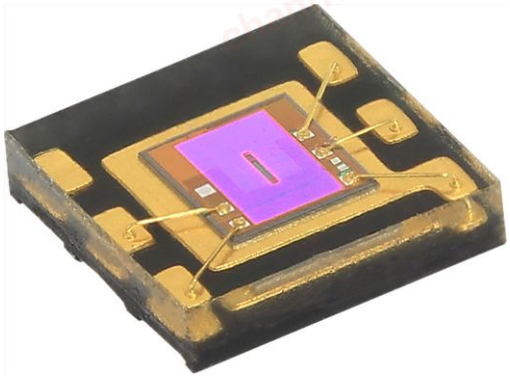
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Low Power, High Sensitivity, I²C Ambient Light Sensor



FEATURES

- Package type: surface-mount
- Dimensions (L x W x H in mm): 2.0 x 2.0 x 0.4
- Integrated modules: ambient light sensor (ALS)
- Supply voltage range V_{DD}: 1.7 V to 3.6 V
- Communication via I²C interface
- I²C bus H-level range: 1.7 V to 3.6 V
- Floor life: 168 h, MSL 3, according to J-STD-020
- Low stand by current consumption: typ. 0.5 µA
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free
e4
RoHS COMPLIANT
HALOGEN FREE
GREEN (5-2008)

DESCRIPTION

VEML6035 is a 16-bit low power, high sensitivity CMOS ambient light sensor operated via a simple I²C command. The sensor offers an active interruption feature that is triggered outside of the threshold window settings eliminating loading on the host. Active average power consumption is around 300 µW.

VEML6035 incorporates a photodiode, amplifiers, and analog / digital circuits in a single chip. Vishay's patented Filtron™ technology, a wafer level optical filter, provides the best spectral sensitivity to match human eye responses. The sensor has excellent temperature compensation to maintain output stability under changing temperature and its refresh rate setting does not need an external RC low pass filter. There is a programmable shutdown mode which reduces current consumption to 0.5 µA. Operating voltage ranges from 1.7 V to 3.6 V.

APPLICATIONS

- Ambient light sensor for mobile devices (e.g. smart phones, touch phones, PDA, GPS) for backlight dimming even under tinted glass
- Ambient light sensor for industrial on- / off-lighting operation
- Optical switch for consumer, computing, and industrial devices and displays

AMBIENT LIGHT FUNCTION

- High ALS sensitivity with minimum detectable intensity of 0.0004 lux/bit supports low transmittance lens design
- 100 Hz and 120 Hz flicker noise rejection
- Excellent temperature compensation
- High dynamic detection resolution

INTERRUPT FEATURE (INT) SUPPORT

Programmable interrupt function with upper and lower thresholds. Adjustable persistence to prevent false triggers.

PRODUCT SUMMARY

PART NUMBER	OPERATING VOLTAGE RANGE (V)	I²C BUS VOLTAGE RANGE (V)	AMBIENT LIGHT RANGE (lx)	AMBIENT LIGHT RESOLUTION (lx)	OUTPUT CODE	ADC RESOLUTION PROXIMITY / AMBIENT LIGHT
VEML6035	1.7 to 3.6	1.7 to 3.6	6710	0.0004	16 bit, I²C	- / 0.0004

ORDERING INFORMATION

ORDERING CODE	PACKAGING	VOLUME (1)	REMARKS
VEML6035	Tape and reel	MOQ: 3000	2.0 mm x 2.0 mm x 0.4 mm

Note

(1) MOQ: minimum order quantity

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ABSOLUTE MAXIMUM RATINGS (T_{amb} = 25 °C, unless otherwise specified)					
PARAMETER	**TEST CONDITION**	**SYMBOL**	**MIN.**	**MAX.**	**UNIT**
Supply voltage		V_{DD}	0	4	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	-	85	°C

BASIC CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)						
PARAMETER	**TEST CONDITION**	**SYMBOL**	**MIN.**	**TYP.**	**MAX.**	**UNIT**
Supply voltage		V_{DD}	1.7	1.8	3.6	V
Shut down current (2)	V_{DD} = 1.8 V	I_{sd}	-	0.5	-	µA
Operation mode current (1)	V_{DD} = 1.8 V, CHANNEL_EN = 0 (ALS only)	I_{DD}	-	170	-	µA
	V_{DD} = 1.8 V, CHANNEL_EN = 0 (ALS only), PSM = 1 = EN (5)	I_{DD}	-	90	-	µA
	V_{DD} = 1.8 V, CHANNEL_EN = 1 (ALS and WHITE)	I_{DD}	-	225	-	µA
I^2C clock rate range		f_{SCL}	10	-	400	kHz
I^2C bus input H-level range	V_{DD} = 1.8 V	V_{ih}	1.2	-	V_{DD}	V
I^2C bus input L-level range	V_{DD} = 1.8 V	V_{il}	0	-	0.4	V
Output low voltage SDA	3 mA sink current	V_{ol}	0	-	0.4	V
Digital resolution (LSB count)	With GAIN = 1, DG = 1, SENS = 0		-	0.0004	-	lx/step
Detectable minimum illuminance (3)	With GAIN = 1, DG = 1, SENS = 0	$E_{V\ min.}$	-	0.004	-	lx
Detectable maximum illuminance	With GAIN = 0, DG = 0, SENS = 1	$E_{V\ max.}$	-	6710	-	lx
Dark offset (4)	With GAIN = 1, DG = 1, SENS = 0		-	-	5	step

Notes

(1) Light source: white LED

(2) Light conditions: dark

(3) The part has a typical zero offset of 10 counts at the set max. resolution of 0.0004lx/step, so the first valid measurement will be at an illuminance of 0.004lx (typ.)

