

EM30718 Datasheet

I²C Interface Digital Proximity and Ambient Light Sensor

Version 1.0

2014-07-08

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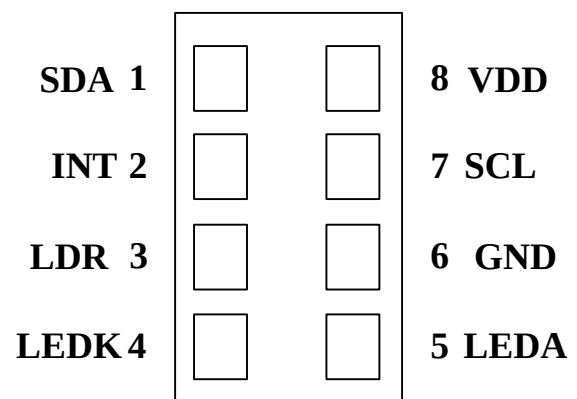
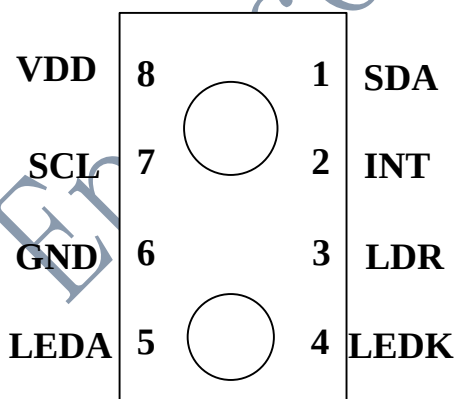
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Description

EM30718 is an I²C interface sensor includes Ambient Light Sensor (ALS), Proximity Sensor (PS), and built-in LED driver. It is designed especially for smart phones and tablets with capacitive touch panel. With its ultra-low-power design, it is also useful for proximity wake-up application.

Features

- Proximity Sensor, Ambient Light Sensor, LED driver and IR LED integrated in a single Optical Module
- Wide Spectrum Response of Ambient Light Sensor (ALS)
- 50Hz/60Hz Flicker Noise Rejection
- Temperature Compensation
- Higher Sensitivity of Proximity Sensing with better SNR design
- Programmable Interrupt for PS and ALS
- Proximity Sensor (PS) Ambient Light Rejection'
- Built-In LED constant current driver high voltage tolerance up to 5.5V
- PS offset adjust for crosstalk calibration
- Enhanced PS dark surface detect flexibility
- Programmable LED driver current
- Average Current (Operation Current 95μA in low-power mode, Sleep Mode Current 0.5μA)
- Output Type: I²C Bus (ALS/PS) up to 400K Hz
- Operation Voltage 2.5V ~ 3.6V
- Logic Interface Voltage VBUS = 1.8V or VBUS = VDD
- Minimum External Components
- Package: ((3.95mmX2.35mmX1.35mm))
- RoHS package



Functional Block Diagram

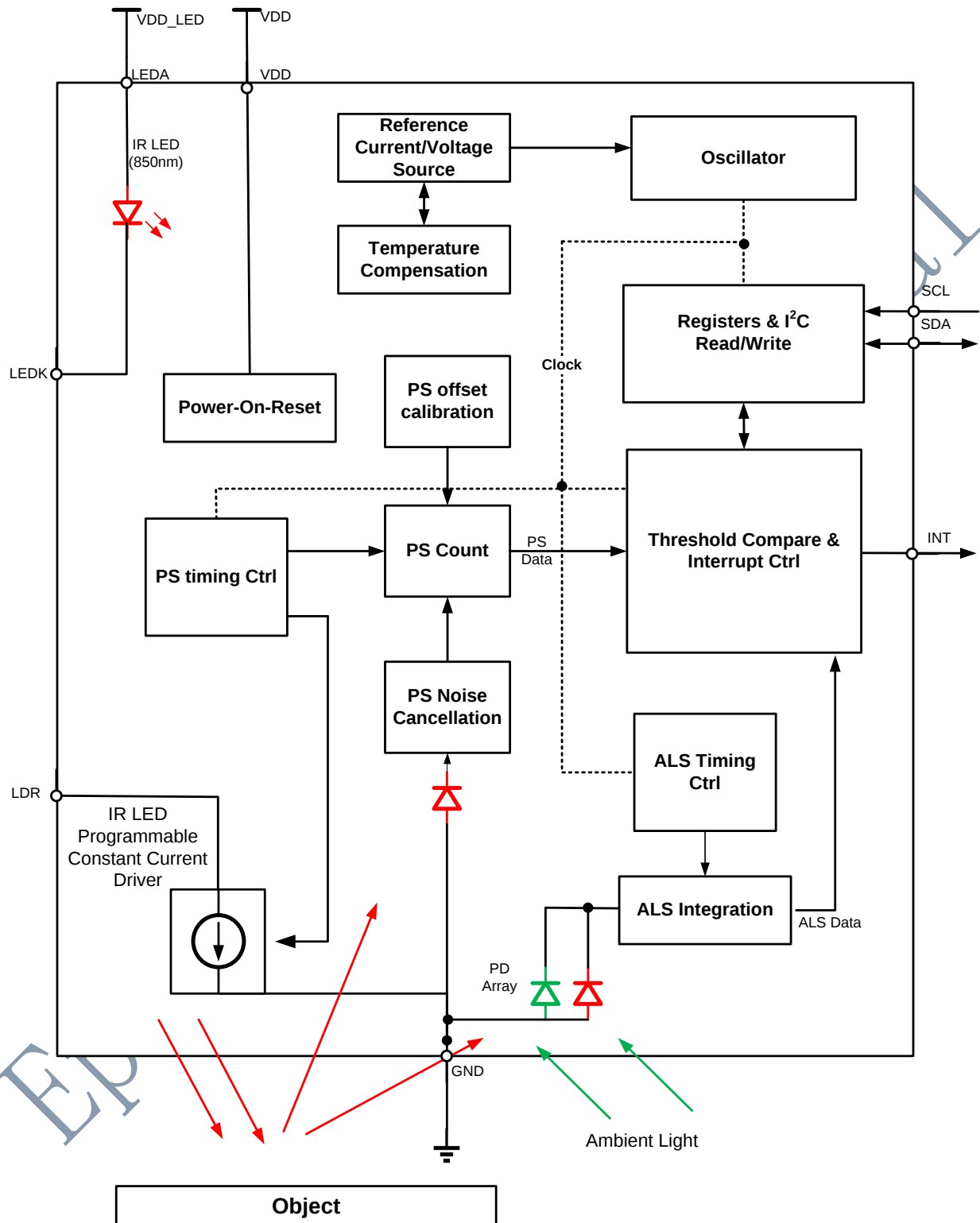


Fig. 1 EM30718 Functional Block Diagram

PIN Configuration

Table. 1 Pin Configuration

Pin No.	Pin Name	Type	Description
1	SDA	I/O(Open Drain)	I ² C Serial data I/O terminal -serial data I/O for I ² C
2	INT	O(Open Drain)	Interrupt.
3	LDR	O(Open Drain)	LED driver for proximity emitter
4	LEDK	O	LED Cathode, connect to LDR pin in most systems to use internal LED driver circuit
5	LEDA	I	LED Anode, connect to VDD or VDD_LED on PCB
6	GND		Power supply ground. All voltages are referenced to GND
7	SCL	I(Open Drain)	I ² C serial clock input terminal — clock signal for I ² C serial data.
8	VDD		Power Supply voltage

Parameters

Table. 2 I²C bus timing characteristics

Symbol	Parameters	Minimum	Typical	Maximum	Units	Condition
f _{clk}	SCL clock frequency	10k		100k	Hz	Normal Mode
		10k		400k	Hz	Fast Mode
t _{SUDAT}	data set up time	250			ns	Normal Mode
		100			ns	Fast Mode
t _{HDDAT}	data hold time			300	ns	Normal Mode
				90	ns	Fast Mode
t _{rise}	clock/data rise time			1000	ns	Normal Mode
				300	ns	Fast Mode
t _{fall}	clock/data fall time			300	ns	Normal Mode
				300	ns	Fast Mode
t _{LOW}	I ² C clock (SCL) low cycle	4.7			μs	Normal Mode
		1.3			μs	Fast Mode
t _{HIGH}	I ² C clock (SCL) high cycle	4.0			μs	Normal Mode
		0.6			μs	Fast Mode
t _{BUF}	Bus free time between the start and stop state	4.7			μs	Normal Mode
		1.3			μs	Fast Mode

t _{HDSTA}	(repeat) started state holding time after this period produce the first clock	4.0			μs	Normal Mode
		0.6			μs	Fast Mode
t _{SUSTA}	Repeat the start state set up time	4.7			μs	Normal Mode
		0.6			μs	Fast Mode
t _{SUSTO}	Stop state set up time	4.0			μs	Normal Mode
		0.6			μs	Fast Mode
t _{TIMEOUT}	Low detection clock/data timeout time	25	35		ms	Normal Mode
					ms	Fast Mode
C _{load}	The capacitive load for each bus line			400	pF	
R _{BUS}	Pull up resistors SDA and SCL system bus	1		-	KΩ	
t _{VD}	Data valid time			0.9	μs	
t _{VDACK}	Data valid acknowledge time			0.9	μs	

Table. 3 Electrical Characteristics

Symbol	Min	Typ	Max	Units	Introductions
V _{DD}	2.6		3.6	V	Supply voltage
I _{DD}		95	150	μA	DC power supply current (with LED turned off)
V _{pull_up}	1.6		3.6	V	I ² C power supply voltage
I _{DD_SD}		500		nA	Shut Down Current
T _A	-40		85	°C	Recommended operating temperature
V _{IL}			0.54	V	SCL/SDA Input low voltage
V _{IH}	1.25			V	SCL/SDA Input high voltage

Table. 4 Optical Characteristics

Parameters	Min	Typ	Max	Units	Descriptions (T _a = +25 °C)
Full scale ALS count value			4095	count s	ALS register maximum count
ALS detect range			2000	lux	ALS detection range
Full scale PS ADC count value			1023	count s	PS ADC maximum count

