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LITEON®
OPTOELECTRONICS

Optical Sensor

Product Data Sheet

LTR-91400

Spec No.: DS86-2016-0050

Effective Date: 09/14/2016

Revision: -

LITE-ON DCC

RELEASE

BNS-OD-FC001/A4

LITE-ON Technology Corp. / Optoelectronics
No.90,Chien 1 Road, Chung Ho, New Taipei City 23585, Taiwan, R.O.C.
Tel: 886-2-2222-6181 Fax: 886-2-2221-1948 / 886-2-2221-0660
http://www.liteon.com/opto

OPTICAL SENSOR
LTR-91400

Description

LTR-91400 is an integrated low voltage I²C ambient light sensor [ALS], gesture sensor [GS] and proximity sensor [PS], with built-in emitter in a single miniature chipled lead-free surface mount package.

This sensor converts light intensity to a digital output signal capable of direct I2C interface. The gesture sensor provides object motion direction information based on the reflected IR light detected by the 4 photodiodes for East, West, North and South direction. Besides, ambient light sensor provides a linear response over a wide dynamic range and is well suited to applications under high ambient brightness. With built-in proximity sensor (emitter and detector), it offers the feature to detect object at a user configurable distance.

The sensor supports an interrupt feature that removes the need to poll the sensor for a reading which improves system efficiency. The sensor also supports several features that help to minimize the occurrence of false triggering. This CMOS design and factory-set one time trimming capability ensure minimal sensor-to-sensor variations for ease of manufacturability to the end customers.

Application

To control brightness of the display panel, and/or detection of object or motion in mobile, computing, and consumer devices.

Features

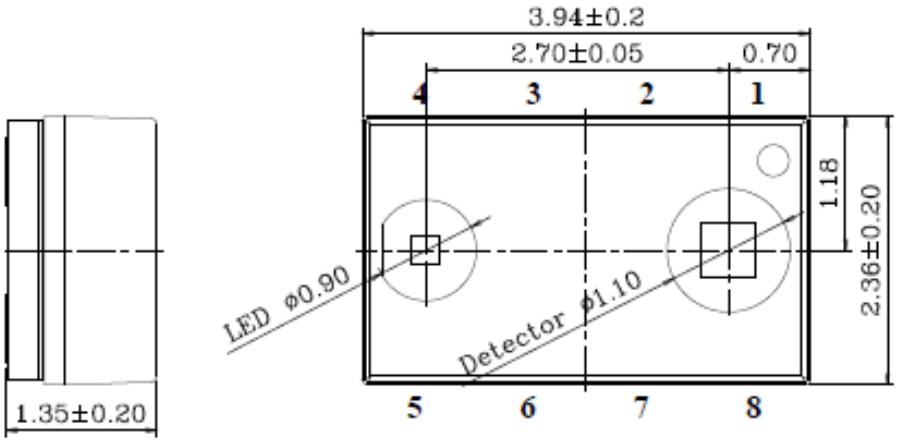
- I²C interface (Standard mode @100kHz or Fast mode @400kHz)
- Gesture, Ambient Light, and Proximity Sensing in one ultra-small ChipLED package
- Very low power consumption with sleep mode capability
- Operating voltage ranges: 2.4V to 3.6V
- Operating temperature ranges: -30 to +70 ºC
- Programmable interrupt function for ALS, PS, and GS.
- Built-in temperature compensation circuit
- RoHS and Halogen free compliant

- **GS Features**
  - 4 photodiodes for East, West, North and South direction
  - 32 dataset storage FIFO
  - 8-bit effective resolution
  - Programmable LED drive settings
  - Programmable crosstalk correction
- **ALS Features**
  - 16-bits effective resolution
  - Wide dynamic range of 1:15,000,000 with linear response
  - Close to human eye spectral response
  - Automatic rejection for 50Hz/60Hz lighting flicker
- **PS Features**
  - Built-in LED driver and detector
  - 11-bit effective resolution
  - Programmable LED drive settings
  - Programmable crosstalk correction
  - High Ambient Light Suppression

Ordering Information

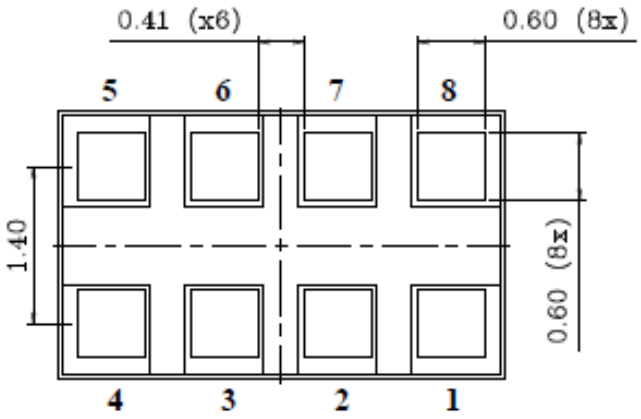
Part Number	Packaging Type	Package	Quantity
LTR-91400	Tape and Reel	8-pins Chip-led package	8000

1. Outline Dimensions



Pin-Out Assignment:

