Proximity Sensing Module

BM32S2021-1

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Features

- Wide distance detection application
- Operating voltage: 3.3V/5.0V
- Low current consumption
  - Operating current: Typ. 1.5mA
    (3.3V / object detected at 85cm / scanning time = 0.5s)
  - Standby current: Typ. 14μA
    (3.3V / default at 85cm / scanning time = 0.5s)
- Wide operating range: Distance 1~100cm
- Factory-calibrated
- Detection distance learning function
- Optional communication interfaces: UART Mode or I/O Mode

General Description

The BM32S2021-1 is an infrared proximity sensing module, which is 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. Compared with the general infrared sensing modules on the market, this module has a small size, supports detection of objects at a distance of up to 100cm and has a low standby current consumption of 14μA at 3.3V, allowing the module to meet the requirements of a large number of product applications with varying power designs.

Having a modular design ensures much reduced product development time. This proximity sensing module is suitable used for all types of smart home electronic products, such as smart door locks, smart makeup mirrors, smart sanitary ware and automatic dryers. The module provides two user selectable output modes, namely I/O and UART types. When used together with a dedicated development platform, the required module characteristics can be rapidly setup and adjusted to implement fast and convenient product development.

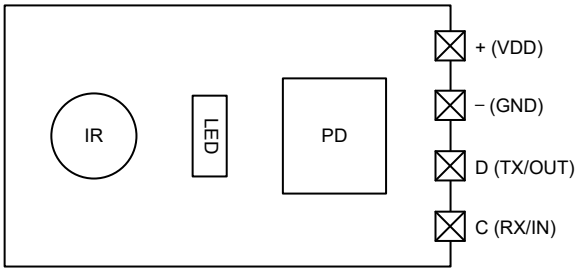
Applications

- White goods
- Consumer electronics
- Electrical door locks
- Bath equipments

Selection Table

Part Number	Distance (25°C / Indoor / White A4 Paper)	Interface
BM32S2021-1	1~100cm	UART (9600bps), I/O

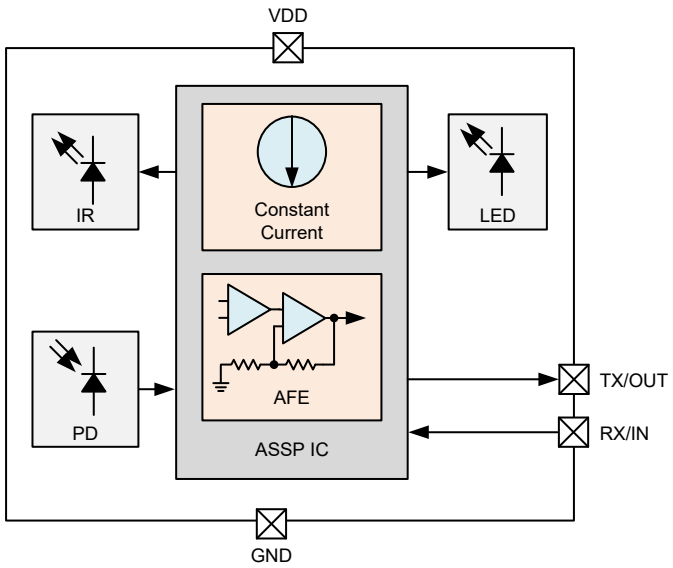
Pin Assignment



Pin Description

Pin Symbol	Mode	Function	Description
C	I/O	IN	Learning key input
	UART	RX	UART (9600bps) receiving pin
D	I/O	OUT	Level output (default: active low)
	UART	TX	UART (9600bps) transmitting pin
–	UART, I/O	GND	Connect to ground
+	UART, I/O	VDD	Positive power supply (V_{DD}<5.5V)

