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

FEATURES

- Package type: surface mount
- Dimensions (L x W x H in mm): 4.90 x 2.40 x 0.83
- Integrated infrared emitter, proximity sensor, 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

RoHS COMPLIANT
GREEN
(5-2008)

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

IR anode	1	10 IR cathode
SDA	2	9 GND
INT	3	8 GND
SCL	4	
V_{DD}	5	7 nc
		6 nc

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

PRODUCT SUMMARY

PART NUMBER	OPERATING RANGE (mm)	OPERATING VOLTAGE RANGE (V)	I²C BUS VOLTAGE RANGE (V)	LED PULSE CURRENT [1] (mA)	OUTPUT CODE
VCNL3020	1 to 200	2.5 to 3.6	1.7 to 5	10 to 200	16 bit, I²C

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	
VCNL4000demokit [2]	-	MOQ: 1 pc	-

Notes

[1] MOQ: minimum order quantity

[2] VCNL4000 demokit provides USB dongle, basic software including Vishay licence. The VCNL3020 sensor board could be ordered free of charge. For your order please contact sensorstechsupport. Software updates for VCNL3020 could be downloaded from web site: www.vishay.com/optical-sensors/list/product-83476/

ABSOLUTE MAXIMUM RATINGS (T_{amb} = 25 °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	°C
Storage temperature range		T_{stg}	- 25	+ 85	°C
Total power dissipation	$T_{amb} \leq 25$ °C	P_{tot}		50	mW
Junction temperature		T_j		100	°C

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 IR anode			2.5		5	V
I²C 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
I²C clock rate range		f_{SCL}			3400	kHz

CIRCUIT BLOCK DIAGRAM
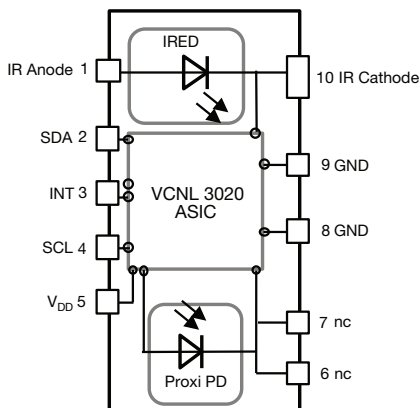
TEST CIRCUIT
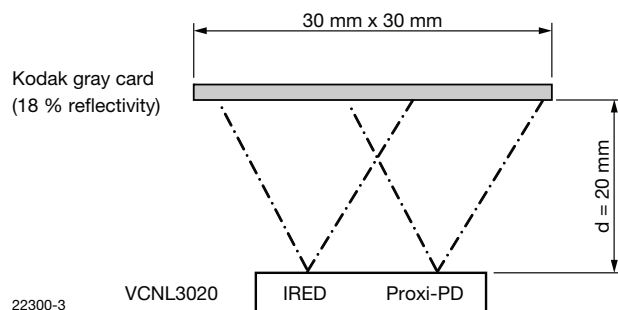
Note

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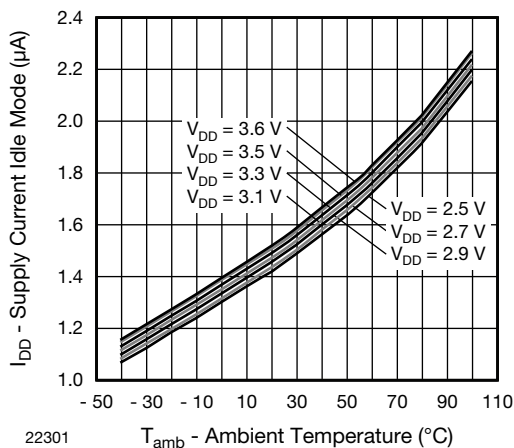 Pads 6 and 7 are only considered as solder pads

For technical questions, contact: sensorstechsupport@vishay.com

BASIC CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)

