

## RGBCIR Color Sensor With I<sup>2</sup>C Interface



### ADDITIONAL RESOURCES



### DESCRIPTION

VEML3328SL sensor senses red, green, blue, clear, and IR light by incorporating photodiodes, amplifiers, and analog / digital circuits into a single CMOS chip. With this sensor, the brightness and color temperature of a display backlight can be adjusted based on the ambient light source, and it can differentiate indoor from outdoor lighting environments.

### FEATURES

- Package type: surface-mount
- Dimensions (L x W x H in mm): 2.95 x 1.50 x 1.50
- Integrated modules: color sensor and signal conditioning IC
- Supports low transmittance (dark) lens design
- Provides 16-bit resolution for each channel (R, G, B, C, and IR)
- Package: OPLGA4 SV (side view)
- Temperature compensation: -40 °C to +85 °C
- Low power consumption I<sup>2</sup>C (SMBus compatible) interface
- Floor life: 168 h, MSL 3, according to J-STD-020
- Output type: I<sup>2</sup>C bus
- Operation voltage: 2.6 V to 3.6 V
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



### APPLICATIONS

- Automatic white balancing and color cast correction in digital cameras
- Automatic LCD backlight adjustment
- Maintaining consistent true color and ideal brightness levels on handheld displays as users move between indoor and outdoor environments
- On / off light switching in industrial and consumer applications
- Active monitoring of LED color output for IoT and smart lighting

PRODUCT SUMMARY				
PART NUMBER	OPERATING VOLTAGE RANGE (V)	I <sup>2</sup> C BUS VOLTAGE RANGE (V)	PEAK SENSITIVITY (nm)	OUTPUT CODE
VEML3328SL	2.6 to 3.6	1.7 to 3.6	590, 610, 560, 470, 825 (C, R, G, B, IR)	16 bit, I <sup>2</sup> C



ORDERING INFORMATION			
ORDERING CODE	PACKAGING	VOLUME <sup>(1)</sup>	REMARKS
VEML3328SL	Tape and reel	MOQ: 2500 pcs	2.95 mm x 1.50 mm x 1.50 mm

**Note**

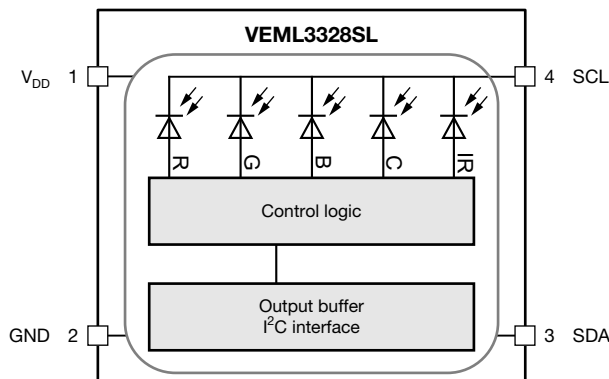
<sup>(1)</sup> MOQ: minimum order quantity

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	4	V
Operation temperature range		$T_{amb}$	-40	+85	$^{\circ}\text{C}$
Storage temperature range		$T_{stg}$	-40	+85	$^{\circ}\text{C}$

RECOMMENDED OPERATING CONDITIONS ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)					
PARAMETER	TEST CONDITION	SYMBOL	MIN.	MAX.	UNIT
Supply voltage		$V_{DD}$	2.6	3.6	V
Operation temperature range		$T_{amb}$	-40	+85	$^{\circ}\text{C}$
I <sup>2</sup> C bus operating frequency		$f_{(I2CCLK)}$	10	400	kHz

PIN DESCRIPTIONS			
PIN ASSIGNMENT	SYMBOL	TYPE	FUNCTION
1	$V_{DD}$	-	Supply voltage
2	GND	-	Power supply ground; all voltages are referenced to GND
3	SDA	I / O (open drain)	I <sup>2</sup> C digital bus data input / output
	SCL	I	I <sup>2</sup> C digital bus clock input