Block Diagram



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. Characteristics

Ta=25°C

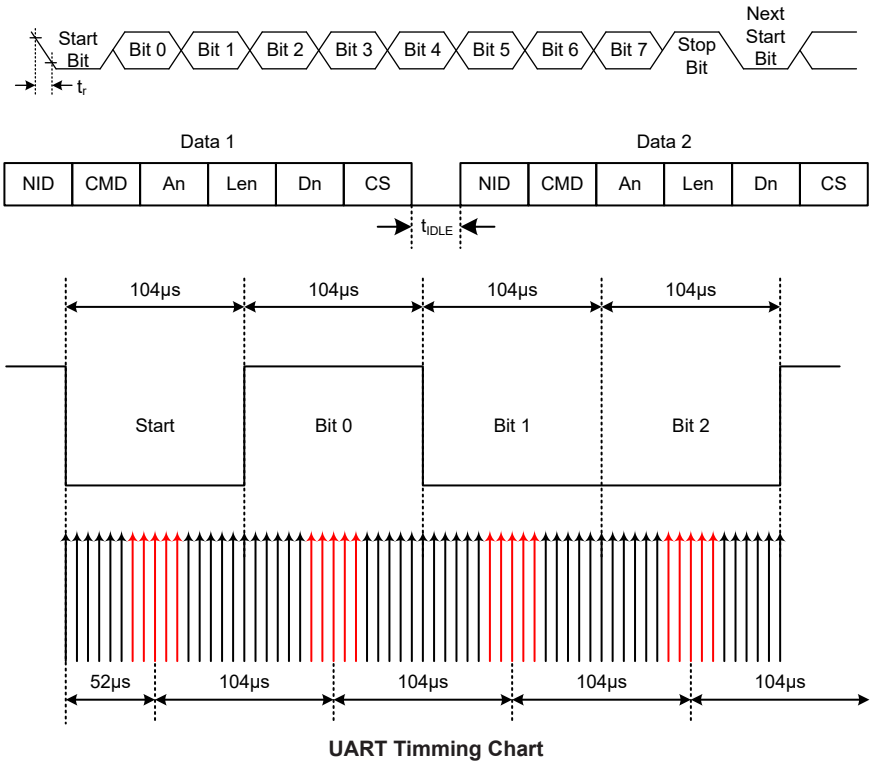
Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DD}	Operating Voltage	—	—	3.0	—	5.5	V
I_{DD}	Operating Current, (Proximity Sensing Mode, LED on)	3.3V	Object detected at 85cm, Scanning time=0.5s	—	1.5	2.5	mA
		5V		—	3.0	4.5	
I_{STB}	Standby Current (No Object Detected)	3.3V	I/O Mode, Default distance at 85cm, Scanning time = 8ms	—	640	960	μA
		5V		—	900	1350	
		3.3V	I/O Mode, Default distance at 85cm, Scanning time = 16ms	—	320	480	
		5V		—	500	750	
		3.3V	I/O Mode, Default distance at 85cm, Scanning time = 32ms	—	160	240	
		5V		—	250	375	
		3.3V	I/O Mode, Default distance at 85cm, Scanning time = 64ms	—	80	120	
		5V		—	120	180	
		3.3V	I/O Mode, Default distance at 85cm, Scanning time = 0.125s	—	45	70	
		5V		—	70	105	
		3.3V	I/O Mode, Default distance at 85cm, Scanning time = 0.25s	—	25	40	
		5V		—	35	55	
		3.3V	I/O Mode, Default distance at 85cm, Scanning time = 0.5s	—	14	20	
		5V		—	20	30	
		3.3V	I/O Mode, Default distance at 85cm, Scanning time = 1s	—	7	12	
		5V		—	12	20	
		3.3V	I/O Mode, Default distance at 85cm, Scanning time = Full Speed (no sleep)	—	1.5	3.0	mA
		5V		—	2.0	5.5	

A.C. Characteristics

UART Interface

Ta=25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
BDR	UART Baud Rate	—	—	—	9600	—	bps
t_{IDLE}	Interval between each UART Data Transmission	—	—	10	—	—	ms
t_r	Rising or Falling Time	—	—	—	—	0.3	μs



UART Timming Chart

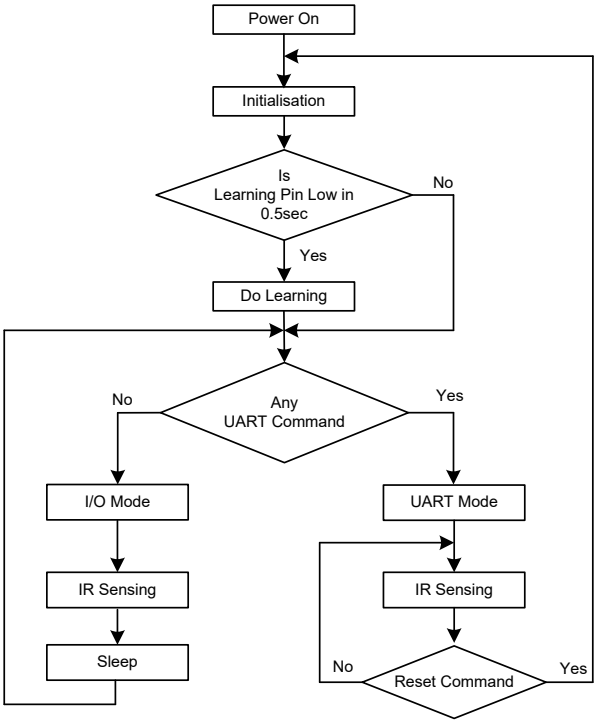
Functional Description

System Description

To achieve stable proximity sensing action, the BM32S2021-1 only requires a light-sheilding mechanism. The module can help users quickly implement proximity sensing function on products and reduce the product development period.