(4) The dark offset can be above or below 0

(5) IT =100 ms, PSM_WAIT = 3.2 s

CIRCUIT BLOCK DIAGRAM

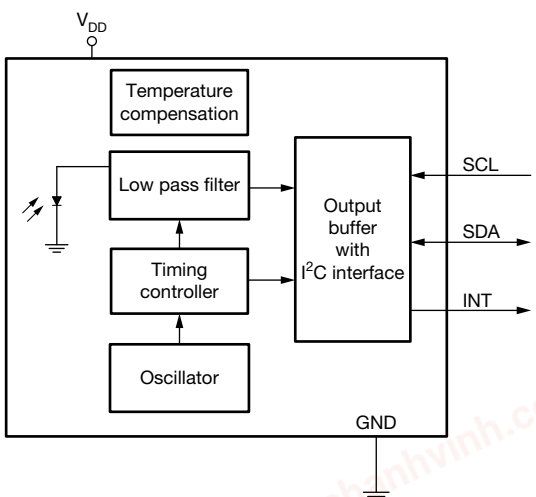


Fig. 1 - Block Diagram

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I²C TIMING CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)						
PARAMETER	**SYMBOL**	**STANDARD MODE (1)**		**FAST MODE (1)**		**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	$t_{(HDDAT)}$	0	3450	0	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

Note

(1) Data based on standard I²C protocol requirement, not tested in production

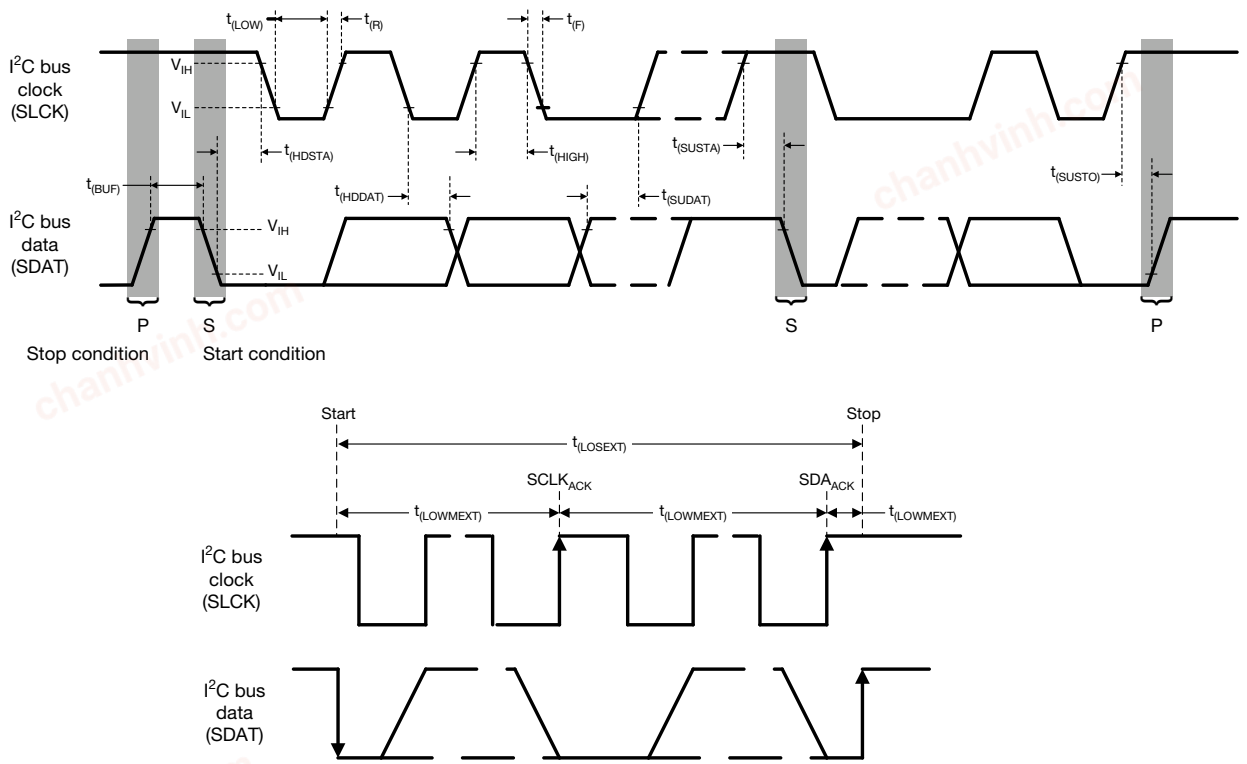


Fig. 2 - I²C Timing Diagram

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PARAMETER TIMING INFORMATION

