HM8005-H

Datasheet

Ambient Light and Proximity Sensor

Version 1.70

HiveMotion Co., Ltd.

This document contains information on a new product. Specifications and information herein are subject to change without notice.

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2	1.10	James. NK	Modified table 7-3 Power Consumption	2012-01-30
3	1.20	James. NK	Added figure 10-2 PCB layout guide	2012-02-06
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Ambient Light / Proximity Sensor

1. Specification

DESCRIPTION

HM8005 is a single chip including ALS(Ambient Light Sensor), PS(Proximity Sensor) and built-in LED to fit applications such as mobile phone, notebook, TV, keyboard, etc...

ALS measures the light intensity or brightness of light as a sensor same as human eye can detect the brightness of a light wavelength.

PS (Proximity Sensor) detects its own reflecting LED light under the strong sunlight and various light environments without influence.

HM8005 operates via I2C command. I2C command and Internal Scheduler control can control LED driver, ALS and PS's analog and digital blocks. This scheme provides controlling IR LED current amount, sleep mode, wake up mode and interrupt mode to reach optimized low power operation.

PARAMETER		TYPICAL VALUE
ALS	Dynamic Range	1,000,000 : 1
	ALS Count Bit Width	20 bits
	ALS Count mode	Direct update or Weighted average (1/2, 1/4, 1/8, 1/16)
	ALS Detection notice	Interrupt or Polling
PS	Max detection distance	[T.B.D]
	PS Detection notice	Interrupt or Polling
	LED Current	20mA step : 20mA~160mA 25mA step : 25mA~200mA
	LED Pulse Width	4us~24us (1.33us step)
Power Consumption	*Active	PS : 450uA, ALS : 570uA PS&ALS : 650uA
	Sleep	320uA
	Power Down	1uA
Operating Voltage		LEDA : 2.6V ~ 4.6V VDD : 2.6 V ~ 3.6 V I/O : 1.62V ~ 3.6V
Operating Temperature		-30°C ~ 85°C
Package Dimension		4.0 x 2.4 x 1.35 (mm), 8pin

FEATURES

- Integrated LED Driver
  - LED pulse width control
  - LED current control
- ALS output : I2C(20bit, polling or interrupt)
- PS output : I2C(polling or interrupt)
- Auto sleep mode : enter into sleep mode in wait time
- Manual sleep mode: I2C instruction
- wait time: 0ms ~ 2550ms (10ms step)
- ALS data output - Direct update or Weighted Average
- PS detection - Programmable Pattern comparison

APPLICATIONS

- Smart Phones & Tablets(i.e. Android OS, Linux OS, Windows OS, iOS, Symbian OS based phones)
- High featured phones with full touch screen
- Portable and Handheld devices (PDA, PMP, etc…)
- Personal Computer/Note books or LCD Monitor, LCD/PDP TV backlight systems
- Digital Photo frames / Wireless keyboards
- Automobile in dash audio video control / Automobile touch screen control system
- Applications with Capacitive Touch Panel
- Automatic menu popup / Contact less switches
- Automatic speaker phone enable

2. Block Diagram

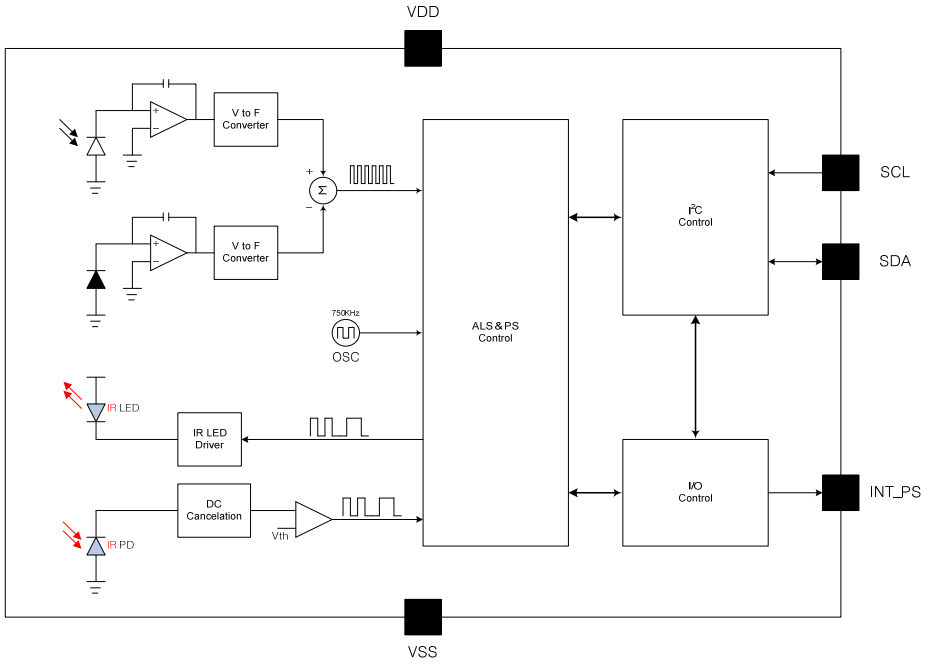


Figure 2-1 Block Diagram

HM8005 has ASL block to measure the ambient light luminance, PS block for proximity measurement, LED driver block for to drive current appropriately, I2C to interface with the host system, I/O control to tell proximity recognition(or interrupt), and OSC to supply clock to the chip. Furthermore, oscillator and power regulators are embedded for ease of use.

Luminance(Ambient light value) data measured by ALS can be read through I2C by host system. For proximity detection recognition check (or alarm), INT_PS pin(port) can have direct output or host system can read specific register address through I2C line.

In order to reduce the load on host system, interrupt mode can be used through INT_PS pin to control ALS and PS.

3. System Interface

3.1. System Initialization

Figure 3-1 shows reset scheme. Internal POR (Power On Reset) circuit maintains its state for about 200us when the external power is on, 64 clocks after 200us POR state, internal reset (resetn) is going to be released.

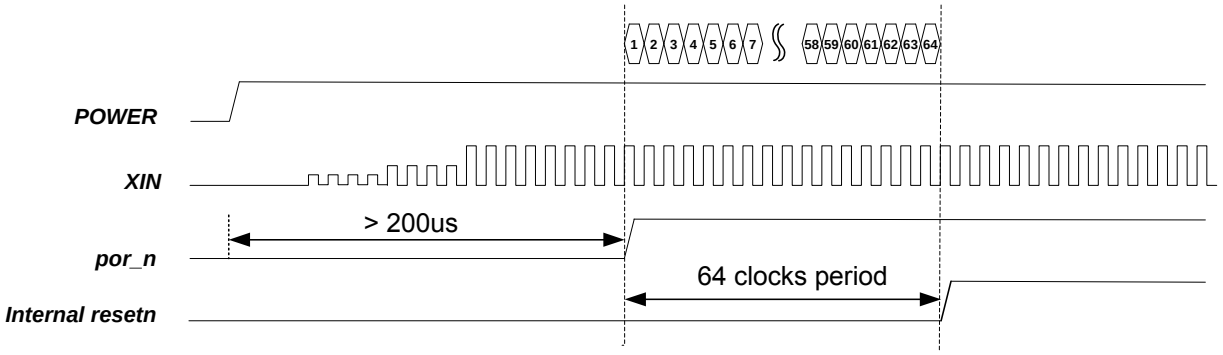


Figure 3-1 System Reset Scheme

3.2. Power Saving Mode

HM8005 has two steps of power saving mode. First is sleep mode and the other step is power down mode, the former can selectively disable PS or ALS to reduce power consumption, the latter stops the whole system activity until host system wakes up HM8005 by I2C.

Since each power saving mode maintains the latest chip status, host system doesn't have to initialize again to resume the operation.

3.3. I2C interface

HM8005 has I2C slave mode logic circuit embedded.

*** HM8005 I2C Slave Device Address**

Slave Mode	Write Device Address	8'h76
	Read Device Address	8'h77

3.3.1. I2C Condition

•Start / Stop Condition

Data Line and the Clock Line keep position in high level when bus is not in use. Start Condition has to meet following operation that during Clock Line maintains High, Data Line transitions take place from High to Low. On the other hand, when Clock Line is High, if Data Line changes from Low to High, it is defined as Stop Condition.

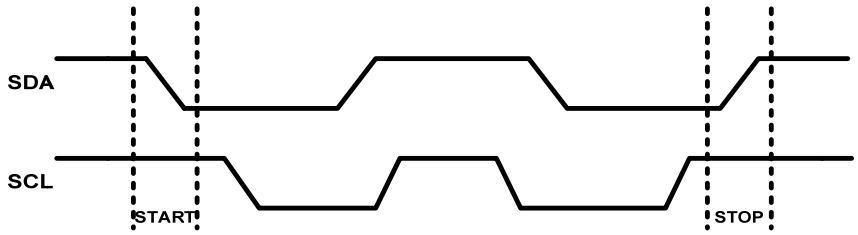


Figure 3-2 Start / Stop

•Acknowledge

All the addresses and data are transmitted with 8-bit word format via I2C slave. I2C slave transmits acknowledge signal "0" after the transmission of each word. This is generated in every 9 clock cycle.