1. VDD
2. SCL
3. GND
4. LEDA
5. LEDK
6. LDR
7. INT
8. SDA

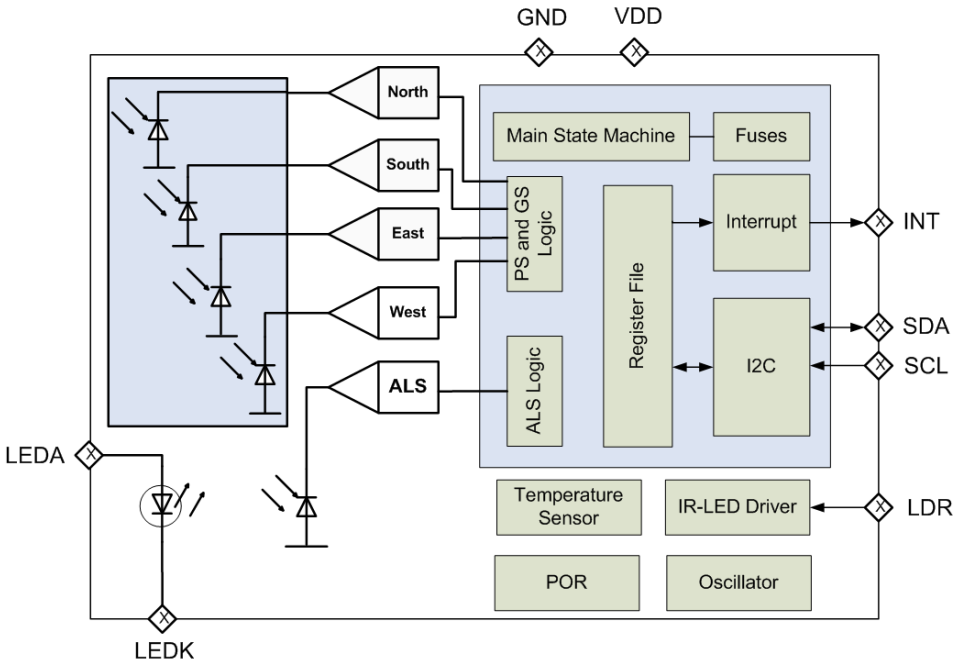


Note:

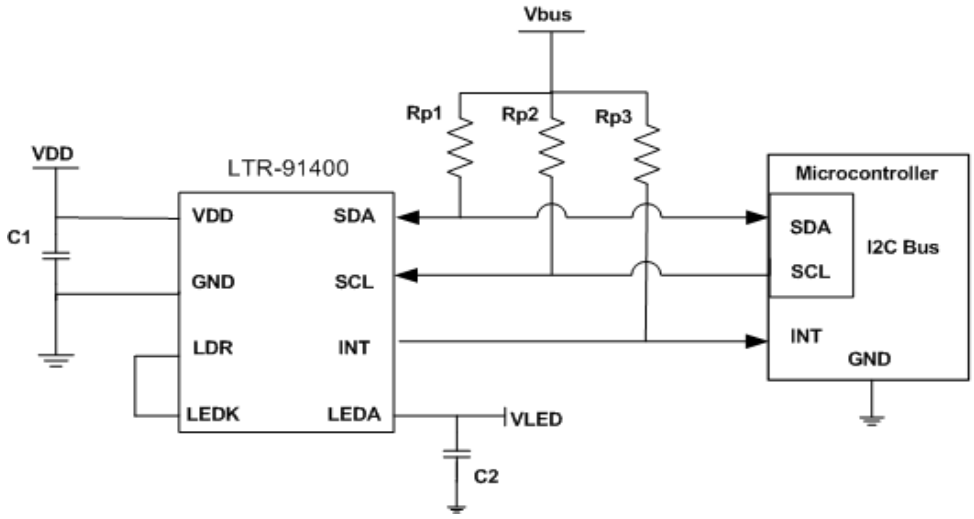
1. All dimensions are in millimeters

2. Functional Block Diagram

LTR-91400 contains 5 integrated photodiodes (1 for ambient light and 4 photodiodes for East, West, North, and South direction) for respective photocurrent measurement. The photodiode currents are converted to digital values by ADCs. The sensor also included a driver circuit for an external IRLED, as well as some peripheral circuits such as an internal oscillator, a current source, voltage reference, and internal fuses to store trimming information.



3. Application Circuit



Note: It is a must that VDD and VLED to be separated.

I/O Pins Configuration Table

Pin	I/O Type	Symbol	Description
1	Supply	VDD	Power Supply Voltage
2	IN	SCL	I^2C serial data
3	Ground	GND	Power Supply Ground. All voltages are referenced to GND
4	IN	LEDA	LED Anode. Connect to VLEDA on PCB
5	NC	LEDK	LED Cathode. Connect to LDR pin when using internal LED driver circuit
6	OUT	LDR	Proximity IR LED driver
7	OUT	INT	Interrupt
8	IN/OUT	SDA	I^2C serial clock

Recommended Application Circuit Components

Component	Recommended Value
Rp1, Rp2, Rp3 [1]	1 kΩ to 10 kΩ
C1, C2	1uF ± 20%, X7R Ceramic

Notes:

[1] Selection of pull-up resistors value is dependent on bus capacitance values. For more details, please refer to I2C Specifications: http://www.nxp.com/documents/user_manual/UM10204.pdf

4. Rating and Specification

4.1. Absolute Maximum Rating at Ta=25°C

Parameter	Symbol	Rating	Unit
Supply Voltage	VDD	3.8	V
Digital Voltage Range	SCL, SDA, INT	-0.5 to 3.8	V
Digital Output Current	SCL, SDA, INT	-1 to 20	mA
Storage Temperature	T_{stg}	-40 to 85	°C

Note: Exceeding these ratings could cause damage to the sensor. All voltages are with respect to ground. Currents are positive into, negative out of the specified terminal.