Fig. 1 - Idle Current vs. Ambient Temperature

Fig. 2 - Idle Current vs. V_{DD}
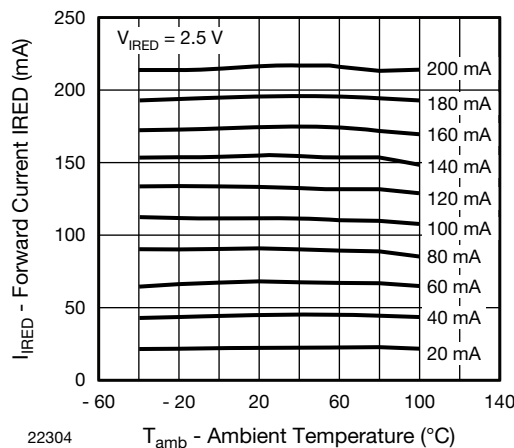
Fig. 3 - Proximity Value vs. Distance
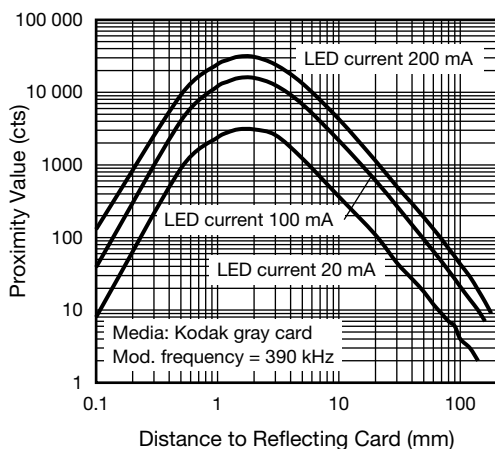
Fig. 4 - Forward Current vs. Temperature

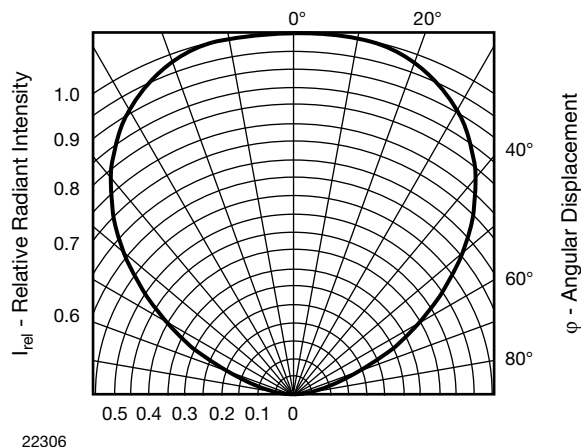Fig. 5 - Relative Radiant Intensity vs. Wavelength

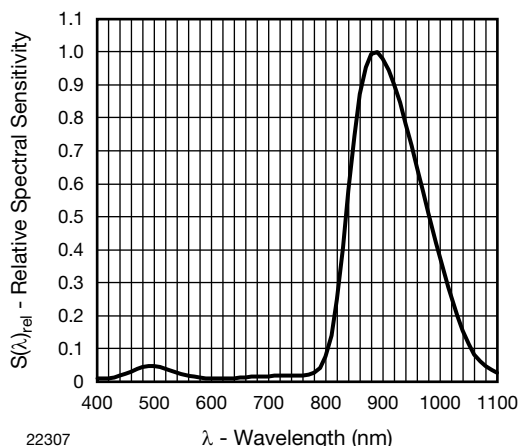Fig. 6 - Relative Radiant Intensity vs. Angular Displacement

Fig. 7 - Relative Spectral Sensitivity vs. Wavelength
(Proximity Sensor)
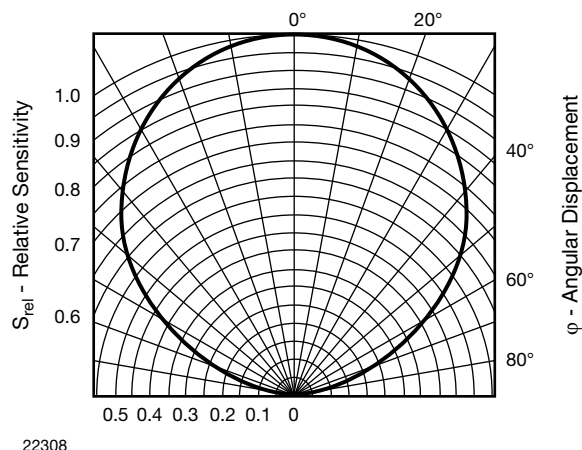
Fig. 8 - Relative Radiant Sensitivity vs. Angular Displacement
(Proximity Sensor)

