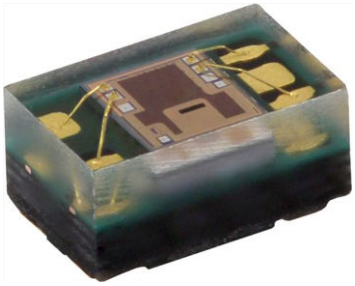
Датчики цвета
VEML3328, VEML3328SL, VEML6040
Технические характеристики

RGBCIR Color Sensor With I²C Interface



ADDITIONAL RESOURCES

Design Tools | Related Documents | 3D Models | Application Notes

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.

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

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

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)	I²C 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, I²C

ORDERING INFORMATION			
ORDERING CODE	**PACKAGING**	**VOLUME (1)**	**REMARKS**
VEML3328	Tape and reel	MOQ: 2500 pcs	2.00 mm x 1.25 mm x 1.00 mm

Note

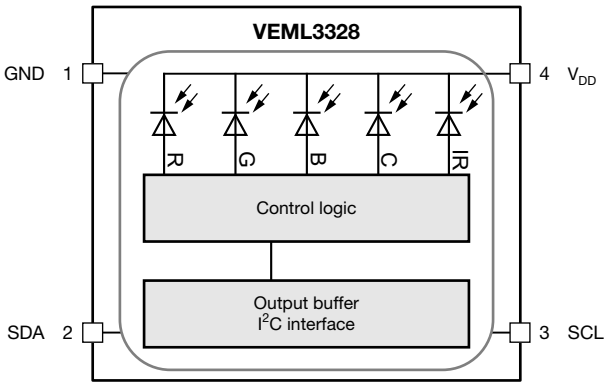
(1) MOQ: minimum order quantity

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 °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	°C
I^2C 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^2C digital bus data input / output
3	SCL	I	I^2C digital bus clock input
4	V_{DD}	-	Supply voltage

BLOCK DIAGRAM



BASIC CHARACTERISTICS (T_{amb} = 25 °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^2C 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/(µW/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)			R, G, B, C, IR	0	-	3	counts
Operating temperature range			T_{amb}	-40	-	+85	°C
Shutdown current (1)		Light condition = dark	I_{DD}	0	800	1000	nA

Notes

(1) Test condition: V_{DD} = 3 V, temperature: 25 °C

(2) IT: 100 ms, SENS = (0) = x 1, DG = (0 : 0) = x 1, GAIN = (0 : 0) = x 1

(3) IT: 400 ms, SENS = (0) = x 1, DG = (1 : 0) = x 4, GAIN = (1 : 0) = x 4

I²C BUS TIMING CHARACTERISTICS (T_{amb} = 25 °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
I²C clock (SCK) low period	$t_{(LOW)}$	4.7	-	1.3	-	µs
I²C 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

