EM30918 Datasheet

Long Distance Proximity Sensor / Ambient Light Sensor / IR Sensor with I²C Interface

Revision V 1.3

2016-05-25 Updated

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FIGURE LIST

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1. Description

EM30918 is a low-power I²C interface 5in1 module includes Ambient Light Sensor (ALS), Long-Distance Proximity Sensor (PS), IR Sensors, and internal Current Drivers with IR VCSEL Diode. It is designed for applications such as smart phone and tablets with capacitive touch panel.

EM30918 is application specific for custom-made products and no need of a controller to initialize and control. The gain and threshold values could be custom-made and detection result could automatically output.

The device detects ambient light intensity in wide range when it is designed as ALS only. The ALS can be configured to work in 2 modes, low-light-mode and normal-light-mode. The ALS in normal-light-mode detection range is 4 times larger than in low-light-mode. To get more precise result of ambient light, the value of IR register should be deduct from the value of ALS register.

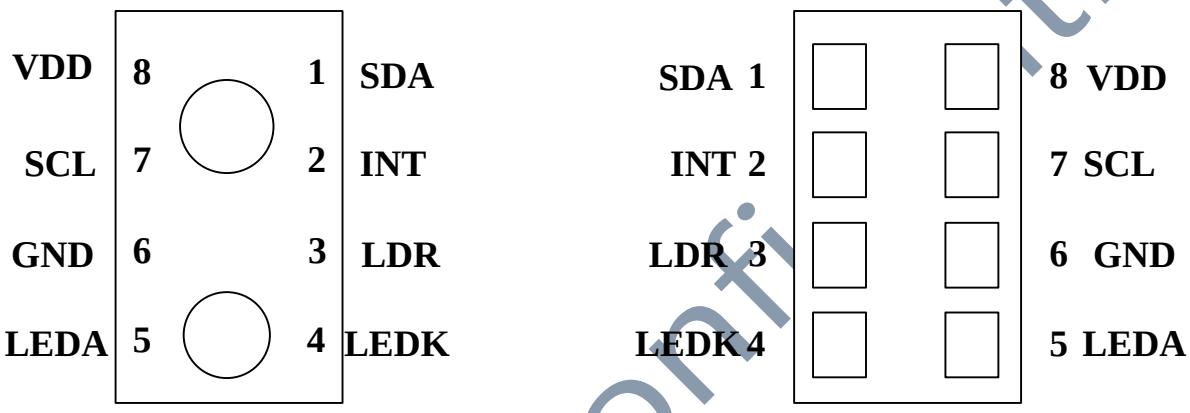
Proximity Sensor is designed to tolerant at least 2.0mm air gap. 850nm wavelength IR VCSEL Diode outputs IR light outwards and reflects to pixel arrays. The proximity sensor detects proximity with large amount of ambient light noise rejected. The range of up to 50K lux of ambient light noise can be rejected internally. In order to removing component variations and eliminate offset caused by IR reflection, EM30918 set 2 registers for compensation. 2048 steps programmable current driver is more flexible to remove component-to-component variation, and also increased dynamic range for PS detection.

Both ALS and PS can work simultaneously. All pixels are controlled by analog-MUX in different modes.

2. Features

- Proximity Sensor with corner compensation, Long-Distance Proximity Sensor, Ambient Light Sensor, IR Sensor, 1 current drivers and IR VCSEL Diode integrated in a single Optical Module
- Wide Spectrum Response of Ambient Light Sensor (ALS)
- 50Hz/60Hz Flicker Noise Rejection
- IR sensor
- Temperature Compensation
- Higher Sensitivity of Proximity Sensing, Detecting Distance of 18% gray card up to 50CM
- Proximity Sensor (PS) with Ambient Light Rejection
- Proximity detect rates is up to 1000Hz
- 2048 Steps Programmable current driver for flexibility and removing component variations
- More than 2 pixels for proximity detection compensation
- Proximity detection in parallel for Long-Distance Proximity Detection
- Preset mode for specific applications without MCU configuration
- Offset register adjustment for compensation of IR reflection caused system offset
- Programmable Interrupt for PS and ALS
- Low Average Operation Power consumption
- 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: (4.0mmX2.4mmX1.35mm)
- RoHS package



