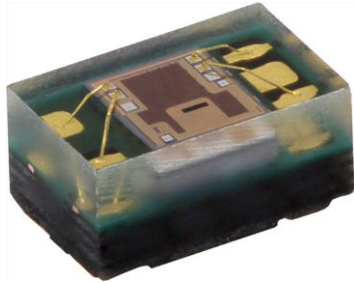


Color Sensor With I²C Interface



DESCRIPTION

VEML3328 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.

VEML3328 provides excellent temperature compensation capability for keeping the output stable under changing temperature. The sensor's functions are easily operated via the simple command format of I²C (SMBus compatible) interface protocol. VEML3328 has a low operating voltage range of 2.6 V to 3.6 V and is packaged in a lead (Pb)-free OPLGA package which offers the best market-proven reliability.

FEATURES

- Package type: surface-mount
- Dimensions (L x W x H in mm): 2.0 x 1.25 x 1.0
- 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
- Temperature compensation: -40 °C to +85 °C
- Low power consumption I²C (SMBus compatible) interface
- Floor life: 168 h, MSL 3, according to J-STD-020
- Output type: I²C bus
- Operation voltage: 2.6 V to 3.6 V
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912



APPLICATIONS

- Handheld device
- Notebook
- Consumer device
- Industrial and mechanical application

PRODUCT SUMMARY				
PART NUMBER	OPERATING VOLTAGE RANGE (V)	I ² C BUS VOLTAGE RANGE (V)	PEAK SENSITIVITY (nm)	OUTPUT CODE
VEML3328	2.6 to 3.6	1.7 to 3.6	590, 610, 560, 470, 825 (C, R, G, B, IR)	16 bit, I ² C

ORDERING INFORMATION			
ORDERING CODE	PACKAGING	VOLUME ⁽¹⁾	REMARKS
VEML3328A30G	Tape and reel	MOQ: 2500 pcs	2.00 mm x 1.25 mm x 1.00 mm

Note

⁽¹⁾ MOQ: minimum order quantity

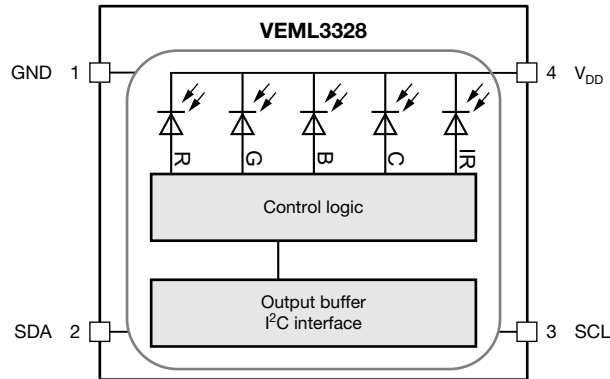
ABSOLUTE MAXIMUM RATINGS (T _{amb} = 25 °C, unless otherwise specified)					
PARAMETER	TEST CONDITION	SYMBOL	MIN.	MAX.	UNIT
Supply voltage		V _{DD}	0	4	V
Operation temperature range		T _{amb}	-40	+85	°C
Storage temperature range		T _{stg}	-40	+85	°C

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 ² C bus operating frequency		$f_{(I2CCLK)}$	10	400	kHz