Full scale PS count value			255	count s	PS registers the maximum count
PS LED drive	15		200	mA	PS LED drive current
LED duty cycle		1:500			LED duty cycle, cycle of PS 100 ms
V _F		1.45	1.60	V	LED Forward Voltage, I _F =20 mA
V _R	5			V	LED Reverse Voltage, I _R =10 μ A
P _O	3.0			mW	LED Radiant Power, I _F =20 mA
λ_p		850		nm	LED Peak Wavelength, I _F =20 mA
$\Delta\lambda$		50		nm	Spectrum Width of Half Value, I _F =20 mA
T _R		25		ns	LED Optical Rise Time, I _F =20 mA
T _F		13		ns	LED Optical Fall Time, I _F =20 mA

PS Spectral Response Range

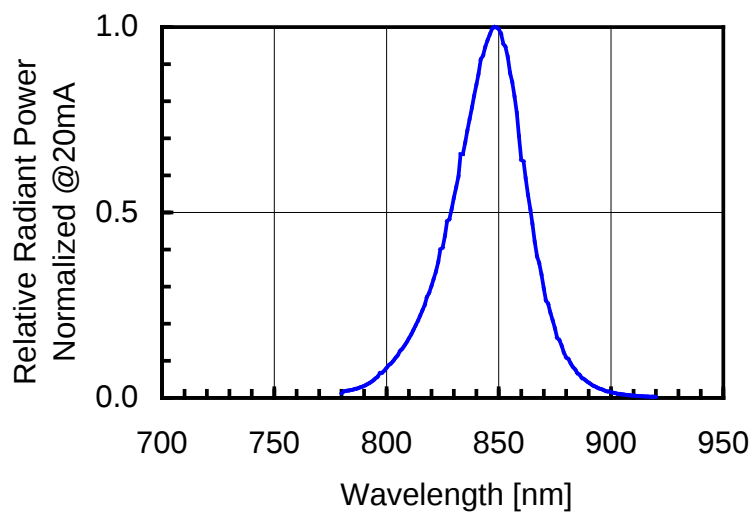


Fig. 2 PS Spectral Response Range

Table. 5 Absolute Maximum Ratings

Parameters	Symbol	Min.	Max.	Units	Condition
Storage Temperature	T _S	-40	85	°C	
Operation Temperature	T _A	-40	85	°C	
Supply Voltage	V _{DD}	-0.5	3.6	V	
LED Voltage	V _{DD_LED}		5.5	V	
ESD	V _{ESD}	2K		V	HBM

I²C State Machine

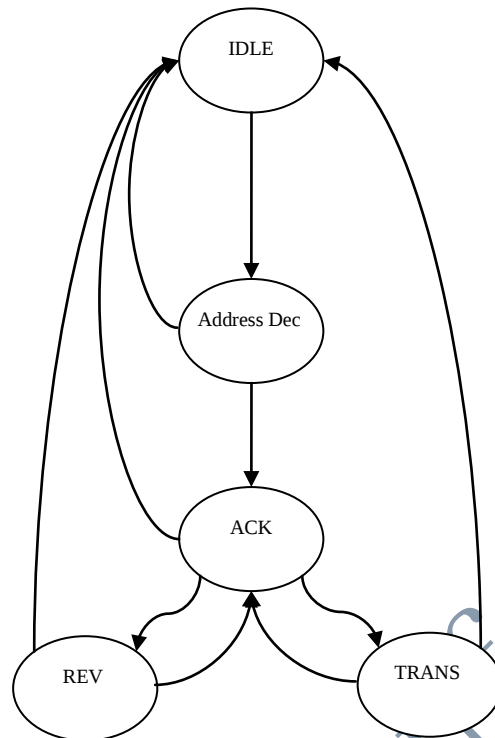


Fig. 3 Slave State Machine

Timing

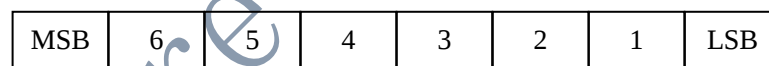


Fig. 4 Data Structure

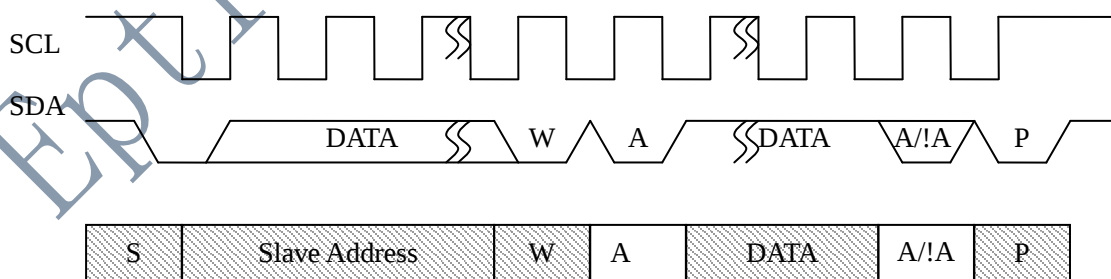


Fig. 5 Write waveform

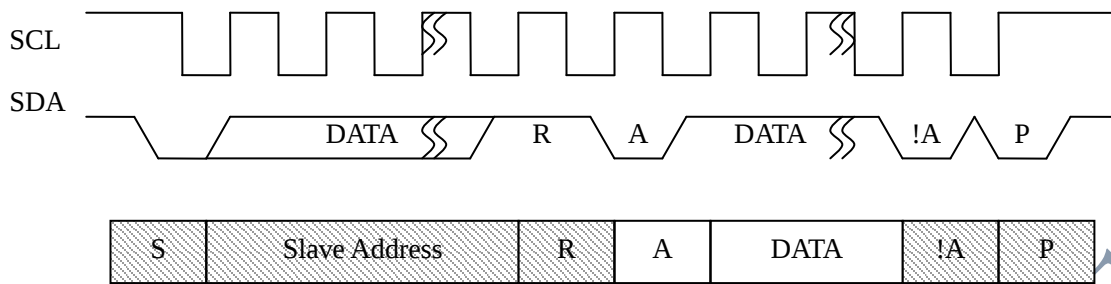


Fig. 6 Read waveform

Registers Operation



Fig. 7 Register random write operation

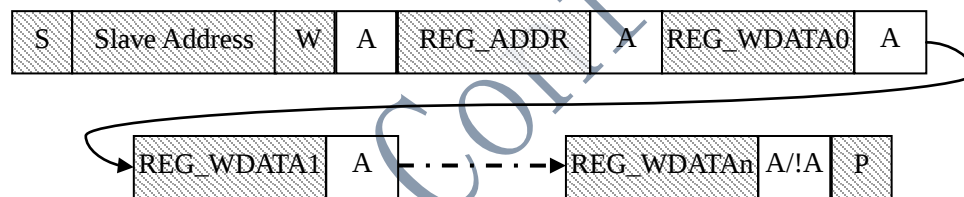


Fig. 8 Register page write operation

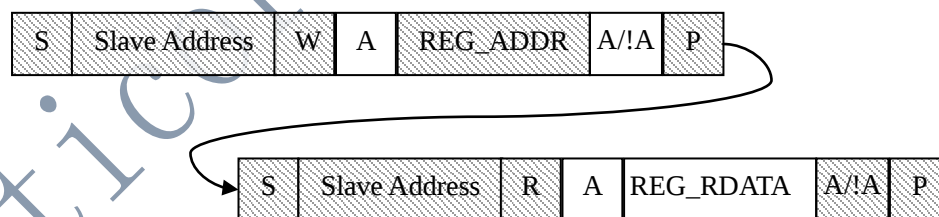


Fig. 9 Register random read operation

Function Description

EM30718 ALS and PS can work at the same time. ALS detects ambient light in every 100ms, and the detection value is the average of the ambient light during the period of 100 ms; PS can be set one detection in every 100 ms or 800 ms, and its LED driver current is programmable in order to meet requirements of different applications.

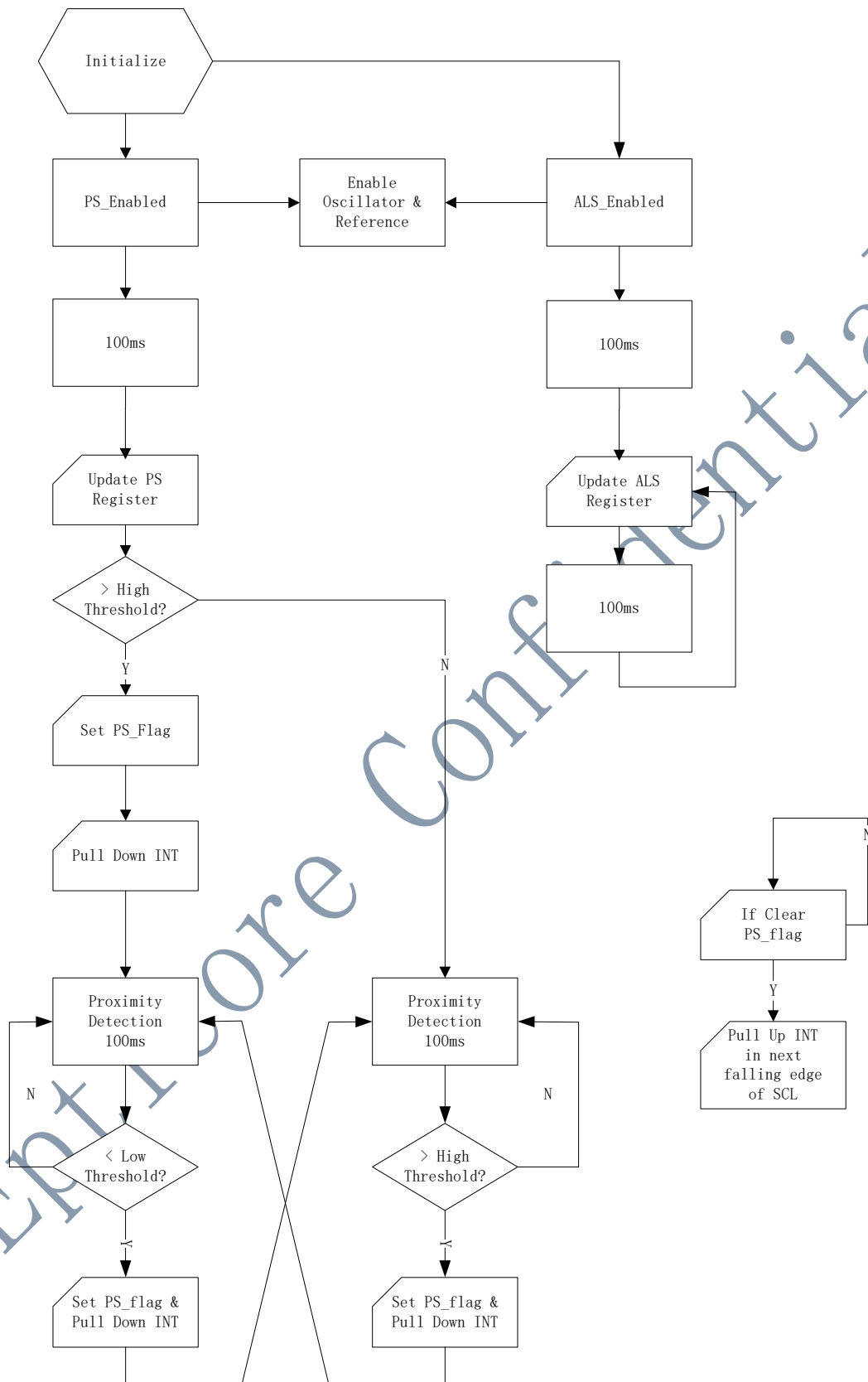


Fig. 10 Sensor Operation State Machine

When both the ALS and PS are enabled, it is recommended that the software is operating in ALS Polling (Polling)/PS Interrupt (Interrupt) mode, ie. ALS register is read in every 200 ms, and main controller will adjust the backlight pulse width according to the count of ALS.

