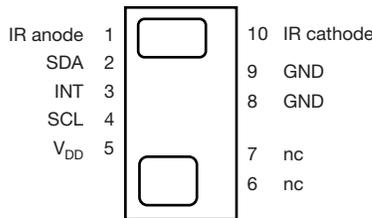


Fully Integrated Proximity Sensor with Infrared Emitter, I²C Interface, and Interrupt Function



DESCRIPTION

The VCNL3020 is a fully integrated proximity sensor. Fully integrated means that the infrared emitter is included in the package. It has 16 bit resolution. It includes a signal processing IC and features standard I²C communication interface. It features an interrupt function.

APPLICATIONS

- Proximity sensor for mobile devices (e.g. smart phones, touch phones, PDA, GPS) for touch screen locking, power saving, etc.
- Proximity / optical switch for consumer, computing and industrial devices and displays

FEATURES

- Package type: surface mount
- Dimensions (L x W x H in mm): 4.90 x 2.40 x 0.83
- Integrated modules: infrared emitter (IRED), proximity sensor (PD), and signal conditioning IC
- Interrupt function
- Supply voltage range V_{DD}: 2.5 V to 3.6 V
- Supply voltage range IR anode: 2.5 V to 5 V
- Communication via I²C interface
- I²C bus H-level range: 1.7 V to 5 V
- Floor life: 72 h, MSL 4, acc. J-STD-020
- Low stand by current consumption: 1.5 μA
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912



PROXIMITY FUNCTION

- Built-in infrared emitter and photo-pin-diode for proximity function
- 16 bit effective resolution for proximity detection range ensures excellent cross talk immunity
- Programmable LED drive current from 10 mA to 200 mA in 10 mA steps
- Excellent ambient light suppression by signal modulation
- Proximity distance up to 200 mm

| PRODUCT SUMMARY | | | | | | |
|-----------------|----------------------|-----------------------------|--|---------------------------------------|--------------------------|--|
| PART NUMBER | OPERATING RANGE (mm) | OPERATING VOLTAGE RANGE (V) | I ² C BUS VOLTAGE RANGE (V) | LED PULSE CURRENT ⁽¹⁾ (mA) | OUTPUT CODE | ADC RESOLUTION PROXIMITY / AMBIENT LIGHT |
| VCNL3020 | 1 to 200 | 2.5 to 3.6 | 1.7 to 5 | 10 to 200 | 16 bit, I ² C | 16 bit / - |

Note

⁽¹⁾ Adjustable through I²C interface

| ORDERING INFORMATION | | | |
|-----------------------------------|---------------|-----------------------|-----------------------------|
| ORDERING CODE | PACKAGING | VOLUME ⁽¹⁾ | REMARKS |
| VCNL3020-GS08 | Tape and reel | MOQ: 3300 pcs | 4.90 mm x 2.40 mm x 0.83 mm |
| VCNL3020-GS18 | | MOQ: 13 300 pcs | |
| Sensor starter kit ⁽²⁾ | - | MOQ: 1 pc | - |

Notes

⁽¹⁾ MOQ: minimum order quantity

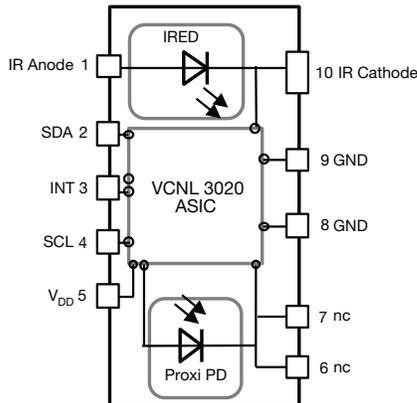
⁽²⁾ A sensor starter kit is available, along with an add-on demo board for each of the sensors.

Please visit www.vishay.com/moreinfo/vcnldemokit/ for more information.