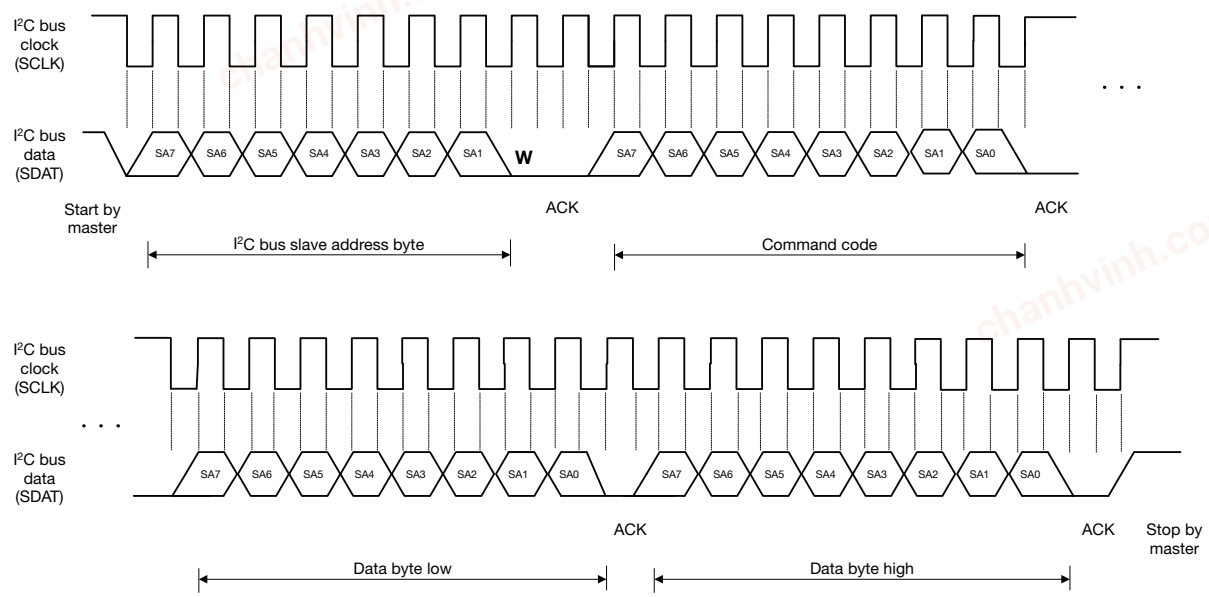


Fig. 3 - I²C Bus Timing for Sending Word Command Format

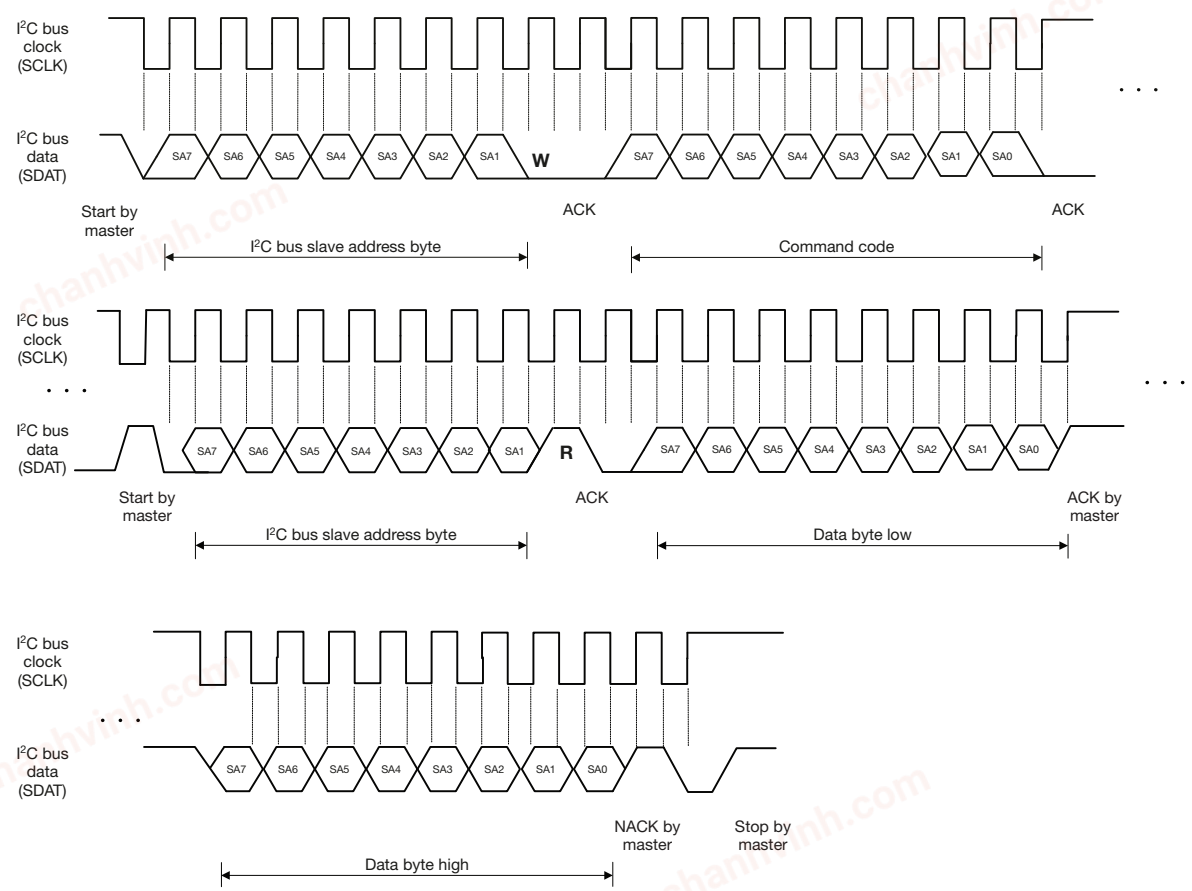


Fig. 4 - I²C Bus Timing for Receive Word Command Format

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

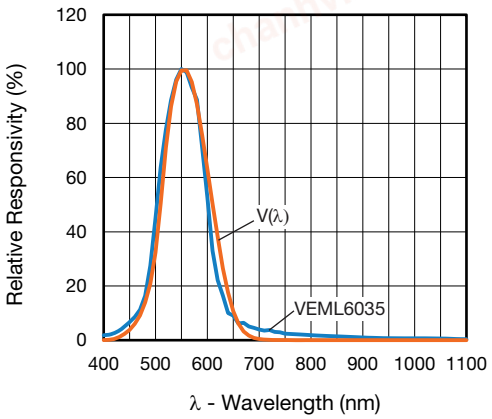


Fig. 5 - Normalized ALS Channel Spectral Response

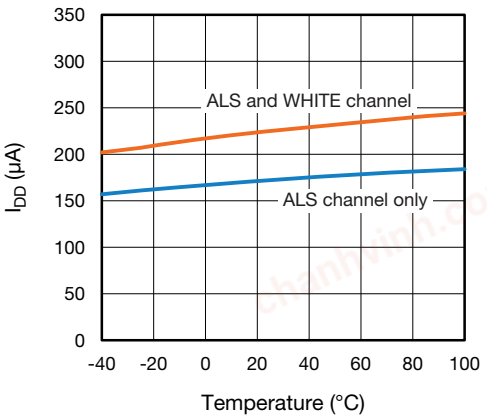


Fig. 8 - I_{DD} vs. Temperature Characteristics

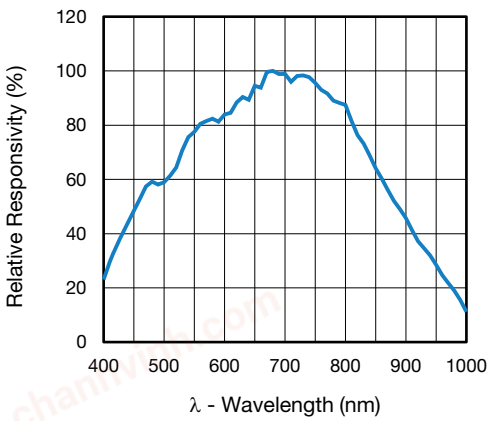


Fig. 6 - Normalized WHITE Channel Spectral Response

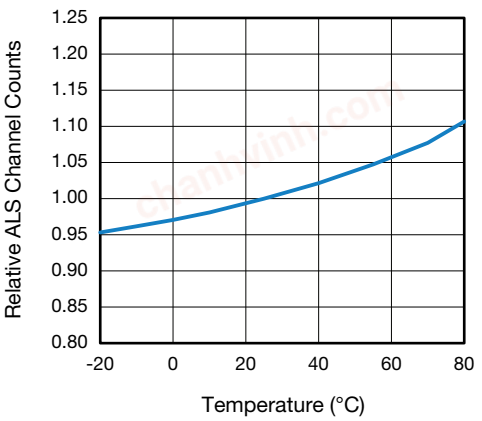


Fig. 9 - Normalized ALS Counts vs. Temperature

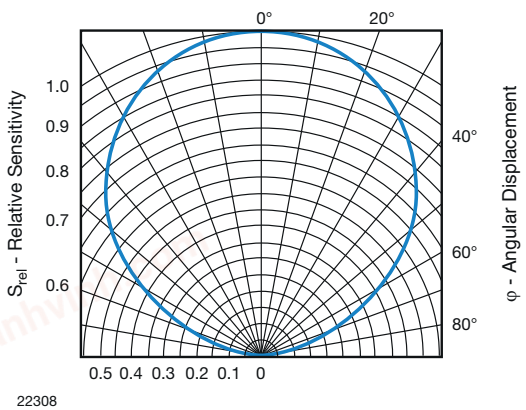


Fig. 7 - View Angle

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APPLICATION INFORMATION

VEML6035 is a cost effective solution of ambient light sensor with I²C bus interface. The standard serial digital interface is easy to access “Ambient Light Signal” without complex calculation and programming by external controller. Beside the digital output also a flexible programmable interrupt pin is available.

1. Application Circuit

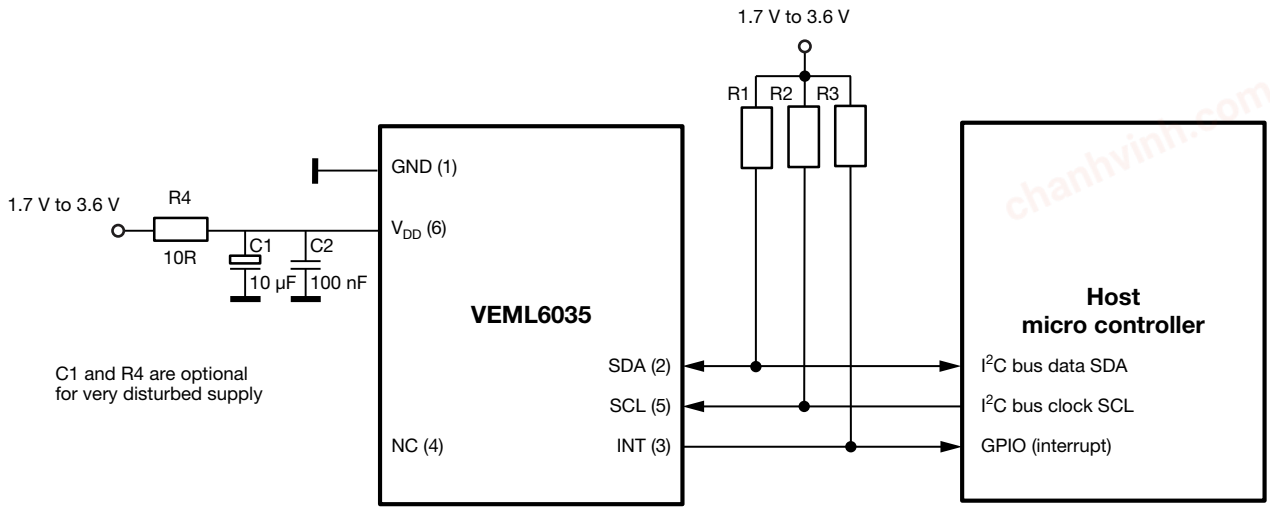


Fig. 10 - Application Circuit
(x) = Pin Number

Note

- The interrupt pin is an open drain output. Proposed values for the pull-up resistors should be > 1 kΩ, e.g. 2.2 kΩ to 4.7 kΩ for the R1 and R2 (at SDA and SCL) and 10 kΩ to 100 kΩ for R3 (at interrupt). Normally just one decoupling capacitor is needed. This should be ≥ 100 nF and placed close to the V_{DD} pin. For detailed description about set-up and use of the interrupt as well as more application related information see application note: “Designing VEML6035 Into an Application” (www.vishay.com/doc?84944)