After the PS upper and lower threshold initialization is completed, PS count move from lower than low threshold to higher than high threshold, or move from higher than high threshold to lower than low threshold will trigger and Interrupt. The INT interrupt signals for PS will then call a procedure to turn off CTP or turn on CTP etc. In order to prevent glitch detection caused by PS jitter, the high threshold should be set higher than low threshold by 10 count at least;

Once the interrupt is triggered, the INT pin will be drive to low. It will remain to be "0" level until register 0x02 is cleared to "0x00" with a falling edge of SCLK. In this interrupt mode, threshold values do not need to change in the procedure of Interrupt, and reduces the software's effort.

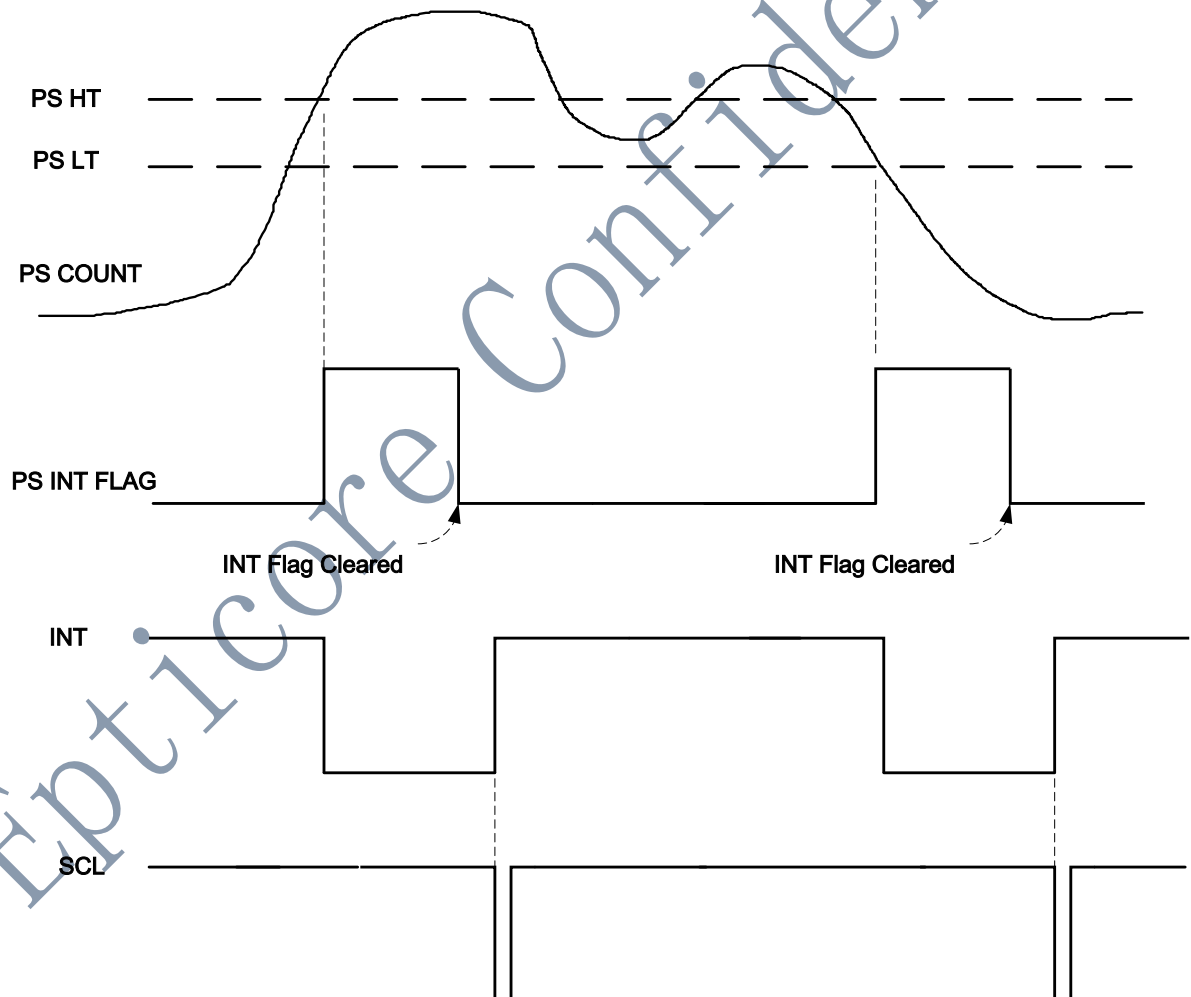


Fig. 11 Transient Interrupt Mode Operation

Software Initialization Description

EM30718 software on initialization process is recommended as follows:

```
WriteRegData(1, 0); //Disable and Power down
WriteRegData(2, 0); //Clear all Interrupt Flag
WriteRegData(0x0e, 0); //Initialize Reset Register
```

```
uint8 PSLT, PSHT;
PSLT = 0x40; //64 – PS Low Threshold Value
PSHT = 0x48; //72 – PS High Threshold Value
WriteRegData (3, PSLT);
WriteRegData (4, PSHT);
WriteRegData(0xf, 0x00); //Initialize PS offset
//Disable ALS Interrupt
WriteRegData (5, 0x00);
WriteRegData (6, 0xf0);
WriteRegData (7, 0xff);
```

```
if(val == 0x03) //Enable both PS & ALS {
    int PSLT=0x40;
    int PSHT=0x48;

    i2c_smbus_write_byte_data(this_client, 0x02, 0);
    i2c_smbus_write_byte_data(this_client, 0x03, PSLT);
    i2c_smbus_write_byte_data(this_client, 0x04, PSHT);
    i2c_smbus_write_byte_data(this_client, 0x0F, 0x00);
    i2c_smbus_write_byte_data(this_client, 0x05, 0x00);
    i2c_smbus_write_byte_data(this_client, 0x06, 0xF0);
    i2c_smbus_write_byte_data(this_client, 0x07, 0xFF);
    i2c_smbus_write_byte_data(this_client, 0x01, 0xBE);
}
else if(val & EM30718_PROXIMITY) //Enable PS only
{
    int PSLT =0x40;
    int PSHT=0x48;
    i2c_smbus_write_byte_data(this_client, 0x03, PSLT);
    i2c_smbus_write_byte_data(this_client, 0x04, PSHT);
    i2c_smbus_write_byte_data(this_client, 0x0F, 0x00);
```

```
i2c_smbus_write_byte_data(this_client, 0x01, 0xB8);  
  
}  
else if(val & EM30718_ALS) //Enable ALS only  
{  
    i2c_smbus_write_byte_data(this_client, 0x05, 0x00);  
    i2c_smbus_write_byte_data(this_client, 0x06, 0xF0);  
    i2c_smbus_write_byte_data(this_client, 0x07, 0xFF);  
    i2c_smbus_write_byte_data(this_client, 0x01, 0x06);  
}
```

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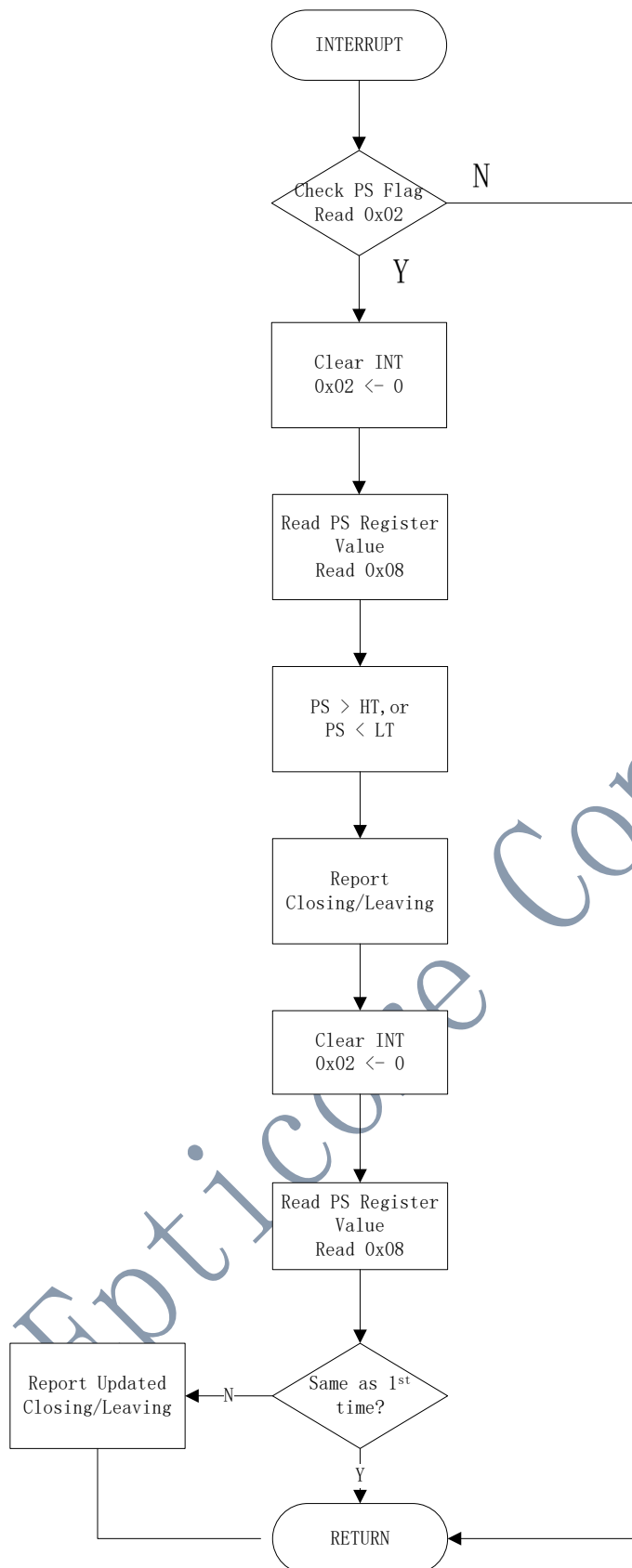