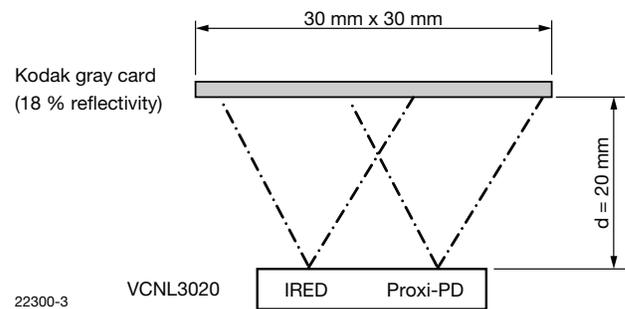
Contact any catalog distributor or a local Vishay sales representative to purchase the sensor starter kit and contact sensorstechsupport@vishay.com to receive an add-on sensor board.

| ABSOLUTE MAXIMUM RATINGS ($T_{amb} = 25\text{ }^{\circ}\text{C}$, unless otherwise specified) | | | | | |
|--|---|-----------|------|------|--------------------|
| PARAMETER | TEST CONDITION | SYMBOL | MIN. | MAX. | UNIT |
| Supply voltage | | V_{DD} | -0.3 | 5.5 | V |
| Operation temperature range | | T_{amb} | -25 | +85 | $^{\circ}\text{C}$ |
| Storage temperature range | | T_{stg} | -25 | +85 | $^{\circ}\text{C}$ |
| Total power dissipation | $T_{amb} \leq 25\text{ }^{\circ}\text{C}$ | P_{tot} | | 50 | mW |
| Junction temperature | | T_j | | 100 | $^{\circ}\text{C}$ |

| BASIC CHARACTERISTICS ($T_{amb} = 25\text{ }^{\circ}\text{C}$, unless otherwise specified) | | | | | | |
|---|--|-----------|------|------|------|---------------|
| PARAMETER | TEST CONDITION | SYMBOL | MIN. | TYP. | MAX. | UNIT |
| Supply voltage V_{DD} | | | 2.5 | | 3.6 | V |
| Supply voltage IR anode | | | 2.5 | | 5 | V |
| I ² C Bus H-level range | | | 1.7 | | 5 | V |
| INT H-level range | | | 1.7 | | 5 | V |
| INT low voltage | 3 mA sink current | | | | 0.4 | V |
| Current consumption | Standby current, no IRED-operation | | | 1.5 | 2 | μA |
| Current consumption proximity mode incl. IRED (averaged) | 2 measurements per second, IRED current 20 mA | | | 5 | | μA |
| | 250 measurements per second, IRED current 20 mA | | | 520 | | μA |
| | 2 measurements per second, IRED current 200 mA | | | 35 | | μA |
| | 250 measurements per second, IRED current 200 mA | | | 4 | | mA |
| I ² C clock rate range | | f_{SCL} | | | 3400 | kHz |

CIRCUIT BLOCK DIAGRAM

Note

- nc must not be electrically connected
- Pads 6 and 7 are only considered as solder pads

TEST CIRCUIT


BASIC CHARACTERISTICS ($T_{amb} = 25\text{ }^{\circ}\text{C}$, unless otherwise specified)