2. I²C Interface

The VEML6035 contains actual six 16 bit command codes for operation control, parameter setup, and result buffering. All registers are accessible via I²C communication. Fig. 7 shows the basic I²C communication with VEML6035. The built in I²C interface is compatible with I²C modes “standard” and “fast”: 10 kHz to 400 kHz. I²C H-level range = 1.3 V to 3.6 V. Please refer to the I²C specification from NXP for details.

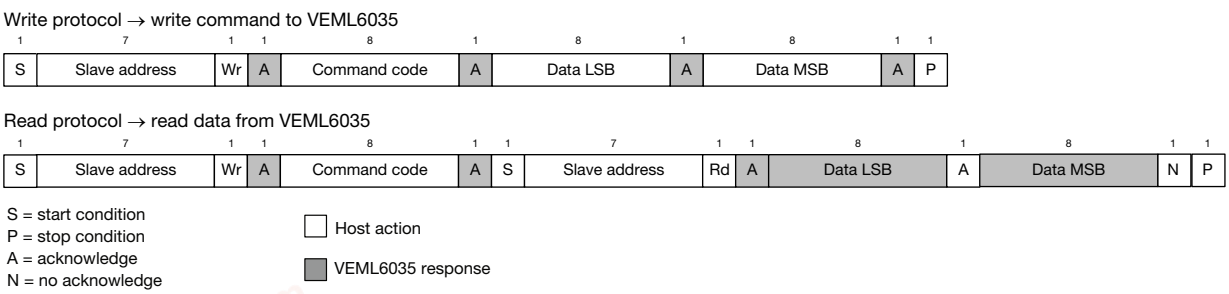


Fig. 11 - VEML6035 Command Protocol

Device Address

The VEML6035 has one fix slave address for the host programming and accessing selection. The predefined 7 bit I²C bus address is set to 0101001 = 0x29. The least significant bit (LSB) defines read or write mode. Accordingly the bus address is set to 0101 0010 = 52h for write and 0101 0011 = 53h for read.

Auto-Memorization

VEML6035 can memorize the last ambient data before shutdown and keep this data before waking up. When VEML6035 is in shutdown mode, the host can freely read this data via read command directly. When VEML6035 wakes up, the data will be refreshed by new detection.

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Command Register Format

There are 6 command codes provided by VEML6035. Formats of these command code and registers' definition explanations are shown in below table.