4.2. Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply Voltage	VDD	2.4		3.6	V
LED Supply Voltage	VLED	2.5		4.35	V
Interface Bus Power Supply Voltage	VIO	1.7		3.6	V
I2C Bus Input Pin High Voltage	VIH_SCL, VIH _SDA	1.2			V
I2C Bus Input Pin Low Voltage	VIL_SCL, VIL_SDA			0.6	V
Operating Temperature	T_{ope}	-30		70	°C

4.3. Electrical Specifications (VDD = 3.0V, Ta=25°C, unless otherwise noted)

Parameter	Min.	Typ.	Max	Unit	Condition
Active Supply Current 1		210		uA	ALS in active mode ALS integration time = 100ms ALS measurement repeat rate = 400ms
Active Supply Current 2		100		uA	PS in active mode, 25% Duty Cycle, 8us Pulse Width, 100mA, 8 Pulses PS measurement repeat rate = 100ms Not including VLED current
Active Supply Current 3		450		uA	GS+PS in active mode, 25% Duty Cycle, 8us Pulse Width, 100mA, 8 Pulses PS measurement repeat rate = 100ms Full 32 dataset, GS wait time = 0ms
Standby Current			5	uA	Standby / Sleep Mode
Initial Startup Time			100	ms	Min wait time after power up (supply ramp-up to 2.4V) before sending I2C commands

Wakeup Time from Standby		10	ms	Max wait time after turning device from stand-by to active before measurements starts
Leakage Current	-5	5	uA	SDA, SCL, INT pins

4.4. Characteristics ALS Ambient Light Sensor

Parameter	Min.	Typ.	Max.	Unit	Condition
Full ADC Resolution		16		bits	
Dark Count		0	10	count	Lux = 0, T_{ope}=25°C
ADC Ch0 Count Gain X128		34000		count	Lux=100, White LED, CCT~5K
ALS Lux Accuracy	-20		20	%	
50/60 Hz flicker noise error	-5		5	%	

4.5. Characteristics Proximity Sensor

Parameter	Min.	Typ.	Max.	Unit	Condition
Full ADC Resolution		11		bits	
LED peak wavelength		940		nm	
Detection Distance	50			mm	Under dark tinted window 25% Duty Cycle, 8us Pulse Width, 100mA, 2 Pulses, 18% Gray Card
LED Pulse Width		8		us	
LED Duty Cycle		25		%	
LED Peak Current	12.5		300	mA	Programmable LED current
Measurement repeat rate	6.125		800	msec	
Number of LED Pulses	1		15	Pulses	
Ambient Light Suppression			50K	lux	Direct Sunlight

4.6. Characteristics Gesture Sensor

Parameter	Min.	Typ.	Max.	Unit	Condition
Full ADC Resolution		8		bits	
LED peak wavelength		940		nm	
FIFO RAM		32		set	Sets of 4 bytes
Detection Distance		10		cm	With recommended optical design
LED Pulse Width		8		us	
LED Duty Cycle		25		%	
LED Peak Current	12.5		300	mA	

Measurement repeat rate	6.125	800	msec	Follow PS measurement repeat rate
Number of LED Pulses	1	15	Pulses	
Ambient Light Suppression		50K	lux	Direct Sunlight

4.7. Typical Device Parameter
(VDD = 3.0V, Ta=25ºC, default power-up settings, unless otherwise noted)

Power Spectral Responsivity of Detector

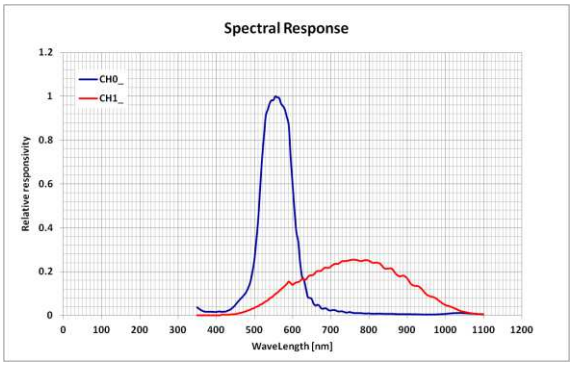


Figure 4.7.1: Spectral Response of ALS

Anglular of Incidence

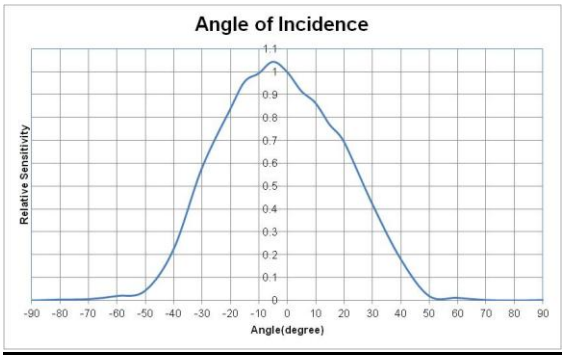


Figure 4.7.2: Anglular of ALS

PS Response

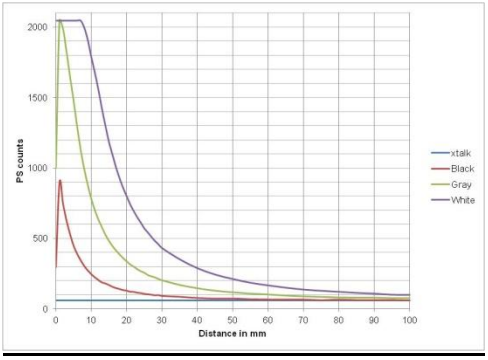


Figure 4.7.3: PS response

Anglular of LED

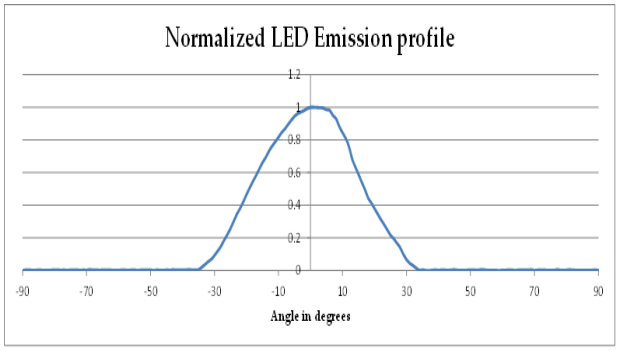
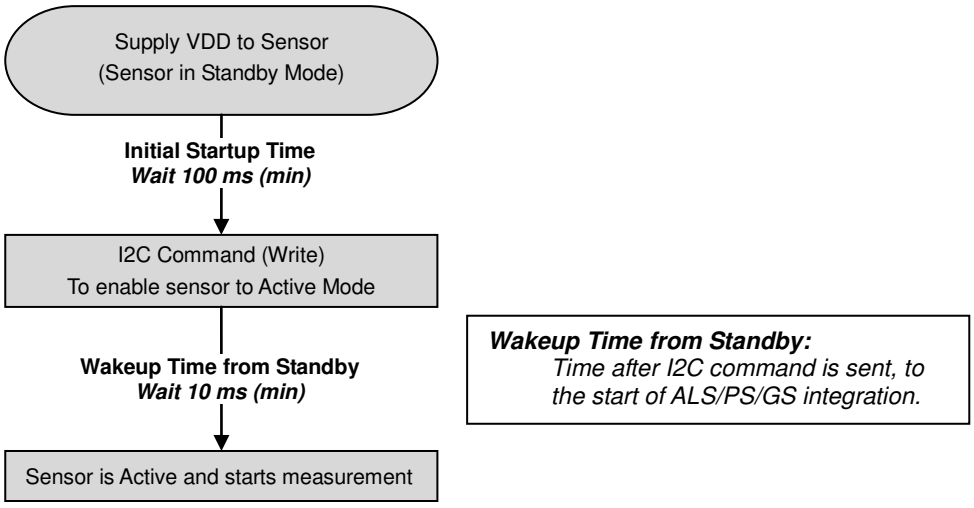