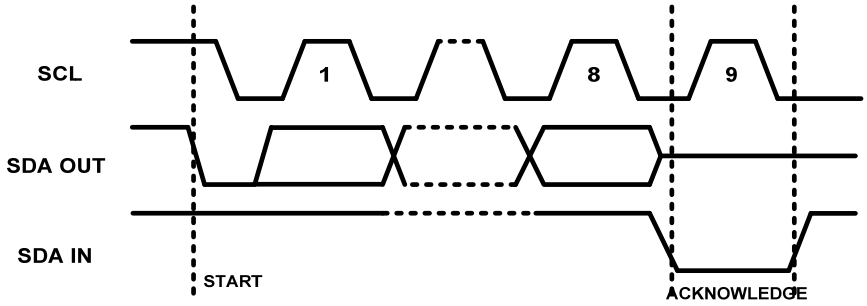


Figure 3-3 Acknowledge

3.3.2. I2C Slave Operation

HM8005 operates as slave via SCL, SDA pins (I2C interface). HM8005 register is controlled via I2C Slave interface, supporting Byte Write and Byte Read mode but not Burst mode.

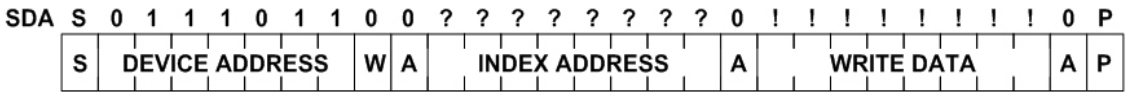
• Byte Write

Write operation by host is sequentially operated and completed by sending Device(write) Address, Index Address and Write Data. Acknowledge Bit is sent by HM8005 to host after each address part or data part is received. Each Acknowledge Bit indicates whether HM8005 has received data or not (communication success or failure). I2C Slave (HM8005) accepts data only if device address sent by host matches with it own device address.

• Byte Read

Read operation by host is sequentially operated and completed by sending Device(write) Address, Index Address, Device(read) address and Read Data. Acknowledge Bit is sent by HM8005 to host after each address part or data part is received. Each Acknowledge Bit indicates whether HM8005 has received data or not (communication success or failure). I2C Slave (HM8005) accepts data only if device address sent by host matches with it own device address.

Byte Write Operation



Byte Read Operation

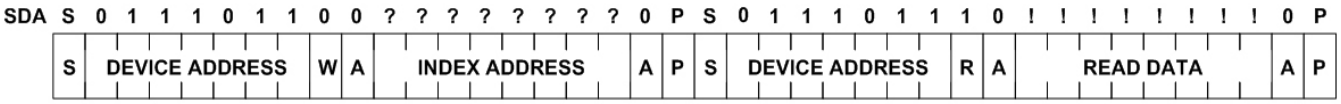


Figure 3-4 I2C Slave Read, Write Operation

3.4. ALS, PS Scheduler

ALS block in HM8005 checks ambient light brightness and PS block checks proximity distance. Both blocks repeat checking mode and sleep mode (with certain period). Scheduler controls this repeated cycle operation. State machine for ALS is controlled by a scheduler and state machine for PS is controlled by another scheduler. Hence, each state machine can be controlled independently. Figure 3-5 shows each operation steps of two state machines.

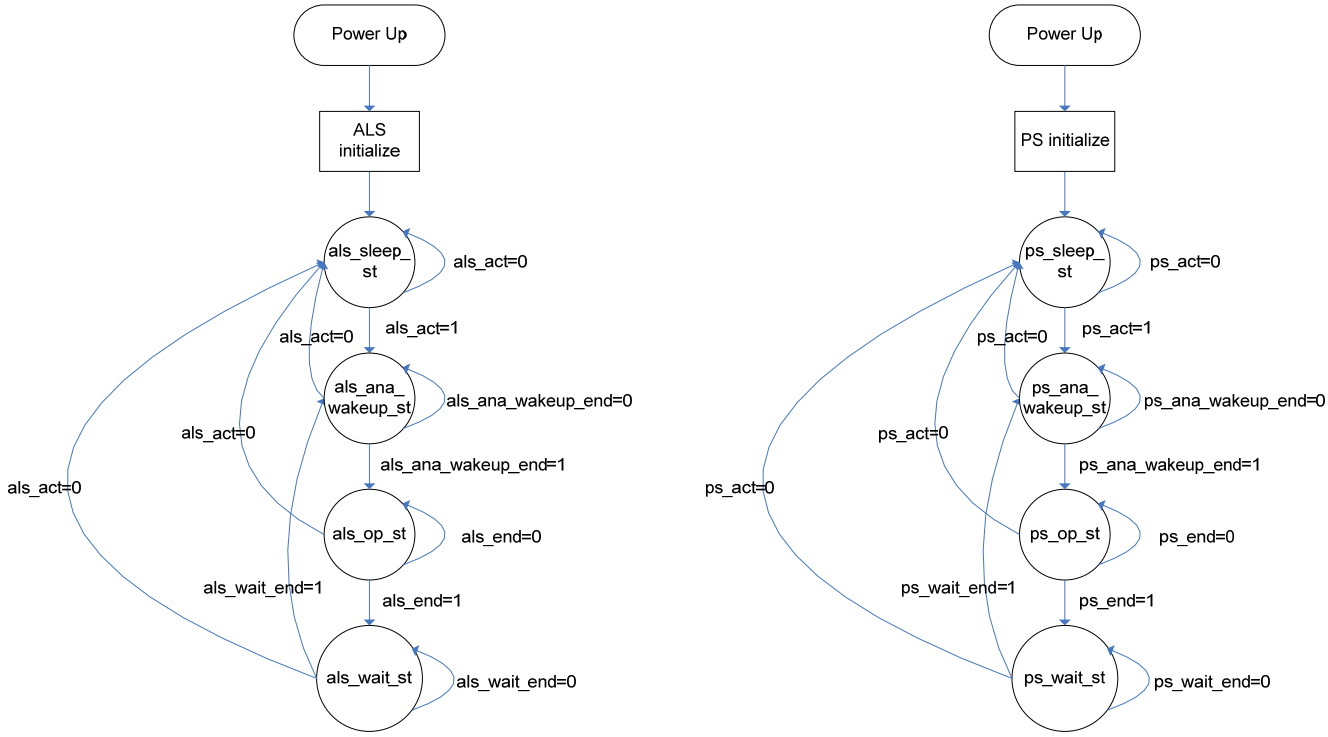


Figure 3-5 ALS, PS scheduler state machine

Following are definition of each state.

- sleep_st: only Scheduler, OSC, LDO and BGR are in operation mode. Both digital and analog block in ALS and PS are not in operation.
- ana_wakeup_st: analogue block in ALS or PS is in operation mode and digital block not in operation. Digital block is waiting for analogue block to be stabilized.
- op_st: Both analogue and digital block in operation mode.
- wait_st: Same as “sleep_st”, except it moves its state automatically to “ana_wakeup_st” according to its registered time set.

ALS wakeup time is adjustable within the range of 0 - 41us with 1.33us in each step. PS wakeup time is adjustable within the range of 0 - 170us with 1.33us in each step.

HM8005 has default working time (ALS: 665ms, PS: 320us) which is also adjustable by changing register set. Default ALS wait time is 50ms and default PS wait time is 10ms. Both ALS and PS can adjust its wait time from 10ms up to 2550ms with 10ms in each step.

Figure 3-6, Figure 3-7 shows ALS, PS operation timing.

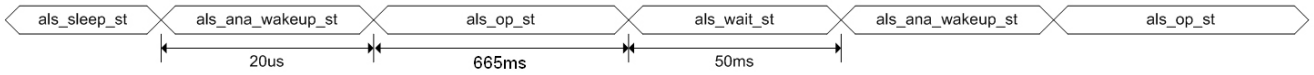


Figure 3-6 ALS default setting timing

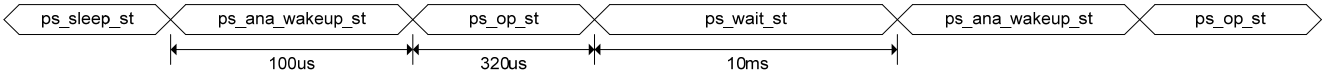


Figure 3-7 PS default setting timing

3.5. I/O Control

Device host system is connected to HM8005 via INT_PS port and I2C pin. INT_PS port has an open drain architecture same as I2C.

ALS and PS in HM8005 has normal mode and interrupt mode.

Host system receives indication of proximity detection or Interrupt signal via INT_PS port. INT_PS port output indicates proximity detection in Normal mode. In normal mode, “high” indicates proximity is detected and “low” indicates proximity is not detected.

INT_PS port is used for either ALS interrupt mode or PS interrupt mode. In interrupt mode, PS interrupt or ALS interrupt is indicated to host system by INT_PS port output in “high”. HM8005 operation is paused holding the latest data when interrupt occurs. Host systems can set HM8005 back into its operation stage (prior to interrupt state) when needed. Detailed description of “interrupt mode” is referred in chapter #4 ALS (Ambient Light sensor) and chapter #5. PS (Proximity sensor) part.

The default INT_PS state is set to “disable” by default and controlled by OPCON(0x01) register.

Figure 3-8 shows register set and descriptions.

