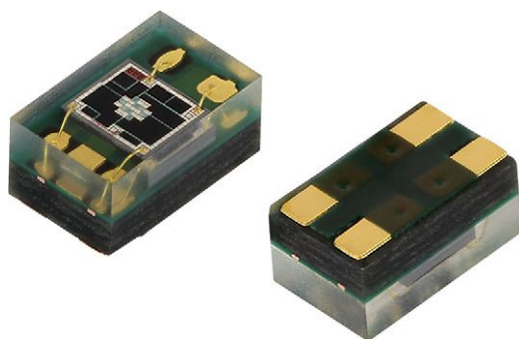


## UVA and UVB Light Sensor with I<sup>2</sup>C Interface



### DESCRIPTION

The VEML6075 senses UVA and UVB light and incorporates photodiode, amplifiers, and analog / digital circuits into a single chip using a CMOS process. When the UV sensor is applied, it is able to detect UVA and UVB intensity to provide a measure of the signal strength as well as allowing for UVI measurement.

The VEML6075 provides excellent temperature compensation capability for keeping the output stable under changing temperature. VEML6075's functionality is easily operated via the simple command format of I<sup>2</sup>C (SMBus compatible) interface protocol. VEML6075's operating voltage ranges from 1.7 V to 3.6 V. VEML6075 is packaged in a lead (Pb)-free 4 pin 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: ultraviolet sensor (UV), and signal conditioning IC
- Converts solar UV light intensity to digital data
- Excellent UVA and UVB sensitivity
- Reliable performance of UV radiation measurement under long time solar UV exposure
- 16-bit resolution per channel
- UVA and UVB individual channel solution
- Low power consumption I<sup>2</sup>C protocol (SMBus compatible) interface
- Package: OPLGA
- Temperature compensation: -40 °C to +85 °C
- Output type: I<sup>2</sup>C bus
- Operation voltage: 1.7 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

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

### PRODUCT SUMMARY

| PART NUMBER | OPERATING VOLTAGE RANGE (V) | I <sup>2</sup> C BUS VOLTAGE RANGE (V) | PEAK SENSITIVITY UVA, UVB (nm) | RANGE OF SPECTRAL BANDWIDTH $\lambda_{0.5}$ (nm) | OUTPUT CODE              |
|-------------|-----------------------------|----------------------------------------|--------------------------------|--------------------------------------------------|--------------------------|
| VEML6075    | 1.7 to 3.6                  | 1.7 to 3.6                             | 365, 330                       | ± 10                                             | 16 bit, I <sup>2</sup> C |

#### Note

(1) Adjustable through I<sup>2</sup>C interface

### ORDERING INFORMATION

| ORDERING CODE | PACKAGING     | VOLUME (1)    | REMARKS                   |
|---------------|---------------|---------------|---------------------------|
| VEML6075      | Tape and reel | MOQ: 2500 pcs | 2.0 mm x 1.25 mm x 1.0 mm |

#### Note

(1) MOQ: minimum order quantity

**ABSOLUTE MAXIMUM RATINGS** ( $T_{amb} = 25^{\circ}\text{C}$ , unless otherwise specified)

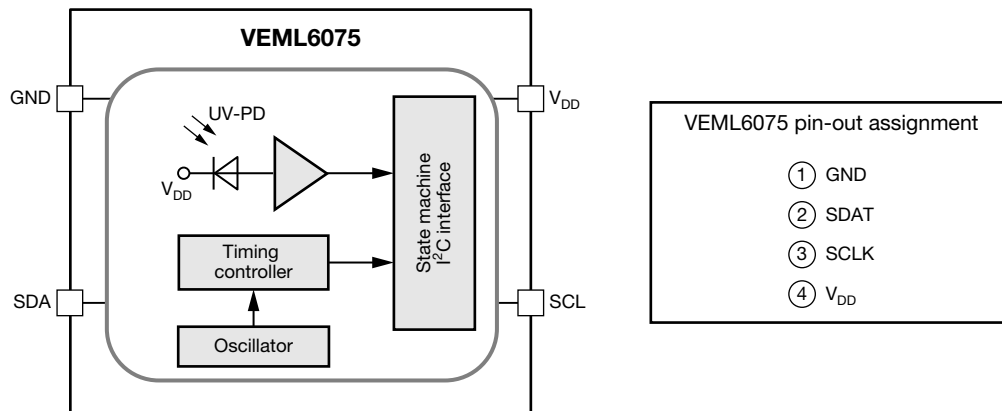
| PARAMETER                   | TEST CONDITION | SYMBOL    | MIN. | MAX. | UNIT               |
|-----------------------------|----------------|-----------|------|------|--------------------|
| Supply voltage              |                | $V_{DD}$  | 0    | 3.6  | V                  |
| Operation temperature range |                | $T_{amb}$ | -40  | +85  | $^{\circ}\text{C}$ |
| Storage temperature range   |                | $T_{stg}$ | -40  | +85  | $^{\circ}\text{C}$ |

**RECOMMENDED OPERATING CONDITIONS** ( $T_{amb} = 25^{\circ}\text{C}$ , unless otherwise specified)

| PARAMETER                                | TEST CONDITION | SYMBOL         | MIN. | MAX. | UNIT               |
|------------------------------------------|----------------|----------------|------|------|--------------------|
| Supply voltage                           |                | $V_{DD}$       | 1.7  | 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              | GND      | I                  | Ground                                        |
| 2              | SDAT     | I / O (open drain) | I <sup>2</sup> C data bus data input / output |
| 3              | SCLK     | I                  | I <sup>2</sup> C digital bus clock input      |
| 4              | $V_{DD}$ | I                  | Power supply input                            |