Figure 4.7.4: Angular of LED

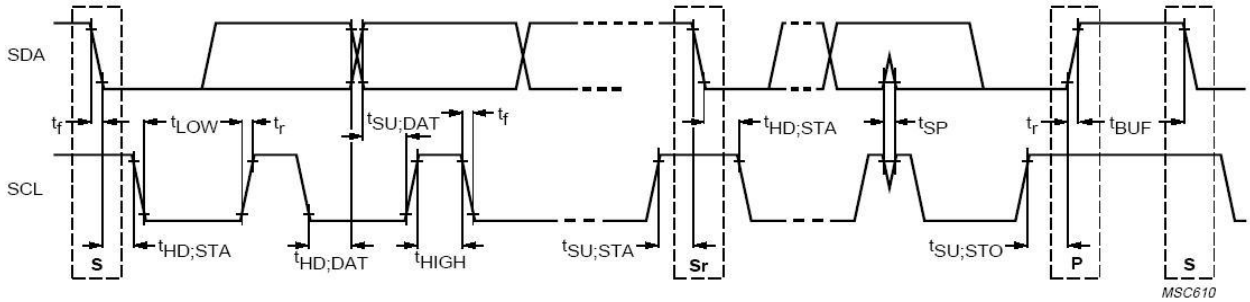
4.8. Startup Sequence



AC Electrical Characteristics

All specifications are at VBus = 1.7V, T_{ope} = 25°C, unless otherwise noted.

Parameter	Symbol	Min.	Max.	Unit
SCL clock frequency	f_{SCL}	100	400	kHz
Bus free time between a STOP and START condition	t_{BUF}	1.3		us
Hold time (repeated) START condition. After this period, the first clock pulse is generated	$t_{HD;STA}$	0.6		us
LOW period of the SCL clock	t_{LOW}	1.3		us
HIGH period of the SCL clock	t_{HIGH}	0.6		us
Set-up time for a repeated START condition	$t_{SU;STA}$	0.6		us
Set-up time for STOP condition	$t_{SU;STO}$	0.6		us
Rise time of both SDA and SCL signals	t_r	30	300	ns
Fall time of both SDA and SCL signals	t_f	30	300	ns
Data hold time	$t_{HD;DAT}$	30		s
Data setup time	$t_{SU;DAT}$	100		ns
Pulse width of spikes which must be suppressed by the input filter	t_{SP}	0	50	ns