Fig. 12 Recommended Interrupt Procedure Flowchart

Registers Definition

Table. 6 Registers and Register bits

ADDR	REG NAME	BIT									
		7	6	5	4	3	2	1	0	Default	
0x00	(n/a)	PID									0x31
0x01	CONFIG	PS_EN	PS_SLP	PS_DR[2:0]			ALS_EN	ALS_RANGE	ALSIR_MODE	0xBF	
0x02	INTERR UPT	PS_FL AG	PS_PRST[1:0]		(write 0)	ALS_FL G	ALS_PRST[1:0]		INT_CTRL	0x00	
0x03	PS_LT	PS_LT[7:0]									0x00
0x04	PS_HT	PS_HT[7:0]									0xFF
0x05	ALSIR_ TH1	ALSIR_LT[7:0]									0x00
0x06	ALSIR_ TH2	ALSIR_HT[3:0]				ALSIR_LT[11:8]					0xF0
0x07	ALSIR_ TH3	ALSIR_HT[11:4]									0xFF
0x08	PS_DATA	PS_DATA[7:0]									0x00
0x09	ALSIR_ DT1	ALSIR_DATA[7:0]									0x00
0x0A	ALSIR_ DT2	don't use				0x00					0x00
0x0E	TEST1	(write 0x00)									0x00
0x0F	TEST2	(write 0x00)									0x00

Table. 7 REGISTER 0x00 (RESERVED)

BIT #	ACCESS	Default	Name	FUNCTION/OPERATION
7:0	RO	0x31	PID	Product ID - readable

Table. 8 REGISTER 0x01 (CONFIGURE) - PROX/ALS CONFIGURATION

BIT #	Read -write	Default	Name	Name/operation description
7	RW	1	PS_EN (PS Enable)	When= 0, proximity sensing is disabled When=1, proximity sensing is enabled.
6	RW	0	PS_SLP(PS Sleep)	When=0, PS IR LED for pulse spacing 100ms, typically used in smart phone/tablet applications; When=1, PS IR LED for pulse spacing 800ms, typically used in low-power proximity wake-up applications;
5:3	RW	111	PS_DR (PS Drive)	111; LED drive current for 200mA;(TBD) 110; LED drive current for 100mA; (TBD) 101; LED drive current for 50mA; (TBD) 100; LED drive current for 25mA; (TBD) 011; LED drive current for 120mA; (TBD)

				010; LED drive current for 60mA; (TBD) 001; LED drive current for 30mA; (TBD) 000; LED drive current for 15mA; (TBD)
2	RW	1	ALS_EN (ALS Enable)	When=0, ALS/IR sensing is disabled When=1, continuous ALS/IR sensing is enabled with new data ready every 100ms
1	RW	1	(ALSIR_MODE)	When=0,N/A When=1, ALS/IR Register stores ambient light detection value
0	RW	1	ALS_RANGE (ALS Range)	0, ALS in normal mode

Table. 9 REGISTER 0x02 (INTERRUPT) - PROX/ALS INTERRUPT CONTROL

BIT #	ACCESS	Default	BIT Name	Function/Operation
7	FLAG	0	PS_FLAG	When=0, no prox interrupt event has occurred since power-on or last "clear" When=1, a prox interrupt event occurred. Clearable by writing "0"
6 : 4	RW	000	(Unused)	Unused register bit - write 0
3	FLAG	0	ALS_FLAG	When = 0, no ALS interrupt event has occurred since power-on or last "clear" When = 1, an ALS interrupt event occurred. Clearable by writing "0"
2:0	RW	000	(Unused)	Unused the register bit -write 0

Table. 10 REGISTER 0x03 (PROX_LT) - INTERRUPT LOW THRESHOLD FOR PROXIMITY SENSOR

BIT #	ACCESS	Default	BIT Name	Function/operation
7:0	RW	0x00	PS_LT (Prox Threshold)	8-bit interrupt low threshold for proximity sensing

Table. 11 REGISTER 0x04 (PROX_HT) - INTERRUPT HIGH THRESHOLD FOR PROXIMITY SENSOR

BIT #	ACCESS	Default	BIT Name	Function/operation
7:0	RW	0xFF	PS_HT (Prox Threshold)	8-bit interrupt high threshold for proximity sensing

Table. 12 REGISTER 0x05 (ALSIR_TH1)-INTERRUPT LOW THRESHOLD FOR ALS/IR

BIT #	ACCESS	Default	BIT Name	Function/operation
7:0	RW	0x00	ALSIR_LT[7:0] (ALS/IR Low threshold.)	Lower 8 bits (of 12 bits) for ALS/IR low interrupt threshold

Table. 13 REGISTER 0x06 (ALSIR_TH2) INTERRUPT LOW/HIGH THRESHOLDS FOR ALS/IR

BIT #	ACCESS	Default	BIT Name	Function/operation
-------	--------	---------	----------	--------------------

7:4	RW	1111	ALSIR_HT[3:0] (ALS/IR High Thr)	Lower 4 bits (of 12 bits) for ALS/IR high interrupt threshold
3:0	RW	0000	ALSIR_LT[11:8] (ALS/IR low thr.)	upper 4 bits (of 12 bits) for ALS/IR low interrupt threshold

Table. 14 REGISTER 0x07 (ALSIR_TH3) - INTERRUPT HIGH THRESHOLD FOR ALS/IR

BIT #	ACCESS	Default	BIT Name	Function/operation
7:0	RW	0xFF	ALSIR_HT[11:4] (ALS/IR High Thr.)	Upper 8 bits (of 12 bits) for ALS/IR high interrupt threshold

Table. 15 REGISTER 0x08 (PROX_DATA) - PROXIMITY SENSOR DATA

BIT #	ACCESS	Default	BIT Name	Function/operation
7:0	RO	0x00	PS_DATA (Proximity Data)	Results of 8-bit proximity sensor ADC conversion

Table. 16 Register 0x09 (ALSIR_DT1) - ALS/IR sensor data (Lower 8 bits)

BIT #	ACCESS	Default	BIT Name	Function/operation
7:0	RO	0x00	ALSIR_DATA (ALS/IR data)	Lower 8 bits (of 12 bits) from result of ALS/IR sensor conversion

Table. 17 Register 0x0A(ALSIR_DT2) - ALS/IR sensor data(upper 4 bits)

BIT #	ACCESS	Default	BIT Name	Function/operation
7:4	RO	0000	(Unused)	Unused bits.
3:0	RO	0000	ALSIR_DATA (ALS/IR data)	Upper 4 bits (of 12 bits) from result of ALS/IR sensor conversion

Table. 18 Register 0x0E (RESET) - Soft Reset

BIT #	ACCESS	Default	BIT Name	Function/operation
7:0	RO	0x00	Write as 0x00	Soft Reset register. When 0x00, in normal operation

BIT #	ACCESS	Default	BIT Name	Name/operation
7	RW	0	Unused (write as 0)	Unused the register bit - write zero unless for soft trigger mode;
6 : 4	RW	000	Test mode	Reserved
3	RW	0	Unused (write as 0)	Unused the register bit - write zero, u unless to soft trigger mode ;
2	RW	0	Unused (write as 0)	Unused the register bit - write zero unless to soft trigger mode ;
1	RW	0	(Unused)	Reserved bits.
0	RW	0	(Unused)	Reserved bits.

Table. 19 Register 0x0F (OFFSET) - Offset Control of PS

BIT #	ACCE SS	Default	BIT Name	Function/operation
7:0	RW	0x00	Write as 0x00	Test mode register. When 0x00, in normal operation

BIT #	ACCESS	Default	BIT Name	Name/operation
7	RW	0	Unused (write as 0)	Unused the register bit - write zero unless to soft trigger mode
6	RW	0	Unused (write as 0)	Unused the register bit - write zero unless to soft trigger mode
5	RW	0	Unused (write as 0)	Unused the register bit - write zero unless to soft trigger mode
4:1	RW	0000	Offset_Ctrl	Offset_Ctrl controlled by 0 x0f to register, the default value is 0 x00 1111; PS offset value is around -480 counts; 1110; PS offset value is around -448 counts; 1101; PS offset value is around -416 counts; 1100; PS offset value is around -384 counts; 1011; PS offset value is around -352 counts; 1010; PS offset value is around -320 counts; 1001; PS offset value is around -288 counts; 1000; PS offset value is around -256 counts; 0111; PS offset value is around -224 counts; 0110; PS offset value is around -192 counts; 0101; PS offset value is around -160 counts; 0100; PS offset value is around -128 counts; 0011; PS offset value is around -96 counts; 0010; PS offset value is around -64 counts; 0001; PS offset value is around -32 counts; 0000; PS offset value is 0 count;
0	RW	0	Unused (write as 0)	Unused the register bit - write zero unless to soft trigger mode

Table. 20 I²C Device address

operation	I ² C Device address								address
	7	6	5	4	3	2	1	0	
Write Register	0	1	0	0	1	0	0	0	0x48H
Read Register	0	1	0	0	1	0	0	1	0x49H