**BLOCK DIAGRAM**

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

| PARAMETER                     | TEST CONDITION                                                                      | SYMBOL              | MIN. | TYP. | MAX. | UNIT                              |
|-------------------------------|-------------------------------------------------------------------------------------|---------------------|------|------|------|-----------------------------------|
| Supply operation voltage      |                                                                                     | $V_{DD}$            | 1.7  | -    | 3.6  | V                                 |
| Supply current                | $V_{DD} = 1.8\text{ V}$                                                             | $I_{DD}$            | -    | 480  | -    | $\mu\text{A}$                     |
| I <sup>2</sup> C signal input | Logic high                                                                          | $V_{IH}$            | 1.5  | -    | -    | V                                 |
|                               | Logic low                                                                           | $V_{IL}$            | -    | -    | 0.8  |                                   |
| I <sup>2</sup> C signal input | Logic high                                                                          | $V_{IH}$            | 1.4  | -    | -    | V                                 |
|                               | Logic low                                                                           | $V_{IL}$            | -    | -    | 0.6  |                                   |
| Operating temperature         |                                                                                     | $T_{amb}$           | -40  | -    | +85  | $^{\circ}\text{C}$                |
| Shutdown current              | Light condition = dark;<br>$V_{DD} = 1.8\text{ V}$ , $T_{amb} = 25^{\circ}\text{C}$ | $I_{DD}(\text{SD})$ | -    | 800  | -    | nA                                |
| UVA responsivity              | $I_T = 50\text{ ms}^{(1)}$                                                          |                     | -    | 0.93 | -    | counts/ $\mu\text{W}/\text{cm}^2$ |
| UVB responsivity              | $I_T = 50\text{ ms}^{(2)}$                                                          |                     | -    | 2.1  | -    | counts/ $\mu\text{W}/\text{cm}^2$ |
| Visible / infrared response   | W-LED / IRED (940 nm)                                                               |                     | -    | 0.5  | < 1  | %                                 |

**Notes**
<sup>(1)</sup> Nichia NCSU033X (365 nm)

<sup>(2)</sup> UVTOP310TO39HS (315 nm)

| I <sup>2</sup> C TIMING CHARACTERISTICS (T <sub>amb</sub> = 25 °C, unless otherwise specified) |                       |               |      |           |      |      |
|------------------------------------------------------------------------------------------------|-----------------------|---------------|------|-----------|------|------|
| PARAMETER                                                                                      | SYMBOL                | STANDARD MODE |      | FAST MODE |      | UNIT |
|                                                                                                |                       | MIN.          | MAX. | MIN.      | MAX. |      |
| Clock frequency                                                                                | f <sub>(SMBCLK)</sub> | 10            | 100  | 10        | 400  | kHz  |
| Bus free time between start and stop condition                                                 | t <sub>(BUF)</sub>    | 4.7           | -    | 1.3       | -    | μs   |
| Hold time after (repeated) start condition;<br>after this period, the first clock is generated | t <sub>(HDSTA)</sub>  | 4.0           | -    | 0.6       | -    | μs   |
| Repeated start condition setup time                                                            | t <sub>(SUSTA)</sub>  | 4.7           | -    | 0.6       | -    | μs   |
| Stop condition setup time                                                                      | t <sub>(SUSTO)</sub>  | 4.0           | -    | 0.6       | -    | μs   |
| Data hold time                                                                                 | t <sub>(HDDAT)</sub>  | -             | 3450 | -         | 900  | ns   |
| Data setup time                                                                                | t <sub>(SUDAT)</sub>  | 250           | -    | 100       | -    | ns   |
| I <sup>2</sup> C clock (SCK) low period                                                        | t <sub>(LOW)</sub>    | 4.7           | -    | 1.3       | -    | μs   |
| I <sup>2</sup> C clock (SCK) high period                                                       | t <sub>(HIGH)</sub>   | 4.0           | -    | 0.6       | -    | μs   |
| Clock / data fall time                                                                         | t <sub>(F)</sub>      | -             | 300  | -         | 300  | ns   |
| Clock / data rise time                                                                         | t <sub>(R)</sub>      | -             | 1000 | -         | 300  | ns   |

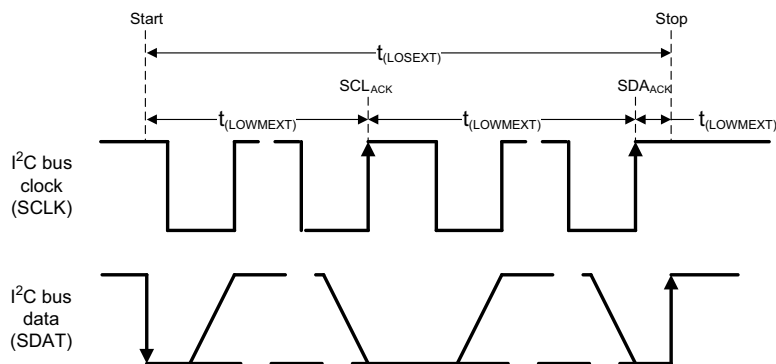
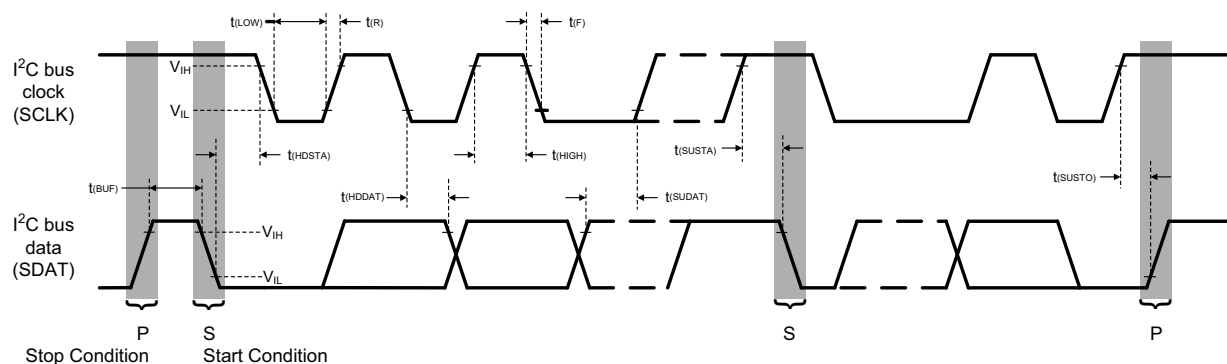