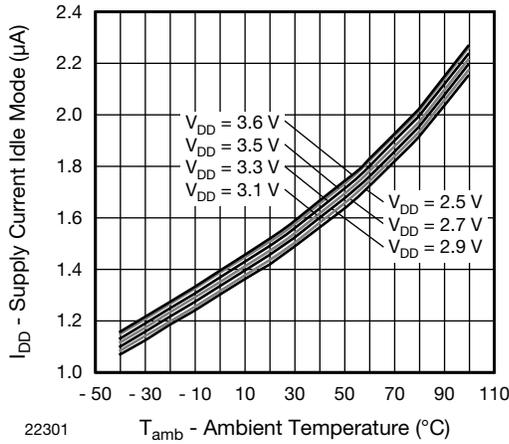


Fig. 1 - Idle Current vs. Ambient Temperature

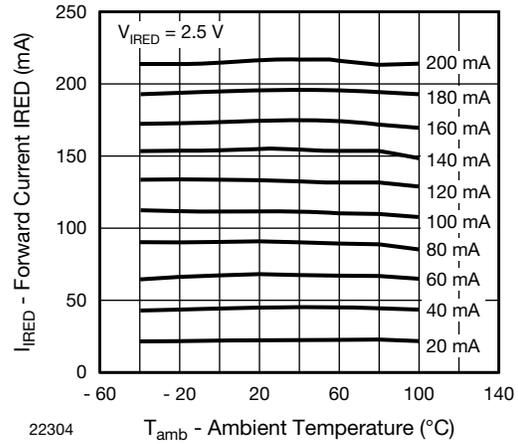


Fig. 4 - Forward Current vs. Temperature

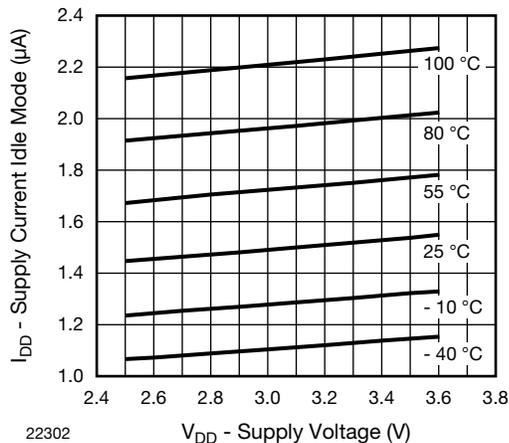


Fig. 2 - Idle Current vs. V_{DD}

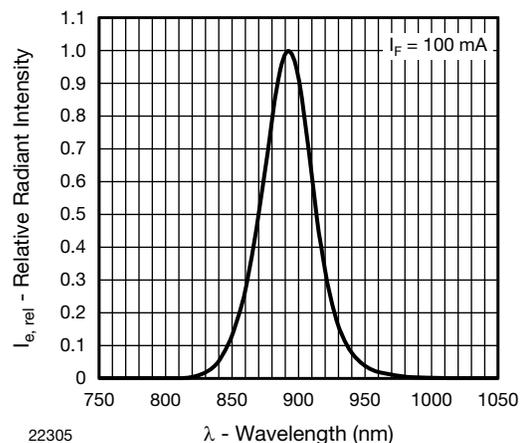


Fig. 5 - Relative Radiant Intensity vs. Wavelength

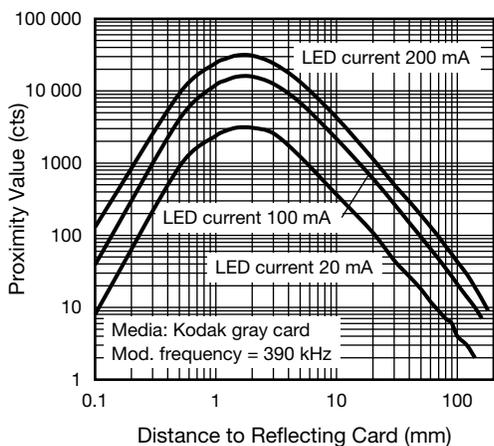


Fig. 3 - Proximity Value vs. Distance

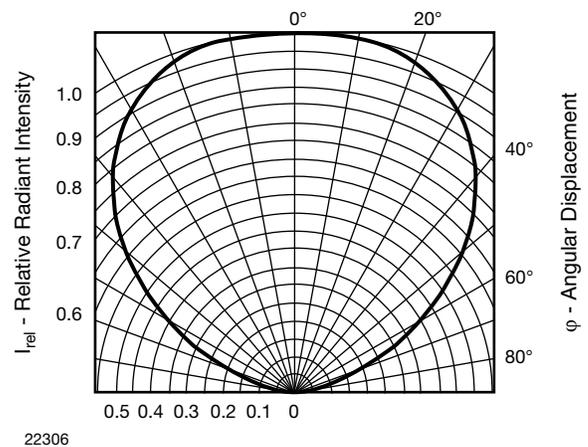


Fig. 6 - Relative Radiant Intensity vs. Angular Displacement

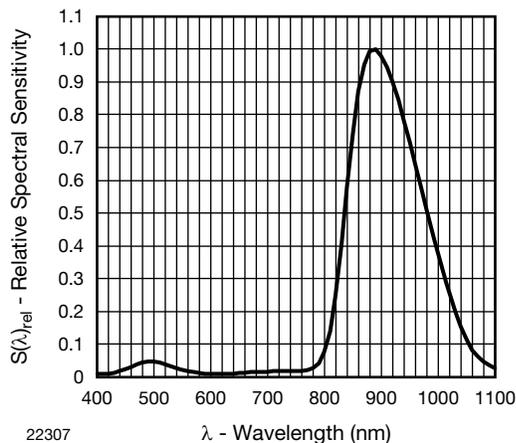


Fig. 7 - Relative Spectral Sensitivity vs. Wavelength (Proximity Sensor)

