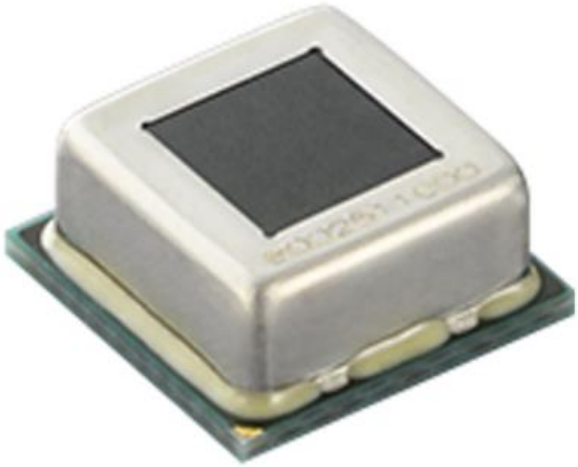
Application Note

SMD Digital Pyroelectric Infrared Sensor

IRS-D200ST00R1

Version 5 2025.08



Features and Benefits

- ✓ Small size / Low profile
- ✓ SMD (Reflow soldering applicable)
- ✓ Low supply current
- ✓ Digital output (I^2C)
- ✓ High – resolution output
- ✓ MCU Wake-up by Interrupt signal
- ✓ Setting adjustable interrupt conditions to avoid false detection
- ✓ Variable filter characteristic
- ✓ High RF noise immunity
- ✓ Internal circuit (Including Pre-AMP)

Applications

- ✓ IP Camera
- ✓ Doorbell
- ✓ Thermostat
- ✓ IoT Devices
  - Wireless devices
  - Battery devices
  - Low power motion detection devices
- ✓ Lighting control
- ✓ Home appliances

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1. General Information

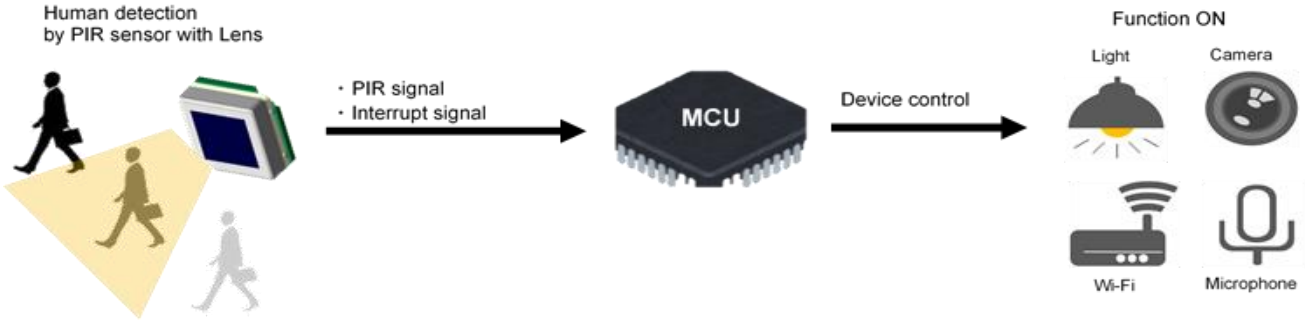
1.1 Introduction

The IRS-D200ST00R1 is extremely small digital PIR sensor with high performance (High S/N / reliability, good immunity to external disturbance).

The IRS-D200ST00R1 is SMD sensor that can be capable of reflow soldering while maintaining high S/N and it supports digital output. Since it is the world's smallest SMD PIR sensor, it can contribute to the flexibility of product design and can be adapted to the product design. The IRS-D200ST00R1 has a built-in pyroelectric element/pre-AMP/AD converter/digital signal processing.

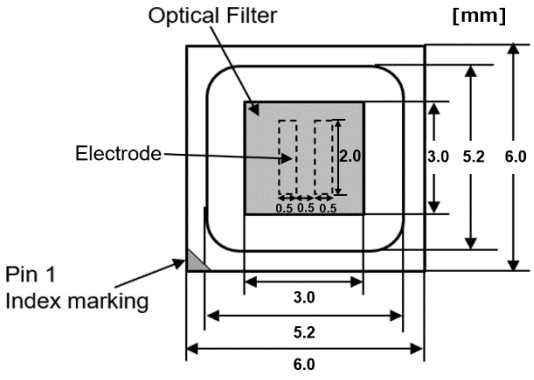
Depending on the usage, It can be selected the usage mode from continuous data output and INT mode. If a PIR signal is required, a high-resolution PIR signal can be acquired through I^2C. By using the INT signal, it is possible to use the MCU and other functions to sleep mode and trigger the MCU only when a person comes, greatly reducing the current consumption of the entire system.

1.2 Image of how to use



- Available to detect human
- Available to achieve low consumption of the system by the wake-up function.

1.3 Product figures / dimensions / spec.



Power supply	1.8V – 3.3V
Package size	6.0 * 6.0 * 2.6 mm
FoV(Hor. / Ver.)	±55° / ±42°
Current consumption	Typ.8μA
Digital Interface	I2C / Interrupt signal
ADC	16bit
Operating Tmeperature	-25 – 85°℃

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1.4 Pin Configurations and Land pattern(TOP View)

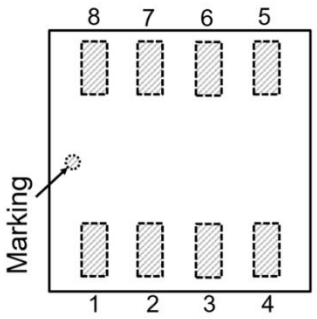


Fig. Pin Configurations

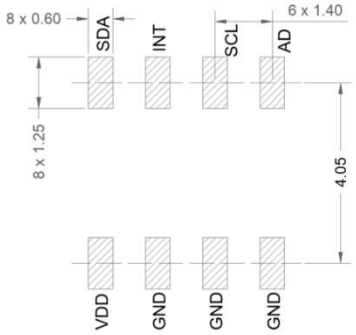


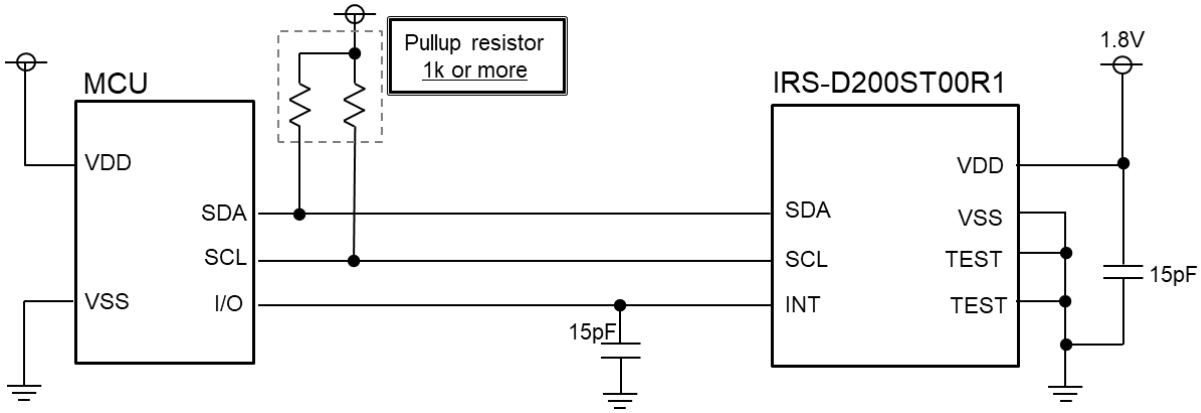
Fig. Land pattern

*PIR output difer by the orientation of the electode.

