BRIGHTEK

BRIGHTEK (EUROPE) LIMITED

Brighten Up The World With LED !

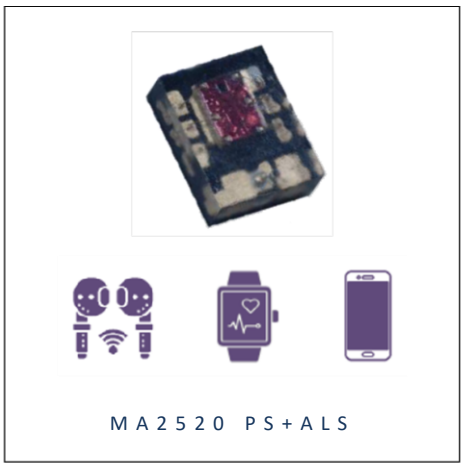
ISO/TS 16949:2009 BS EN ISO 14001:2004 QC 080000 IECQ HSPM

Release Date: 04 October 2023 Version: A1.1

PRODUCT DATASHEET

- Proximity Sensor + Ambient Light Sensor
- 2520 0.78t
- 940nm

N0S65S85 (MA2520)
Proximity Sensor (PS) + ALS



MA2520 PS+ALS

RoHS Compliant

FEATURES:

- **Package:** Black MA2520 PCB Miniature Module with:
  - ❖ **Proximity Sensor (PS)**
    - ✓ Selectable ADC Output, up to 16-bit
    - ✓ Auto calibration cross-talk
    - ✓ Low power consumption by optimal VCSEL control
  - ❖ **Ambient light sensor (ALS)**
    - ✓ 50Hz/60Hz Flicker Noise and IR Rejection
    - ✓ Spectrum response characteristic close to human visibility
- **Interface:** I^2C (Fast Speed Mode at 400KHz)
- **Dedicated Interrupt Pin**
- **Soldering methods:** Reflow soldering
- **MSL Level:** acc. to J-STD Level 3

APPLICATIONS:

- True Wireless Stereo
- Wearable Device
- Smart Phone
- 3C Consumer Goods
- Smart Robot

CHARACTERISTICS:

Maximum Ratings (Ta=25°C)

Parameter	Symbol	Ratings	Unit
VCSEL Supply Forward Current	I_F	12	mA
V_{DD} Supply Voltage	V_{DD}	+4.5	V
Operating Temperature	T_{OPR}	-40~+85	°C
Storage Temperature	T_{STG}	-40~+100	°C
Soldering Temperature	T_{sol}	260	°C

VCSEL Characteristics (I_F=9mA, tp=10ms, Ta=25°C)

Parameter	Symbol	Ratings	Unit
Forward Voltage (typ./max.)	V_F	2.0/2.2	V
Reverse Current (max.)	I_R	10	μA
Peak Wavelength (typ.)	λ_P	940	nm
Total Radiant Power (typ.)	Φ_e	5.7	mW
Viewing Angle (min.)	$2\Theta_{1/2}$	25	deg

Analog Characteristics (V_{DD}=3.0V, Ta=25°C)

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Shutdown Current	I_{STD}	---	0.1	0.5	μA
INT Output Saturation Voltage (IO=3.0mA)	$V_{OL(INT)1}$	---	---	0.4	V
IRDR Pin Low Voltage (IRDR=100mA Setting)	$V_{L(IRDR)}$	---	---	0.3	V
Terminal Leakage Current (SDA, SCL, INT, IRDR Terminal)	I_{LEAK}	-10	---	10	μA
SDA Low Level Output Voltage (Io=3.0mA)	$V_{OL(SDA)}$	---	---	0.4	V
Set-up Time After Power On	T_{PON}	---	---	2.0	ms

Ambient Light Sensor Characteristics (V_{DD}=3.0V, Ta=25°C)

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
ALS Supply Current at ALS Mode	$I_{DD}1$	---	130	180	μA
ALS Dark Output (Ev=0 lx, ALS gain x128, T_{ALS}=800ms)	ALS_{DARK}	---	---	3	count
ALS A/D Resolution (IRDR=100mA)	RES_ALS	16			bit
ALS Maximum Detection Illuminance (ALS gain x1, Tint=50ms)	MAX_ILL	---	77709	---	lx
ALS Output (ALS gain x1, Tint=50ms, Ev=300lx Fluorescent Lamp)	DATA_ ALS	203	253	303	count
ALS A/D Conversion Time	t_{ALS}	42.5	50	57.5	ms
ALS Sensitivity Peak Wavelength	$\lambda_{P(ALS)}$	---	600	---	nm

Proximity Sensor Characteristics (V_{DD}=3.0V, Ta=25°C)

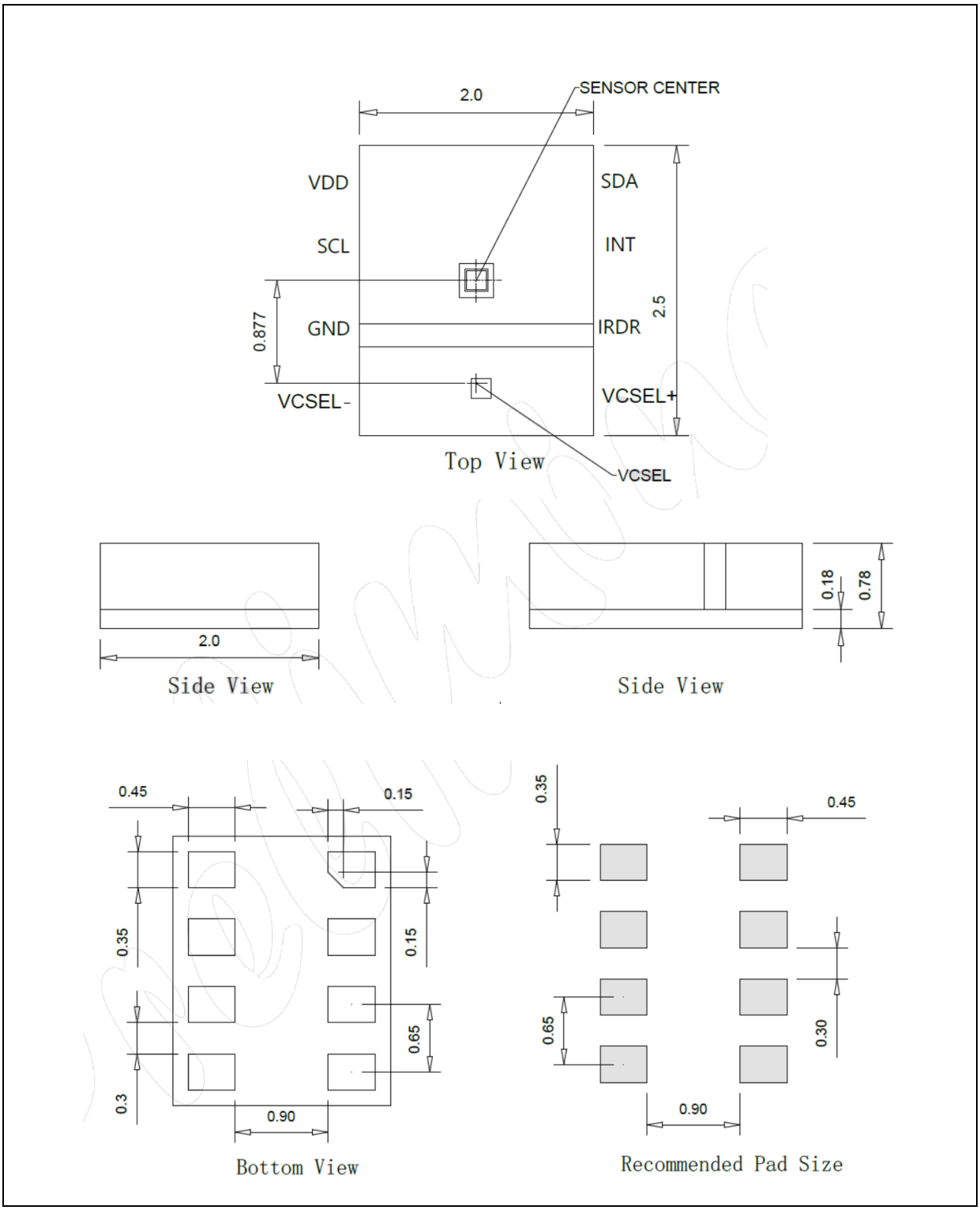
Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
PS Supply Current (Except IR Drive Current)	$I_{DD}2$	---	175	240	µA
PS Supply Current at Wait State	I_{WAIT}	---	---	30	µA
PS Dark Output (PS gain x4, Pulse=8, IRDR=100mA setting, A/DC=16bit)	PS_{DARK}	---	---	100	count
PS A/D Resolution	RES_PS	10~16			bit
PS Output (PS gain x1, Pulse=8, IRDR=100mA setting, A/DC=16bit, Ei=400µW/cm2)	DATA_PS	---	11000	---	count
PS A/D Conversion Time (PS A/DC=16 bit)	t_{PS}	21.4	25.2	28.9	ms
PS Wait Time (12.5ms setting)	t_{WAIT}	10.6	12.5	14.3	ms