Operating Principle

The BM32S2021-1 executes initialization after power on. Then it starts detection waiting for objects to approach. When an object enters the detection range, the output pin level will change (high active or low active output or pulse output). The output pin status can be used to determine the proximity status.



System Flowchart

Reading Object's Proximity Value

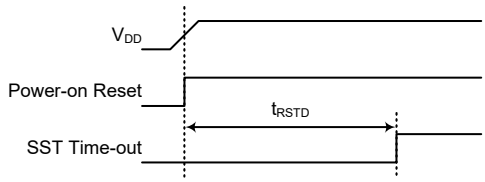
The host device can read the value from the BM32S2021-1 via the corresponding UART command. Continuous reading is allowed.

Communication Method	Minimum Continuous Reading Time	Unit
UART	10	ms

Reset and Initialization

Power-on Reset

The most fundamental and unavoidable reset is the one that occurs after power is first applied to the microcontroller. As well as ensuring that the Program Memory begins execution from the first memory address, a power-on reset also ensures that certain other registers are preset to known conditions. All the I/O port and port control registers will power up in a high condition ensuring that all pins will be first set to inputs.



Note: t_{RSTD} is power-on delay with typical time=48ms

Power-on Reset Timing Chart

Detection Distance Learning Function

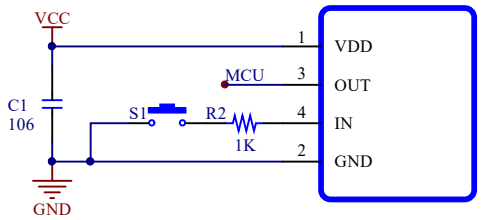
The default detection distance of the module is 85cm. This function can be used to set other detection distances according to the application requirements. The device must enter the distance learning function in 0.5s after power-on.

Place the object to be detected at the desired distance. Pull the IN pin to low level in 0.5s after power-on, the module indicator will flash. Then release the IN pin. The distance learning is completed when the indicator stops flashing.

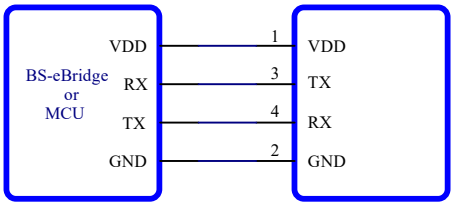
Note that the longer the distance, the larger the error. To use a master MCU to control the module to enter the learning function (I/O mode), the whole module should be powered on again or the master MCU should send a Module Reset command (send command first then pull the IN pin low).

Application Circuits

I/O Mode



UART Mode



Interface

The BM32S2021-1 supports the UART communication method. In the UART mode, the host device can read the measurement result and device information from the BM32S2021-1. More details about the communication are described in the following UART section.

In the UART mode, IN and OUT pins are used as the communication pins and the IR detection reacts at Fast Mode by default. Switching back to I/O mode is implemented by sending a Module Reset command from the host device.

UART Interface

Send any command to the moudule 0.5s after power-on, the module will enter the UART mode. The UART protocol is as follows:

1. NID: 0x55
2. Command (CMD)

   0x80: read parameters from module

   0xC0: write parameters to module
3. Register address: An
4. Data length: Len
5. Data Content: Dn
6. CheckSum (CS): CS = NID + CMD + An + LEN + Dn; (take the lower 8 bits of the checksum)

NID	Command	Register Address	Data lentgh	Data Content	CheckSum
0x55	CMD	An	Len	Dn	CS
1	2	3	4	5	6

Special Commands

No.	NID	CMD	CS	Content
1	0x55	0x10	0x65	Module Reset. The module can be switched from UART mode to I/O mode via this command. Module Response: 0x55, Ack, CS.
2	0x55	0x19	0x6E	Module Enters Distance Learning Mode. Place the object to be detected at the desired distance, then the module indicator will flash. The distance learning is completed when the indicator stops flashing. Module Response: 0x55, Ack, CS.
3	0x55	0x1A	0x6F	Write to EEPROM. Write the required parameter first, then send this command, so that the required parameter will be written into the EEPROM. Module Response: 0x55, Ack, CS.
4	0x55	0x1C	0x71	Read from EEPROM. Read parameters from EEPROM. Module Response: 0x55, Ack, CS.

