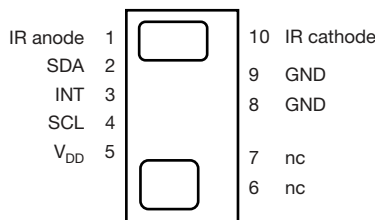


## Fully Integrated Proximity Sensor with Infrared Emitter, I<sup>2</sup>C Interface, and Interrupt Function



### 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 I<sup>2</sup>C 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<sub>DD</sub>: 2.5 V to 3.6 V
- Supply voltage range IR anode: 2.5 V to 5 V
- Communication via I<sup>2</sup>C interface
- I<sup>2</sup>C 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](http://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 <sup>2</sup> C BUS VOLTAGE RANGE (V)	LED PULSE CURRENT <sup>(1)</sup> (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 <sup>2</sup> C	16 bit / -

#### Note

<sup>(1)</sup> Adjustable through I<sup>2</sup>C interface

ORDERING INFORMATION			
ORDERING CODE	PACKAGING	VOLUME <sup>(1)</sup>	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 <sup>(2)</sup>	-	MOQ: 1 pc	-

#### Notes

<sup>(1)</sup> MOQ: minimum order quantity

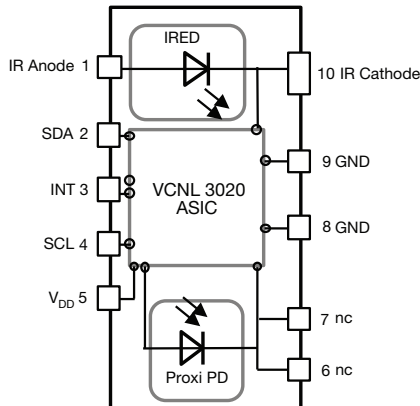
<sup>(2)</sup> A sensor starter kit is available, along with an add-on demo board for each of the sensors.

Please visit [www.vishay.com/moreinfo/vcnldemokit/](http://www.vishay.com/moreinfo/vcnldemokit/) for more information.

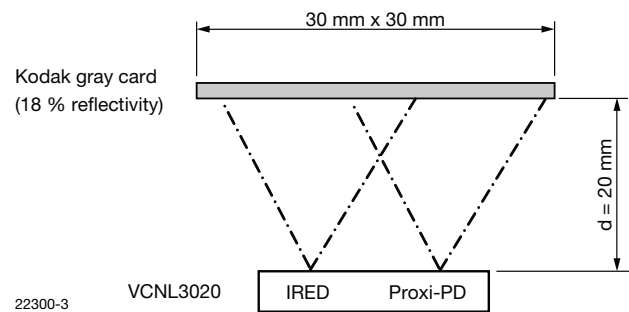
Contact any catalog distributor or a local Vishay sales representative to purchase the sensor starter kit and contact [sensorstechsupport@vishay.com](mailto:sensorstechsupport@vishay.com) to receive an add-on sensor board.

<b>ABSOLUTE MAXIMUM RATINGS</b> ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , 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	$^{\circ}\text{C}$

<b>BASIC CHARACTERISTICS</b> ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , 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 <sup>2</sup> 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	$\mu\text{A}$
Current consumption proximity mode incl. IRED (averaged)	2 measurements per second, IRED current 20 mA			5		$\mu\text{A}$
	250 measurements per second, IRED current 20 mA			520		$\mu\text{A}$
	2 measurements per second, IRED current 200 mA			35		$\mu\text{A}$
	250 measurements per second, IRED current 200 mA			4		mA
I <sup>2</sup> 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)

