Nanjing TianYiHeXin Electronics Co.,Ltd.

HX3313
Heart rate sensor

Product Definition

Ultra-low power Wearable, Optical ,Heart-Rate Sensor and Proximity Sensor with I 2C Interface .

Description

HX3313 is an ultra-low power wearable, optical, heart-rate monitor and Proximity sensor with I2C Interface. HX3313 include Transmitter and Receiver two parts . The Transmitter supports two green switching light-emitting diode (LED) and one Infrared LED ; The Receiver have two photodiode、AFE and a high resolution ADC . Heart rate Sensor is designed to monitor heart rate by PPG reflective method with DC cancellation scheme . The proximity sensing is realized by Infrared LED, a proximity detection photodiode, programmable pulse LED driver circuit . The current from the photodiode is digitized using an analog-to-digital converter (ADC). The ADC code can be read out using an I2C interface. HX3313 have three fully-integrated LED driver . The device has a high dynamic range transmit and receive circuitry that helps with the sensing of very small signal levels .

Features

- **Transmitter:**
  - Dynamic Range:101 dB
  - 2-Bit Programmable LED Current from 12.5mA to 100 mA
  - Support of two green LED for optimized HRM
  - Support of IR LED for Proximity sensor
- **Receiver:**
  - 24-Bit ADC Representation of the Current Input from a Photodiode in Twos Complement Format
  - Programmable Gain
  - Individual DC Offset Subtraction DAC at TIA Input for Each LED and Ambient Phase
  - Average Current Less Than 150 μA for PPG Signal Acquisition
  - Dynamic Range: 98dB

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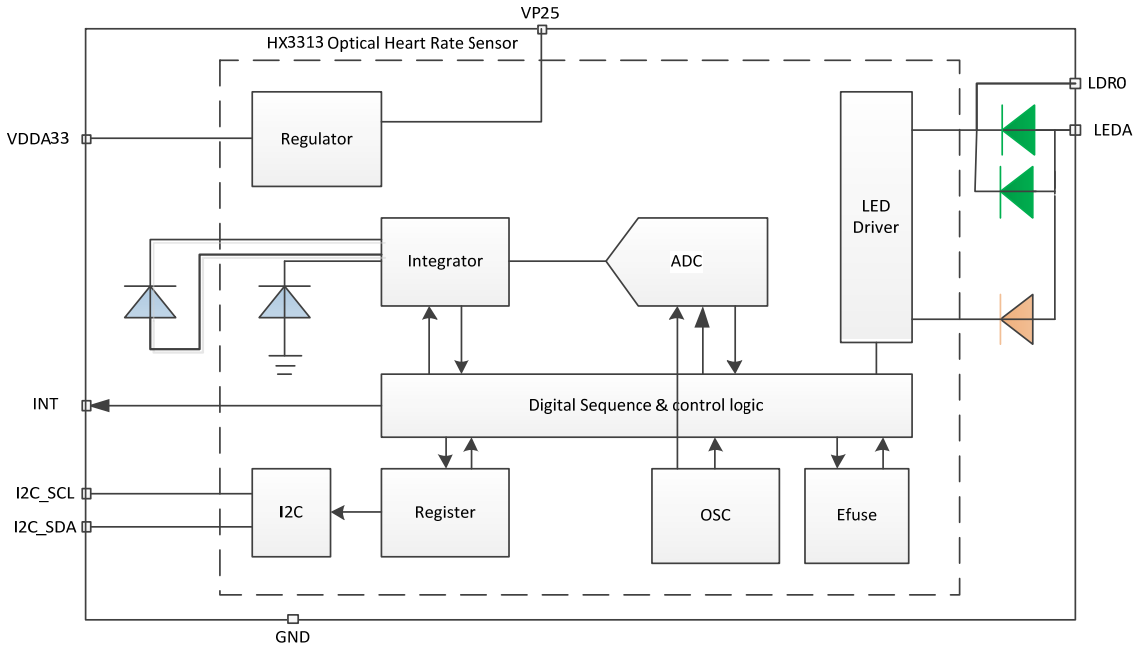
- **Pulse Sample Frequency: 10 SPS to 1000 SPS**
- **HX3313 Ultra-low power Heart Rate Static monitor 270uA**
- **Interface: I2C BUS up to 800KHz**
- **Operating Temperature Range: -20℃ to 85℃**
- **Supplies: Rx: 2.7 V to 3.6 V, Tx: 3 V to 5.25 V**
- **Package size :6.0mm×3.5mm×1mm**