PIN DESCRIPTIONS

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

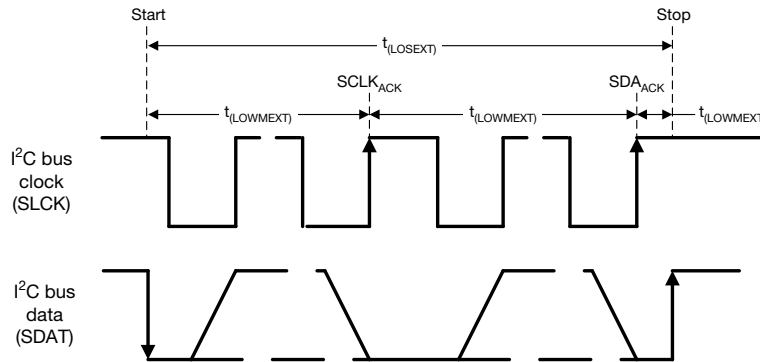
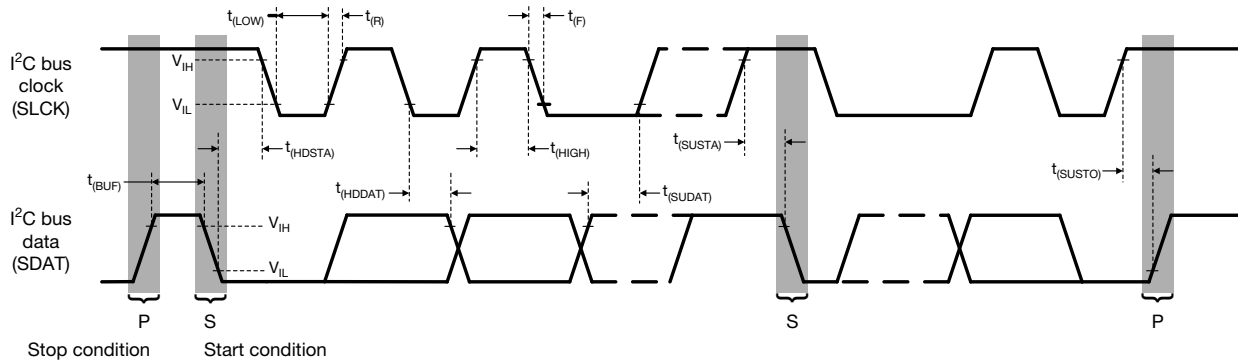
BLOCK DIAGRAM

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

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

Notes

- (1) Test condition: $V_{DD} = 3\text{ V}$, temperature: $25\text{ }^{\circ}\text{C}$
 (2) IT: 100 ms, HD(0) x 1, gain 1 (0 : 0) x 1, and gain 2 (0 : 0) x 1
 (3) IT: 400 ms, HD(0) x 1, gain 1 (1 : 0) x 4, and gain 2 (1 : 0) x 4

I²C BUS TIMING CHARACTERISTICS ($T_{amb} = 25\text{ }^{\circ}\text{C}$, 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	-	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	$t_{(HDDAT)}$	-	3450	-	900	ns
Data setup time	$t_{(SUDAT)}$	250	-	100	-	ns
I ² C clock (SCK) low period	$t_{(LOW)}$	4.7	-	1.3	-	μs
I ² C clock (SCK) high period	$t_{(HIGH)}$	4.0	-	0.6	-	μs
Clock / data fall time	t_f	-	300	-	300	ns
Clock / data rise time	t_r	-	1000	-	300	ns