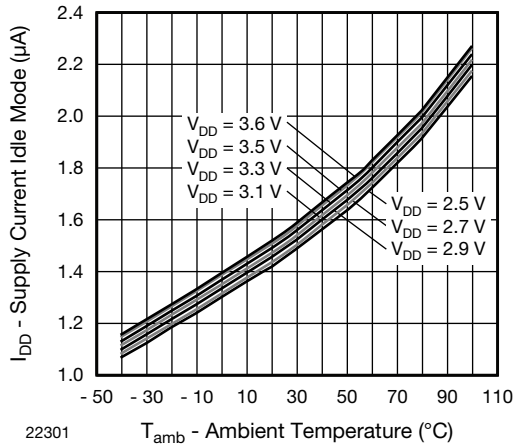


Fig. 1 - Idle Current vs. Ambient Temperature

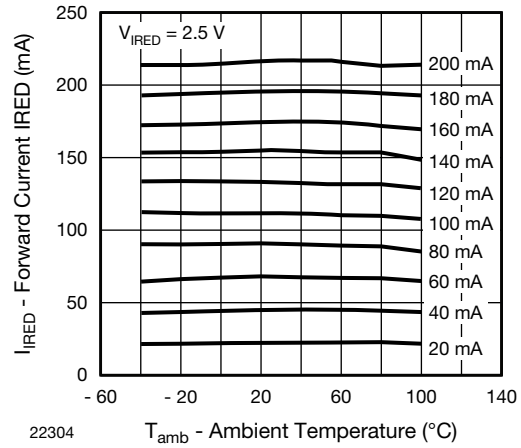


Fig. 4 - Forward Current vs. Temperature

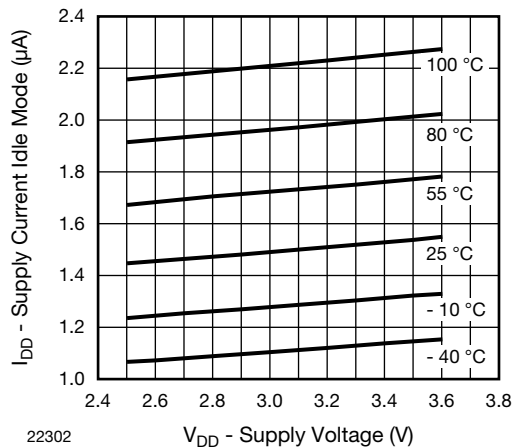


Fig. 2 - Idle Current vs.  $V_{DD}$

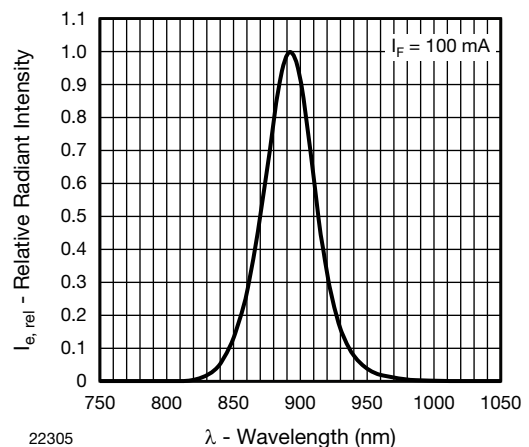


Fig. 5 - Relative Radiant Intensity vs. Wavelength

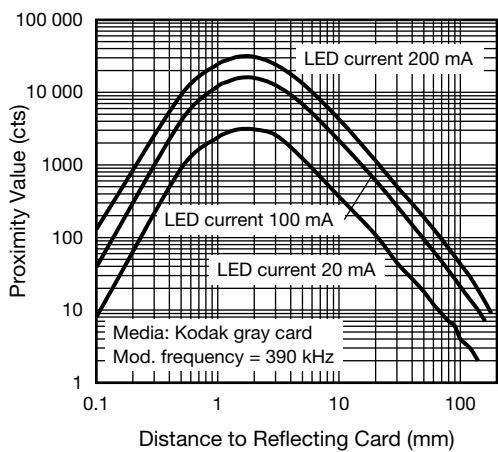


Fig. 3 - Proximity Value vs. Distance

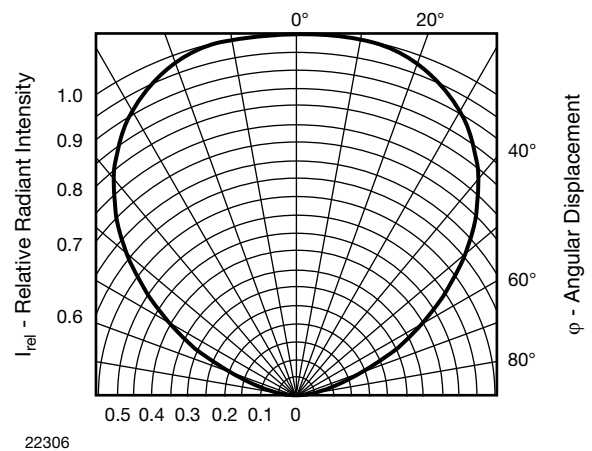