Fig. 1 - I<sup>2</sup>C Bus Timing Diagram



## PARAMETER TIMING INFORMATION

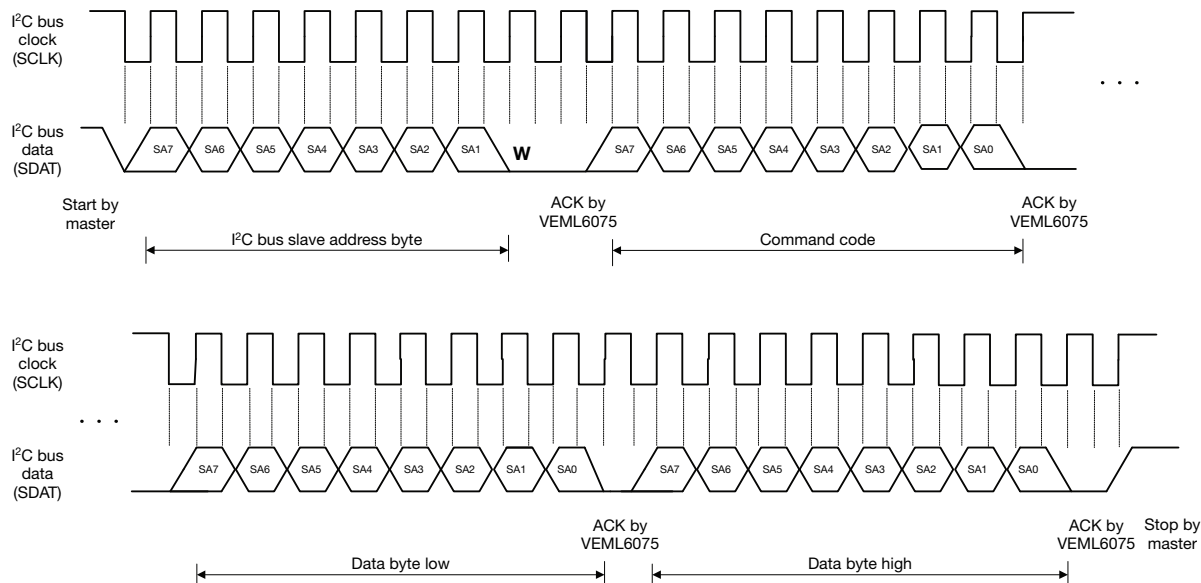


Fig. 2 - I<sup>2</sup>C Bus Timing for Sending Word Command Format

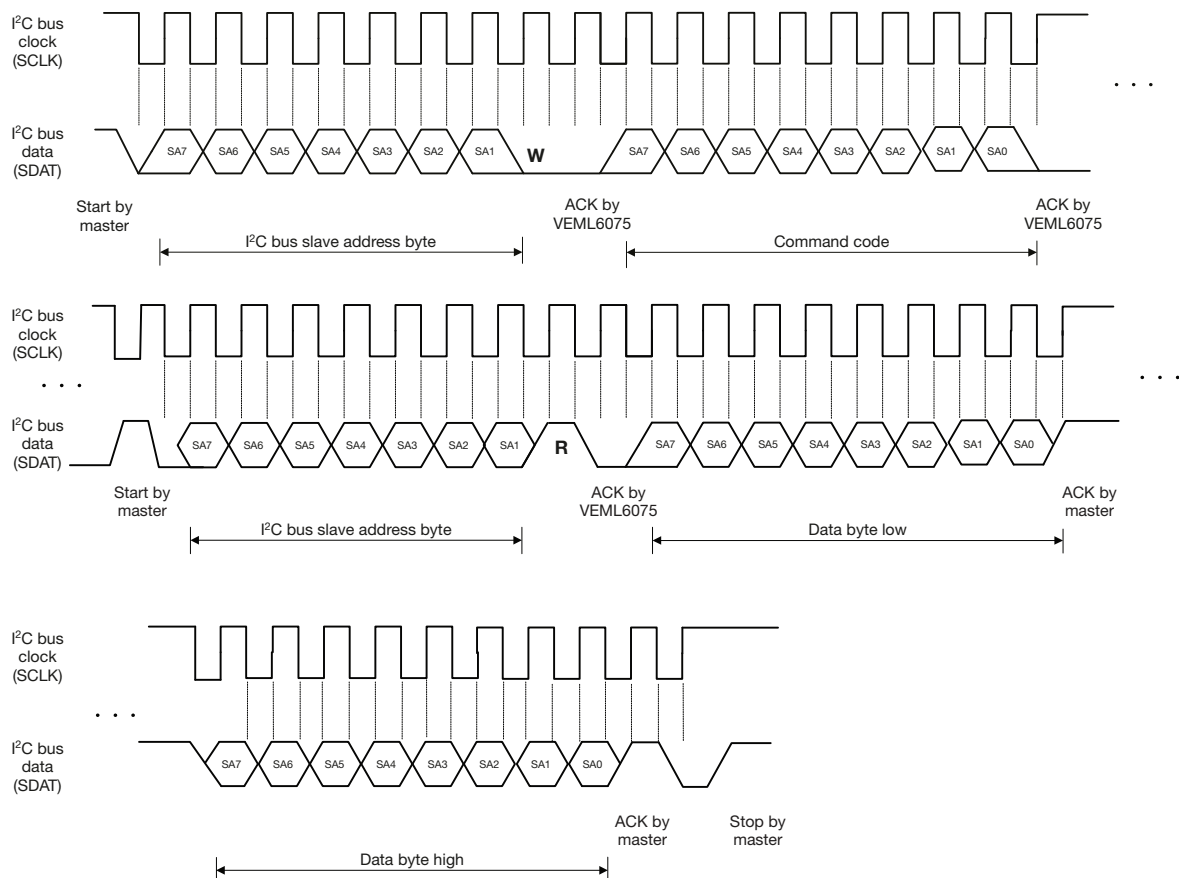


Fig. 3 - I<sup>2</sup>C Timing for Receive Word Command Format

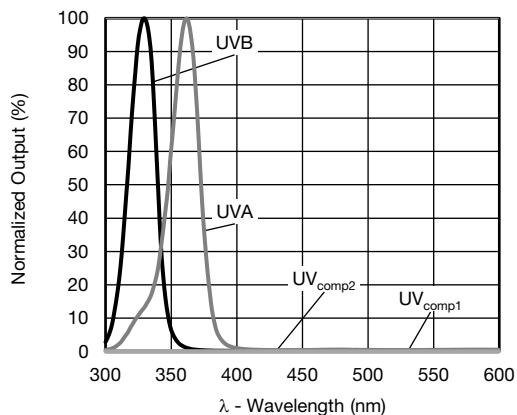
**TYPICAL PERFORMANCE CHARACTERISTICS** ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified)


Fig. 4 - Normalized Spectral Response

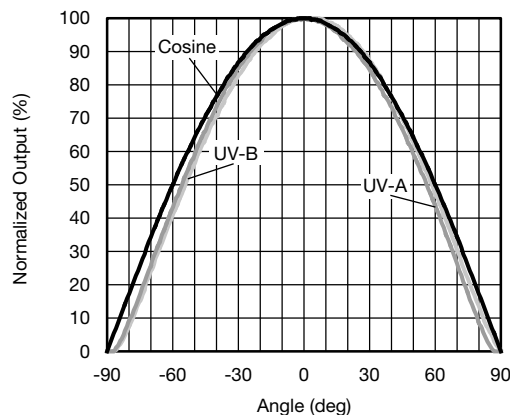


Fig. 5 - Normalized Output vs. View Angle

**APPLICATION INFORMATION**
**Pin Connection with the Host**

The configuration and data registers of the VEML6075 are accessed via the I<sup>2</sup>C interface. The hardware schematic is shown below in fig. 6.