 Fig. 1 - I²C Bus Timing Diagram

PARAMETER TIMING INFORMATION

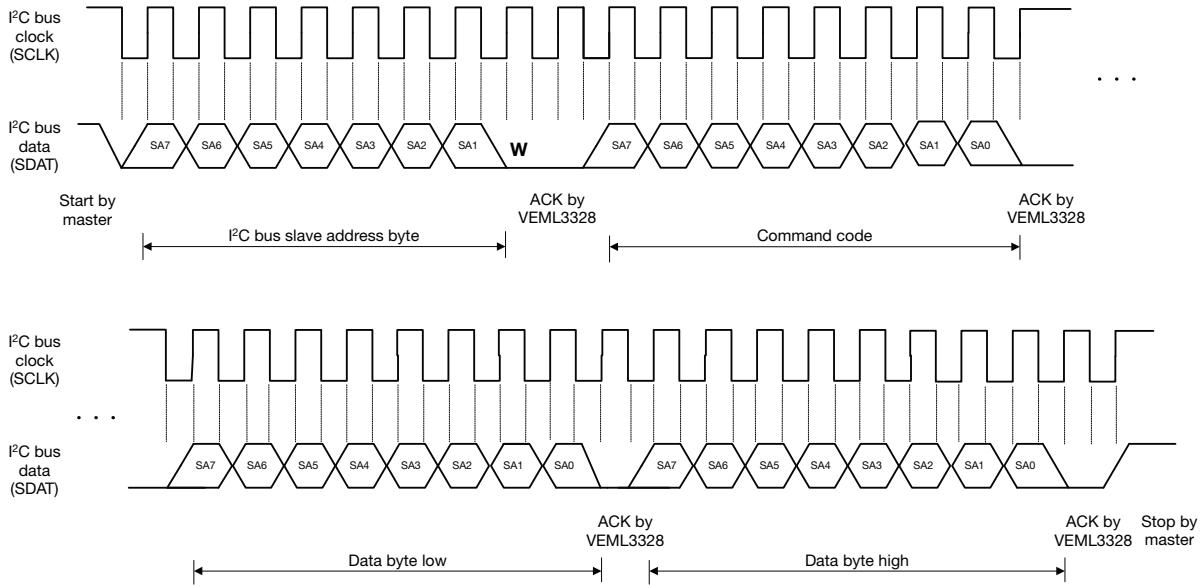


Fig. 2 - I²C Bus Timing for Sending Word Command Format

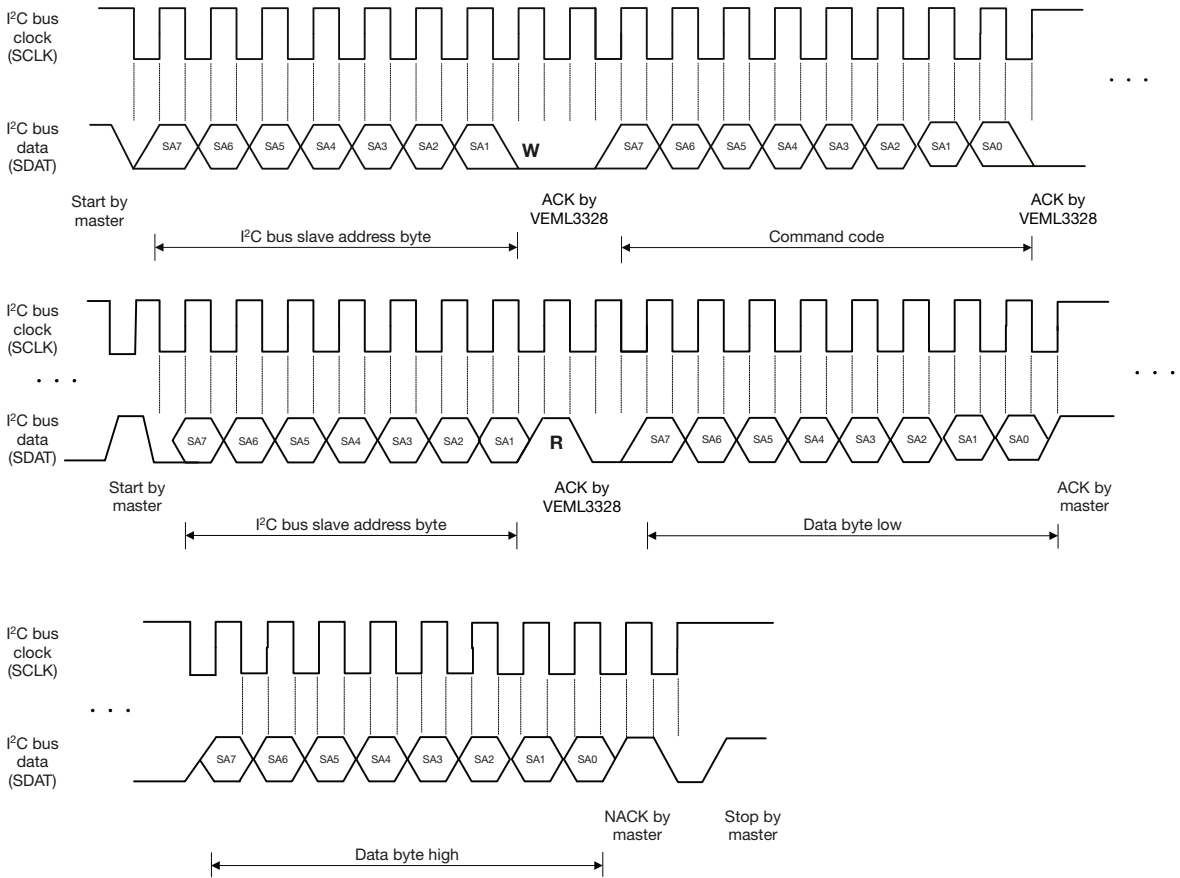


Fig. 3 - I²C Bus Timing for Receiving Word Command Format

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

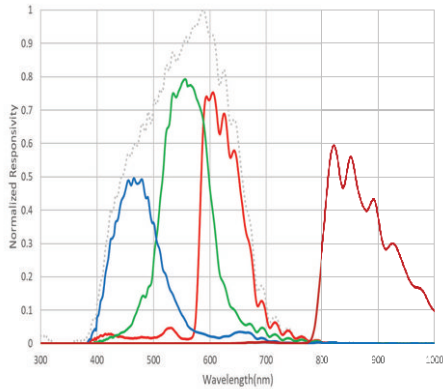


Fig. 4 - Normalized Responsivity vs. Wavelength

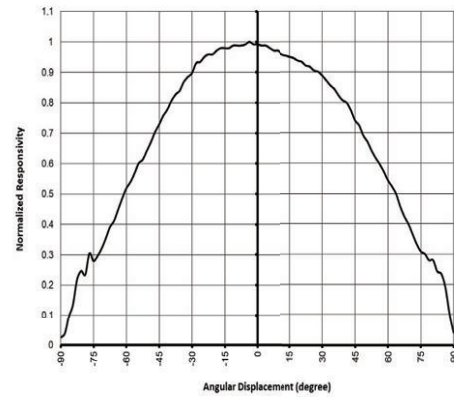


Fig. 5 - Normalized Responsivity vs. Angular Displacement

APPLICATION INFORMATION

Pin Connection With the Host

VEML3328 is a cost effective solution for color and IR sensor with I²C interface. The standard serial digital interface easily accesses “light intensity” without using complex calculations and programming by an external controller.

The additional capacitor near the V_{DD} pin in the circuit is used for power supply noise rejection. The value is recommended at 0.1 μF. The pull-high resistors for the I²C bus design are recommended to be 2.2 kΩ.

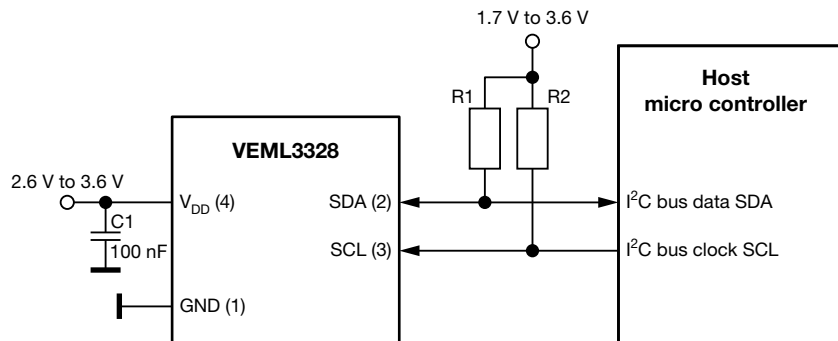