**BLOCK DIAGRAM**





<b>BASIC CHARACTERISTICS</b> ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)						
PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage		$V_{DD}$	2.6	3.0	3.6	V
Supply current <sup>(1)</sup>		$I_{DD}$	500	580	1000	$\mu\text{A}$
I <sup>2</sup> C signal input <sup>(1)</sup>	Logic high	$V_{IH}$	1.2	-	-	V
	Logic low	$V_{IL}$	-	-	0.4	
Peak sensitivity wavelength		$\lambda_{PC}$	-	590	-	nm
		$\lambda_{PR}$	-	610	-	
		$\lambda_{PG}$	-	560	-	
		$\lambda_{PB}$	-	470	-	
		$\lambda_{PIR}$	-	825	-	
Irradiance responsivity	520 nm LED <sup>(1)(2)</sup>	C	-	57	-	counts/ $(\mu\text{W}/\text{cm}^2)$
	850 nm LED <sup>(1)(2)</sup>	IR	-	25	-	
	643 nm LED <sup>(1)(2)</sup>	R	-	41	-	
	520 nm LED <sup>(1)(2)</sup>	G	-	39	-	
	460 nm LED <sup>(1)(2)</sup>	B	-	34	-	
Sensitivity	5000 K WLED <sup>(1)(3)</sup>	G	-	0.003	-	lx/count
Dark offset <sup>(1)(3)</sup>		R, G, B, C, IR	0	-	3	counts
Operating temperature range		$T_{amb}$	-40	-	+85	$^{\circ}\text{C}$
Shutdown current <sup>(1)</sup>	Light condition = dark	$I_{DD}$	0	800	1000	nA

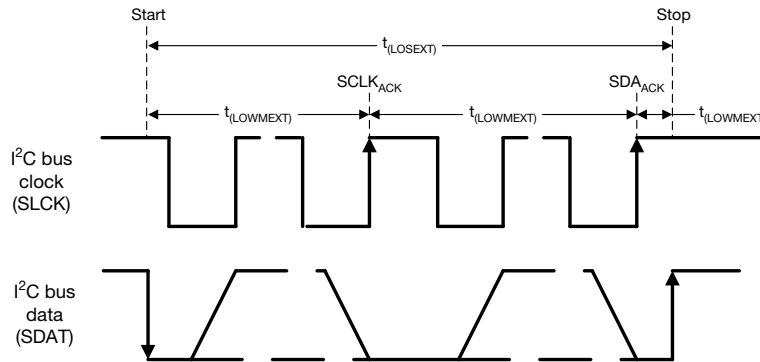
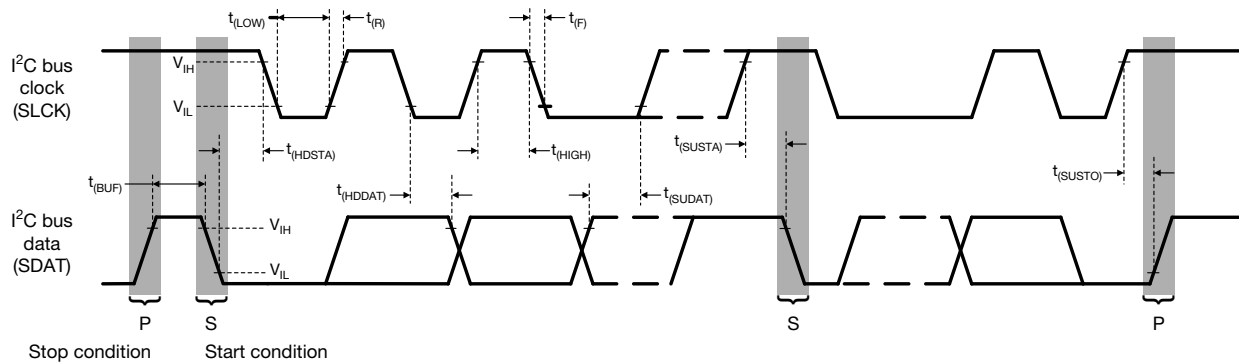
**Notes**

<sup>(2)</sup> Test condition:  $V_{DD} = 3\text{ V}$ , temperature:  $25\text{ }^{\circ}\text{C}$

<sup>(3)</sup> IT: 100 ms, SENS = (0) = x 1, DG = (0 : 0) = x 1, GAIN = (0 : 0) = x 1