The 0.1  $\mu\text{F}$  capacitor near the  $V_{DD}$  pin is used for power supply noise rejection. The 2.2 k $\Omega$  is suitable for the pull high resistor of I<sup>2</sup>C.

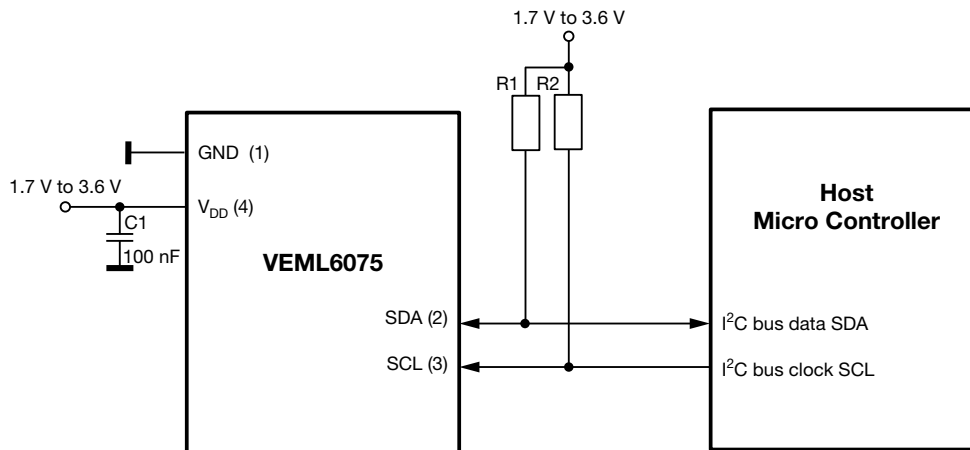


Fig. 6 - Hardware Pin Connection Diagram

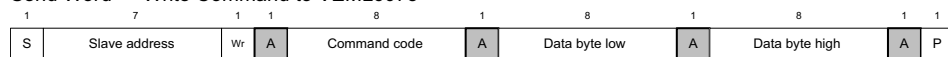


## Digital Interface

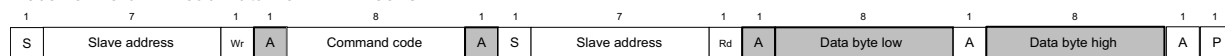
The VEML6075 contains a CONF register (00h) used for operation control and parameter setup. Measurement results are stored in four separate registers, one each for UVA, UVD, UVB, UV<sub>comp1</sub>, and UV<sub>comp2</sub> (07h to 0Bh respectively). All registers are accessible via I<sup>2</sup>C communication. Fig. 7 shows the basic I<sup>2</sup>C communication with the VEML6075. Each of the registers in the VEML6075 are 16 bit wide, so 16 bit should be written when a write command is sent, and 16 bit should be read when a read command is sent.