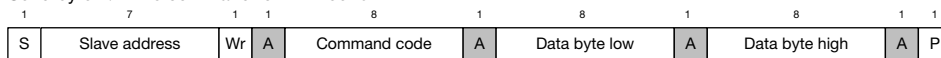


Fig. 6 - Hardware Pin Connection Diagram (Slave Address 0x10)

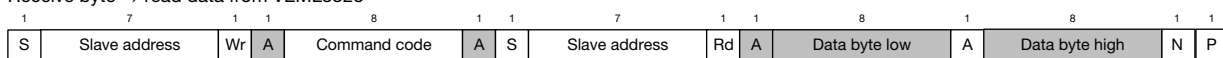
Digital Interface

VEML3328 contains a command register written via the I²C bus. All operations can be controlled by the command register. The simple command structure allows the user to easily program the operation setting and latch the light data from VEML3328. VEML3328’s I²C command format description for read and write operations between VEML3328 and the host is shown in Fig. 7. The white areas indicate the host activity and the gray areas indicate VEML3328’s acknowledgement of the host access activity.

Send byte → write command to VEML3328



Receive byte → read data from VEML3328



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

Host action
 VEML3328 acknowledge

Fig. 7 - Command Protocol Format



Command Register Format

VEML3328 uses 0x10 slave address for 7-bit I²C addressing protocol. VEML3328 has 16-bit resolution for each channel (R, G, B, C, and IR).

