Low Power, High Sensitivity, I²C Ambient Light Sensor

FEATURES

- Package type: surface-mount
- Dimensions (L x W x H in mm): 2.35 x 1.8 x 1
- Integrated modules: ambient light sensor (ALS)
- Supply voltage range V_{DD}: 1.7 V to 2.0 V
- Low operating current: 40 µA (typ.)
- Communication via I²C interface
- Inter feature (INT) support
- Floor life: 168 h, MSL 3, according to J-STD-020
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free

e4

RoHS COMPLIANT

HALOGEN FREE

GREEN (5-2008)

DESCRIPTION

Designed using CMOS process technology, the VEML32186 is an advanced ambient light sensor featuring an I²C protocol interface. It is easy to operate via simple I²C commands.

Incorporating a photodiode, amplifiers, and analog circuits all within a single chip, it achieves spectral sensitivity optimized to closely match the response of the human eye.

Offering excellent temperature compensation, the VEML32186 also features a robust refresh rate setting that eliminates the need for an external RC low pass filter. A software shutdown mode reduces power consumption to less than 1 µA.

APPLICATIONS

- Handheld device
- Notebook
- Consumer device
- Industrial and medical application
- Computing, industrial devices, and displays

AMBIENT LIGHT FUNCTION

- High ALS sensitivity with minimum detectable intensity of 0.00375 lx/cnt supports low transmittance lens design
- Excellent temperature compensation
- High dynamic detection resolution
- Software shutdown mode control

PRODUCT SUMMARY

PART NUMBER	OPERATING VOLTAGE RANGE (V)	I²C BUS VOLTAGE RANGE (V)	PEAK SENSITIVITY (nm)	AMBIENT LIGHT RANGE (lx)	AMBIENT LIGHT RESOLUTION (lx)	OUTPUT CODE	ADC RESOLUTION PROXIMITY / AMBIENT LIGHT
VEML32186	1.7 to 2.0	1.7 to 2.0	550, 700 (ALS, W)	0 to 20 000	0.03	14 bit to 16 bit, I²C	0.00375

ORDERING INFORMATION

ORDERING CODE	PACKAGING	VOLUME (1)	REMARKS
VEML32186	Tape and reel	MOQ: 2500	2.35 mm x 1.80 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}	1.7	2	V
Operation temperature range		T_{amb}	-40	+85	°C
Storage temperature range		T_{stg}	-40	+85	°C

RECOMMENDED OPERATING CONDITION (T_{amb} = 25 °C, unless otherwise specified)					
PARAMETER	**TEST CONDITION**	**SYMBOL**	**MIN.**	**MAX.**	**UNIT**
Supply voltage		V_{DD}	1.7	2	V
Operation temperature range		T_{amb}	-40	+85	°C
I^2C bus operating frequency		$f_{(I^2C\ clk)}$	10	400	kHz

CIRCUIT BLOCK DIAGRAM

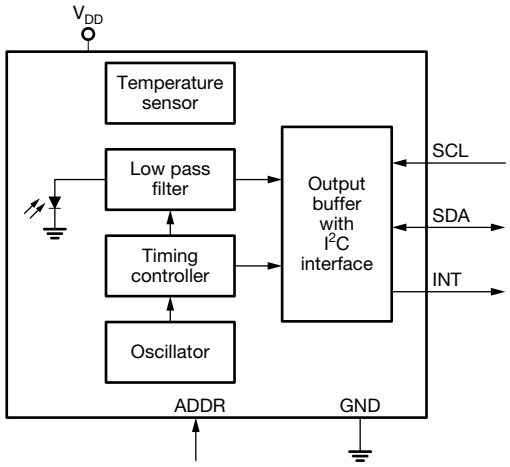
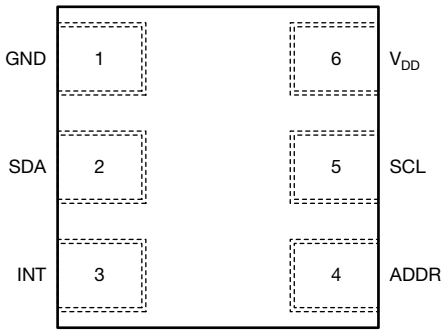


Fig. 1 - Block Diagram

PIN DESCRIPTIONS



1	Ground	4	ADDR
2	I^2C data	5	I^2C clock
3	Interrupt	6	Power

Fig. 2 - Pin Descriptions (top view)