Top View　　Bottom View

3. Fnctional Block Diagram

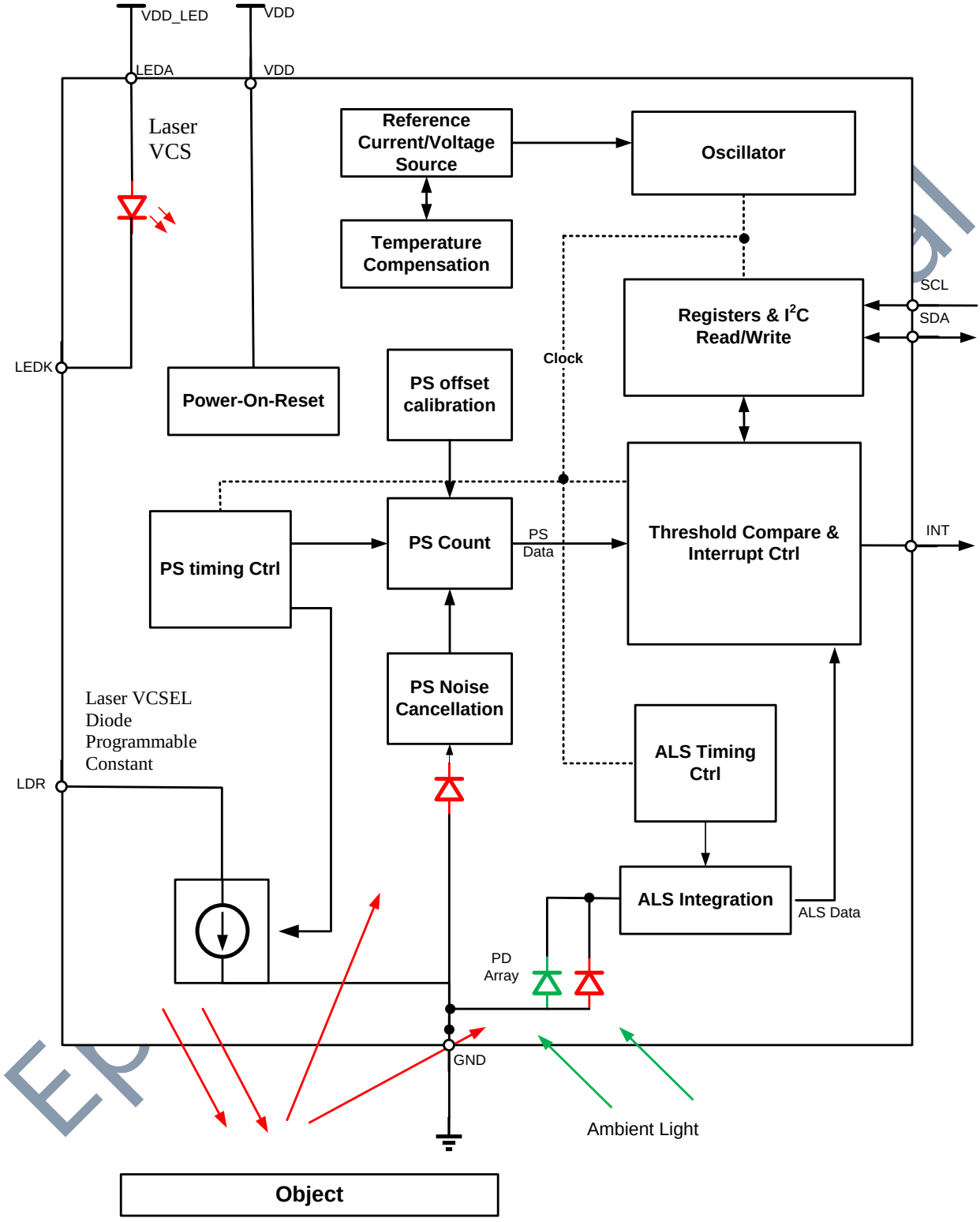


Fig. 1 EM30918 Functional Block Diagram

4. PIN Configuration

Table. 1 Pin Configuration

Pin No.	Pin Name	Type	Description
1	SDA	I/O(Open Drain)	I²C Serial data I/O terminal -serial data I/O for I²C
2	INT	O(Open Drain)	Interrupt.
3	LDR	O(Open Drain)	Current driver for proximity emitter - up to 200mA
4	LEDK	O	VCSEL Diode Cathode, connect to LDR pin in most systems to use internal current driver circuit
5	LEDA	I	VCSEL Diode Anode, connect to VDD on PCB
6	GND		Power supply ground. All voltages are referenced to GND
7	SCL	I(Open Drain)	I²C serial clock input terminal — clock signal for I²C serial data.
8	VDD		Power Supply voltage

5. Functional Description

5.1 ALS

In Normal ALS mode, Ambient Light Sensor detects ambient light from 0.3lux to 21Klux. The sensitivity of light is 0.3 lux/count, and totally 2.1Klux in full range; The typical resolution of ADC is 12bits and 100ms conversion time.

In low-lux mode, 8 times of ADC gain is chosen for receiving ambient light. The detect range is 0.04lux to 2100lux.

Considering cover lens with 15% transmittance at 550nm, the ALS detection range is up to 140K lux.

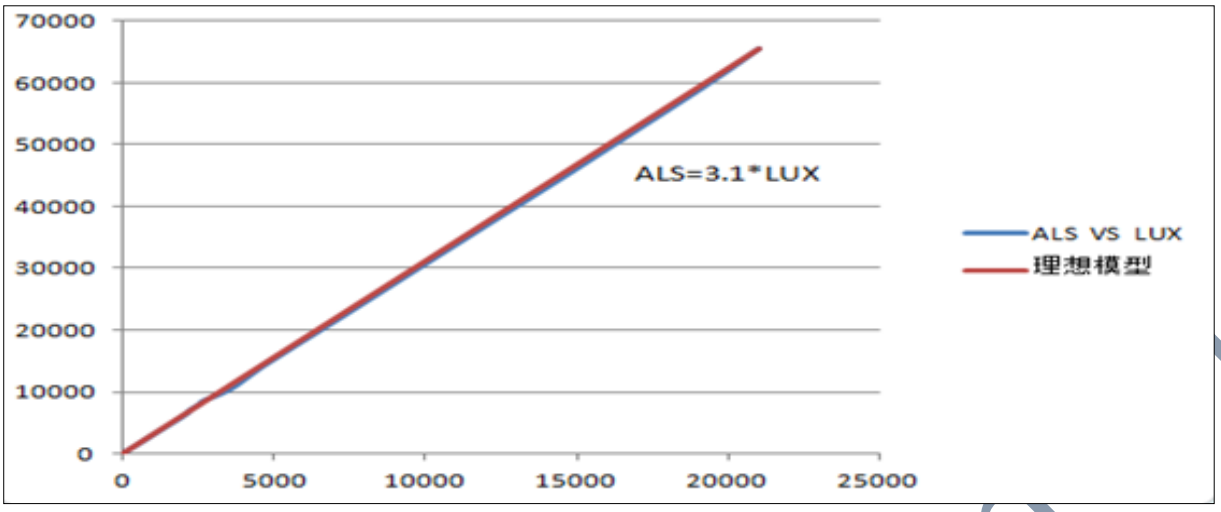


Fig. 2 EM30918 ALS value vs. ambient light lux

5.2 PS

The proximity Sensor detects distance by measuring the reflected light.