TABLE 1 - COMMAND CODE DESCRIPTION					
COMMAND CODE	REGISTER NAME	DATE BYTE LOW / HIGH	BIT	FUNCTION DESCRIPTION	R / W
0x00	Reserved	Low	7	Set 0	R / W
	HD		6	High dynamic range mode (1) = x 1/3 (0) = x 1	
	IT		5 : 4	Integration time setting (0 : 0) = 50 ms (0 : 1) = 100 ms (1 : 0) = 200 ms (1 : 1) = 400 ms	
	AF		3	Auto / manual force mode 0 = auto mode 1 = force mode	
	TRIG		2	Proceed one detecting cycle at manual force mode 0 = no trigger 1 = trigger one time detect cycle	
	Reserved		1		
	SD	0	Shutdown setting 00 = power on 11 = shut down		
	SD_ALS only	7	6	0 = power on all channels 1 = power on G, C, and IR (R, B shut down)	
	Gain 1	High	5 : 4	(0 : 0) = x1 (0 : 1) = x2 (1 : 0) = x4 (1 : 1) = reserved	
	Gain 2		3 : 2	(1 : 1) = x1/2 (0 : 0) = x1 (0 : 1) = x2 (1 : 0) = x4	
	Reserved		1 : 0	Set (0 : 0)	
	0x01	Reserved	Low	7 : 0	
High			7 : 0		
0x02	Reserved	Low	7 : 0		
		High	7 : 0		
0x03	Reserved	Low	7 : 0		
		High	7 : 0		
0x04	C_LSB	Low	7 : 0	C LSB data	R
	C_MSB	High	7 : 0	C MSB data	
0x05	R_LSB	Low	7 : 0	R LSB data	
	R_MSB	High	7 : 0	R MSB data	
0x06	G_LSB	Low	7 : 0	G LSB data	
	G_MSB	High	7 : 0	G MSB data	
0x07	B_LSB	Low	7 : 0	B LSB data	
	B_MSB	High	7 : 0	B MSB data	
0x08	IR_LSB	Low	7 : 0	IR LSB data	
	IR_MSB	High	7 : 0	IR MSB data	
0x0C	ID_L	Low	7 : 0	Device ID 0x28	
	Reserved	High	7 : 0		

Note

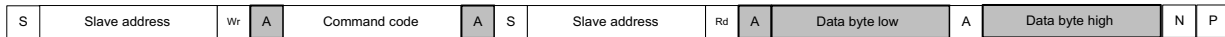
- Slave address is 7-bit addressing protocol

Data Access

VEML3328 has 16-bit high resolution sensitivity for each channel. To represent the 16-bit data, it has to apply two bytes. One byte is for LSB and the other byte is for MSB. The host needs to follow the read word protocol. The data format shows as below

TABLE 2 - 16-BIT DATA FORMAT																
VEML3328 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