Applications

- Optical Heart-Rate Monitoring (HRM)
- Optical Heart-Rate Variability (HRV)
- Proximity Detect (PS)
- Blood Pressure (BP)

Function Block Diagrams



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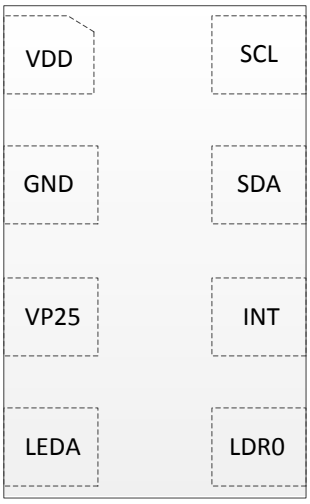
Pin Configuration



TOP VIEW

PIN LIST :

Pin	Name	Type	Description
1	VDD	A	Power supply; 1-μF decapacitor to GND
2	GND	A	Common ground for transmitter and receiver
3	VP25	A	Internal 2.5V LDO output pin ,only need 1-μF capacitor to GND
4	LEDA	A	Anode of led , connect toVDD
5	LDR0	A	LED driver pin ;floating in normal work
6	INT	D	ADC ready interrupt signal (output)for HRM and INT signal for PS
7	SDA	D	I2C data, external pull up resistor (for example, 10 k Ω)
8	SCL	D	I2C CLK, external pull up resistor (for example, 10 k Ω)

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Specifications

Absolute Maximum Ratings(T_a=25℃,unless otherwise specified)

Parameter	Min	Max	Unit
VDD	-0.2	4	V
LEDA	-0.2	6	
Analog inputs	VDD – 0.3	VDD + 0.3	V
Digital inputs	VDD – 0.3	VDD+ 0.3	V
Input current to any pin except supply pins		±7	mA
Operating temperature range	-20	85	℃
Maximum junction temperature		125	

Recommended Operating Conditions

	Min	Max	Unit
VDD	2.7	3.6	V
LEDA	3	5.5	V
Supply voltage accuracy	±5		%
Specified temperature range	-20	85	℃
Maximum junction temperature		125	

ESD Ratings

		Value	Unit
V(esd) Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001	±2000	V
	Charged device model (CDM), per JEDEC specification JESD22-C101	±250	

Green LED Characteristics

Parameter	Min	Typ.	Max	Units	Description
V_F		2.7	3.0	V	LED Forward Voltage, I_F=20mA
V_R	5			V	LED Reverse Voltage, I_R=10μA
P_O	3.0			mW	LED Radiant Power, I_F=20mA
λ_p		520		nm	LED peak wavelength, I_F=20mA
Δ_λ		50		nm	Spectral Radiation Bandwidth
T_R		25		ns	LED optical Rise time, I_F=20mA
T_F		13		ns	LED optical Fall time, I_F=20mA

Feature Description

Analog-to-Digital Converter (ADC)

The AFE has an ADC that provides a 24-bit representation of the current from the photodiode. The ADC codes corresponding to the sampling phase can be read out from 24-bit registers in twos complement format.

I²C Protocol

Interface and control are accomplished through an I²C serial compatible interface to a set of registers that provide access to device control functions and output data. The address of HX3313 is 0x44, the device also supports the 7-bit I²C addressing protocol.