I^2C Bus Characteristics (V_{DD}=3.0V, Ta=25°C)

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
I^2C Bus Clock Frequency	F_{I2C}	---	---	400	kHz
Input Voltage L	V_{IL}	---	---	0.15 xV_{DD}	V
Input Voltage H	V_{IH}	0.55 xV_{DD}	---	---	V
High Level Input Current	I_{IH}	-10	---	10	µA
Data Transfer Wait Time	t_{BUF}	1.3	---	---	µs
SCL Start Hold Time	$t_{HD:SDA}$	0.6	---	---	µs
SCL Low Level Hold Time	t_{LOW}	1.3	---	---	µs
SCL High Level Hold Time	t_{HIGH}	0.6	---	---	µs
Start Condition Setup Time	$t_{SU:STA}$	0.6	---	---	µs
SDA Data Setup Time	$t_{SU:DAT}$	100	---	---	ns
SDA, SCL Rise Time	t_R	---	---	300	ns
SDA, SCL Fall Time	t_F	---	---	300	ns
Stop Condition Setup Time	$t_{SU:STO}$	0.6	---	---	µs

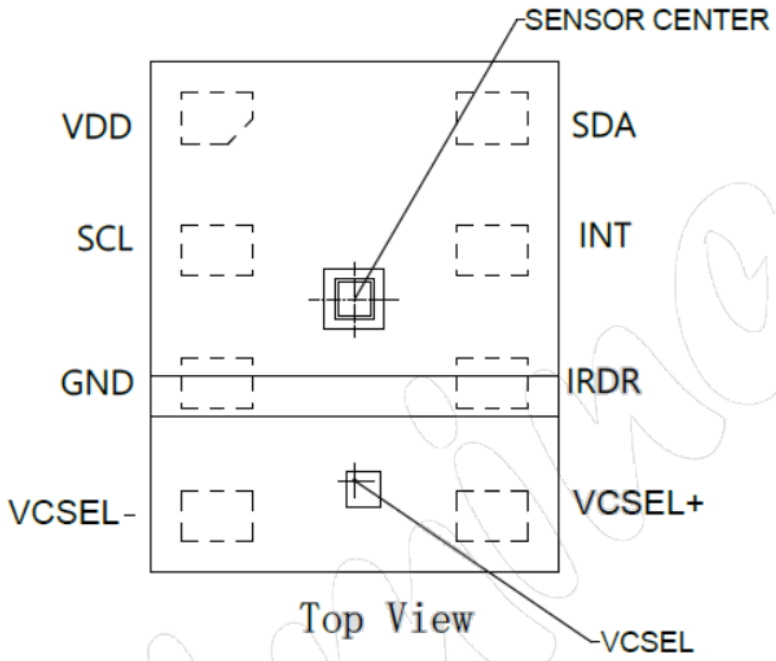
OUTLINE DIMENSION:

Package Dimension:



1. All dimensions are in millimetre (mm).
2. Tolerance ±0.1mm, unless otherwise noted.
3. Keep free of mechanical items which interfere with module operation in irradiate and receive area.

PIN CONFIGURATION:



Pin Name	Description
VDD	Power Supply
SCL	I2C serial clock signal
GND	Ground
VCSEL-	VCSEL cathode
SDA	I^2C serial data signal
INT	Interrupt pin
IRDR	LED Driver output pin
VCSEL+	VCSEL anode

1. I²C Bus Conditions:

I²C bus is inter-IC bus system to transfer data by 2 lines of SDA and SCL which were developed by NXP Semiconductors. Data transfer is performed by 1 byte, and acknowledgement is sent when each byte is complete. Data transfer takes place MSB first from a start condition. For more detailed I2C bus system, please refer to the specification released from NXP Semiconductors.

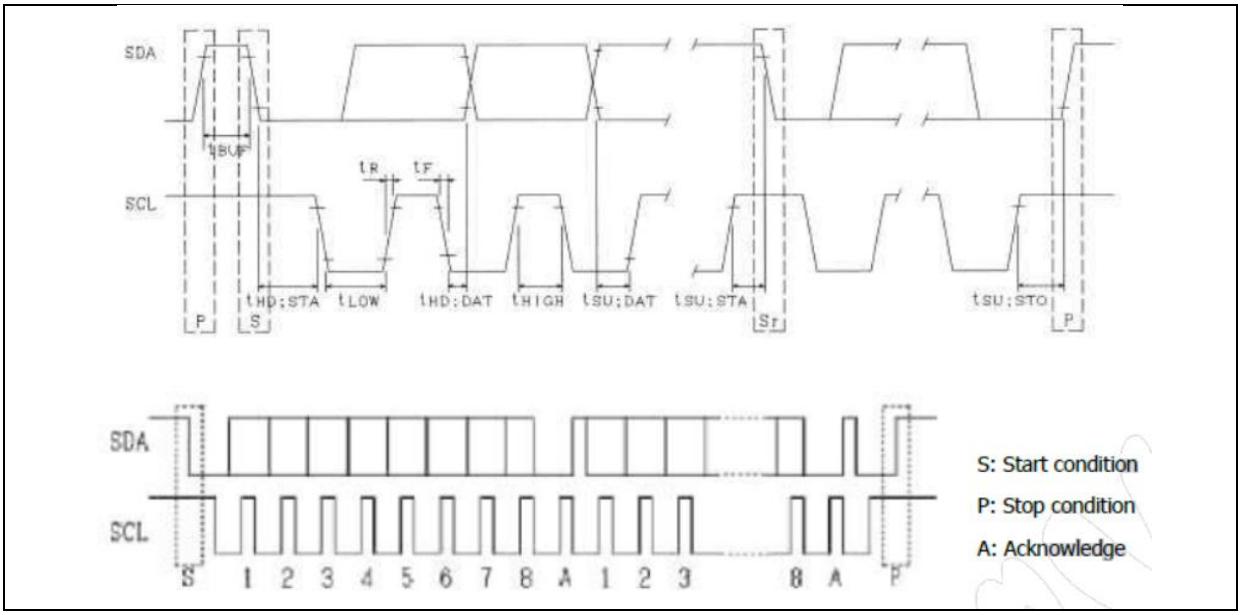


Figure 1. I²C Bus Timing Diagram

I²C Data Format:

1.1 Read Mode:

The data format for read mode is set as below:

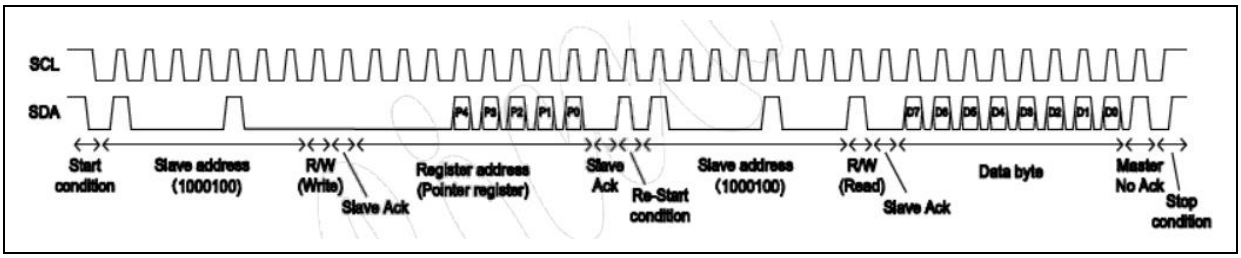


Figure 2. I²C Bus Timing Diagram (Read Mode)

1.2 Write Mode:

The data format for read mode is set as below:

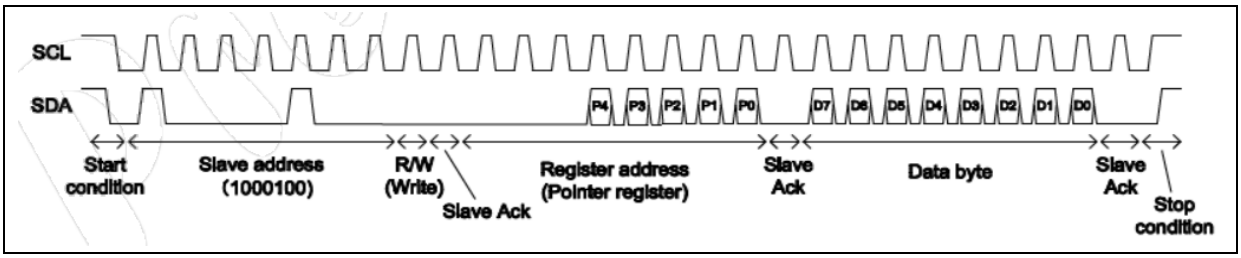


Figure 3. I²C Bus Timing Diagram (Write Mode)