Please use at thcorrect electrode direction.(Refer to 3.1)

Pin No.	Symbol	Function
1	VDD	Power supply
2	TEST	Test pin
3	TEST	*Test pin should be connected to GND
4	GND	Ground
5	AD	Slave address
6	SCL	I²C Serial clock
7	INT	Interrupt output
8	SDA	I²C Data output

1.5 Circuit example

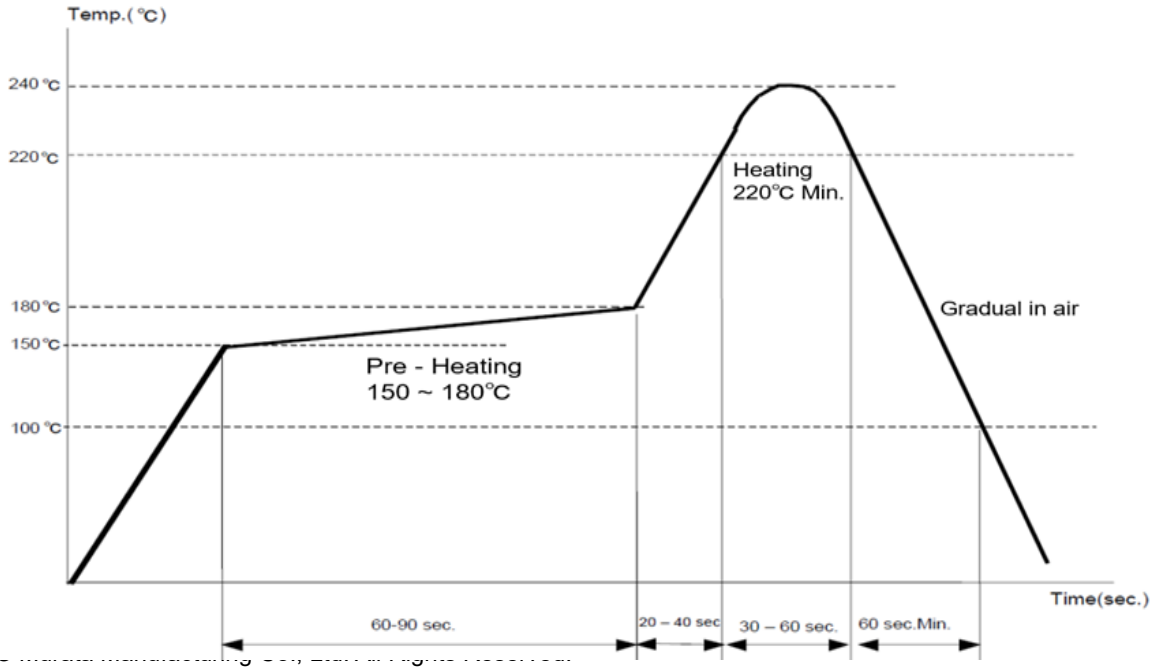


*When using a pull-up resistance value less than 1kΩ, sensor noise could be large.

*If it has RF effect to PIR sensor, please refer 3.2 Circuit example for the RF noise.

1.6 Reflow profile

- Recommended reflow profile : PIsease see the below figure
- Cycle of reflow : 2 times
- Recommendable composition of solder : Sn-3Ag-0.5Cu



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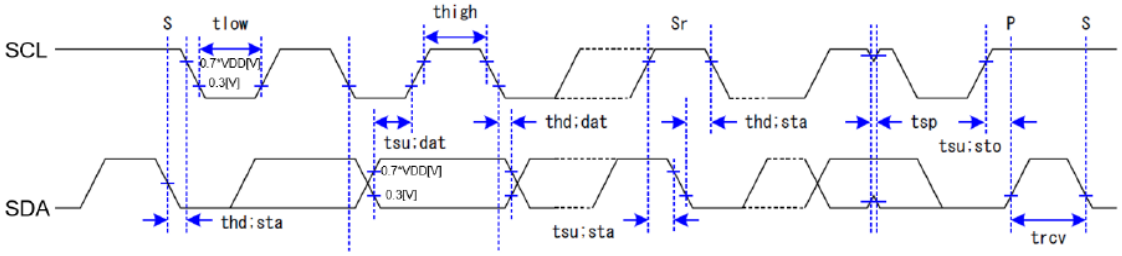
2. Data communication

2.1 I²C interface



S : Start Condition
Sr : Repeated start condition
P : Stop Condition

Parameter	Symbol	Standard Mode		Fast Mode		Unit
		Min.	Max.	Min.	Max.	
SCL frequency	fscl		100		400	kHz
SDA/SCL High level input voltage	VIH	0.7*VDD		0.7*VDD		V
SDA/SCL Low level input voltage	VIL		0.3		0.3	V
SCL Low period	tlow	4.7		1.3		us
SCL High period	thigh	4.0		0.6		us
Start condition hold time	thd;sta	4.0		0.6		us
Stop condition set-up time	tsu;sto	4.0		0.6		us
Start condition set-up time	tsu;sta	4.7		0.6		us
Data set-up time	tsu;dat	250		200		ns
Data hold time	thd;dat	0		0		us
Rise time SDA,SCL	tr		1000		300	ns
Fall time SDA,SCL	tf		300		300	ns
Pulse width of spikes	tsp		50		50	ns
Bus free time between start-stop	tbuf	1.3		1.3		us

* SDA/SCL Low level input voltage should be≦0.3V

2.2 I²C I/F functions

① Standard mode 100kbits/s Available
② Fast mode 400kbits/s Available
③ 7bit slave address Available
④ Gneral call address Not available
⑤ Bath clear Not available

2.3 Slave address

IRS-D200ST00R1 has 2 slave address.
When the slave address pin is connected to GND : 0x48
When the slave address pin is connected to VDD : 0x49

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2.4 Register map

Address	DATA							
	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
0x00								OP
0x01	Reserved, Do not modify							
0x02	DATA_BUFL[7:0]							
0x03	DATA_BUFH[7:0]							
0x04					STATUS[3:0]			
0x05	OVERCOUNT_UP[3:0]				OVERCOUNT_LO[3:0]			
0x06								SAMPLR
0x07							LPFR	HPFR
0x08	Reserved, Do not modify							
0x09					INTSEL[3:0]			
0x0A						THRESHCOUNT[2:0]		
0x0B	THRESH_HR[7:0]							
0x0C	THRESH_LR[7:0]							
0x0D	TIMER_LR[7:0]							
0x0E							TIMER_HR[1:0]	
0x0F to 0x19	Reserved, Do not modify							

Address	Name	Register	Remarks	Default
0x00	OP	[0]	"0" = Operation state, "1" = Sleep state	0
0x02	DATA_BUFL	[7:0]	The output signal of PIR. The data is refreshed when INTSEL="0001" (The refresh timing depends on SAMPLR)	0000 0000
0x03	DATA_BUFH	[7:0]		
0x04	STATUS	[3:0]	It can check the conditions of INT occurred.(Applied only the conditions set in INTSEL) "0001"= Continuous data output, "0010"= INT occurs when TIMER=0, "0100" or "1000" = INT occurs when meets the condition (Refer to 2.6.4)	0000
0x05	OVERCOUNT_UP	[3:0]	It can see the number of exceeding the threshold *The number is counted at upper & lower limits respectively *Overcount is applied only when INTSEL="0100" or "1000"	0000
0x05	OVERCOUNT_LO	[3:0]		0000
0x06	SAMPLR	[0]	ODR(Output data Rate) ; "0" = 50Hz, "1" = 100Hz	0
0x07	LPFR	[0]	LPF(Low pass filter) ; "0" = 10Hz, "1" = 7Hz	0
0x07	HPFR	[0]	HPF(High pass filter) ; "0" = 0.3Hz, "1" = 0.5Hz	0
0x09	INTSEL	[3:0]	Determine the conditions of INT occurrence "0001"= Continuous data output, "0010"= INT occurs when TIMER=0, "0100" or "1000" = INT occurs when meets the condition (Refer to 2.6.4)	0000
0x0A	THRESHCOUNT	[2:0]	Determine the counts of exceeding threshold to generate INT *Applied when INTSEL is set "0100" or "1000"	000
0x0B	THRESH_HR	[7:0]	Determine the upper & lower threshold (Threshold must be set by 8bit) *Applied when INTSEL is set "0100" or "1000"	0000 0000
0x0C	THRESH_LR	[7:0]		0000 0000
0x0D	TIMER_LR	[7:0]	Determine the period to count the number of exceeding threshold to generate INT *Applied when INTSEL is set "0100" or "1000"	0000 0000
0x0E	TIMER_HR	[1:0]		00