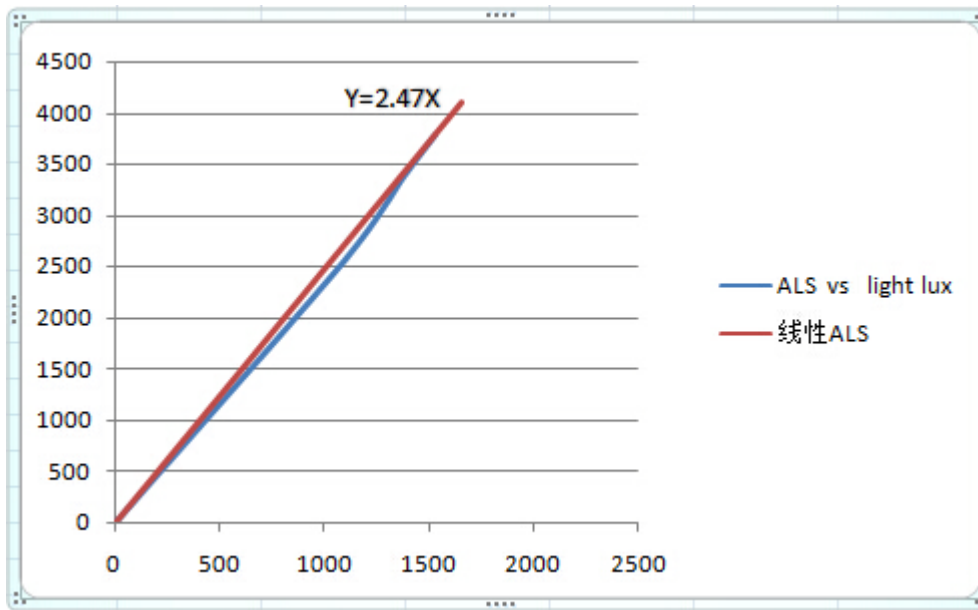


Fig. 13 ALS value vs. ambient light lux

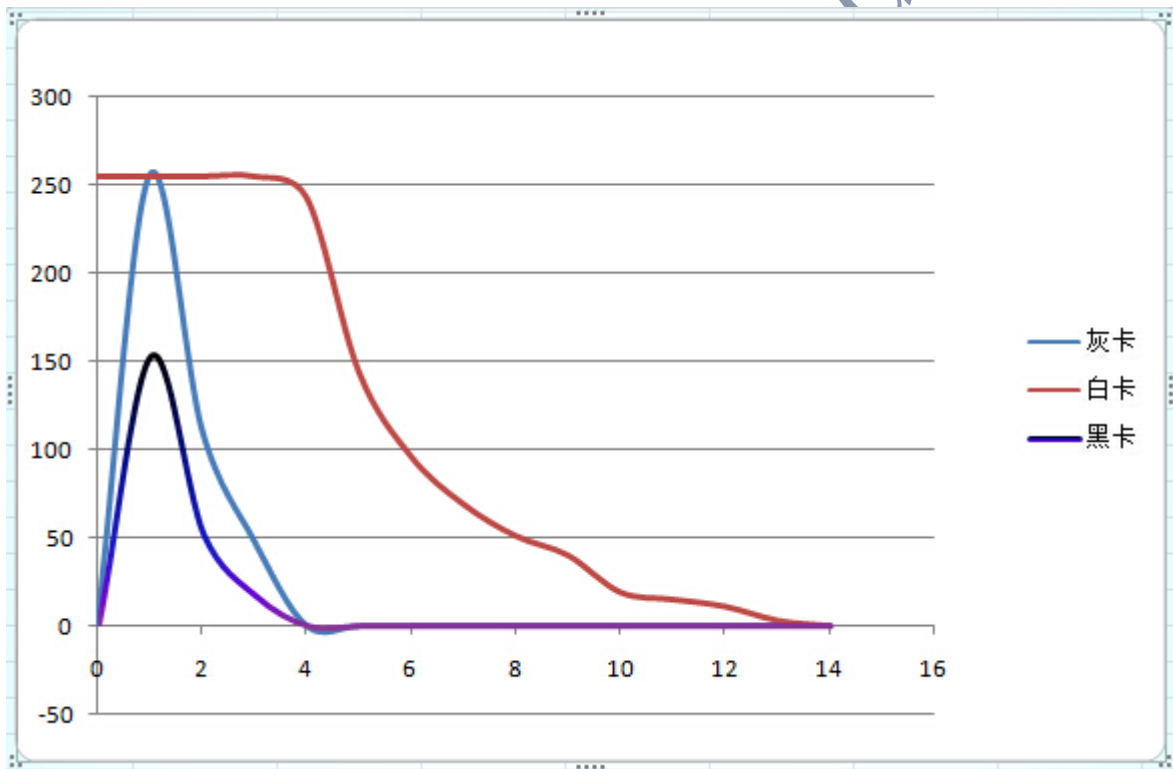
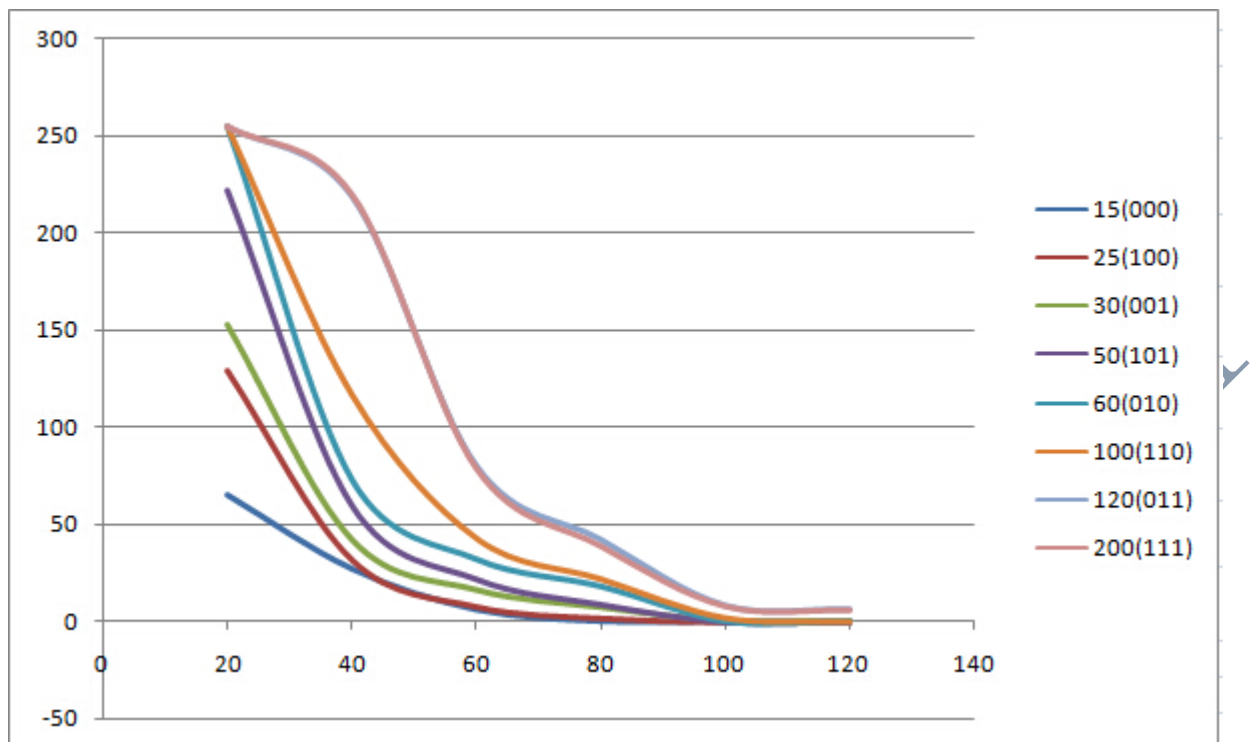


Fig. 14 PS value vs. distance (mm) in different reflecting surface



TBD

Fig. 15 PS value vs. distance (mm) in different LED drive current (Reflecting surface is grey card with 63% black and 37% white)

