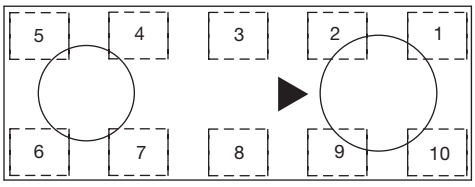
# High Sensitivity Long Distance Proximity and Ambient Light Sensor With I²C Interface

## DESCRIPTION

VCNL4100 integrates a high sensitivity long distance proximity sensor (PS), ambient light sensor (ALS), and 940 nm IRED into one small package. It incorporates photodiodes, amplifiers, and analog to digital converting circuits into a single chip using a CMOS process. The 16-bit high resolution ALS offers excellent sensing capabilities with sufficient selections to fulfill most applications whether a dark or high transparency lens design. VCNL4100 offers individual programmable high and low threshold interrupt features for the best utilization of resources and power saving on the microcontroller. For the 8-bit proximity sensing function, VCNL4100 has a built-in intelligent cancellation scheme that eliminates background light issues. The persistence feature prevents false judgment of proximity sensing due to ambient light noise.

The adoption of the patented Filtron™ technology achieves the closest ambient light spectral sensitivity to real human eye responses. VCNL4100 provides excellent temperature compensation capability for keeping the output stable under changing temperature. ALS and PS functions are easily operated via the simple command format of I²C (SMBus compatible) interface protocol. Operating voltage ranges from 2.5 V to 3.6 V.

## PIN DEFINITION




Top View

| | | | |
|---|---|---|---|
| 1 | GND | 6 | LED+ |
| 2 | LED_Cathode | 7 | NC |
| 3 | $V_{DD}$ | 8 | INT |
| 4 | NC | 9 | SDAT |
| 5 | LED- | 10 | SCLK |

## FEATURES

- Package type: surface-mount
- Dimensions (L x W x H in mm): 8.0 x 3.0 x 1.8
- Integrated modules: infrared emitter (IRED), ambient light sensor (ALS), proximity sensor (PS), and signal conditioning IC
- Operates ALS and PS in parallel structure
- Filtron™ technology adoption for robust background light cancellation
- Supports low transmittance (dark) lens design
- Temperature compensation: -40 °C to +85 °C
- Low power consumption I²C (SMBus compatible) interface
- Floor life: 168 h, MSL 3, according to J-STD-020
- Output type: I²C bus (ALS / PS)
- Operation voltage: 2.5 V to 3.6 V
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free

e4

RoHS COMPLIANT

HALOGEN FREE GREEN (5-2008)

## PROXIMITY FUNCTION

- Immunity to red glow (940 nm IRED)
- Intelligent background light cancellation
- Smart persistence scheme to reduce PS response time
- Proximity distance up to 1 m

## AMBIENT LIGHT FUNCTION

- Fluorescent light flicker immunity
- Spectrum close to real human eye responses
- Selectable maximum detection range (655 / 1311 / 2621 / 5243) lux with highest sensitivity 0.01 lux/step

## INTERRUPT

- Programmable interrupt function for ALS and PS with upper and lower thresholds
- Adjustable persistence to prevent false triggers for ALS and PS

## APPLICATIONS

- Presence detection to activate displays in printers, copiers, and home appliances
- Collision detection in robots and toys
- Proximity sensing and lighting control in offices, corridors and public buildings
- Vehicle occupancy detection in parking lots
- Proximity detection in lavatory appliances

| PRODUCT SUMMARY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PART NUMBER | OPERATING RANGE (mm) | OPERATING VOLTAGE RANGE (V) | I²C BUS VOLTAGE RANGE (V) | IRED PULSE CURRENT (mA) | AMBIENT LIGHT RANGE (lx) | AMBIENT LIGHT RESOLUTION (lx) | OUTPUT CODE | ADC RESOLUTION PROXIMITY / AMBIENT LIGHT |
| VCNL4100 | 0 to 1000 | 2.5 to 3.6 | 1.8 to 3.6 | 800 (1) | 0.01 to 5243 | 0.01 | 16 bit, I²C | 8 bit / 16 bit |

**Note**

(1) Maximum allowed current for VCNL4100 internal IRED

| ORDERING INFORMATION | | | | |
|---|---|---|---|---|
| ORDERING CODE | PACKAGING | VOLUME (1) | PIN NUMBER | REMARKS |
| VCNL4100 | Tape and reel | MOQ: 2500 pcs | 10 | 8.0 mm x 3.0 mm x 1.8 mm |

**Note**

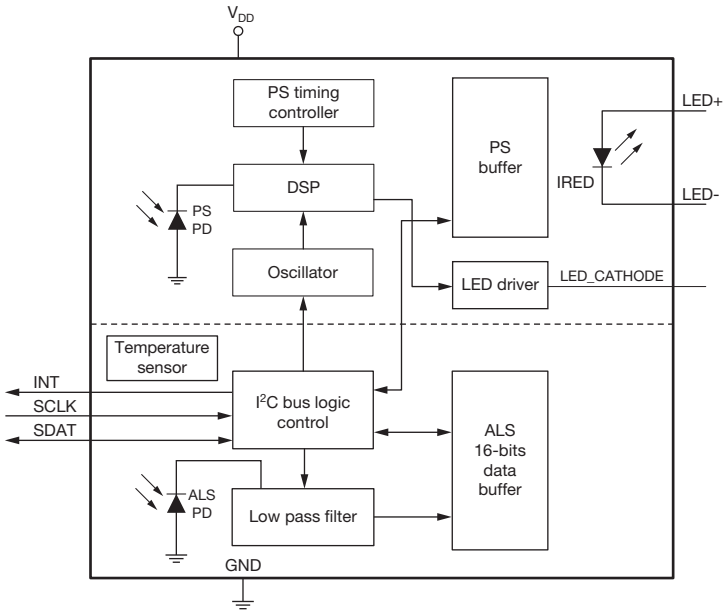
(1) MOQ: minimum order quantity

| ABSOLUTE MAXIMUM RATINGS ($T_{amb}$ = 25 °C, unless otherwise specified) | | | | | |
|---|---|---|---|---|---|
| PARAMETER | TEST CONDITION | SYMBOL | MIN. | MAX. | UNIT |
| Supply voltage | | $V_{DD}$ | - | 5.0 | V |
| Operation temperature range | | $T_{amb}$ | -40 | +85 | °C |
| Storage temperature range | | $T_{stg}$ | -40 | +100 | °C |

| RECOMMENDED OPERATING CONDITIONS ($T_{amb}$ = 25 °C, unless otherwise specified) | | | | | |
|---|---|---|---|---|---|
| PARAMETER | TEST CONDITION | SYMBOL | MIN. | MAX. | UNIT |
| Supply voltage | | $V_{DD}$ | 2.5 | 3.6 | V |
| Operation temperature range | | $T_{amb}$ | -40 | +85 | °C |
| I²C bus operating frequency | | $f_{(I2CCLK)}$ | 10 | 400 | kHz |

| PIN DESCRIPTIONS | | | |
|---|---|---|---|
| PIN ASSIGNMENT | SYMBOL | TYPE | FUNCTION |
| 1 | GND | I | Ground |
| 2 | LED_CATHODE | I | IRED cathode connection |
| 3 | $V_{DD}$ | I | Power supply input |
| 4 | NC | - | No connection |
| 5 | LED- | O | IRED cathode |
| 6 | LED+ | I | IRED anode |
| 7 | NC | - | No connection |
| 8 | INT | O | Interrupt pin |
| 9 | SDAT | I / O (open drain) | I²C data bus data input / output |
| 10 | SCLK | I | I²C digital bus clock input |

