Blood Oxygen and Heart Rate Module

BMH08002-4

Revision: V1.00 Date: July 26, 2023

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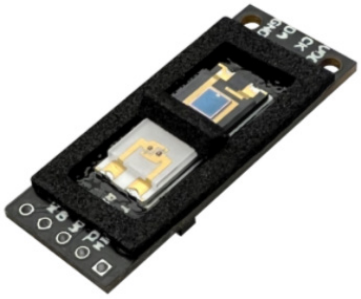
Features



- Operating voltage: 3.3V~5.5V
- Operating current: 5mA @ 3.3V
- Low power consumption:
  - 110μA sleep current
  - 1μA power-down mode current
- Blood oxygen saturation (SpO2) measurement:
  - Range: 70%~99%
  - Accuracy: ±2%
- Heart rate measurement:
  - Range: 30~250BPM
  - Accuracy:
    - ±2BPM @ (measurement range: 30~100BPM)
    - ±2% @ (measurement range: 100~250BPM)
- Perfusion index:
  - Range: 0.5%~25%
- Communication interface:
  - UART
- Integrates reflective blood oxygen sensor
- Directly output blood oxygen value, heart rate and blood perfusion index
- Size: 27mm×11mm

General Description

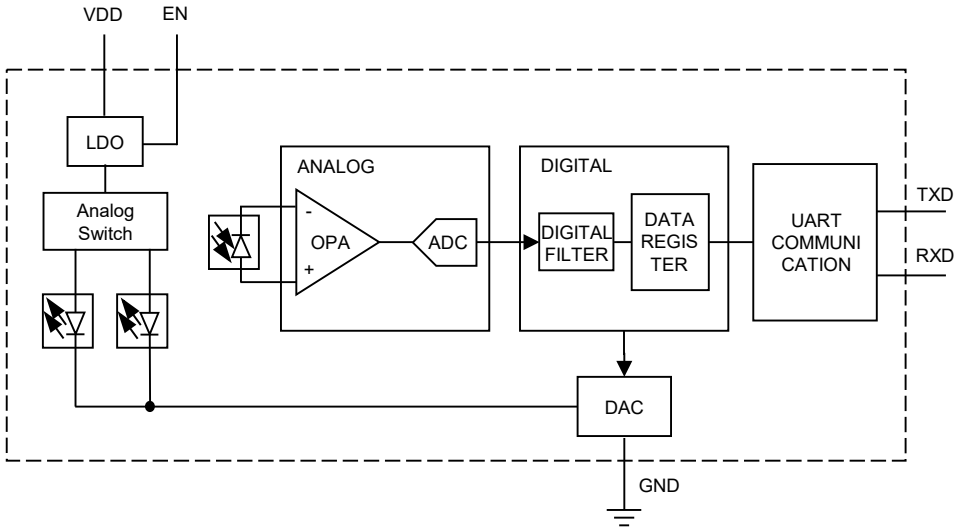
The BMH08002-4 is a blood oxygen and heart rate module from Best Modules, it mainly consists of a reflective blood oxygen pulse rate sensor and a Holtek A/D Flash MCU with Dual Operational Amplifiers, the HT66F4550. The module can measure the SpO2, heart rate and perfusion index (PI). The external MCU can read the measured values and set the operating mode and related parameters using the UART interface on the module. The HT66F4550 has dual four-level adjustable bandwidth OPAs and a 16 bit high-performance voice D/A converter. The module is suitable for applications such as fingertip blood oxygen measurement, intelligent wearable devices and health care measurement products, etc.

Applications

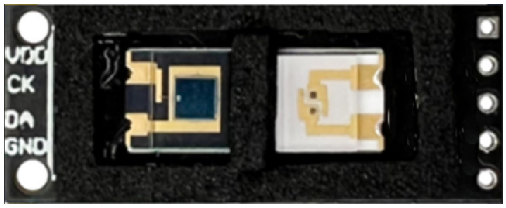
- Intelligent wearable devices
- Fingertip blood oxygen measurement
- Health care measurement

Block Diagram

This module integrates A/D converter, digital signal processing, LED emitter with 660nm red light and 905nm infrared light and communication function.