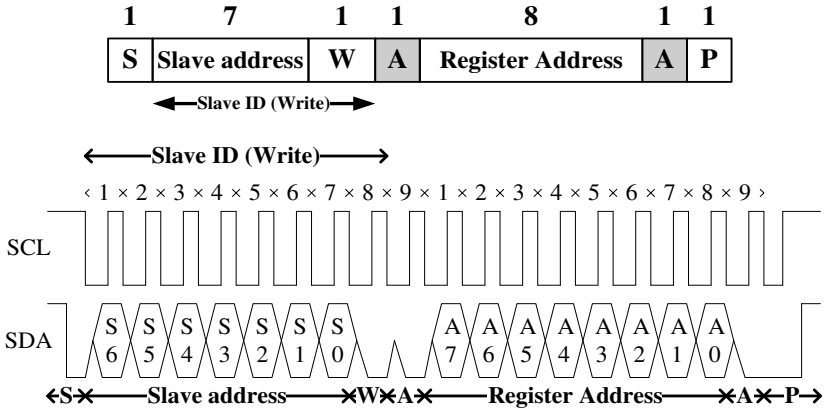


Definition of timing for I^2C bus

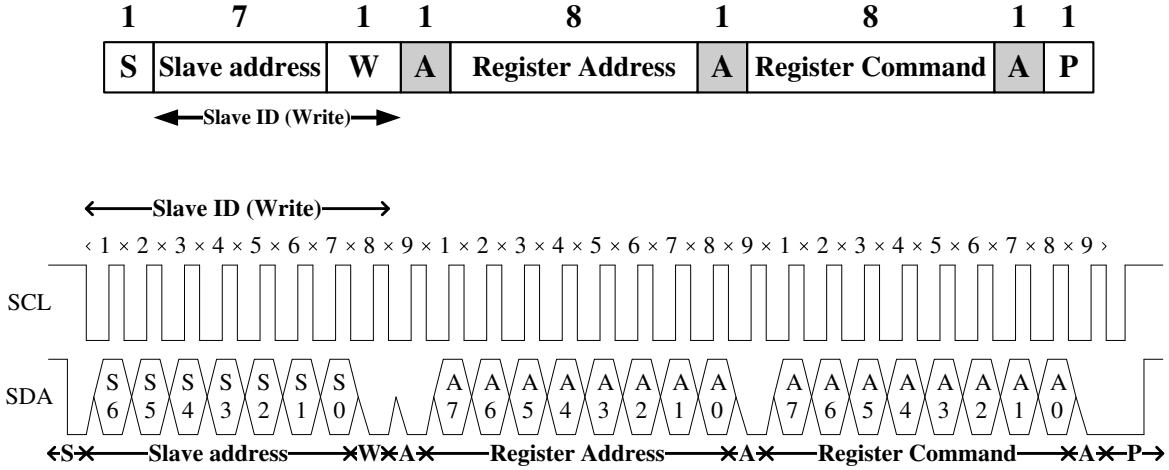
5. Principle of Operation

5.1. I2C Protocol

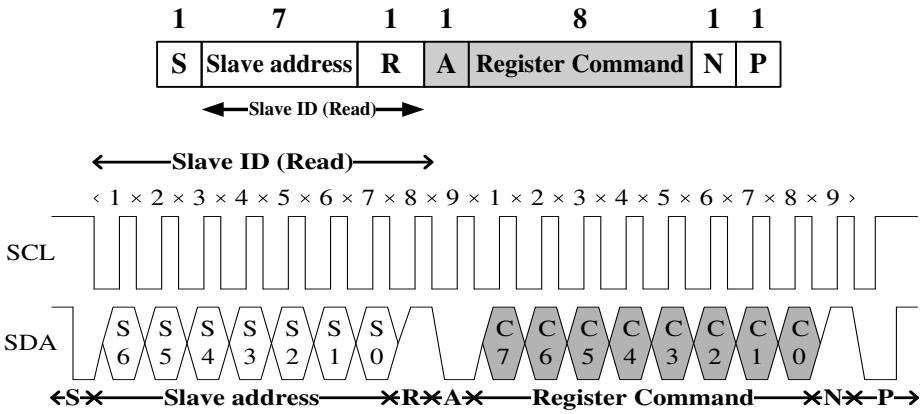
5.1.1. I2C Write Protocol (type 1)



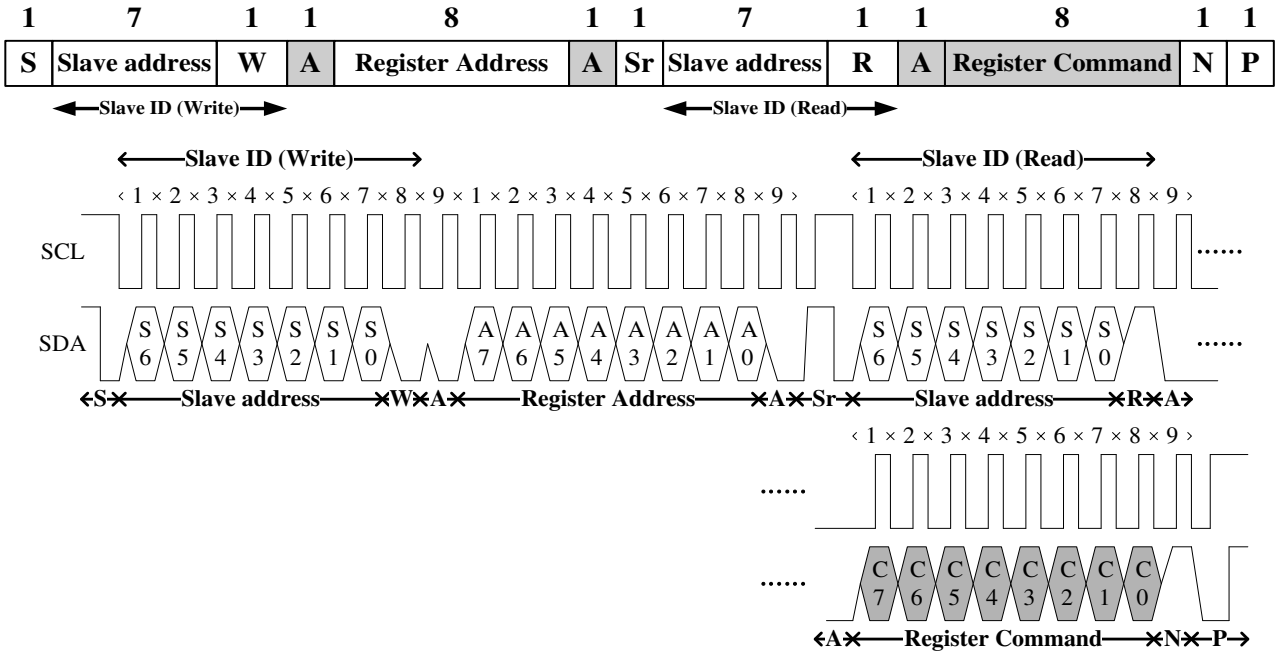
5.1.2. I2C Write Protocol (type 2)



5.1.3. I2C Read Protocol



5.1.4. I2C Read (Combined format) Protocol



A	Acknowledge (0 for an ACK)	**N**	Non-Acknowledge(1 for an NACK)
S	Start condition	**Sr**	Repeated Start condition
P	Stop condition		
W	Write (0 for writing)	**R**	Read (1 for read)
	Slave-to-master		Master-to-Slave

5.2. I2C Slave Address

The 7 bits slave address for this sensor is 0x23H. A read/write bit should be appended to the slave address by the master device to properly communicate with the sensor.

