VCSEL Proximity Sensing Digital Sensor

BM32S212x-1

Revision: V1.10 Date: November 21, 2024

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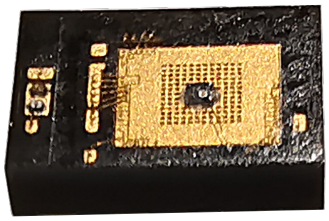
Table of Contents

Features

- Short distance detection application
- Operating voltage: 2.0V~5.0V
- Integrated modules: VCSEL, Photodiode (PD) and signal conditioning MCU
- Low power consumption
- Operating distance range:
  - BM32S2122-1: ≤10cm
  - BM32S2123-1: ≤30cm
- Factory-calibrated
- Detection distance learning function
- Output type: I^2C & IRQ
- Package type: Surface-mount OLGA-8
- Dimensions: 4.0×3.0×0.9mm



General Description

The devices are infrared proximity sensing modules, which are designed for object detection applications. When an object enters the detection range, the reflected energy of the infrared will change. Proximity is determined by detecting changes in reflection. The modules have small sizes, support detection of objects at a distance of up to 30cm and have the low operation current consumption of 10μA at 3.3V, allowing the module to meet the requirements of a large number of product applications with varying power designs.

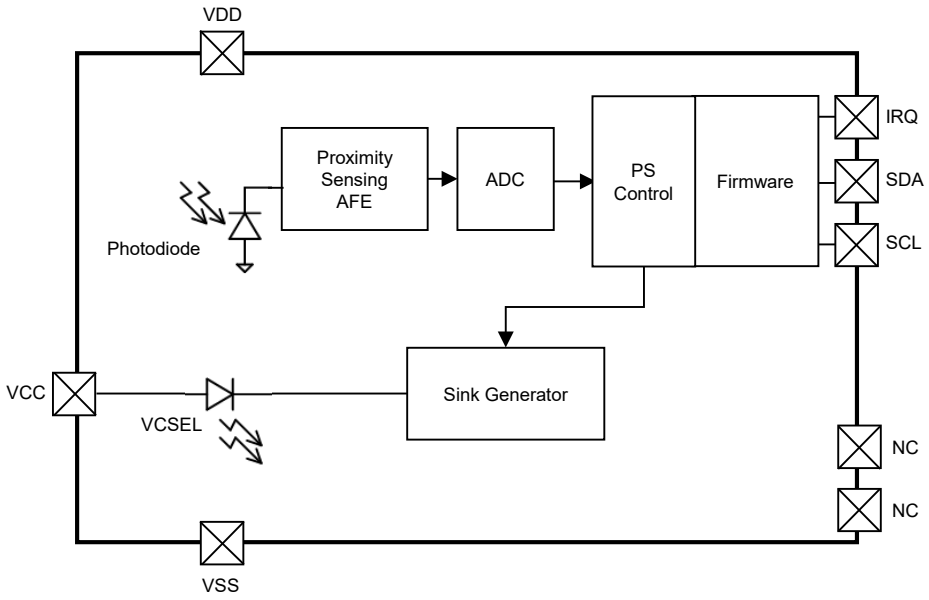
Applications

- Wearable
- Consumer electronics
- Sanitary ware
- Urinal

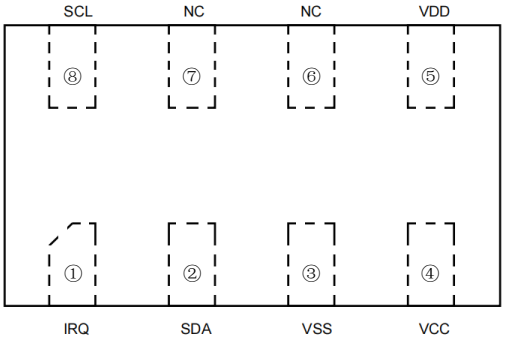
Selection Table

Part No.	Description
BM32S2122-1	Detection distance ≤ 10cm
BM32S2123-1	Detection distance ≤ 30cm

Block Diagram



Pin Assignment



Pin Description

Pin	Function	Type	Description
1	IRQ	DO	Output a low level when proximity triggering
2	SDA	DI/DO	I²C data line
3	VSS	P	Ground
4	VCC	P	VCSEL power
5	VDD	P	Sensor power
6, 7	NC	—	No-connect
8	SCL	DI/DO	I²C clock line