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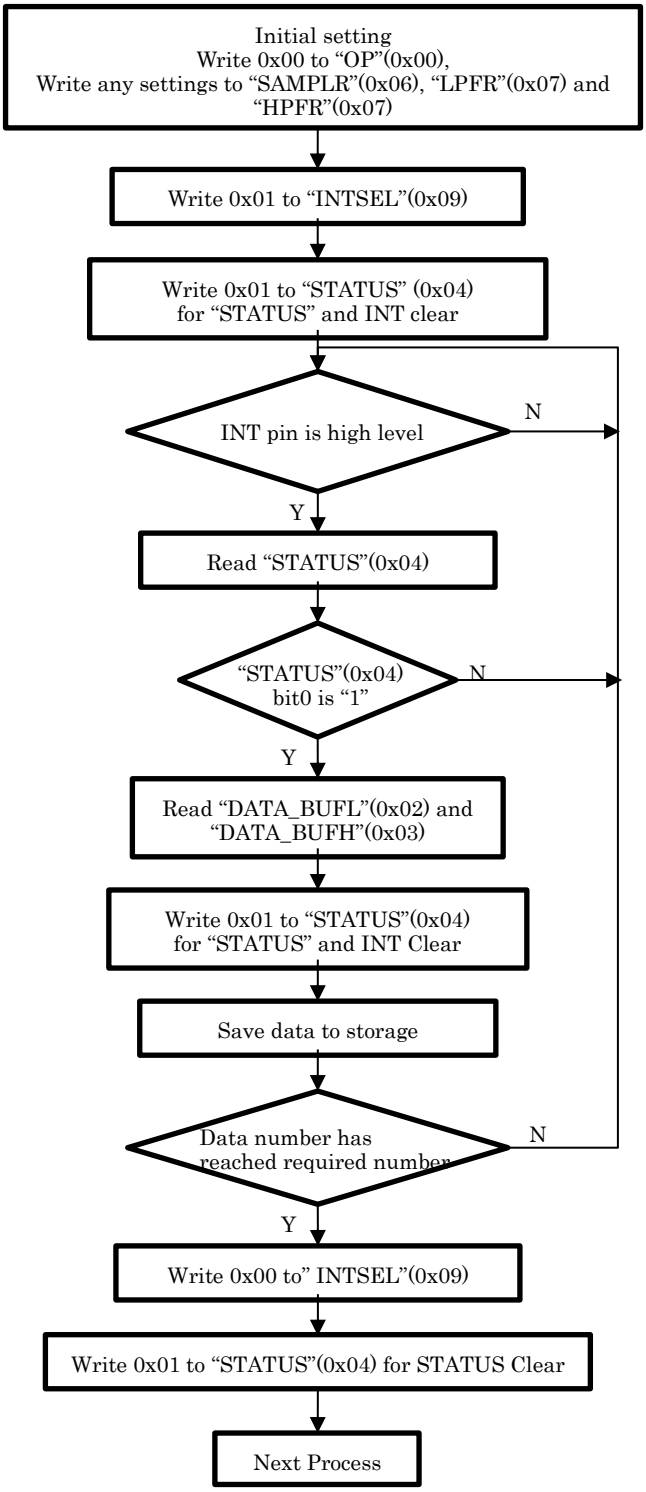
2.5 Flow chart example

2.5.1 Measurement of sensor signal (Continuous data output mode)



*** For an example of the source code, Please check the "INT signal.pdf".It is the source code when using "NUCLEO-L476RG". When you use another MCU, you need to change the source code to match the MCU.**

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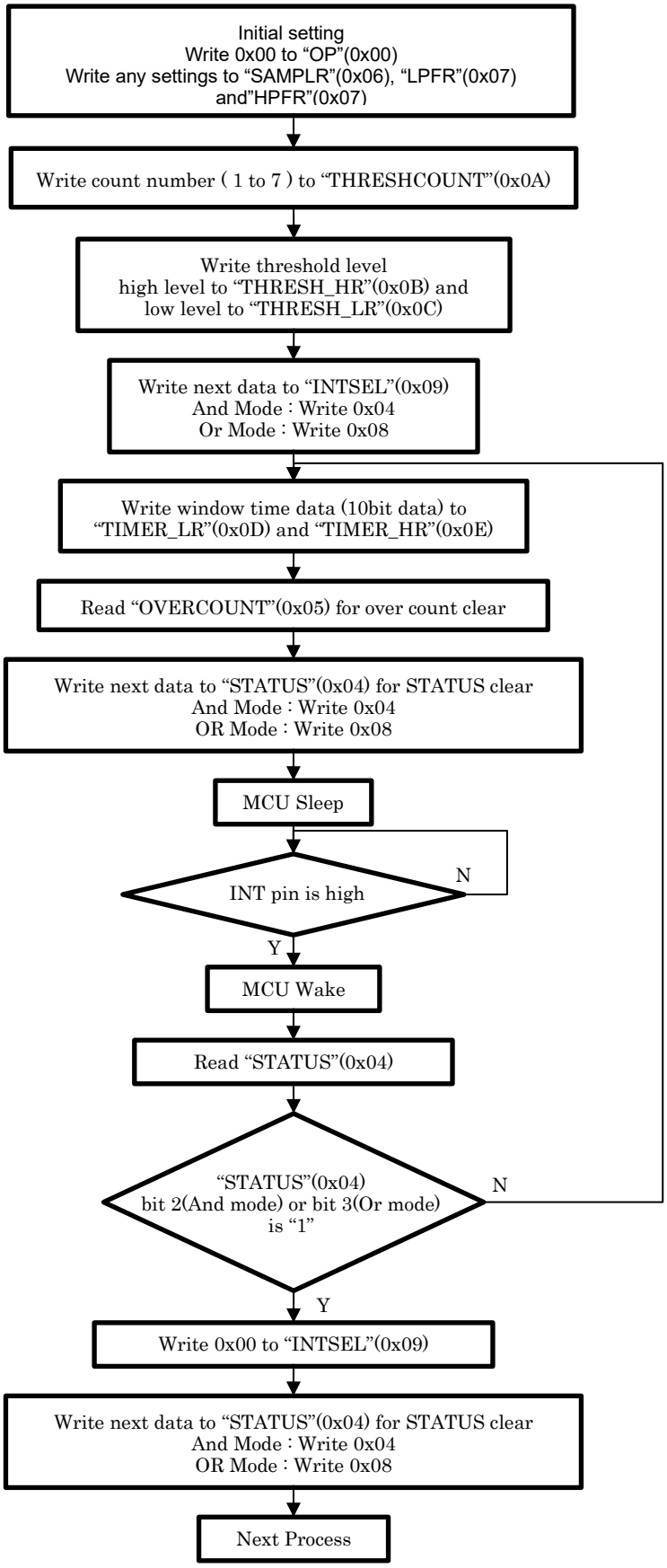
2.5.2 Wake-up of MCU with INT function



*** For an example of the source code, Please check the “INT signal.pdf”.It is the source code when using “NUCLEO-L476RG”. When you use another MCU, you need to change the source code to match the MCU.**

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2.6 Interrupt function

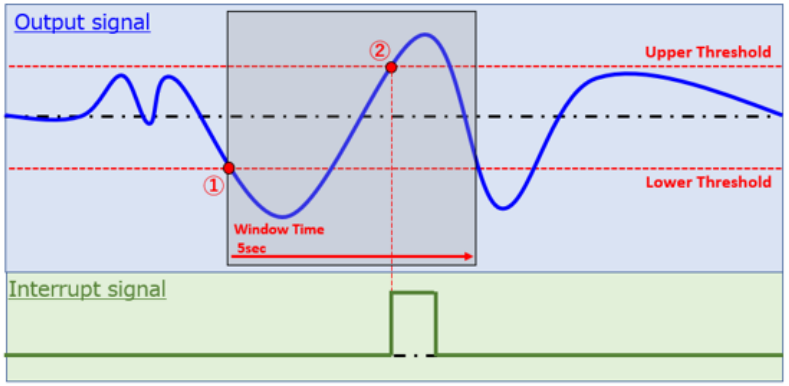
2.6.1 Conditions settingS

INT condition can be selected depending on the application. It can reduce the false detection.