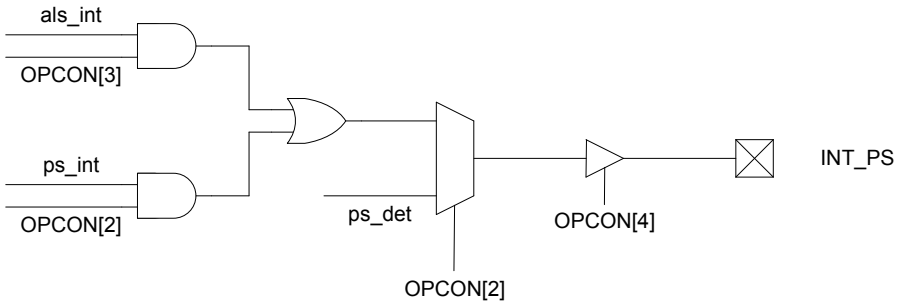


Figure 3-8 INT_PS port control

4. ALS (Ambient Light Sensor)

4.1. Overview

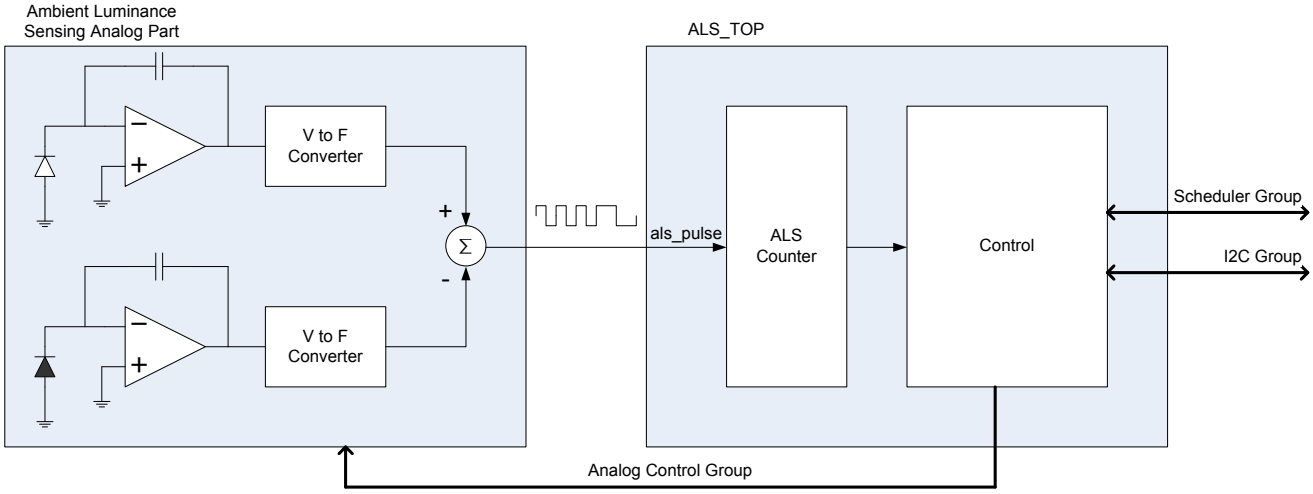


Figure 4-1 ALS Block Diagram

ALS(Ambient Light Sensor) has photo diod, which generates “current” proportion to light income. HM8005 counts the value of current and screen out light sources such as IR which are not detectable by human eye.

ALS is composed with counter and control block (output). ALS counter supports 20 bit and ALS controller sets light integration time, drive interrupt, execution of moving average.

4.2. Function Description

4.2.1. ALS Count Operation

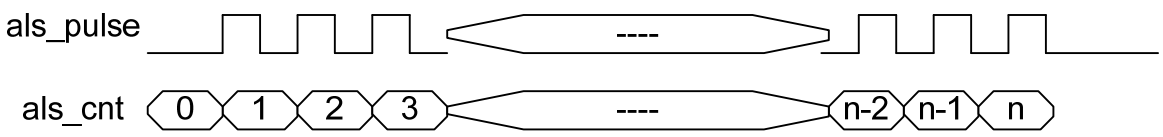


Figure 4-2 ALS Count Operation

Figure 4-2 descibes ALS block count and output. "als_pulse" generated (Figure4-2) by light source is converted into "als_cnt". Time for "als-cnt" can be adjusted in order to measure ultra low ambient light source or brightness (i.e. 0.1Lux). This time is configurable by ALS_INTG(0x11), ALS_STEPH(0x12), ALS_STEPL(0x13) registers.

Formula to cacluate integration time are as follows;

(([ALS_STEPH, ALS_STEPL] + 1) x 1.33us) x ALS_INTG

4.2.2. ALS Interrupt mode

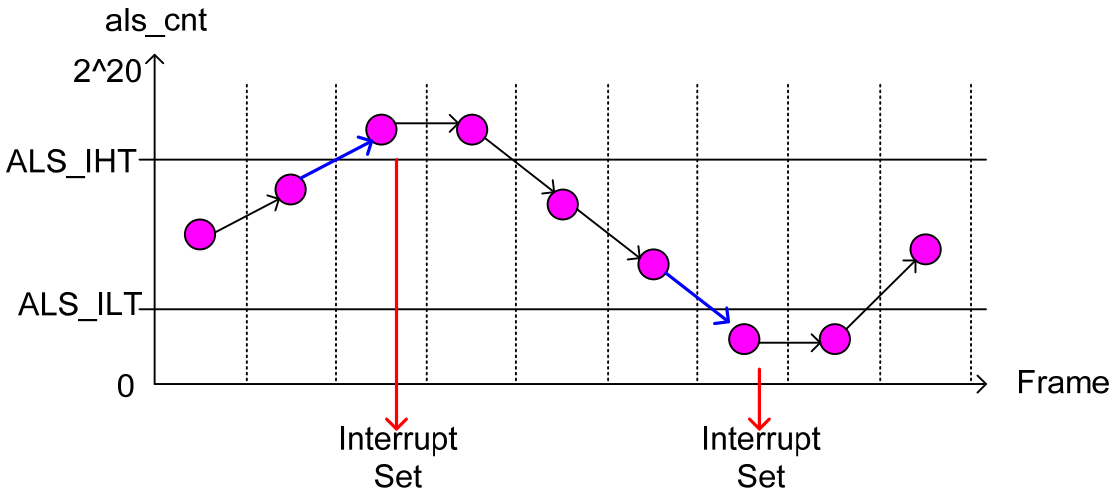


Figure 4-3 ALS Interrupt Mode

In interrupt mode, "interrupt" occurrs when ALS count value is same or higher than defined value (ALS_IHT) or same or lower than any defined value (ALS_ILT). INT_PS pin(port) is used for this "interrupt" output. Host system should read INT_FLAG[1] register bit to learn whether interrupt was for ALS or PS. Host system can also read ALS_STATUS[0:1] register bit to learn whether the count has happened at low or high threshold settings.

HM8005 keeps interrupt state and its ALS count value until the host system reads the count value(host system reading sequence should be: ALS_CNT_H -> ALS_CNT_M -> ALS_CNT_L), and then HM8005 releases interrupt state and start counting ALS count value. Since threshold value(ALS_IHT, ALS_ILT) is set up with 16bit and ALS count is made of 20bit, user should define either upper 16bit or lower 16bit to be used

for threshold value(ALS_IHT, ALS_ILT) set up.

This interrupt can occur under the condition of several consecutive frames satisfies either higher or lower than threshold value settings. ALS_CON[3:2] (0x08) register setting can define number of consecutive frames . Options for # of frames are 2, 4, 8, 16 frames.

4.2.3. Weighted Average

<Interrupt Condition : consecutive 4 frames over threshold>

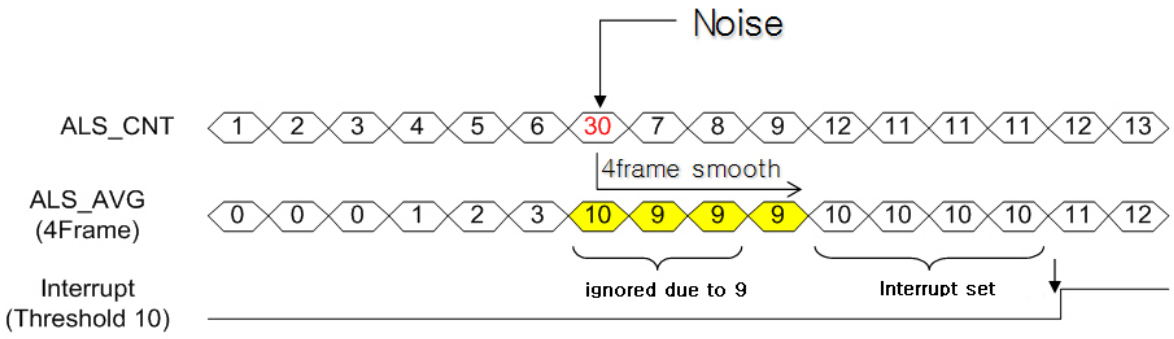


Figure 4-4 Weighted Average Mode

HM8005 supports “Weighted Average” mode to minimize the occurrence of false triggering(noise effect) on ALS value.

Weighted Average Formula: ALS_AVG(n) = weight x ALS_CNT(n) + (1-weight) x ALS_CNT(n-1), n = number of frame.

“Weight” can be set or defined by ALS_CON[1:0](0x08) register setting. 1/2, 1/4, 1/8, 1/16 are Weight options.