Legend: DI/DO=Digital input/output; P=Power

Technical Specifications

Absolute Maximum Ratings

Supply Voltage ..... V_{SS}-0.3V to V_{SS}+5.5V

Input Voltage ..... V_{SS}-0.3V to V_{DD}+0.5V

Storage Temperature..... -40°C to 85°C

Total Power Dissipation 500mW

Note: These are stress ratings only. Stresses exceeding the range specified under "Absolute Maximum Ratings" may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

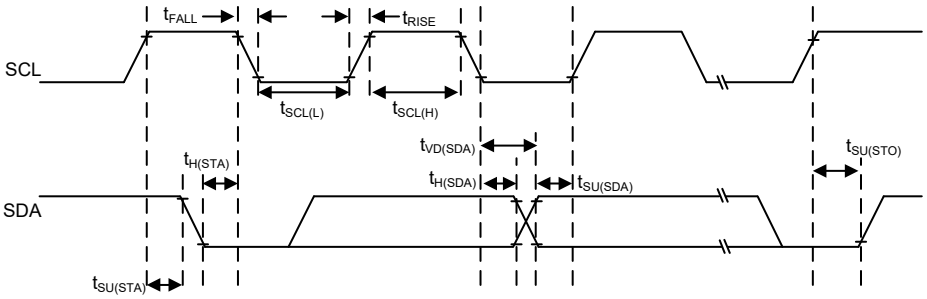
D.C. Electrical Characteristics

Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DD}	Operating Voltage	—	—	2.0	—	5.0	V
V_{CC}	VCSEL Forward Voltage	—	12mA	0.7	—	5.0	V
I_{VCSEL}	VCSEL Driving Current	3.3V	—	—	11	14	mA
I_{STB}	Operation Current	3.3V	Scanning time=512ms	—	10	20	μA
		5V		—	15	35	

I²C Interface Characteristics

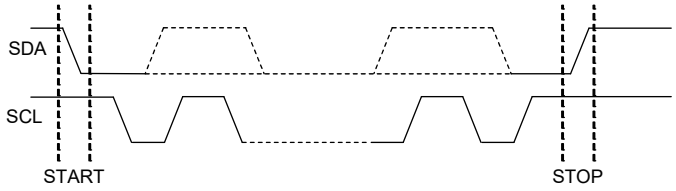
Symbol	Parameter	VDD	Min.	Typ.	Max.	Unit
$t_{SCL(H)}$	SCL Clock High Time	3V/5V	65	—	—	μs
$t_{SCL(L)}$	SCL Clock Low Time	3V/5V	65	—	—	μs
t_{FALL}	SCL and SDA Fall Time	3V/5V	—	—	4.5	μs
t_{RISE}	SCL and SDA Rise Time	3V/5V	—	—	4.5	μs
$t_{SU(SDA)}$	SDA Data Setup Time	3V/5V	25	—	—	μs
$t_{H(SDA)}$	SDA Data Hold Time	3V/5V	25	—	—	μs
$t_{VD(SDA)}$	SDA Data Valid Time	3V/5V	25	—	—	μs
$t_{SU(STA)}$	Start Condition Setup Time	3V/5V	35	—	—	μs
$t_{H(STA)}$	Start Condition Hold Time	3V/5V	35	—	—	μs
$t_{SU(STO)}$	Stop Condition Setup Time	3V/5V	20	—	—	μs
T_{BR}	Data Transfer Rate	—	—	—	7.5	kbps
T_{TO}	Time-Out Period	—	—	70	—	ms



I²C Timing Diagram

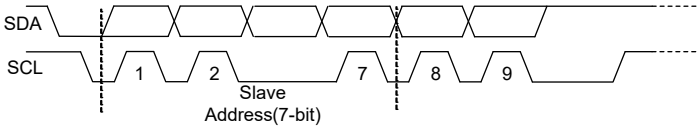
I²C Interface

START and STOP Conditions

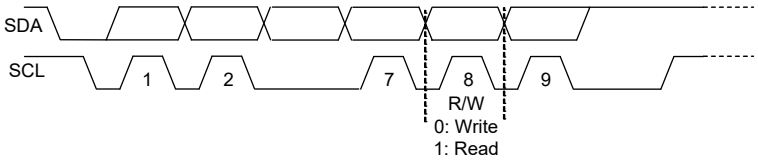


Slave Address

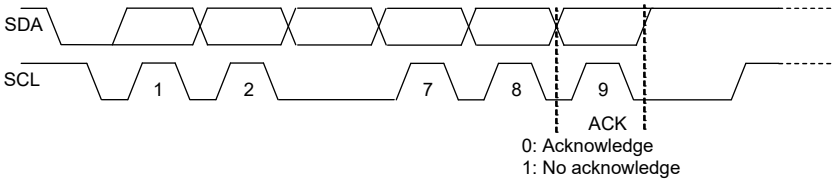
After the START signal, a 7-bit slave address will be transmitted. The slave address is 0x50. (slave address + R/W = 0xA1 or 0xA0)