The built in I<sup>2</sup>C interface is compatible with I<sup>2</sup>C modes “standard” and “fast”: 100 kHz to 400 kHz

Send Word → Write Command to VEML6075



Receive Word → Read Data from VEML6075



S = start condition

P = stop condition

A = acknowledge

Shaded area = VEML6075 acknowledge

Fig. 7 - Command Protocol Format

## Note

- Please note the repeat start condition when data is read from the sensor. A stop condition should not be sent here.

## Slave Address and Function Description

VEML6075 uses 0x10 slave address for 7-bit I<sup>2</sup>C addressing protocol. VEML6075 has 16-bit resolution for each channel (UVA, UVB, UV<sub>comp1</sub>, and UV<sub>comp2</sub>).

| TABLE 1 - VEML6075 COMMAND CODE AND REGISTER DESCRIPTION |                      |               |       |               |                                                  |
|----------------------------------------------------------|----------------------|---------------|-------|---------------|--------------------------------------------------|
| COMMAND CODE                                             | DATE BYTE LOW / HIGH | REGISTER NAME | R / W | DEFAULT VALUE | FUNCTION DESCRIPTION                             |
| 00h                                                      | L                    | UV_CONF       | R / W | 0x00          | UV integration time, function enable and disable |
|                                                          | H                    | Reserved      | R / W | 0x00          | Reserved                                         |
| 01h                                                      | L                    | Reserved      | R / W | 0x00          | Reserved                                         |
|                                                          | H                    | Reserved      | R / W | 0x00          | Reserved                                         |
| 02h                                                      | L                    | Reserved      | R / W | 0x00          | Reserved                                         |
|                                                          | H                    | Reserved      | R / W | 0x00          | Reserved                                         |
| 03h                                                      | L                    | Reserved      | R / W | 0x00          | Reserved                                         |
|                                                          | H                    | Reserved      | R / W | 0x00          | Reserved                                         |
| 04h                                                      | L                    | Reserved      | R / W | 0x00          | Reserved                                         |
|                                                          | H                    | Reserved      | R / W | 0x00          | Reserved                                         |
| 05h                                                      | L                    | Reserved      | R / W | 0x00          | Reserved                                         |
|                                                          | H                    | Reserved      | R / W | 0x00          | Reserved                                         |
| 06h                                                      | L                    | Reserved      | R / W | 0x00          | Reserved                                         |
|                                                          | H                    | Reserved      | R / W | 0x00          | Reserved                                         |
| 07h                                                      | L                    | UVA_Data      | R     | 0x00          | UVA LSB output data                              |
|                                                          | H                    | UVA_Data      | R     | 0x00          | UVA MSB output data                              |
| 08h                                                      | L                    | Reserved      | R     | 0x00          | Reserved                                         |
|                                                          | H                    | Reserved      | R     | 0x00          | Reserved                                         |
| 09h                                                      | L                    | UVB_Data      | R     | 0x00          | UVB LSB output data                              |
|                                                          | H                    | UVB_Data      | R     | 0x00          | UVB MSB output data                              |
| 0Ah                                                      | L                    | UVCOMP1_Data  | R     | 0x00          | UV <sub>comp1</sub> LSB output data              |
|                                                          | H                    | UVCOMP1_Data  | R     | 0x00          | UV <sub>comp1</sub> MSB output data              |
| 0Bh                                                      | L                    | UVCOMP2_Data  | R     | 0x00          | UV <sub>comp2</sub> LSB output data              |
|                                                          | H                    | UVCOMP2_Data  | R     | 0x00          | UV <sub>comp2</sub> MSB output data              |
| 0Ch                                                      | L                    | ID            | R     | 0x26          | Device ID LSB                                    |
|                                                          | H                    | ID            | R     | 0x00          | Device ID MSB                                    |

**Command Register Format**

The VEML6075 has 16-bit registers used to set up the measurements as well as pick up the measurement results. The description of each command format is shown in the following tables.