## BLOCK DIAGRAM




| BASIC CHARACTERISTICS ($T_{amb}$ = 25 °C, unless otherwise specified) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PARAMETER** | | **TEST CONDITION** | **SYMBOL** | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| Supply voltage | | | $V_{DD}$ | 2.5 | - | 3.6 | V |
| Supply voltage for IRED | | | $V_{IRED}$ | 3.8 | - | 5.0 | V |
| Supply current | | Excluded LED driving | $I_{DD}$ | - | 195 | - | µA |
| Shutdown current | | Light condition = dark, $V_{DD}$ = 3.3 V | $I_{DD}$ (SD) | - | 0.2 | - | µA |
| ALS shut down | | ALS disable, PS enable | $I_{ALSSD}$ | - | 180 | - | µA |
| PS shut down | | ALS enable, PS disable | $I_{PSSD}$ | - | 175 | - | µA |
| $I^2C$ signal input | Logic high | $V_{DD}$ = 3.3 V | $V_{IH}$ | 1.5 | - | - | V |
| | Logic low | | $V_{IL}$ | - | - | 0.8 | |
| | Logic high | $V_{DD}$ = 2.6 V | $V_{IH}$ | 1.4 | - | - | V |
| | Logic low | | $V_{IL}$ | - | - | 0.6 | |
| Peak sensitivity wavelength of ALS | | | $\lambda_p$ | - | 550 | - | nm |
| Peak sensitivity wavelength of PS | | | $\lambda_{pps}$ | - | 940 | - | nm |
| Full ALS counts | | 16-bit resolution | | - | - | 65 535 | steps |
| Full PS counts | | 8-bit resolution | | - | - | 255 | steps |
| Detectable intensity | Minimum | IT = 640 ms, $V_{DD}$ = 3.3 V, 1 step (1)(2) | | - | 0.01 | - | lx |
| | Maximum | IT = 80 ms, $V_{DD}$ = 3.3 V, 65 535 steps (1)(2) | | - | 5243 | - | |
| ALS dark offset | | IT = 80 ms, $V_{DD}$ = 3.3 V, normal sensitivity (1) | | 0 | - | 3 | steps |
| Operating temperature range | | | $T_{amb}$ | -40 | - | +85 | °C |
| IRED driving current | | (3) | | - | - | 800 | mA |

**Notes**

(1) Light source: white LED

(2) Maximum detection range to ambient light can be determined by ALS refresh time adjustment. Refer to table 17 “ALS Resolution and Maximum Detection Range”

(3) Based on IRED on / off duty ratio = 1/5120, 1/640, 1/80, and 1/20. The circuitry should use an external MOSFET as shown with fig.10. Please see also the Application Note “Designing the VCNL4100 into an Application” (www.vishay.com/doc?84361).

| **I²C BUS TIMING CHARACTERISTICS** ($T_{amb}$ = 25 °C, unless otherwise specified) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **STANDARD MODE** | | **FAST MODE** | | **UNIT** |
| | | **MIN.** | **MAX.** | **MIN.** | **MAX.** | |
| Clock frequency | $f_{(SMBCLK)}$ | 10 | 100 | 10 | 400 | kHz |
| Bus free time between start and stop condition | $t_{(BUF)}$ | 4.7 | - | 1.3 | - | µs |
| Hold time after (repeated) start condition; after this period, the first clock is generated | $t_{(HDSTA)}$ | 4.0 | - | 0.6 | - | µs |
| Repeated start condition setup time | $t_{(SUSTA)}$ | 4.7 | - | 0.6 | - | µs |
| Stop condition setup time | $t_{(SUSTO)}$ | 4.0 | - | 0.6 | - | µs |
| Data hold time | $t_{(HDDAT)}$ | | 3450 | - | 900 | ns |
| Data setup time | $t_{(SUDAT)}$ | 250 | - | 100 | - | ns |
| I²C clock (SCK) low period | $t_{(LOW)}$ | 4.7 | - | 1.3 | - | µs |
| I²C clock (SCK) high period | $t_{(HIGH)}$ | 4.0 | - | 0.6 | - | µs |
| Detect clock / data low timeout | $t_{(TIMEOUT)}$ | 25 | 35 | - | - | ms |
| Clock / data fall time | $t_{(F)}$ | - | 300 | - | 300 | ns |
| Clock / data rise time | $t_{(R)}$ | - | 1000 | - | 300 | ns |