COMMAND REGISTER FORMAT				
COMMAND CODE	**REGISTER NAME**	**BIT**	**FUNCTION / DESCRIPTION**	**R / W**
00	ALS_CONF 0	15 : 0	ALS gain, integration time, interrupt, and shut down	R / W
01	WH	15 : 8	High threshold window setting (MSB)	R / W
	WH	7 : 0	High threshold window setting (LSB)	R / W
02	WL	15 : 8	Low threshold window setting (MSB)	R / W
	WL	7 : 0	Low threshold window setting (LSB)	R / W
03	Reserved	15 : 3	Reserved	R / W
	PSM_WAIT	2 : 1	(0 : 0) = 0.4 s, (0 : 1) = 0.8 s, (1 : 0) = 1.6 s, (1 : 1) = 3.2 s	R / W
	PSM_EN	0	0 = PSM disabled, 1 = PSM enabled	R / W
04	ALS	15 : 8	MSB 8 bits data of whole ALS 16 bits	R
	ALS	7 : 0	LSB 8 bits data of whole ALS 16 bits	R
05	WHITE	15 : 8	MSB 8 bits data of whole WHITE 16 bits	R
	WHITE	7 : 0	LSB 8 bits data of whole WHITE 16 bits	R
06	IF_L	15	Crossing low threshold INT trigger event	R
	IF_H	14	Crossing high threshold INT trigger event	R
	Reserved	13 : 0	Reserved	R

TABLE 1 - CONFIGURATION REGISTER 00 (HEX)		
REGISTER NAME	**BIT**	**FUNCTION / DESCRIPTION**
Reserved	15 : 13	Reserved
SENS	12	0 = high sensitivity (1 x), 1 = low sensitivity (1/8 x)
DG	11	0 = normal, 1 = double
GAIN	10	0 = normal sensitivity, 1 = double sensitivity
ALS_IT [1]	9 : 6	ALS integration time setting which represents how long ALS can update the readout value. 1100 = 25 ms 1000 = 50 ms 0000 = 100 ms 0001 = 200 ms 0010 = 400 ms 0011 = 800 ms
ALS_PERS	5 : 4	ALS interrupt persistence setting. The interrupt pin is triggered while sensor reading is out of threshold windows after consecutive number of measurement cycle 00 = 1 01 = 2 10 = 4 11 = 8
INT_CHANNEL	3	Selection for which channel the interrupt should trigger 0 = ALS CH interrupt 1 = WHITE CH interrupt
CHANNEL_EN	2	Channel enable function 0 = ALS CH enable only 1 = ALS and WHITE CH enable
INT_EN	1	Interrupt enable setting 0 = INT disable 1 = INT enable
SD	0	Shut down setting 0 = power on 1 = shutdown

Note

(1) Integration times have a tolerance of ± 30 %

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TABLE 2 - HIGH THRESHOLD WINDOWS SETTING 01 (HEX)		
REGISTER NAME	BIT	FUNCTION / DESCRIPTION
01	15 : 8	High threshold window setting (MSB)
	7 : 0	High threshold window setting (LSB)

Note

- INT function must be enabled to trigger on this high threshold

TABLE 3 - LOW THRESHOLD WINDOWS SETTING 02 (HEX)		
REGISTER NAME	BIT	FUNCTION / DESCRIPTION
02	15 : 8	Low threshold window setting (MSB)
	7 : 0	Low threshold window setting (LSB)

Note

- INT function must be enabled to trigger on this low threshold

TABLE 4 - POWER SAFE MODE 03 (HEX)		
REGISTER NAME	BIT	FUNCTION / DESCRIPTION
03	15 : 3	Reserved
	2 : 1	PSM_WAIT (0 : 0) = 0.4 s, (0 : 1) = 0.8 s, (1 : 0) = 1.6 s, (1 : 1) = 3.2 s
	0	PSM_EN 0 = PSM disabled, 1 = PSM enabled

Note

- Please refer also to the application note “Designing the VEML6035 Into an Application” (www.vishay.com/doc?84944)

TABLE 5 - ALS HIGH RESOLUTION OUTPUT DATA 04 (HEX)		
REGISTER NAME	BIT	FUNCTION / DESCRIPTION
04	15 : 8	MSB 8 bits data of whole 16 bits
	7 : 0	LSB 8 bits data of whole 16 bits

TABLE 6 - WHITE CHANNEL OUTPUT DATA 05 (HEX)		
REGISTER NAME	BIT	FUNCTION / DESCRIPTION
05	15 : 8	MSB 8 bits data of whole 16 bits
	7 : 0	LSB 8 bits data of whole 16 bits

TABLE 7 - INTERRUPT STATUS 06 (HEX)		
REGISTER NAME	BIT	FUNCTION / DESCRIPTION
06	15	Low threshold interrupt flag 0 = interrupt not triggered 1 = interrupt occurred
	14	High threshold interrupt flag 0 = interrupt not triggered 1 = interrupt occurred

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CALCULATING THE LUX LEVEL

Command code 04 contains the results of the ALS measurement. This 16-bit code needs to be converted to a decimal value to determine the corresponding lux value. The calculation of the corresponding lux level is dependent on the programmed gain setting and the chosen integration time.

The component is most sensitive with GAIN = 1, DG = 1, SENS = 0 and an integration time of 800 ms, specified to 0.0004 lx/step. Every time the integration time is halved, the resolution is halved, the lx/cnt value is doubled.

The same principle is valid for the gain and sensitivity settings. For GAIN = 0 it is doubled and also for DG = 1 it is again doubled. For SENS = 1 the sensitivity is programmed to just 1/8, to allow for higher illuminations up to about 6.7 klx.