- Data byte low represents LSB and data byte high represents MSB

PACKAGE INFORMATION in millimeters

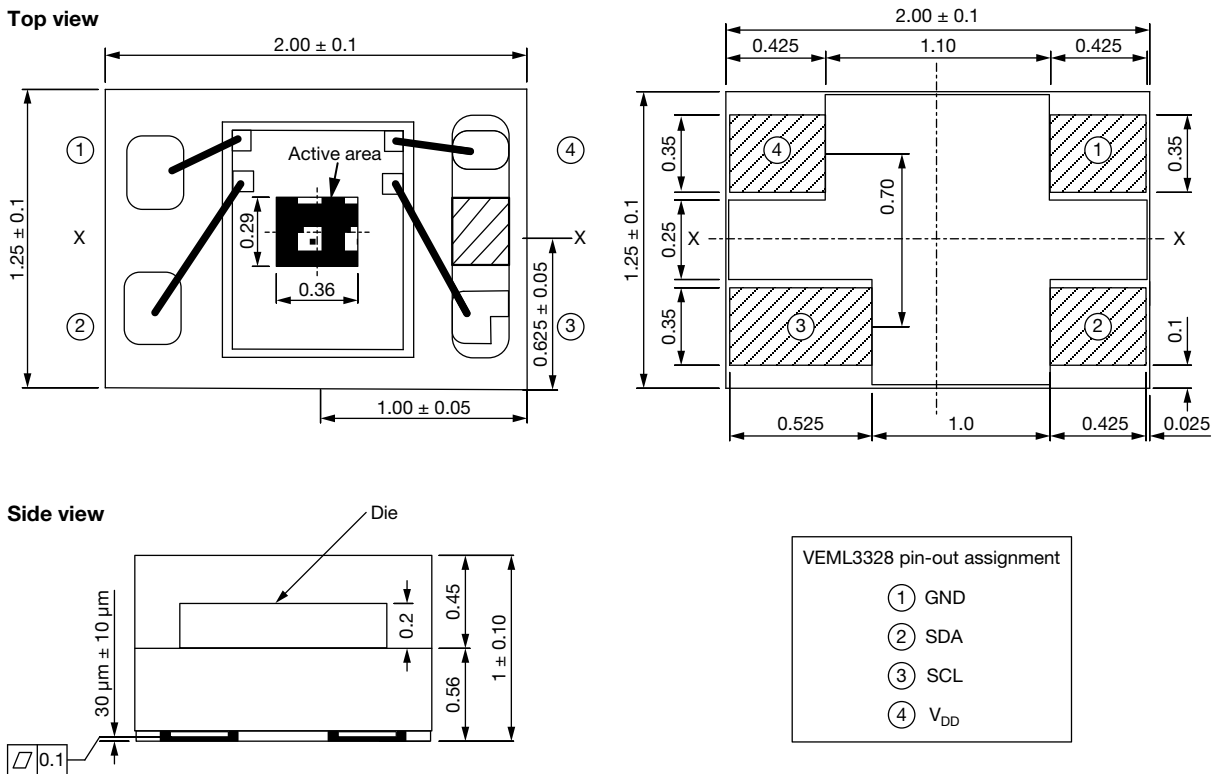


Fig. 8 - VEML3328A3OG Package Dimensions

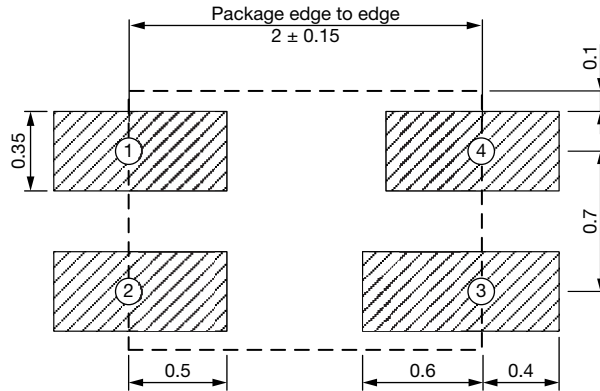


Fig. 9 - VEML3328A3OG PCB Layout Footprint

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