2. Register Structure:

2.1 Pointer Register:

P7	P6	P5	P4	P3	P2	P1	P0
Register Select							

Address	P7	P6	P5	P4	P3	P2	P1	P0	Register Name	R/W	Default
00h	0	0	0	0	0	0	0	0	Operation Mode Select Register	R/W	00h
01h	0	0	0	0	0	0	0	1	Interrupt Flag Register	R/W	00h
02h	0	0	0	0	0	0	1	0	ALS Setting Register	R/W	00h
03h	0	0	0	0	0	0	1	1	(Reserved)	R	00h
04h	0	0	0	0	0	1	0	0	ALS Interrupt Low (LSB) Register	R/W	00h
05h	0	0	0	0	0	1	0	1	ALS Interrupt Low (MSB) Register	R/W	00h
06h	0	0	0	0	0	1	1	0	ALS Interrupt High (LSB) Register	R/W	00h
07h	0	0	0	0	0	1	1	1	ALS Interrupt High (MSB) Register	R/W	00h
08h	0	0	0	0	1	0	0	0	ALS Data (LSB) Register	R	00h
09h	0	0	0	0	1	0	0	1	ALS Data (MSB) Register	R	00h
0Ah	0	0	0	0	1	0	1	0	PS Setting Register	R/W	00h
0Bh	0	0	0	0	1	0	1	1	LED Driver Current Select Register	R/W	00h
0Ch	0	0	0	0	1	1	0	0	LED Drive Pulse Setting Register	R/W	00h
0Dh	0	0	0	0	1	1	0	1	PS Interrupt Low (LSB) Register	R/W	00h
0Eh	0	0	0	0	1	1	1	0	PS Interrupt Low (MSB) Register	R/W	00h
0Fh	0	0	0	0	1	1	1	1	PS Interrupt High (LSB) Register	R/W	00h
10h	0	0	0	1	0	0	0	0	PS Interrupt High (MSB) Register	R/W	00h
11h	0	0	0	1	0	0	0	1	PS Data (LSB) Register	R	00h
12h	0	0	0	1	0	0	1	0	PS Data (MSB) Register	R	00h
13h	0	0	0	1	0	0	1	1	PS Setting Register_2	R/W	00h
14h	0	0	0	1	0	1	0	0	PS Offset Cancel (LSB) Register	R/W	00h
15h	0	0	0	1	0	1	0	1	PS Offset Cancel (MSB) Register	R/W	00h
16h	0	0	0	1	0	1	1	0	(Reserved)	R/W	00h
17h	0	0	0	1	0	1	1	1	(Reserved)	R/W	00h
18h	0	0	0	1	1	0	0	0	Device ID Register	R	11h
19h	0	0	0	1	1	0	0	1	(Reserved)	R	
1Ah	0	0	0	1	1	0	1	0	(Reserved)	R	01h
1Bh	0	0	0	1	1	0	1	1	(Reserved)	R/W	00h
1Ch	0	0	0	1	1	1	0	0	(Reserved)	R/W	00h
1Dh	0	0	0	1	1	1	0	1	(Reserved)	R/W	00h
1Eh	0	0	0	1	1	1	1	0	(Reserved)	R/W	00h
1Fh	0	0	0	1	1	1	1	1	(Reserved)	R/W	00h
D5h	1	1	0	1	0	1	0	1	(Reserved)	R	00h

Address 19h are read-only registers that reflect some of the data of NVM (Non-volatile memory) built-in the ICs. This NVM is used for adjustment (trimming) of various characteristics in IC shipment inspection and has different data for each individual. Therefore, the value of the address 19h varies from 00h to FFh for each individual.

2.2 Operation Mode Select Register (00h):

D7	D6	D5	D4	D3	D2	D1	D0
ALSEN	AINTEN	APERSIST		PSEN	PINTEN	PPERSIST	

Default Value: 00h

2.2.1 ALSEN: ALS Enable Setting:

D7	ALS Enable
0	Disable ALS Function
1	Enable ALS Function

2.2.2 AINTEN: ALS Interrupt Enable Setting:

D6	ALS Interrupt Enable
0	Disable ALS Interrupt Function
1	Enable ALS Interrupt Function

2.2.3 APERSIST: ALS Persistence Count Setting:

D5	D4	ALS Persistence Count
0	0	1 cycle
0	1	4 cycles
1	0	8 cycles
1	1	16 cycles

2.2.4 PSEN: PS Enable Setting:

D3	PS Enable
0	Disable PS Function
1	Enable PS Function

2.2.5 PINTEN: PS Interrupt Enable Setting:

D2	PS Interrupt Enable
0	Disable PS Interrupt Function
1	Enable PS Interrupt Function

2.2.6 PPERSIST: PS Persistence Count Setting:

D1	D0	PS Persistence Count
0	0	1 cycle
0	1	4 cycles
1	0	8 cycles
1	1	16 cycles

2.3 Interrupt Flag Register (01h):

D7	D6	D5	D4	D3	D2	D1	D0
ALI	AHI	-	-	PLI	PHI	-	-

Default Value: 00h

2.3.1 ALI: ALS Low Side Interrupt Flag:

D7	ALS Low Side Interrupt Flag
0	Interrupt is cleared or not triggered yet
1	Interrupt is triggered and will be clearable by writing “0”

2.3.2 AHI: ALS High Side Interrupt Flag:

D6	ALS High Side Interrupt Flag
0	Interrupt is cleared or not triggered yet
1	Interrupt is triggered and will be clearable by writing “0”

2.3.3 PLI: PS Low Side Interrupt Flag:

D3	PS Low Side Interrupt Flag
0	Interrupt is cleared or not triggered yet
1	Interrupt is triggered and will be clearable by writing “0”

2.3.4 PHI: PS High Side Interrupt Flag:

D2	PS High Side Interrupt Flag
0	Interrupt is cleared or not triggered yet
1	Interrupt is triggered and will be clearable by writing “0”

2.4 ALS Setting Register (02h):

D7	D6	D5	D4	D3	D2	D1	D0
AGAIN		AITIME			-	-	-

Default Value: 00h

2.4.1 AGAIN: ALS Gain Setting:

D7	D6	ALS Gain Setting
0	0	x 1
0	1	x 4
1	0	x 16
1	1	x 128

2.4.2 AITIME: ALS A/D Conversion Time Set:

D5	D4	D3	ALS A/D Conversion Time
0	0	0	50ms
0	0	1	100ms
0	1	0	200ms
0	1	1	400ms
1	0	0	800ms
1	0	1	
1	1	0	

The detection resolution and the maximum detection illumination of ALS are changes as follows by the ALS gain and A/DC conversion time setup.

ALS Gain	ALS A/D Conversion Time (ms)	ALS Detection Resolution (lx/count)	Maximum Detection Illuminance (lx)	A/DC Output Resolution
X 1	50	1.186	77,709	16 bit
	100	0.593	38.855	
	200	0.296	19,427	
	400	0.148	9,714	
	800	0.074	4,857	
X 4	50	0.296	19,427	16 bit
	100	0.148	9,714	
	200	0.074	4,857	
	400	0.037	2,428	
	800	0.019	1,214	
X 16	50	0.074	4,857	16 bit
	100	0.037	2,428	
	200	0.019	1,214	
	400	0.0093	607	
	800	0.0046	304	
X 128	50	0.0093	607	16 bit
	100	0.0046	304	
	200	0.0023	152	
	400	0.0012	76	
	800	0.0006	38	