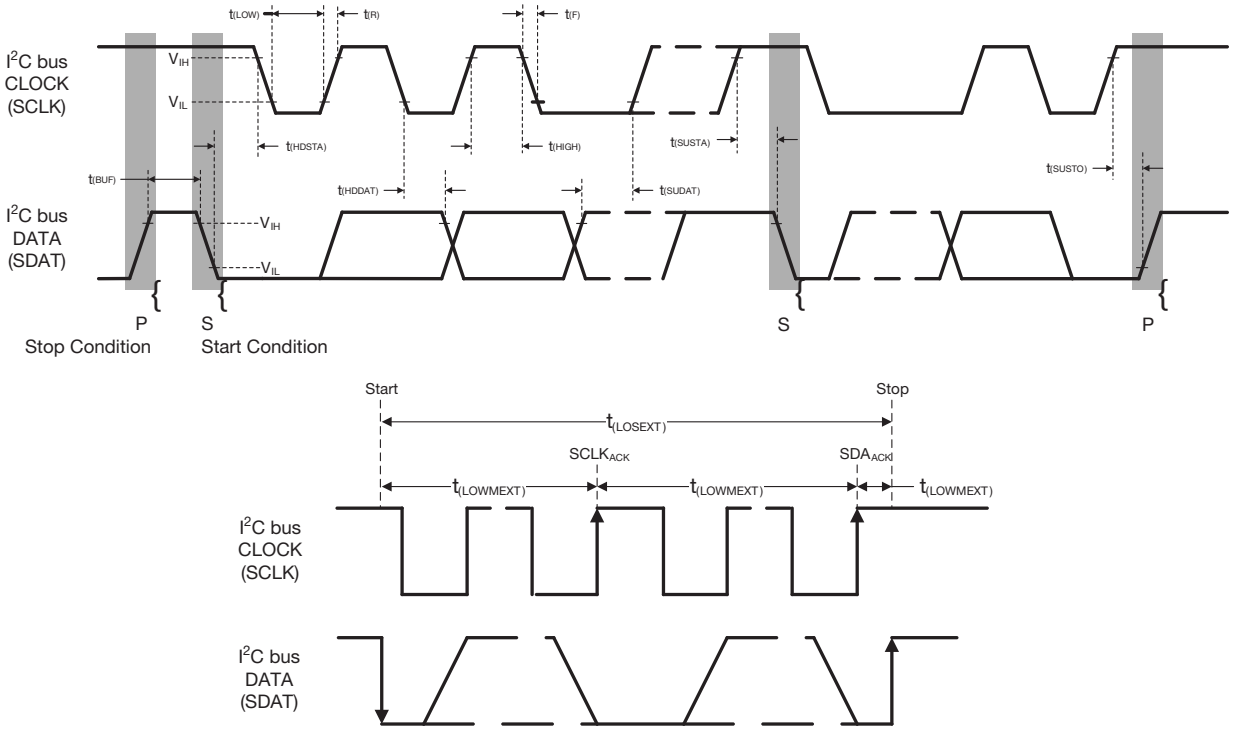



Fig. 1 - I²C Bus Timing Diagram

## PARAMETER TIMING INFORMATION

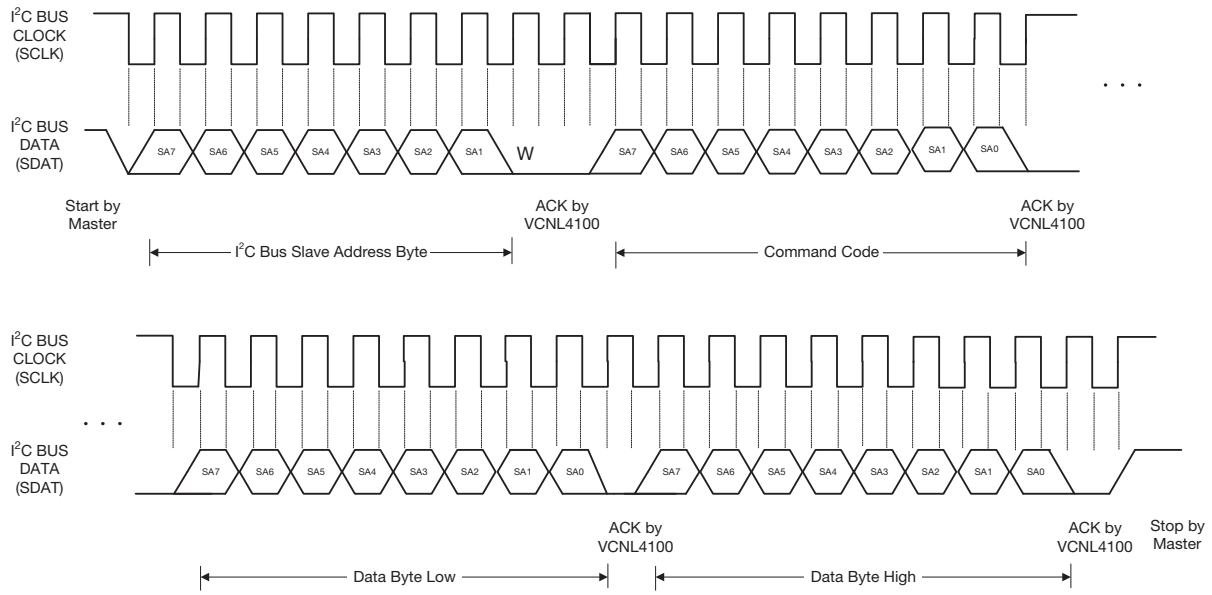



Fig. 2 - I²C Bus Timing for Sending Word Command Format

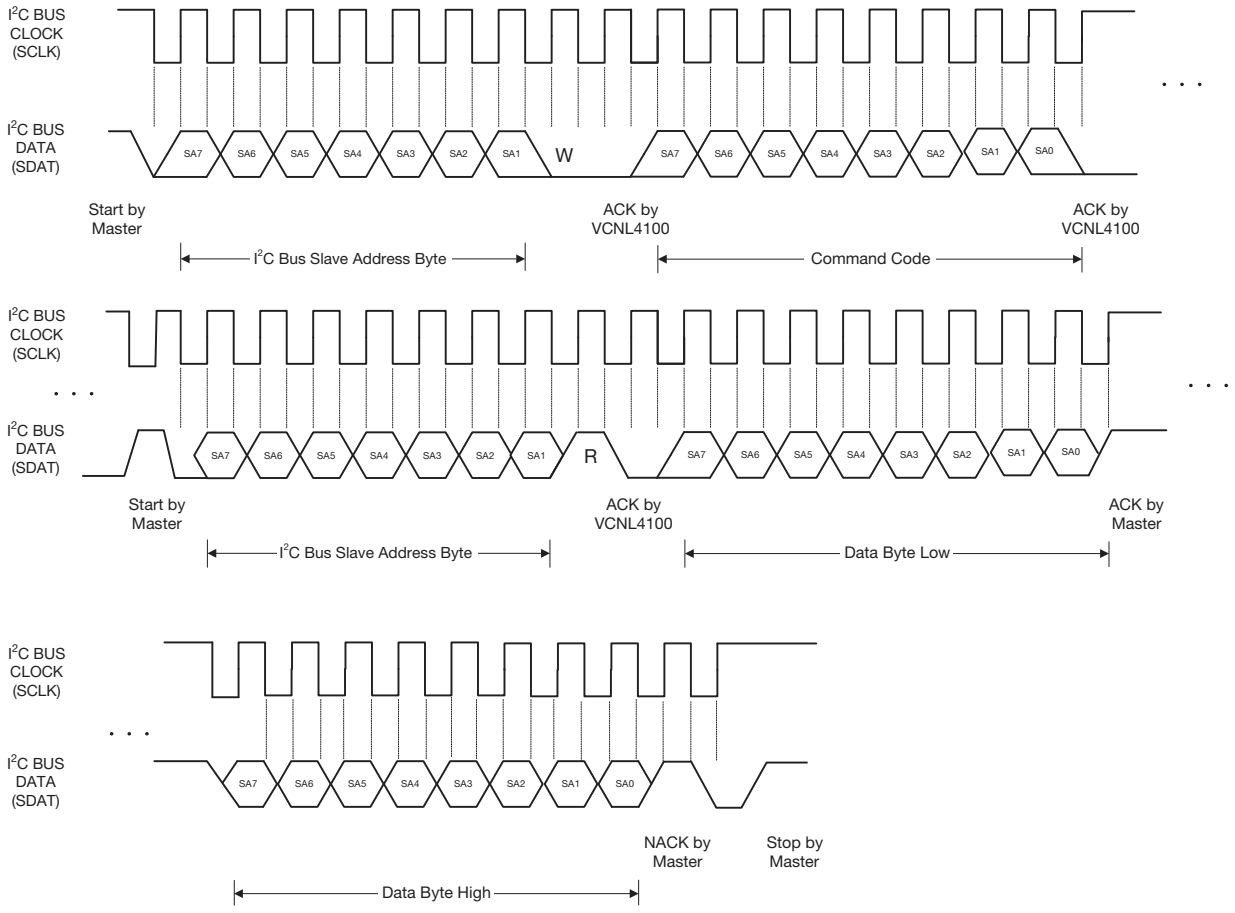



Fig. 3 - I²C Bus Timing for Receiving Word Command Format

## TYPICAL PERFORMANCE CHARACTERISTICS ($T_{amb}$ = 25 °C, unless otherwise specified)

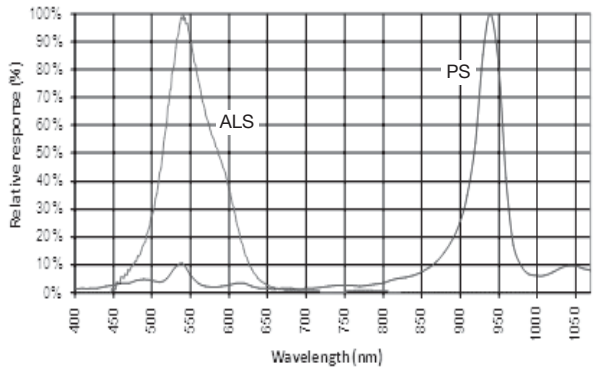



Fig. 4 - Normalized Spectral Response

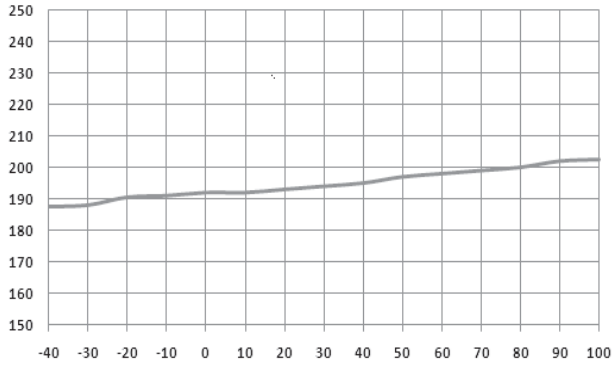



Fig. 7 - $I_{DD}$ vs.Temperature

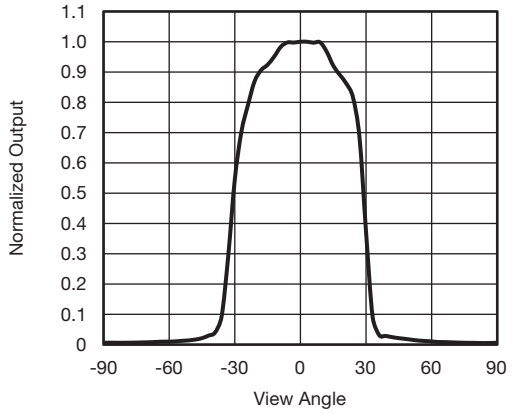



Fig. 5 - ALS Normalized Output vs. View Angle

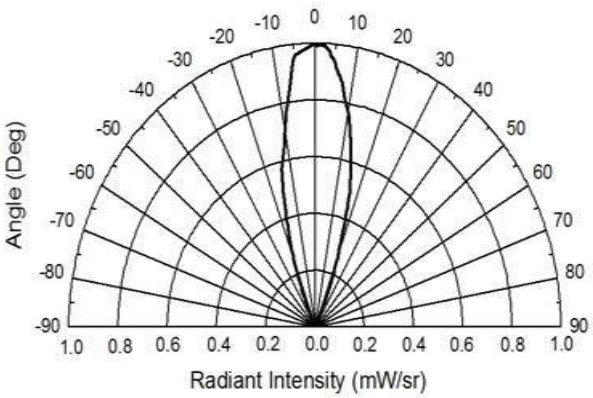



Fig. 8 - Relative Radiant Intensity vs. Angular Displacement

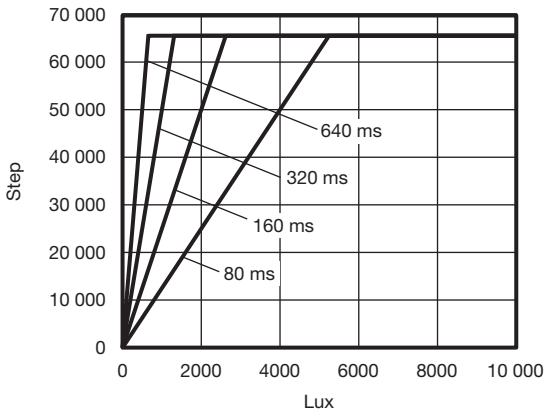



Fig. 6 - ALS Refresh Time vs. Maximum Detection Range

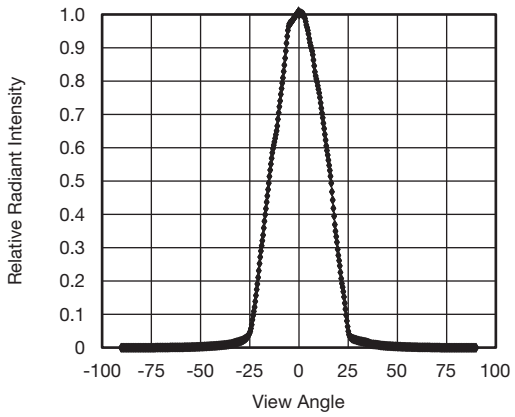



Fig. 9 - Relative Radiant Intensity vs. Angular Displacement

## APPLICATION INFORMATION

### Pin Connection with the Host

VCNL4100 is a cost effective solution of a long distance proximity sensor with I²C interface. The standard serial digital interface easily accesses “light intensity” by using simple calculations.

Application circuitry below shows the added MOSFET which is driven by the ASIC’s pin 2. A 22 kΩ pull-up resistor needs to be added here. The $R_{LED}$ defines the current through the IRED. A small 0.1 µF is sufficient at $V_{DD}$ for power supply noise rejection, but a 2.2 µF should be placed at $V_{IRED}$ to provide the energy for the IRED.

For the I²C bus design, the pull-up voltage refers to the I/O specification of the baseband due to its “open drain” design. The pull-high resistors for the I²C bus lines are recommended to be ≥ 2.2 kΩ.

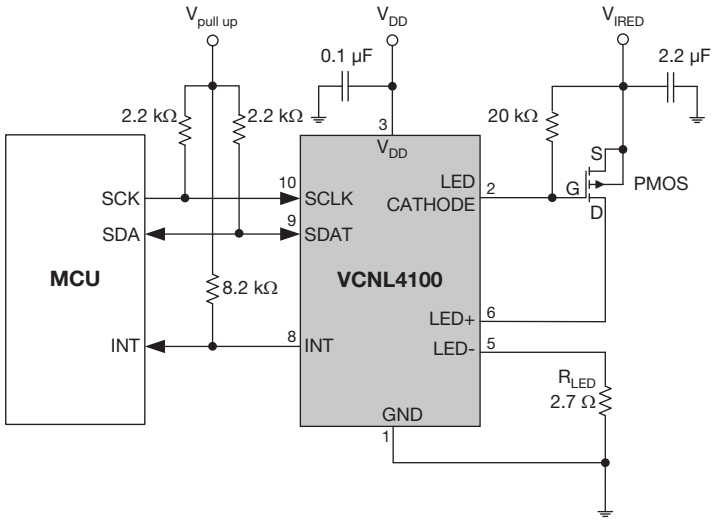



Fig. 10 - Application Diagram

**Notes**

- $V_{DD}$ range: 2.5 V to 3.6 V and $V_{IRED}$ is recommended 5.0 V
- Power path of $V_{DD}$ and $V_{IRED}$ should be routed separately up to stable power source.
- The $R_{LED}$ resister value should be evaluated within ready-made application and the current through VCNL4100-internal IRED should not exceed 800 mA.