<sup>(4)</sup> IT: 400 ms, SENS = (0) = x 1, DG = (1 : 0) = x 4, GAIN = (0 : 0) = x 4

<b>I<sup>2</sup>C BUS TIMING CHARACTERISTICS</b> ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)						
PARAMETER	SYMBOL	STANDARD MODE		FAST MODE		UNIT
		MIN.	MAX.	MIN.	MAX.	
Clock frequency	$f_{(I2CCLK)}$	10	100	10	400	kHz
Bus free time between start and stop condition	$t_{(BUF)}$	4.7	-	1.3	-	$\mu\text{s}$
Hold time after (repeated) start condition; after this period, the first clock is generated	$t_{(HDSTA)}$	4.0	-	0.6	-	$\mu\text{s}$
Repeated start condition setup time	$t_{(SUSTA)}$	4.7	-	0.6	-	$\mu\text{s}$
Stop condition setup time	$t_{(SUSTO)}$	4.0	-	0.6	-	$\mu\text{s}$
Data hold time	$t_{(HDDAT)}$	-	3450	-	900	ns
Data setup time	$t_{(SUDAT)}$	250	-	100	-	ns
I <sup>2</sup> C clock (SCK) low period	$t_{(LOW)}$	4.7	-	1.3	-	$\mu\text{s}$
I <sup>2</sup> C clock (SCK) high period	$t_{(HIGH)}$	4.0	-	0.6	-	$\mu\text{s}$
Clock / data fall time	$t_f$	-	300	-	300	ns
Clock / data rise time	$t_r$	-	1000	-	300	ns