2.5 ALS Interrupt Register:

2.5.1 ALS Interrupt Low (LSB) Register (04h):

D7	D6	D5	D4	D3	D2	D1	D0
ALTLB							

Default Value: 00h

2.5.2 ALS Interrupt Low (MSB) Register (05h):

D7	D6	D5	D4	D3	D2	D1	D0
ALTHB							

Default Value: 00h

2.5.3 ALS Interrupt High (LSB) Register (06h):

D7	D6	D5	D4	D3	D2	D1	D0
AHTLB							

Default Value: 00h

2.5.4 ALS Interrupt High (MSB) Register (07h):

D7	D6	D5	D4	D3	D2	D1	D0
AHTHB							

Default Value: 00h

2.6 ALS Data Register:

2.6.1 ALS Data (LSB) Register (08h):

D7	D6	D5	D4	D3	D2	D1	D0
ADATAL							

Default Value: 00h

2.6.2 ALS Data (MSB) Register (09h):

D7	D6	D5	D4	D3	D2	D1	D0
ADATAH							

Default Value: 00h

2.7 PS Setting Register (0Ah):

D7	D6	D5	D4	D3	D2	D1	D0
PGAIN		PITIME			PWTIME		

Default Value: 00h

2.7.1 PGAIN: PS Gain Setting:

D7	D6	PS Gain Setting
0	0	x 1
0	1	x 2
1	0	x 4
1	1	x 8

2.7.2 PITIME: PS A/D Conversion Time, Output Resolution:

D5	D4	D3	PS A/D Conversion Time	PS A/DC Output Resolution	
				without PS Offset Cancellation	with PS Offset Cancellation
0	0	0	0.4ms	10 bit (max. 1,023 count)	9 bit (max. 511 count)
0	0	1	0.8ms	11 bit (max. 2,047 count)	10 bit (max. 1,023 count)
0	1	0	1.6ms	12 bit (max. 4,095 count)	11 bit (max. 2,047 count)
0	1	1	3.2ms	13 bit (max. 8,191 count)	12 bit (max. 4,095 count)
1	0	0	6.3ms	14 bit (max. 16,383 count)	13 bit (max. 8,191 count)
1	0	1	12.6ms	15 bit (max. 32,767 count)	14 bit (max. 16,383 count)
1	1	0	25.2ms	16 bit (max. 65,535 count)	15 bit (max. 32,767 count)
1	1	1			

2.7.3 PWTIME: PS Wait Time:

D2	D1	D0	PS Wait Time
0	0	0	12.5ms
0	0	1	25ms
0	1	0	50ms
0	1	1	100ms
1	0	0	200ms
1	0	1	400ms
1	1	0	800ms
1	1	1	1600ms

2.8 LED Drive Current Select Register (0Bh):

D7	D6	D5	D4	D3	D2	D1	D0
-	IRDRC			-	-	-	-

Default Value: 00h

D6	D5	D4	LED Drive Current
0	0	0	12.5mA
0	0	1	25.0mA
0	1	0	37.5mA
0	1	1	50.0mA
1	0	0	62.5mA
1	0	1	75.0mA
1	1	0	87.5mA
1	1	1	100.0mA

2.9 LED Drive Pulse Count Setting Register (0Ch):

D7	D6	D5	D4	D3	D2	D1	D0
IRDRP							

Default Value: 00h

D7	D6	D5	D4	D3	D2	D1	D0	LED Drive Pulse Count
0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1	2
0	0	0	0	0	0	1	0	3
0	0	0	0	0	0	1	1	4
~								~
1	1	1	1	1	1	0	0	253
1	1	1	1	1	1	0	1	254
1	1	1	1	1	1	1	0	255
1	1	1	1	1	1	1	1	256

2.10 PS Interrupt Register:

2.10.1 PS Interrupt Low (LSB) Register (0Dh):

D7	D6	D5	D4	D3	D2	D1	D0
PLTLB							

Default Value: 00h

2.10.2 PS Interrupt Low (MSB) Register (0Eh):

D7	D6	D5	D4	D3	D2	D1	D0
PLTHB							

Default Value: 00h

2.10.3 PS Interrupt High (LSB) Register (0Fh):

D7	D6	D5	D4	D3	D2	D1	D0
PHTLB							

Default Value: 00h

2.10.4 PS Interrupt High (MSB) Register (10h):

D7	D6	D5	D4	D3	D2	D1	D0
PHTHB							

Default Value: 00h

2.11 PS Data Register:

2.11.1 PS Data (LSB) Register (11h):

D7	D6	D5	D4	D3	D2	D1	D0
PDATAL							

Default Value: 00h

2.11.2 PS Data (MSB) Register (12h):

D7	D6	D5	D4	D3	D2	D1	D0
PDATAH							

Default Value: 00h

2.12 PS Setting Register_2 (13h):

D7	D6	D5	D4	D3	D2	D1	D0
PSOCEN	(Reserved)			PALDEN	PALDL		-

Default Value: 00h

2.12.1 PSOCEN: PS Offset Cancel Function Enable:

D7	PS Offset Cancel Function Enable
0	Disable PS Offset Cancel Function
1	Enable PS Offset Cancel Function

When PSOCEN is 1, the PS offset cancel function is enabled, and the result of subtracting any value specified by the PS offset cancel (LSB) register (Address 14h) and the PS offset cancel (MSB) register (Address 15h) from the internal PS output data is written to the PS output data register.

2.12.2 D6~D4: Reserved bit.

Make sure to set D6 - D4 to “0”.

2.12.3 PALDEN: PS Correction in Large Ambient Light Enable Setting:

D3	PS Correction in Large Ambient Light Enable Setting
0	Disable PS Correction
1	Enable PS Correction

PALDEN is used for preventing mis-detection when the device was irradiated by excessive light (For example the direct sunlight) at PS sensing.

At the PALDEN=1, a PS output value is corrected to 0count when irradiated by excessive light.

2.12.4 PALDL: Large Ambient Light Detection Level Setting:

D2	D1	Large Ambient Light Detection Level Setting
0	0	Sunlight 37,500lx (typ.)
1	1	Sunlight 35,000lx (typ.)
1	0	Sunlight 32,500lx (typ.)
1	1	Sunlight 30,000lx (typ.)

This register sets the detection level of excessive light at the PS sensing.

2.13 PS Offset Cancel Register:

2.13.1 PS Offset Cancel (LSB) Register (14h):

D7	D6	D5	D4	D3	D2	D1	D0
PSOCL							

Default Value: 00h

2.13.2 PS Offset Cancel (MSB) Register (15h):

D7	D6	D5	D4	D3	D2	D1	D0
0	PSOCH						

Default Value: 00h

2.14 Device ID Register (18h):

D7	D6	D5	D4	D3	D2	D1	D0
DEVID							

Default Value: 11h

This register indicates the part number and silicon revision for product identification.

2.15 Reserved Register (03h, 16h, 17h, 19h, 1Ah, 1Bh, 1Ch, 1Dh, 1Eh, 1Fh, D5h):

Address 03h, 16h, 17h, 19h, 1A, 1Bh, 1Ch, 1Dh, 1Eh, 1Fh and D5h is reserved register.

Be sure to use the default value without writing to these registers.

3. Function Description:

State Diagram:

Figure 4 shows state diagram of N0S65S85.

Device is in Shutdown mode as power is on. Once ALS enable and/or PS enable bit are set “1”, device goes to the following state. ALS interrupt enable bit is set “0”, device goes into ALS A/D conversion state and keep updating ALS data in every conversion time.

ALS interrupt enable is set “1”, device keep comparing updated ALS data and interrupt threshold value until its count reaches to persistence setting count, and ALS data will continuously be updating even after interrupt detected.

Same cycle above is applicable for the PS state as well, PS interrupt enable bit is set “1”, device keep comparing updated PS data and interrupt threshold value until its count reaches to persistence setting count, and PS data will continuously be updating even after interrupt detected.

Anytime when “0” is set for ALS/PS enable bit, device goes into Shutdown mode.

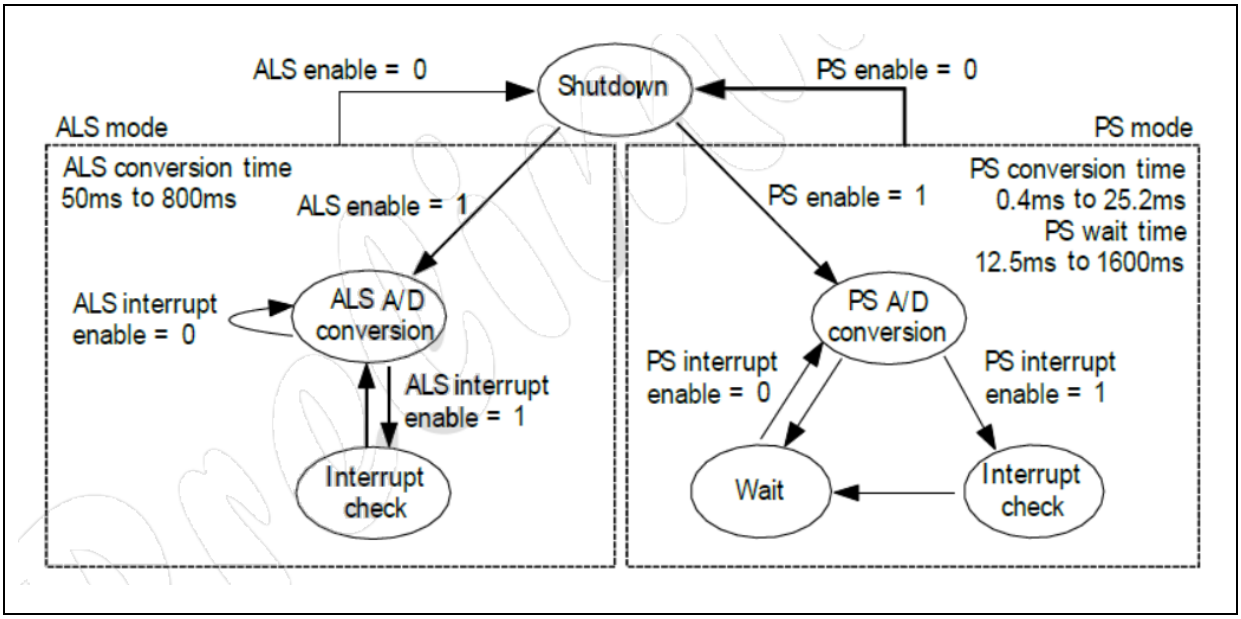


Figure 4. State Diagram

3.1 Shutdown Mode:

Shutdown mode becomes effective when the power is turned on and when the shutdown mode is selected with the operation mode select resister. Power consumption is TYP 0.1uA in the shutdown mode; therefore, the power consumption can lower standby power consumption. The configuration register is readable and writable even in the shutdown mode.