Pin Assignment



1 – VDD
2 – TXD
3 – RXD
4 – GND
5 – EN

Pin Description

Pin	Function	Type	Description
1	VDD	PWR	Module Power
2	TXD	O	UART transmitting pin
3	RXD	I	UART receiving pin
4	GND	PWR	Ground
5	EN	I	Operating enable pin High level input: the module operates (power on), default High level input: the module does not operates (power down)

Legend: PWR: Power; I: Digital input; O: Digital output

Technical Specifications

Absolute Maximum Ratings

Power supply voltage ..... 3.3V to 5.5V

Storage Temperature.....-20℃ to 55℃

Operating (Ambient) Temperature .....10℃ to 40℃

Total Power Consumption 11.6mW

Recommended Operating Conditions

To achieve the best performance of the sensor, it is recommended to directly contact the sensor with the fingertip. If not, a transparent medium should be used between the finger and the sensor, and its thickness should not exceed 2mm. When measuring, it is recommended to choose a place indoors without sunlight to prevent sunlight from affecting the receiver.

D.C. Electrical Characteristics

Ta=25°C, V_{DD}=3.3V

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{DD}	Operating Voltage	$f_{SYS}=f_{HIRC}$=8MHz	3.3	3.3	5.5	V
	Communication logic voltage	$f_{SYS}=f_{HIRC}$=8MHz	—	3.0	—	V
	Storage Temperature	—	-20	—	55	°C
Ta	Operating Temperature	—	10	—	40	°C
I_{DD}	Operating Current	—	—	5	16	mA
	Sleep Current	—	—	114	—	μA
	Power-down Mode Current	EN=0	—	1	—	μA