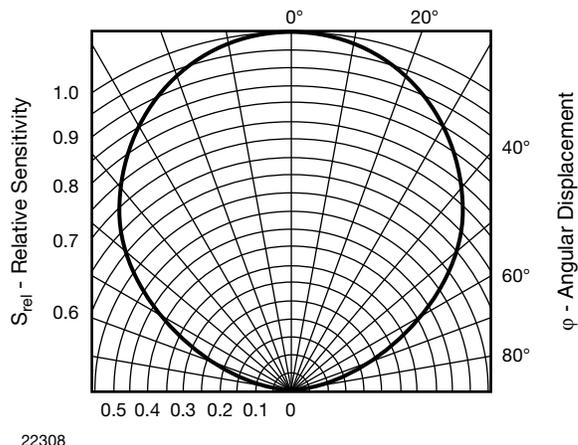


Fig. 8 - Relative Radiant Sensitivity vs. Angular Displacement (Proximity Sensor)

APPLICATION INFORMATION

VCNL3020 is a cost effective solution of proximity sensor with I²C bus interface. The standard serial digital interface is easy to access “Proximity Signal” without complex calculation and programming by external controller. Beside the digital output also a flexible programmable interrupt pin is available.

1. Application Circuit

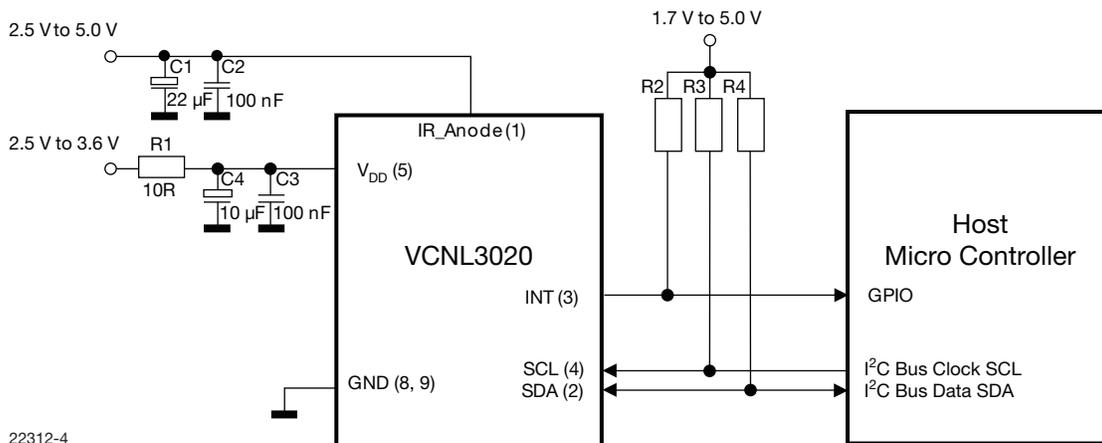


Fig. 9 - Application Circuit (x) = Pin Number

Notes

- The interrupt pin is an open drain output. The needed pull-up resistor may be connected to the same supply voltage as the application controller and the pull-up resistors at SDA/SCL. Proposed value R2 should be >1 kΩ , e.g. 10 kΩ to 100 kΩ. Proposed value for R3 and R4, e.g. 2.2 kΩ to 4.7 kΩ, depend also on the I²C bus speed. For detailed description about set-up and use of the interrupt as well as more application related information see AN: “Designing VCNL3020 into an Application”.
- IR_Cathode needs no external connection. The needed connection to the driver is done internally.

2. I²C Interface

The VCNL3020 contains seventeen 8 bit registers for operation control, parameter setup and result buffering. All registers are accessible via I²C communication. Figure 13 shows the basic I²C communication with VCNL3020.

The built in I²C interface is compatible with all I²C modes (standard, fast, and high speed).

I²C H-level range = 1.7 V to 5 V.

Please refer to the I²C specification from NXP for details.

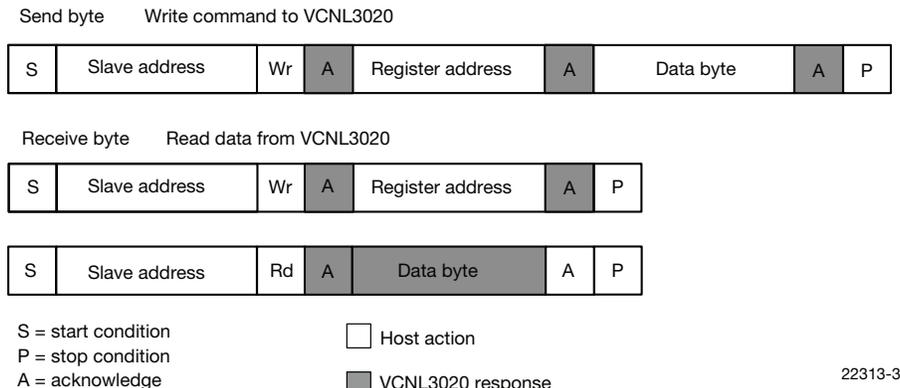


Fig. 10 - Send Byte/Receive Byte Protocol

Device Address

The VCNL3020 has a fix slave address for the host programming and accessing selection. The predefined 7 bit I²C bus address is set to 0010 011 = 13h. The least significant bit (LSB) defines read or write mode. Accordingly the bus address is set to 0010 011x = 26h for write, 27h for read.