5. PS (Proximity Sensor)

5.1. Overview

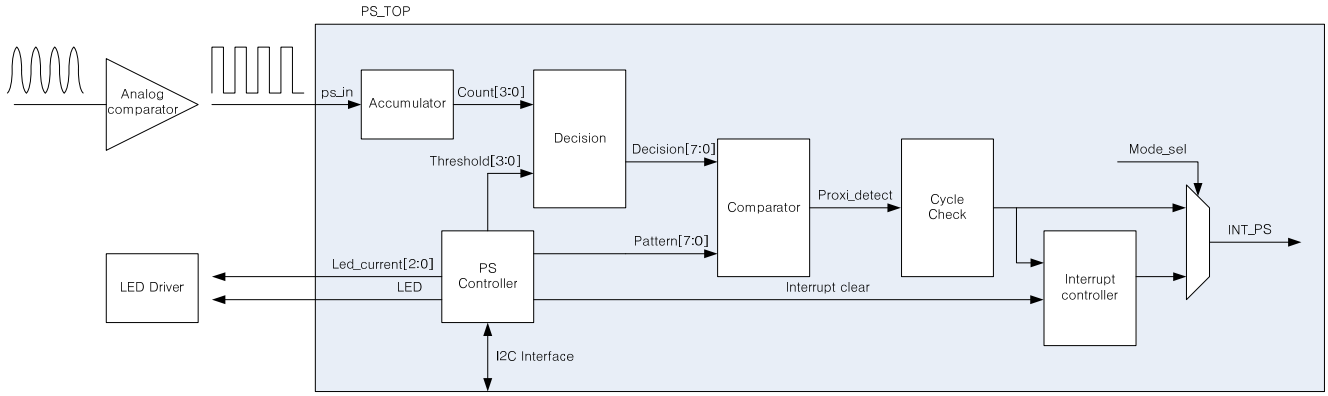


Figure 5-1 PS Block Diagram

PS(Proximity Sensor) detects object proximity distance with binary patterned InfraRed light source.

Proximity detection can be anounced in two ways (normal mode and interrupt mode).

Under normal mode, proxmity recognition signal is sent out through INT_PS pin(port).

Under interrupt mode, host system is interrupted and host system reads register bit to recognize proximity detection.

5.2. Function Description

LED IR signal has two types which are “polling” and “pattern” type.

Polling signal is generated periodically to detect proximity(distance). Once “polling” signal is detected, “pattern” signal is, afterwards, generated and checked in order to decide(differenciate) whether the polling signal is generated by noise or by real “polling” signal. When “pattern” signal is also recognized, INT_PS signal output is ‘high’ or ‘1’. If polling signal sent periodically is not recognized, pattern signal sent again. If pattern signal is also not detected, INT_PS singal output is ‘low’ or ‘0’ meaning proximity detection is released.