The tables below shows these dependencies:

RESOLUTION AND MAXIMUM DETECTION RANGE AT DG = 1

	GAIN = 1, SENS = 0	GAIN = 0, SENS = 0	GAIN = 1, SENS = 1	GAIN = 0, SENS = 1		GAIN = 1, SENS = 0	GAIN = 0, SENS = 0	GAIN = 1, SENS = 1	GAIN = 0, SENS = 1
IT (ms)	TYPICAL RESOLUTION (lx/cnt)					MAXIMUM POSSIBLE ILLUMINATION (lx)			
800	0.0004	0.0008	0.0032	0.0064		26	52	210	419
400	0.0008	0.0016	0.0064	0.0128		52	105	419	839
200	0.0016	0.0032	0.0128	0.0256		105	210	839	1678
100	0.0032	0.0064	0.0256	0.0512		210	419	1678	3355
50	0.0064	0.0128	0.0512	0.1024		(-) [1]	(-) [1]	(-) [1]	(-) [1]
25	0.0128	0.0256	0.1024	0.2048		(-) [1]	(-) [1]	(-) [1]	(-) [1]

RESOLUTION AND MAXIMUM DETECTION RANGE AT DG = 0

	GAIN = 1, SENS = 0	GAIN = 0, SENS = 0	GAIN = 1, SENS = 1	GAIN = 0, SENS = 1		GAIN = 1, SENS = 0	GAIN = 0, SENS = 0	GAIN = 1, SENS = 1	GAIN = 0, SENS = 1
IT (ms)	TYPICAL RESOLUTION (lx/cnt)					MAXIMUM POSSIBLE ILLUMINATION (lx)			
800	0.0008	0.0016	0.0064	0.0128		52	105	419	839
400	0.0016	0.0032	0.0128	0.0256		105	210	839	1678
200	0.0032	0.0064	0.0256	0.0512		210	419	1678	3355
100	0.0064	0.0128	0.0512	0.1024		419	839	3355	6711
50	0.0128	0.0256	0.1024	0.2048		(-) [1]	(-) [1]	(-) [1]	(-) [1]
25	0.0256	0.0512	0.2048	0.4096		(-) [1]	(-) [1]	(-) [1]	(-) [1]

Note

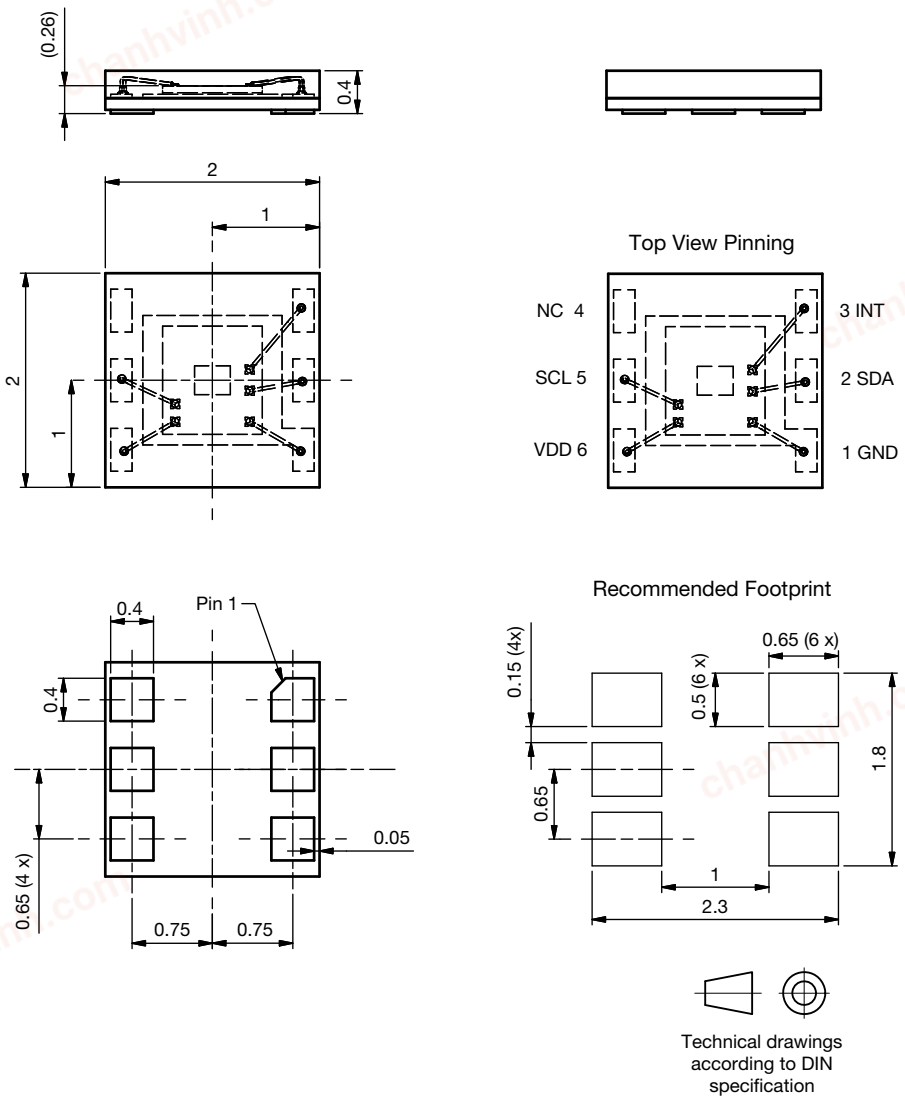
[1] For integration times lower than 100 ms, the maximum count level is no longer 16 bit so half the integration time no longer leads to double the max. lux level

Example:
If the 16-bit word of the ALS data shows: 0000 0101 1100 1000 = 1480 (dec.), the programmed GAIN = 1, DG = 1, SENS = 1 and the integration time is 100 ms, the corresponding lux level is: light level [lx] = 1480 x 0.0256 = 37.888 lx.

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PACKAGE DIMENSIONS in millimeters