Read Commands

No.	NID	CMD	An	Len	CS	Content
1	0x55	0x80	0x00	0x01	0xD6	Version Information Low Byte. Dn: Version low byte Module Response: 0x55, 0xC0, 0x00, 0x01, Dn, CS.
2	0x55	0x80	0x01	0x01	0xD7	Version Information High Byte. Dn: Version high byte Module Response: 0x55, 0xC0, 0x01, 0x01, Dn, CS.
3	0x55	0x80	0x02	0x01	0xD8	Proximity Sensing Status. Dn: 0x00: No object approaching 0x01: There is an object approaching Module Response: 0x55, 0xC0, 0x02, 0x01, Dn, CS.
4	0x55	0x80	0x03	0x01	0xD9	Proximity Sensing Reference Value (The sensing value when IR LED is not emitting). Dn: Proximity Sensing reference value Module Response: 0x55, 0xC0, 0x03, 0x01, Dn, CS.
5	0x55	0x80	0x04	0x01	0xDA	Proximity Sensing Ambient Value (The sensing value when IR LED is emitting). Dn: Proximity Sensing ambient value Module Response: 0x55, 0xC0, 0x04, 0x01, Dn, CS.
6	0x55	0x80	0x08	0x01	0xDE	Proximity Sensing Trigger Threshold Value. When the result of "Ambient value minus Reference value" is greater than the trigger threshold, the module is triggered. Dn: 16~180 (default 16) Module Response: 0x55, 0xC0, 0x08, 0x01, Dn, CS.
7	0x55	0x80	0x09	0x01	0xDF	IR Trigger Debounce Times (Noise Filter). Dn: 0~15 (default 0) Module Response: 0x55, 0xC0, 0x09, 0x01, Dn, CS.
8	0x55	0x80	0x0A	0x01	0xE0	Infrared Detection Reaction Speed. Dn: Default 0x06 (0.5s) 0x00: 8ms, 0x01: 16ms, 0x02: 32ms, 0x03: 64ms, 0x04: 128ms, 0x05: 256ms, 0x06: 0.5s, 0x07: 1s, 0x08: Fast Mode. Module Response: 0x55, 0xC0, 0x0A, 0x01, Dn, CS.
9	0x55	0x80	0x0B	0x01	0xE1	Delay OFF output when an object is detected. (only valid in normal High/Low output mode) Dn: Default 0x00 0x00: Not activate delay OFF output function 0x01~0xFF: Activate delay OFF output function, delay=1~255s Module Response: 0x55, 0xC0, 0x0B, 0x01, Dn, CS.
10	0x55	0x80	0x0C	0x01	0xE2	Mode Function Setup Dn: Default 00010011 Bit 4~0: Indicator setup Bit 4=0 & Bit 3~0=0: Flashing off, indication off Bit 4=0 & Bit 3~0≠0: Flashing off, indication on Bit 4=1 & Bit 3~0=0~15: Flashing on, indication on Flashing interval=1~16s Bit 5: Output mode selection 0: Normal High/Low output mode 1: Pulse/Toggle switching mode Bit 6: Pulse/Toggle selection (only valid when Bit 5=1) 0: Pulse (After object approaches, ON output for 200μs every 1s) 1: Toogle (ON output when object approaches; OFF output when object leaves and approaches again) Bit 7: Output level setup 0: Normal high, low active 1: Normal low, high active Module Response: 0x55, 0xC0, 0x0C, 0x01, Dn, CS.

No.	NID	CMD	An	Len	CS	Content
11	0x55	0x80	0x0D	0x01	0xE3	Current value for infrared tube emission. Dn: 0~63, 5mA/step with one-level amplifier 64~127, 5mA/step with two-level amplifier Calculate the current value as below: Dn>63, $I_{Emission}$=(Dn-64)×5+5 Dn≤63, $I_{Emission}$=Dn×5+5 Ext: Dn=95, $I_{Emission}$=(95-64)×5+5=160 Module Response: 0x55, 0xC0, 0x0D, 0x01, Dn, CS.