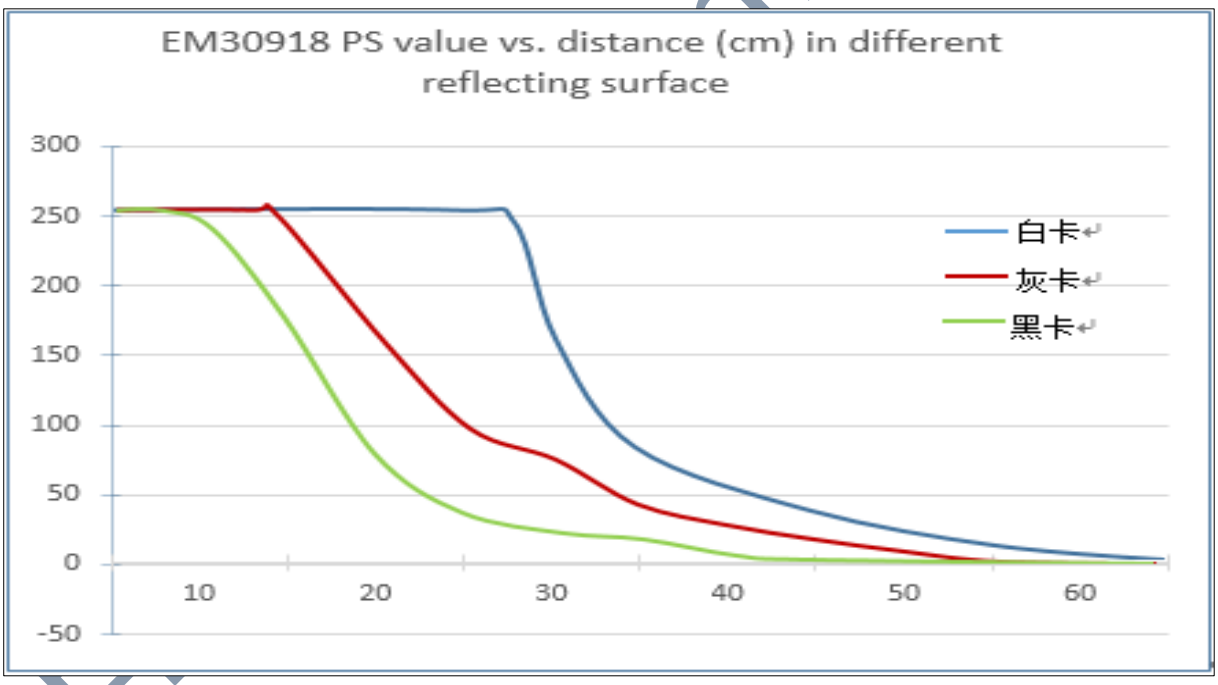


Fig. 3 EM30918 PS value vs. distance (mm) in different reflecting surface

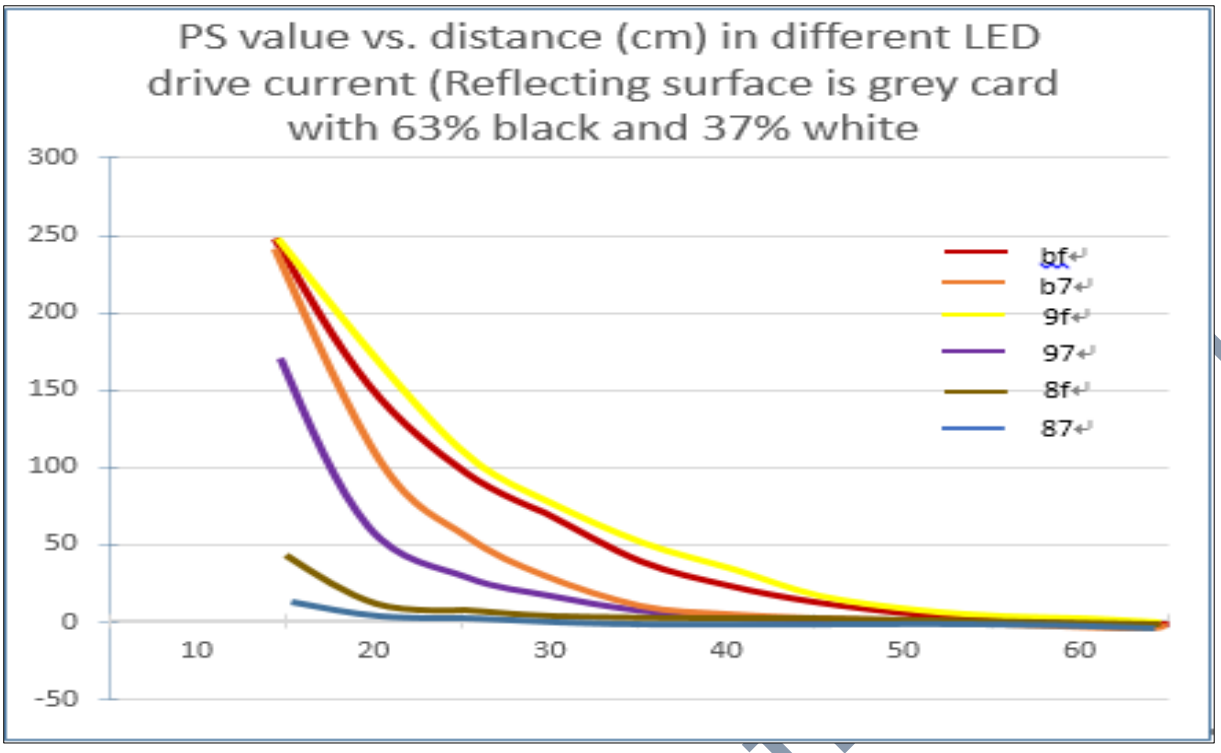


Fig. 4 PS value vs. distance (mm) in different drive current (Reflecting surface is 18% grey card)