HX3313 supports the standard writing and reading protocol. The register index will automatically increase by 1 after the addressed register has been accessed (read or write).

A Acknowledge (0)

P Stop Condition

R Read (1)

S Start Condition

W Write (0)

Sr Repeated Start Condition

■ Master-to- Slave

□ Slave-to-Master

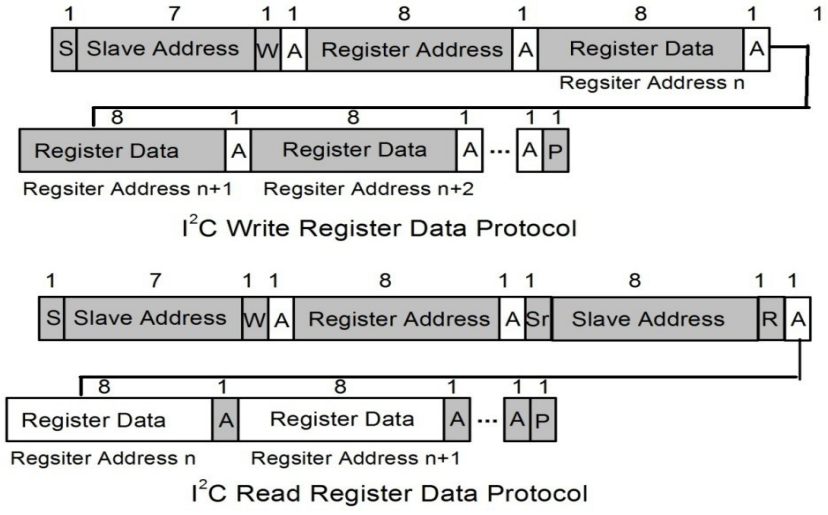


Figure 1. I²C Protocols

Register List

The device is controlled and monitored by data registers accessible through the serial interface. These registers provide for a variety of control functions and can be read to determine results of the ADC conversions. The register set is summarized in Table 1.

Table 1. Register Address

Address	name	R/W	function	Recommend Value
0x00	ID	RO	Device ID	0x22
0x01	Reserved	RO	Reserved	0x01
0x02	Enable	R/W	Hrs and Ps function enable	0x33
0x03	Reserved	RO	Reserved	0x8f
0x04	LED	R/W	Hrs Phase LED on time configuration	0x10
0x05	LED	R/W	Ps Phase LED on time configuration	0x20
0x06	Interrupt	R/W	Interrupt relate configuration	0x50
0x07	Interrupt	R/W	Interrupt relate configuration	0x07
0x08	Interrupt	R/W	Interrupt relate configuration	0x00
0x09	Sleep enable	R/W	Sleep mode enable	0x02
0x14	Offset IDAC	R/W	Ps phase offset idac configuration	0x00
0x15	Offset IDAC	R/W	Hrs phase offset idac configuration	0x00
0x16	Ps interval	R/W	Ps interval between each data	0x40
0xa0	HRS DATA1	RO	hrs_data1_out [7:0]	0x00
0xa1		RO	hrs_data1_out [15:8]	0x00
0xa2		RO	hrs_data1_out [23:16]	0x00
0xa3	ALS DATA1	RO	hrs_data2_out [7:0]	0x00
0xa4		RO	hrs_data2_out [15:8]	0x00
0xa5		RO	hrs_data2_out [23:16]	0x00
0xa6	PS1 DATA1	RO	ps1_data1_out [7:0]	0x00
0xa7		RO	ps1_data1_out [15:8]	0x00
0xa8		RO	ps1_data1_out [23:16]	0x00
0xa9	ALS DATA2	RO	ps3_data2_out [7:0]	0x00
0xaa		RO	ps3_data2_out [15:8]	0x00
0xab		RO	ps3_data2_out [23:16]	0x00
0xc0	LED_DR	RW	LED driver configuration	0x86

ID Register(0x00)

The ID Register(read-only) provides the value for the part number.