Register Addresses

VCNL3020 has seventeen user accessible 8 bit registers. The register addresses are 80h (register #0) to 90h (register #16).

REGISTER FUNCTIONS

Register #0 Command Register

Register address = 80h

The register #0 is for starting proximity measurements. This register contains a flag bit for data ready indication.

| TABLE 1 - COMMAND REGISTER #0 | | | | | | | |
|-------------------------------|--|---------------|-------|---------|-------|---------|--------------|
| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| config_lock | n/a | prox_data_rdy | n/a | prox_od | n/a | prox_en | selftimed_en |
| Description | | | | | | | |
| config_lock | Read only bit. Value = 1 | | | | | | |
| prox_data_rdy | Read only bit. Value = 1 when proximity measurement data is available in the result registers. This bit will be reset when one of the corresponding result registers (reg #7, reg #8) is read. | | | | | | |
| prox_od | R/W bit. Starts a single on-demand measurement for proximity. Result is available at the end of conversion for reading in the registers #7(HB) and #8(LB). | | | | | | |
| prox_en | R/W bit. Enables periodic proximity measurement | | | | | | |
| selftimed_en | R/W bit. Enables state machine and LP oscillator for self timed measurements; no measurement is performed until the corresponding bit is set | | | | | | |

Note

- Beside prox_en first selftimed_en needs to be set. On-demand measurement mode is disabled if selftimed_en bit is set. For the selftimed_en mode changes in reading rates (reg #2) can be made only when b0 (selftimed_en bit) = 0.



Register #1 Product ID Revision Register

Register address = 81h. This register contains information about product ID and product revision.

Register data value of current revision = 21h.

| TABLE 2 - PRODUCT ID REVISION REGISTER #1 | | | | | | | |
|---|-------|---------------------------|-------|-------------|-------|-------|-------|
| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| Product ID | | | | Revision ID | | | |
| Description | | | | | | | |
| Product ID | | Read only bits. Value = 2 | | | | | |
| Revision ID | | Read only bits. Value = 1 | | | | | |

Register #2 Rate of Proximity Measurement

Register address = 82h.

| TABLE 3 - PROXIMITY RATE REGISTER #2 | | | | | | | |
|--------------------------------------|-------|---|-------|-------|--|-------|-------|
| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| n/a | | | | | Rate of Proximity Measurement (no. of measurements per second) | | |
| Description | | | | | | | |
| Proximity rate | | R/W bits. 000 - 1.95 measurements/s (DEFAULT) 001 - 3.90625 measurements/s 010 - 7.8125 measurements/s 011 - 16.625 measurements/s 100 - 31.25 measurements/s 101 - 62.5 measurements/s 110 - 125 measurements/s 111 - 250 measurements/s | | | | | |

Note

- If self_timed measurement is running, any new value written in this register will not be taken over until the mode is actually cycled.

Register #3 LED Current Setting for Proximity Mode

Register address = 83h. This register is to set the LED current value for proximity measurement.

The value is adjustable in steps of 10 mA from 0 mA to 200 mA.

This register also contains information about the used device fuse program ID.

| TABLE 4 - IR LED CURRENT REGISTER #3 | | | | | | | |
|--------------------------------------|-------|---|-------|-------|-------|-------|-------|
| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| Fuse prog ID | | IR LED current value | | | | | |
| Description | | | | | | | |
| Fuse prog ID | | Read only bits. Information about fuse program revision used for initial setup/calibration of the device. | | | | | |
| IR LED current value | | R/W bits. IR LED current = Value (dec.) x 10 mA. Valid Range = 0 to 20d. e.g. 0 = 0 mA , 1 = 10 mA, ..., 20 = 200 mA (2 = 20 mA = DEFAULT) LED Current is limited to 200 mA for values higher as 20d. | | | | | |



Register #7 and #8 Proximity Measurement Result Register

Register address = 87h and 88h. These registers are the result registers for proximity measurement readings. The result is a 16 bit value. The high byte is stored in register #7 and the low byte in register #8.