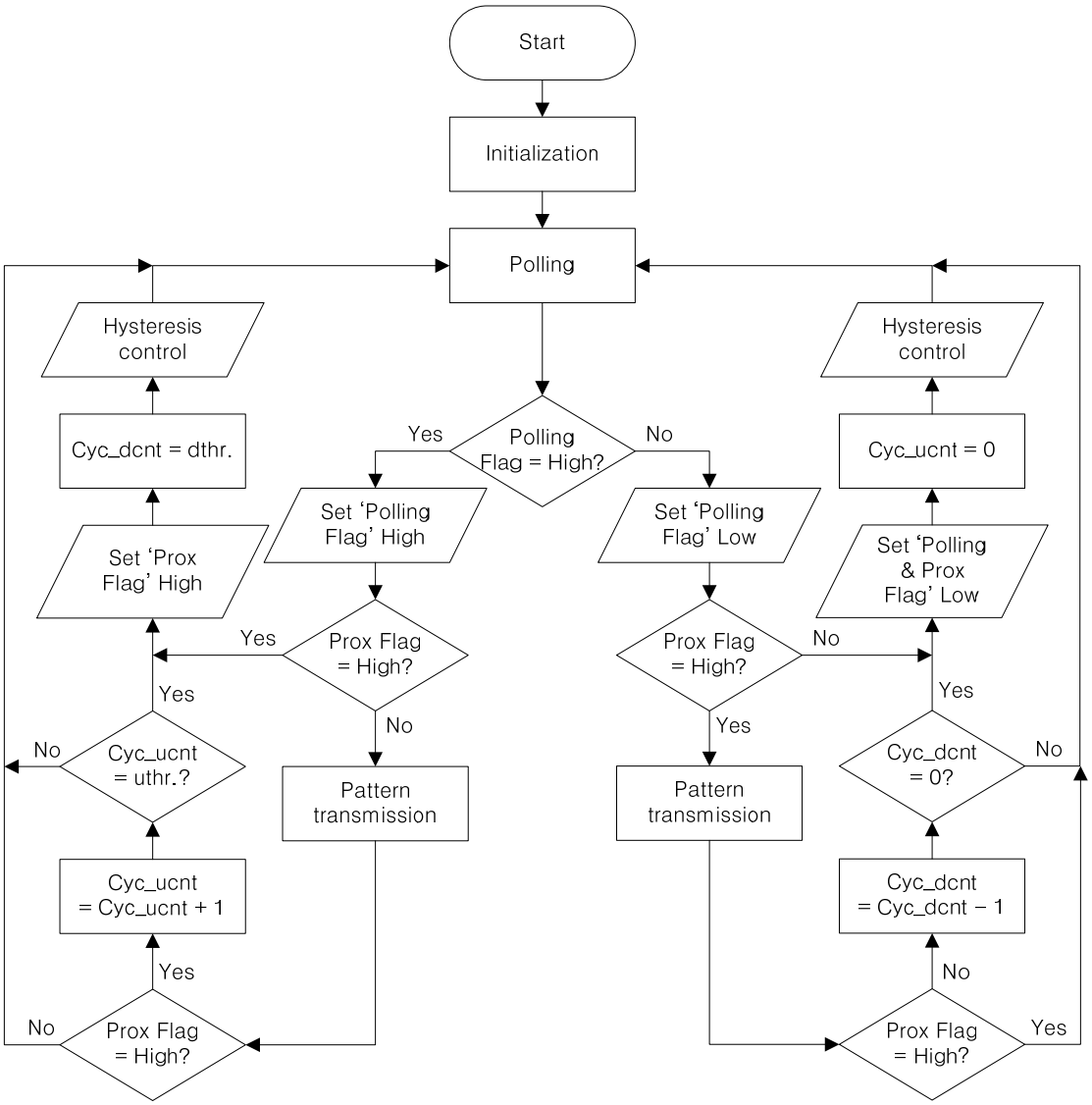


Figure 5-2 PS Flowchart

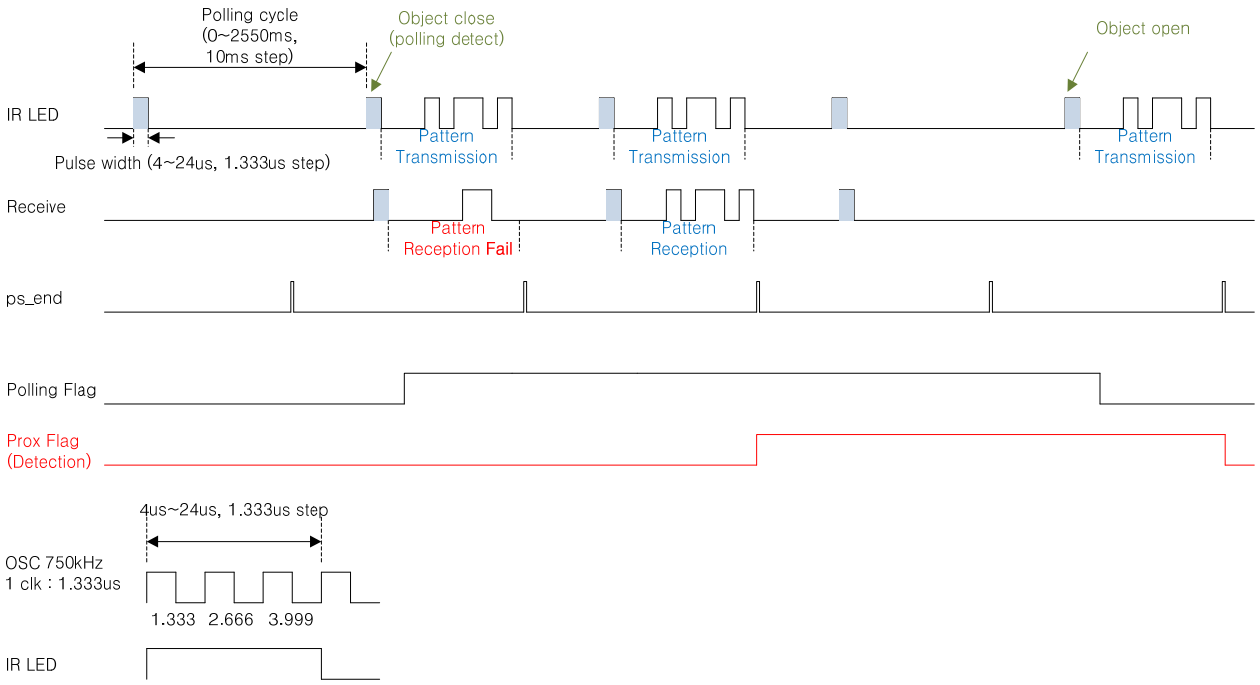


Figure 5-3 PS Operation Waveform

5.2.1. Normal mode

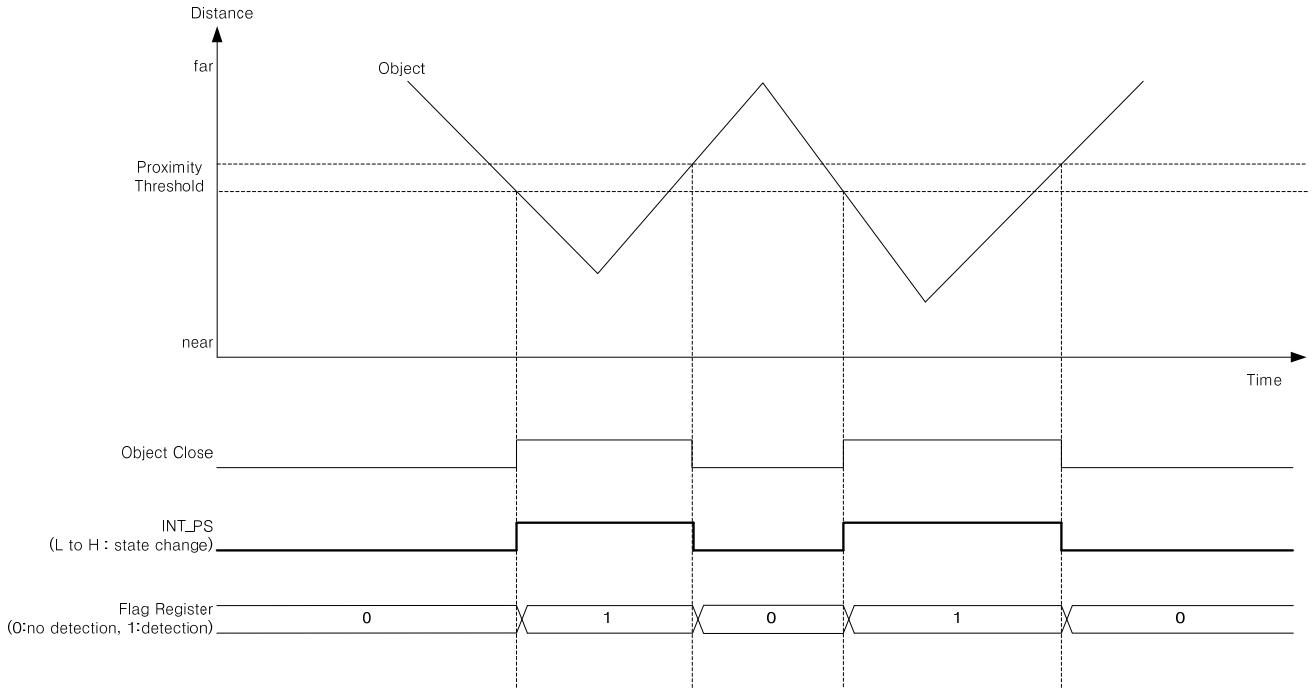


Figure 5-4 PS Normal Mode

Under normal mode, proximity recognition(detection) changes INT_PS signal into ‘high’ and write ‘1’ in internal register(flag register). When proximity detection is released, INT_PS signal is changed into ‘low’ and write internal register(flag register) into ‘0’. Internal register(flag register, PS_DET[0]) can be read through I2C from the host sytem.

5.2.2. Interrupt mode

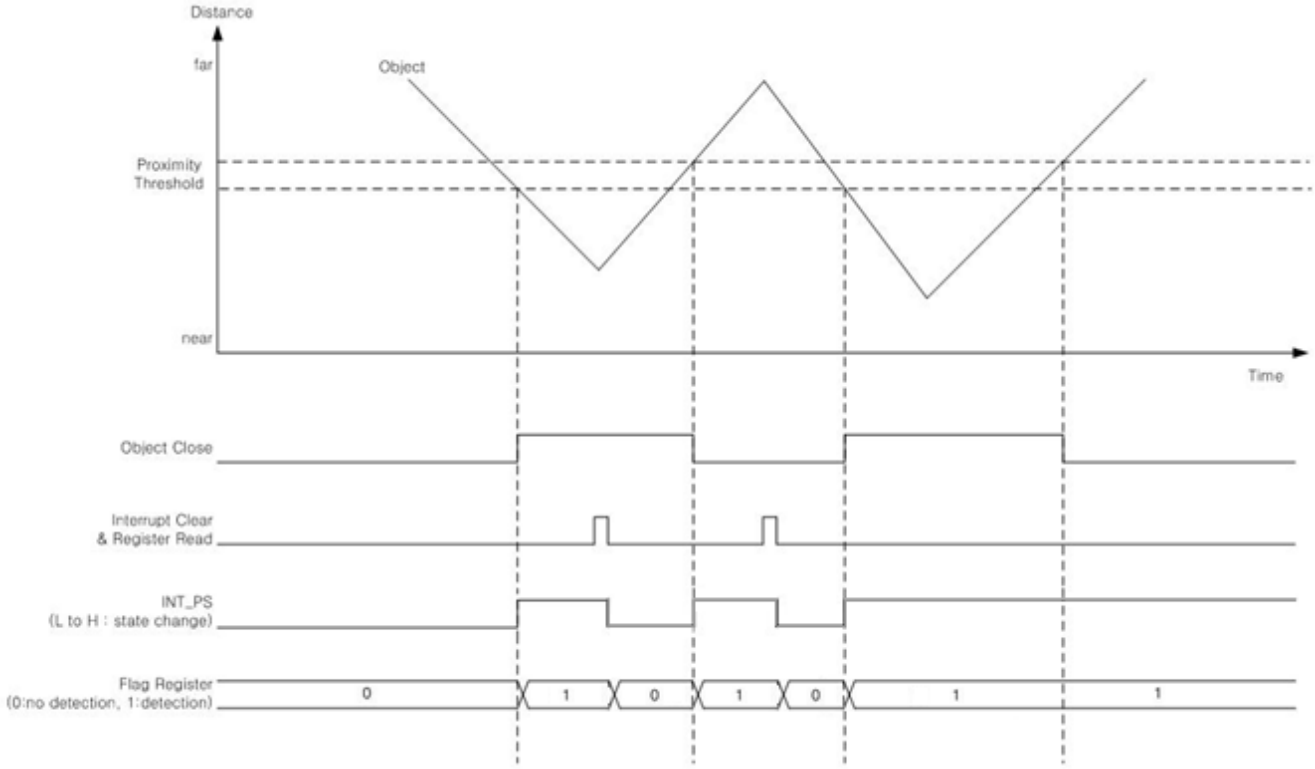


Figure 5-5 PS Interrupt Mode

Under interrupt mode, INT_PS signal changes from ‘low’ or ‘0’ into ‘high’ or ‘1’ whenever proximity is detected or released. INT_PS pin(port) is used for this “interrupt” output. Host system should read INT_FLAG[0] register bit to learn whether interrupt was for ALS or PS. Although proxmity recognition status changes(detected->released or released->detected), INT_PS signal maintains ‘high’ until ‘interrupt clear’ signal comes in. Internal register(flag register) is toggled only if INT_PS signal changes from ‘low’ into ‘high’. Interrupt clear signal is generated by reading PS_DET(0x21) register data. PS_DET[0] data tells whether event was the case of “proximity detection” or “proximity release”.

5.2.3. LED Control

IR LED transfer protocol is show in Figure 5-6. LED pulse width and current can be adjusted by user.

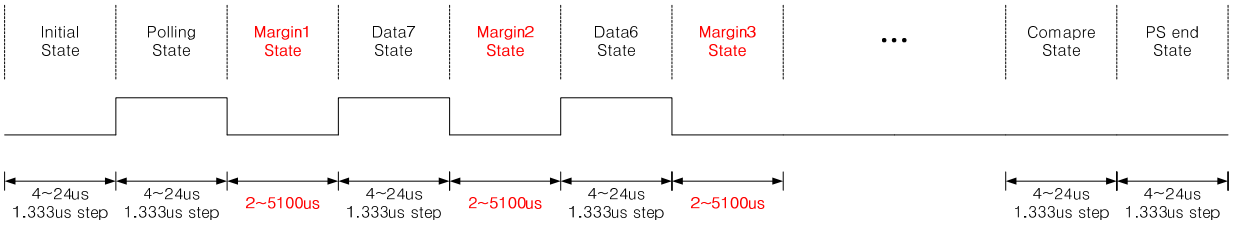


Figure 5-6 LED Protocol

Polling signal and each bit in pattern signal is transferred during the time set by “Pulse Width setting value (data)”.

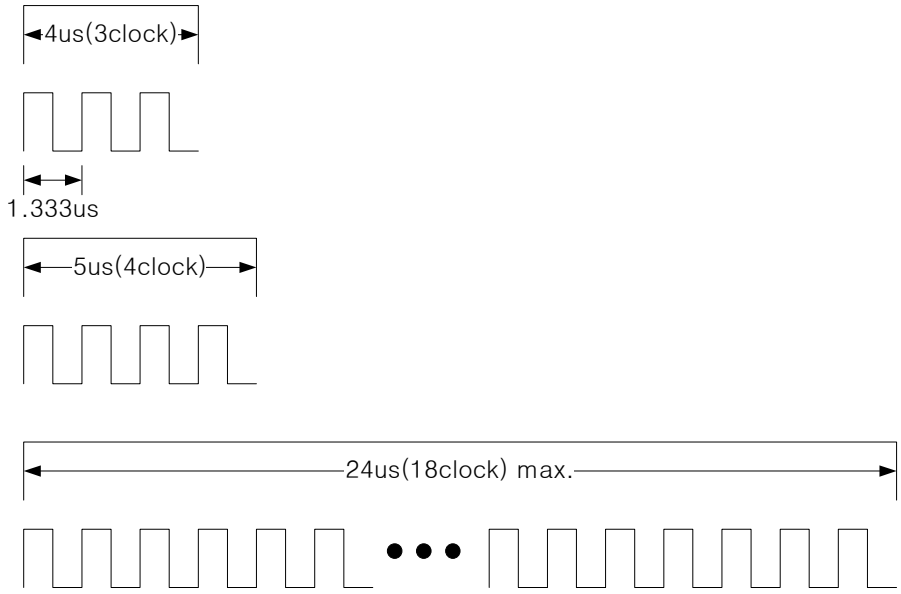


Figure 5-7 LED Pulse Width Control

Figure 5.-7 shows number of clock according to LED Pulse Width setting value (data).