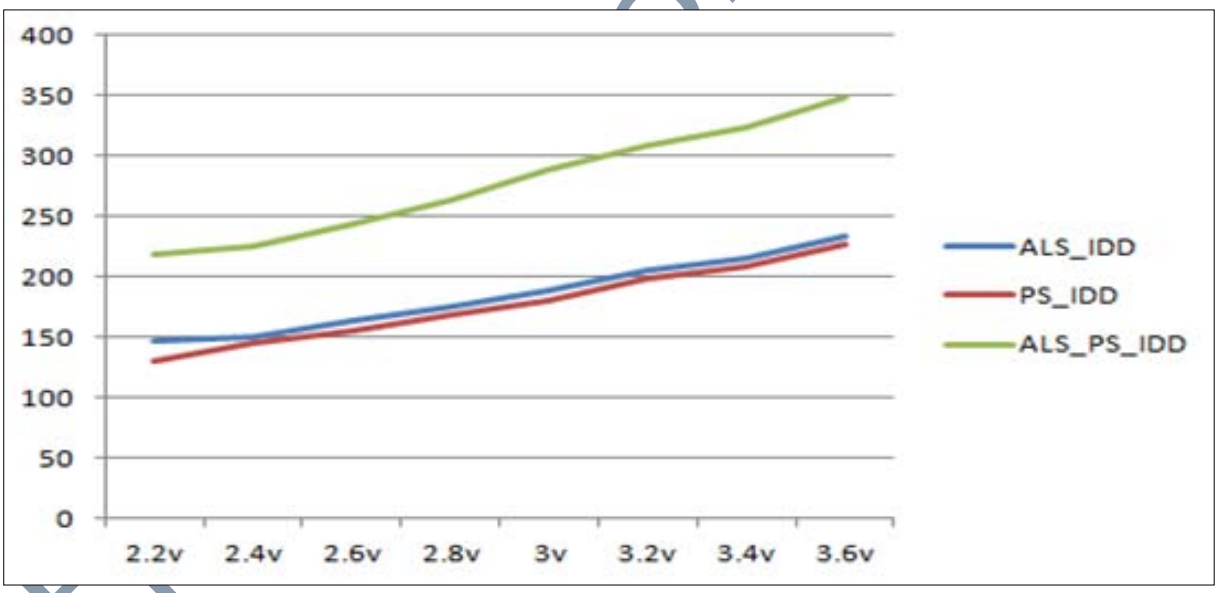


Fig. 5 Operation current vs. supply voltage

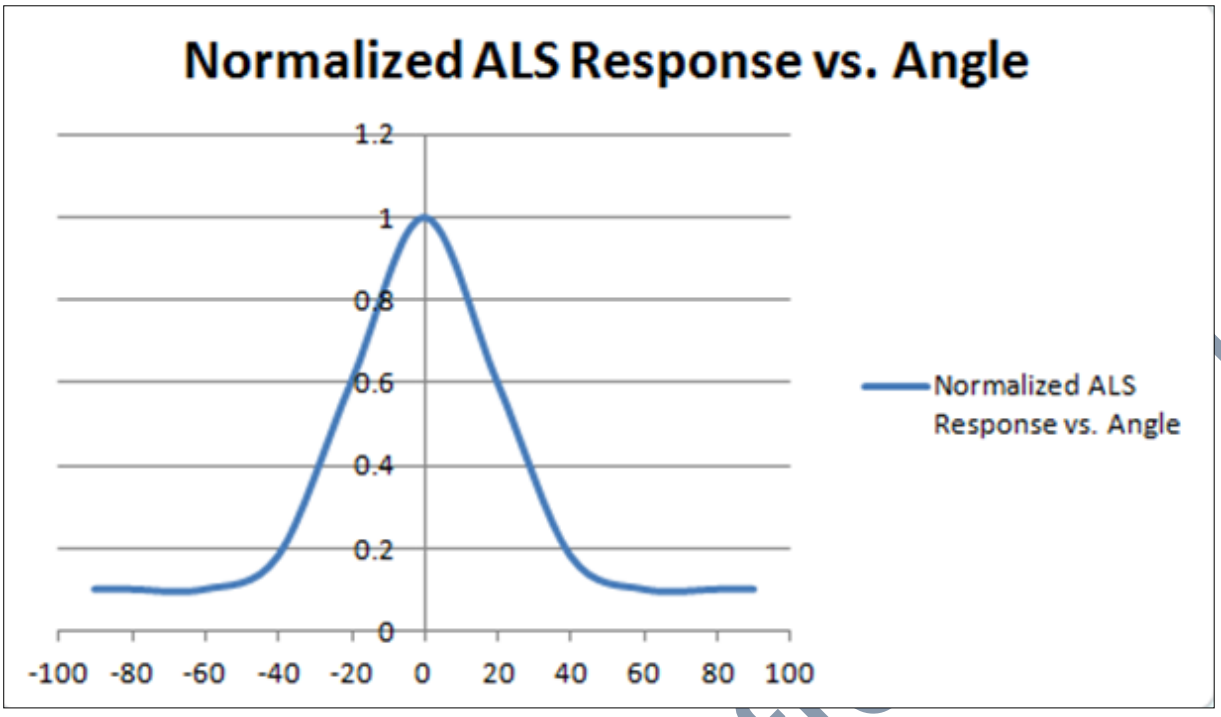


Fig. 6 Normalized ALS Response vs. Angle

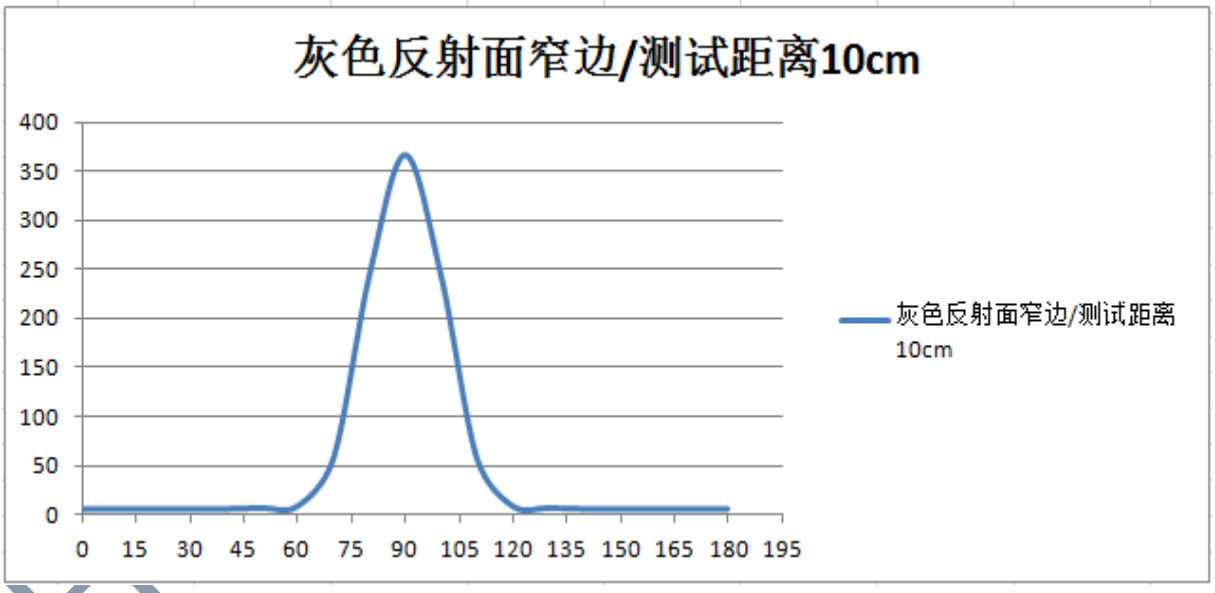


Fig. 7 Normalized PS response vs. Angle

6. 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}	I²C clock (SCL) low cycle	4.7			μs	Normal Mode
		1.3			μs	Fast Mode
t_{HIGH}	I²C 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 acknowVCSEL Diodege			0.9	μs	

	time					

Table. 3 Electrical Characteristics

Symbol	Min	Typ	Max	Units	Introductions
VDD_{LED}	2.6		4.5	V	Supply VCSEL Diode voltage
V_{DD}	2.6		3.6	V	Supply voltage
I_{DD}				μ A	DC power supply current (with VCSEL Diode turned off)
V_{pull_up}	1.6		3.6	V	I²C 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 (Ta = +25 ℃)
Full scale ALS count value			4095	counts	ALS register maximum count
ALS detect range			4095	lux	ALS detection range
Full scale PS ADC count value			255	counts	PS ADC maximum count
Full scale PS count value			255	counts	PS registers the maximum count
PS VCSEL Diode drive	15		200	mA	PS VCSEL Diode drive current
VCSEL Diode duty cycle		1/500			VCSEL Diode duty cycle, cycle of PS 100 ms
V_F		2.5		V	VCSEL Diode Forward Voltage, I_F =200 mA
V_R				V	VCSEL Diode Reverse Voltage, I_R =10 μA
Po	130	140		mW	VCSEL Diode Radiant Power, I_F =200 mA
AveragePo		0.28		mW	VCSEL Diode Average Radiant Power, I_F =200 mA,

λp	835	850	865	nm	VCSEL Diode Peak Wavelength, I_F =200 mA
Δλ				nm	Spectrum Width of Half Value, I_F =200 mA
T_R				ns	VCSEL Diode Optical Rise Time, I_F =20 mA
T_F				ns	VCSEL Diode Optical Fall Time, I_F =20 mA

7. PS Spectral Response Range

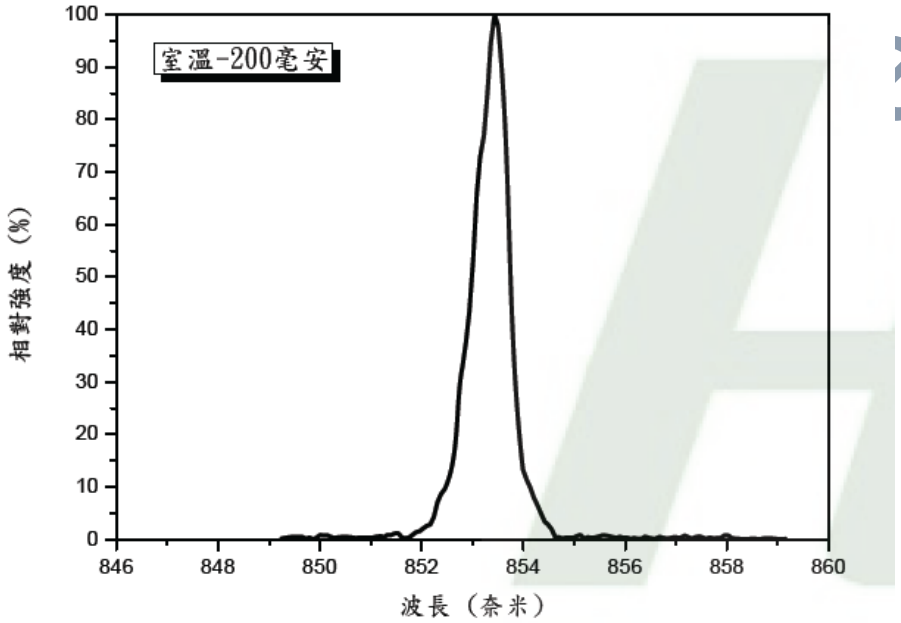


Fig. 8 PS Spectral Response Range (The peak wavelength may change to 940nm)

8. Absolute Maximum Ratings

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}	2.25	3.6	V	
ESD	V_{ESD}	2K		V	HBM
ESD	V_{ESD}	200		V	MM