3.2 ALS Mode:

The ALS mode is for measuring the ambient light illuminance by using an ALS photodiode that has sensitivity to visible-light.

A/D conversion cycle is started by specifying the ALS mode with the operation mode select register, and the output data corresponding to the illuminance is stored in the data register after completing the A/D conversion cycle.

3.3 ALS Interrupt Function:

The ALS interrupt function is for interrupting when the count of the ALS output data meeting the detection condition consecutively persistence setting count. In the interrupting, the interrupting flag according to each condition is set to "1", and the interrupt output pin is set to Low level. The detection condition is that the ALS output data is lower than the Low side threshold value or higher than the High side threshold value. If the output data was out of the detection condition, count is reset to zero.

3.3.1 Detection Condition:

The number of detection is counted with condition below.

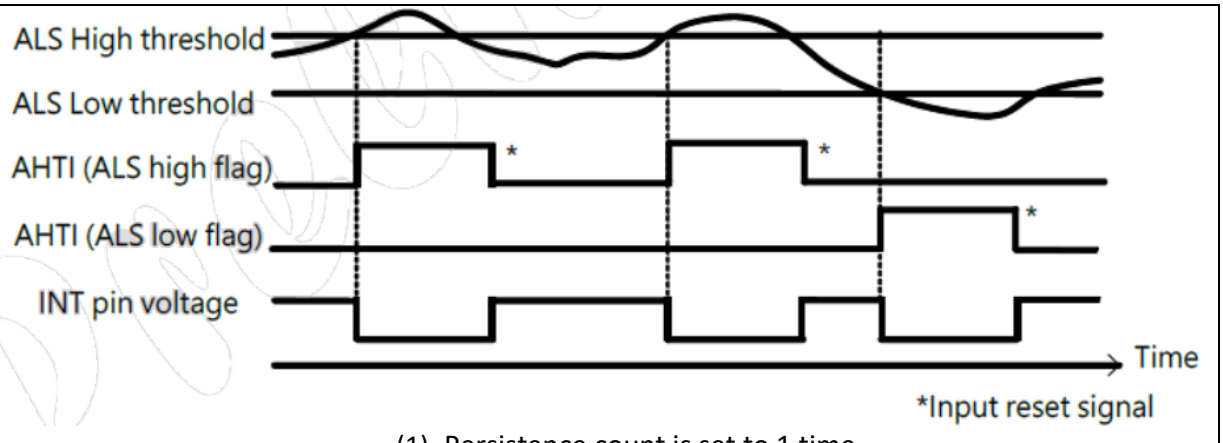
"ALS Output data < Low side threshold value" OR "ALS Output data > High side threshold value".

3.3.2 Flag Set Condition:

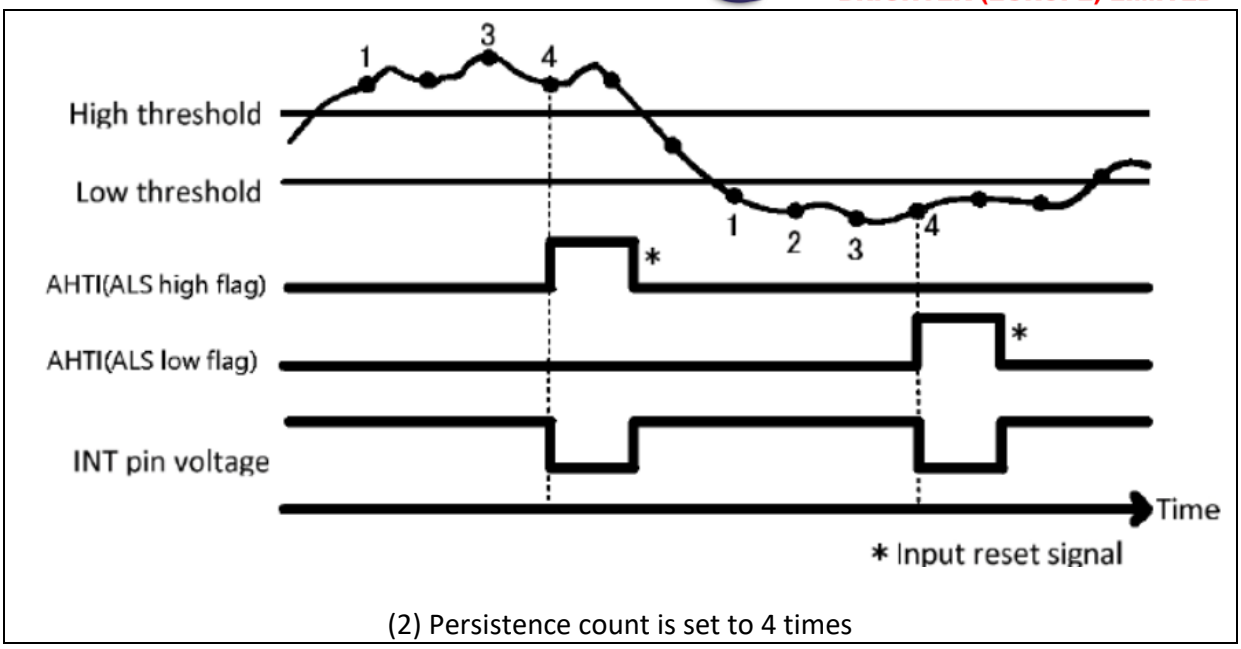
The interrupt flag is set with condition below and INT pin will be active.

"Detection count = ALS persistence setting count".

The number of persistence is selectable from 1, 4, 8 and 16 times by an interruption setting register.



(1) Persistence count is set to 1 time



(2) Persistence count is set to 4 times

Figure 5. ALS Interrupt Function Timing Diagram

3.3.3 State Diagram:

Figure 6 shows state diagram at ALS interrupt mode.

ALS interrupt enable bit is set "1", device keep comparing updated ALS data and interrupt threshold value until its count reaches to persistence setting count, and ALS data will continuously be updating even after interrupt detected. Once detection with persistence setting count is complete, then INT flag (AHTI/ALTI) goes to "1". By resetting INT flag, comparison between updated ALS data with specified conversion time and interrupt threshold value will be restarted.