 Fig. 1 - I<sup>2</sup>C Bus Timing Diagram

**PARAMETER TIMING INFORMATION**

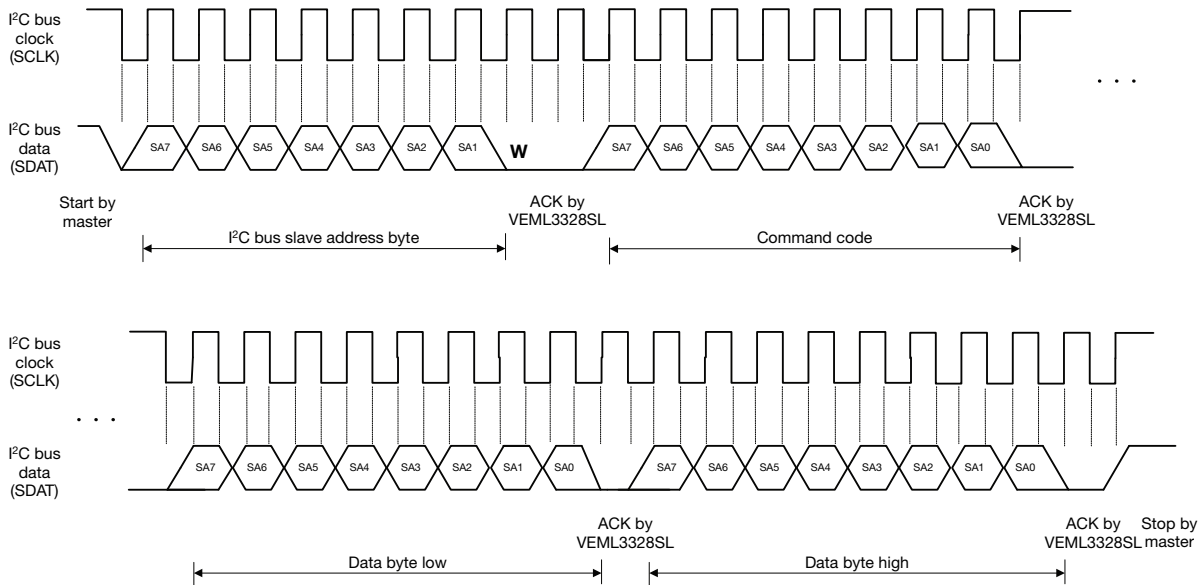


Fig. 2 - I<sup>2</sup>C Bus Timing for Sending Word Command Format

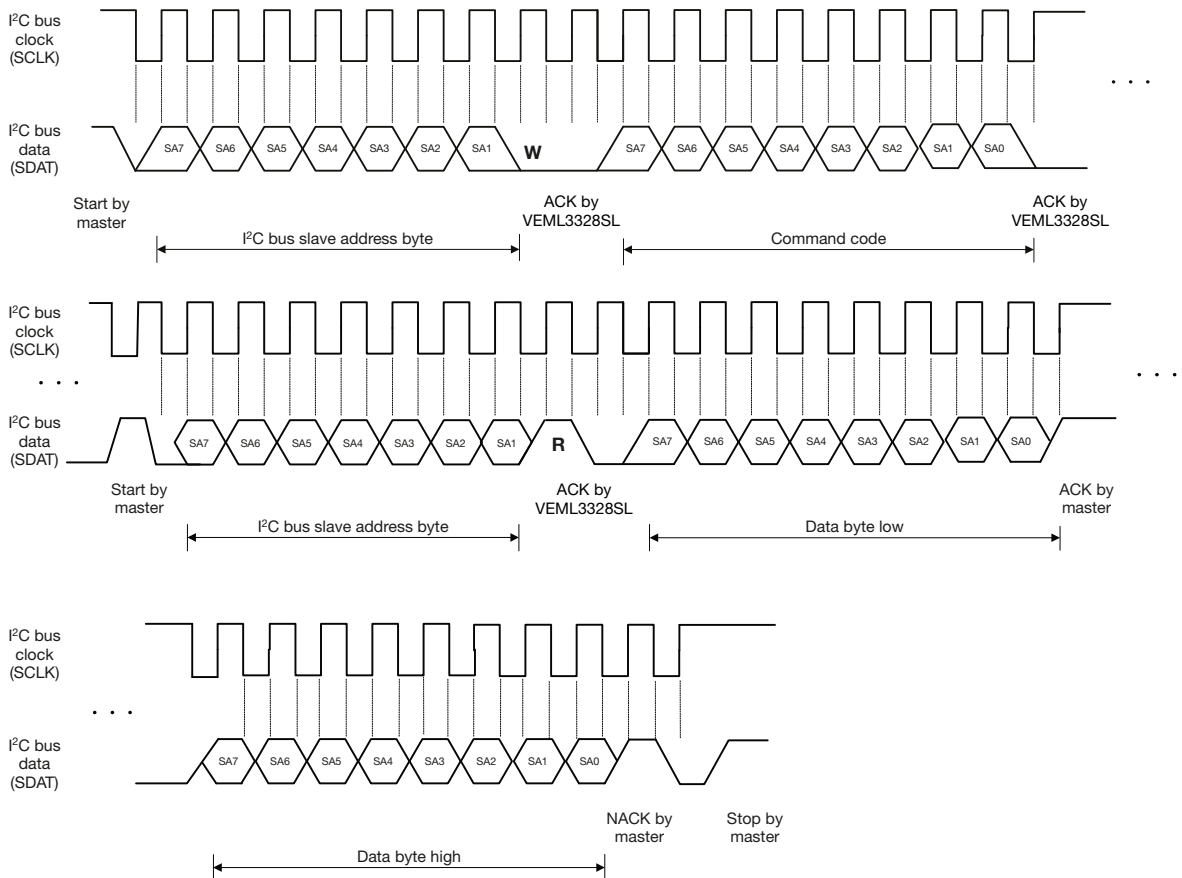


Fig. 3 - I<sup>2</sup>C Bus Timing for Receiving Word Command Format

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

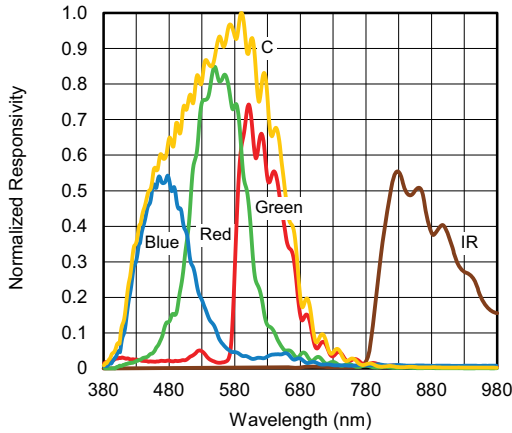


Fig. 4 - Normalized Responsivity vs. Wavelength

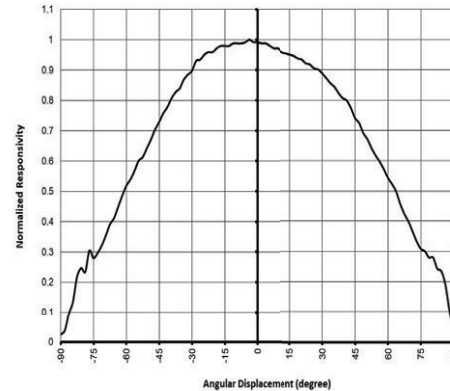


Fig. 5 - Normalized Responsivity vs. Angular Displacement

**APPLICATION INFORMATION**

**Pin Connection With the Host**

The VEML3328SL is a cost effective solution color and IR sensor with an I<sup>2</sup>C interface. All possible settings and result data can be accessed via the standard I<sup>2</sup>C interface.

A typical application circuit is shown in Fig. 6 below. The additional 0.1  $\mu\text{F}$  capacitor near the V<sub>DD</sub> pin in the circuit is used for power supply noise rejection. Pull-up resistors for the I<sup>2</sup>C bus design are recommended to be 2.2 k $\Omega$ .

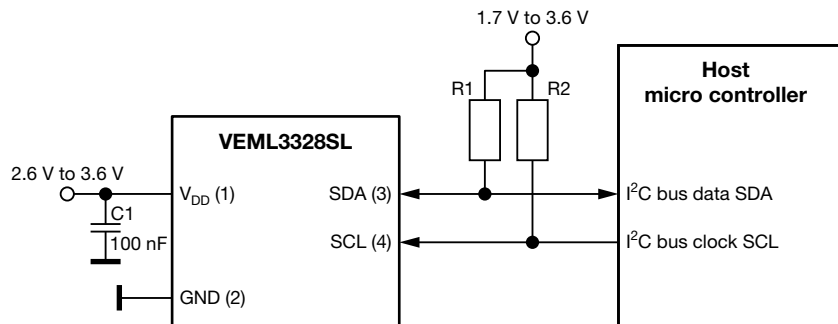
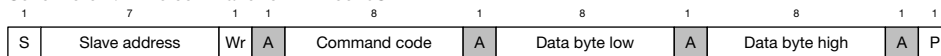