Content	Spec	Register Address
Threshold Value	Upper threshold 8bits Lower threshold 8bits	Upper : 0x0B Lower : 0x0C
Times of exceeding threshold	1 – 7 times	0x0A
Threshold mode	Upper side OR Lower side Upper side AND Lower side	0x09
Window Time	Max.10.23sec(ODR:100Hz) Max. 20.46sec(ODR:50Hz)	0x0D, 0x0E

<Example>
Threshold Value : ±8192 digits
Times of exceeding threshold : 2times
Window Time : 5sec
Threshold mode : "And" mode

*For details of each conditions,
Please refer to 2.6.2 – 2.6.5.

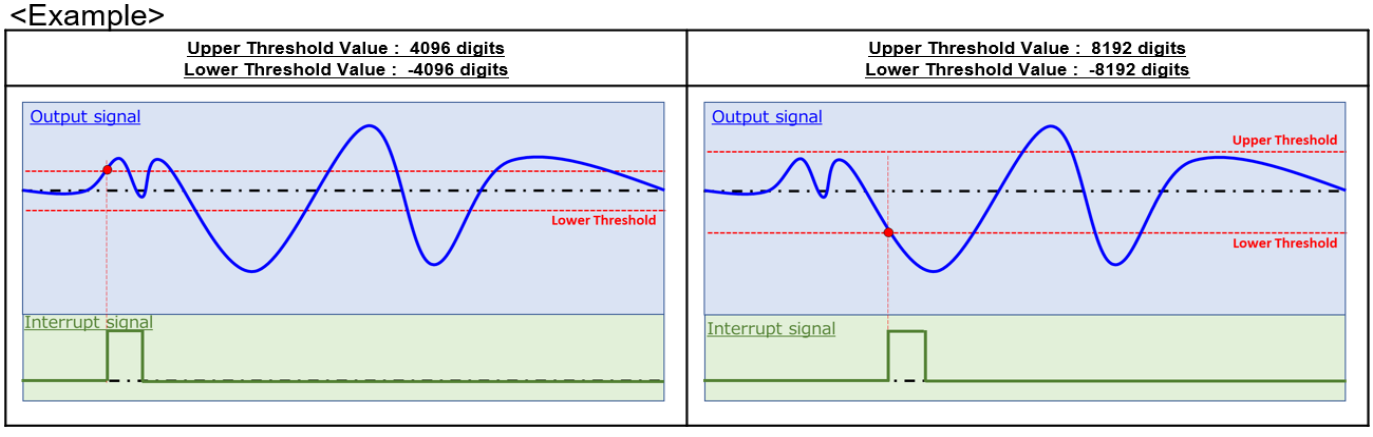


2.6.2 Threshold value

The threshold value can be set in the "Upper threshold" and "Lower threshold".

Binary	Decimal	Upper Threshold Value[digits]	Lower Threshold value[digits]
0000 0000	0	0	0
0000 0001	1	128	-128
0000 0010	2	256	-256
⋮	⋮	⋮	⋮
1111 1110	254	32512	-32512
1111 1111	255	32640	-32640

<Example>



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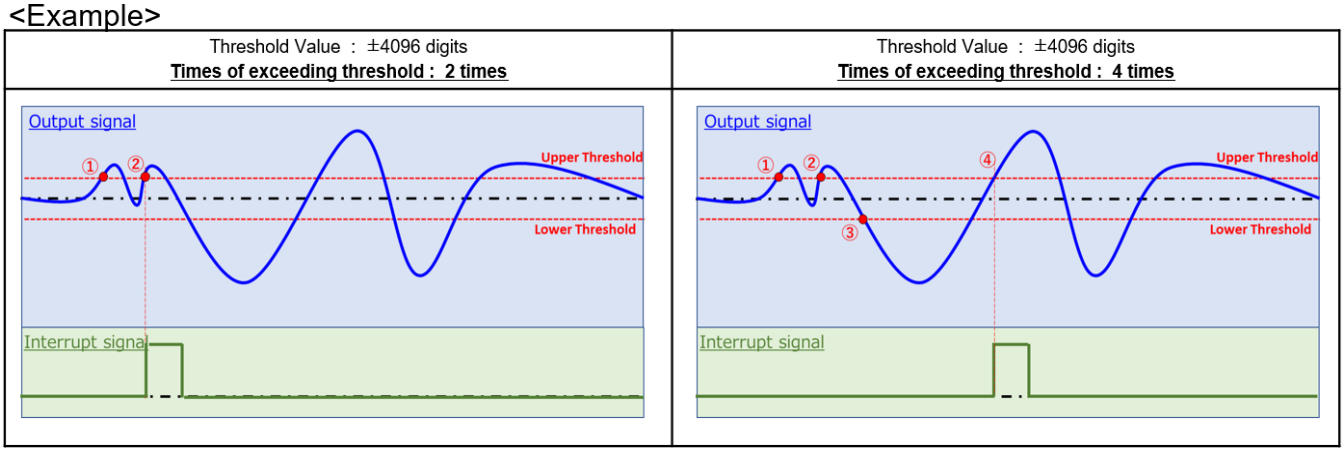
2.6.3 Times of exceeding threshold

Binary	Decimal	Number of times the threshold exceeded
000	0	-
001	1	1 time
010	2	2 times
011	3	3 times
100	4	4 times
101	5	5 times
110	6	6 times
111	7	7 times

If the “Times of exceeding threshold” is more than 2 times, it is needed to set the “Window Time.(Refer 2.6.5)

<Example>



2.6.4 Threshold mode

■And mode : White b0100 to Register Address “0x09”.

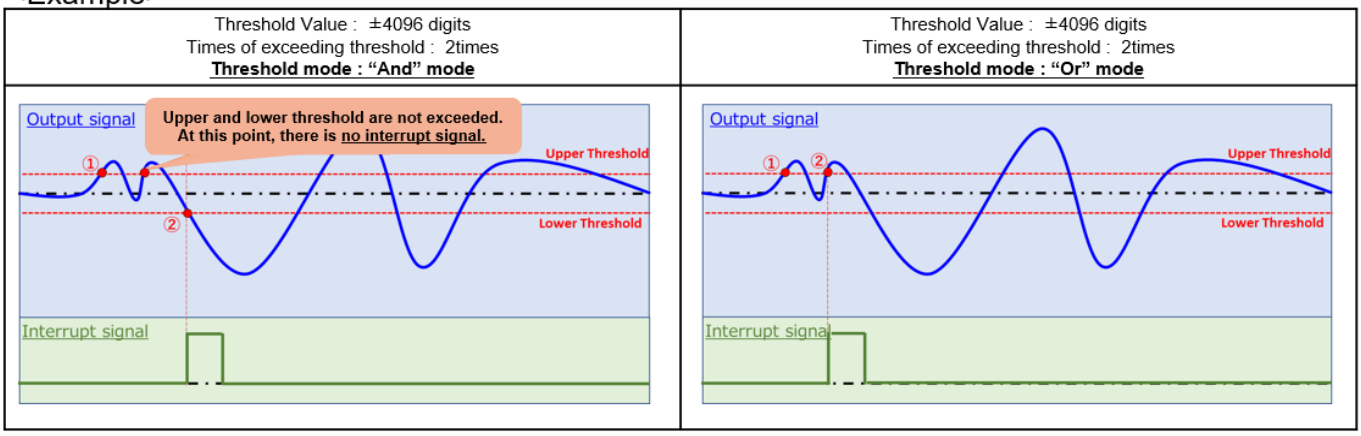
To generate the interrupt signal when the total number of times the upper and lower threshold value have been exceeded the number of times set in a resisger address “0x0A”.

And, If only the upper threshold exceeds the nmber of times, Interrupt does not have.

■Or mode : White b1000 to Register Address “0x09”.