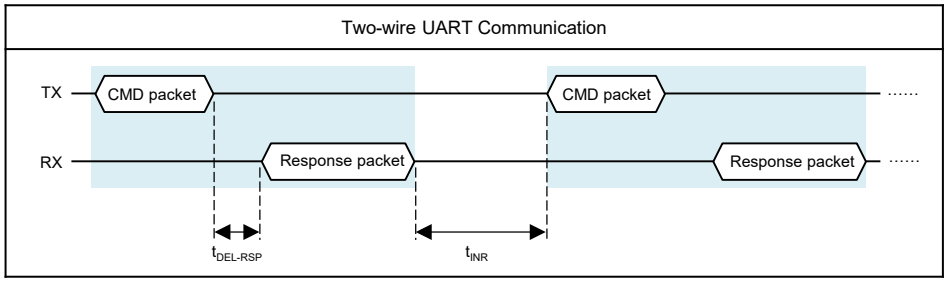
A.C. Electrical Characteristics

System Timing

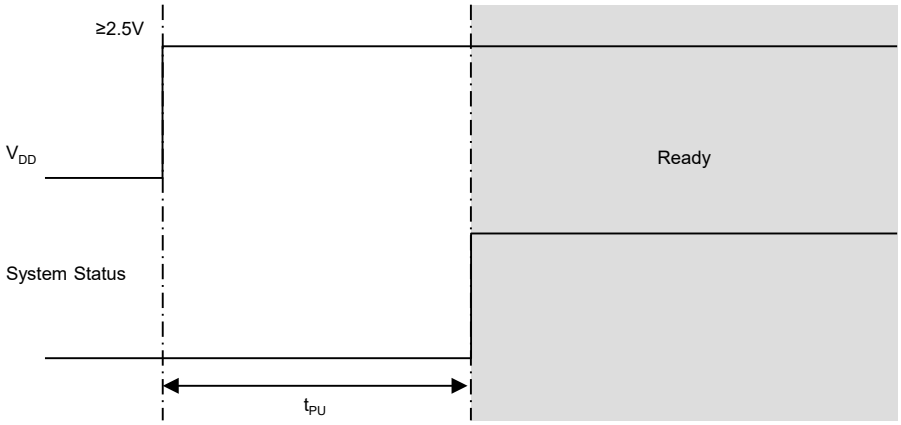
Ta=25°C, V_{DD}=3.3V

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{IH}	Input Hight Voltage	—	2.3	—	3.3	V
V_{IL}	Input Low Voltage	—	0	—	0.6	V
V_{CE}	Enable Pin Voltage	—	1.5	—	3.3	V
t_{PU}	Power-up Time	$f_{SYS}=f_{HIRC}$=8MHz; V_{IN}=3.3V	—	46	—	ms
t_{INR}	Interval Time between Continuous EEPROM Write Instructions	$f_{SYS}=f_{HIRC}$=8MHz	—	50	—	ms
	Interval Time between EEPROM Write and Read Instructions					
	Interval Time between Other Instructions	$f_{SYS}=f_{HIRC}$=8MHz	—	6	—	ms
$t_{DEL-RSP}$	Read Response Delay Time	$f_{SYS}=f_{HIRC}$=8MHz	—	800	—	μs

Communication Timing Diagram:



Power-up Timing Diagram:



Sensor Characteristics

Ta=25°C

Parameter		Conditions	Min.	Typ.	Max.	Unit
SpO2	Measurement Range	—	70	—	99	%
	Resolution	—	—	1	—	%
	Accuracy	PI>0.5%	-2	—	+2	%
Heart Rate	Measurement Range	—	30	—	250	BPM
	Resolution	—	—	1	—	BPM
	Accuracy	Heart rate: 30~100BPM	—	±2	—	BPM
		Heart rate: 100~250BPM	—	±2	—	%
PI	Measurement Range	—	0.5	—	25	%
	Resolution	—	—	0.1	—	%
	Accuracy	PI: 0~2%	—	0.2	—	%
		PI: 2~20%	—	1	—	