Technical drawings according to DIN specification

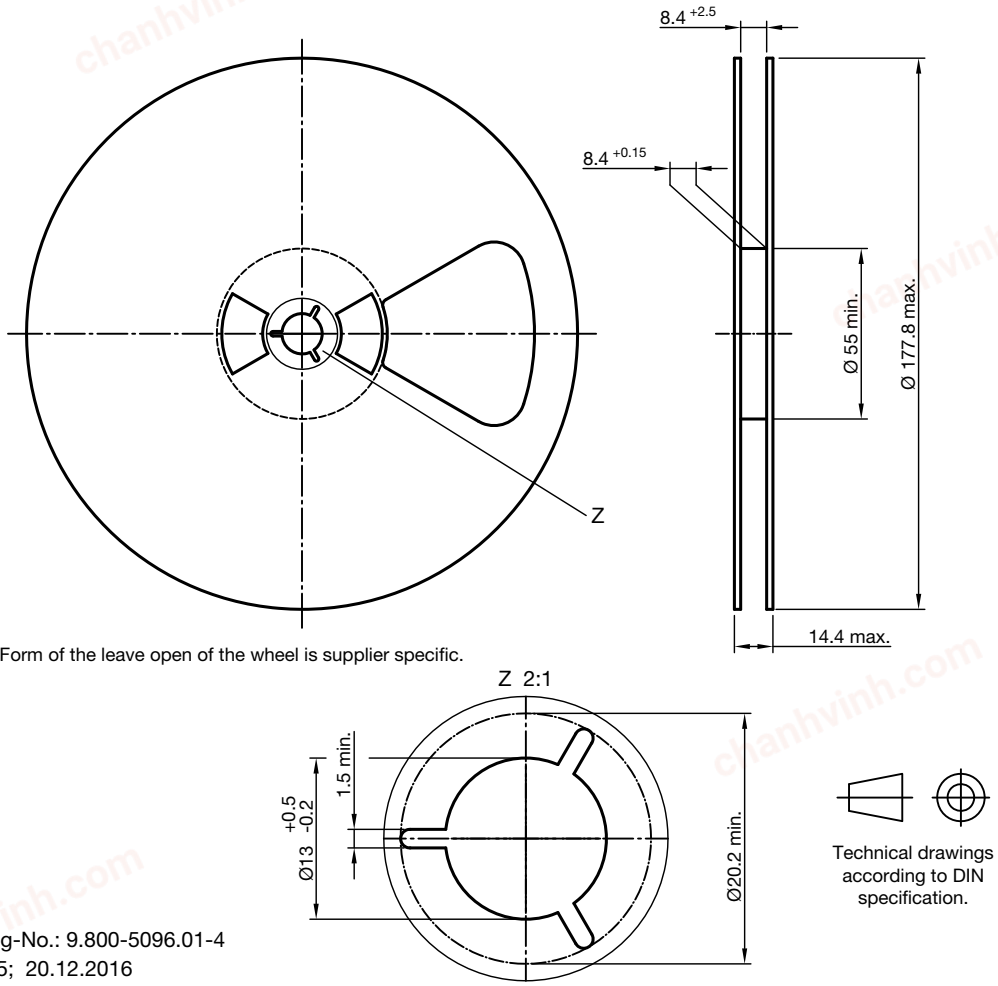
Drawing No.: 6.550-5359.01-4
Issue: 1; 15.03.2019

Not indicated tolerances ± 0.1

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TAPE AND REEL DIMENSIONS in millimeters



Form of the leave open of the wheel is supplier specific.

Technical drawings according to DIN specification.

Drawing-No.: 9.800-5096.01-4
Issue: 5; 20.12.2016

Fig. 12 - 7" Reel, 3000 Pieces

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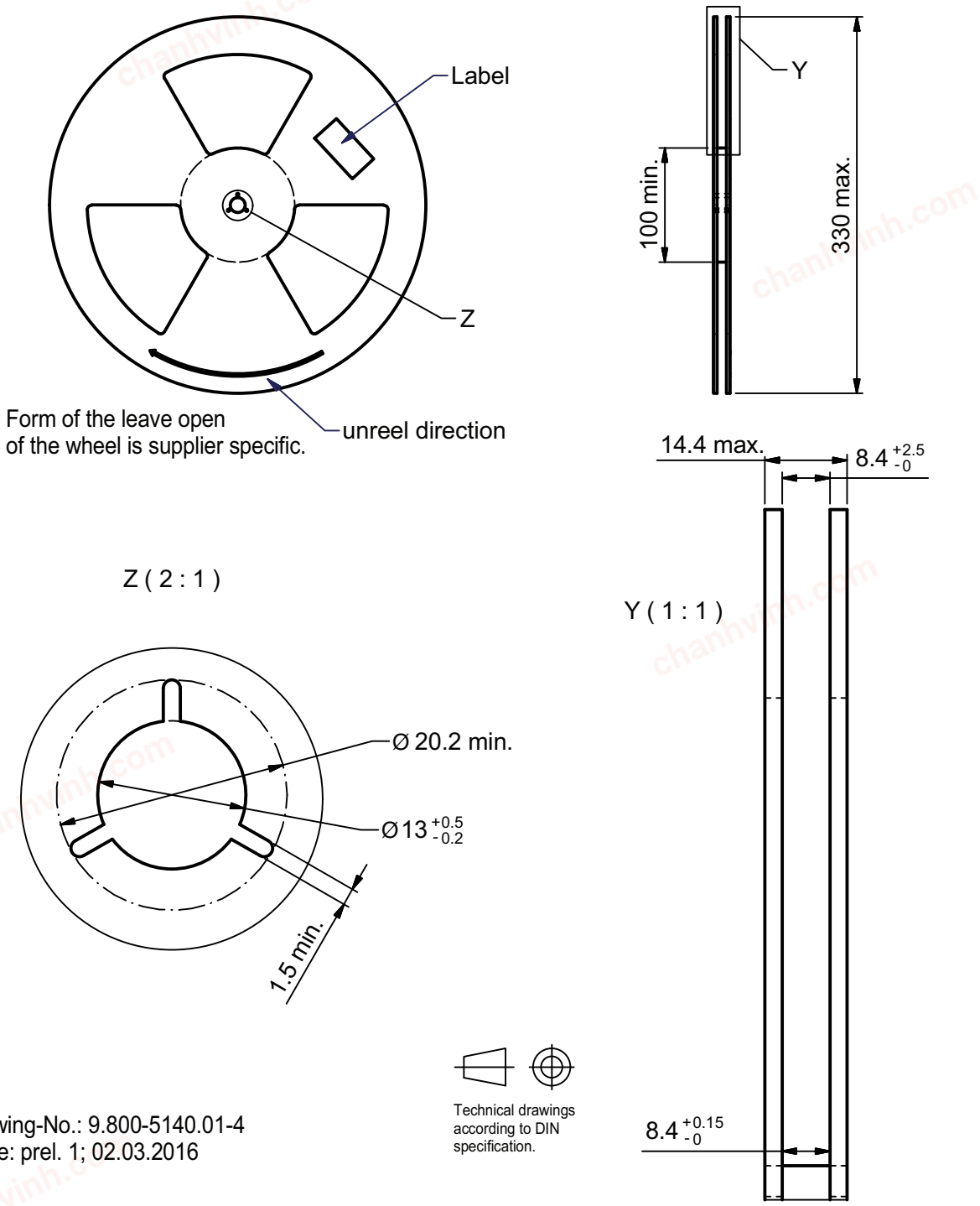
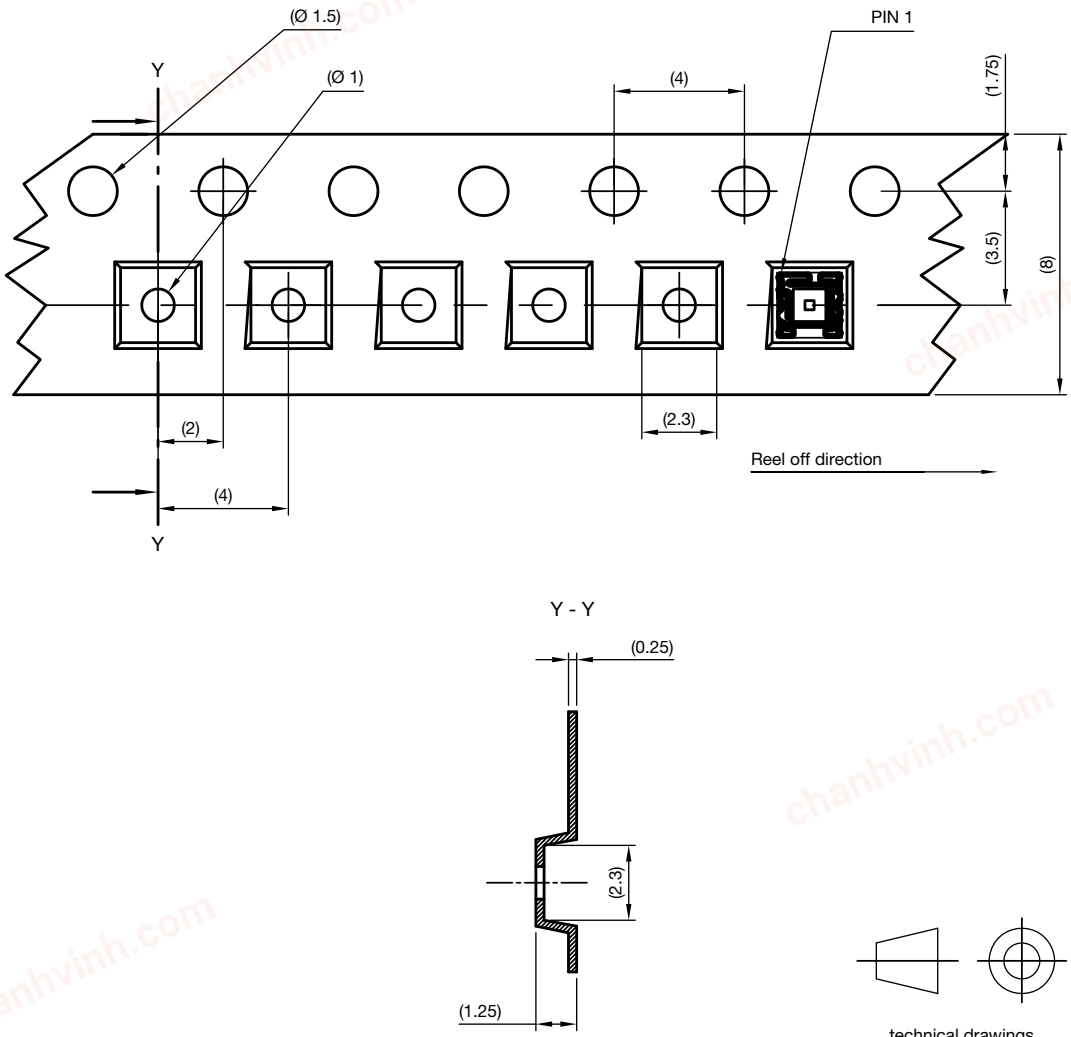