APPLICATION INFORMATION

VCNL3020 is a cost effective solution of proximity sensor with I^2C 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
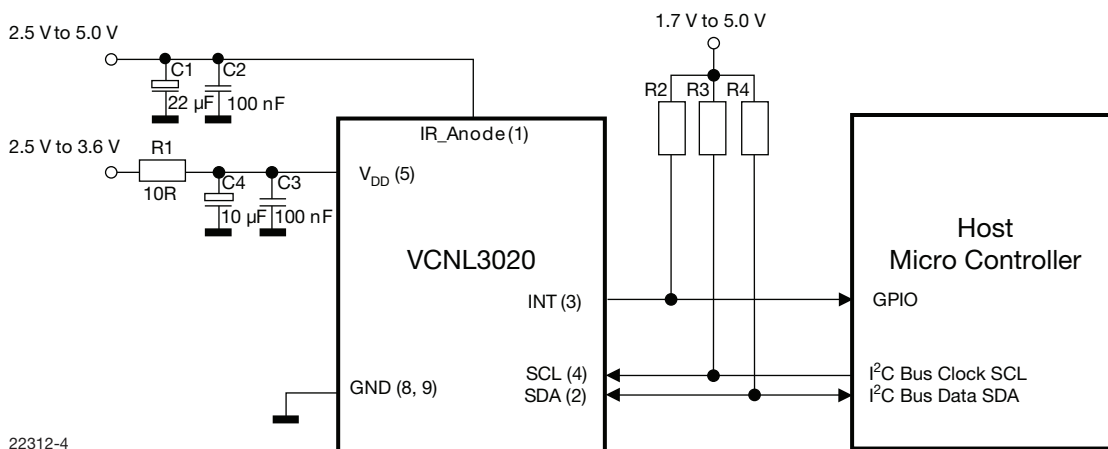
Fig. 9 - Application Circuit
(x) = Pin Number

Note

- 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^2C 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".

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.

Send byte   Write command to VCNL3020

| S | Slave address | Wr | A | Register address | A | Data byte | A | P |

Receive byte   Read data from VCNL3020

| S | Slave address | Wr | A | Register address | A | P |

| S | Slave address | Rd | A | Data byte | A | P |

S = start condition
P = stop condition
A = acknowledge

☐ Host action

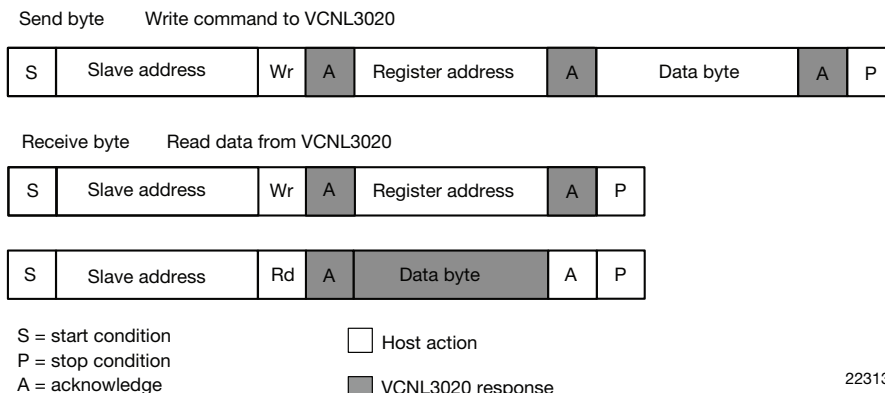▨ VCNL3020 response

22313-3

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 actualy 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.