**TABLE 2 - REGISTER UV\_CONF DESCRIPTION**

| REGISTER NAME            |       | COMMAND CODE: 0x00_L (0x00 DATA BYTE LOW) OR 0x00_H (0x00 DATA BYTE HIGH)                                                                                                                            |   |   |   |   |   |   |   |
|--------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|
| COMMAND                  | BIT   | 7                                                                                                                                                                                                    | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| <b>REGISTER: UV_CONF</b> |       | <b>COMMAND CODE: 0x00_L (0x00 DATA BYTE LOW)</b>                                                                                                                                                     |   |   |   |   |   |   |   |
| COMMAND                  | BIT   | Description                                                                                                                                                                                          |   |   |   |   |   |   |   |
| Reserved                 | 7     | 0                                                                                                                                                                                                    |   |   |   |   |   |   |   |
| UV_IT                    | 6 : 4 | (0 : 0 : 0) = 50 ms, (0 : 0 : 1) = 100 ms, (0 : 1 : 0) = 200 ms, (0 : 1 : 1) = 400 ms, (1 : 0 : 0) = 800 ms, (1 : 0 : 1) = reserved, (1 : 1 : 0) = reserved, (1 : 1 : 1) = reserved.                 |   |   |   |   |   |   |   |
| HD                       | 3     | 0 = normal dynamic setting, 1 = high dynamic setting                                                                                                                                                 |   |   |   |   |   |   |   |
| UV_TRIG                  | 2     | 0 = no active force mode trigger, 1 = trigger one measurement<br>With UV_AF = 1 the VEML6075 conducts one measurement every time the host writes UV_Trig = 1. This bit returns to "0" automatically. |   |   |   |   |   |   |   |
| UV_AF                    | 1     | 0 = active force mode disable (normal mode), 1 = active force mode enable                                                                                                                            |   |   |   |   |   |   |   |
| SD                       | 0     | 0 = power on, 1 = shut down                                                                                                                                                                          |   |   |   |   |   |   |   |

**TABLE 3 - REGISTER 00\_H DESCRIPTION**

| <b>REGISTER: reserved</b> |       | <b>COMMAND CODE: 0x00_H (0x00 DATA BYTE HIGH)</b> |  |  |  |  |  |  |  |
|---------------------------|-------|---------------------------------------------------|--|--|--|--|--|--|--|
| COMMAND                   | BIT   | Description                                       |  |  |  |  |  |  |  |
| Reserved                  | 7 : 0 | Default = (0 : 0 : 0 : 0 : 0 : 0 : 0 : 0)         |  |  |  |  |  |  |  |

**TABLE 4 - REGISTER 01\_L TO 06\_L AND 08\_L; 01\_H TO 06\_H AND 08\_H DESCRIPTION**

| <b>REGISTER: reserved</b> |       | <b>COMMAND CODE: 0x01_L TO 0x06_L AND 0x08_L (0x01 TO 0x06 AND 0x08_L DATA BYTE LOW)<br/>COMMAND CODE: 0x01_H TO 0x06_H AND 0x08_H (0x01 TO 0x06 AND 0x08_H DATA BYTE HIGH)</b> |  |  |  |  |  |  |  |
|---------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|--|--|--|--|
| REGISTER                  | BIT   | Description                                                                                                                                                                     |  |  |  |  |  |  |  |
| Reserved                  | 7 : 0 | Default = (0 : 0 : 0 : 0 : 0 : 0 : 0 : 0)                                                                                                                                       |  |  |  |  |  |  |  |
| Reserved                  | 7 : 0 | Default = (0 : 0 : 0 : 0 : 0 : 0 : 0 : 0)                                                                                                                                       |  |  |  |  |  |  |  |

**TABLE 5 - READ OUT COMMAND CODES DESCRIPTION**

| REGISTER     | COMMAND CODE                 | BIT                     | DESCRIPTION                                                                                                               |
|--------------|------------------------------|-------------------------|---------------------------------------------------------------------------------------------------------------------------|
| UVA_DATA     | 0x07_L (0x07 data byte low)  | 7 : 0                   | 0x00 to 0xFF, UVA LSB output data                                                                                         |
|              | 0x07_H (0x07 data byte high) | 7 : 0                   | 0x00 to 0xFF, UVA MSB output data                                                                                         |
| UVB_DATA     | 0x09_L (0x09 data byte low)  | 7 : 0                   | 0x00 to 0xFF, UVB LSB output data                                                                                         |
|              | 0x09_H (0x09 data byte high) | 7 : 0                   | 0x00 to 0xFF, UVB MSB output data                                                                                         |
| UVCOMP1_DATA | 0x0A_L (0x0A data byte low)  | 7 : 0                   | 0x00 to 0xFF, UV <sub>comp1</sub> LSB output data                                                                         |
|              | 0x0A_H (0x0A data byte high) | 7 : 0                   | 0x00 to 0xFF, UV <sub>comp1</sub> MSB output data                                                                         |
| UVCOMP2_DATA | 0x0B_L (0x0B data byte low)  | 7 : 0                   | 0x00 to 0xFF, UV <sub>comp2</sub> LSB output data                                                                         |
|              | 0x0B_H (0x0B data byte high) | 7 : 0                   | 0x00 to 0xFF, UV <sub>comp2</sub> MSB output data                                                                         |
| ID           | 0x0C_L (0x0C data byte low)  | 7 : 0                   | Default = 0x26, device ID LSB byte                                                                                        |
|              | 0x0C_H (0x0C data byte high) | 7 : 6<br>5 : 4<br>3 : 0 | Company code = 00, (0 : 0),<br>slave address = 0x20,<br>version code (0 : 0 : 0 : 0) = VEML6075 CS,<br>device ID MSB byte |

## Data Access

VEML6075 has 16-bit high resolution sensitivity for each UV channel. 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 6 - 16-BIT DATA FORMAT

|                | VEML6075 16-BIT DATA FORMAT |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   |
|----------------|-----------------------------|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|
|                | 15                          | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Data byte low  |                             |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   |
| Data byte high |                             |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   |

### Note

Receive byte      Read data from VEML6075

|   |               |    |   |              |   |   |               |    |   |                 |   |                 |   |   |
|---|---------------|----|---|--------------|---|---|---------------|----|---|-----------------|---|-----------------|---|---|
| S | Slave address | Wr | A | Command code | A | S | Slave address | Rd | A | Data byte (LSB) | A | Data byte (MSB) | N | P |
|---|---------------|----|---|--------------|---|---|---------------|----|---|-----------------|---|-----------------|---|---|

S = start condition

P = stop condition

A = acknowledge

N = no acknowledge

☐ Host action

■ VEMML6075 response

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

## Data Auto-Memorization

VEML6075 keeps the last results read. These values will remain in the registers, and can be read from these registers, until the device wakes up and a new measurement is made.