Fig. 6 - Hardware Pin Connection Diagram (Slave Address 0x10)

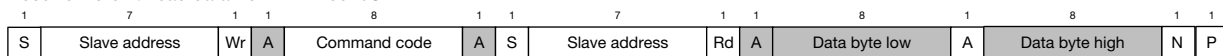
**Digital Interface**

The VEML3328SL contains a command register accessible via the I<sup>2</sup>C bus. All settings can be controlled via this register. The VEML3328SL's I<sup>2</sup>C command format description for read and write operations between VEML3328SL and the host is shown in Fig. 7. The white areas indicate the host activity and the gray areas indicate VEML3328SL's acknowledgement of the host access activity. Note that this protocol must be followed exactly to avoid false communication on the bus. Special care should be taken for the "Read Word" format, as here a repeated start condition is a must, as indicated.

Send word → write command to VEML3328SL



Receive word → read data from VEML3328SL



S = start condition  
 P = stop condition  
 A = acknowledge  
 N = not acknowledge

Host action  
 VEML3328SL acknowledge

Fig. 7 - Command Protocol Format

**Command Register Format**

VEML3328SL uses 0x10 slave address for 7-bit I<sup>2</sup>C addressing protocol. VEML3328SL has 16-bit resolution for each channel (R, G, B, C, and IR).