Register #15 Proximity Modulator Timing Adjustment

Register address = 8Fh.

TABLE 13 - PROXIMITY MODULATOR TIMING ADJUSTMENT #15							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Modulation delay time			Proximity frequency		Modulation dead time		
Description							
Modulation delay time	R/W bits. Setting a delay time between IR LED signal and IR input signal evaluation. This function is for compensation of delays from IR LED and IR photo diode. Also in respect to the possibility for setting different proximity signal frequency. Correct adjustment is optimizing measurement signal level. (DEFAULT = 0)						
Proximity frequency	R/W bits. Setting the proximity IR test signal frequency The proximity measurement is using a square IR signal as measurement signal. Four different values are possible: 00 = 390.625 kHz (DEFAULT) 01 = 781.25 kHz 10 = 1.5625 MHz 11 = 3.125 MHz						
Modulation dead time	R/W bits. Setting a dead time in evaluation of IR signal at the slopes of the IR signal. (DEFAULT = 1) This function is for reducing of possible disturbance effects. This function is reducing signal level and should be used carefully.						

Note
- The settings for best performance will be provided by Vishay. With first samples this is evaluated to:
  Delay Time = 0 ; Dead Time = 1 and Prox Frequency = 0 . With that register#15 should be programmed with 1 (= default value).

Register #16 Ambient IR Light Level Register

Register address = 90h.

This register is not intended to be used by customer.

3. IMPORTANT APPLICATION HINTS AND EXAMPLES

3.1 Receiver standby mode

In standby mode the receiver has the lowest current consumption of about 1.5 µA. In this mode only the I^{2}C interface is active. This is always valid, when there are no proximity measurement demands executed. Also the current sink for the IR-LED is inactive, so there is no need for changing register #3 (IR LED current).

3.2 Data Read

In order to get a certain register value, the register has to be addressed without data like shown in the following scheme. After this register addressing, the data from the addressed register is written after a subsequent read command.
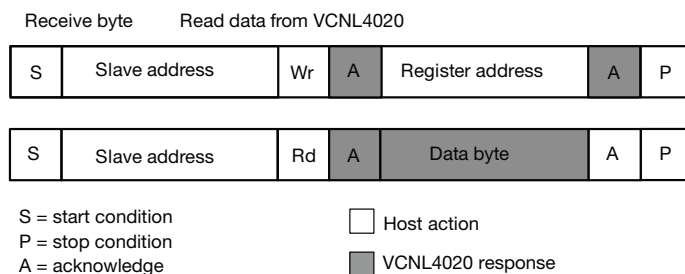

Fig. 11 - Send Byte/Receive Byte Protocol

The stop condition between these write and read sequences is not mandatory. It works also with a repeated start condition.

Note
- For reading out 2 (or more) subsequent registers like the result registers, it is not necessary to address each of the registers separately. After one read command the internal register counter is increased automatically and any subsequent read command is accessing the next register.

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])}

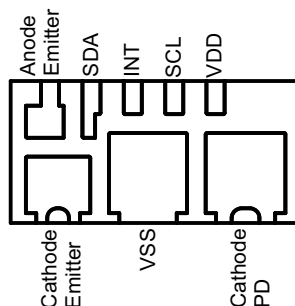Read register #8: command: 27h, data (VCNL3020_I²C_Bus_Read_Adr., {Low Byte Data of Proximity Result register #8 [88])}