To generate the interrupt signal when the total number of times the upper and lower threshold value have been exceeded the number of times set in a resisger address “0x0A”.

<Example>



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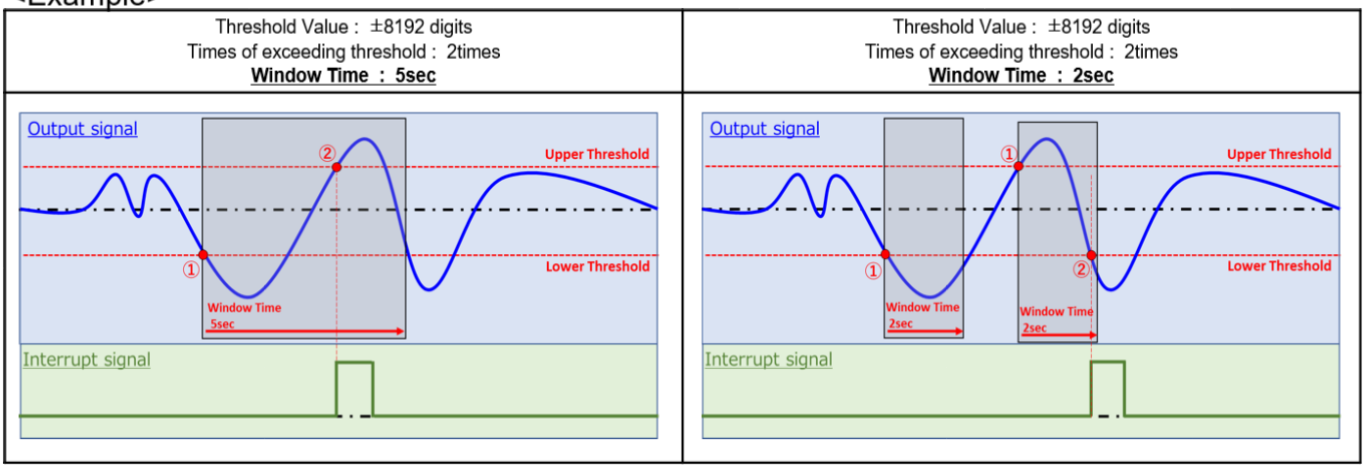
2.6.5 Window time

“Window Time” is the time trigger condition for the interrupt.

Binary		Decimal	Window Time [s]	
TIMER_HR(0x0E)	TIMER_LR(0x0D)		ODR = 50Hz	ODR = 100Hz
00	0000 0000	0	0	0
00	0000 0001	1	0.02	0.01
00	0000 0010	2	0.04	0.02
⋮	⋮	⋮	⋮	⋮
00	1111 1111	255	5.10	2.55
01	0000 0000	256	5.12	2.56
⋮	⋮	⋮	⋮	⋮
11	1111 1111	1023	20.46	10.23

<Example>



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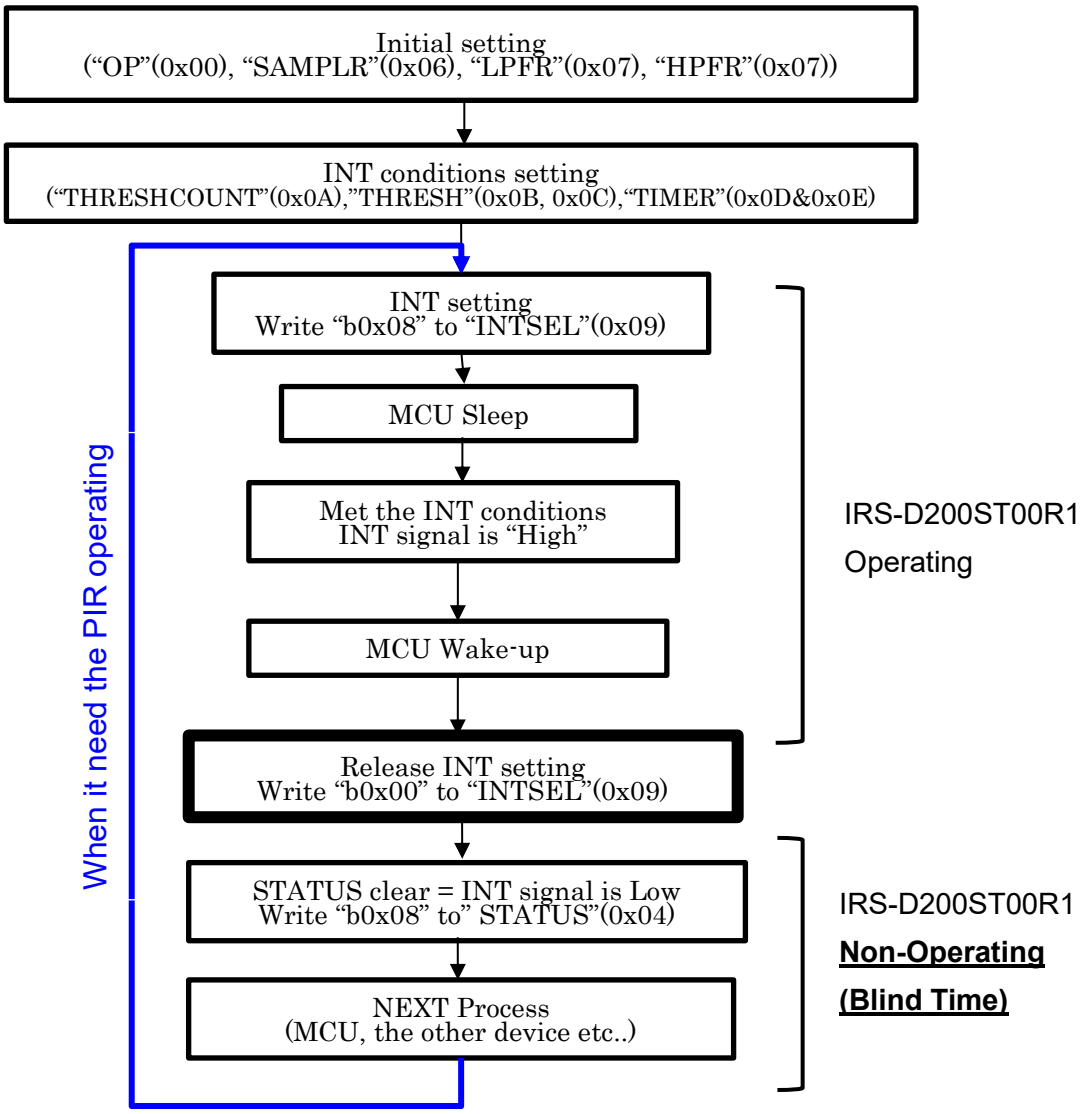
2.6.6 Blind time

When it does not need Interrupt signal from IRS-D200ST00R1.

By writing “0x00” to “INTSEL”’(0x09), It can stop it.

The flowing chart is reference.(“Threshold mode” of this chart is “or mode”)



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3. Demo Kit

3.1 Enclosed parts

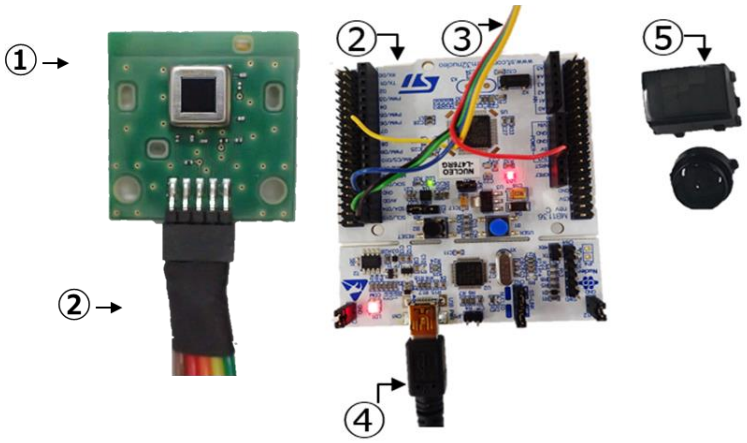
① Sensor Board

② MCU Board

③ Cable (Sensor ~ MCU)