I²C Slave Address									
Command Type	(0x23H)							(0x23H)	(0x23H)
	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
Write	0	1	0	0	0	1	1	0	0x46H
Read	0	1	0	0	0	1	1	1	0x47H

6. Register Set

Address	R / W	Register Name	Description	Reset Value
0x80	RW	ALS_CTRL	ALS operation mode control, and SW reset	0x00
0x81	RW	PS_CTRL	PS operation mode control	0x40
0x82	RW	GS_CTRL	GS operation mode control	0x00
0x83	RW	ALS_MEAS_RATE	ALS measurement rate in active mode	0x0B
0x84	RW	ALS _THRES_UP_LSB	ALS interrupt upper threshold, LSB	0xFF
0x85	RW	ALS _THRES_UP_MSB	ALS interrupt upper threshold, MSB	0xFF
0x86	RW	ALS _THRES_LOW_LSB	ALS interrupt lower threshold, LSB	0x00
0x87	RW	ALS _THRES_LOW_MSB	ALS interrupt lower threshold, MSB	0x00
0x88	RW	PS_LED	PS LED settings	0x70
0x89	RW	PS_MEAS_RATE	PS measurement rate settings	0x40
0x8A	RW	RESERVED	RESERVED	0x00
0x8B	RW	PS_XTALK_NE_LSB	Crosstalk correction on PS North East detector, LSB	0x00
0xCB	RW	PS_XTALK_NE_MSB	Crosstalk correction on PS North East detector, MSB	0x00
0x8C	RW	PS_XTALK_SW_LSB	Crosstalk correction on PS South West detector, LSB	0x00
0xCC	RW	PS_XTALK_SW_MSB	Crosstalk correction on PS South West detector, MSB	0x00
0x8D	RW	PS_THRES_UP_LSB	PS interrupt upper threshold, LSB	0xFF
0xCD	RW	PS_THRES_UP_MSB	PS interrupt upper threshold, MSB	0x07
0x8E	RW	PS_THRES_LOW_LSB	PS interrupt lower threshold, LSB	0x00
0xCE	RW	PS_THRES_LOW_MSB	PS interrupt lower threshold, MSB	0x00
0x8F	RW	INTERTUPT_PERSIST	PS and ALS interrupt persist settings	0x00
0x90	RW	GS_LED	GS LED settings	0x70
0x91	RW	GS_WAIT	GS wait time settings	0x00
0x92	RW	GS_PERSIST	GS interrupt persist settings	0x00
0x93	RW	GS_ENTRY_LSB	GS entry threshold value (1st entry), LSB	0xFF
0xC3	RW	GS_ENTRY_MSB	GS entry threshold value (1st entry), MSB	0x07
0x94	RW	GS_EXIT	GS exit threshold value	0x00
0x95	RW	GS_GATE	GS Gate after the 1st entry	0x00
0x96	RW	GS_ XTALK_N	Crosstalk correction on GS North detector	0x00
0x97	RW	GS_ XTALK_S	Crosstalk correction on GS South detector	0x00
0x98	RW	GS_ XTALK_E	Crosstalk correction on GS East detector	0x00
0x99	RW	GS_ XTALK_W	Crosstalk correction on GS West detector	0x00
0x9A	R	PART_ID	Part Number ID and revision IDs	0xC1
0x9B	R	MANUFACT_ID	Manufacturer ID	0x05
0x9C	R	ALS_STATUS	ALS new data status	0x00
0x9D	R	PS_STATUS	PS new data status	0x00

0x9E	R	GS_STATUS	GS new data status	0x00
0xA0 ~ 0xA3	R	RESERVED	RESERVED	0x00
0xA4	R	ALS_CH0_LSB	ALS measurement CH0 data, LSB	0x00
0xA5	R	ALS_CH0_MSB	ALS measurement CH0 data, MSB	0x00
0xA6	R	ALS_CH1_LSB	ALS measurement CH1 data, LSB	0x00
0xA7	R	ALS_CH1_MSB	ALS measurement CH1 data, MSB	0x00
0xA8 – 0xAF	R	RESERVED	RESERVED	0x00
0xB0	R	PS_DATA_LSB	PS measurement data, LSB	0x00
0xB1	R	PS_DATA_MSB	PS measurement data, MSB	0x00
0xB2	R	GS_FIFO_ADDR	GS FIFO address pointer	0x00
0xB3	R	GS_FIFO_ACCESS_N	GS North data	0x00
0xB4	R	GS_FIFO_ACCESS_S	GS South data	0x00
0xB5	R	GS_FIFO_ACCESS_E	GS East data	0x00
0xB6	R	GS_FIFO_ACCESS_W	GS West data	0x00

6.1. ALS_CTRL Register (Address: 0x80) (Read/Write)

The ALS_CTRL register controls ALS operation modes as well as the soft (SW) reset for the whole chip. At any mode (stand-by or active), the I^2C circuitry is always active.

0x80	ALS_CTRL (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved		*ALS_INT*	*ALS_GAIN*			*SW_RST*	*ALS_MODE*

Field	Bits	Default	Description	
Reserved	7:6	00	--	
ALS_INT	5	0	ALS Interrupt Enable. When ALS Interrupt is enabled, Interrupt is given when CLEAR channel exceed specified ALS Threshold.	
			0	Disable **(default)**
			1	Enable
ALS_GAIN	4:2	000	000	Gain 1X **(default)**
			001	Gain 4X
			010	Gain 16X
			011	Gain 64X
			100	Gain 128X
			101	Gain 256X
			11X	Reserved
SW_RST	1	0	Reset registers to default values, with sensor into standby mode.	
			0	No action **(default)**
			1	Reset Registers to default values
ALS_MODE	0	0	0	Stand-by mode **(default)**
			1	Active mode

6.2. PS_CTRL Register (Address: 0x81) (Read/Write)

This register controls the Proximity Sensor (PS) operation modes.

0x81	PS_CTRL (default = 0x40)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	NEAR/FAR_ Status_EN	*Reserved*		*PS_Offset _EN*	*PS_GAIN*		*PS_MODE*	*PS_INT*

Field	Bits	Default	Description	
NEAR / FAR_Status_EN	7	0	0	Disable NEAR/FAR Status reporting **(default)**
			1	Enable NEAR/FAR Status reporting
Reserved	6:5	10	--	--
PS_Offset_EN	4	0	For crosstalk correction feature. When enabled, PS DATA will be subtracted with PS_XTALK register data.	
			0	Disabled **(default)**
			1	Enabled
PS_GAIN	3:2	00	00	X1 **(default)**
			01/10/11	Reserved
PS_MODE	1	0	0	Stand-by mode **(default)**
			1	Active mode
PS_INT	0	0	0	Disable **(default)**
			1	Enable

6.3. GS_CTRL Register (Address: 0x82) (Read/Write)

This register controls the Gesture Sensor (GS) operation modes.