PACKAGE DIMENSIONS in millimeters

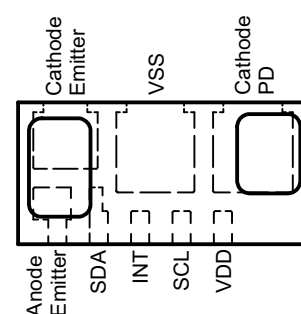Pinning Bottom view

Pinning Top view

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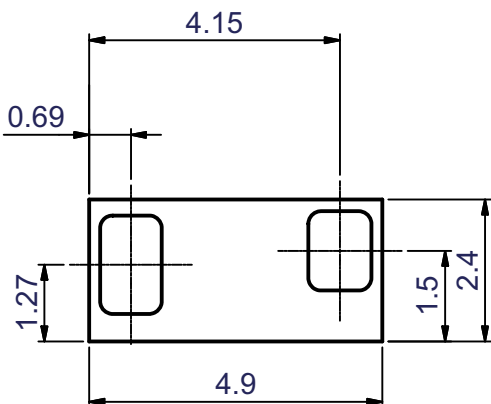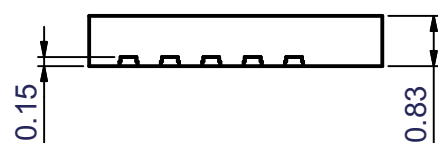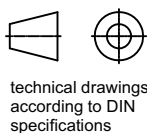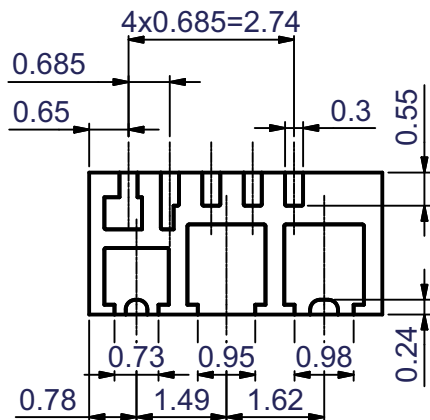
Drawing refers to following types: VCNL3020
Drawing-No.: 6.550-5319 Issue: prel. 14. MAY 2012