Fig. 6 - Relative Radiant Intensity vs. Angular Displacement

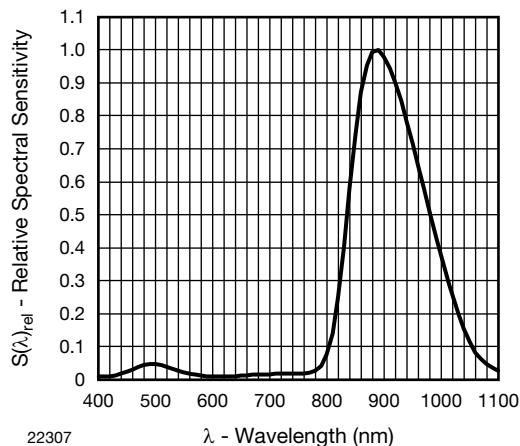


Fig. 7 - Relative Spectral Sensitivity vs. Wavelength (Proximity Sensor)

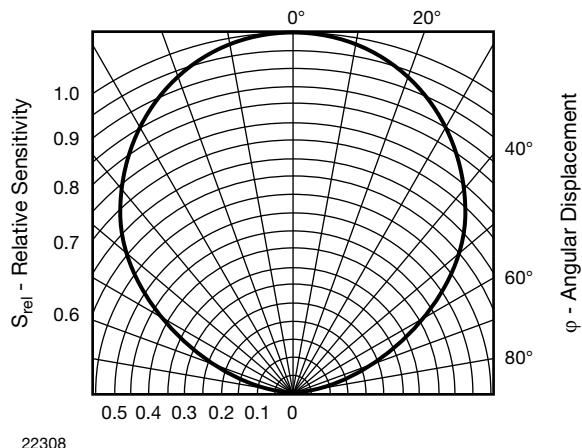


Fig. 8 - Relative Radiant Sensitivity vs. Angular Displacement (Proximity Sensor)

**APPLICATION INFORMATION**

VCNL3020 is a cost effective solution of proximity sensor with I<sup>2</sup>C 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**