④ USB cable (MCU ~ PC)

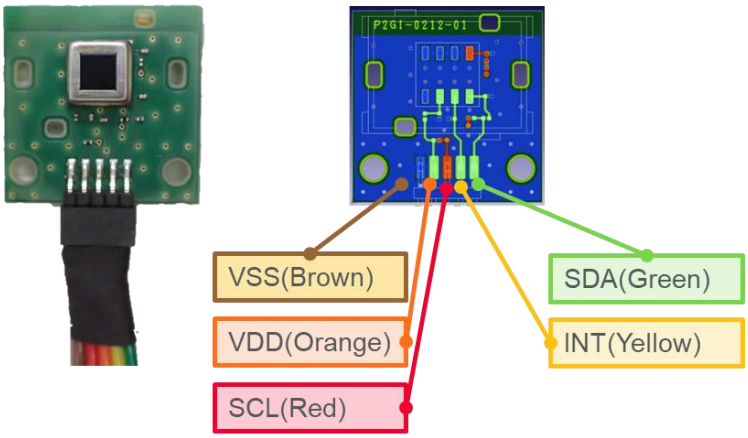
⑤ Lens (E650, E654, E669)



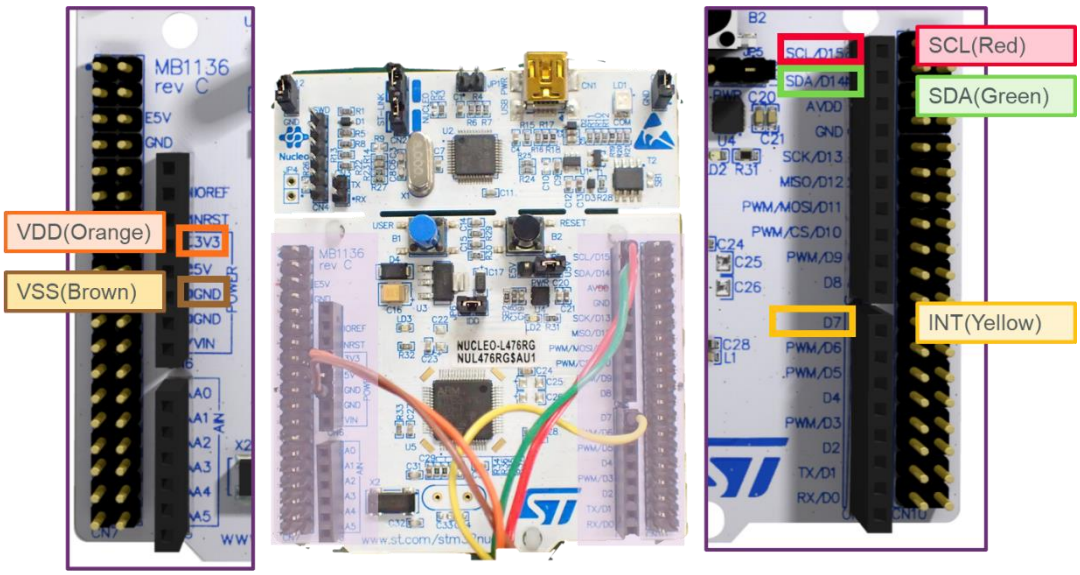
3.2 Connection

3.2.1 Sensor board

To connect sensor board to MCU board



3.2.2 MCU board



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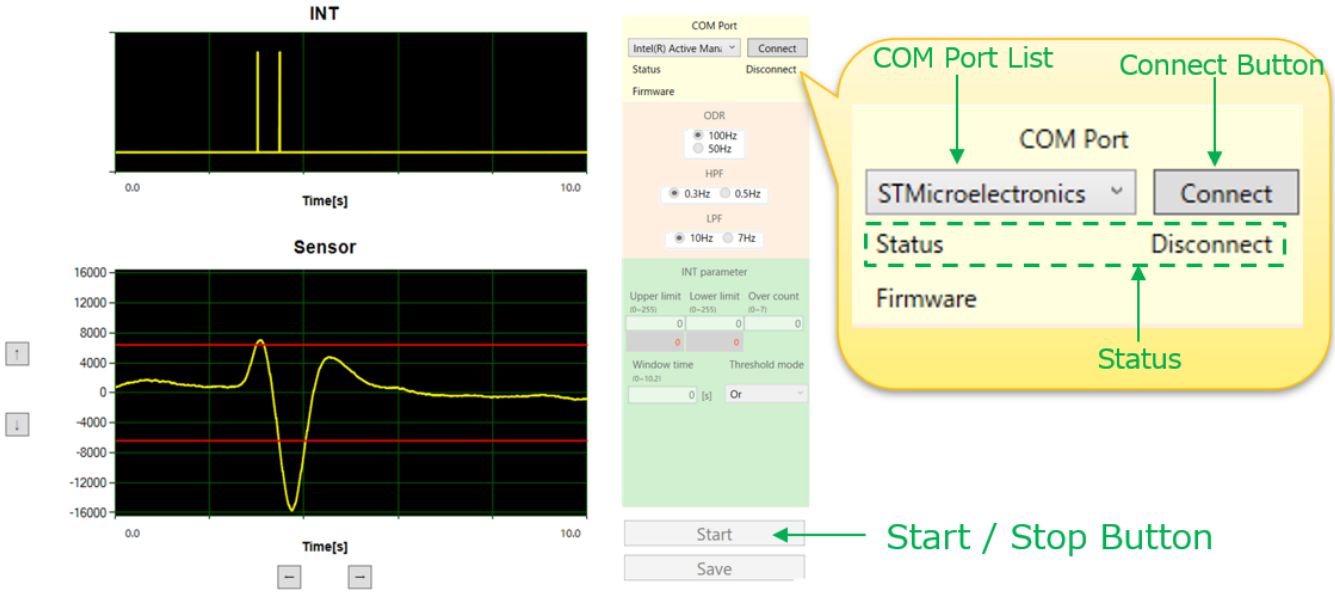
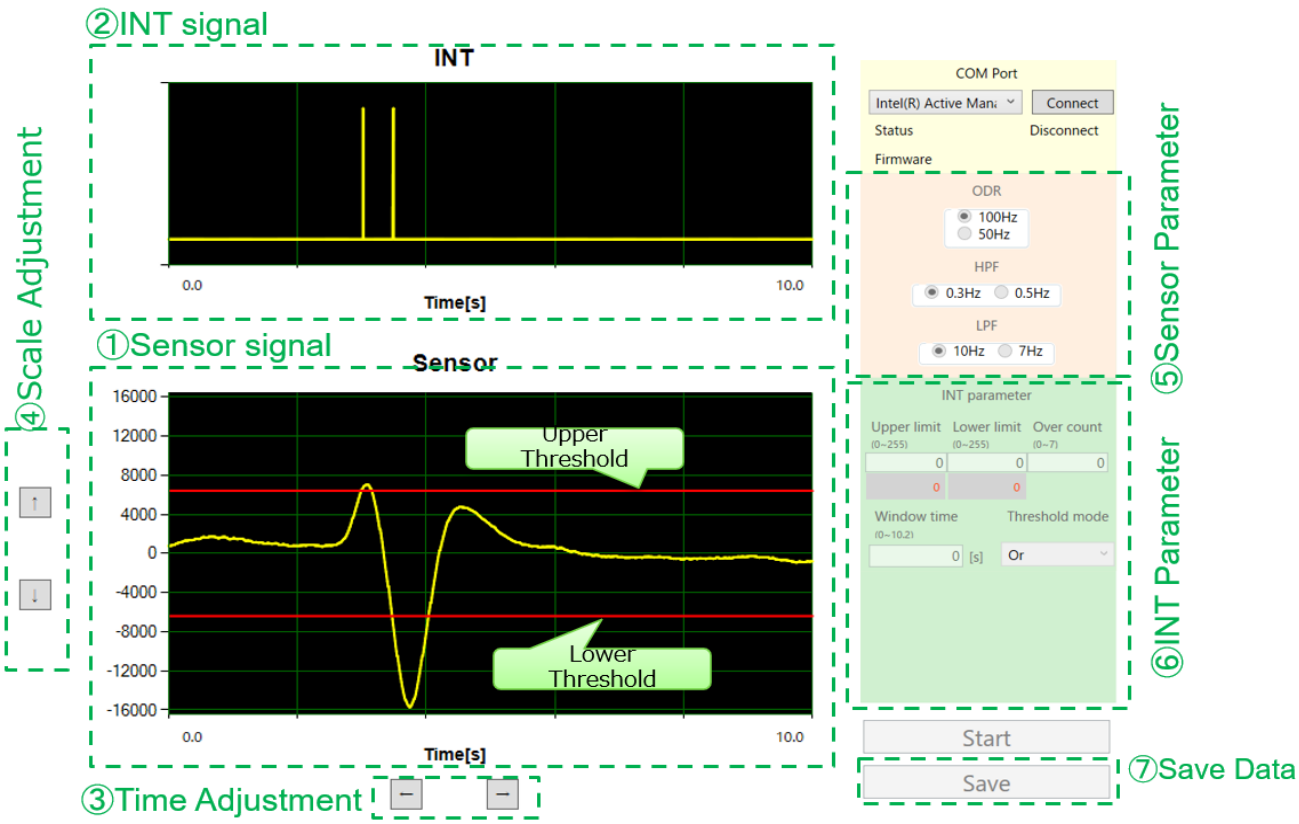
3.3 Demo application Interface

