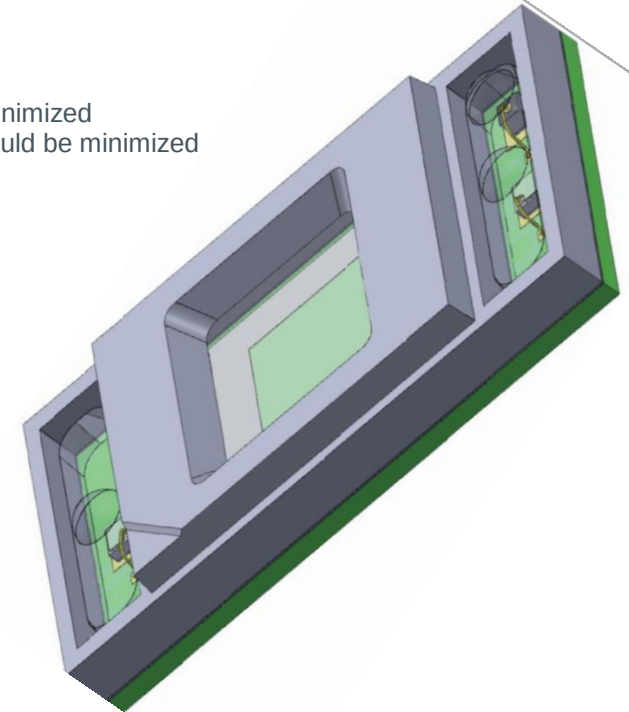
● Electrode + PPG

Optical-Mechanical Integration

- No air gap between glass and skin
- Do not make glass thicker or air gap wider to keep optical cross talk low
- Signal gets stronger with increasing air gap, but also cross-talk increases and SNR decreases
- The Thickness of the cover glass should be minimized for better performance & crosstalk. Also, airgap should be minimized.



→ Glass Cover should be minimized
→ Air gap to sensor should be minimized





Thank you!

Please visit our website
www.ams.com