0x82	GS_CTRL (default = 0x00)							
	Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
	Reserved	***GS_Force Start***	***GS_FIFO Reset***	***GS_Offset _EN***	***GS_GAIN***		***GS_MODE***	***GS_INT***

Field	Bits	Default	Description	
Reserved	7	0	--	
GS_Force Start	6	0	0	GS force start disable (based on threshold setting at register address 0x93)
			1	GS force start enable (ignore threshold value)
GS_FIFO Reset	5	0	0	FIFO not reset
			1	FIFO reset
GS_Offset_EN	4	0	For crosstalk correction feature. When enabled, GS DATA will be subtracted with GS_XTALK register data.	
			0	Disabled **(default)**
			1	Enabled
GS_GAIN	3:2	00	00	X1 **(default)**
			01/10/11	Reserved
GS_MODE	1	0	0	Stand-by mode **(default)**
			1	Active mode
GS_INT	0	0	0	Disable **(default)**
			1	Enable

6.4. ALS_MEAS_RATE Register (Address: 0x83) (Read/Write)

This register controls the integration time and timing of the periodic measurement of the ALS in active mode.

0x83	ALS_MEAS_RATE (default = 0x0B)							
	Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
	Reserved			***ALS Integration Time***		***ALS Measurement Rate***		

Field	Bits	Default	Description	
Reserved	7:5	000	--	
ALS Integration Time	4:3	01	00	50ms
			01	100ms **(default)**
			10	200ms
			11	400ms
ALS Measurement Rate	2:0	011	000	50ms
			001	100ms
			010	200ms
			011	400ms **(default)**
			1XX	800ms

6.5. ALS_THRES_UP Registers (Address: 0x84 ~ 0x85) (Read/Write)

These registers are used to set the upper limit of the interrupt threshold for ALS. Interrupt functions compare the value in the ALS_THRES_UP registers to the measured data in the ALS_DATA register. The data format should be the same as that of ALS_DATA register.

Field	Register	Default	Description
ALS_THRES_UP_LSB	0x84	1111 1111	ALS least significant byte of the upper interrupt threshold, bit 0 is the LSB of the 16-bit data
ALS_THRES_UP_MSB	0x85	1111 1111	ALS most significant byte of the upper interrupt threshold, bit 7 is the MSB of the 16-bit data

6.6. ALS_THRES_LOW Register (Address: 0x86 ~ 0x87) (Read/Write)

These registers are used to set the lower limit of the interrupt threshold for ALS. Interrupt functions compare the value in the ALS_THRES_LOW registers to the measured data in the ALS_DATA register. The data format should be the same as that of ALS_DATA register.

Field	Register	Default	Description
ALS_THRES_LOW_LSB	0x86	0000 0000	ALS least significant byte of the lower interrupt threshold, bit 0 is the LSB of the 16-bit data
ALS_THRES_LOW_MSB	0x87	0000 0000	ALS most significant byte of the lower interrupt threshold, bit 7 is the MSB of the 16-bit data

6.7. PS_LED Register (Address: 0x88) (Read/Write)

This register sets the PS LED Boost and the Drive Strength.

0x88	PS_LED (default = 0x70)							
	Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
	Reserved				***PLED_BOOST***		***PLED_DRIVE***	

Field	Bits	Default	Description	
Reserved	7:4	0111	Must write 0101	
PLED_BOOST	3:2	00	00	1x **(default)**
			01	1.5x
			10	2x
			11	3x
PLED_DRIVE	1:0	00	00	100mA **(default)**
			01	50mA
			10	25mA
			11	12.5mA

6.8. PS_MEAS_RATE Register (Address: 0x89) (Read/Write)

This register controls PS measurement time and number of PS LED Pulses.

0x89	PS_MEAS_RATE (default = 0x40)							
	Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
	PS Measurement Time			***Reserved***	**PS number of LED pulses**			

Field	Bits	Default	Description	
PS Measurement Time	7:5	010	000	6.125ms
			001	50ms
			010	100ms **(default)**
			011	200ms
			100	400ms
			101	800ms

			110	12.5ms
			111	25ms
Reserved	4	0	Must write 1	
PS number of LED pulses	3:0	0000	Specifies PS LED number of pulses. If PS number of pulse set to 0, the pulse count will be 1	

6.9. PS_XTALK_NE Registers (Address: 0x8B, 0xCB) (Read/Write)

These registers provide crosstalk correction on PS North+East detectors pair.

Field	Register	Default	Description
PS_XTALK_NE_LSB	0x8B	0000 0000	PS North+East Data will subtract this value, LSB
PS_XTALK_NE_MSB	0xCB	000	PS North+East Data will subtract this value, MSB.

6.10. PS_XTALK_SW Registers (Address: 0x8C, 0xCC) (Read/Write)

These registers provide crosstalk correction on PS South+West detectors pair.

Field	Register	Default	Description
PS_XTALK_SW_LSB	0x8C	0000 0000	PS South+West Data will subtract this value, LSB.
PS_XTALK_SW_MSB	0xCC	000	PS South+West Data will subtract this value, MSB.

6.11. PS_THRES_UP Register (Address: 0x8D, 0xCD) (Read/Write)

This register is used to set the upper limit of the absolute interrupt threshold value. Interrupt functions compare the value in the PS_THRES_UP registers to measured data value in PS_DATA registers. The data format for PS_THRES_UP must be the same as that of PS_DATA registers.