BITS	FIELD	Description
7:0	ID	0x22

Enable Register(0x02)

The enable Register used to enable HRS and PS function.

BITS	FIELD	Description
7	Reserved	0
6	PS enable	1:PS function enable ; 0 PS function disable ;
5:4	PS ADC OSR	PS OSR: 00:128 01:256 10:512 11:1024
3	Reserved	0
2	PS enable	1:PS function enable ; 0 PS function disable ;
1:0	PS ADC OSR	PS OSR: 00:128 01:256 10:512 11:1024

LED Register(0x04)

The LED Register used to set LED on time in HRS phase ;

BITS	FIELD	Description
7:0	LED	LED on time in hrs phase :

LED Register(0x05)

The LED Register used to set LED on time in PS phase ;

BITS	FIELD	Description
7:0	LED	LED on time in HRS phase :

SLEEP Register(0x09)

The Sleep register is used to enable and disable the chip ,when sleep function is enabled , I_vdd<1uA.

BITS	FIELD	Description
7:1	Reserved	Reserved
0	Sleep	1:power down; 0:power on

LED DR Register(0xc0)

The Sleep register is used to enable and disable the chip ,when sleep function is enabled , I_vdd<1uA.

BITS	FIELD	Description
7:2	Reserved	Reserved
1:0	Led driver	00 : 12.5mA 01 : 25mA 10 : 50mA 11 : 100mA

Application Information

A typical application for HX3313 is shown in Figure 2. The I^2C signals and the Interrupt are open-drain outputs and require pull-up resistor (R_P). It is recommended use 10 kΩ resistor when running at 400kbps. A 10 KΩ pull up resistor ($R_{PI)}$ can be used for the interrupt line.

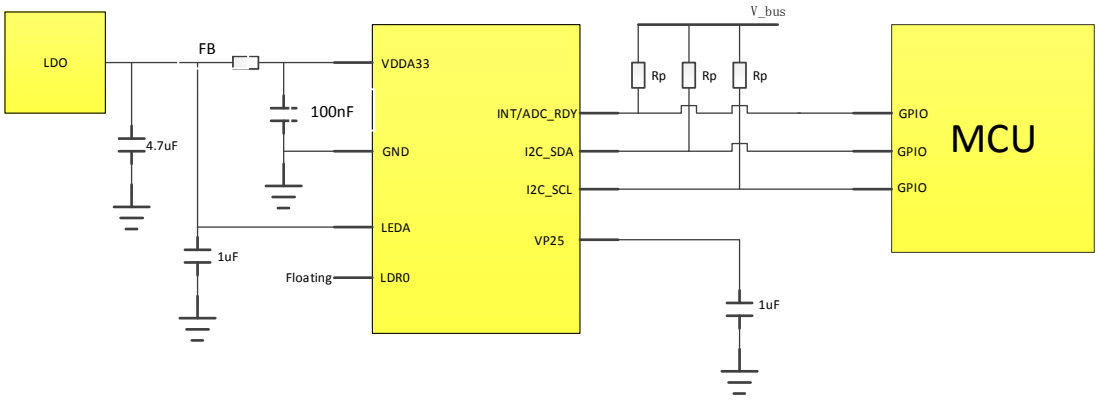


Figure 2. Typical Application Schematic Diagram

PCB Pad Layout

Suggest PCB pad layout guidelines for the surface module are shown in Figure4. Flash Gold is recommended surface finish for the landing pads.