Read or Write Control

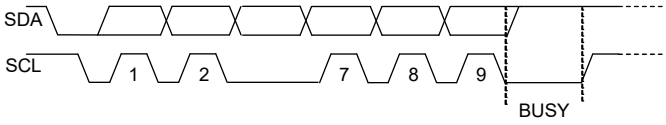


Acknowledge

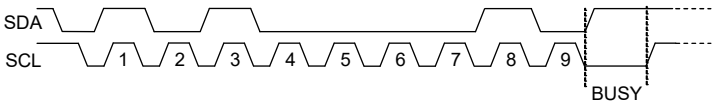


Slave Busy

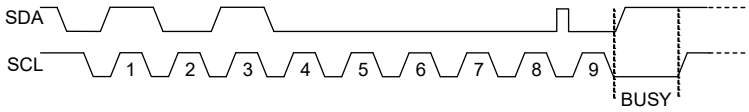
After a data byte (8-bit+ACK) is transmitted, the slave device is busy with processing the received data (slave busy) and cannot receive the next data byte. At this time the SCL line is pulled down and the master can continue to transmit the data until the SCL line is pulled high again.



Master Read

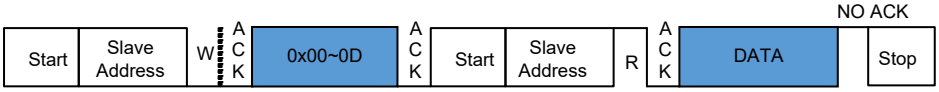


Master Write

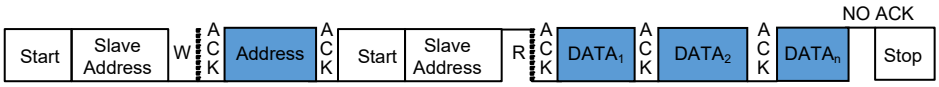


Read Setting Register

The master read a setting byte of the sensor.



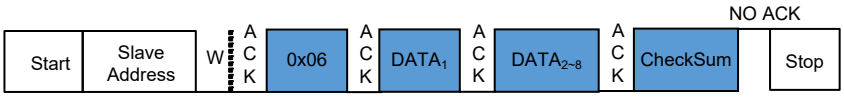
The master read n setting bytes of the sensor.



Write Setting Register

When the master writes the setting byte to the BM32S21xx-1, it must write all data bytes consecutively, starting with 0x06, and the last byte is the checksum.

CheckSum (8-bit): $DATA1_{(06)} + DATA2_{(07)} + \ldots + DATA8_{(0D)}$



When the setting is changed, the sensor will be reset. For about 0.8s later the sensor can normally operate after reset.

I²C Register Map

Address	Name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Access
00	SENSOR_STATUS	CALF3	CALF2	CALF1	STU3	STU2	STU1	PROXF2	PROXF1	R/W
01	PROX_LEVEL	Proximity Level								R
02	REF_DATA_LOW	Reference Data Low								R
03	REF_DATA_HIGH	0				Reference Data High				R
04	NOW_DATA_LOW	Now Data Low								R
05	NOW_DATA_HIGH	0				Now Data High				R
06	—	0								R/W
07	—	0								R/W
08	STATUS_DBC	Proximity Debounce Times								R/W
09	CURRENT	VCSEL Driving Current								R/W
0A	PROX_THR	Proximity Threshold								R/W
0B	LEAVE_THR	Leaving Threshold								R/W
0C	OPTION	MODE	0	Maximum Hold Time			Proximity Scan Cycle			R/W
0D	CALIBRATE_TIME	0				Calibration Period				R/W
0E	CHECK SUM	Check Sum								R/W
0F	FW_VER	0x02								R

• SENSOR_STATUS (Address: 0x00)

Address	Name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Access
00	SENSOR_STATUS	CALF3	CALF2	CALF1	STU3	STU2	STU1	PROXF2	PROXF1	R/W