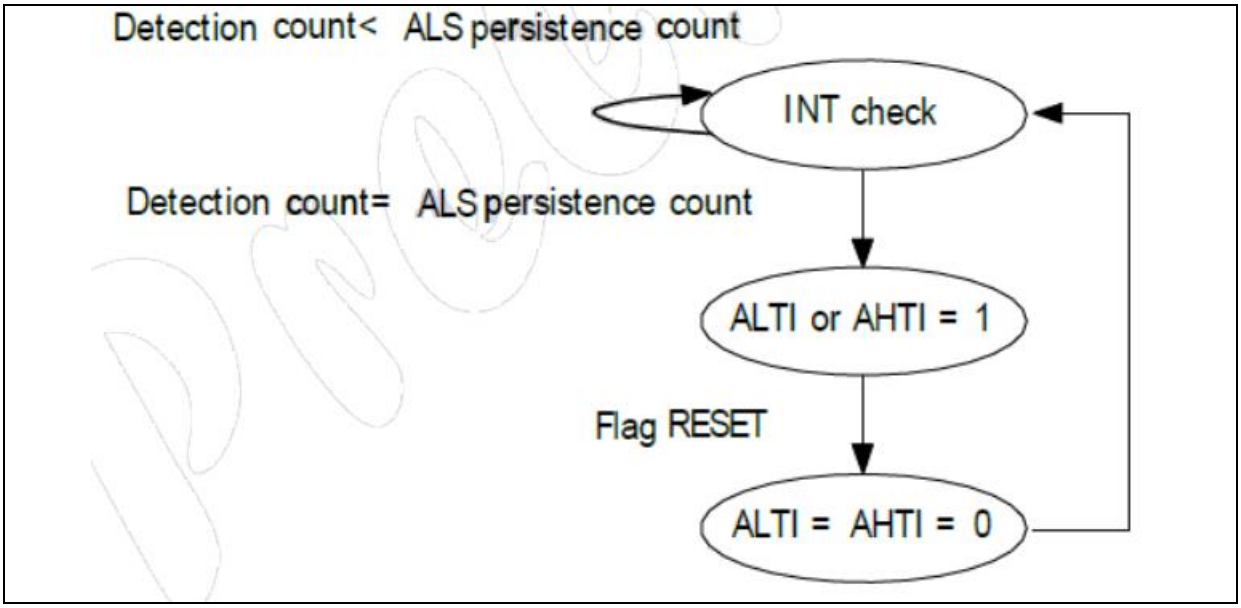


Figure 6. State Diagram of ALS Interrupt Mode

3.4 PS Mode:

PS mode drives IR-LED connected to IRDR pin, and detects IR intensity in sync with IR-LED driving. When an object is close to IC at the time of LED driving, the reflected light irradiates to IC, therefore detection of proximity is possible by IR intensity sensing.

The IR-LED drive and AD conversion cycle are started by specifying the PS enable with the operation select register. Then, the output data corresponding to the reflected IR intensity is stored in the data register.

IR-LED is controlled by the LED driver built in IC. A drive current value (12.5 to 100mA) and the pulse count (1 to 256pulses) is selectable, and it is possible to adjust proximity detection distance. Moreover, measurement interval in PS mode can be adjusted with PS wait time setting (12.5 to 1600ms).

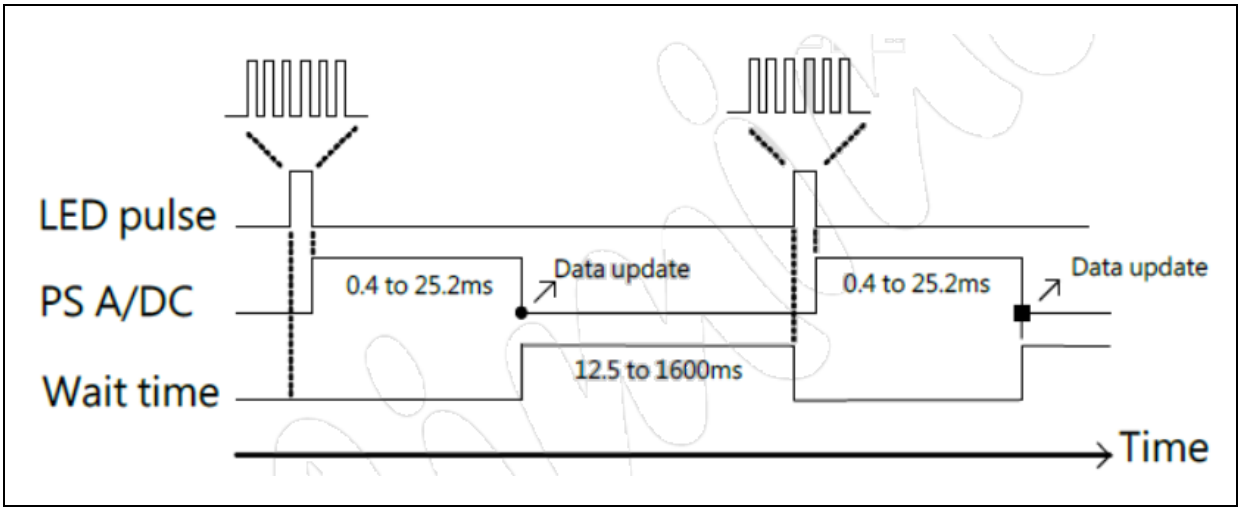


Figure 7. PS Mode Timing Diagram

PS supply current at the time of PS LED ON.

PS supply current when IR-LED is on is depending on setting of the number of LED pulse, drive current, A/D conversion time and wait time. Calculation method of PS current consumption is as below:

$$\text{PScurrent consumption(average)} = \frac{(20us\times 8pulses\times 12.5mA)+(6.3ms\times 0.175mA)+(12.5ms\times 0.02mA)}{19.12ms}$$

$$= 175.3uA$$

Setting conditions:

- Pulse count = 8pulses (pulse width is 20us)
- PS wait time = 12.5ms
- LED drive current = 12.5mA
- PS current (Wait) = 0.02mA
- PS A/D conversion time =6.3ms
- Sensing cycle time = 19.12ms
- PS current (Active) = 0.175mA

3.5 PS Interrupt Function:

The PS interrupt function is for interrupting when the count of the PS output data meeting the detection condition consecutively persistence setting count. In the interrupting, the interrupting flag according to each condition is set to "1", and the interrupt output pin is set to Low level. The detection condition is that the PS output data is lower than the Low side threshold value or higher than the High side threshold value. If the output data was out of the detection condition, count is reset to zero.

3.5.1 Detection Condition:

The number of detection is counted with condition below.

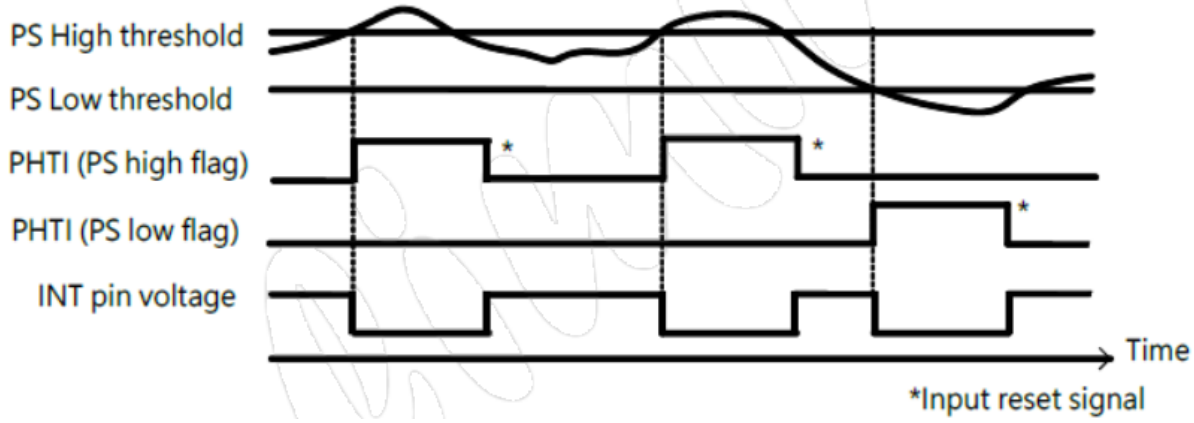
"PS Output data < Low side threshold value" OR "PS Output data > High side threshold value".

3.5.2 Flag Set Condition:

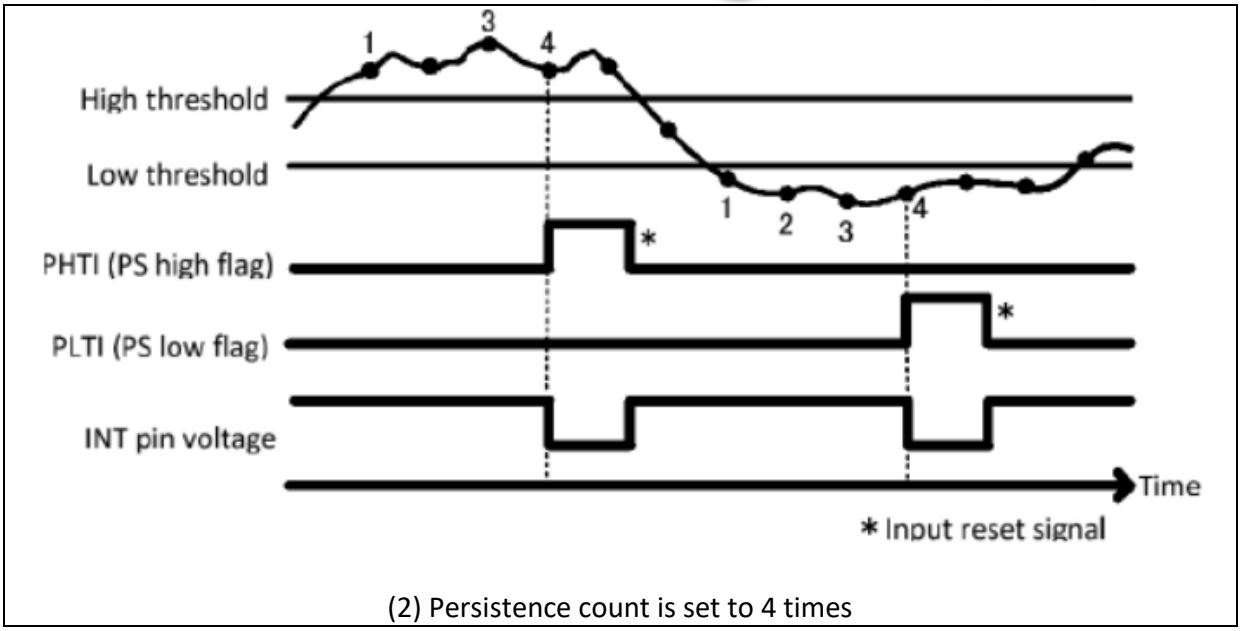
The interrupt flag is set with condition below and INT pin will be active.