PIN DESCRIPTIONS			
PIN ASSIGNMENT	**SYMBOL**	**TYPE**	**FUNTION**
1	GND	I	Power supply ground; all voltages are referenced to GND
2	SDA	I / O (open drain)	I^2C digital bus data input / output
3	INT	O (open drain)	Interrupt pin (active low)
4	ADDR	-	Address select; pull high to select address 0x48 or low to select address 0x10
5	SCL	I	I^2C digital clock input
6	V_{DD}	I	Supply voltage

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	2.0	V
Supply current (1)	Active state	I_{DD}	20	40	60	µA
Shut down current (1)(2)	Idle state	I_{sd}	0	1	2	µA
I^2C clock rate range (1)		f_{SCL}	10	-	400	kHz
I^2C signal input, logic high (1)		V_{IH}	1.26	-	-	V
I^2C signal input, logic low (1)		V_{IL}	-	-	0.4	V
Output low voltage SDA (1)	3 mA sink current	V_{OL}	0	-	0.4	V
Detectable minimum illuminance (1)(3)	ALS_IT = 800 ms, Gain 1 = x 2, Gain2 = x 16		-	0.0038	-	lx
Detectable illuminance (1)(3)	ALS_IT = 100 ms, Gain 1 = x 2, Gain2 = x 16		-	0.03	-	lx
Detectable maximum illuminance	ALS_IT = 100 ms, Gain 1 = x 1, Gain2 = x 1		-	20 000	-	lx
Dark offset (1)(2)	ALS_IT = 100 ms, Gain 1 = x 2, Gain2 = x 8		0	0	2	code

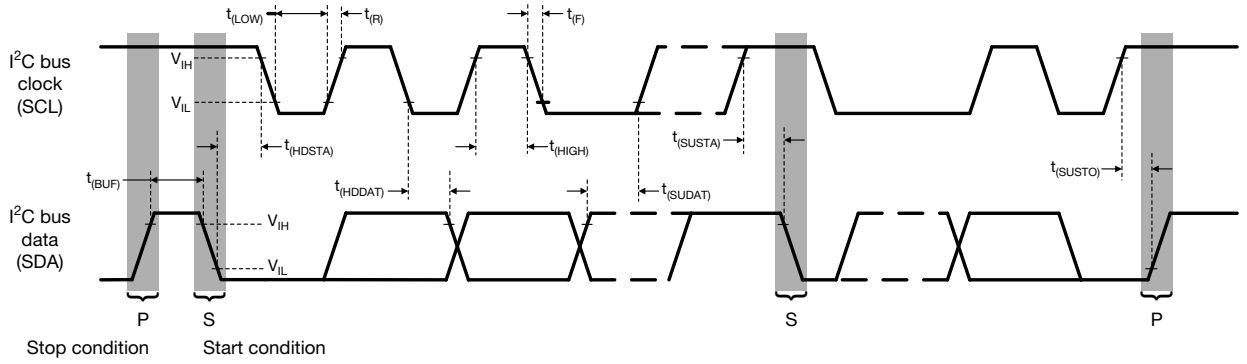
Notes

(1) Test condition: V_{DD} = 1.8 V, temperature: 25 °C
(2) Light conditions: 5000K white LED
(3) Light conditions: dark

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	$t_{(HDDAT)}$	-	3450	-	900	ns
Data setup time	$t_{(SUDAT)}$	250	-	100	-	ns
I²C clock (SCL) low period	$t_{(LOW)}$	4.7	-	1.3	-	µs
I²C clock (SCL) 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