**TABLE 1 - COMMAND CODE DESCRIPTION**

COMMAND CODE	REGISTER NAME	BIT	FUNCTION DESCRIPTION	R / W
0x00	SD1	15	Shutdown setting <sup>(1)</sup> SD1 = 0 power on; SD1 = 1 shutdown (default)	R / W
	SD_ALS only	14	0 = power on all channels (default) 1 = power on G, C, and IR (R, B shutdown)	
	DG	13 : 12	(0 : 0) = x 1 (default) (0 : 1) = x 2 (1 : 0) = x 4 (1 : 1) = reserved	
	GAIN	11 : 10	(1 : 1) = x 1/2 (0 : 0) = x 1 (default) (0 : 1) = x 2 (1 : 0) = x 4	
	Reserved	9 : 8	Set (0 : 0)	
	Reserved	7	Set 0	
	SENS	6	0 = high sensitivity (default); 1 = low sensitivity (1/3)	
	IT	5 : 4	Integration time setting (0 : 0) = 50 ms (default) (0 : 1) = 100 ms (1 : 0) = 200 ms (1 : 1) = 400 ms	
	AF	3	Auto / active force mode 0 = auto mode (default); 1 = active force mode	
	TRIG	2	Trigger a single measurement when in active force mode. This bit resets to "0" automatically when the measurement cycle is complete. 0 = no trigger (default); 1 = trigger one measurement cycle	
	Reserved	1	Set 0	
SD0	0	Shutdown setting <sup>(1)</sup> SD0 = 0 power on; SD0 = 1 shutdown (default)		

**Note**

<sup>(1)</sup> For power on, both SD0 and SD1 have to be set to 0. For shutdown, both SD0 and SD1 have to be set to 1

**TABLE 2 - DATA REGISTERS**

COMMAND CODE	REGISTER NAME	DATE BYTE LOW / HIGH	BIT	FUNCTION DESCRIPTION	R / W
0x04	C_LSB	Low	7 : 0	Clear channel LSB data	R
	C_MSB	High	7 : 0	Clear channel MSB data	
0x05	R_LSB	Low	7 : 0	Red channel LSB data	
	R_MSB	High	7 : 0	Red channel MSB data	
0x06	G_LSB	Low	7 : 0	Green channel LSB data	
	G_MSB	High	7 : 0	Green channel MSB data	
0x07	B_LSB	Low	7 : 0	Blue channel LSB data	
	B_MSB	High	7 : 0	Blue channel MSB data	
0x08	IR_LSB	Low	7 : 0	Infrared channel LSB data	
	IR_MSB	High	7 : 0	Infrared channel MSB data	
0x0C	ID_L	Low	7 : 0	Device ID 0x28	
	Reserved	High	7 : 0		

**Note**

- Command codes 0x01 to 0x03 and 0x09 to 0x0B are reserved



**Data Access**

Each of the C, R, G, B, and IR result registers has a 16-bit resolution (2 bytes). One byte is the LSB and the other byte is the MSB. The host needs to follow the read word protocol as shown in Fig. 7. The data format shows as below.

**TABLE 2 - 16-BIT DATA FORMAT**

VEML3328SL 16-BIT DATA FORMAT																
Data bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Data byte low									←—————→							
Data byte high	←—————→															

**Note**

S	Slave address	Wr	A	Command code	A	S	Slave address	Rd	A	Data byte low	A	Data byte high	N	P
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- Data byte low represents LSB and data byte high represents MSB