LED current setting has two options which are 20mA mode and 25mA mode. Mode is selected from PS_LED_CON[7](‘h1D). Default current value is set by 100mA.

- 20mA mode has 8 steps (each step in 20mA) from 20mA up to 160mA.
- 25mA mode has 8 steps (each steps in 25mA) from 25mA up to 200mA.

5.2.4. Pattern Comparison

In the middle of LED pulse, HM8005 compares several clocks and count the results. If the counted value exceeds threshold, pattern comparison delivers success signal which is '1'.

LED pulse width can be set in between 4us ~ 24us (1.333us in each step).

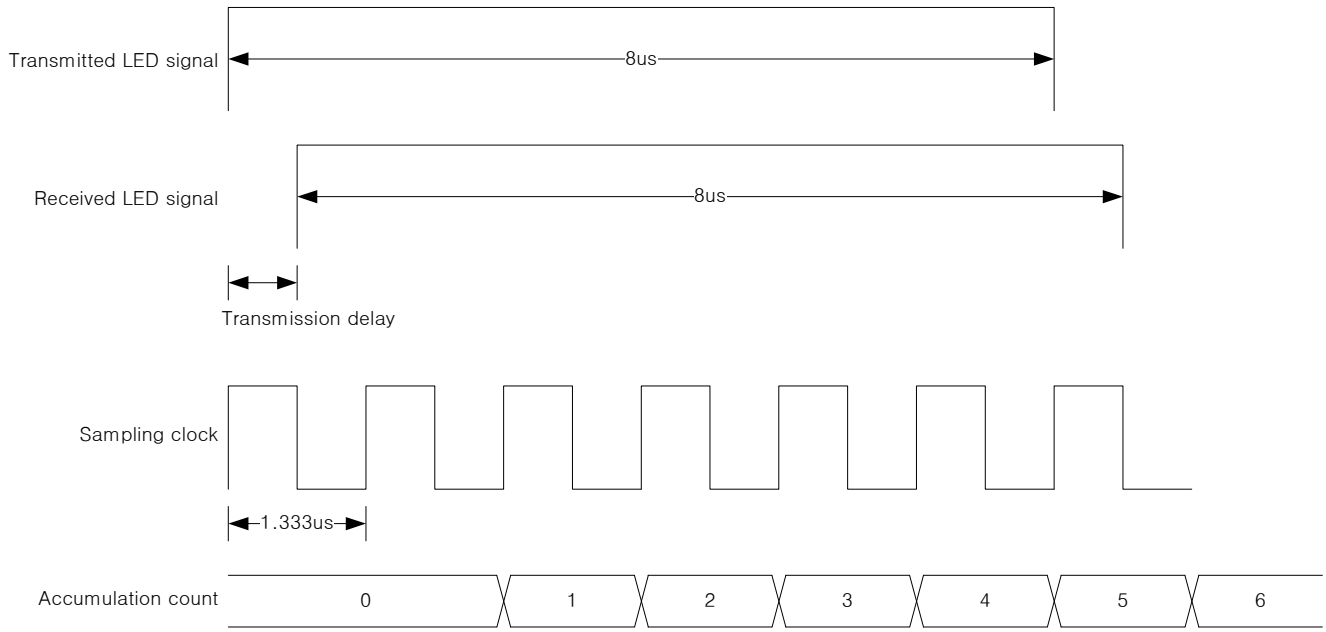


Figure 5-8 LED signal count

6. Register Description

ADDRESS (HEX)	REGISTER NAME	R/W	DEFAULT (HEX)	DESCRIPTION
SYSTEM				
0x00	DEVICE_ID	R	-	[7:4] : pixel type [3:0] : revision number
0x01	OPCON	R/W	0x00	[7] : reserved [6] : ACdS mode control(0 : ACdS disable, 1 : ACdS enable) [5] : power down control(0 : active mode, 1 : power down mode) [4] : INT_PS output control(0 : output disable, 1 : output enable) [3] : ALS interrupt mode control (0 : normal operation, 1 : interrupt operation) [2] : PS interrupt mode control (0 : normal operation, 1 : interrupt operation) [1] : ALS control(0 : disable, 1 : enable) [0] : PS control(0 : disable, 1 : enable)
0x02	INT_FLAG	R	0x00	[7:2] : reserved [1] : ALS interrupt flag [0] : PS interrupt flag
0x03	ALS_WAIT_TIME	R/W	0x05	[7:0] : ALS wait time control wait time = ALS_WAIT_TIME[7:0]*10ms
0x04	PS_WAIT_TIME	R/W	0x01	[7:0] : PS wait time control wait time = PS_WAIT_TIME[7:0]*10ms
0x05	ALS_ANA_WAKEUP_TIME	R/W	0x0E	[7:5] : reserved [4:0] : als analog wake up time control wait time = (ALS_ANA_WAKEUP_TIME[4:0]+1)*1.33us
0x06	PS_ANA_WAKEUP_TIME	R/W	0x4A	[7] : reserved [6:0] : ps analog wake up time control wait time = (PS_ANA_WAKEUP_TIME[6:0]+1)*1.33us
AMBIENT LIGHT SENSOR				
0x08	ALS_CON	R/W	0x45	[7] : Interrupt source Selection 0: ALS Counter LSB 16bit 1: ALS Counter MSB 16bit [6] : Interrupt Hold Enable [5] : Interrupt Multi Frame Enable [4] : Weighted Average enable [3:2] : Interrupt Frame Selection 00 : 2 Frames 01 : 4 Frames 10 : 8 Frames 11 : 16 Frames [1:0] : Weighted Average Selection 00 : 1/2 01 : 1/4 10 : 1/8 11 : 1/16

0x09	ALS_STATUS	R/O	0x01	[7] : Interrupt Flag bit [6] : ALS Counter Overflow Flag bit [5:2] : reserved [0:1] : Present Luminance Position 00 : Lower than Interrupt Low Threshold 01 : Upper than Interrupt Low Threshold and Lower than Interrupt High Threshold 10 : Upper than Interrupt High Threshold 11 : X
0x0A	ALS_CNT_H	R/W	0x00	[7:4] : reserved [3:0] : High Byte of ALS Counter
0x0B	ALS_CNT_M	R/W	0x00	[7:0] : Middle Byte of ALS Counter
0x0C	ALS_CNT_L	R/W	0x00	[7:0] : Low Byte of ALS Counter
0x0D	ALS_IHTH	R/W	0xFF	[7:0] : High Byte of Interrupt High Threshold
0x0E	ALS_IHTL	R/W	0xFF	[7:0] : Low Byte of Interrupt High Threshold
0x0F	ALS_ILTH	R/W	0x00	[7:0] : High Byte of Interrupt Low Threshold
0x10	ALS_ILTL	R/W	0x00	[7:0] : Low Byte of Interrupt Low Threshold
0x11	ALS_INTG	R/W	0x64	[7:0] : Integration Time Set (Default 665ms) Int. Time = ALS_INTG[7:0]*({ALS_STEPH[7:0],ALS_STEPL[7:0]}+1)
0x12	ALS_STEPH	R/W	0x13	[7:0] : High Byte of Integration Time Step(1.33us)
0x13	ALS_STEPL	R/W	0x87	[7:0] : Low Byte of Integration Time Step(1.33us)
PROXIMITY SENSOR				
0x19	PS_CON	R/W	0x04	[7:6] : Reserved [5] : LED always on 0 : LED normal operation 1 : LED always 'high' [4] : Reserved [3] : INT_PS out inverting 0 : Inverting disable 1 : Inverting enable [2] : Polling bit 'high' or 'low' selection 0 : Polling bit 'low' 1 : Polling bit 'high' [1:0] : Reserved
0x1A	PS_BIT_CHECK	R/W	0x11	[7:4] : Bit check count for object detection [3:0] : Bit check count for object release
0x1B	PS_CNT_STEP	R/W	0x02	[7:4] : Reserved [3:0] : Margin counter step (4'b0010~4'b1111)
0x1C	PS_MTIME	R/W	0x08	[7:0] : Margin time (1 step = margin counter step * 1.333us)
0x1D	PS_CYC_THR	R/W	0x11	[7:4] : Cycle threshold count for object detection [3:0] : Cycle threshold count for object release
0x1E	PS_LED_DET	R/W	0x33	[7] : PS LED current range selection for object detection 0 : 25mA~200mA range (25mA step) 1 : 20mA~160mA range (20mA step) [6:4] : PS LED current for object detection(5~40mA , 5mA step or 25~200mA, 25mA step)

				000 : 20mA or 25mA 001 : 40mA or 50mA 010 : 60mA or 75mA 011 : 80mA or 100mA 100 : 100mA or 125mA 101 : 120mA or 150mA 110 : 140mA or 175mA 111 : 160mA or 200mA [3:0] : PS LED pulse width for object detection(4~24us, 1.333us step) 0000 : 3.999us 0001 : 5.332us 0010 : 6.665us 0011 : 7.998us 0100 : 9.331us 0101 : 10.664us 0110 : 11.997us 0111 : 13.330us 1000 : 14.663us 1001 : 15.996us 1010 : 17.329us 1011 : 18.662us 1100 : 19.995us 1101 : 21.328us 1110 : 22.661us 1111 : 23.994us
0x1F	PS_LED_REL	R/W	0x43	[7] : PS LED current range selection for object release 0 : 25mA~200mA range (25mA step) 1 : 20mA~160mA range (20mA step) [6:4] : PS LED current for object release(5~40mA , 5mA step or 25~200mA, 25mA step) 000 : 20mA or 25mA 001 : 40mA or 50mA 010 : 60mA or 75mA 011 : 80mA or 100mA 100 : 100mA or 125mA 101 : 120mA or 150mA 110 : 140mA or 175mA 111 : 160mA or 200mA [3:0] : PS LED pulse width for object release(4~24us, 1.333us step) 0000 : 3.999us 0001 : 5.332us 0010 : 6.665us 0011 : 7.998us 0100 : 9.331us 0101 : 10.664us 0110 : 11.997us 0111 : 13.330us 1000 : 14.663us 1001 : 15.996us 1010 : 17.329us 1011 : 18.662us 1100 : 19.995us 1101 : 21.328us 1110 : 22.661us 1111 : 23.994us