Note

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



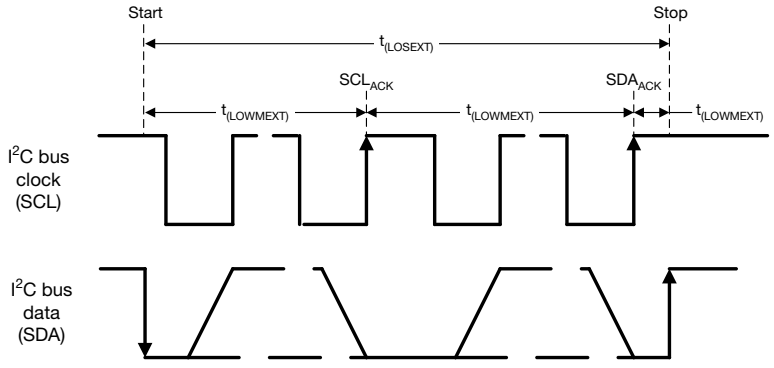


Fig. 3 - I²C Timing Diagram

PARAMETER TIMING INFORMATION

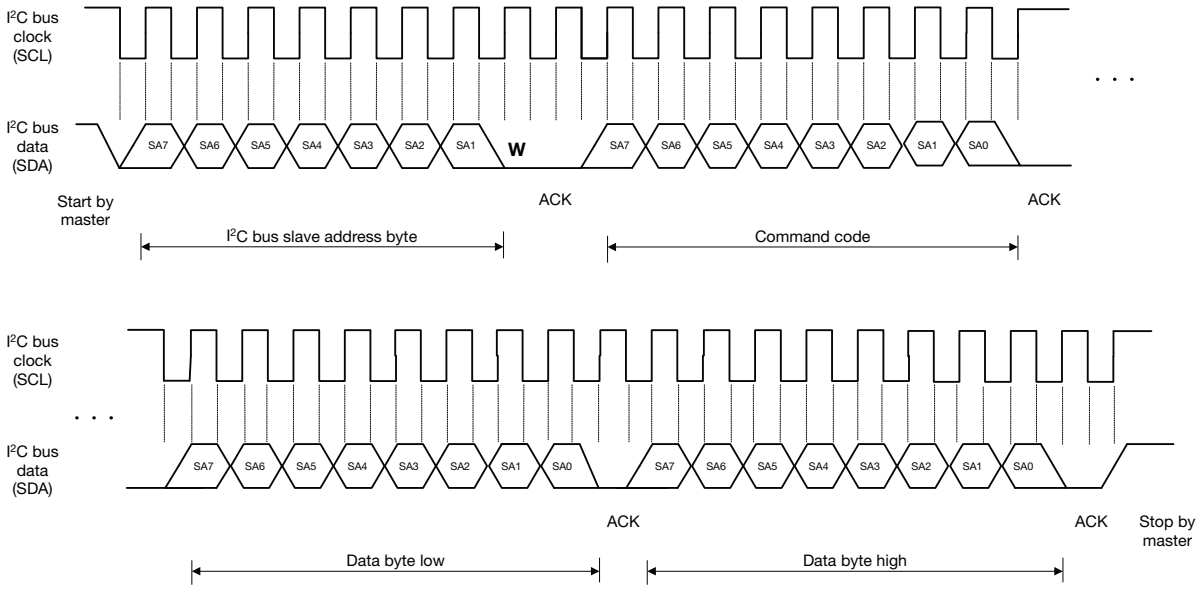


Fig. 4 - I²C Bus Timing for Sending Word Command Format

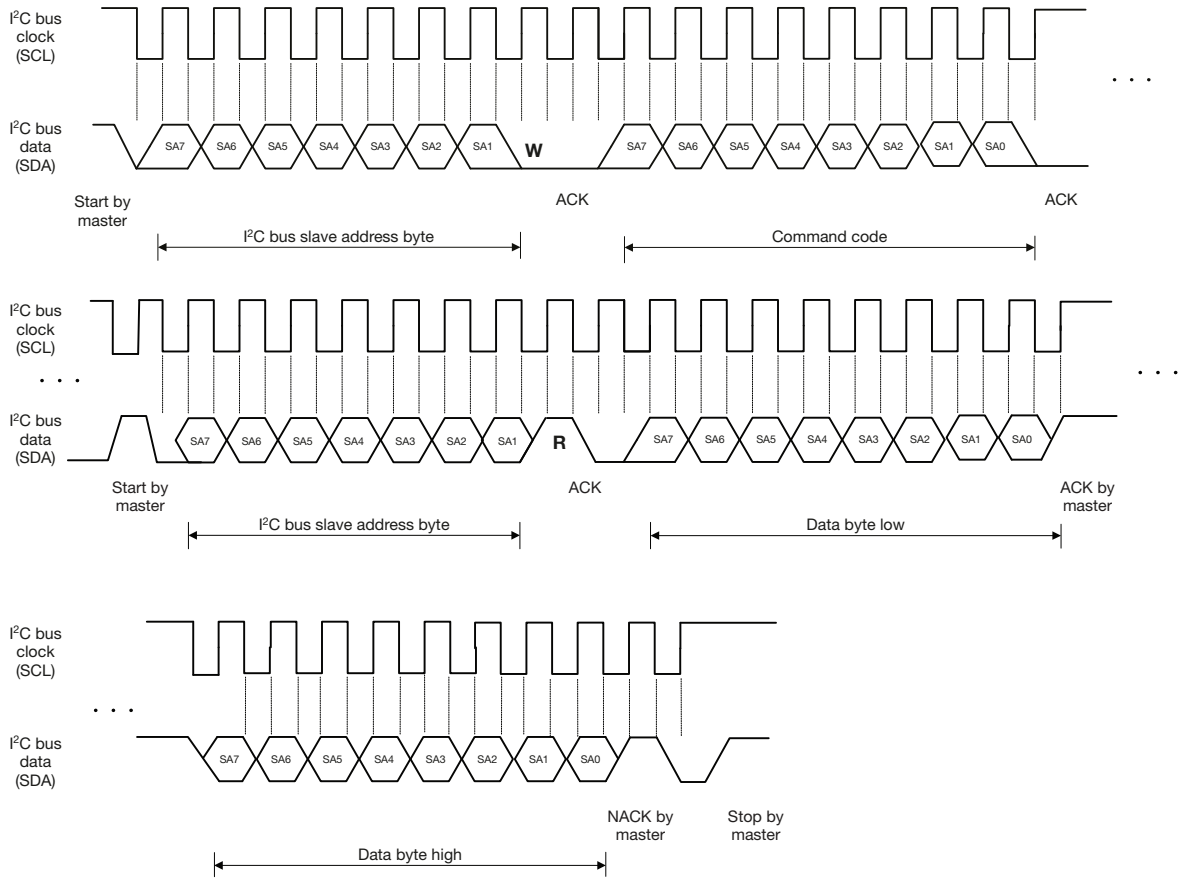


Fig. 5 - I²C Bus Timing for Receive Word Command Format

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

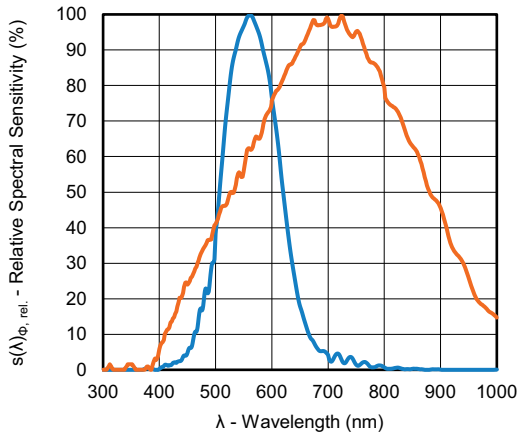


Fig. 6 - Relative Spectral Sensitivity vs. Wavelength

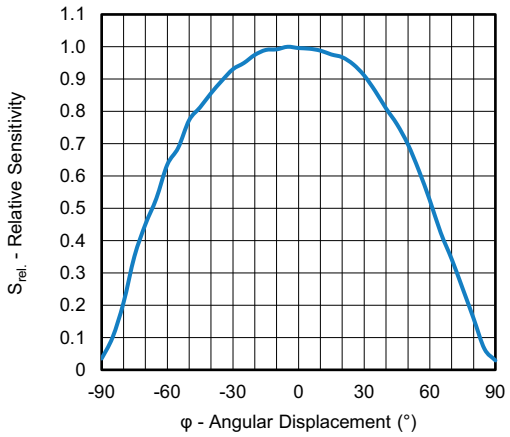


Fig. 7 - Relative Sensitivity vs. Angular Displacement

APPLICATION INFORMATION

1. Pin Connection With the Host

Known for being a cost-effective solution, the VEML32186 is an ambient light sensor featuring an I²C interface. You can easily access “light intensity” readings through its standard serial digital interface without complex calculations or external controller programming.

Locating a 0.1 µF capacitor near the V_{DD} pin in the circuit is recommended for power supply noise rejection. Ensuring proper I²C communication, the design suggests using 2.2 kΩ pull-up resistors on the bus lines.