3.3.1 Preperation for operating a demo kit

①To select “ST Microelectronics ST Link Virtual COM Port” from COM Port List.
②To press the "Connect" button and confirm that "Status" is "Connect“.
③To press "Start“ button, the output of Sensor and INT is displayed ("Start" changes to "Stop")
④To press “Stop” button, the output of Sensor and INT is stopped.



3.3.2 Interface function 1



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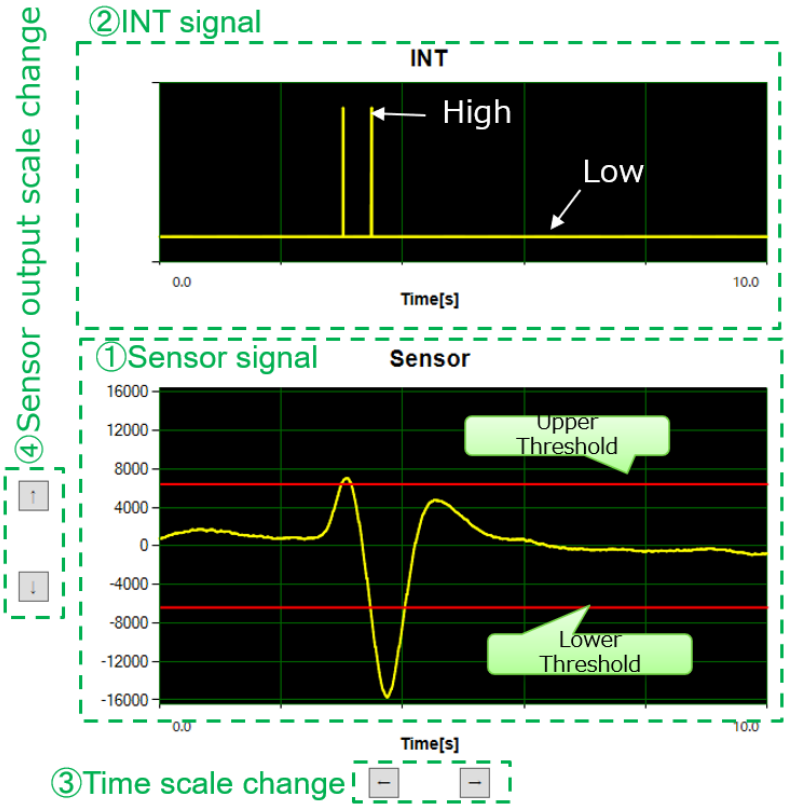
3.3.3 Interface function 2



①Sensor signal
You can check the sensor output.
You can display the threshold by clicking the screen.

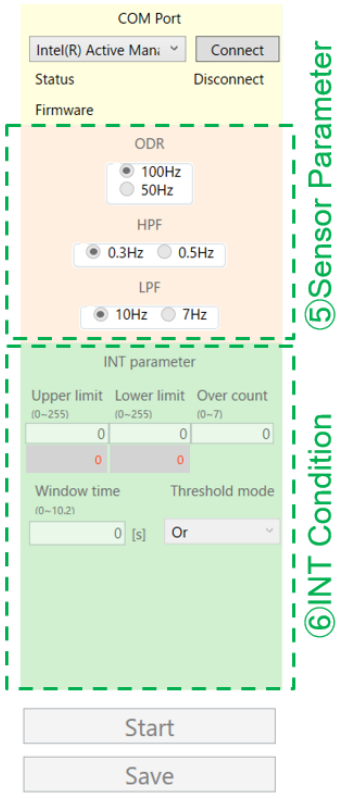
②INT signal
You can check the Interrupt output.
When meet the Interrupt condition,
INT output is "High" signal.

③Time scale change
You can select the 4 condition.
(10s, 20s, 30s, 60s)
" → " button to scale up.
" ← " button to scale down.

④Sensor output scale change
You can select the 4 condition.
(±4000, ±8000, ±16000, ±32000)
" ↑ "button to scale up.
" ↓ "button to scale down.

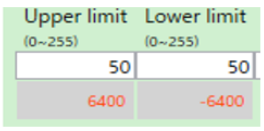
X axis : Time[s]
Y axis : Sensor output[digits]

3.3.4 Interface function 3



⑤Sensor Parameter
You can select the sensor output parameter.
- ODR(Output Data Rate)
  You can select the Sensor signal sampling frequency.
  To select from "100Hz" and "50Hz".
- HPF(High Pass Filter)
  HPF cutoff frequency can be selected from "0.3Hz" and "0.5Hz".
- LPF(Low Pass Filter)
  LPF cutoff frequency can be selected from "7Hz" and "10Hz".

⑥INT(Interrupt) Parameter
You can change the INT condition.
INT condition has "Upper limit", "Lower limit", "Over count", "Window time" and Threshold mode.
- Upper Limit / Lower Limit
  You can select the threshold. It divides 32768digits into 256.
  It can set the upper and lower limits separately.
  And you can see the value of threshold by gray part.



- Over Count
  You can select the number of times the threshold is exceeded from 1 to 7 times.

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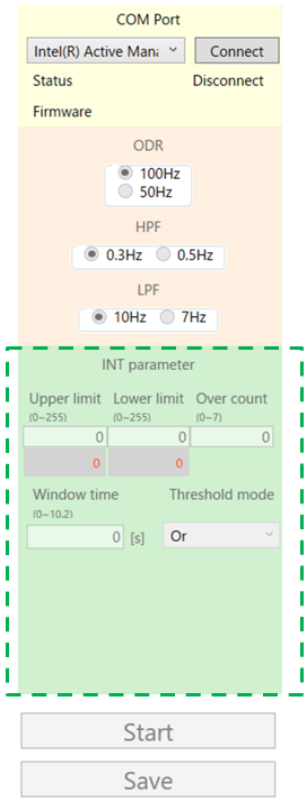
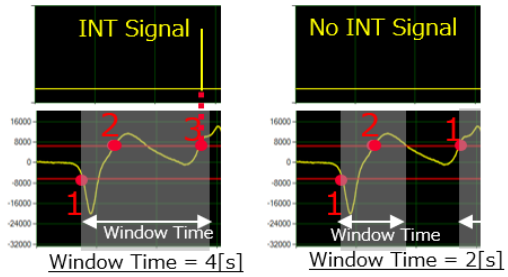
3.3.5 Interface function 4