### Digital Interface

VCNL4100 applies single 7-bit slave address 0x60 (HEX) following I²C protocol. All operations can be controlled by the command register. The simple command structure helps users easily program the operation setting and latch the light data from VCNL4100. As fig. 11 shows, VCNL4100’s I²C command format is simple for read and write operations between VCNL4100 and the host. The white sections indicate host activity and the gray sections indicate VCNL4100’s acknowledgement of the host access activity. Write word and read word protocols are suitable for accessing registers particularly for 16-bit ALS data and 8-bit PS data. Interrupt can be cleared by reading data out from register: INT_Flag.


Fig. 11 - Command Protocol Format

### Function Description

VCNL4100 applies a 16-bit high resolution ALS that provides the best ambient light sensing capability up to 0.011375 lx/step which works well under a low transmittance lens design (dark lens). A flexible interrupt function of ALS (register: ALS_CONF) is also supported. The INT signal will not be asserted by VCNL4100 if the ALS value is not over high INT threshold window level, or lower than low INT threshold window level of ALS. As long as the ALS INT is asserted, the host can read the data from VCNL4100.

For proximity sensor function, VCNL4100 supports different kinds of mechanical design to achieve the best proximity detection performance for any color object. The basic PS function settings, such as duty ratio, integration time, interrupt, and PS enable / disable and persistence, are handled by the register: PS_CONF1. Duty ratio controls the PS response time. Integration time represents the duration of the energy being received. The interrupt is asserted when the PS detection levels over the high threshold level setting (register: PS_THDH) or lower than low threshold (register: PS_THDL). If the interrupt function is enabled, the host reads the PS output data from VCNL4100 that saves host loading from periodically reading PS data. More than that, INT flag (register: INT_Flag) indicates the behavior of INT triggered under different conditions. PS persistence (PS_PERS) sets up the PS INT asserted conditions as long as the PS output value continually exceeds the threshold level.

Descriptions of each slave address operation are shown in table 1.