"Detection count = PS persistence setting count".

The number of persistence is selectable from 1, 4, 8 and 16 times by an interruption setting register.



(1) Persistence count is set to 1 time



(2) Persistence count is set to 4 times

Figure 8. PS Interrupt Function Timing Diagram

3.5.3 State Diagram:

Figure 9 shows state diagram at PS interrupt mode.

PS interrupt enable is set "1", device keep comparing updated PS data and interrupt threshold value until its count reaches to persistence setting count, and PS data will continuously be updating even after interrupt detected. Once detection with persistence setting count is complete, then INT flag (PHTI/PLTI) goes to "1". By resetting INT flag, comparison between updated PS data with specified conversion time and interrupt threshold value will be restarted.

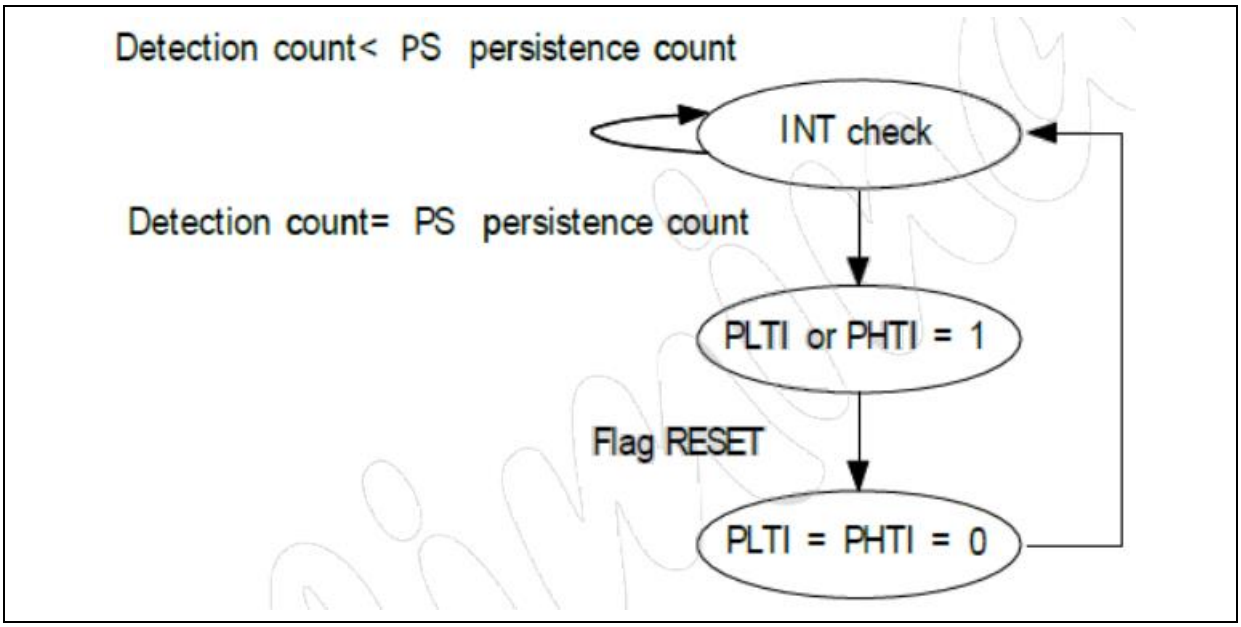


Figure 9. State Diagram of PS Interrupt Mode

4. Test Circuit Diagram:

4.1 Shutdown Current, Supply Current, ALS Output, PS Output:

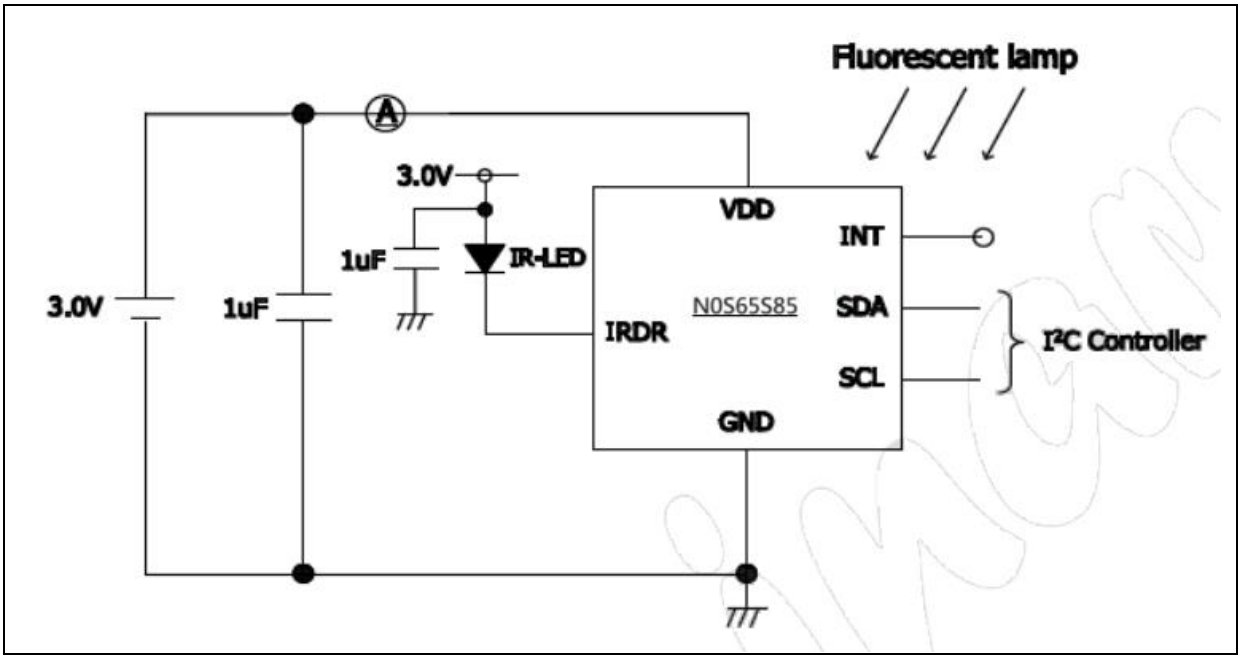


Figure 10. Measurement Circuit_1

4.2 IRDR Output Current:

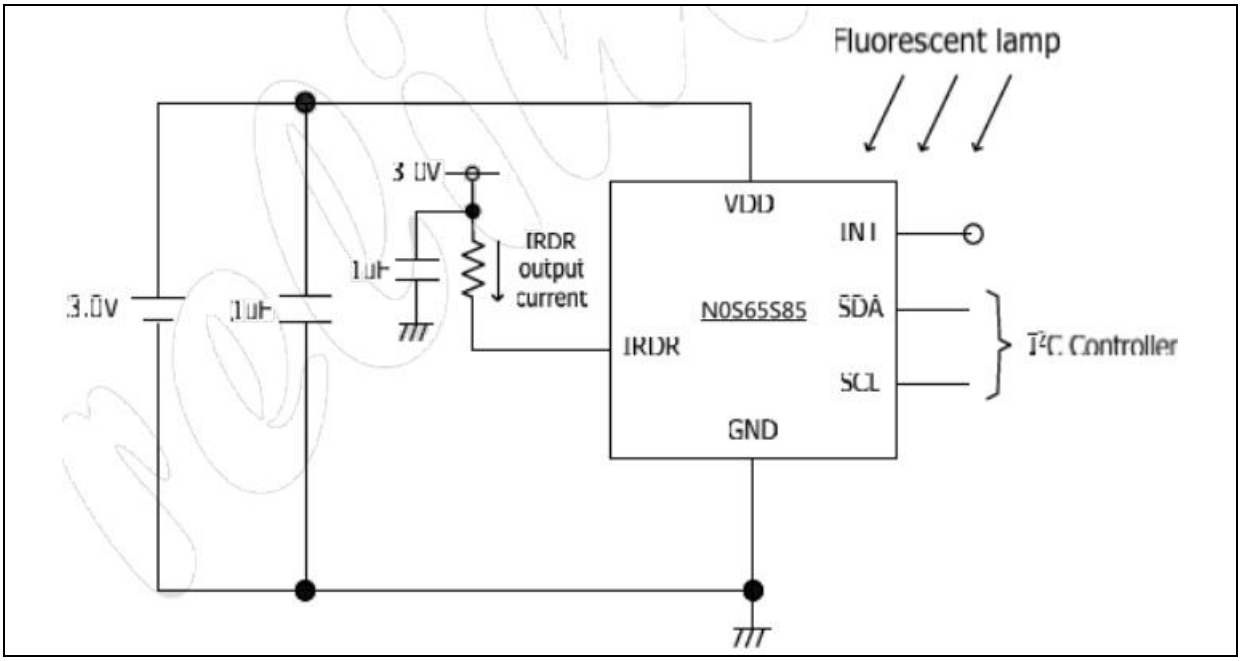


Figure 11. Measurement Circuit_2

5. Typical Application Circuit:

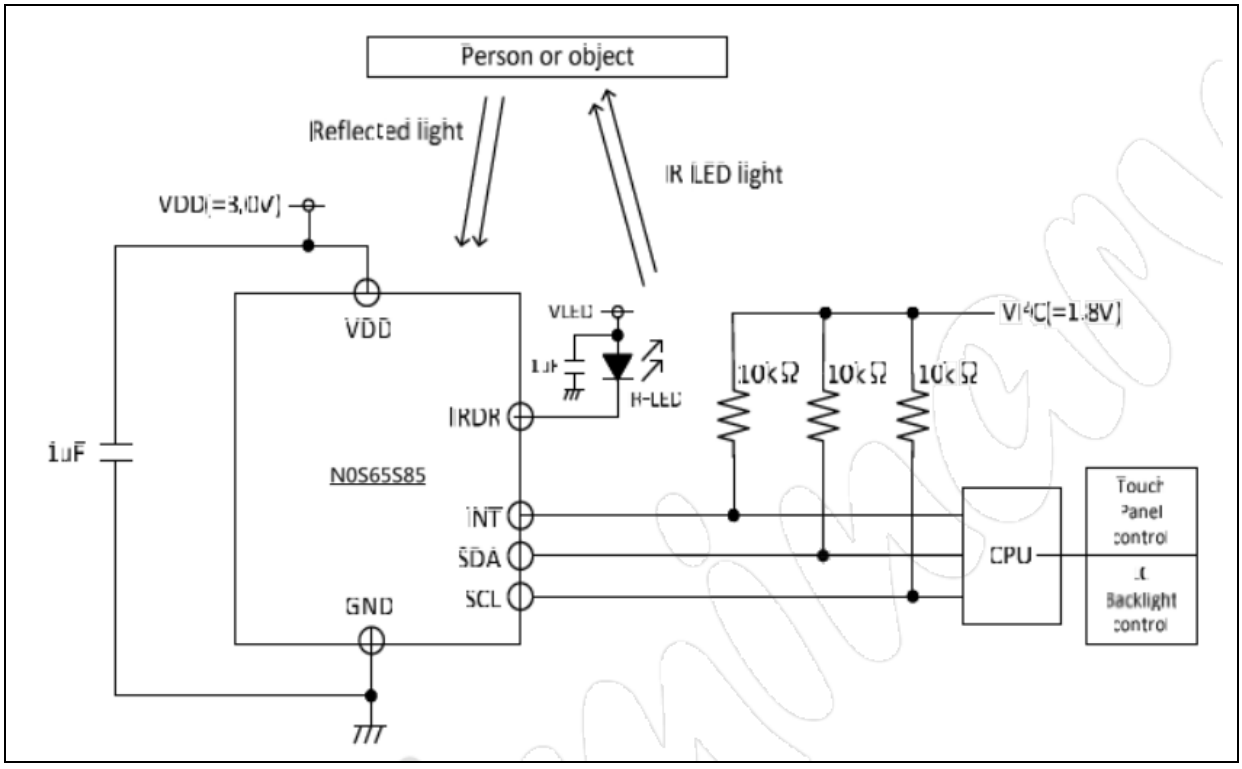


Figure 12. Application Circuit

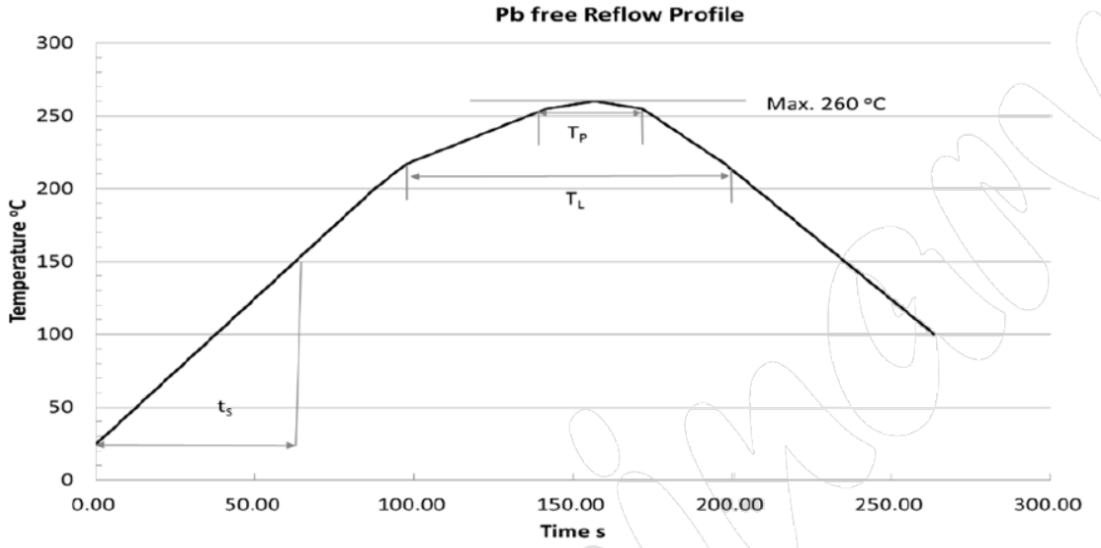
- To avoid power supply noise, place 1uF capacitor as close as possible to the VDD terminal. IR-LED is drove with pulse current, noise to be generated with especially driving current more than 100mA range may influence proximity sensing. To avoid this noise, place 1uF capacitor as close as possible to the Anode terminal. Power supply of VLED and VDD is preferred to be separated.

- Brightek shall not assume any liability for any accident or damage caused by use of this circuit.