9. I²C State Machine

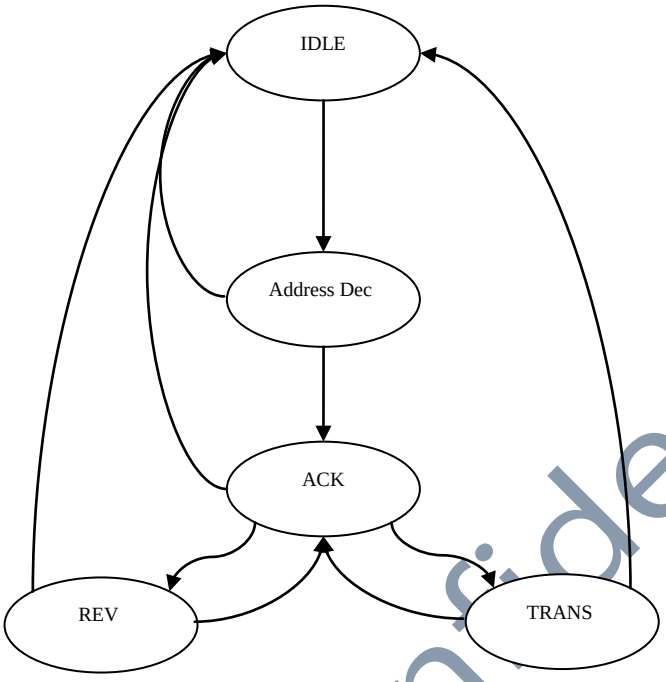


Fig. 9 Slave State Machine

10.Timing

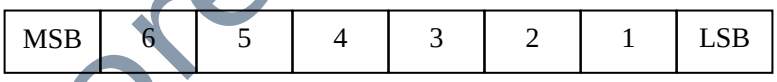


Fig. 2 Data Structure

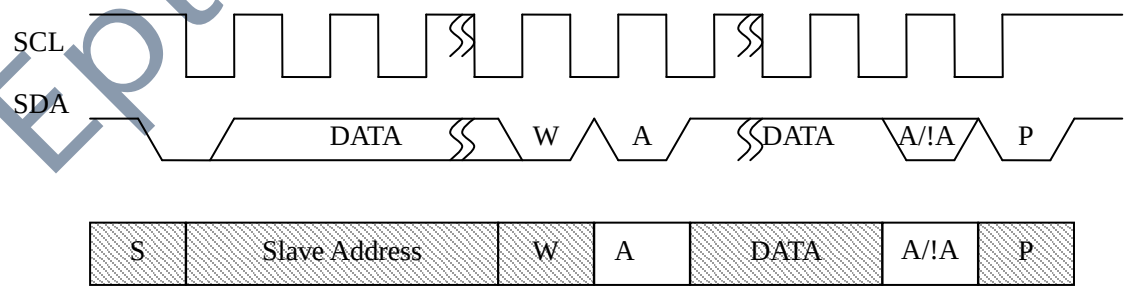


Fig. 3 Write waveform

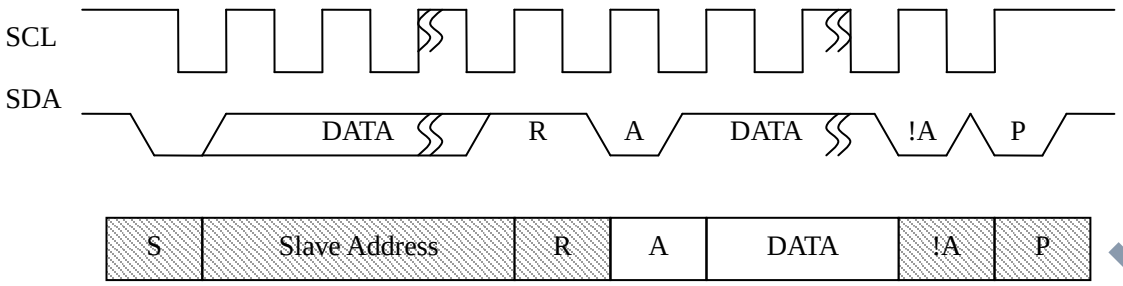


Fig. 4 Read waveform

11.Registers Operation

Fig. 5 Register random write operation

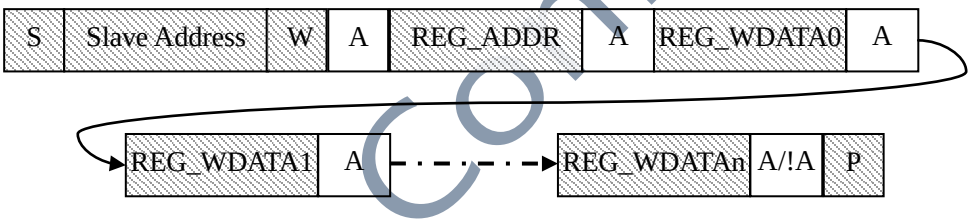


Fig. 6 Register page write operation

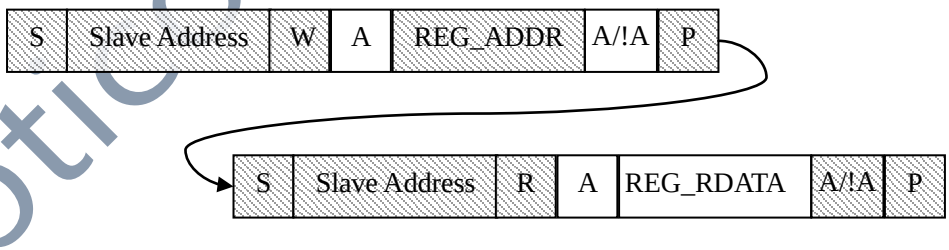


Fig. 7 Register random read operation

12.Registers Definition

Function Modes:

1. Proximity Sensing.
2. Proximity Sensing in Enhance Mode

3. Reserved
4. Reserved
5. Ambient Light Sensin

Table. 6 Registers Set

ADDR	REG NAME	BIT								
		7	6	5	4	3	2	1	0	Default
0x00	PID	PID								0x31
0x01	CONFIG	PS EN	PS_SLP	PS_DR[2:0]			ALS_EN	ALS_RANGE	ALSIR_MODE	0xBF
0x02	INTERRUPT	PS_FLAG	PS_PRST[1:0]		(write 0)	ALS_FLAG	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				ALSIR_DATA[3:0]				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 disabVCSEL Diode When=1, proximity sensing is enabVCSEL Diode.
6	RW	0	PS_SLP(PS Sleep)	When=0, PS IR VCSEL Diode for pulse spacing 100ms, typically used in smart phone/tablet applications; When=1, PS IR VCSEL Diode for pulse spacing 800ms, typically used in low-power proximity wake-up applications;
5:3	RW	111	PS_DR (PS Drive)	111; VCSEL Diode drive current for 200mA;(TBD) 110; VCSEL Diode drive current for 100mA; (TBD) 101; VCSEL Diode drive current for 50mA; (TBD) 100; VCSEL Diode drive current for 25mA; (TBD) 011; VCSEL Diode drive current for 120mA; (TBD) 010; VCSEL Diode drive current for 60mA; (TBD) 001; VCSEL Diode drive current for 30mA; (TBD)

				000; VCSEL Diode drive current for 15mA; (TBD)
2	RW	1	ALS_EN (ALS Enable)	When=0, ALS/IR sensing is disabVCSEL Diode When=1, continuous ALS/IR sensing is enabVCSEL Diode with new data ready every 100ms
1	RW	1	ALS_RANGE (ALS Range)	When=0,N/A When=1, ALS Range in normal mode
0	RW	1	(ALSIR_MODE)	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 interrupt event has occurred since power-on or last “clear” When=1,PS must be enabVCSEL Diode and an 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 interrupt event has occurred since power-on or last “clear” When = 1, ALS must be enabVCSEL Diode and an 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]	upper 4 bits (of 12 bits) for ALS/IR low interrupt

			(ALS/IR low thr.)	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)	Lower 8-bits output of internal 11-bits proximity sensor ADC, and result shows oxFF for values larger than 0xFF

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 When Register 0x0E = 0x9C and Register 0x0F =0xE1, the soft reset is triggered.