**TABLE 1 - COMMAND CODE AND REGISTER DESCRIPTION**

| COMMAND CODE | REGISTER NAME | R / W | DEFAULT VALUE | FUNCTION DESCRIPTION |
|---|---|---|---|---|
| 00H_L | ALS_CONF | R / W | 00H | ALS integration time, persistence, interrupt, and function enable / disable |
| 00H_H | Reserved | R / W | 00H | Reserved |
| 01H_L | ALS_THDH_L | R / W | 00H | ALS high interrupt threshold LSB byte |
| 01H_H | ALS_THDH_M | R / W | 00H | ALS high interrupt threshold MSB byte |
| 02H_L | ALS_THDL_L | R / W | 00H | ALS low interrupt threshold LSB byte |
| 02H_H | ALS_THDL_M | R / W | 00H | ALS low interrupt threshold MSB byte |
| 03H_L | PS_CONF1 | R / W | 00H | PS duty ratio, integration time, persistence, and PS enable / disable |
| 03H_H | PS_CONF2 | R / W | 00H | PS gain, ITB, interrupt setting |
| 04H_L | PS_CONF3 | R / W | 00H | PS active forced, averaging, background light cancellation setting |
| 04H_H | PS_SPO | R / W | 00H | Set initial value to “0xA0” or “0x20” |
| 05H_L | Reserved | R / W | 00H | Reserved |
| 05H_H | Reserved | R / W | 00H | Reserved |
| 06H_L | PS_THDL | R / W | 00H | PS low interrupt threshold setting |
| 06H_H | PS_THDH | R / W | 00H | PS high interrupt threshold setting |
| 07H_L | Reserved | R / W | 00H | Reserved |
| 07H_H | Reserved | R / W | 00H | Reserved |
| 08H_L | PS_Data | R | 00H | PS output data |
| 08H_H | Reserved | R | 00H | Reserved |
| 09H_L | ALS_Data_L | R | 00H | ALS LSB output data |
| 09H_H | ALS_Data_M | R | 00H | ALS MSB output data |
| 0AH_L | Reserved | R | 00H | Reserved |
| 0AH_H | Reserved | R | 00H | Reserved |
| 0BH_L | Reserved | R | 00H | Reserved |
| 0BH_H | INT_Flag | R | 00H | ALS, PS interrupt flags |

### Command Register Format

VCNL4100 provides an 8-bit command register for ALS and PS controlling independently. The description of each command format is shown in following tables.

**TABLE 2 - REGISTER: ALS_CONF DESCRIPTION**

| REGISTER NAME | | COMMAND CODE: 0xH_L (0xH DATA BYTE LOW) OR 0xH_H (0xH DATA BYTE HIGH) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Command | Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| **ALS_CONF** | | **COMMAND CODE: 00H_L (00H DATA BYTE LOW)** | | | | | | | |
| Command | Bit | Description | | | | | | | |
| ALS_IT | 7 : 6 | (0 : 0) = 80 ms; (0 : 1) = 160 ms; (1 : 0) = 320 ms; (1 : 1) = 640 ms<br>ALS integration time setting, longer integration time has higher sensitivity | | | | | | | |
| Reserved | 5 : 4 | Default = (0 : 0), reserved | | | | | | | |
| ALS_PERS | 3 : 2 | (0 : 0) = 1, (0 : 1) = 2, (1 : 0) = 4, (1 : 1) = 8<br>ALS interrupt persistence setting | | | | | | | |
| ALS_INT_EN | 1 | 0 = ALS interrupt disable, 1 = ALS interrupt enable | | | | | | | |
| ALS_SD | 0 | 0 = ALS power on, 1 = ALS shut down | | | | | | | |

**TABLE 3 - REGISTER: RESERVE COMMAND DESCRIPTION**

| Reserved | | COMMAND CODE: 00H_H (00H DATA BYTE HIGH) |
|---|---|---|
| Command | Bit | Description |
| Reserved | 7 : 0 | Default = 00H |

**TABLE 4 - REGISTER ALS_THDH_L AND ALS_THDH_M DESCRIPTION**

| ALS_THDH_L<br>ALS_THDH_M | | COMMAND CODE: 01H_L (01H DATA BYTE LOW)<br>COMMAND CODE: 01H_H (01H DATA BYTE HIGH) |
|---|---|---|
| Register | Bit | Description |
| ALS_THDH_L | 7 : 0 | 00H to FFH, ALS high interrupt threshold LSB byte |
| ALS_THDH_M | 7 : 0 | 00H to FFH, ALS high interrupt threshold MSB byte |

**TABLE 5 - REGISTER: ALS_THDL_L AND ALS_THDL_M DESCRIPTION**

| ALS_THDL_L<br>ALS_THDL_M | | COMMAND CODE: 02H_L (02H DATA BYTE LOW)<br>COMMAND CODE: 02H_H (02H DATA BYTE HIGH) |
|---|---|---|
| Register | Bit | Description |
| ALS_THDL_L | 7 : 0 | 00H to FFH, ALS low interrupt threshold LSB byte |
| ALS_THDL_M | 7 : 0 | 00H to FFH, ALS low interrupt threshold MSB byte |

**TABLE 6 - REGISTER: PS_CONF1 DESCRIPTION**

| PS_CONF1 | | COMMAND CODE: 03H_L (03H DATA BYTE LOW) |
|---|---|---|
| Command | Bit | Description |
| PS_Duty | 7 : 6 | (0 : 0) = 1/5120, (0 : 1) = 1/640, (1 : 0) = 1/80, (1 : 1) = 1/20<br>PS IRED on / off duty ratio setting |
| PS_ IT | 5 : 4 | (0 : 0) = 1T, (0 : 1) = 1.3T, (1 : 0) = 1.6T, (1 : 1) = 2T<br>PS integration time setting |
| PS_PERS | 3 : 2 | (0 : 0) = 1, (0 : 1) = 2, (1 : 0) = 3, (1 : 1) = 4<br>PS interrupt persistence setting |
| Reserved | 1 | Default = 0, reserved |
| PS_SD | 0 | 0 = PS power on, 1 = PS shut down |

| TABLE 7 - REGISTER: PS_CONF2 DESCRIPTION | | |
|---|---|---|
| **PS_CONF2** | | **COMMAND CODE: 03H_H (03H DATA BYTE HIGH)** |
| Command | Bit | Description |
| PS_ITB | 7 : 6 | (0 : 0) = 1/2T, (0 : 1) = 1T, (1 : 0) = 2T, (1 : 1) = 4T<br>PS IT bank setting |
| PS_GAIN | 5 : 4 | (0 : 0) = /4, (0 : 1) = /2, (1 : 0) = 1, (1 : 1) = 2 |
| Reserved | 3 | Default = 0, reserved |
| PS_SP_INT_EN | 2 | 0 = disable INT function for PS enter / leave sunlight protection mode<br>1 = issue INT while PS enter / leave sunlight protection mode. While PS enter sunlight protection mode, the PS output will keep 0xFF |
| Reserved | 1 | Default = 0, reserved |
| PS_INT_EN | 0 | 0 = PS INT function disable<br>1 = PS INT function enable |

| TABLE 8 - REGISTER: PS_CONF3 DESCRIPTION | | |
|---|---|---|
| **PS_CONF3** | | **COMMAND CODE: 04H_L (04H DATA BYTE LOW)** |
| Command | Bit | Description |
| PS_AV | 7 : 6 | (0 : 0) = /2, (0 : 1) = /4, (1 : 0) = /8, (1 : 1) = /16 |
| PS_AV_EN | 5 | 0 = PS average function disable, 1 = PS average function enable |
| Reserved | 4 | Default = 0, reserved |
| PS_AF | 3 | 0 = active force mode disable (normal mode), 1 = active force mode enable |
| PS_TRIG | 2 | 0 = no PS active force mode trigger, 1 = trigger one time cycle<br>VCNL4100 output one cycle data every time host writes in “1” to sensor. The state returns to “0” automatically. |
| PS_MPULSE | 1 | 0 = disable, 1 = enable<br>PS multi pulse mode setting; PS multi pulse number set by PS_AV [1 : 0] |
| Reserved | 0 | Default = 0, reserved |