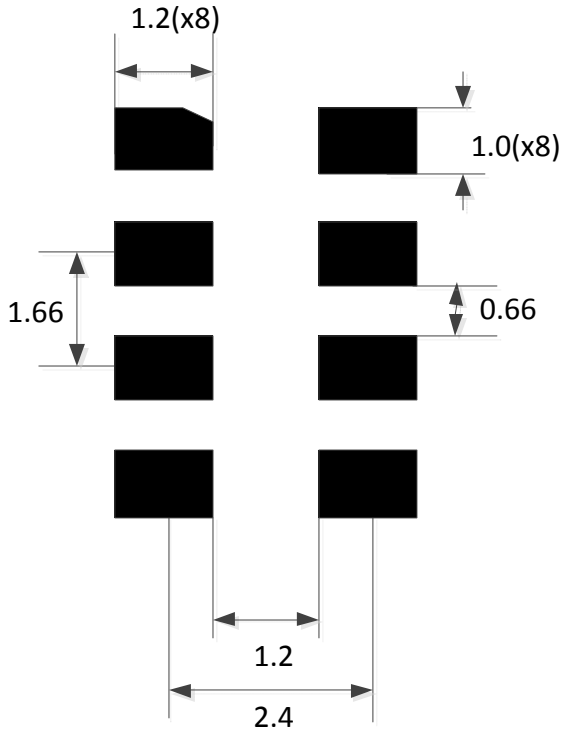


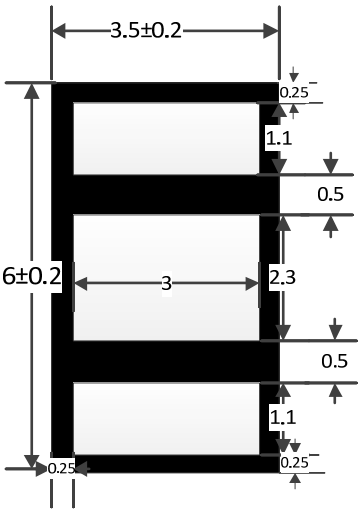
Figure 3. Suggested Module PCB layout

Note: All linear dimensions are in mm

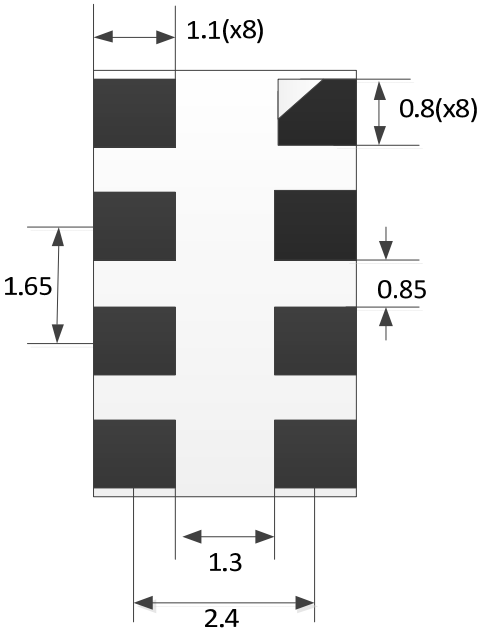
Package Information

MODULE

Top View



Bottom View



Side View

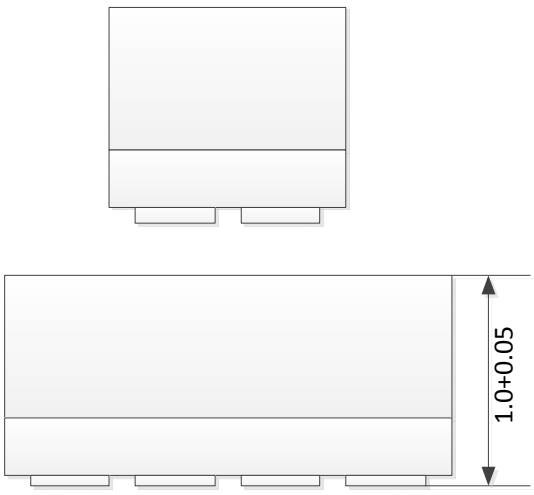


Figure 4. Package information

Notes: All linear dimensions are in mm. Dimension tolerance is ±0.05mm unless otherwise noted.

