

PAH8001EI-2G: Optical Heart Rate Detection Sensor

General Description

The PAH8001EI-2G is a high performance and low power CMOS-processed optical sensor with Green LED and integrated Digital Signal Processor serving as a Heart Rate Detection sensor. It is based on optical technology which measures the variation of human blood movement in the vessel and using this measured data to estimate heart beat rate.

Key Features

- Heart rate detection function
- Ultra-low power consumption with power saving modes during no touch movement period
 - LPT sleep1
 - LPT sleep2
- Flexible sleep rate control
- Flexible communication interface
 - I²C
 - 4-wire SPI
 - 2-wire SPI
- I²C interface up to 1 Mbit/s
- SPI interface up to 1 Mbit/s
- Hardware reset support
- Hardware power down support
- Integrated chip-on-board LED with wavelength of 525nm

Applications

- Healthcare/Sports wearable device
- Photoplethysmogram waveform
- Smart wearable eg. watch, wrist-band

Key Parameters

Parameter	Value
Operating Junction Temperature (°C)	-20 to +60
Interfaces	I2C, 2-Wire SPI, 4-Wire SPI
Input Clock (MHz)	6.8Mhz
Supply Voltage (V)	V _{DDM} : 3.3 – 3.6 V _{DDIO} : 1.62 – 3.6
Average Supply Current (mA)	Run: 1.5 Sleep1: 0.16 Sleep2: 0.04 Power down: 0.015
Frame Rate (fps)	Up to 3000
Heart Rate Measurement Range (bpm)	30 - 210
Package Size (mm)	3.0 x 4.7 x 1.0

Ordering Information

Part Number	Package Type
PAH8001EI-2G	16-pin LGA Package



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1.0 System Overview

The heart rate detection of PAH8001 is based on optical measurement technique that uses a light source and a detector to detect cardio-vascular pulse wave that propagates through body. The detected signal (pulse wave) is called photoplethysmography and its acronym in some literatures is PPG or PTG. The PPG signal reflects the blood movement in the vessel, which goes from the heart to the fingertips through the blood vessels in a wave-like motion. Therefore, we can use this PPG signal to estimate heart rate. This optical based technology could offer significant benefits to healthcare application as it is noninvasive yet accurate and simple to use.