**PACKAGE INFORMATION** in millimeters

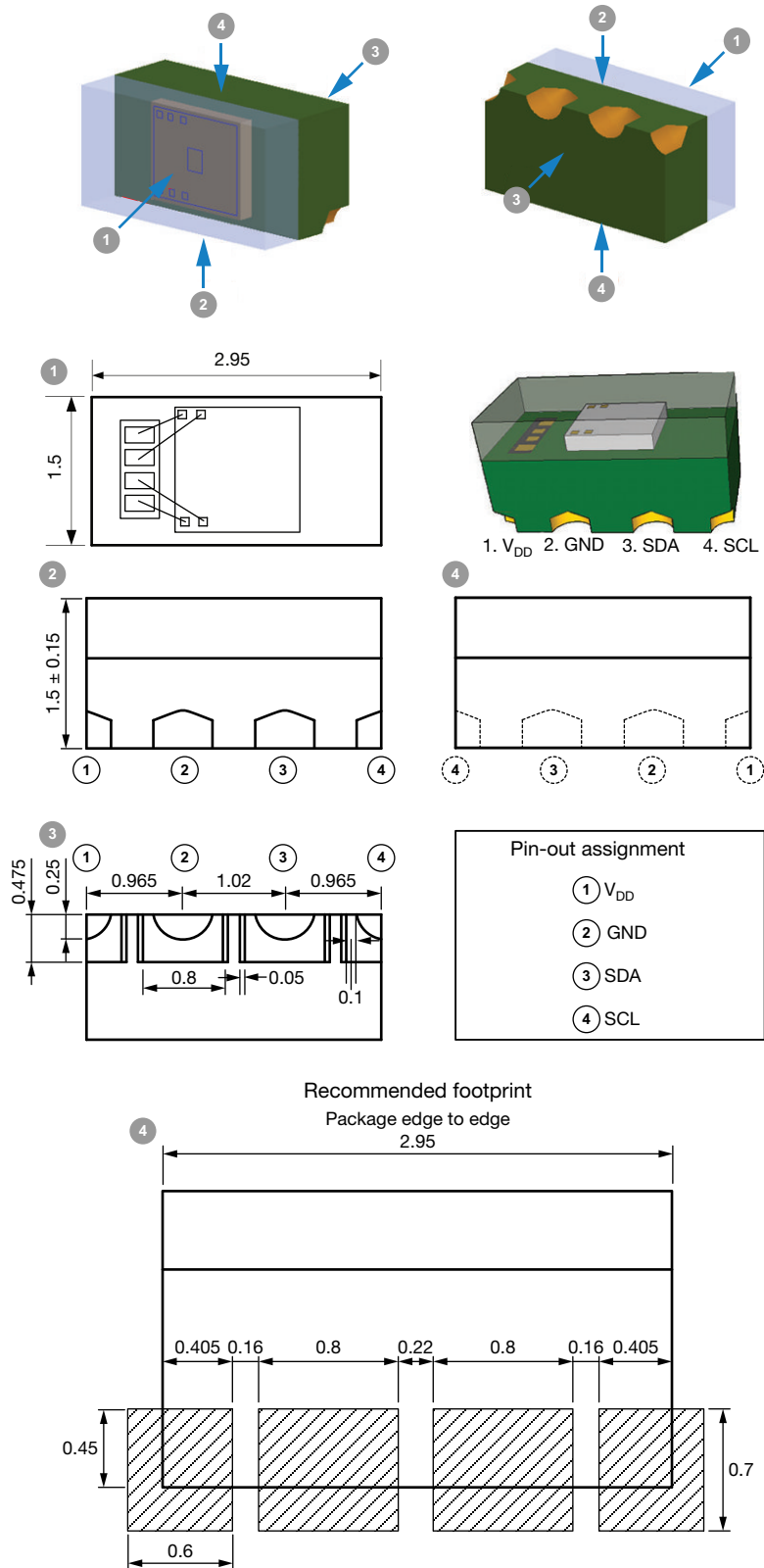


Fig. 8 - VEML3328SL A3OZ Package Dimensions



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	

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

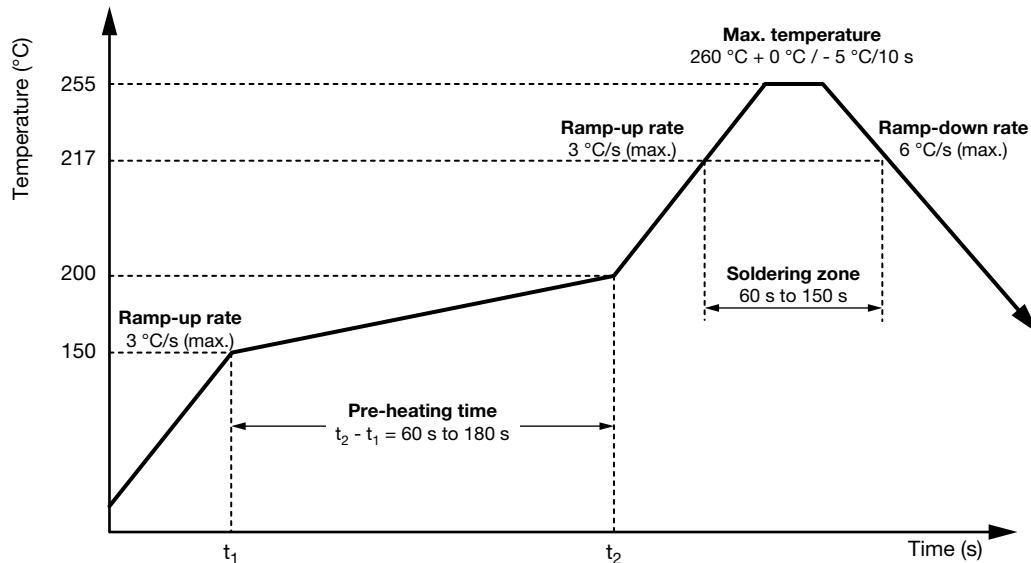


Fig. 9 - VEML3328SL OPLGA Solder Reflow Profile Chart