I^2C protocol for starting a learning calibration: 0xa0+0x00+SENSOR_STATUS

CALF3: Proximity Sensing AFE calibration
0: None
1: Calibrating

CALF2: Power-on calibration
0: None
1: Calibrating

CALF1: Moving calibration
0: None
1: Calibrating

STU3: Distance learning mode (no covered plate + with object)
0: Normal operation
1: Start the current learning
The threshold remains unchanged after the learning has started, the current value is automatically adjusted to be able to detect objects. Within 1.5 seconds of power-on, pull the IRQ pin down for more than 0.4 seconds and then pull the IRQ pin high, this bit will be set high.

STU2: Learning mode after a plate has been covered (no object)
0: Normal operation
1: Start the current learning
After the learning has started, the current value is automatically adjusted so that the current A/D value is less than 3072.

STU1: Distance learning mode after a plate has been covered (with object)
0: Normal operation
1: Start the threshold learning
The current value remains unchanged after the learning has started, the threshold is automatically adjusted to be able to detect objects.

PROXF2: Real-time proximity status (Without debounce)
0: No proximity
1: Proximity detected

PROXF1: Proximity status after debounce (Determine by PROX_THR)
0: No proximity
1: Proximity detected

• PROX_LEVEL (Address: 0x01)

Address	Name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Access
01	PROX_LEVEL	Proximity Level								R

Proximity Level: Proximity level of an object
00000000: No proximity
00000001: Farthest
⋮
01100100: Nearest

• REF_DATA_LOW (Address: 0x02)

Address	Name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Access
02	REF_DATA_LOW	Reference Data Low								R

Reference Data Low: A/D value low bits of VCSEL without emission
00000000~11111111：0~255

• REF_DATA_HIGH (Address: 0x03)

Address	Name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Access
03	REF_DATA_HIGH	0				Reference Data High				R

Reference Data High: A/D value high bits of VCSEL without emission
0000~1111: 0~15

• NOW_DATA_LOW (Address: 0x04)

Address	Name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Access
04	NOW_DATA_LOW	Now Data Low								R

Now Data Low: A/D value low bits of VCSEL emission
00000000~11111111: 0~255

• NOW_DATA_HIGH (Address: 0x05)

Address	Name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Access
05	NOW_DATA_HIGH	0				Now Data High				R

Now Data High: A/D value high bits of VCSEL emission
0000~1111: 0~15

• STATUS_DBC (Address: 0x08)

Address	Name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Access
08	STATUS_DBC	Proximity Debounce Times								R/W

Proximity Debounce Times: Determine proximity trigger (PROXF) debounce times
00000001~00010000: When level is bigger than threshold and exceeds debounce times, PROXF=1 (Default 10)

• CURRENT (Address: 0x09)

Address	Name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Access
09	CURRENT	VCSEL Driving Current								R/W

VCSEL Driving Current: Setting VCSEL Driving Current
00000001~0000000B: 2~12mA (Default 0x0A=11mA)

• PROX_THR (Address: 0x0A)

Address	Name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Access
0A	PROX_THR	Proximity Threshold								R/W

Proximity Threshold: Determine proximity trigger (PROXF) level
00000100~00100000: When level is bigger than threshold and exceeds debounce times, PROXF=1 (Default 8)

• LEAVE_THR (Address: 0x0B)

Address	Name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Access
0B	LEAVE_THR	Leaving Threshold								R/W

Leaving Threshold: Determine leaving threshold level
00000100~00100000: When level is smaller than threshold and exceeds debounce times, PROXF=0 (Default 6)

• OPTION (Address: 0x0C)

Address	Name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Access
0C	OPTION	MODE	0	Maximum Hold Time			Proximity Scan Cycle			R/W

MODE: Touch mode selection
0: Reference mode
1: Absolute mode
In absolute mode, the maximum trigger output time and the automatic calibration function are disabled.

Maximum Hold Time: Maximum trigger output time
000: Disable (Default)
001: 2s
010: 4s
011: 8s
100: 16s
101: 32s
110: 64s
111: 128s

Proximity Scan Cycle: Proximity scanning period
000: 8ms
001: 16ms
010: 32ms
011: 64ms
100: 128ms
101: 256ms
110: 512ms (Default)
111: 1024ms

• CALIBRATE_TIME (Address: 0x0D)

Address	Name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Access
0D	CALIBRATE_TIME	0				Calibration Period				R/W

Calibration Period: Calibration period
0000: 0.5s
0001: 1.0s
0010: 1.5s
0011: 2.0s (Default)
⋮
1111: 8.0s
Plus 0.5s for all settings when [Proximity Scan Cycle] = 111.