| TABLE 9 - REGISTER: PS_MS DESCRIPTION | | |
|---|---|---|
| **Reserved** | | **COMMAND CODE: 04H_H (04H DATA BYTE HIGH)** |
| Command | Bit | Description |
| PS_SPO | 7 : 0 | Set initial value = 0xA0 (PS_OUT = 0xFF while PS into sunlight protection<br>Set initial value = 0x20 (PS_OUT = 0x00 while PS into sunlight protection |

| TABLE 10 - REGISTER RESERVE COMMAND DESCRIPTION | | |
|---|---|---|
| **Reserved** | | **COMMAND CODE: 05H_L (05H DATA BYTE LOW)** |
| Register | Bit | Description |
| Reserved | 7 : 0 | Default = 00H |

| TABLE 11 - REGISTER: RESERVE COMMAND DESCRIPTION | | |
|---|---|---|
| **Reserved** | | **COMMAND CODE: 05H_H (05H DATA BYTE HIGH)** |
| Register | Bit | Description |
| Reserved | 7 : 0 | Default = 00H |

| TABLE 12 - REGISTER: PS_THDL DESCRIPTION | | |
|---|---|---|
| **PS_THDL** | | **COMMAND CODE: 06H_L (06H DATA BYTE LOW)** |
| Register | Bit | Description |
| PS_THDL | 7 : 0 | 00H to FFH, PS low interrupt threshold setting |

| TABLE 13 - REGISTER: PS_THDH DESCRIPTION | | |
|---|---|---|
| **PS_THDH** | | **COMMAND CODE: 06H_H (06H DATA BYTE HIGH)** |
| Register | Bit | Description |
| PS_THDH | 7 : 0 | 00H to FFH, PS high interrupt threshold setting |

| TABLE 14 - REGISTER: RESERVE COMMAND DESCRIPTION | | |
|---|---|---|
| **Reserved** | | **COMMAND CODE: 07H_L (07H DATA BYTE LOW)** |
| Register | Bit | Description |
| Reserved | 7 : 0 | Default = 00H |

| TABLE 15 - REGISTER: RESERVE COMMAND DESCRIPTION | | |
|---|---|---|
| **Reserved** | | **COMMAND CODE: 07H_H (07H DATA BYTE HIGH)** |
| Register | Bit | Description |
| Reserved | 7 : 0 | Default = 00H |

| TABLE 16 - READ OUT REGISTER DESCRIPTION | | | |
|---|---|---|---|
| **REGISTER** | **COMMAND CODE** | **BIT** | **DESCRIPTION** |
| PS_Data | 08H_L (08H data byte low) | 7 : 0 | 00H to FFH, PS output data |
| Reserved | 08H_H (08H data byte high) | 7 : 0 | Default = 00H |
| ALS_Data_L | 09H_L (09H data byte low) | 7 : 0 | 00H to FFH, ALS LSB output data |
| ALS_Data_M | 09H_H (09H data byte high) | 7 : 0 | 00H to FFH, ALS MSB output data |
| Reserved | 0AH_L (0AH data byte low) | 7 : 0 | |
| Reserved | 0AH_H (0AH data byte high) | 7 : 0 | |
| Reserved | 0BH_L (0BH data byte low) | 7 : 0 | Default = 00H |
| INT_Flag | 0BH_H (0BH data byte high) | 7<br>6<br>5<br>4<br>3<br>2<br>1<br>0 | PS_SPF_LEAVE, PS leaving protection mode<br>PS_SPF_ENTER, PS entering protection mode<br>ALS_IF_L, ALS crossing low THD INT trigger event<br>ALS_IF_H, ALS crossing high THD INT trigger event<br>Default = 0, reserved<br>Default = 0, reserved<br>PS_IF_CLOSE, PS rise above PS_THDH INT trigger event<br>PS_IF_AWAY, PS drop below PS_THDL INT trigger event |

### Adjustable Sampling Time

VCNL4100's embedded LED driver drives the external IRED with the "LED CATHODE" pin by a pulsed duty cycle. The IRED on / off duty ratio can be programmable by $I^2C$ command at register: PS_Duty is related to the current consumption and PS response time. The higher the duty ratio selected, the faster response time achieved with higher power consumption.

### Threshold Window Setting

- ALS Threshold Window Setting (Applying ALS INT)

  Register: ALS_THDH_L and ALS_THDH_M define 16-bit ALS high threshold data for LSB byte and MSB byte. Register: ALS_THDL_L and ALS_THDL_M define 16-bit ALS low threshold data for LSB byte and MSB byte. As long as ALS INT function is enabled, INT will be asserted once the ALS data exceeds ALS_THDH or goes below ALS_THDL. To easily define the threshold range, multiply the value of the resolution (lx/step) by the threshold level (refer table 17).

**TABLE 17 - ALS RESOLUTION AND MAXIMUM DETECTION RANGE**

| ALS_IT | | SENSITIVITY (lx/step) | MAXIMUM DETECTION RANGE (lx) |
|---|---|---|---|
| ALS_IT (7 : 6) | INTEGRATION TIME | | |
| (0, 0) | 80 ms | 0.08 | 5243 |
| (0, 1) | 160 ms | 0.04 | 2621 |
| (1, 0) | 320 ms | 0.02 | 1311 |
| (1, 1) | 640 ms | 0.01 | 655 |

The following is an example of the application for ALS_IT = 160 ms. If ALS_THDH = 07D0(HEX) and ALS_THDL = 03E8(HEX), then the ALS INT will not asserted if the ALS value does not exceed 80 lx [07D0(HEX) = 2000 steps x 0.04 lx/step = 80 lx] or lower than 40 lx [03E8(HEX) = 1000 steps x 0.04 lx/step = 40 lx.

- ALS Persistence
  The ALS INT is asserted as long as the ALS value is higher or lower than the threshold window when ALS_PERS (1 / 2 / 4 / 8 times) is set to one time. If ALS_PERS is set to four times, then the ALS INT will not be asserted if the ALS value is not over (or lower) than the threshold window for four continued refresh times (integration time).

- Programmable PS Threshold
  VCNL4100 provides both high and low thresholds 8-bit data setting for proximity sensor. (register: PS_THDL, PS_THDH) that fulfills different mechanical designs with the best proximity detection capability for any kind of objects.

- PS Persistence
  The PS persistence function (PS_PERS 1 / 2 / 3 / 4) helps to avoid false trigger of the PS INT. For example, if PS_PERS = 3 times, the PS INT will not be asserted unless the PS value is greater than the PS threshold (PS1_THDH) value for three periods of time continuously.

### Data Access

All VCNL4100 command registers are readable. To access 16-bit high resolution ALS output data, it is suitable to use read word protocol to read out data by just one command at register: ALS_Data_L and ALS_Data_M. To represent the 16-bit data of ALS, it has to apply two bytes. One byte is for LSB, and the other byte is for MSB as shown in table 18. In terms of reading out 8-bit PS data, host just need to access register: PS_Data.

**TABLE 18 - 16-BIT ALS DATA FORMAT**

| | VCNL4100 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Register | ALS_Data_M | | | | | | | | ALS_Data_L | | | | | | | |

### Interrupt (INT)

VCNL4100 has ALS and PS interrupt feature operated by a single pin “INT”. The purpose of the interrupt feature is to actively inform the host once INT has been asserted. With the interrupt function applied, the host does not need to constantly pull data from the sensor, but to only read data from the sensor when receiving interrupt request from the sensor. As long as the host enables ALS interrupt (register: ALS_INT_EN) or PS interrupt (register: PS_INT) function, the level of INT pin (pin 8) is able to be pulled low once INT asserted. All of registers are accessible even INT is asserted.