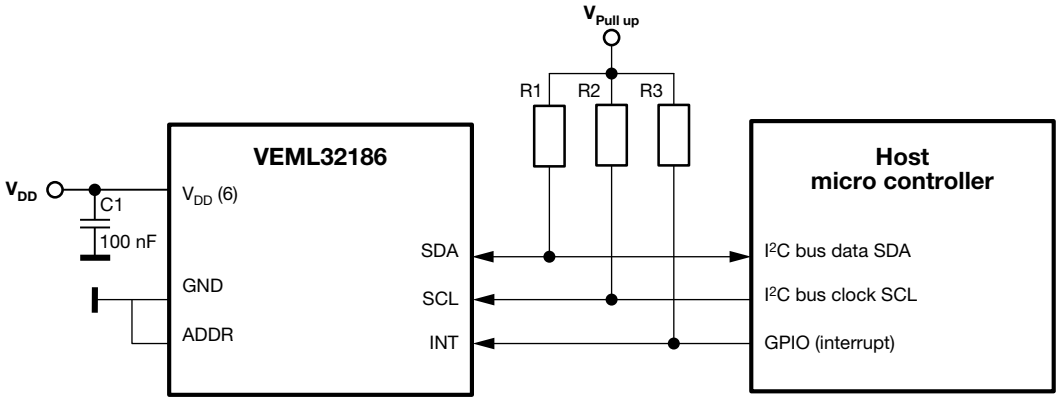


Fig. 8 - Hardware Pin Connection Diagram

APPLICATION CIRCUIT PARAMETERS		
METER	**VALUE**	**DESCRIPTION**
V_{DD}	1.7 V to 2 V	A staple power supply such as a low dropout regulator or a switching regulator is required; the power supply isolation can be further improved with a decoupling capacitor C_1
$V_{pull\ up}$	1.7 V to 2 V	A staple power supply such as a low dropout regulator or a switching regulator is required; a voltage level shifter is required if the I2C bus voltage from the microcontroller is higher than 2 V
C_1	100 nF	Decoupling capacitors are recommended to reduce the noise in the supply voltage
R_1 to R_2	2.2 kΩ to 4.7 kΩ	Pull-up resistors within the range of 2.2 kΩ to 4.7 kΩ are recommended; any increase in bus capacitance or resistance will increase the logic high transition time
R_3	4.7 kΩ to 22 kΩ	Pull-up resistor within the range of 4.7 kΩ to 22 kΩ is recommended

Digital Interface

Registered via the I²C bus, the VEML32186 contains a command register that controls all sensor operations. Operations are easily programmed using this simple command structure, allowing the user to set operation parameters and latch light data from the sensor.

Both read and write I²C command formats between the VEML32186 and the host are detailed in Fig. 9.

Blocks of white in the figure represent host activity, while gray blocks indicate the VEML32186's acknowledgement of access.

Interactions between the host and sensor follow this command protocol to ensure accurate data exchange. Every transfer cycle corresponds to host commands and sensor responses, allowing reliable communication over I²C.

Fig. 9 - Command Protocol Format

Command Register Format

The VEML32186 has two fix slave addresses for the host programming and accessing selection.

With ADDR pin plugged to power supply = high = V_{DD}, the predefined 7 bit I²C bus address is set to 1001000 = 0x48.

The least significant bit (LSB) defines read or write mode. Accordingly the bus address is set to 1001 0000 = 90h for write and 1001 0001 = 91h for read.

With ADDR pin plugged to ground = low, the slave address (7 bit) is set to 0010000 = 0x10. According 8 bit the bus address is then 0010 0000 = 20h for write and 0010 0001 = 21h for read.