Not indicated tolerances ± 0.1

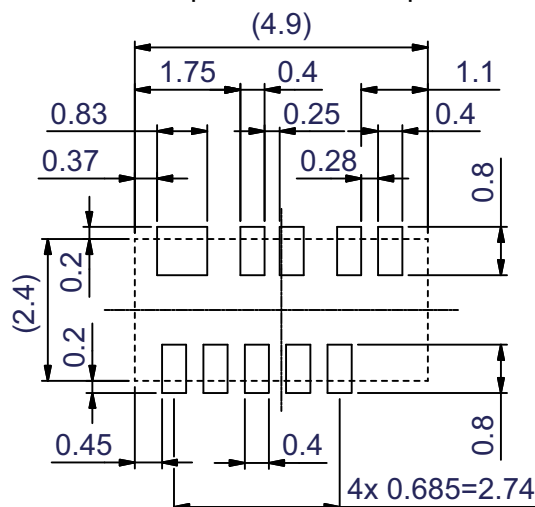**TAPE AND REEL DIMENSIONS** in millimeters
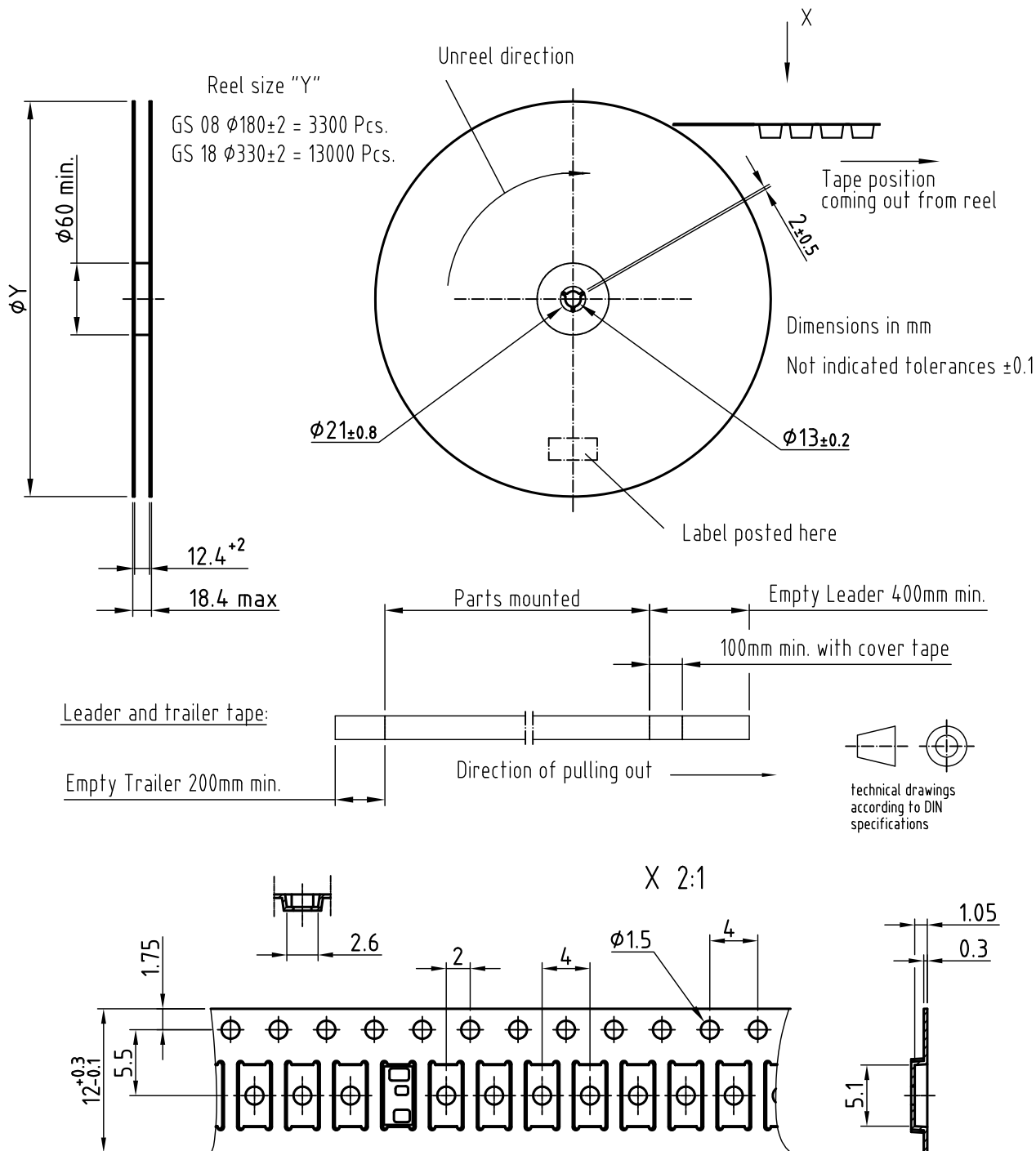
Reel size "Y"

GS 08 ϕ180±2 = 3300 Pcs.
GS 18 ϕ330±2 = 13000 Pcs.

Unreel direction

X

Tape position
coming out from reel

ϕ60 min.

ϕY

2±0.5

Dimensions in mm

Not indicated tolerances ±0.1

ϕ21±0.8

ϕ13±0.2

Label posted here

12.4 $^{+2}$

18.4 max

Parts mounted

Empty Leader 400mm min.

100mm min. with cover tape

Leader and trailer tape:

Empty Trailer 200mm min.

Direction of pulling out

technical drawings
according to DIN
specifications

X 2:1

1.75

2.6

2

4

ϕ1.5

4

1.05

0.3

12 $^{+0.3}_{-0.1}$

5.5

5.1

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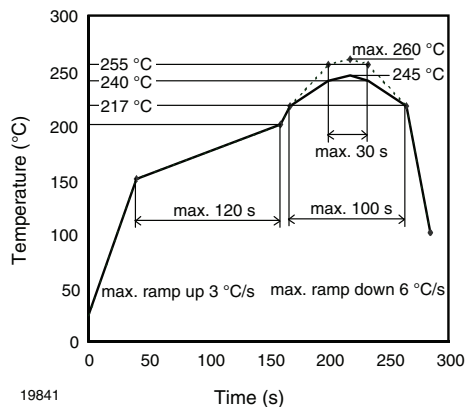
SOLDER PROFILE

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: $T_{amb} < 30\ °C$, 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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- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits,General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.

Как с нами связаться

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