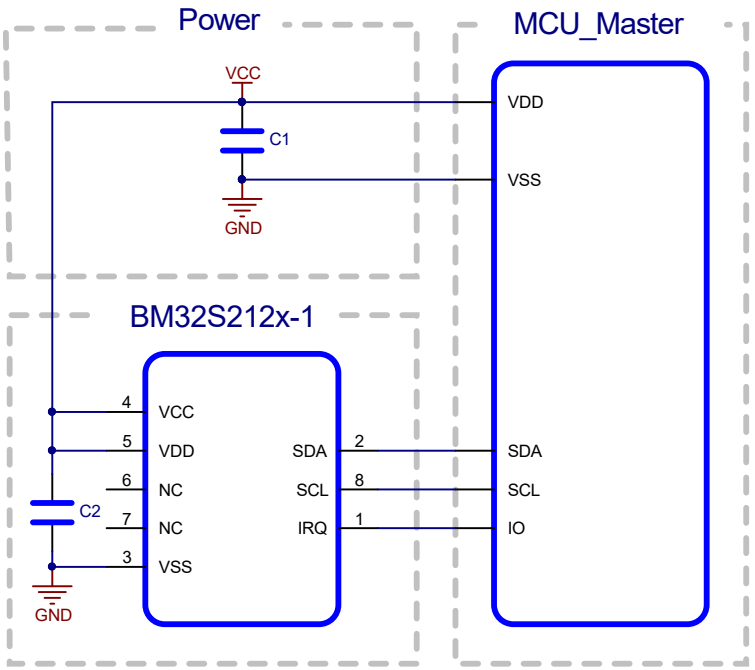
• CHECK SUM (Address: 0x0E)

Address	Name	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Access
0E	CHECK SUM	Check Sum								R/W

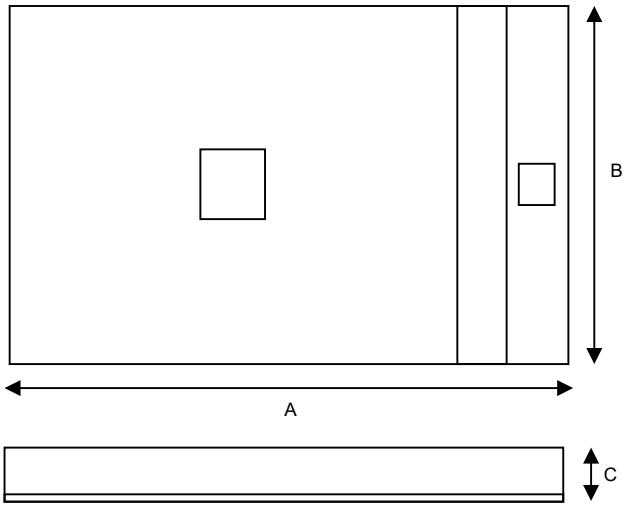
Check Sum: After the checksum is successfully written, the data will be stored in the EEPROM, and the IC will automatically reset

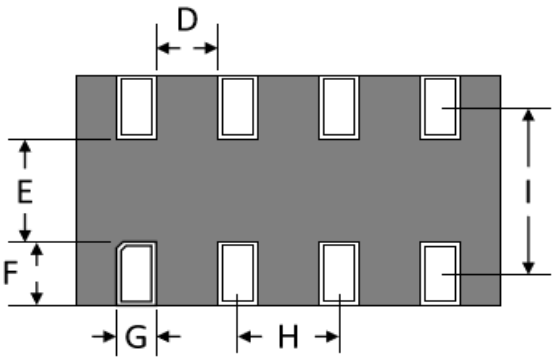
Check Sum (8-bit): $DATA1_{(06)} + DATA2_{(07)} + \ldots + DATA8_{(0D)}$

Application Circuits



Dimensions





Symbol	Unit	
	mm	inch
A	4.00	0.157
B	3.00	0.118
C	0.90	0.035
D	0.53	0.021
E	1.50	0.059
F	0.70	0.028
G	0.40	0.016
H	0.93	0.037
I	2.20	0.087

Reference Information

Revision History

Date	Author	Issue	Modification Information
2024.11.18	姚尊宇	V1.00	First version

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