Fig. 13 - 13" Reel, 10 000 Pieces

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Drawing-No.: 9.700-5397.01-4
Issue: 1; 19.02.16

Fig. 14 - Taping

RECOMMENDED STORAGE AND REBAKING CONDITIONS				
PARAMETER	**CONDITIONS**	**MIN.**	**MAX.**	**UNIT**
Storage temperature		5	50	°C
Relative humidity		-	60	%
Open time		-	72	h
Total time	From the date code on the aluminized envelope (unopened)	-	6	months
Rebaking	Tape and reel: 60 °C	-	22	h
	Tube: 60 °C	-	22	h

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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

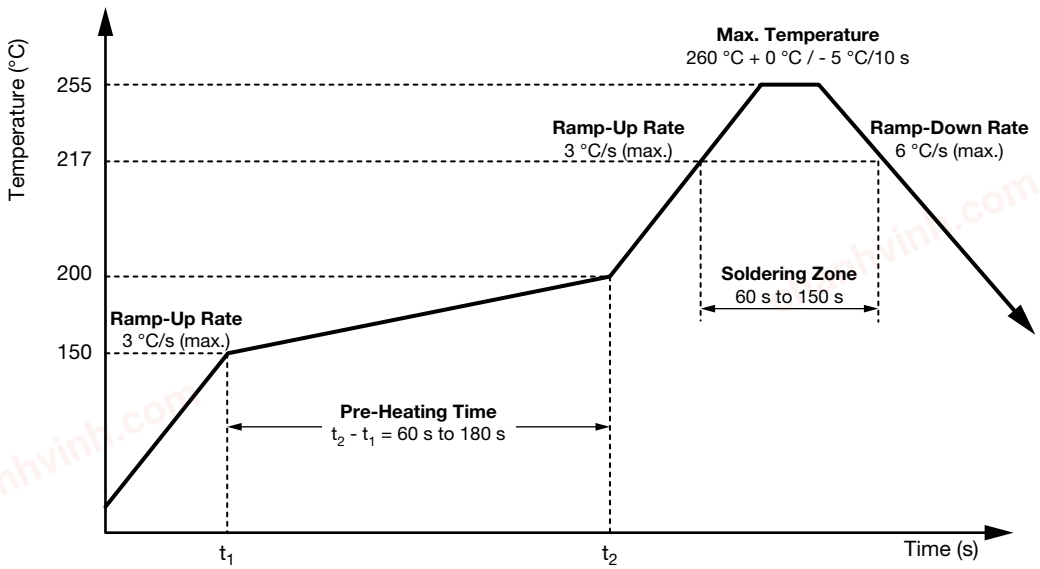


Fig. 15 - VEML6035 Solder Reflow Profile Chart

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: 168 h

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

Moisture sensitivity level 3, according 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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