| TABLE 5 - PROXIMITY RESULT REGISTER #7 | | | | | | | |
|--|-------|-------|-------|-------|-------|-------|-------|
| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| Description | | | | | | | |
| Read only bits. High byte (15:8) of proximity measurement result | | | | | | | |

| TABLE 6 - PROXIMITY RESULT REGISTER #8 | | | | | | | |
|--|-------|-------|-------|-------|-------|-------|-------|
| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| Description | | | | | | | |
| Read only bits. Low byte (7:0) of proximity measurement result | | | | | | | |

Register #9 Interrupt Control Register

Register address = 89h.

| TABLE 7 - INTERRUPT CONTROL REGISTER #9 | | | | | | | |
|---|---|-------|-------|-------------------|-------|--------------|---------------|
| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| Int count exceed | | | n/a | INT_PROX_ready_EN | n/a | INT_THRES_EN | INT_THRES_SEL |
| Description | | | | | | | |
| Int count exceed | R/W bits. These bits contain the number of consecutive measurements needed above/below the threshold 000 - 1 count = DEFAULT 001 - 2 count 010 - 4 count 011 - 8 count 100 - 16 count 101 - 32 count 110 - 64 count 111 - 128 count | | | | | | |
| INT_PROX_ready_EN | R/W bit. Enables interrupt generation at proximity data ready | | | | | | |
| INT_THRES_EN | R/W bit. Enables interrupt generation when high or low threshold is exceeded | | | | | | |
| INT_THRES_SEL | R/W bit. 0: thresholds are applied to proximity measurements | | | | | | |



Register #10 and #11 Low Threshold

Register address = 8Ah and 8Bh. These registers contain the low threshold value. The value is a 16 bit word. The high byte is stored in register #10 and the low byte in register #11.

| TABLE 8 - LOW THRESHOLD REGISTER #10 | | | | | | | |
|---|-------|-------|-------|-------|-------|-------|-------|
| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| Description | | | | | | | |
| R/W bits. High byte (15:8) of low threshold value | | | | | | | |

| TABLE 9 - LOW THRESHOLD REGISTER #11 | | | | | | | |
|---|-------|-------|-------|-------|-------|-------|-------|
| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| Description | | | | | | | |
| R/W bits. Low byte (7:0) of low threshold value | | | | | | | |

Register #12 and #13 High Threshold

Register address = 8Ch and 8Dh. These registers contain the high threshold value. The value is a 16 bit word. The high byte is stored in register #12 and the low byte in register #13.

| TABLE 10 - HIGH THRESHOLD REGISTER #12 | | | | | | | |
|--|-------|-------|-------|-------|-------|-------|-------|
| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| Description | | | | | | | |
| R/W bits. High byte (15:8) of high threshold value | | | | | | | |

| TABLE 11 - HIGH THRESHOLD REGISTER #13 | | | | | | | |
|--|-------|-------|-------|-------|-------|-------|-------|
| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| Description | | | | | | | |
| R/W bits. Low byte (7:0) of high threshold value | | | | | | | |

Register #14 Interrupt Status Register

Register address = 8Eh. This register contains information about the interrupt status indicates if high or low going threshold exceeded.

| TABLE 12 - INTERRUPT STATUS REGISTER #14 | | | | | | | | |
|--|-------|--|-------|----------------|-------|-------|------------|-----------|
| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | |
| n/a | | | | int_prox_ready | n/a | | int_th_low | int_th_hi |
| Description | | | | | | | | |
| int_prox_ready | | R/W bit. Indicates a generated interrupt for proximity | | | | | | |
| int_th_low | | R/W bit. Indicates a low threshold exceed | | | | | | |
| int_th_hi | | R/W bit. Indicates a high threshold exceed | | | | | | |

Note

- Once an interrupt is generated the corresponding status bit goes to 1 and stays there unless it is cleared by writing a 1 in the corresponding bit. The int pad will be pulled down while at least one of the status bit is 1.