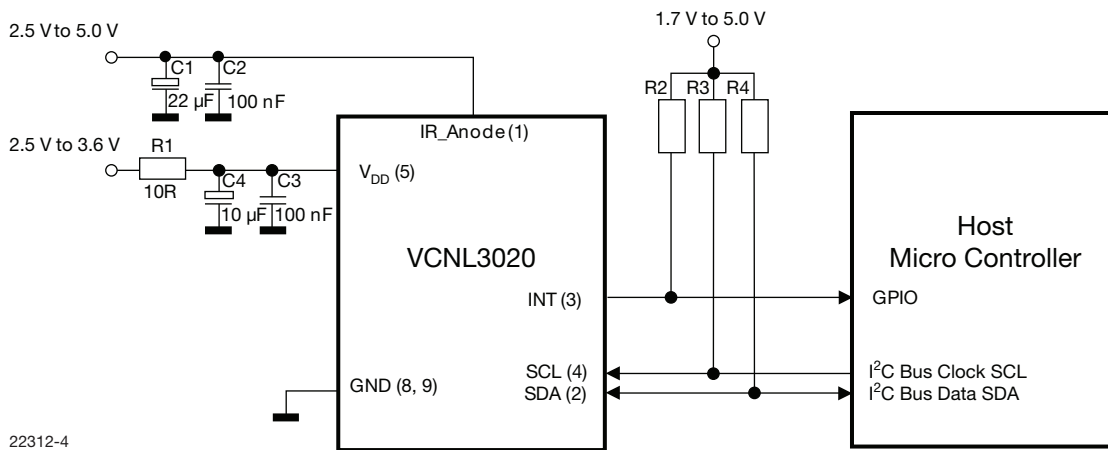


Fig. 9 - Application Circuit (x) = Pin Number

**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 I<sup>2</sup>C 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. I<sup>2</sup>C Interface**

The VCNL3020 contains seventeen 8 bit registers for operation control, parameter setup and result buffering. All registers are accessible via I<sup>2</sup>C communication. Figure 13 shows the basic I<sup>2</sup>C communication with VCNL3020.

The built in I<sup>2</sup>C interface is compatible with all I<sup>2</sup>C modes (standard, fast, and high speed).

I<sup>2</sup>C H-level range = 1.7 V to 5 V.

Please refer to the I<sup>2</sup>C specification from NXP for details.

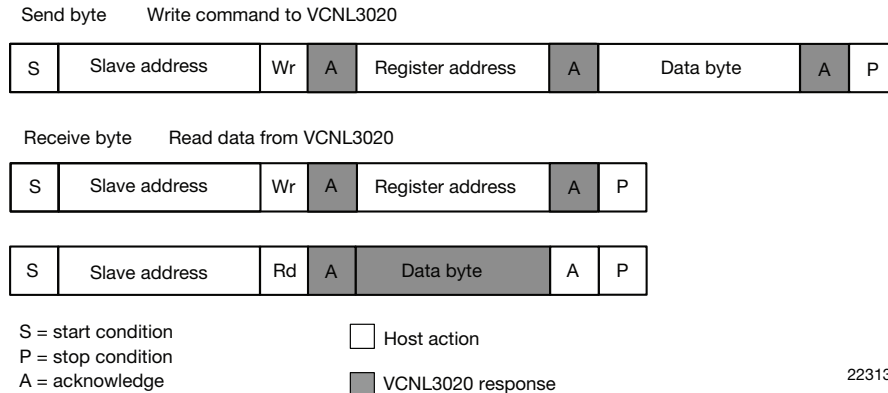


Fig. 10 - Send Byte/Receive Byte Protocol

**Device Address**

The VCNL3020 has a fix slave address for the host programming and accessing selection. The predefined 7 bit I<sup>2</sup>C 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			
<b>Description</b>							
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)		
<b>Description</b>							
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					
<b>Description</b>							
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
<b>Description</b>							
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
<b>Description</b>							
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
<b>Description</b>							
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
<b>Description</b>							
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
<b>Description</b>							
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
<b>Description</b>							
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
<b>Description</b>							
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
<b>Description</b>							
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.





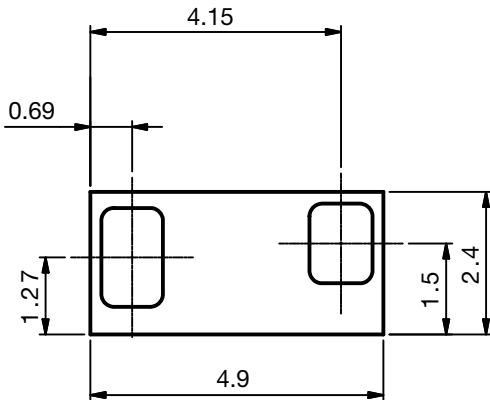
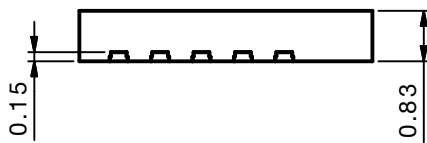
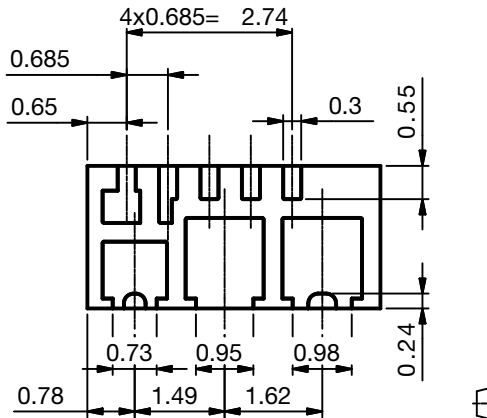
Example: read register "Proximity Result Register" #7 and #8:

Addressing:command: 26h, 87h (VCNL3020\_I<sup>2</sup>C\_Bus\_Write\_Adr., Proximity Result Register #7 [87])

Read register #7: command: 27h, data (VCNL3020\_I<sup>2</sup>C\_Bus\_Read\_Adr., {High Byte Data of Proximity Result register #7 [87]})

Read register #8: command: 27h, data (VCNL3020\_I<sup>2</sup>C\_Bus\_Read\_Adr., {Low Byte Data of Proximity Result register #8 [88]})

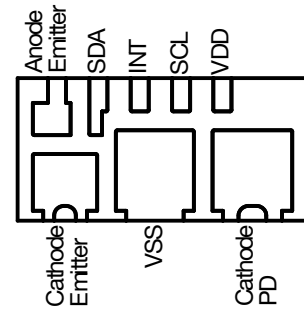
**PACKAGE DIMENSIONS** in millimeters



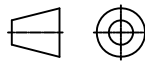
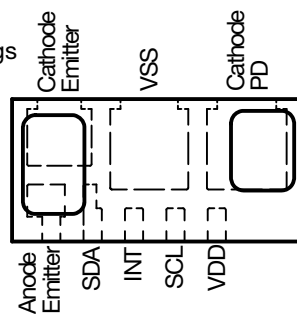
Drawing refers to following types: VCNL3020  
 Drawing-No.: 6.550-5319 Issue: prel. 14. MAY 2012