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 #	ACCESS	Default	BIT Name	Function/operation
7:0	RW	0x00	Write as 0x00	Offset register. When 0x00, in normal operation, When Register 0x0E = 0x9C and Register 0x0F =0xE1, the soft reset is triggered.

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 controlVCSEL Diode 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	I²C Device address								
	7	6	5	4	3	2	1	0	address
Write Register	0	1	0	0	1	0	0	0	0x48H
Read Register	0	1	0	0	1	0	0	1	0x49H

13.Sample Application

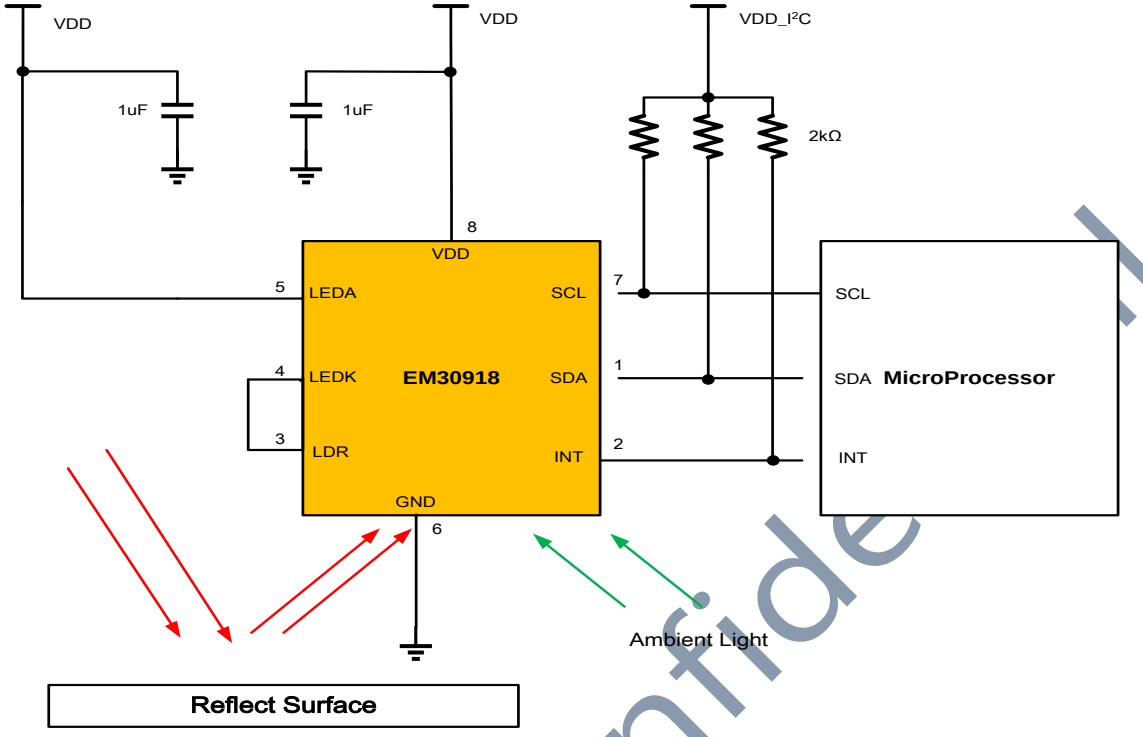


Fig. 8 Typical Application Circuit I: VDD_LED = VDD (Typically 2.8V)