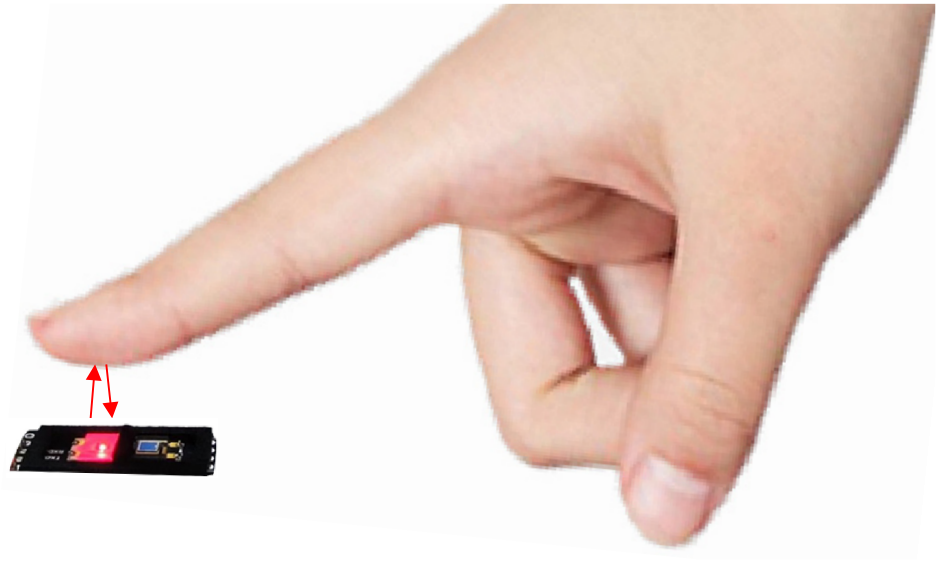
Functional Description

System Description

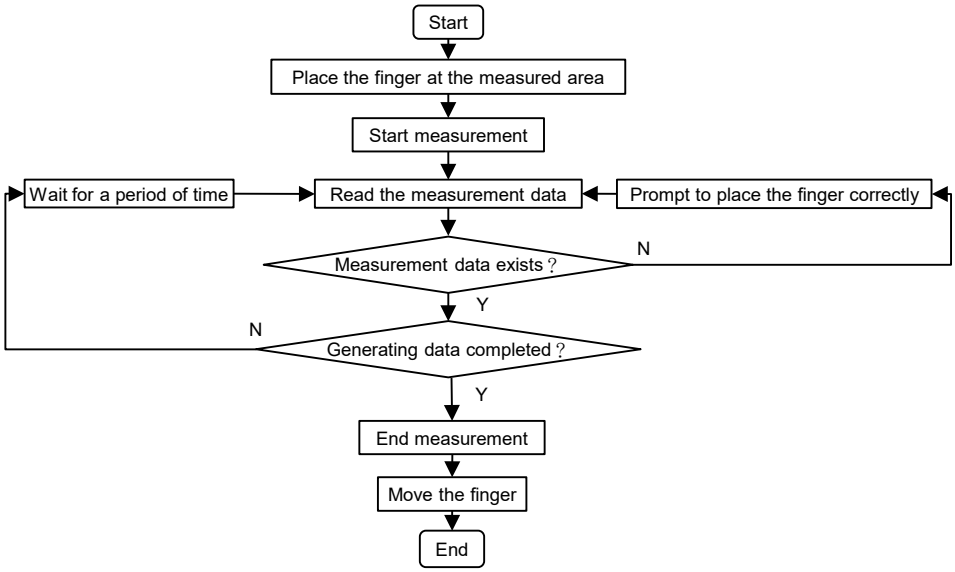
Operating Principle

The LED emitter in the BMH08002-4 blood oxygen and heart rate module can emit red light with a wavelength of 660nm and IR light with a wavelength of 905nm. The module alternately emits these two types of light. When the receiver receives the light reflected by the finger, it generated a current signal. The signal will be amplified and filtered by an operational amplifier, and sampled by the ADC to calculate the finger's reflectance of the two types of light, and then convert to blood oxygen and heart rate. The obtained measurement results will be sent to the receiver through the UART protocol.

Operation Diagram



A complete measurement operation procedure is shown in the following diagram



Sleep Mode

Enter the sleep mode when receiving the sleep instruction, wake up when receiving the start measurement instruction. If lower power consumption is required, the module power can be turned off using the EN pin.

Communication Interface

The BMH08M002-4 supports the UART communication method. In the UART communication mode, the module is used as a Slave, the Master can read the measurement value (SpO2, heart rate and perfusion index) from the BMH08M002-4.

UART Interface

Baud Rate

- Baud rate: 38400bps

Communication Protocol

There are four instruction frame formats, known as write EEPROM instruction frame, read EEPROM instruction frame, measurement instruction frame and measurement value instruction frame

Write EEPROM instruction frame:

• Host → Module

Head	CMD	OP_Code	Addr	Data	CheckSum	Tail
0x55	0xB1	1 Byte	1 Byte	2 Byte	1 Byte	0xAA

• Module → Host

Head	CMD	OP_Code	Addr	Data	CheckSum	Tail
0x55	0xB1	1 Byte	1 Byte	2 Byte	1 Byte	0xAA

Frame content introduction:

- Head: Data packet start character, fixed as 0x55
- CMD: Insruction frame is 0xB1, the special instruction frame for Module → Host is 0xB0
- OP_Code: Command code
- Addr: EEPROM address, the Addr of non EEPROM instruction frame is 0x00
- Data: Data (D_1=Data_H, D_2=Data_L)
- CheckSum=CMD+OP_Code+Addr+Data
- Tail: Data packet end character, fixed as 0xAA

Read EEPROM instruction frame:

• Host → Module

Head	CMD	OP_Code	Addr	Data	CheckSum	Tail
0x55	0xB1	1 Byte	1 Byte	0x0000	1 Byte	0xAA

• Module → Host

Head	CMD	OP_Code	Addr	Data	CheckSum	Tail
0x55	0xB1	1 Byte	1 Byte	2 Byte	1 Byte	0xAA

Measurement instruction frame:

• Host → Module

Head	CMD	OP_Code	Addr	Data	CheckSum	Tail
0x55	0xB1	1 Byte	1 Byte	0x0000	1 Byte	0xAA

• Module → Host

Head	CMD	OP_Code	Addr	Data	CheckSum	Tail
0x55	0xB1	1 Byte	1 Byte	2 Byte	1 Byte	0xAA

Measurement value instruction frame:

• Host → Module

Head	CMD	OP_Code	Addr	Data	CheckSum	Tail
0x55	0xB1	0x03	0x00	0x0000	1 Byte	0xAA

• Module → Host

Head	CMD	Data	CheckSum	Tail
0x55	0xB0	11 Byte	1 Byte	0xAA

Frame content introduction:

- Data (D_1~D_{11}): Blood oxygen information packet

Periodic Send mode, Continuous Upload mode: The module will automatically upload Module → Host data

Upload rate:

Periodic Send mode: Set by the "Periodic Send time interval" instruction (OP_Code=0x04, Addr=0x0A)

Continuous Upload mode: Upload data every 20ms

Write EEPROM Instruction Set (1):

No.	Functional Description	OP_ Code	Addr	Data	Response Data	Note
1	Configure the operating mode	0x04	0x01	D_1 D_2	D_1D_2	Operating mode configuration table (2)
2	Configure the IR light minimum intensity	0x04	0x02	D_1 D_2	D_1D_2	Data range is 0~30000 (3)
3	Configure the IR light maximum intensity	0x04	0x04	D_1 D_2	D_1D_2	
4	Configure the red light minimum intensity	0x04	0x06	D_1 D_2	D_1D_2	Data range is 0~30000 (3)
5	Configure the red light maximum intensity	0x04	0x08	D_1 D_2	D_1D_2	
6	Configure the time interval for Periodic Sending data	0x04	0x0A	D_1 D_2	D_1D_2	Data range is 3~65535, time interval=Data×4ms

Note 1: The write EEPROM instruction requires 50ms, during which the EEPROM cannot be read or written

Note 2: Operating mode configuration table

D_1D_2	Description
Bit7~Bit5	Undefined
Bit4	Emitter control logic (hardware layout, the infrared and red light on/off are controlled by two pins) 0: Pin 1 controls the infrared light on/off, Pin 2 controls the red light on/off (default, this product is fixed to use this hardware layout) 1: Pin 2 controls the infrared light on/off, Pin 1 controls the red light on/off (do not use)
Bit3	Full-scale pulse intensity value parameter update mode selection bit 0: Automatic update mode (default, the Full-scale pulse intensity value parameter will be automatically updated) 1: Trigger update mode (in this mode, the full-scale pulse intensity value will only refresh when sending the "Update PPG waveform full-scale pulse intensity value parameter" instruction.) Note: 1. The full-scale pulse intensity value parameter will be used for calculating the PPG waveform value. The peak values in the PPG waveform will vary with different full-scale pulse intensity values. 2. The automatic update mode is suitable for applications where the pulse intensity histogram is displayed such as LED oximeters. 3. The rigger update mode is suitable for applications where PPG pulse waveform are displayed over a period of time.
Bit2~Bit1	Data transmission mode selection bit 00: Periodic Send mode (default) 01: Inquire-respond mode 10: Continuous Upload mode (PPG waveform mode, suitable for applications where real-time waveform display is required) 11: Periodic Send mode
Bit0	Red light on or off when using IR light for finger placement status detection 0: Red light off (default) 1: Red light blinking Note: 1. In non sleep mode, the module will continuously detect the finger placement status. 2. The finger placement status uses the IR light to detect, the red light only uses as an light indicator.

Note 3: Continuous uploading is suitable for PPG waveform mode and applications where real-time waveform display is required

Note 4: The configured IR light minimum intensity should be less than the IR light maximum intensity

Read EEPROM Instruction Set:

No.	Functional Description	OP_Code	Addr	Data	Response Data	Note
1	Obtain the operating mode configuration	0x05	0x01	0x0000	D_1D_2	Operating mode reference information table (2)
2	Obtain the infrared light minimum intensity	0x05	0x02	0x0000	D_1D_2	Data range is 0~30000 (3)
3	Obtain the infrared light maximum intensity	0x05	0x04	0x0000	D_1D_2	
4	Obtain the red light minimum intensity	0x05	0x06	0x0000	D_1D_2	Data range is 0~30000 (3)
5	Obtain the red light maximum intensity	0x05	0x08	0x0000	D_1D_2	
6	Obtain the Periodic Send time interval	0x05	0x0A	0x0000	D_1D_2	Data range is 3~65535, time interval=Data×4ms

Measurement Instruction Set:

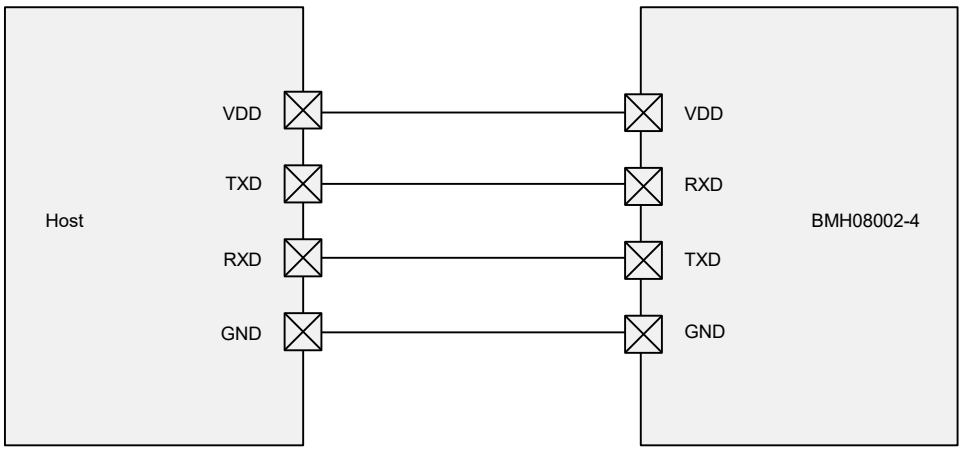
No.	Functional Description	OP_ Code	Addr	Data	Response Data	Note
1	Measurement Control	0x01	0x00	D_1 D_2	D_1D_2	Start the measurement, Data=0x0000 End the measurement, Data=0x0001 Enter the sleep mode, Data=0x0002
2	Update the PPG waveform full-scale pulse intensity value parameter	0x02	0x00	0x0000	0x0000	Suitable for Continuous Upload (PPG waveform) mode
3	Calibrate the detection sensitivity	0x06	0x00	0x0000	0x0000	

Measurement Value Instruction Set:

No.	Functional Description	OP_ Code	Addr	Data	Response Data	Note
1	Read the measurement value	0x03	0x00	0x0000	D_1~D_{11}, refer to the following instructions	

Data (D_1~D_{11})
D_1: Measurement status,
0: No finger pressed, no valid data
1: A finger pressed, no valid data
2: A finger pressed, a valid data measured
D_2: Blood oxygen, range: (35~99)%
D_3: Heart rate, range: (30~250)BPM
D_4: Perfusion index, range (0~200), 1 represents 0.1%
D_5: Heart rate variability, range (0~255)ms
D_6: Pulse intensity, range (0~16)
D_7: Heart systolic time, range 0~255ms
D_8: PPG waveform 1 high bit
D_9: PPG waveform 1 low bit
D_{10}: PPG waveform 2 high bit
D_{11}: PPG waveform 2 low bit
Note: PPG waveform 1 is the PPG waveform value calculated based on the full-scale pulse intensity value parameter after IR light detection.
PPG waveform 2 is the PPG waveform value calculated based on the full-scale pulse intensity value parameter after red light detection.
Where the full-scale pulse intensity value parameter will be used for calculating the PPG waveform value. Different full-scale pulse intensity values will result in different full-scale values (wave peaks) in the PPG waveform.
The Bit3 in the operating mode configuration table can select the full-scale pulse intensity value parameter refresh mode:
1. Automatic update mode: automatically refresh
2. Trigger update mode: it will only refresh when sending the "Update PPG waveform full-scale pulse intensity value parameter" instruction