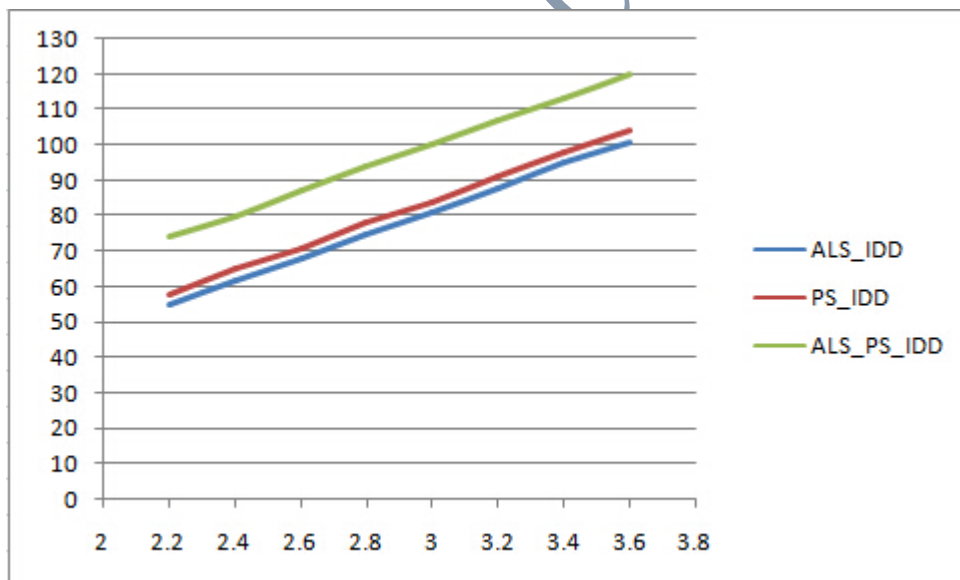


Fig. 16 Operation current vs. supply voltage

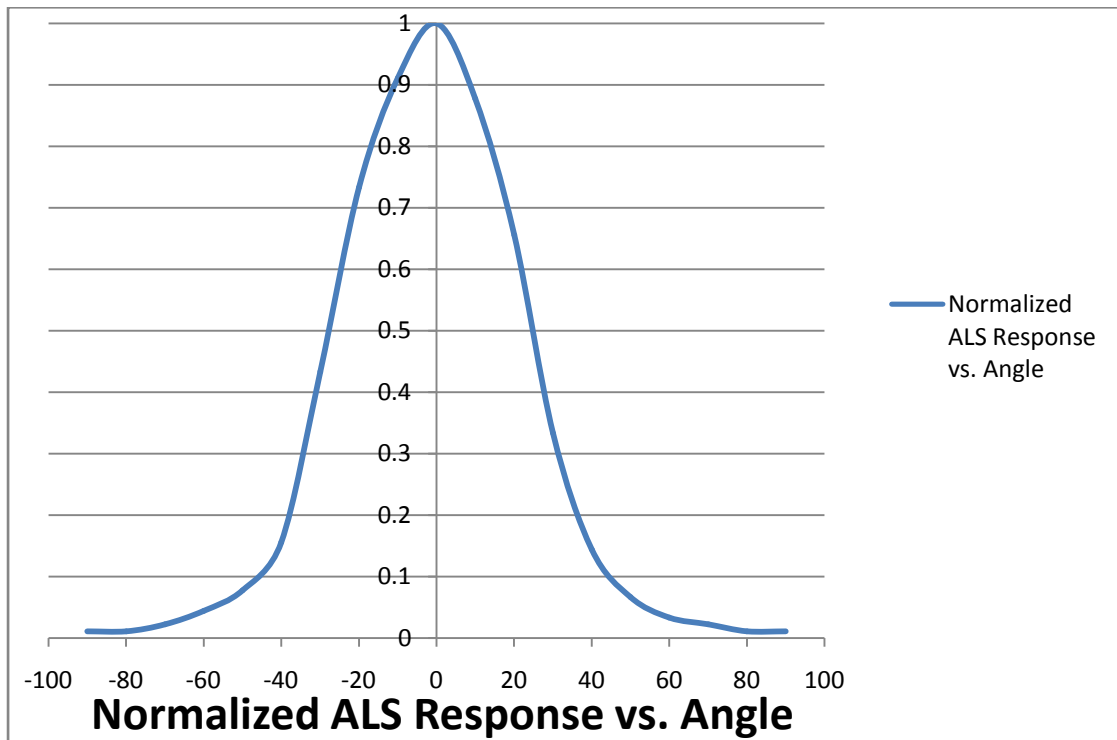


Fig. 17 Normalized ALS Response vs. Angle

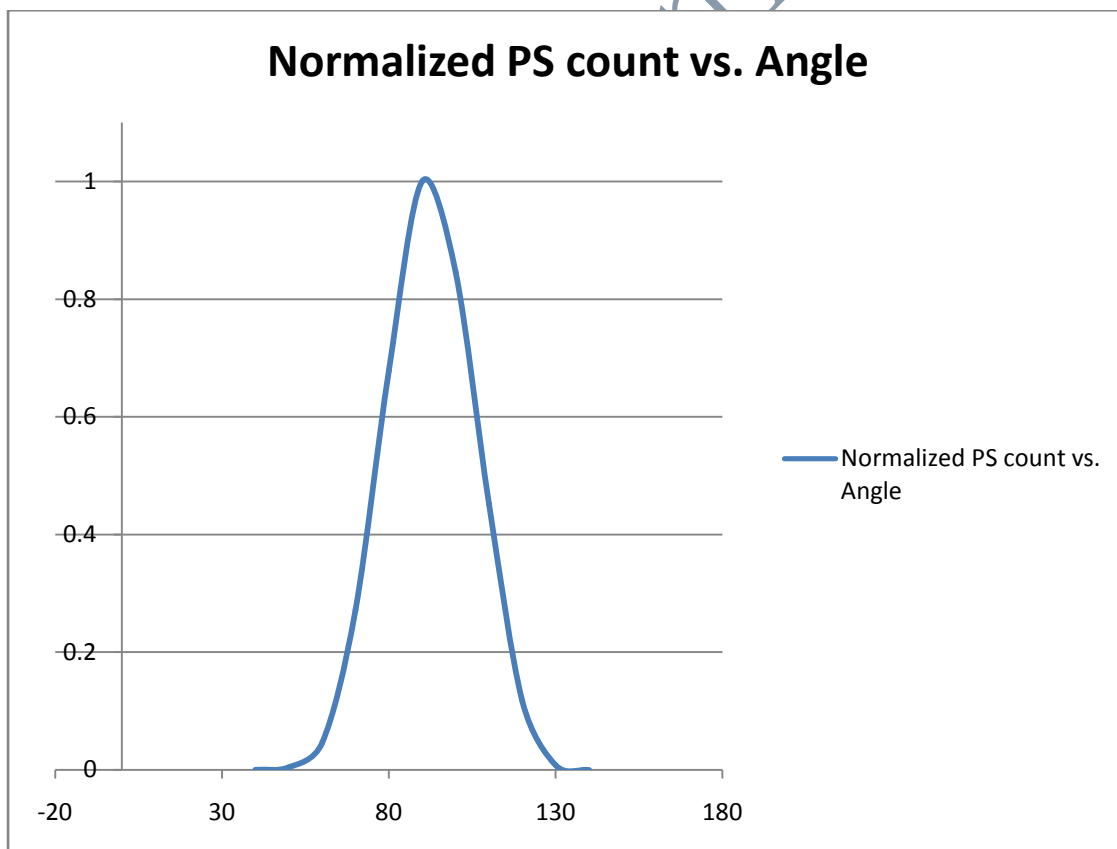


Fig. 18 Normalized PS response vs. Angle

Sample Application

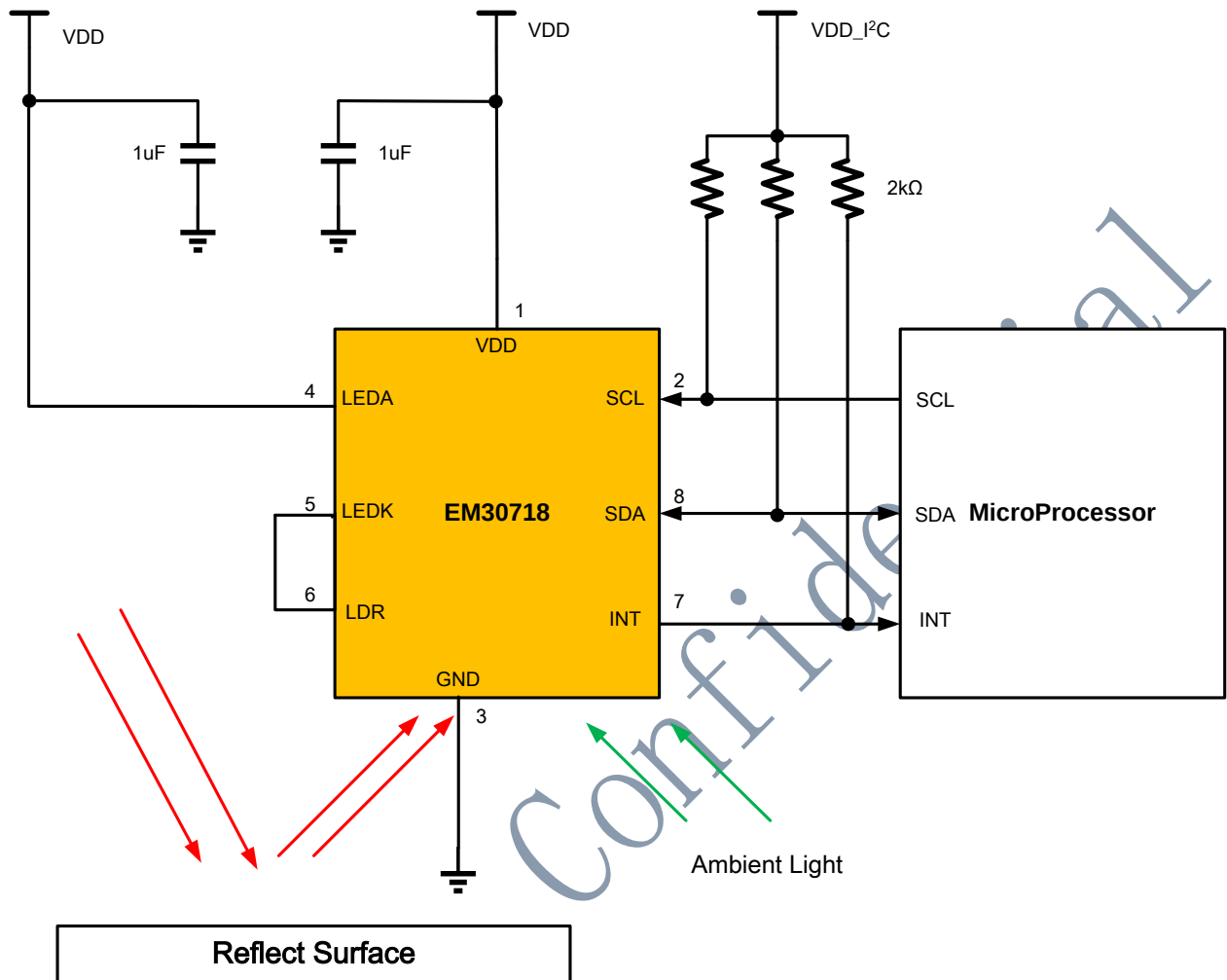


Fig. 19 Typical Application Circuit of EM30718