COMMAND CODE DESCRIPTION

COMMAND CODE	REGISTER NAME	BIT	FUNCTION DESCRIPTION	R / W
0x00	Reserved	[15 : 13]	Set 0	R / W
	Initialization	[12]	0: disable; 1: enable	R / W
	Gain2	[11 : 9]	000 = x 1 001 = x 2 010 = x 4 011 = x 8 100 = x 16 101 = reserved	R / W
	Gain1	[8]	0 = x 1; 1 = x 2	R / W
	IT	[7 : 5]	integration time setting 000 = 25 ms (14 bit) 001 = 50 ms (15 bit) 010 = 100 ms (16 bit) 011 = 200 ms (16 bit) 100 = 400 ms (16 bit) 101 = 800 ms (16 bit)	R / W
	ALS_PERS	[4 : 3]	ALS channel INT Persistence protect number setting 00 = 1 01 = 2 10 = 4 11 = 8	R / W
	Reserved	[2]	Set 0	R / W
	ALS_INT_EN	[1]	Interrupt enable setting 0 = disable; 1 = enable	R / W
	SD	[0]	Shut down setting 0 = power on; 1 = shut down	R / W
0x01	ALS_WH	[15 : 8]	ALS high threshold Window setting (MSB)	R / W
	ALS_WH	[7 : 0]	ALS high threshold Window setting (LSB)	R / W
0x02	ALS_WL	[15 : 8]	ALS low threshold Window setting (MSB)	R / W
	ALS_WL	[7 : 0]	ALS low threshold Window setting (LSB)	R / W
0x03	Reserved	[15 : 0]		R / W
0x04	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
0x05	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
0x06	ALS_IF_L	[15]	ALS crossing Low threshold INT trigger event	R
	ALS_IF_H	[14]	ALS crossing High threshold INT trigger event	
	Reserved	[13 : 0]		
0x07	ID	[15 : 8]	ID part number: 21 = 0010 0001	R
	ID	[7 : 0]	ID part number: 86 = 1000 0110	
0x08	Reserved	[15 : 8]		R / W
0x09	Reserved	[15 : 8]		R / W
0x0A	Reserved	[15 : 8]		R / W
0x0B	Reserved	[15 : 8]		R / W
0x0C	Reserved	[15 : 8]		R
0x0D	Reserved	[15 : 8]		R
0x0E	Reserved	[15 : 8]		R
0x0F	Reserved	[15 : 8]		R

Data Access

Starting with 16-bit high resolution sensitivity, VEML32186 measures each channel accurately.

To represent this 16-bit data, two bytes are used: one for the least significant byte (LSB) and another for the most significant byte (MSB). Ensure the host follows the read word protocol to correctly retrieve this data. VEML32186 data format is shown below. Each detail of the data format is illustrated as follows.