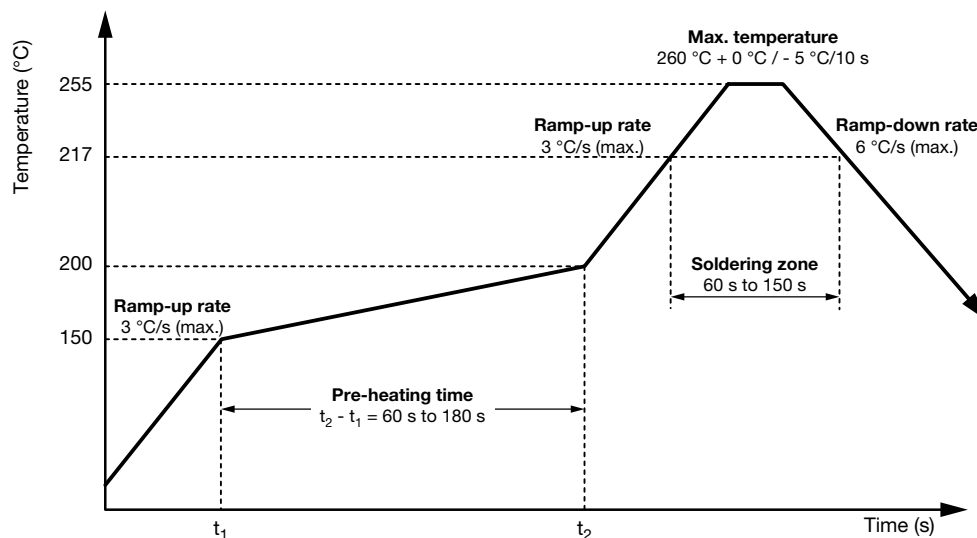


Fig. 10 - VEM3328 OPLGA Solder Reflow Profile Chart

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

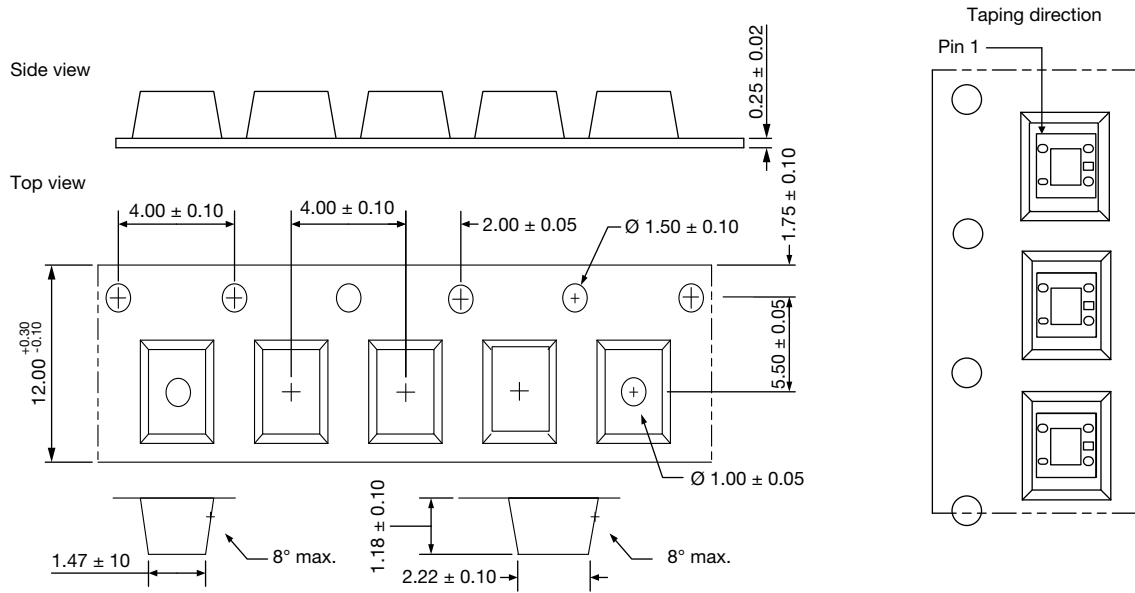


Fig. 11 - VEML3328 A3OG Package Carrier Tape

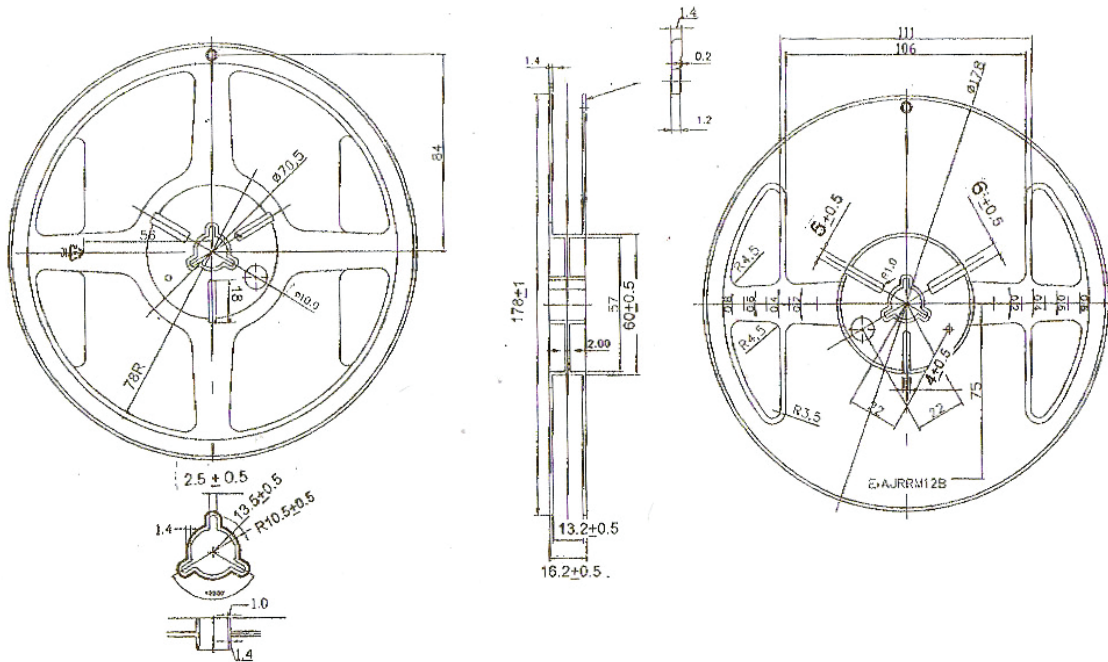


Fig. 12 - Reel Dimensions