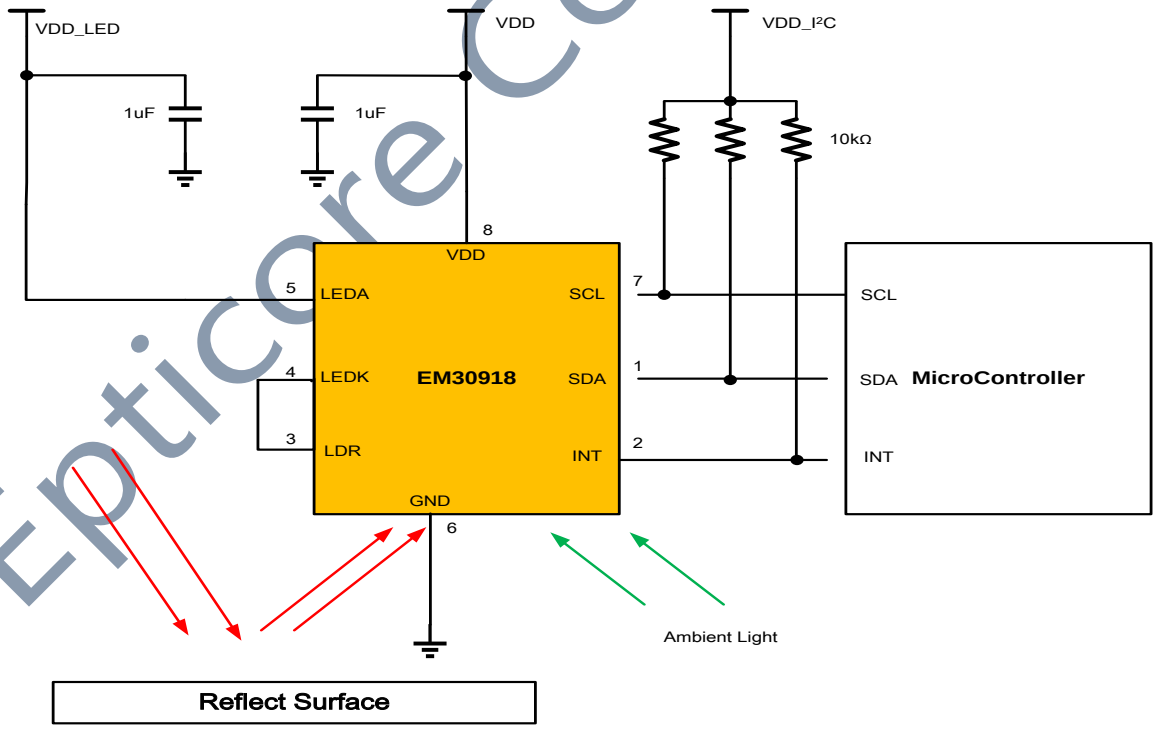


Fig. 9 Typical Application Circuit II: VDD_LED= Vbat (3.7V ~ 4.2V),VDD =2.8V

14.PCB Design

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

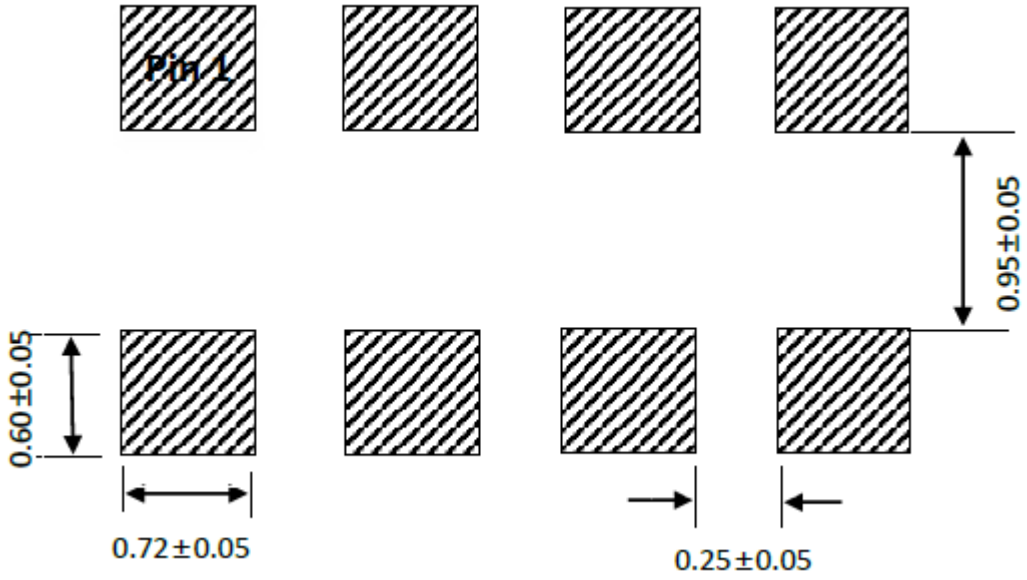


Fig. 10 PCB layout design guide for EM30918 (all linear dimensions are in mm)

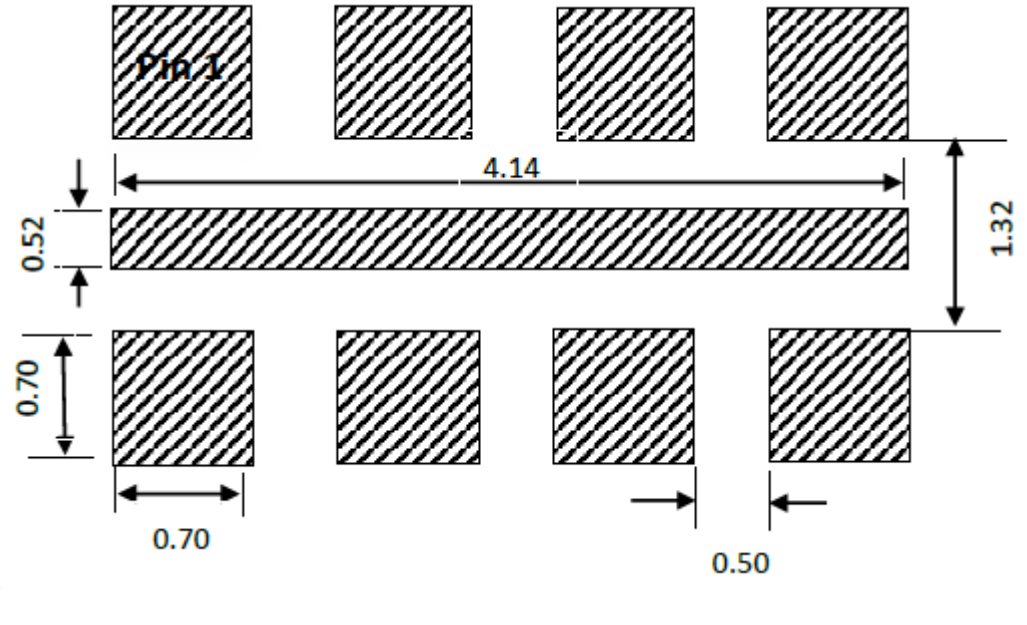


Fig. 11 PCB layout design guide for EM30918-25 (all linear dimensions are in mm)