16-BIT DATA FORMAT

	VEML32186 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

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

PACKAGE INFORMATION in millimeters

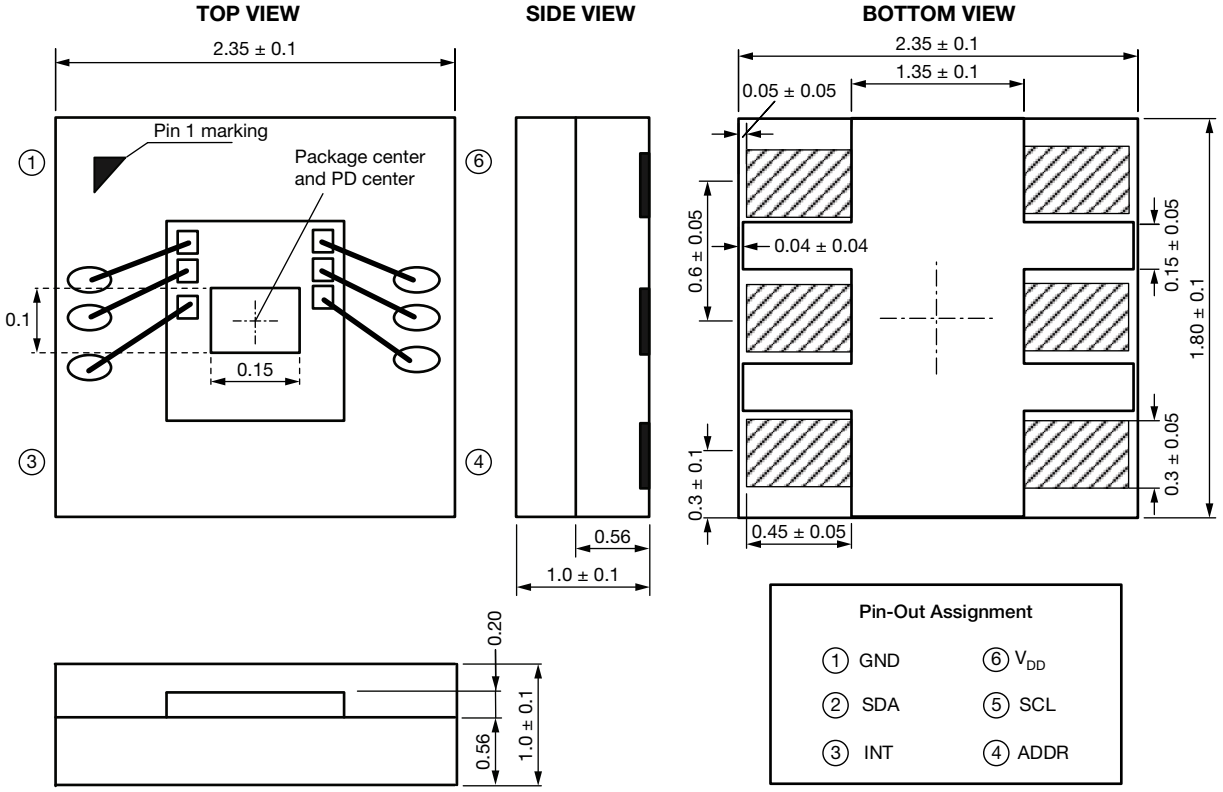


Fig. 10 - Package Dimensions

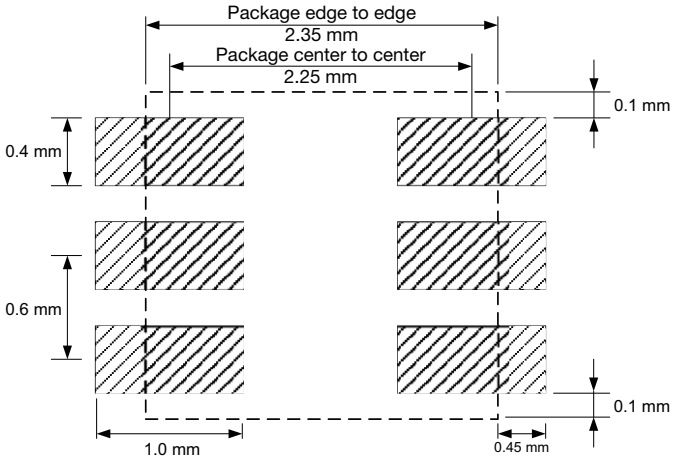


Fig. 11 - PCB Layout Footprint

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	h

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 120 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

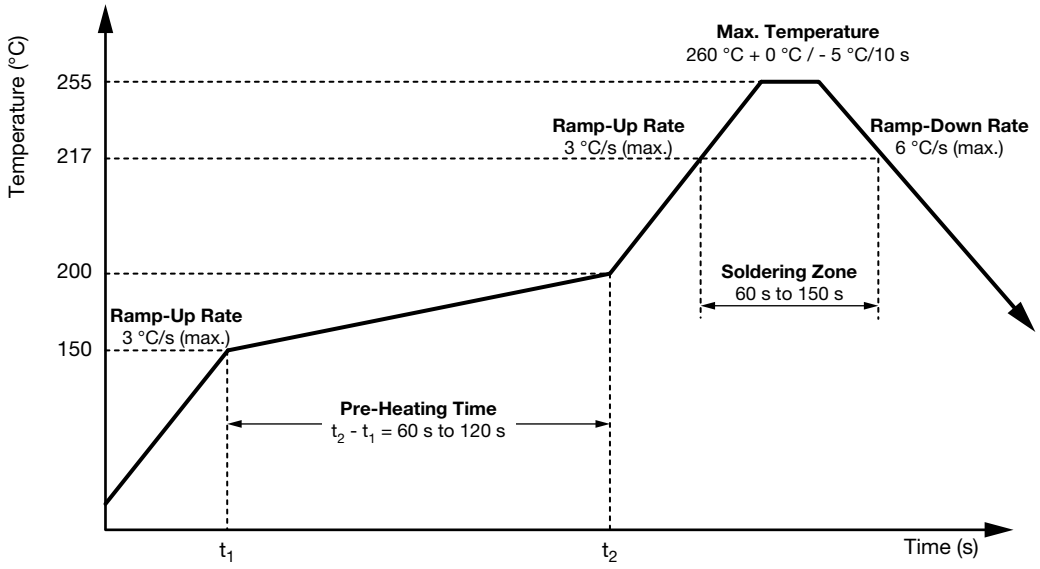


Fig. 12 - OPLGA Solder Reflow Profile Chart

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 AND REEL DIMENSIONS in millimeters