**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 min (min.)

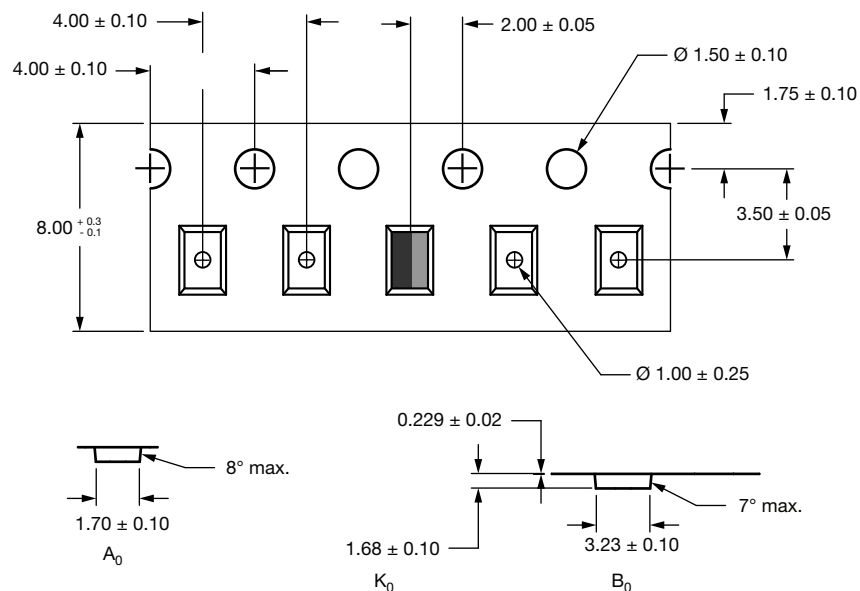
**TAPE PACKAGING INFORMATION** in millimeters


Fig. 10 - VEML3329SL A3OZ Package Carrier Tape

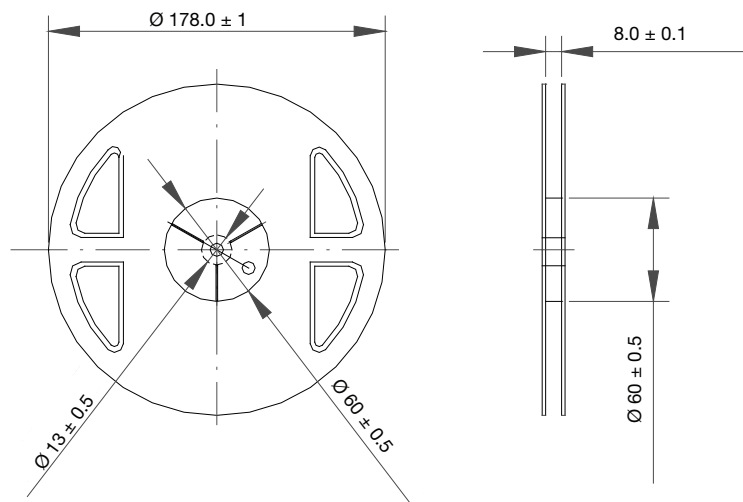


Fig. 11 - Reel Dimensions



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