Not indicated tolerances ± 0.1

Pinning Bottom view

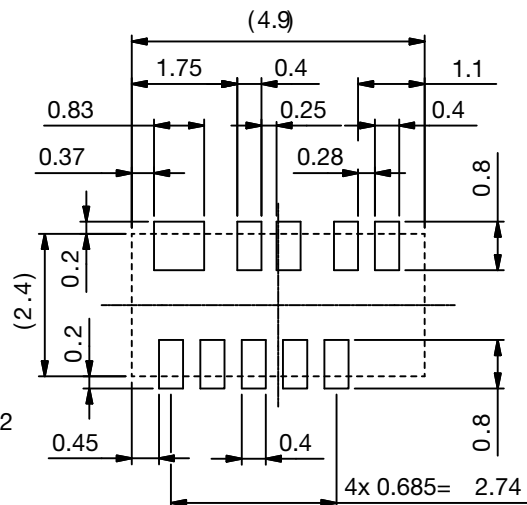


Pinning Top view

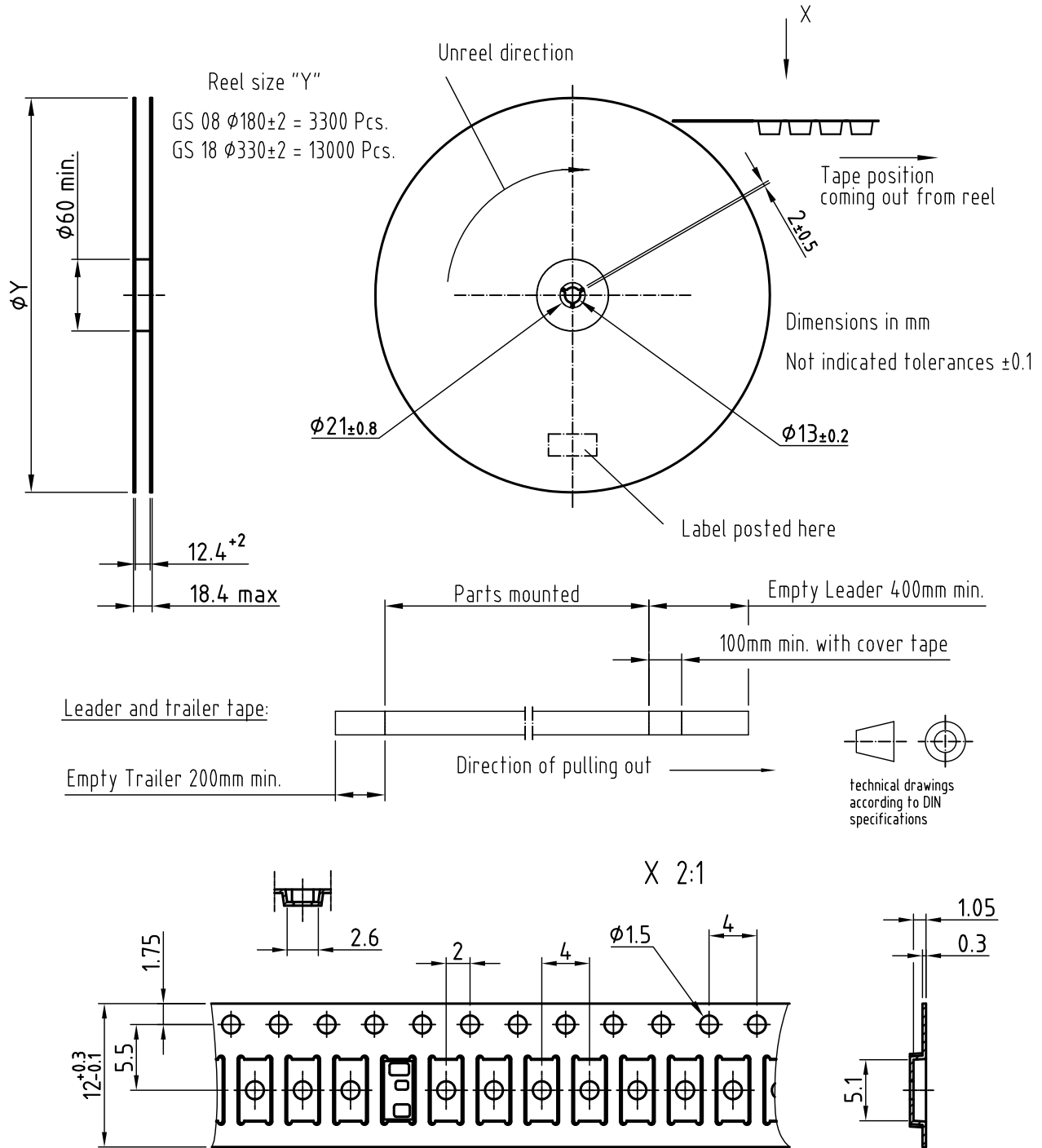


technical drawings according to DIN specifications

Proposed PCB Footprint



**TAPE AND REEL DIMENSIONS** in millimeters



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

**SOLDER PROFILE**

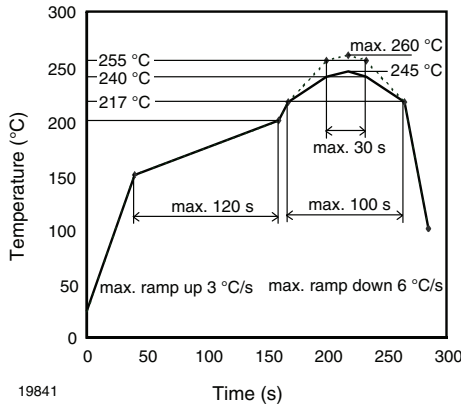


Fig. 12 - Lead (Pb)-free Reflow Solder Profile acc. J-STD-020

**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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