Soldering Information

The module has been tested and has demonstrated an ability to be reflow soldered to a PCB substrate. The process, equipment, and material used in these test are detailed below. The solder reflow profile describes the expected maximum heat exposure of components during the solder reflow process of product on a PCB. Temperature is measured on top of component. The components should be limited to a maximum of three passes through this solder reflow profile.

Table 9. Solder Reflow Profile

Parameter	Reference	Device
Average temperature gradient in preheating		2.5℃/sec
Soak time	t_{soak}	2 to 3 minutes
Time above 217℃ (T_1)	t_1	Max 60 sec
Time above 230℃ (T_1)	t_2	Max 50 sec
Time above T_{peak}-10℃ (T_3)	t_3	Max 10 sec
Peak temperature in reflow	T_{peak}	260℃
Temperature gradient in cooling		Max-5℃/sec

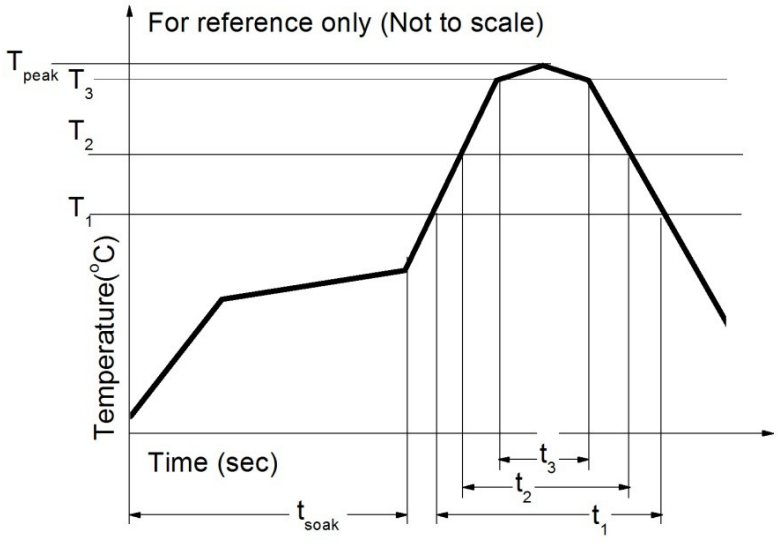
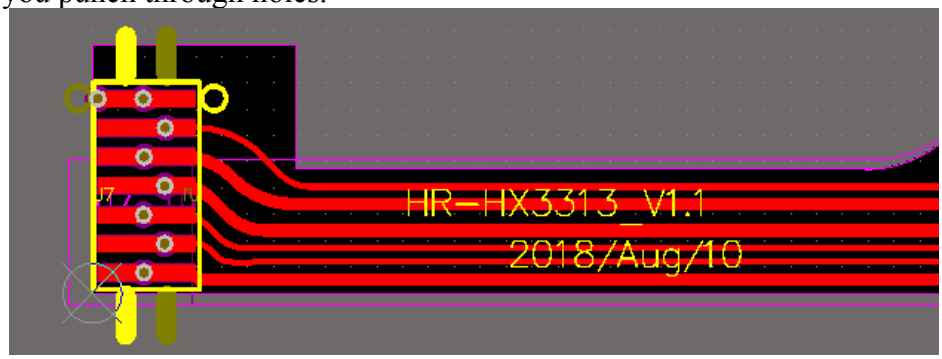


Figure 5. Solder reflow profile graph

PCB Layout Design Suggest：

1. HX3313 need to lonely LDO to supply power, best on the low swing and low noise output voltage。
2. Line width of VDDA33 and LADA is greater than 12mil,It's best to punch twice when you punch through holes.



3. The spacing between power ,source and signal is about 10mil, while that between signal and signal is about 8mil

4. The filter capacitor should be close to the pin of the chip and not too far away