1.1 Block Diagram

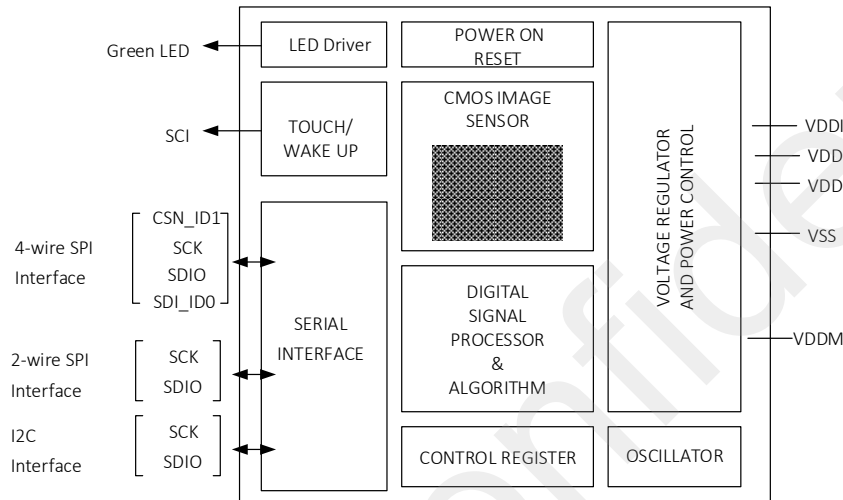


Figure 1. PAH8001 Functional Block Diagram

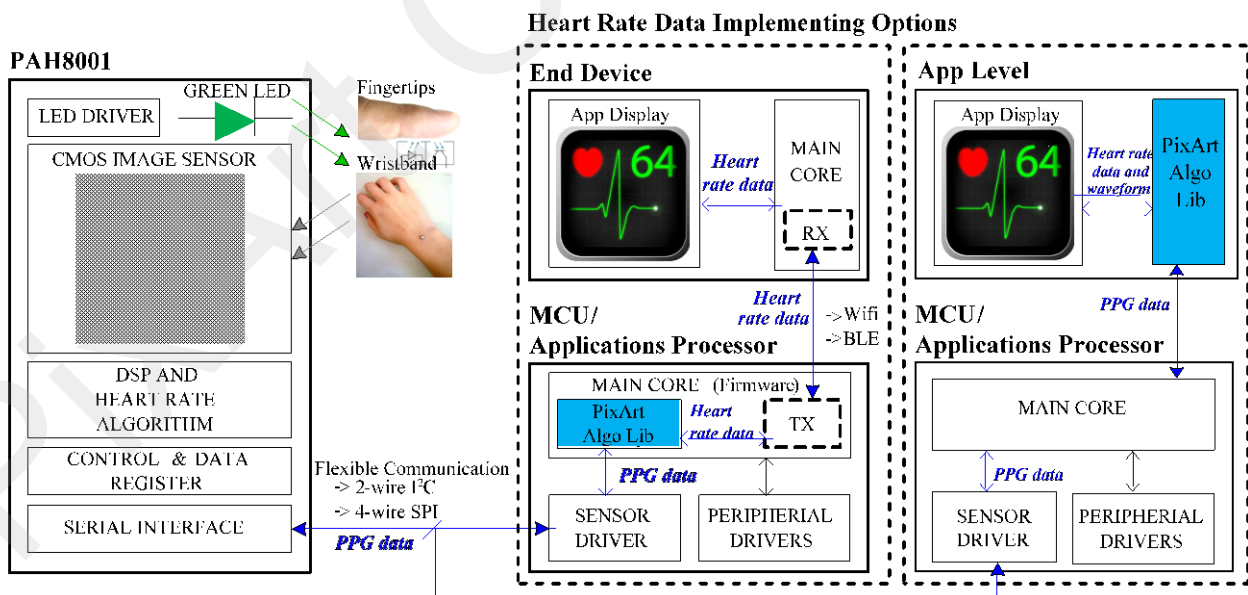


Figure 2. System Block Diagram

2.0 Signal Description

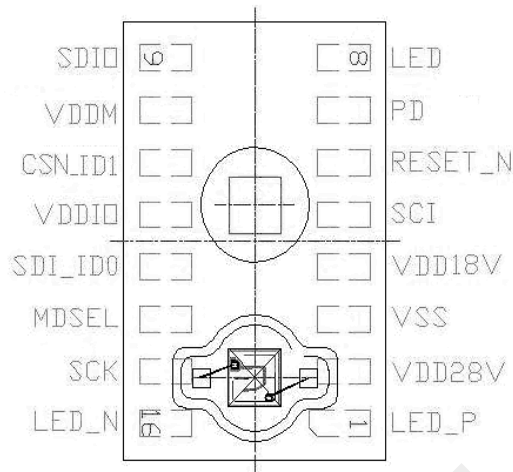


Figure 3. Pin Configuration

Table 1. PAH8001 Signal Pins Description

Pin No.	Signal Name	Type	Description
Functional Group:		Power Supplies	
1	LED_P	Power	LED Anode. Provide VDDM supply voltage
2	VDD28V	Output	Analog circuit power regulator output. Must connect a 0.1μF capacitor to GND
3	VSS	Ground	Chip Ground
4	VDD18V	Output	Analog and digital circuit power regulator output. Must connect a 0.1μF capacitor to GND
10	VDDM	Power	Power supply for internal power regulator. VDDM: 3.3 – 3.6 V
12	VDDIO	Power	I/O power supply. VDDIO: 1.62 – 3.6 V
16	LED_N	LED	LED Cathode. Must connect to LED
Functional Group:		Control Interface	
9	SDIO	BiDir	4-Wire SPI: Data Output pin 2-Wire SPI: Data In-Out pin I ² C: Data In-Out pin
11	CSN_ID1	Input	4-Wire SPI: Chip Select (Active Low) I ² C: Address Set ID1 (Tri state IO)
13	SDI_ID0	Input	4-Wire SPI: Data Input pin I ² C: Address Set ID0 (Tri-State IO)
15	SCK	Input	2-Wire SPI/ 4-Wire SPI/ I ² C: Serial Clock pin
Functional Group:		Functional I/O	
5	SCI	Output	Touch On/Off INT (Active High)
6	RESET_N	Input	Hardware control to enter Reset mode Level High: Exit Reset mode Level Low: Enter Reset mode Set to high when not using