ALS INT asserted when ALS value crosses over the value set by register: ALS_THDH or is lower than the value set by register: ALS_THDL.

PS INT asserted when PS value crosses over the value set by register: PS_THDH or is lower than the value set by register: PS_THDL.

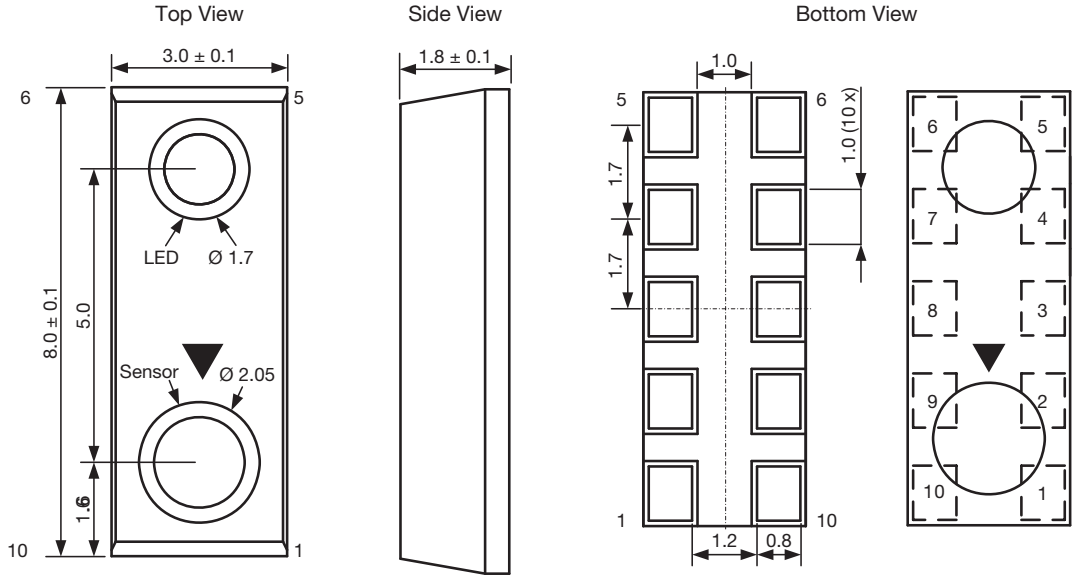
**Interrupt Flag**

Register: INT_Flag represents all of interrupt trigger status for ALS and PS. Any flag value changes from “0” to “1” state, the level of INT pin will be pulled low. As long as host reads INT_Flag data, the bit will change from “1” state to “0” state after reading out. The INT level will be returned to high afterwards.

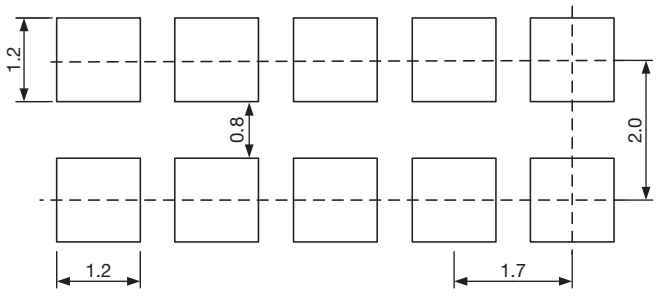
## PROXIMITY DETECTION HYSTERESIS

A PS detection hysteresis is important to keep the PS state in a certain range of detection distance. For example, PS INT asserts when PS value over PS_THDH. Host switches on panel backlight and then clears INT. When PS value is less than PS_THDL, host switches off panel backlight. Any PS value lower than PS_THDH or higher than PS_THDL PS INT will not be asserted. Host keeps the same state.

## PACKAGE INFORMATION in millimeters




For Reflow Soldering (PCB Footprint)




| | | | |
|---|---|---|---|
| 1 | GND | 6 | LED+ |
| 2 | LED_Cathode | 7 | NC |
| 3 | VDD | 8 | INT |
| 4 | NC | 9 | SDAT |
| 5 | LED- | 10 | SCLK |

Fig. 12 - VCNL4100 Package Dimensions

## LAYOUT NOTICE AND REFERENCE CIRCUIT

### Circuit Layout Reference

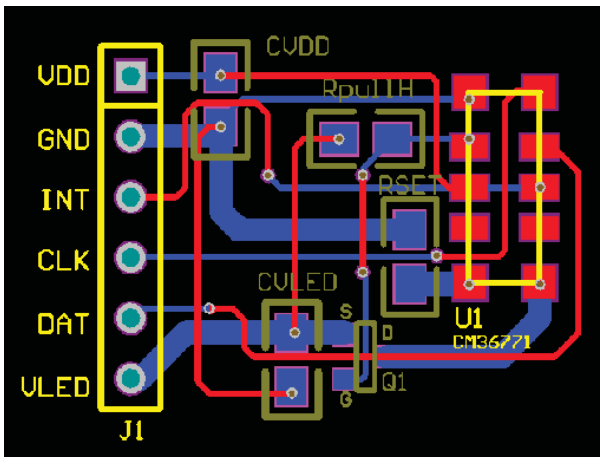



Fig. 13 - Suggested VCNL4100 Layout

## APPLICATION CIRCUIT BLOCK REFERENCE

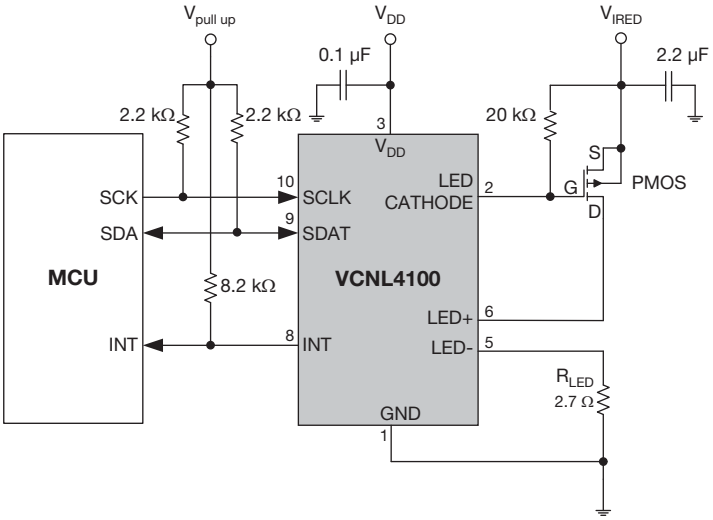



Fig. 14 - VCNL4100 Application Circuit

**Notes**

- $V_{DD}$ range: 2.5 V to 3.6 V and $V_{IRED}$ is recommended 5.0 V
- Power path of $V_{DD}$ and $V_{IRED}$ should be independent layout
- The $R_{LED}$ resistor value is reference for test stage, it should be adjusted again for the product usage basing on the power and the lens final design.

| RECOMMENDED STORAGE AND REBAKING CONDITIONS | | | | |
|---|---|---|---|---|
| **PARAMETER** | **CONDITIONS** | **MIN.** | **MAX.** | **UNIT** |
| Storage temperature | | 5 | 50 | °C |
| Relative humidity | | - | 60 | % |
| Open time | | - | 168 | h |
| Total time | From the date code on the aluminized envelope (unopened) | - | 12 | months |
| Rebaking | Tape and reel: 60 °C | - | 22 | h |
| | Tube: 60 °C | - | 22 | h |

## RECOMMENDED INFRARED REFLOW

Soldering conditions which are based on J-STD-020 C.

| IR REFLOW PROFILE CONDITION | | | |
|---|---|---|---|
| **PARAMETER** | **CONDITIONS** | **TEMPERATURE** | **TIME** |
| Peak temperature | | 255 °C + 0 °C / - 5 °C (max.: 260 °C) | 10 s |
| Preheat temperature range and timing | | 150 °C to 200 °C | 60 s to 180 s |
| Timing within 5 °C to peak temperature | | | 10 s to 30 s |
| Timing maintained above temperature / time | | 217 °C | 60 s to 150 s |
| Timing from 25 °C to peak temperature | | | 8 min (max.) |
| Ramp-up rate | | 3 °C/s (max.) | |
| Ramp-down rate | | 6 °C/s (max.) | |

Recommend Normal Solder Reflow is 235 °C to 255 °C.