0x20	PS_LED_PAT	R/W	0xC1	[7:0] : PS LED pattern data
0x21	PS_DET	R	0x00	[7:1] : Reserved [0] : PS Detection data
0x22	PS_ANA_CON1	R/W	0x33	[7:4] : PS Analog comparator hysteresis for object detection 0000 : 12mV or 57mV 0001 : 15mV or 59mV 0010 : 18mV or 61mV 0011 : 21mV or 63mV 0100 : 24mV or 64mV 0101 : 27mV or 66mV 0110 : 30mV or 67mV 0111 : 33mV or 69mV 1000 : 36mV or 71mV 1001 : 39mV or 73mV 1010 : 42mV or 75mV 1011 : 45mV or 77mV 1100 : 48mV or 79mV 1101 : 51mV or 81mV 1110 : 54mV or 83mV [3:0] : PS Analog comparator hysteresis for object release 0000 : 12mV or 57mV 0001 : 15mV or 59mV 0010 : 18mV or 61mV 0011 : 21mV or 63mV 0100 : 24mV or 64mV 0101 : 27mV or 66mV 0110 : 30mV or 67mV 0111 : 33mV or 69mV 1000 : 36mV or 71mV 1001 : 39mV or 73mV 1010 : 42mV or 75mV 1011 : 45mV or 77mV 1100 : 48mV or 79mV 1101 : 51mV or 81mV 1110 : 54mV or 83mV

7. Electrical & Optical Characteristics

Symbol	Parameter	Rating		Unit
		MIN	MAX	
LED A	Supply Voltage	-0.3	4.6	V
VDD	Supply Voltage	-0.3	4	V
T_{str}	Storage Temperature	-40 to 125		℃

Table 7-1 Absolute Maximum Ratings

Symbol	Parameter	Rating			Unit
		MIN	TYP	MAX	
LED A	LED Supply Voltage	2.6	3.0	4.4	V
VDD	Supply Voltage	2.6	3.0	3.6	V
VDDIO	I/O (I2C) Voltage	1.62	3.0	3.6	V
T_{opr}	Operating Temperature	-30		85	℃

Table 7-2 Recommended Operating Condition

Symbol	Parameter	Condition	MIN	TYP	MAX	Unit
IDDps	PS Active Current (detected, 1,000 Lx)	VDD = 2.8V LED = 100mA PS active time = 320us PS wait time = 10ms	-	450	-	uA
IDDals	ALS Active Current (1,000 Lx)	VDD = 2.8V ALS integration time = 30ms	-	570	-	uA
IDDS	Sleep Current	VDD = 2.8V	-	320	-	uA
IDDP	Power Down Current	VDD = 2.8V	-	1	-	uA

Table 7-3 Power Consumption

Symbol	Parameter	VDD = 3.0V±10%, gray 90%			Unit
		MIN	TYP	MAX	
DC Characteristics					
VIL	Input low voltage level	-	-	0.35*VDD	V
VIH	Input high voltage level	0.58*VDD	-	-	
IIH	Input leakage high level	-5		5	uA
IIL	Input leakage low level	-5		5	
VOL				0.4	V
VOH		VDD-0.4			
IOZ		-5		5	uA
Optical Characteristics					
DR	ALS dynamic range	0.1	-	100,000	lux
λ_p	ALS peak sensitivity wavelength		550		nm
D_{on}	PS maximum detection distance	-	-	[T.B.D]	Cm
D_{off}	PS minimum no detection distance	[T.B.D]	-	-	cm
ILED	LED current	5		200	mA
λ_{led}	LED peak wavelength		850		nm

Table 7-4 DC & Optical Characteristics

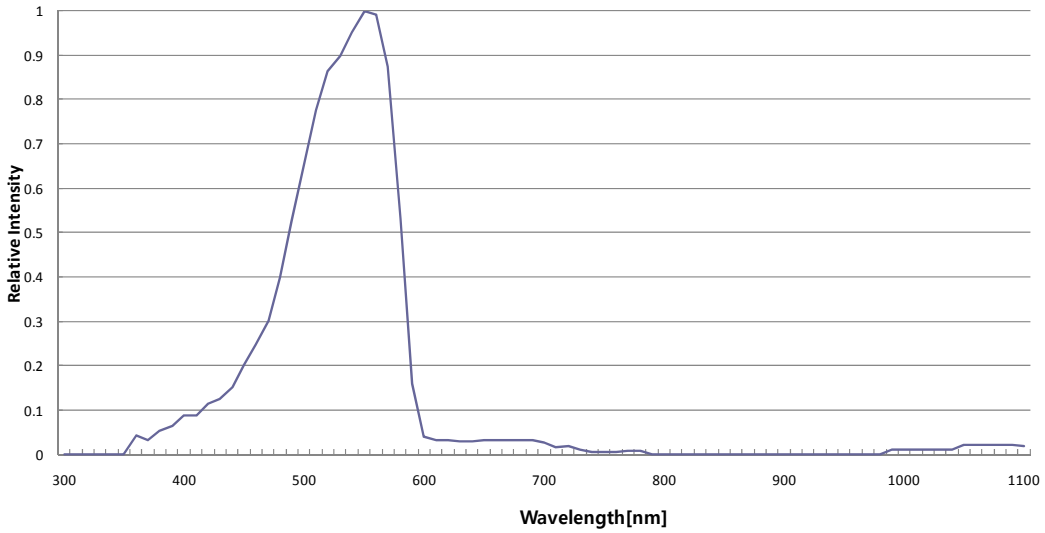


Figure 7-1 ALS spectral response

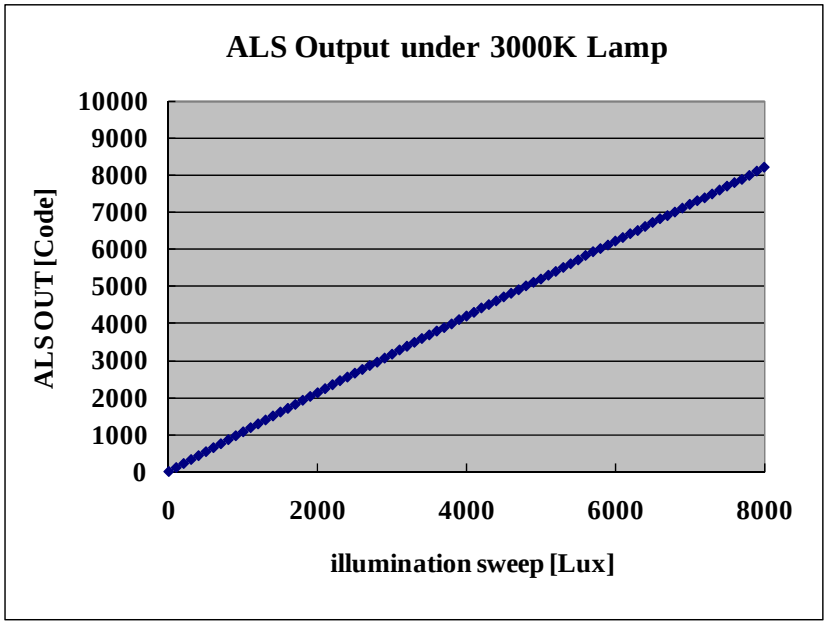
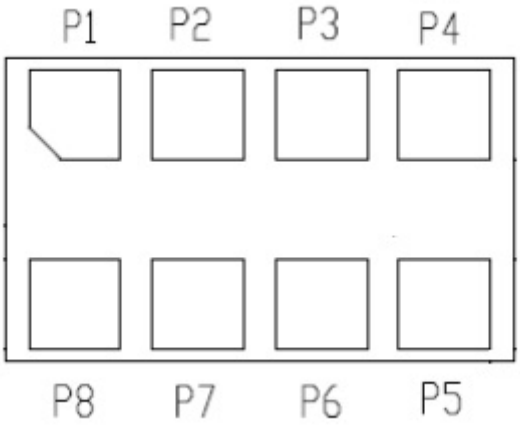