Pin No.	Signal Name	Type	Description
7	PD	Input	Hardware control to enter Power Down mode with internal 1MΩ pull-down resistor Level High: enter power down mode Level Low: leave power down mode Set to low when not using
8	LED	Output	LED driver connection. Must connect to LED_N
14	MDSEL	Input	Tri state IO. For mode selection of 2-Wire SPI, 4-Wire SPI or I ² C I ² C: Pull down. Tie to GND 4-Wire SPI: Floating 2-Wire SPI: Pull high. Tie to VDDIO

3.0 Mechanical Dimensions

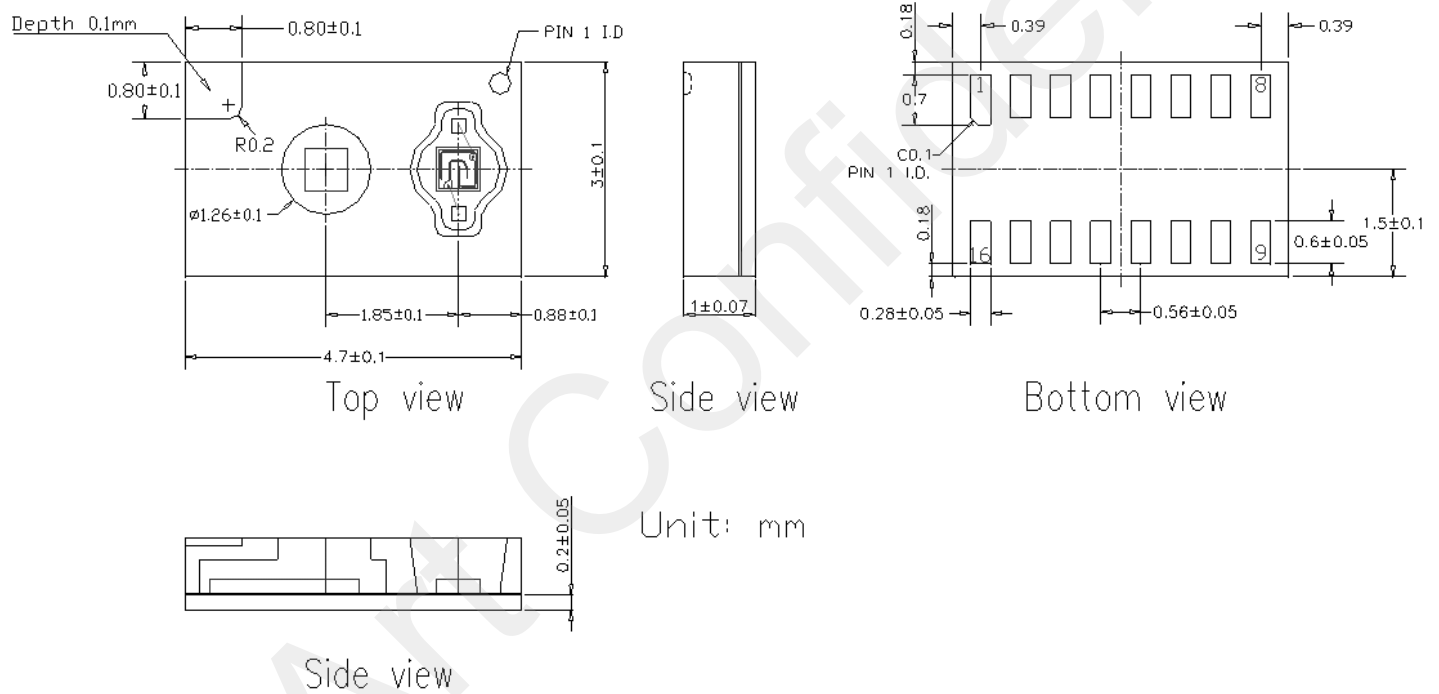


Figure 4. Package Outline Diagram

4.0 Reference Schematics

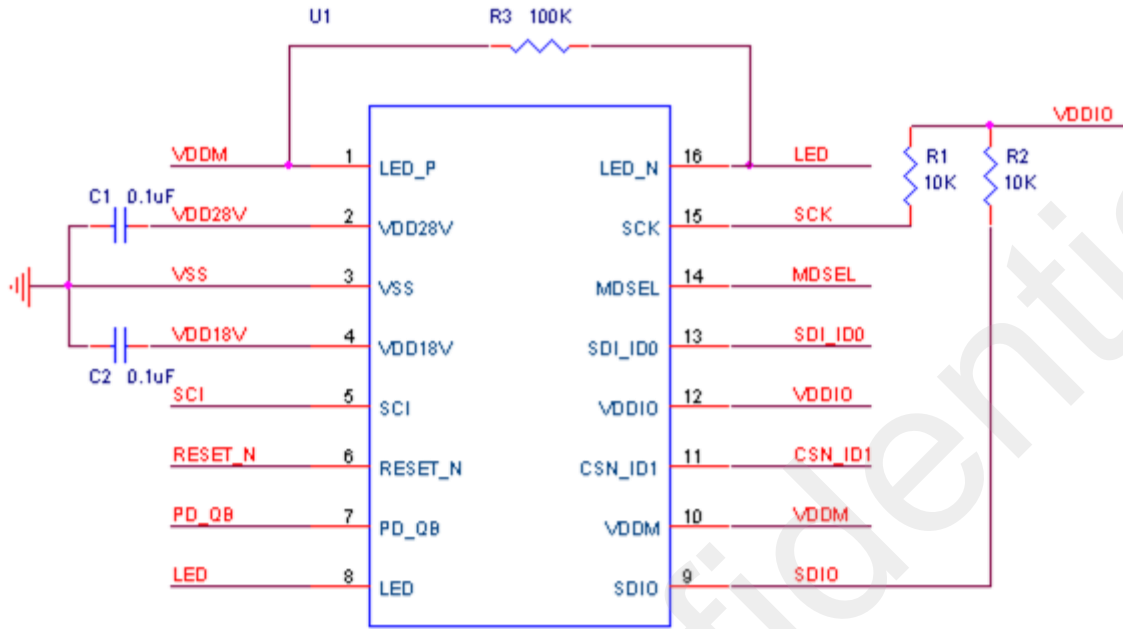


Figure 5. Application Circuit of PAH8001

Design Notes

1. VDDM & VDDIO = 3.3V~3.6V (for 3.3V System).
2. VDDM = 3.3V~3.6V, VDDIO: 1.62V~1.98V (for 1.8V System).
3. Connect R1 and R2 for I2C Only.
4. VDD28V and VDD18V must have 0.1μF bypass capacitor connected to GND.
5. SCI can connect to MCU HW INT as Touch INT for power saving (Active high).
6. VDDM and VDDIO power noise must be under 100mV.
7. Tie MDSEL to VDDIO for 2-Wire SPI, floating for 4-Wire SPI, and GND for I²C.
8. ID0 and ID1 can be directly tied to VDDIO or GND based on your I²C ID selection.
9. LED pin must pull high with 100K resistor to VDDM for internal circuit voltage reference
10. At power on, VDDM and VDDIO must be powered on at the same time or VDDIO to be powered on first before VDDM.
11. At power off, VDDM and VDDIO must be powered off at the same time or VDDIO to be powered off first before VDDM.