### UV-Index Calculation

In order to use the result data to calculate the UV-Index, please refer to the “Designing the VEML6075 into an Application” application note ([www.vishay.com/doc?84339](http://www.vishay.com/doc?84339)).

### PACKAGE INFORMATION in millimeters

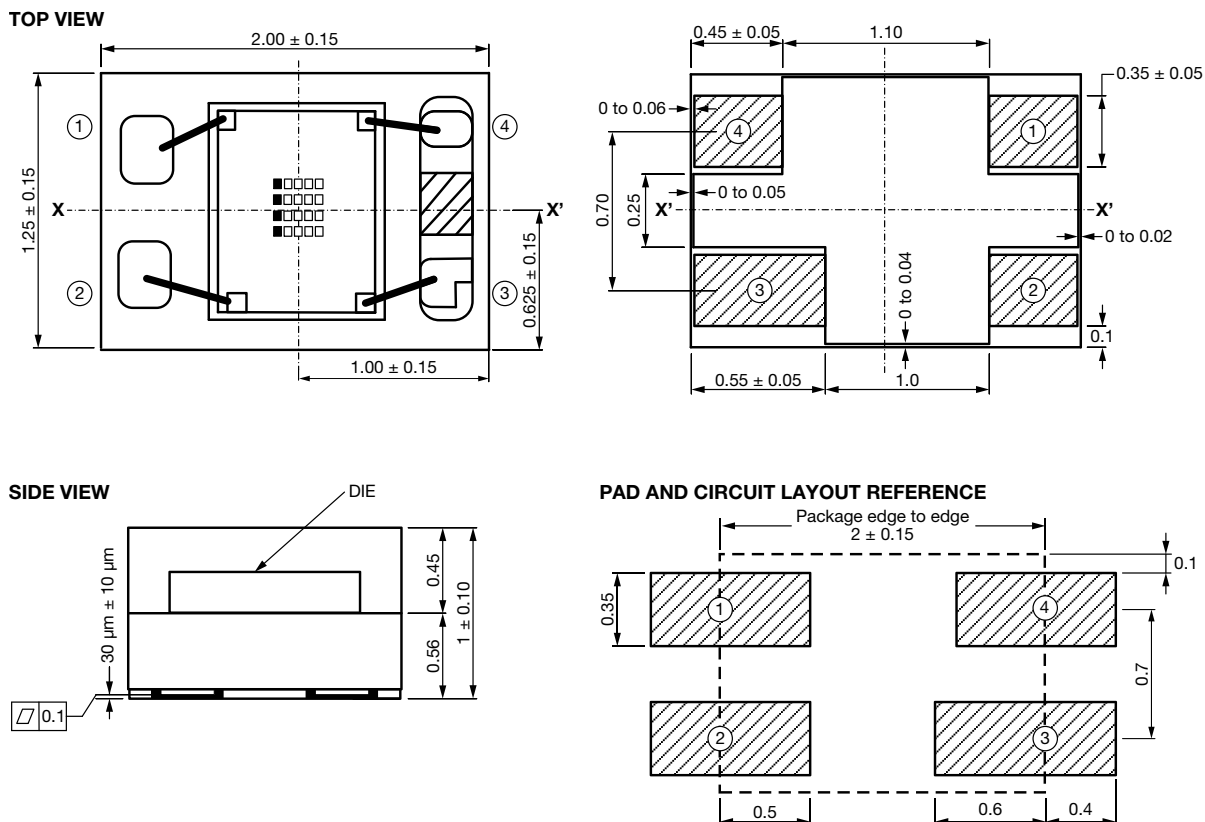


Fig. 8 - VEML6075 A3OP Package Dimensions

**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   | 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 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