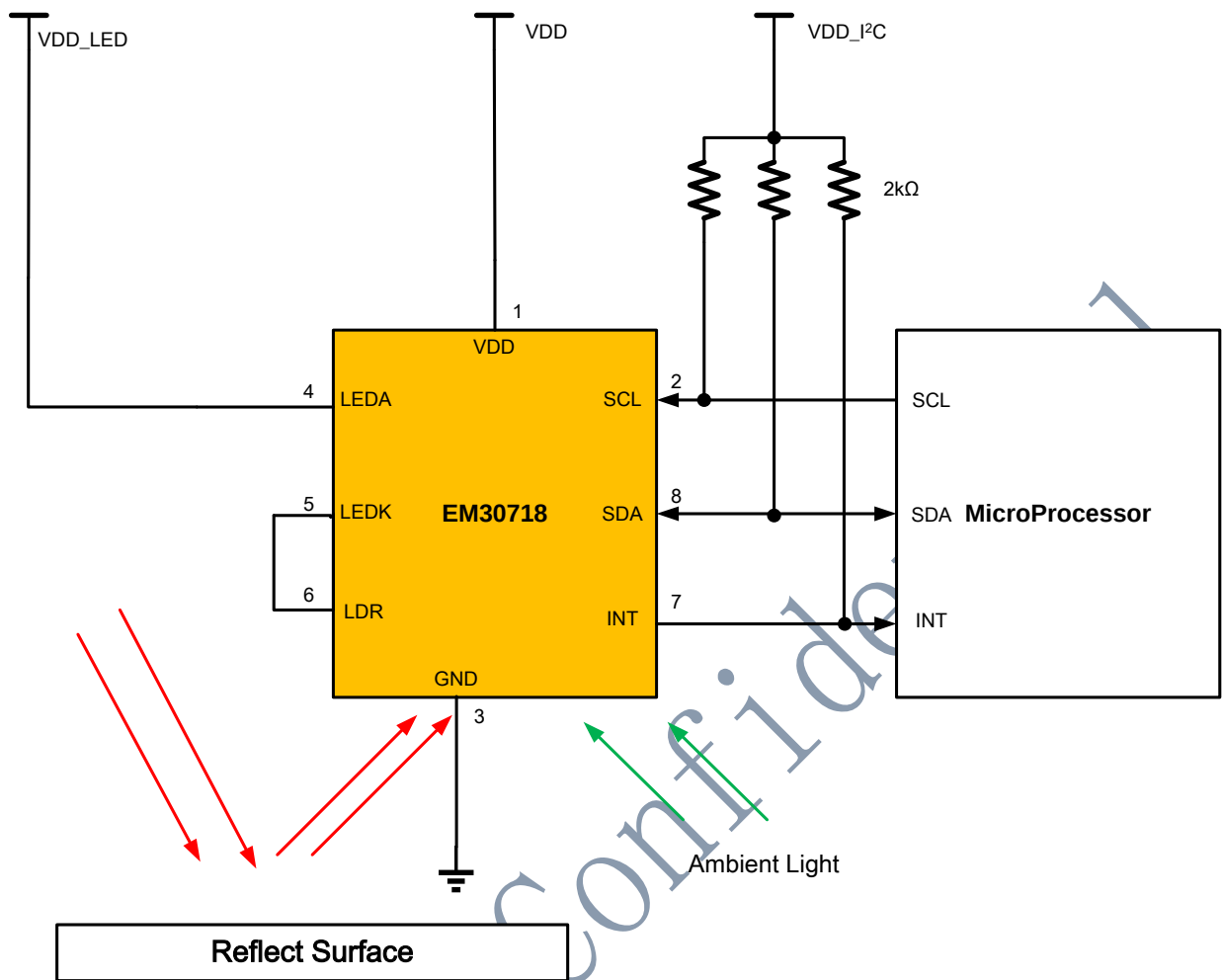


Fig. 20 Typical Application Circuit of EM30718 in cases of LEDA connect to VBAT directly.

PCB Design

Suggested PCB pad layout guidelines for the Dual Flat No-Lead surface mount package are shown below.

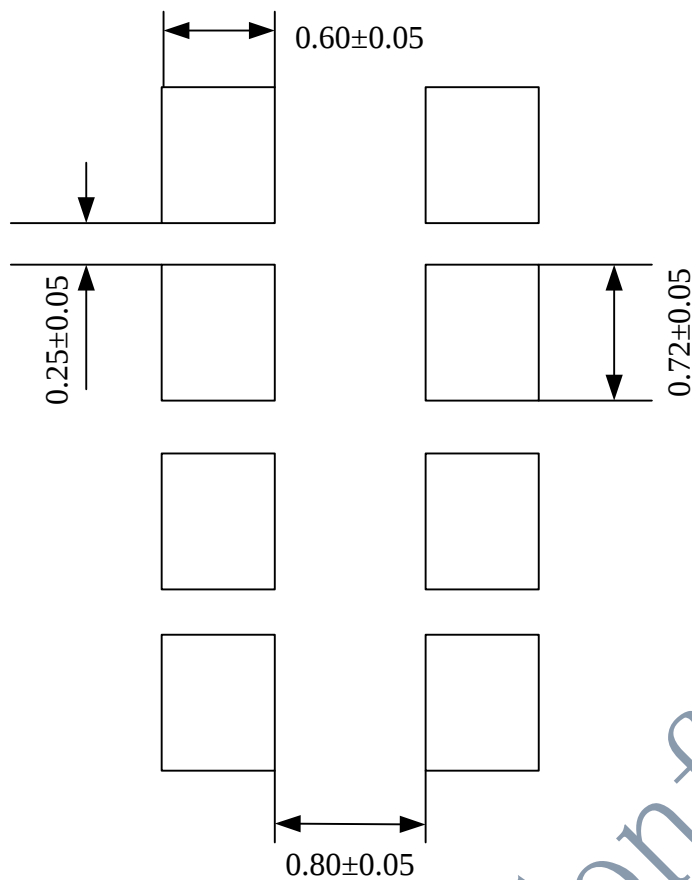


Fig. 21 PCB layout design guide (all linear dimensions are in mm)