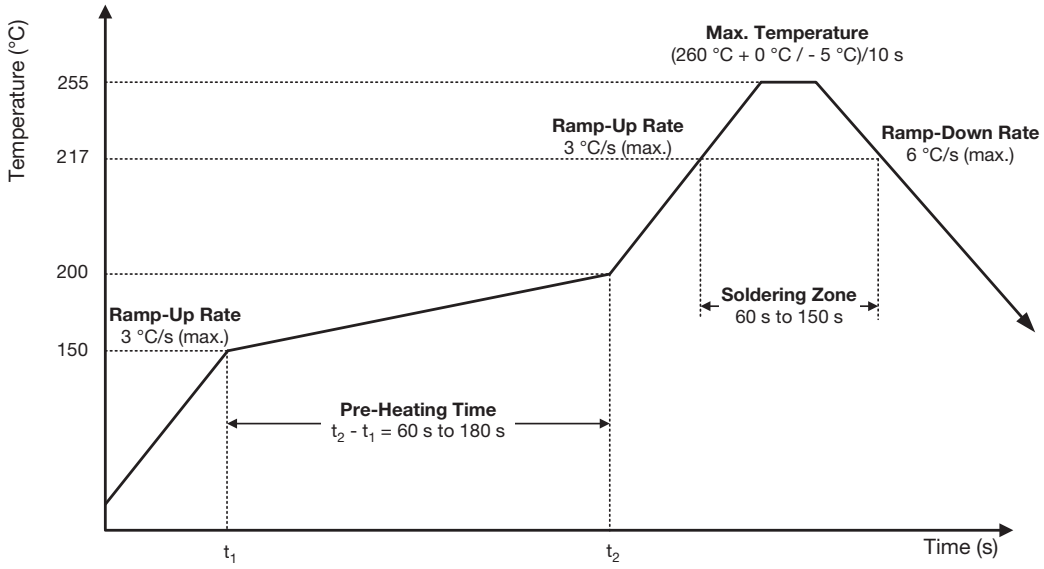



Fig. 15 - VCNL4100 Solder Reflow Profile Chart

## RECOMMENDED IRON TIP SOLDERING CONDITION AND WARNING HANDLING

1. Solder the device with the following conditions:
   1.1. Soldering temperature: 400 °C (max.)
   1.2. Soldering time: 3 s (max.)
2. If the temperature of the method portion rises in addition to the residual stress between the leads, the possibility that an open or short circuit occurs due to the deformation or destruction of the resin increases.
3. The following methods: VPS and wave soldering, have not been suggested for the component assembly.
4. Cleaning method conditions:
   4.1. Solvent: methyl alcohol, ethyl alcohol, isopropyl alcohol
   4.2. Solvent temperature < 45 °C (max.)
   4.3. Time: 3 minutes (min.)

**TAPE PACKAGING INFORMATION** in millimeters

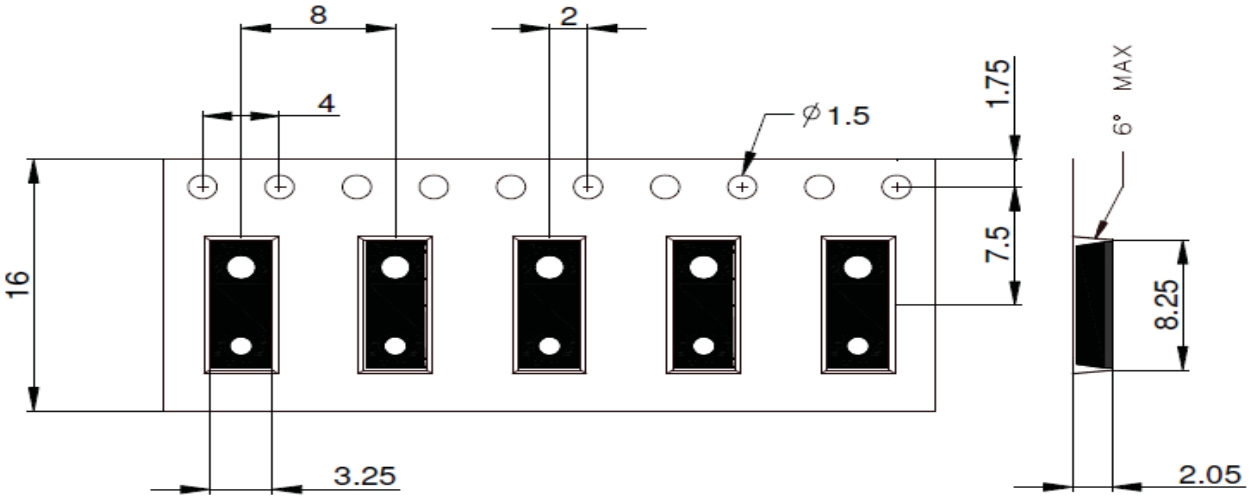



Fig. 16 - Package Carrier Tape

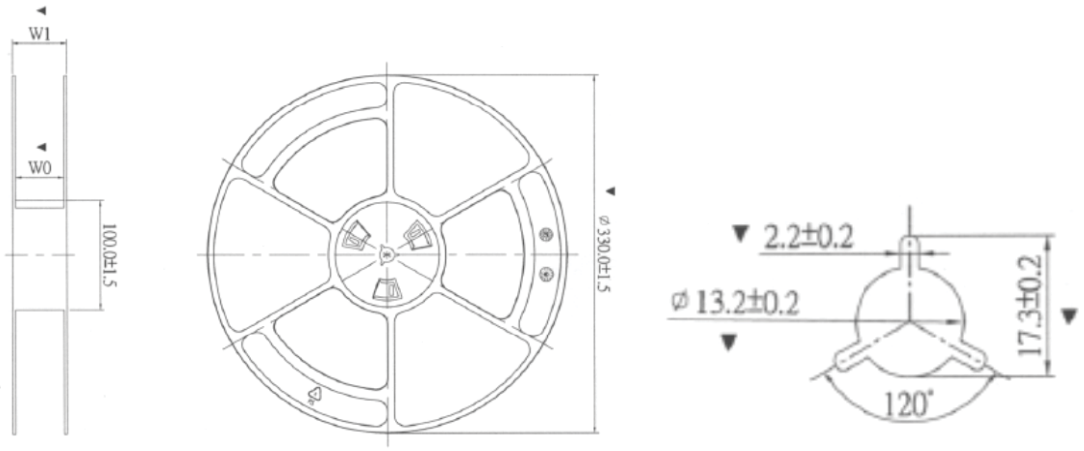



Fig. 17 - Reel Dimensions

# Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, “Vishay”), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and / or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Hyperlinks included in this datasheet may direct users to third-party websites. These links are provided as a convenience and for informational purposes only. Inclusion of these hyperlinks does not constitute an endorsement or an approval by Vishay of any of the products, services or opinions of the corporation, organization or individual associated with the third-party website. Vishay disclaims any and all liability and bears no responsibility for the accuracy, legality or content of the third-party website or for that of subsequent links.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.