- Brightek shall not assume any liability for any issues related to industrial property rights and/or other rights owned by third parties or shall not grant any license regarding use of this circuit.

RECOMMENDED SOLDERING PROFILE:

Lead-free Solder IR Reflow:



Profile Feature	Symbol	Pb-Free (SnAgCu) Assembly			Unit
		Minimum	Recommendation	Maximum	
Ramp-up rate to preheat 25 °C to 150 °C			2	3	K/s
Time t_S T_{Smin} to T_{Smax}	t_S	60	100	120	s
Ramp-up rate to peak T_{Smax} to T_P			2	3	K/s
Liquidus temperature	T_L		217		°C
Time above liquidus temperature	t_L		80	100	s
Peak temperature	T_P		245	260	°C
Time within 5 °C of the specified peak temperature TP - 5 K	T_P	10	20	30	s
Ramp-down Rate T_P to 100 °C			3	4	K/s
Time 25 °C to T_P				480	s

Note:

1. We recommend the reflow temperature 240°C (±5°C). The maximum soldering temperature should be limited to 260°C.
2. Maxima reflow soldering: 2 times.
3. Before, during, and after soldering, should not apply stress on the components and PCB board.

PRECAUTIONS OF USE:

Storage:

It is recommended to store the products in the following conditions:

- Humidity: 60% R.H. Max.
- Temperature: 5°C~30°C (41°F ~86°F).

Shelf life in sealed bag: 12 months at 5°C~30°C and <60% R.H.

Once the package is opened, the products should be used within 1 week. Otherwise, they should be kept in a damp-proof box with descanting agent stored at R.H.<10% and apply baking before use.

ESD (Electrostatic Discharge):

Static Electricity or power surge will damage the LED. Use of a conductive wrist band or anti-electrosatic glove is recommended when handing the LED all time. All devices, equipment, machinery, work tables, and storage racks must be properly grounded.

REVISION RECORD:

Version	Date	Summary of Revision
A1.0	30/05/2022	Datasheet set-up.
A1.1	04/10/2023	New datasheet format.