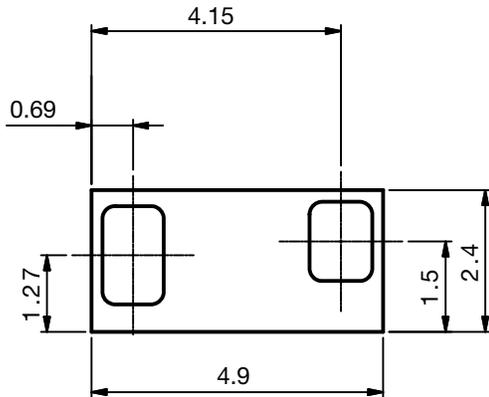
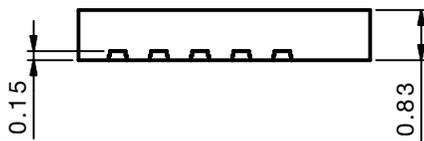
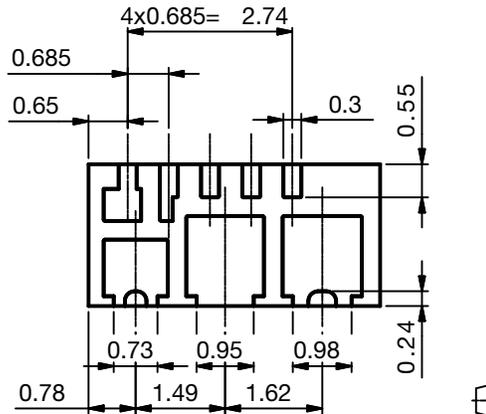
Example: read register "Proximity Result Register" #7 and #8:

Addressing:command: 26h, 87h (VCNL3020_I²C_Bus_Write_Adr., Proximity Result Register #7 [87])

Read register #7: command: 27h, data (VCNL3020_I²C_Bus_Read_Adr., {High Byte Data of Proximity Result register #7 [87]})

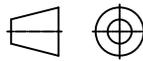
Read register #8: command: 27h, data (VCNL3020_I²C_Bus_Read_Adr., {Low Byte Data of Proximity Result register #8 [88]})

PACKAGE DIMENSIONS in millimeters



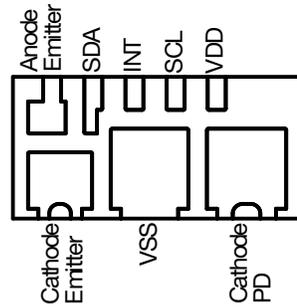
Drawing refers to following types: VCNL3020
 Drawing-No.: 6.550-5319 Issue: prel. 14. MAY 2012