15.Package Outline Dimensions

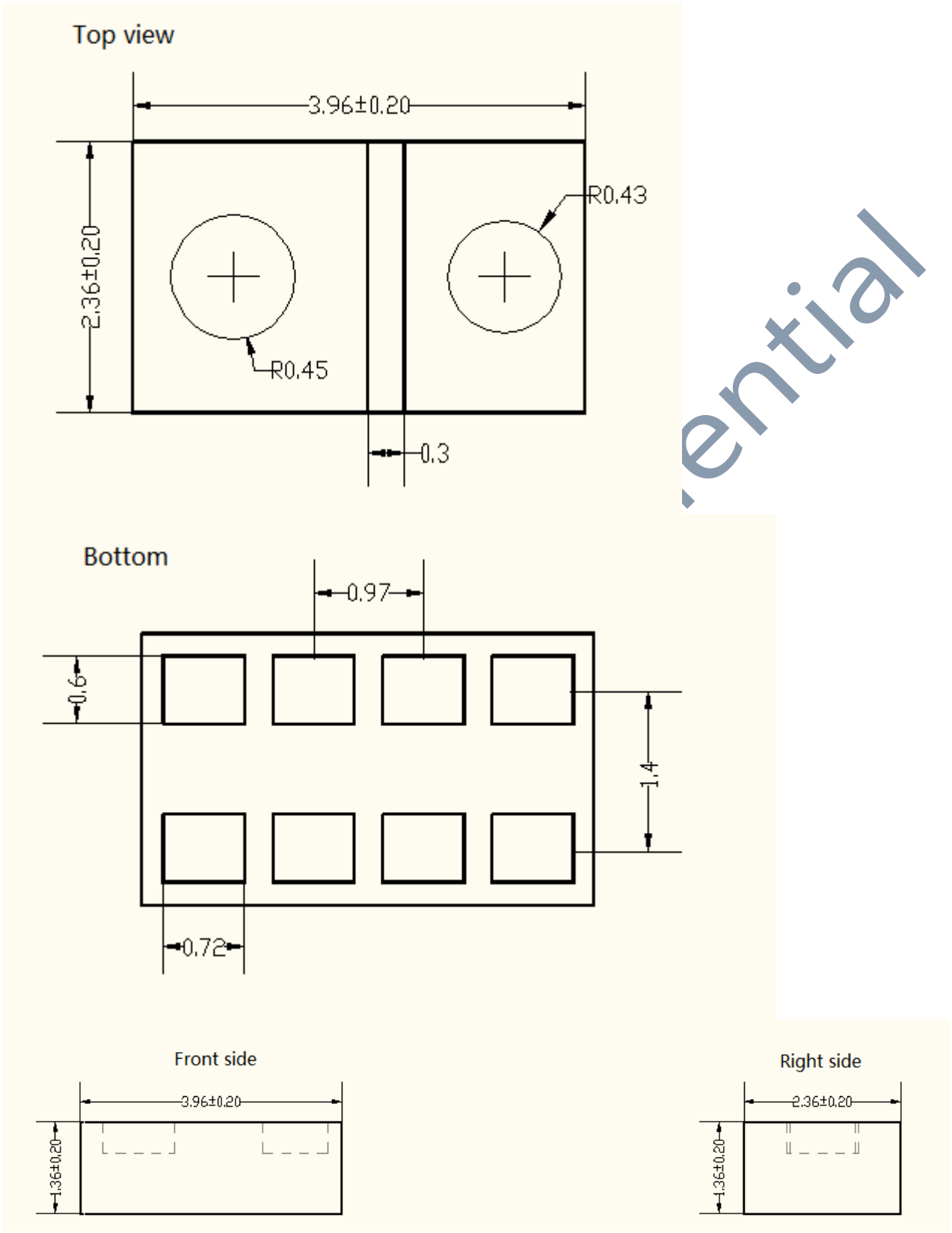
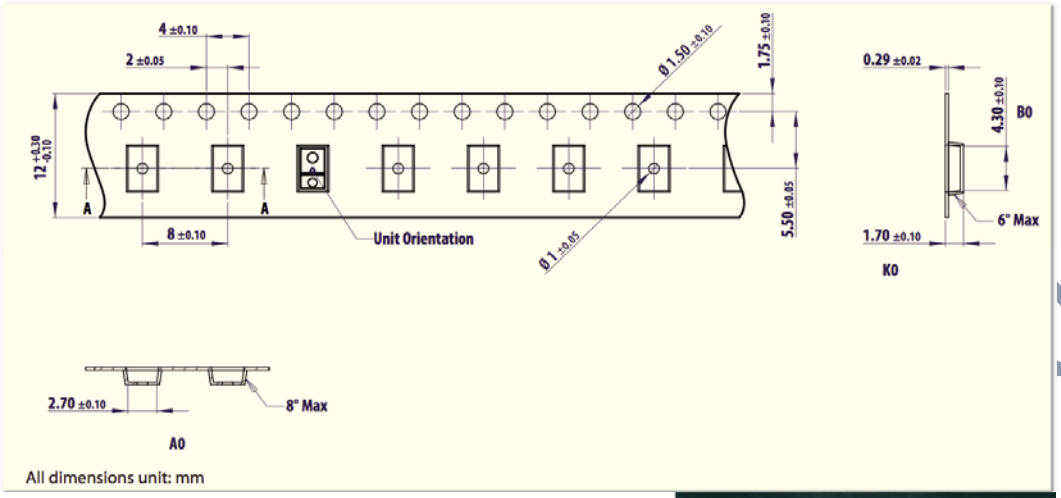
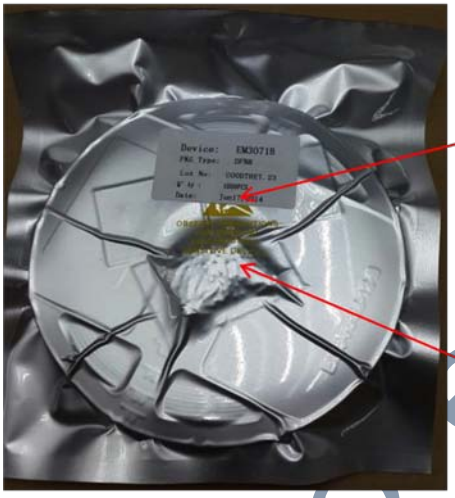


Fig. 12 EM30918 Package Outline Dimensions

16.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
EM30918 (7" reel)	1000EA	2000EA	20000EA	MBB/Label/Temperature Card/Silica gel

Fig. 21 Tape & Reel Information

17.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_{peak}-10°C(T_3)	T_3	Max 10 sec
Peak temperature in reflow	T_{peak}	260°C
Temperature gradient in cooling		Max-5°C/sec

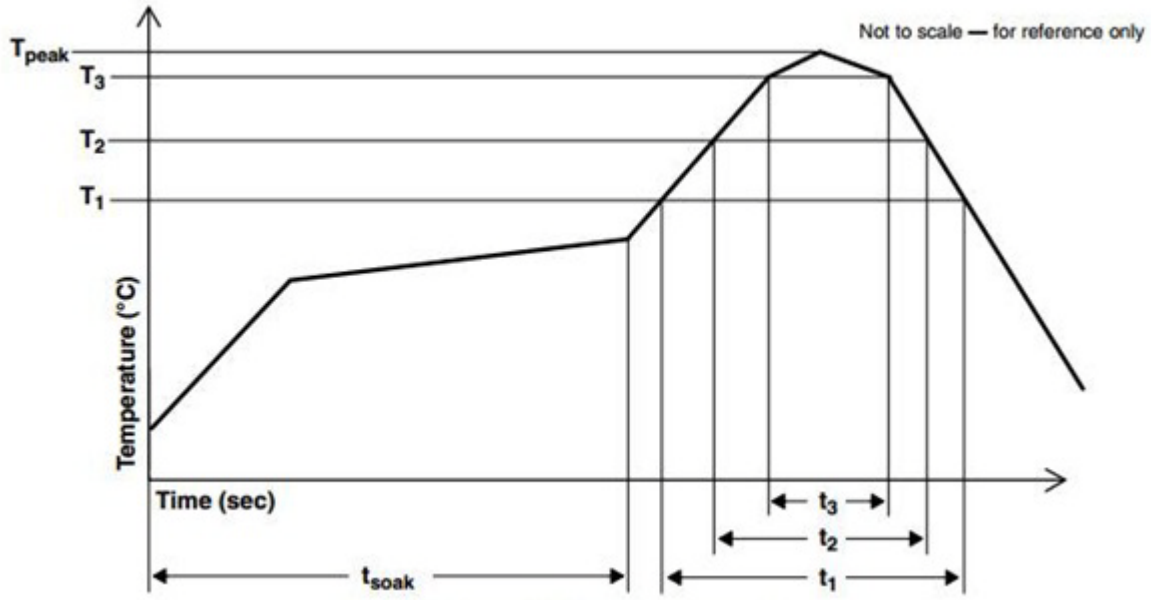
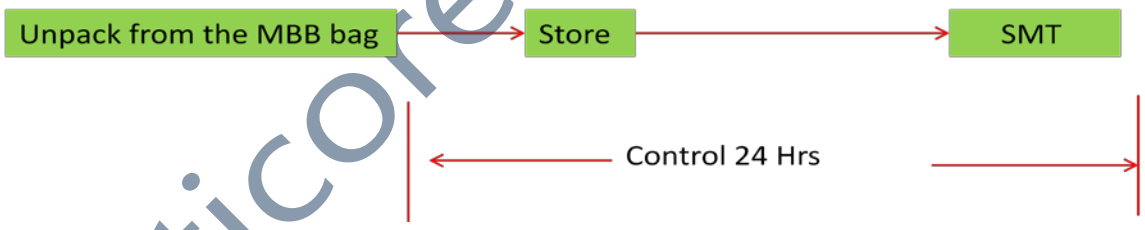


Fig. 22 Recommended Reflow Profile for SMT

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℃ for 12 hours.



History

Date	Author	Modification
2014-6-18		First Created
2015-12-30	Binghua_Chen	Updated
2016-2-24	Justin Wang	Updated

etc. of the product.

Epticore Microelectronics Co. Ltd.

For product information and a complete list of distributors, please contact sales@epticore.com or go to our web site:
http://www.epticore.com