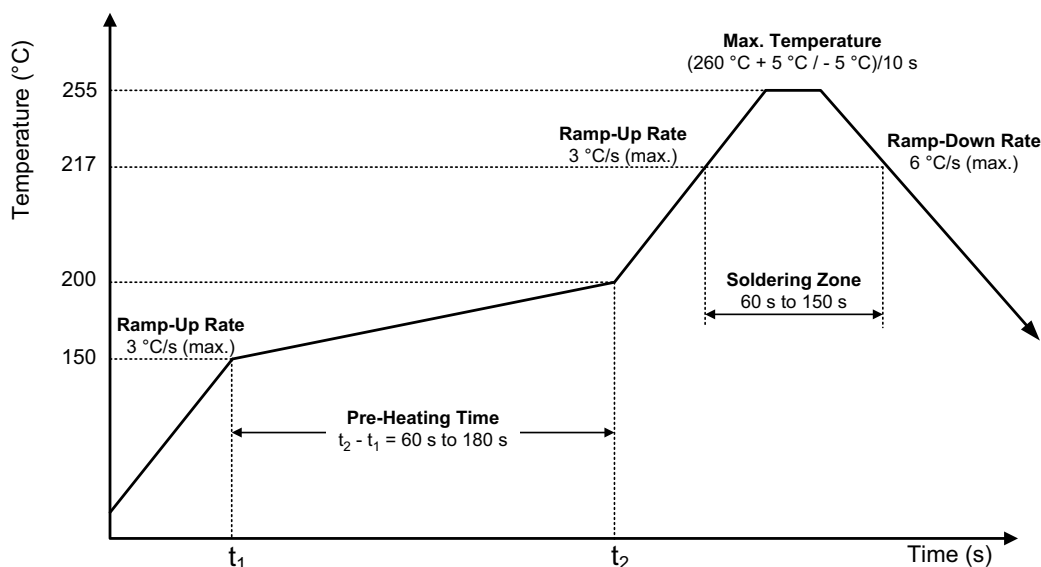


Fig. 9 - VEML6075 OPLGA Solder Reflow Profile Chart

**RECOMMENDED IRON TIP SOLDERING CONDITION AND WARNING HANDLING**

- Solder the device with the following conditions:
  - Soldering temperature: 400 °C (max.)
  - Soldering time: 3 s (max.)
- 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.
- The following methods: VPS and wave soldering, have not been suggested for the component assembly.
- Cleaning method conditions:
  - Solvent: methyl alcohol, ethyl alcohol, isopropyl alcohol
  - Solvent temperature < 45 °C (max.)
  - Time: 3 min (min.)

**TAPE PACKAGING INFORMATION** in millimeters

### DIMENSION OF CARRIER TAPE

### SIDE VIEW

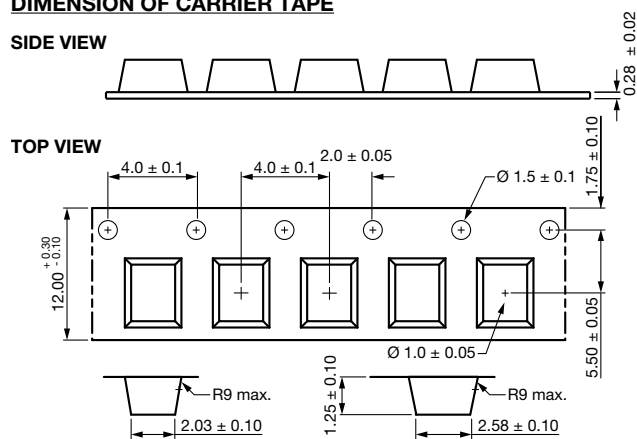


Fig. 10 - VEML6070 A3OP Package Carrier Tape

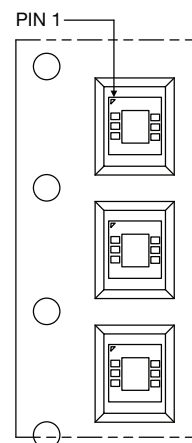


Fig. 11 - Taping Direction

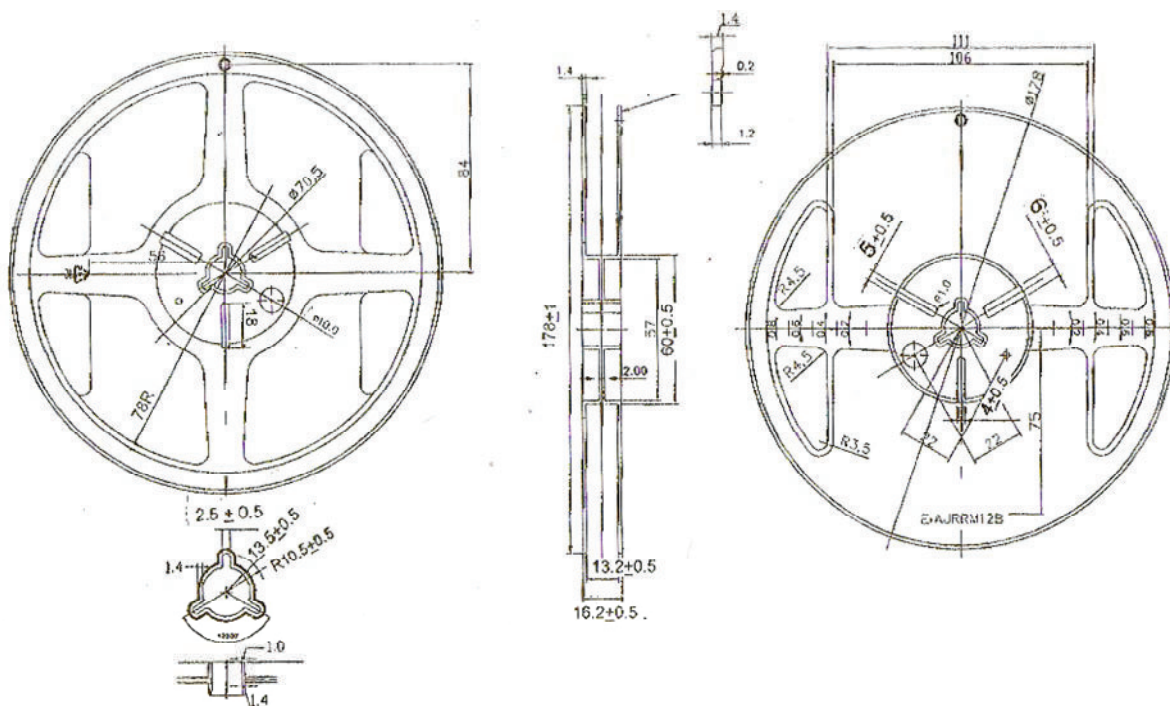


Fig. 12 - Reel Dimension



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