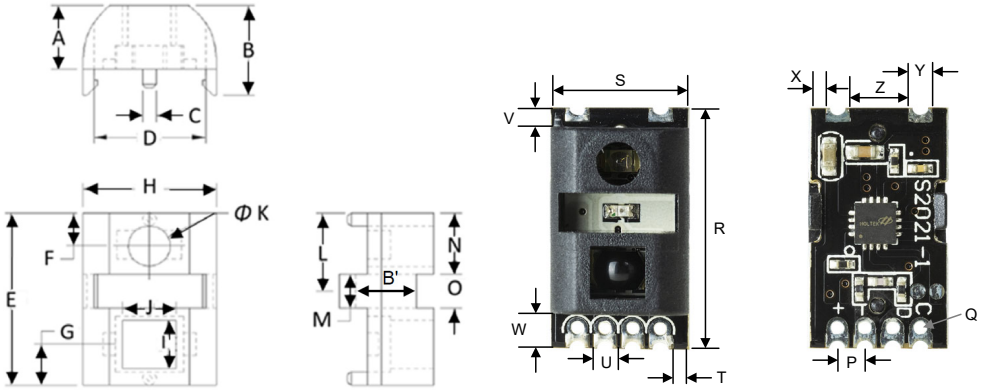
Write Commands

No.	NID	CMD	An	Len	Dn	CS	Content
1	0x55	0xC0	0x08	0x01	Dn	CS	Proximity Sensing Trigger Threshold Value. Dn: 16~180 Module Response: 0x55, Ack, CS.
2	0x55	0xC0	0x09	0x01	Dn	CS	IR Trigger Debounce Times (Noise Filter). Dn: 0~15 Module Response: 0x55, Ack, CS.
3	0x55	0xC0	0x0A	0x01	Dn	CS	Infrared Detection Reaction Speed. Dn: 0x00: 8ms, 0x01: 16ms, 0x02: 32ms, 0x03: 64ms, 0x04: 128ms, 0x05: 256ms, 0x06: 0.5s, 0x07: 1s, 0x08: Fast Mode. Module Response: 0x55, Ack, CS.
4	0x55	0xC0	0x0B	0x01	Dn	CS	Delay OFF output when an object is detected. (only valid in normal High/Low output mode) Dn: 0: Not activate delay OFF output function (always high/low level output) 1~255: Activate delay OFF output function, delay= 1~255s Module Response: 0x55, Ack, CS.
5	0x55	0xC0	0x0C	0x01	Dn	CS	Mode Function Setup. This setup will take effect only after the module is switched back to the I/O mode via the Reset command sent by the host device. Dn: Bit 4~0: Indicator setup Bit 4=0 & Bit 3~0=0: Flashing off, indication off Bit 4=0 & Bit 3~0≠0: Flashing off, indication on Bit 4=1 & Bit 3~0=0~15: Flashing on, indication on Flashing interval=1~16s Bit 5: Output mode selection 0: Normal High/Low output mode 1: Pulse/Toggle switching mode Bit 6: Pulse/Toggle selection (only valid when Bit 5=1) 0: Pulse (After object approaches, ON output for 200μs every 1s) 1: Toogle (ON output when object approaches; OFF output when object leaves and approaches again) Bit 7: Output level setup 0: Normal high, low active 1: Normal low, high active Module Response: 0x55, Ack, CS.
6	0x55	0xC0	0x0D	0x01	Dn	CS	Current value for infrared tube emission. Dn: 0~63, 5mA/step with one-level amplifier 64~127, 5mA/step with two-level amplifier Module Response: 0x55, Ack, CS.

Module Responses

No.	NID	Ack	CS	Content
1	0x55	0x7F	D4	Completed
2	0x55	0x7E	D3	Failed

Dimensions



No.	Unit	
	mm	inch
A	5.0	0.197
B	7.1	0.280
B'	5.4	0.213
C	1.0	0.039
D	8.4	0.331
E	13.5	0.531
F	2.6	0.102
G	3.2	0.126
H	10.0	0.394
I	3.8	0.150
J	4.0	0.157
K	3.2	0.126
L	6.2	0.244
M	2.7	0.106
N	4.8	0.189
O	2.7	0.106
P	2.0	0.079
Q	0.7	0.028
R	17.5	0.689
S	10.1	0.398
T	1.0	0.039
U	1.8	0.071
V	1.0	0.039
W	2.2	0.866
X	1.0	0.039
Y	2.0	0.079
Z	4.2	0.165