Not indicated tolerances ± 0.1

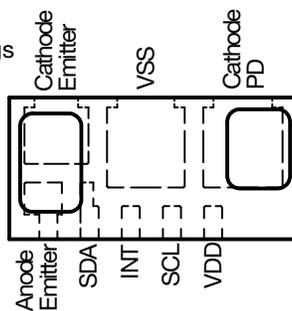


technical drawings according to DIN specifications

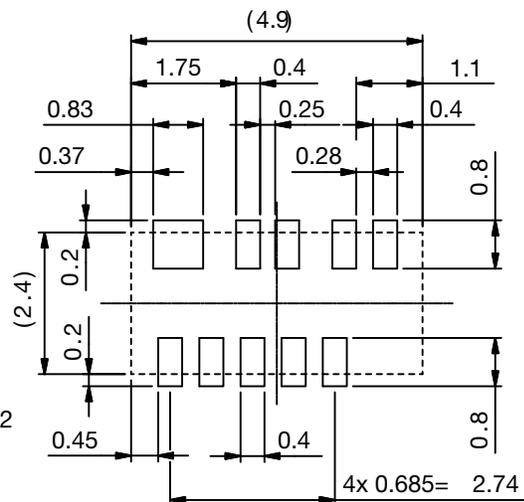
Pinning Bottom view



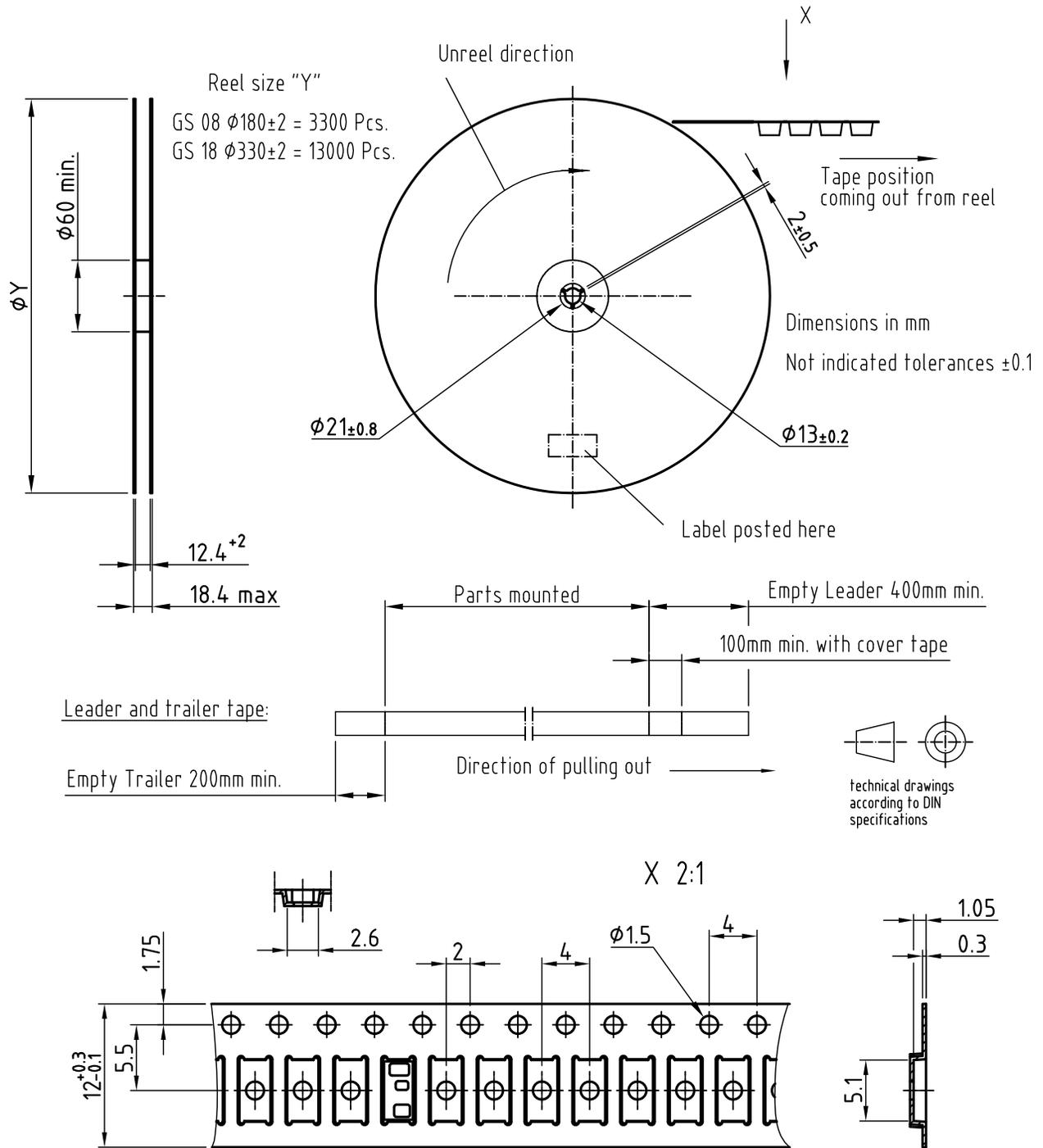
Pinning Top view



Proposed PCB Footprint



TAPE AND REEL DIMENSIONS in millimeters



Drawing-No.: 9.700-5387.01-4
 Issue: prel; 22.11.11

SOLDER PROFILE

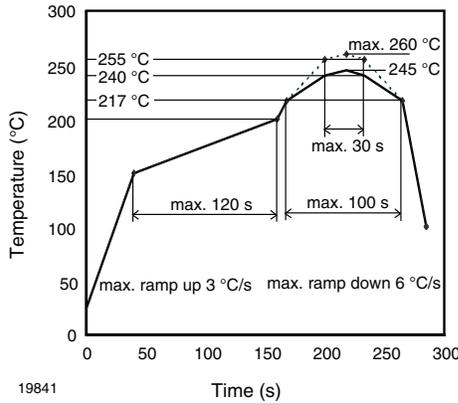


Fig. 12 - Lead (Pb)-free Reflow Solder Profile acc. J-STD-020

DRYPACK

Devices are packed in moisture barrier bags (MBB) to prevent the products from moisture absorption during transportation and storage. Each bag contains a desiccant.

FLOOR LIFE

Floor life (time between soldering and removing from MBB) must not exceed the time indicated on MBB label:

Floor life: 72 h

Conditions: $T_{amb} < 30\text{ °C}$, $RH < 60\%$

Moisture sensitivity level 4, acc. to J-STD-020.

DRYING

In case of moisture absorption devices should be baked before soldering. Conditions see J-STD-020 or label. Devices taped on reel dry using recommended conditions 192 h at 40 °C (+ 5 °C), $RH < 5\%$.



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