Package Outline Dimensions

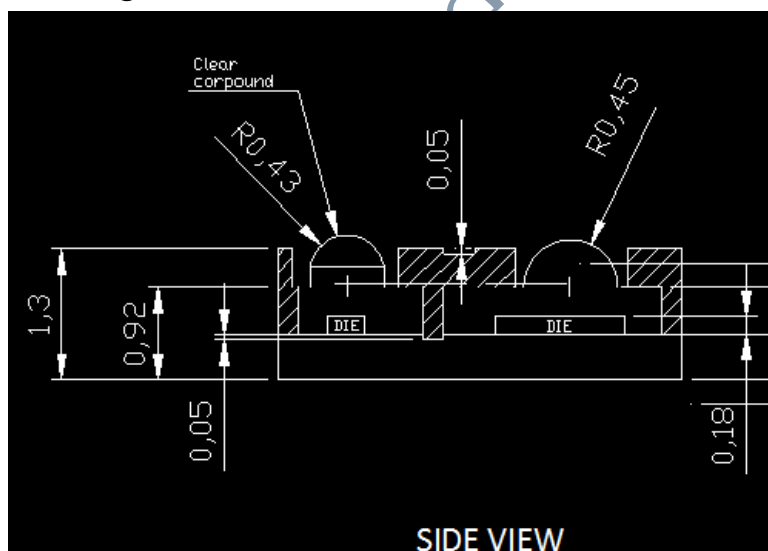


Fig. 22 Side view of package

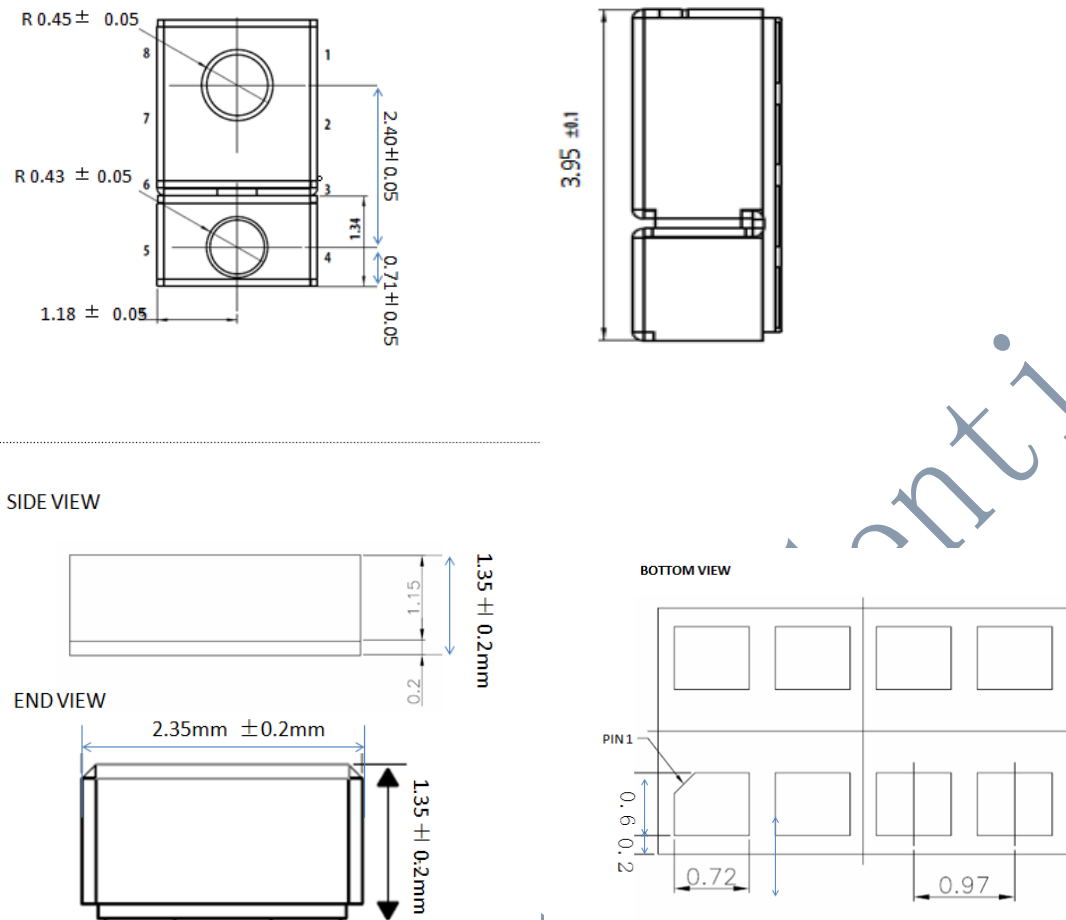


Fig. 23 Package Outline Dimensions

Recommended Structure Design

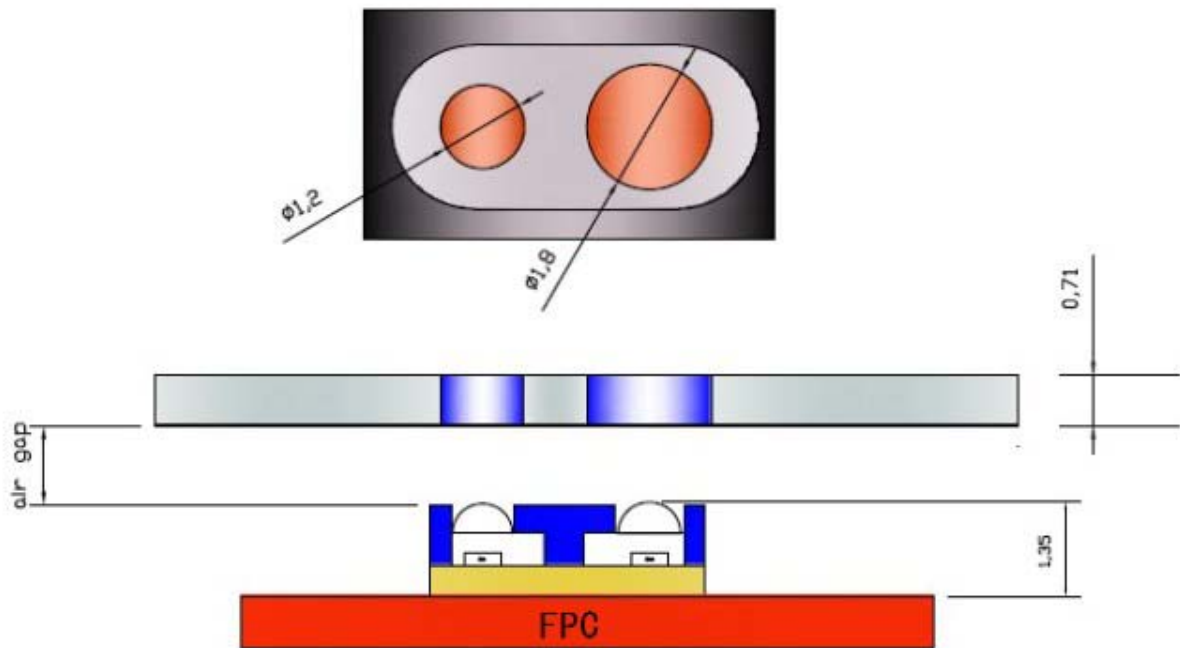


Fig. 24 Recommended in case of Air gap ≤ 1.0 mm, without rubber

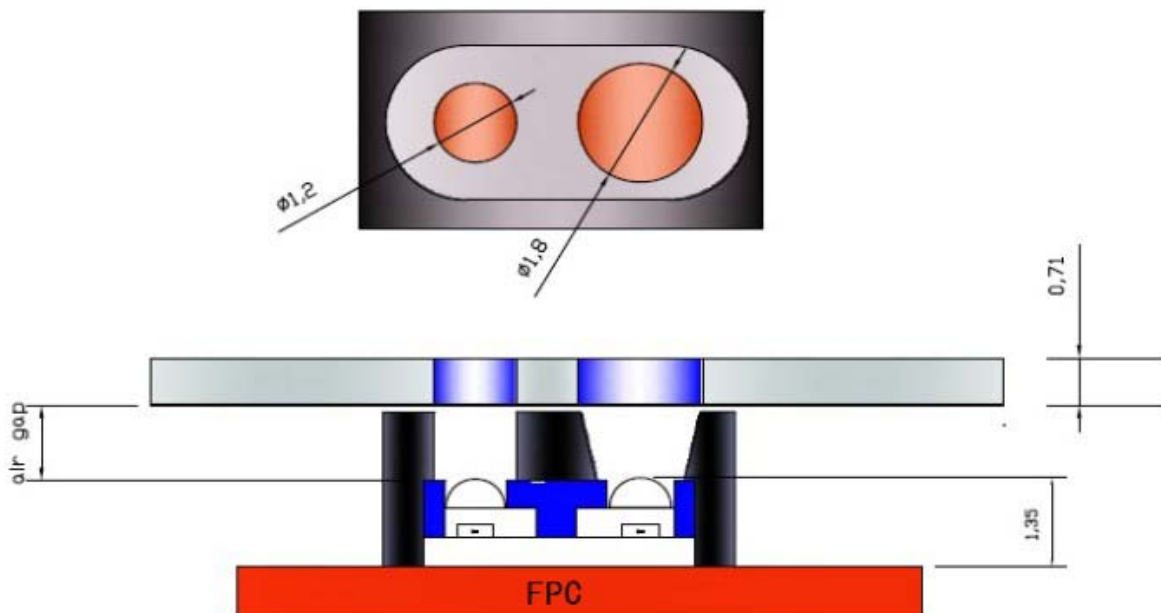
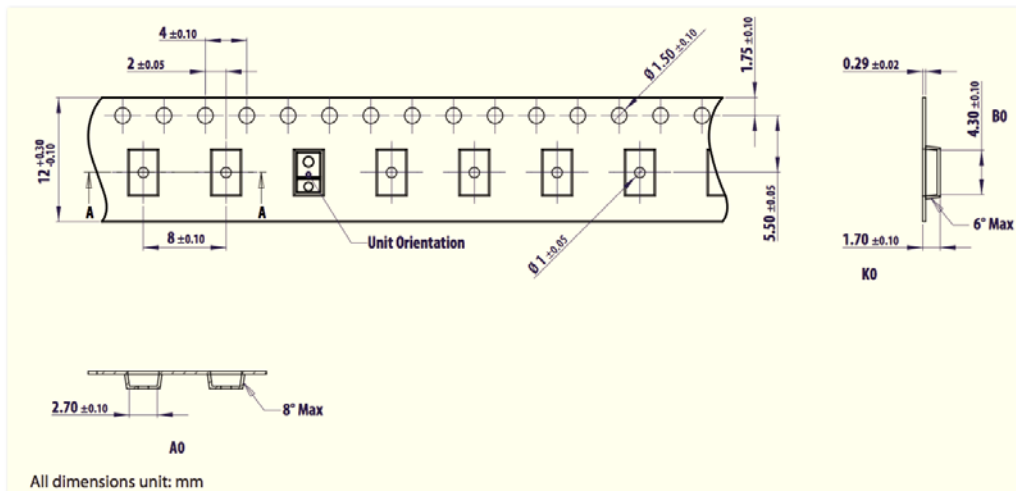


Fig. 25 Recommended in case of Air gap > 1.0 mm, with rubber added

Packing

Tape and reel dimensions is compliant to JEDEC MSL 3



Ordering Information	Q'TY/REEL	Q'TY/inside box	Q'TY/outside box	Remark
EM30718 (7' reel)	1000EA	2000EA	20000EA	MBB/Label/Temperature Card/Silica gel

Fig. 26 Tape & Reel Information

Recommended Reflow Profile

PARAMETER	REFERENCE	DEVICE
Average temperature gradient in preheating		2.5°C/sec
Soak time	t_{soak}	2 to 3 minutes
Time above 217°C(T_1)	T_1	Max 60 sec
Time above 230°C(T_2)	T_2	Max 50 sec
Time above $T_{\text{peak}}-10^\circ\text{C}$ (T_3)	T_3	Max 10 sec
Peak temperature in reflow	T_{peak}	260°C
Temperature gradient in cooling		Max-5°C/sec

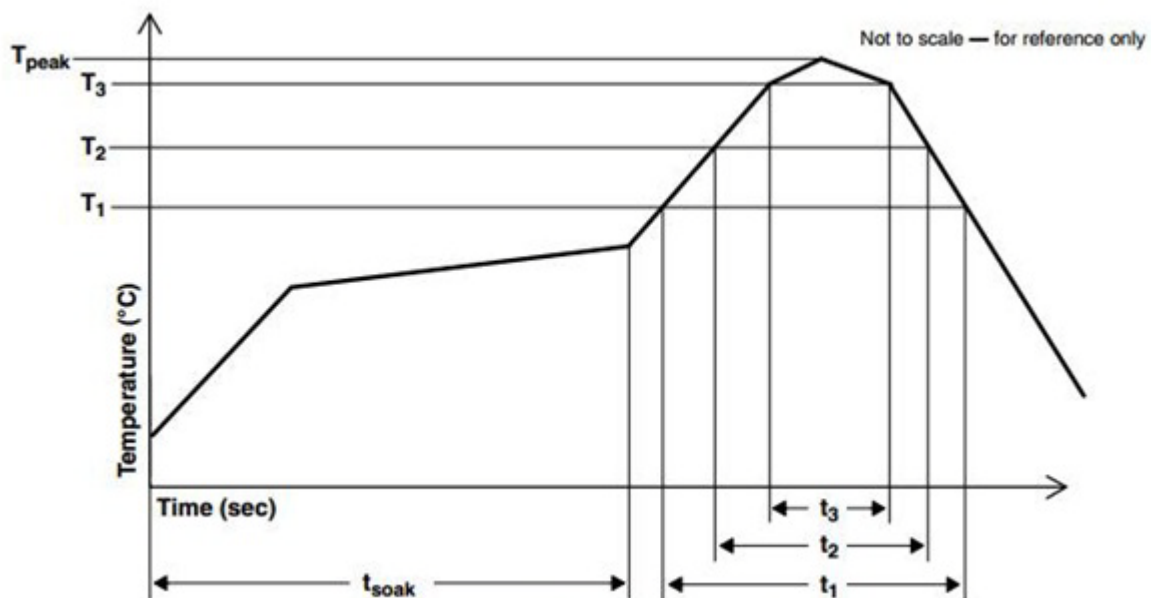
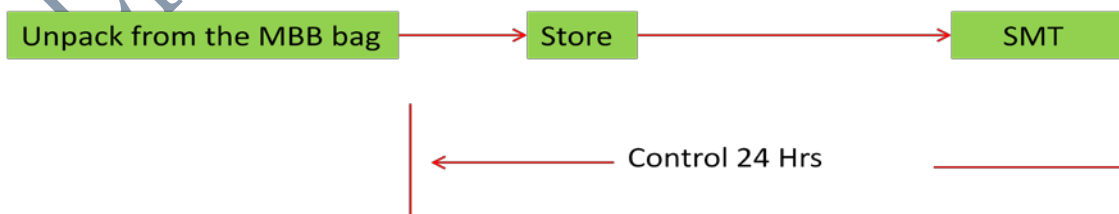


Fig. 27 Recommended Reflow Profile for SMT

The product require to control strictly to prevent moisture absorption into unit. The recommend control is as following. Rebaking of the reel will be required if the devices is unpack from the MBB bag more than 24 hours. If rebaking is required, it should be done at 50°C for 12 hours.



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- 2. No responsibilities are assumed by us for any consequence resulting from any wrong or improper operation, etc. of the product.*

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