Field	Register	Default	Description
PS_THRES_UP_LSB	0x8D	1111 1111	PS upper interrupt threshold value, LSB
PS_THRES_UP_MSB	0xCD	111	PS upper interrupt threshold value, MSB

6.12. PS_THRES_LOW Register (Address: 0x8E, 0xCE) (Read/Write)

This register is used to set the lower limit of the absolute interrupt threshold value. Interrupt functions compare the value in the PS_THRES_LOW registers to measured data value in PS_DATA registers. The data format for PS_THRES_LOW must be the same as that of PS_DATA registers.

Field	Register	Default	Description
PS_THRES_LOW_LSB	0x8E	0000 0000	PS lower interrupt threshold value, LSB

PS_THRES_LOW_MSB	0xCE	000	PS lower interrupt threshold value, MSB

6.13. INTERRUPT PERSIST Register (Address: 0x8F) (Read/Write)

This register sets the N number of times the measurement is out of the threshold range settings before asserting the INTERRUPT pin.

0x8F	INTERRUPT PERSIST (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	PS_PERSIST				*ALS_PERSIST*			

Field	Bits	Default	Description	
PS_PERSIST	7:4	0000	0000	Every PS value out of threshold range **(default)**
			0001	1 consecutive PS values out of threshold range
			.....	.....
			1111	15 consecutive PS values out of threshold range
ALS_PERSIST	3:0	0000	0000	Every ALS value out of threshold range **(default)**
			0001	1 consecutive ALS values out of threshold range
			….	….
			1111	15 consecutive ALS values out of threshold range

6.14. GS_LED Register (Address: 0x90) (Read/Write)

This register sets the GS LED Boost and the Drive Strength.

0x90	GS_LED (default = 0x70)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved				*GLED_BOOST*		*GLED_DRIVE*	

Field	Bits	Default	Description	
Reserved	7:4	0111	Must write 0101	
GLED_BOOST	3:2	00	00	1x **(default)**
			01	1.5x
			10	2x
			11	3x
GLED_DRIVE	1:0	00	00	100mA **(default)**
			01	50mA
			10	25mA
			11	12.5mA

6.15. GS_WAIT Register (Address: 0x91) (Read/Write)

This register controls GS wait time and number of GS LED Pulses.

0x91	GS_WAIT (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved	*GS Wait Time*			*GS Number of LED pulses*			

Field	Bits	Default	Description	
Reserved	7	0	--	
GS Wait Time	6:4	000	000	0ms **(default)**
			001	2ms
			010	4ms
			011	6ms
			100	10ms
			101	14ms
			110	18ms
			111	22ms
GS Number of LED pulses	3:0	0000	Specifies GS LED number of pulses. If GS number of pulse set to 0, the pulse count will be 1.	

6.16. GS_PERSIST Register (Address: 0x92) (Read/Write)

This register set the occurrence of gesture exit.

0x92	GS_PERSIST (default = 0x00)							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	Reserved				*GS_PERSIST*		*Reserved*	

Field	Bits	Default	Description	
Reserved	7:4	0000	--	
GS PERSIST	3:2	00	00	1st gesture exit occurrence will exit gesture detections.
			01	2nd gesture exit occurrence will exit gesture detections.
			10	3rd gesture exit occurrence will exit gesture detections.
			11	4th gesture exit occurrence will exit gesture detections.
Reserved	1:0	00	--	

6.17. GS_ENTRY Register (Address: 0x93, 0xC3) (Read/Write)

This register compares with Proximity value PS_DATA, to determine if were to enter the gesture integration. GS_ENTRY to be greater than Xtalk level. Example: Xtalk = 100, set GS_ENTRY = 150.

Setting GS_Entry to 0x00 will force sensor to enter gesture integration as long as GS_MODE is enabled.

Please refer to GS state machine (Page 28) for more details.

Field	Register	Default	Description
GS_ENTRY_LSB	0x93	1111 1111	GS entry threshold value, LSB
GS_ENTRY_MSB	0xC3	111	GS entry threshold value, MSB

6.18. GS_EXIT Register (Address: 0x94) (Read/Write)

This register compares with Gesture value to determine if were to exit the gesture integration.

Please refer to GS state machine (Page 28) for more details.

Field	Register	Default	Description	
GS_EXIT	0x94	0000 0000	GS exit threshold value.	
			0xFF	Prevent gesture event detection
			….	GS exit threshold value. Recommended to be same level to GS entry threshold value. Example: GS_EXIT = GS_ENTRY
			0x00	Force sensor to complete 32 GS datasets. **(default)**

6.19. GS_GATE Register (Address: 0x95) (Read/Write)

After entry threshold (value in GS_ENTRY) is exceeded, this register provides additional gate before final entry into the GS machine. This register is the threshold value of considering there is a gesture event when the absolute delta count of either W-E or N-S exceeding the threshold value.

Field	Register	Default	Description	
GS_GATE	0x95	0000 0000	GS threshold value.	
			0xFF	Prevent gesture event detection
			….	GS threshold value.
			0x00	Always trigger gesture event even if there is no gesture event. **(default)**

6.20. GS_XTALK Registers (Address: 0x96 ~ 0x99) (Read/Write)

These registers provide crosstalk correction for the detectors.

Field	Register	Default	Description
GS_XTALK_N	0x96	0000 0000	GS North Data will subtract this value.
GS_XTALK_S	0x97	0000 0000	GS South Data will subtract this value.
GS_XTALK_E	0x98	0000 0000	GS East Data will subtract this value.
GS_XTALK_W	0x99	0000 0000	GS West Data will subtract this value.

6.21. PART_ID Register (Address: 0x9A) (Read Only)

This register defines the part number of the device.

0x9A	PART_ID (default = 0xC1)							
	Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
	Part ID				***Reserved***			

Field	Bits	Default	Description
Part ID	7:4	1100	Part Number ID
Reserved	3:0	0001	--

6.22. MANUFACT_ID Register (Address: 0x9B) (Read Only)

This register defines the manufacturer identification.

Field	Register	Default	Description
MANUFACT_ID	0x9B	05H	Manufacturer ID