Figure 7-2 ALS linearity response

8. Pin Information



Pin location at top view

Pin	Pin Name
P1	SDA
P2	INT
P3	LDR
P4	LED K
P5	LED A
P6	GND
P7	SCL
P8	VDD

Pin description

Figure 8-1 Pin Map

9. Typical Circuit Configuration

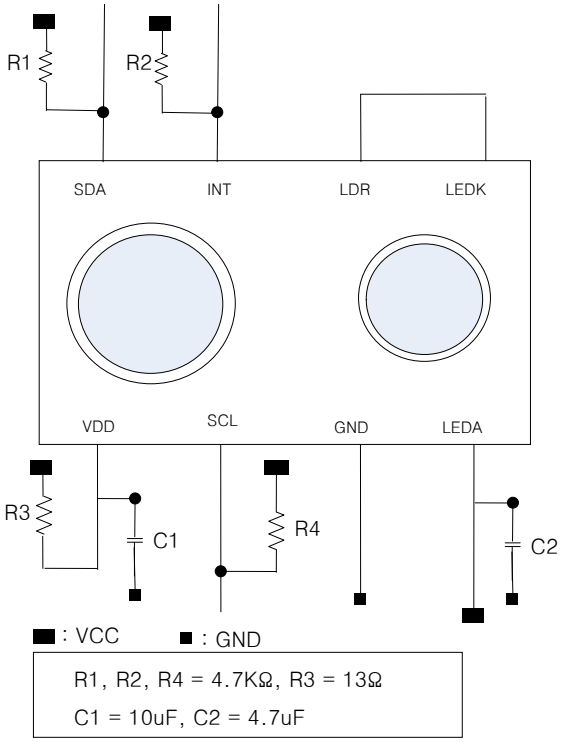
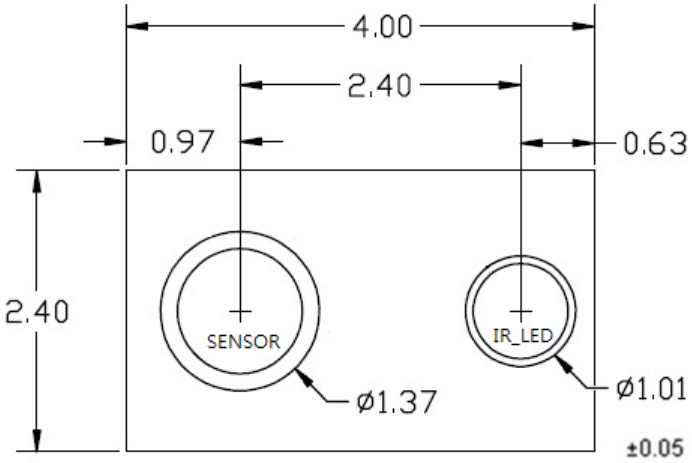


Figure 9-1 Typical Circuit Configuration

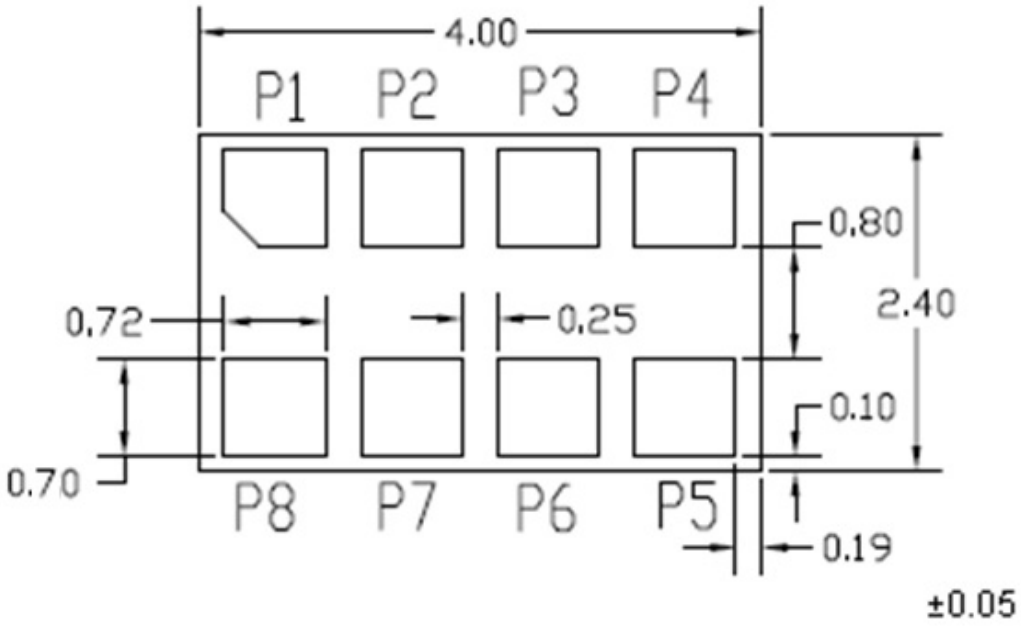
❖ Note

- Sequence of PCB Power Pattern : VDD –> LED_A

10. PKG Dimension



Top view



Pin location at top view

Vertical view

Figure 10-1 Package Dimension

*PCB layout guidance

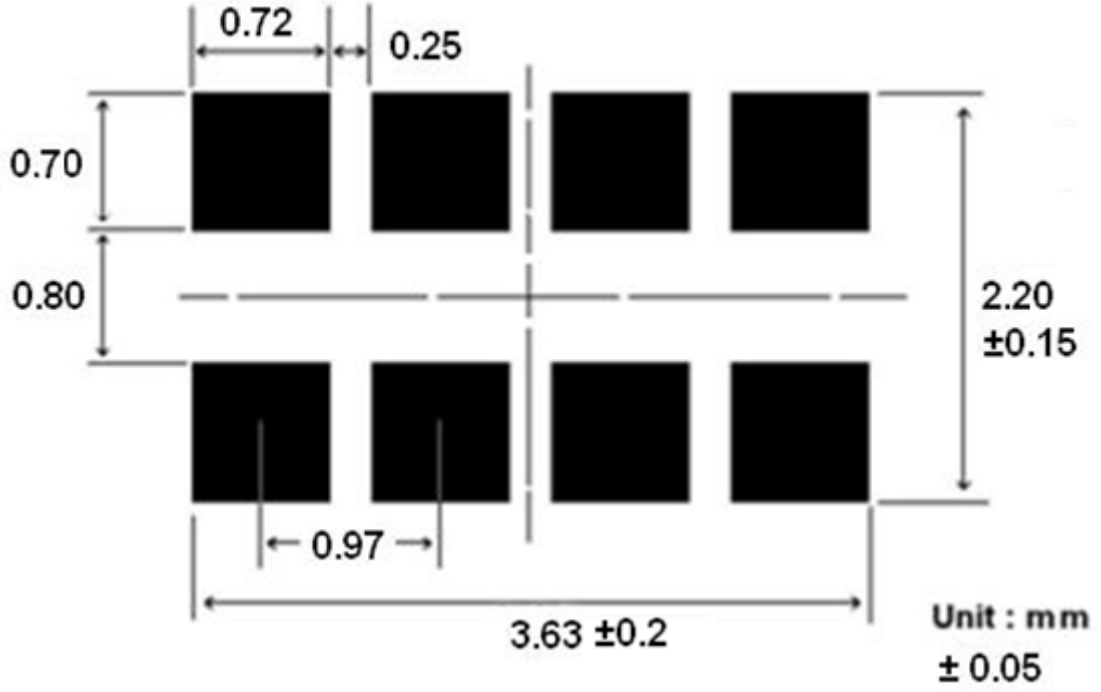


Figure 10-2 PCB layout guide

11. Management and Reflow conditions

11.1.1. Storage Environment

◦ Temperature & ◦ Humidity conditions : **30 ℃↓, 60 %.R.H ↓**

11.1.2. Bake conditions

◦ **Must be a bake before Reflow(SMT).** Because the package characteristics.
It is independent of the opening times (open the packing).

◦**Bake of Reel**

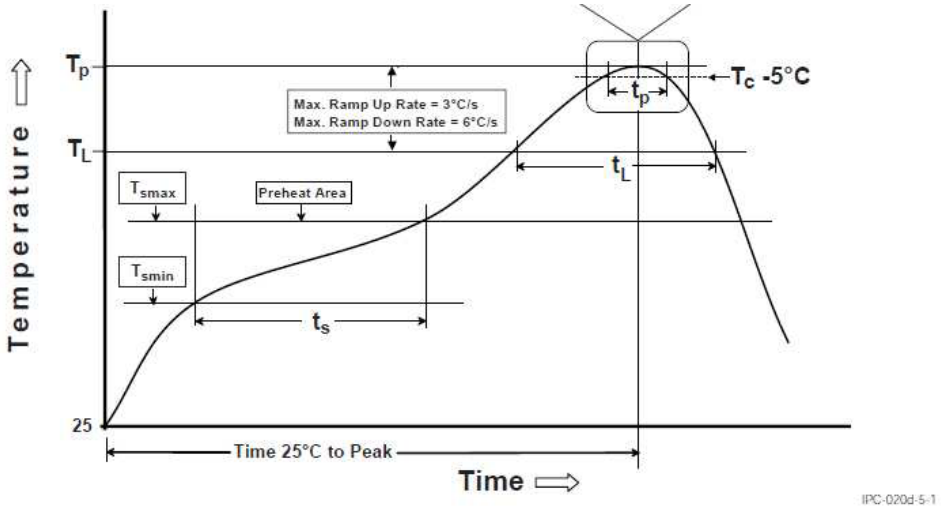
Temperature conditions : 24 H, 80℃

◦ Bake of Bulk

Temperature conditions : 16H, 125℃

11.1.3. Reflow profile

◦ JEDEC standard. (IPC/JEDEC J-STD-020D.1)



Profile Feature	Pb-Free Assembly
Temperature Min (T_{smin}) Temperature Max (T_{smax}) Time (t_s) from (T_{smin} to T_{smax})	150 ℃ 200 ℃ 60-120 seconds
Ramp-up rate (T_L to T_P)	3 ℃ / second max
Liquidous temperature (T_L) Time (t_L) maintained above T_L	217 ℃ 60-150 seconds
Peak Package body temperature (T_P)	260 ℃
Time (t_P) within 5 ℃ of the specified classification temperature (T_c)	30 seconds
Ramp-down rate (T_P to T_L)	6 ℃ / second max.
Time 25 ℃ to peak temperature	8 minutes max.

Figure 11-1 Reflow profile