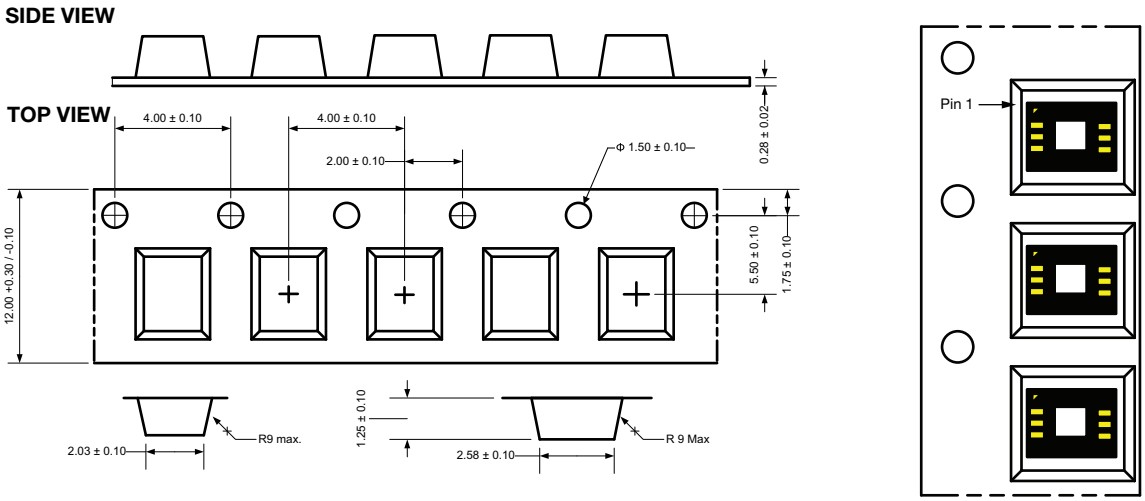


Fig. 13 - Package Carrier Tape

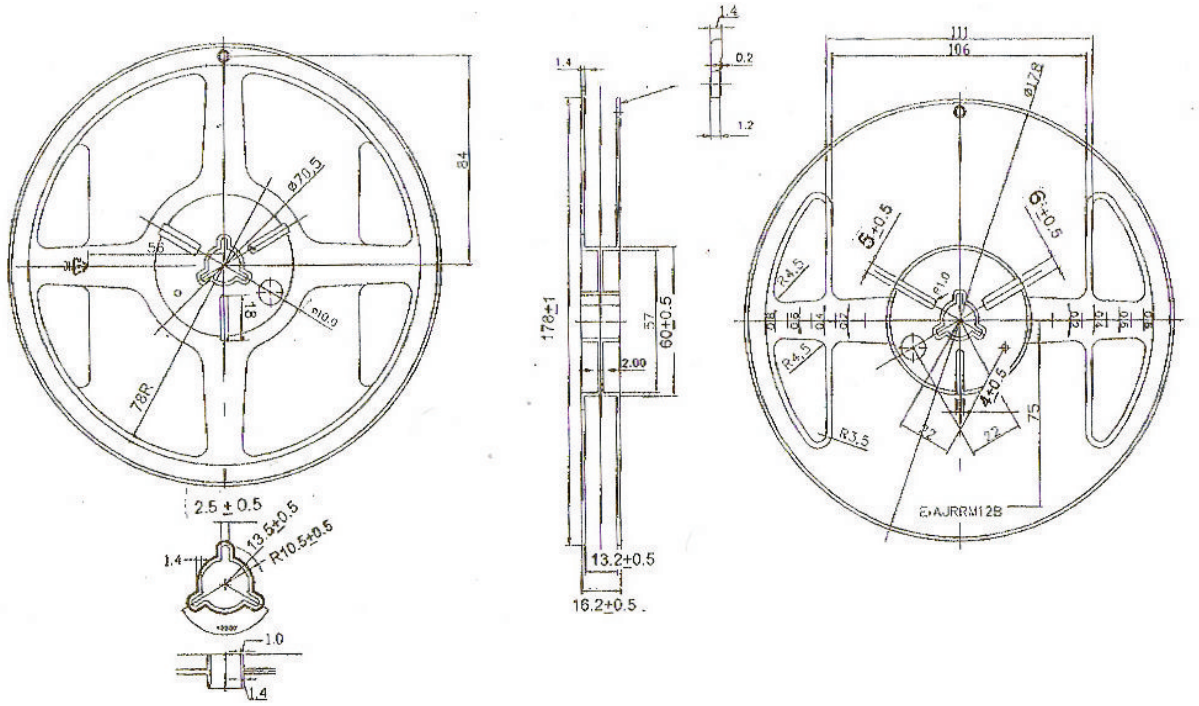


Fig. 14 - Reel Dimensions

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