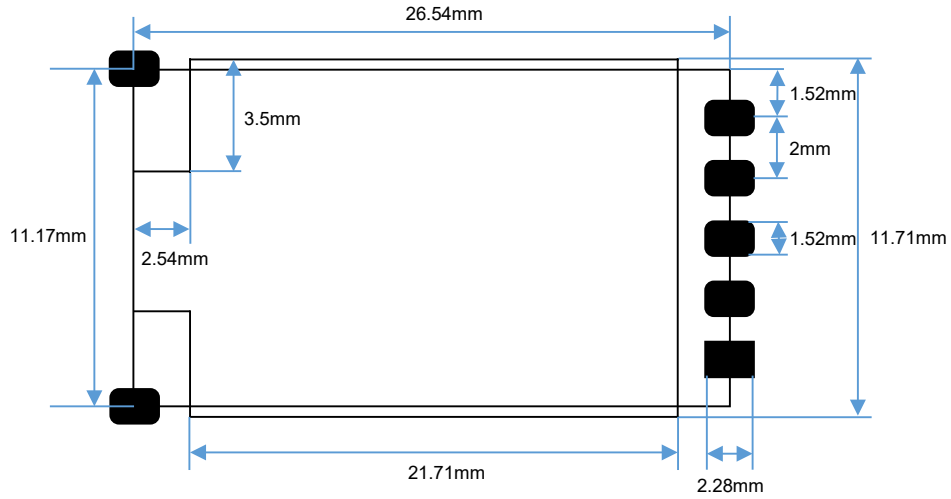
Application Circuits



Note: The RX and TX in the serial interface receiver need to be cross connected with the TX and RX in the transmitter

Layout Description

PCB Footprint

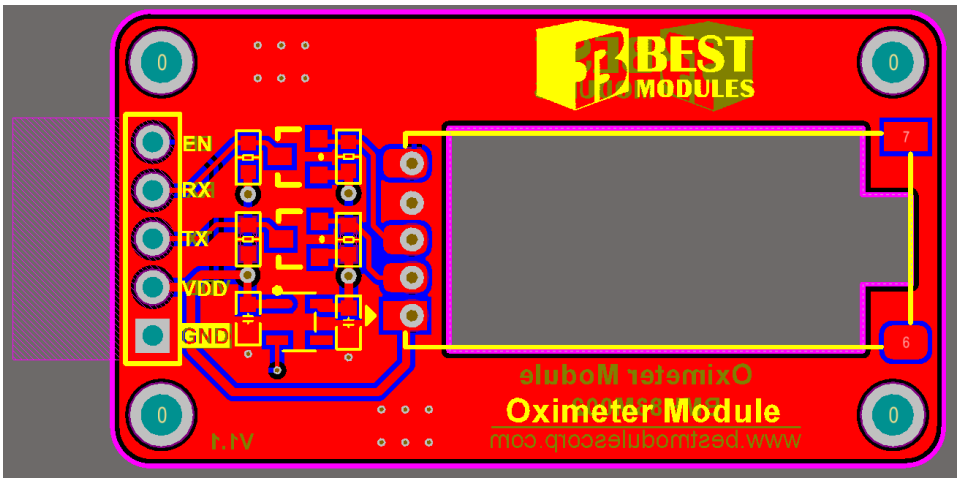


Layout Considerations

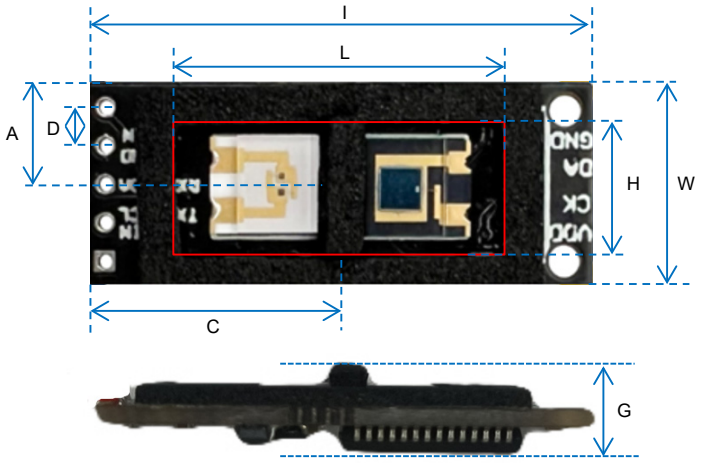
1. Stay away from luminous components and avoid the impact of other light sources on the receiver, such as sunlight
2. Stay away from high-frequency signal lines

Layout Example

The following diagram shows the BMH83M002 module from Best Modules, and the layout shows an on-board sensor module on the bottom board



Dimensions



Symbol \ Unit	mm	inch
I	27	1.06
W	11	0.43
D	2	0.08
A	6.5	0.26
C	13.5	0.53
L	11	0.43
H	5.1	0.2
G	5.1	0.2

Reference Information

Modification History

Data	Author	Issue	Modification Information
2023.03.30	—	V1.00	First Version

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Best Modules

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