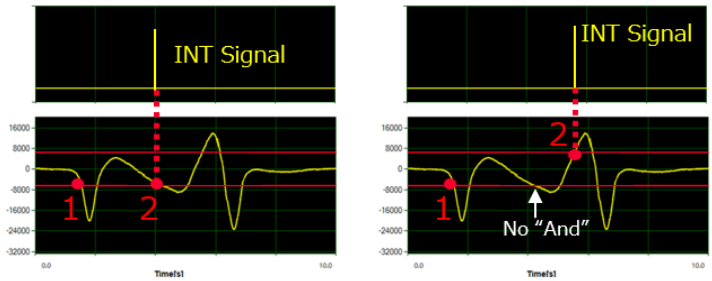
⑥INT(Interrupt) Parameter

- Window Time
  You can select from while 0.0 ~ 10.2[s].
  INT become "High" , when the Over Count number is reached within Window Time.
  <Example：Over Count = 3 times>



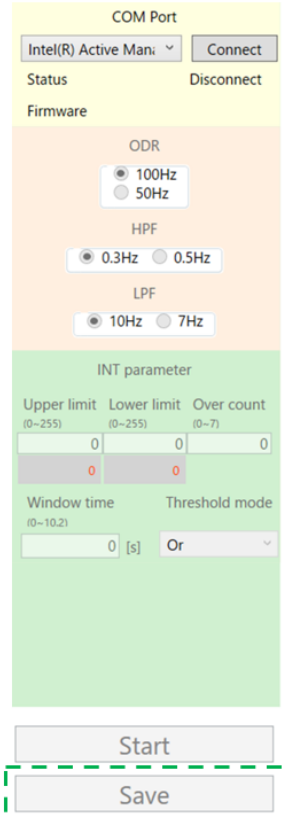
Window Time = 4[s] Window Time = 2[s]

- Threshold mode
  You can select the “Or mode” and “And mode”.
  <Example：Over Count = 2 times>



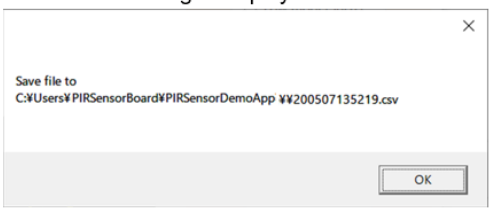
“Or” Mode “And” Mode

3.3.6 Interface function 5

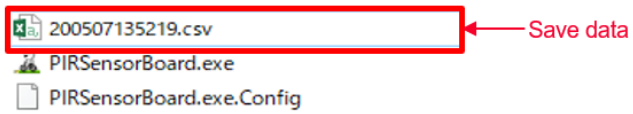


⑦Save Data

1. Stop the waveform by “Stop” Button
2. Press the “Save” Button
3. File save dialog is displayed



4. Waveform data have the same folder of “PIRSensorBoard.exe”



5. Save file has “Time[ms]”, “INT output” and “Sensor output”

※CSV file name
It is saved date.
200629103730
Year Month Day Time

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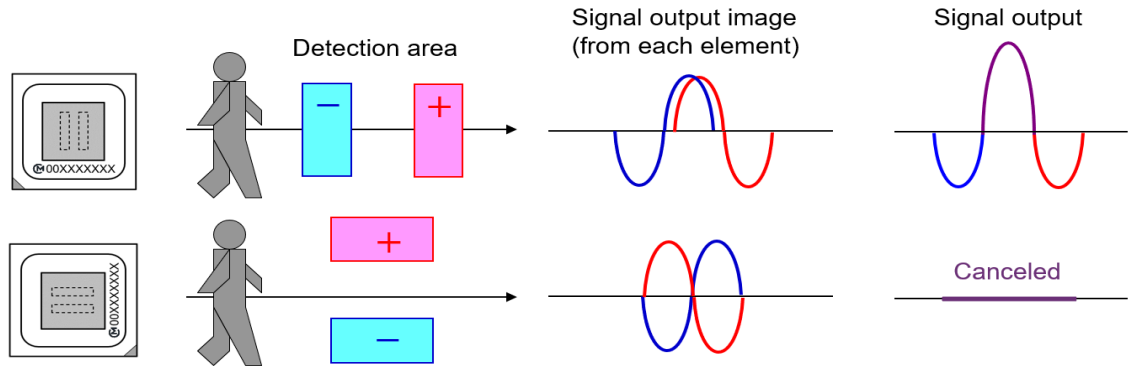
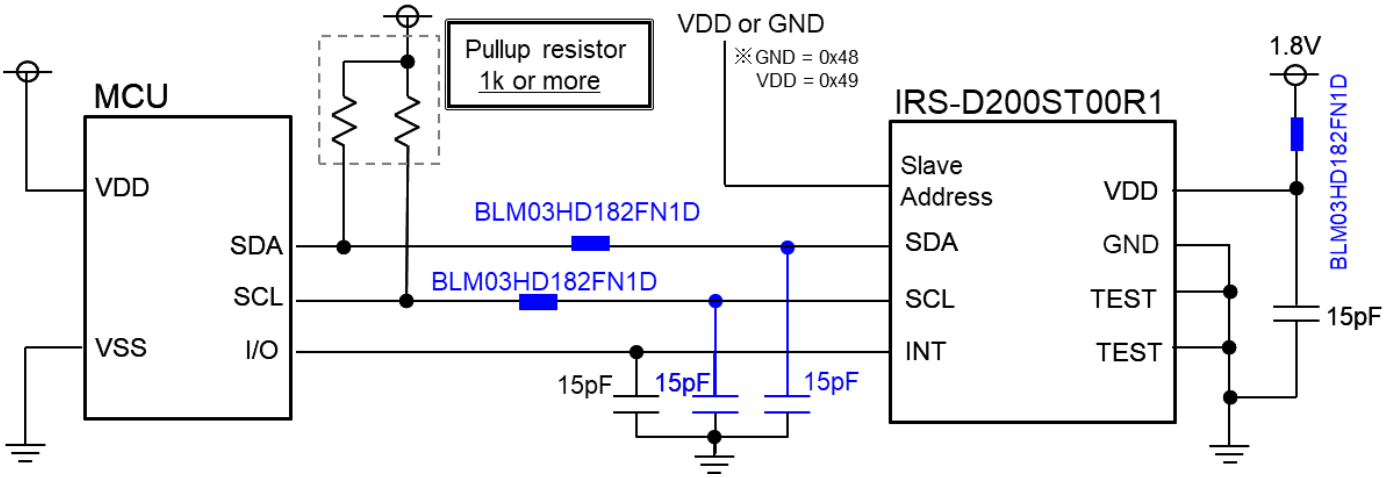
4. Notes / Precaution

4.1 Direction of the electrodes

Please be sure to keep the electrodes direction to avoid signal output cancelation.



4.2 Circuit example for the RF noise



*If it has RF effects to PIR sensor, it can be avoided by ferrite bead, capacitor and other EMI components.

4.3 Precautions for use

1) Please make sure that your product has been evaluated in view of your specifications with our product being mounted to your poduct.
2) In the case of outdoor use, suitable optical filter and water / humidity proof structure should be applied.
3) Please use a stabilized power supply to prevent failure or malfunction.
4) Please avoid using the pyroelectric infrared sensor in the following conditions to prevent failure or malfunction.
   a) In such a fluid as water, alcohol etc. corrosive gas(SO2,CI2,NOX etc.) or sea breeze.
   b) In high humidity
   c) In a place exposed directly to sunlight or headlight of automobile.
   d) In a place exposed to rapid ambient temperature change.
   e) In a place exposed directly to blow from air-conditioner or heater.
   f) In a place exposed to strong vibration.

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g) In a place exposed to strong electromagnetic field.

h) In a place where there are obstacles (glass,walls,etc.) which are infrared ray cannot pass through in detection area of the pyroelectric infrared sensor.

i) In a place where electrification and static electricity are generated.

j) In any other similar places mentioned above a) ~ i).

5) Note for PCB design

a) Avoid placing heatgenerating components near to the pyroelectric infrared sensor.

- Pyroelectric infrared sensor may react to heat change and generate output signal.

b) Avoid placing RF components near to the pyroelectric infrared sensor.

- Antenna, RF transmitter and module.

c) The wiring pattern should be wide and short to avoid false detection due to RF noise.

d) Design with sufficiently enhanced ground plane.

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