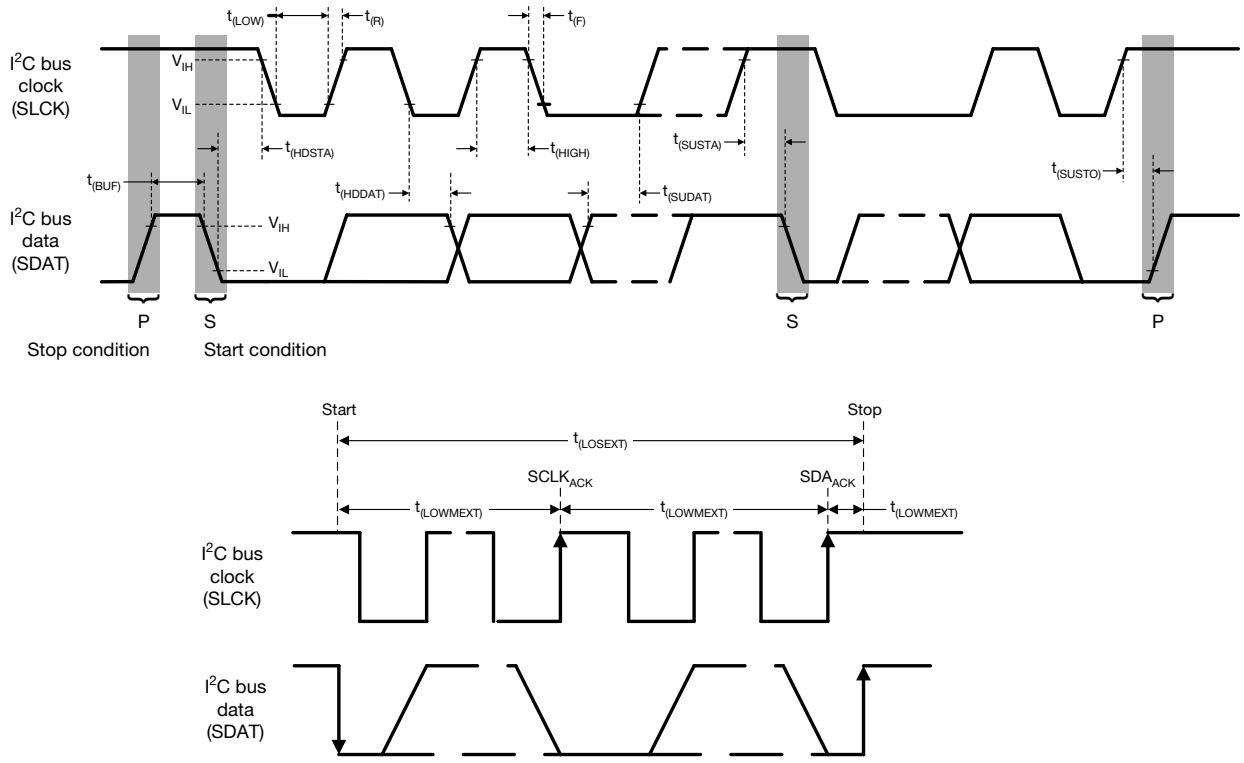


Fig. 1 - I²C Bus Timing Diagram

PARAMETER TIMING INFORMATION

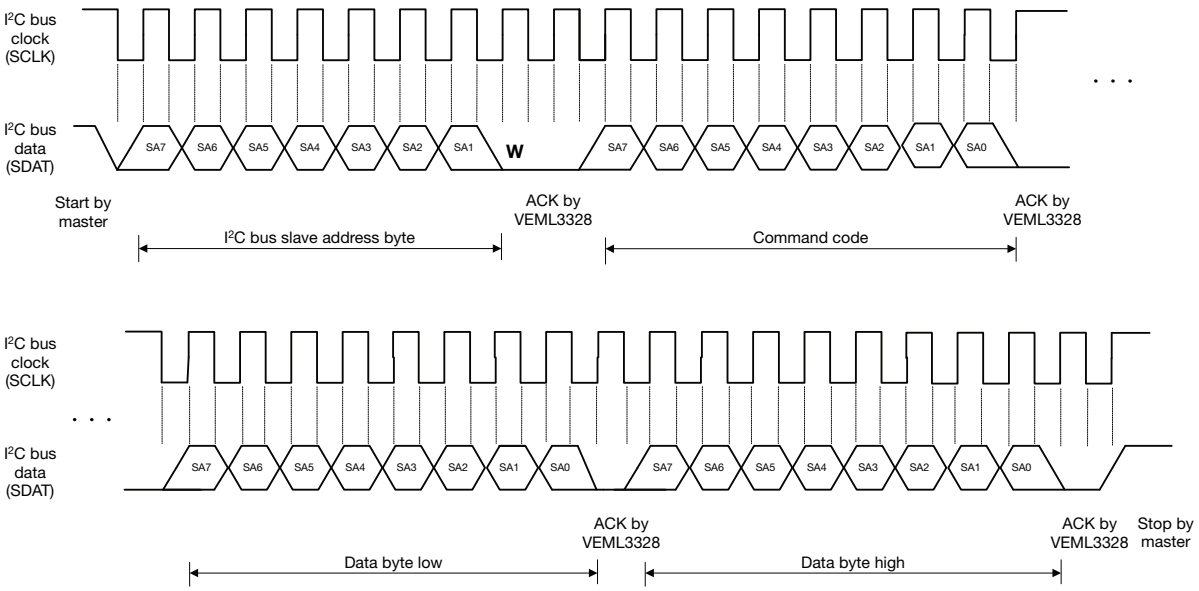


Fig. 2 - I²C Bus Timing for Sending Word Command Format

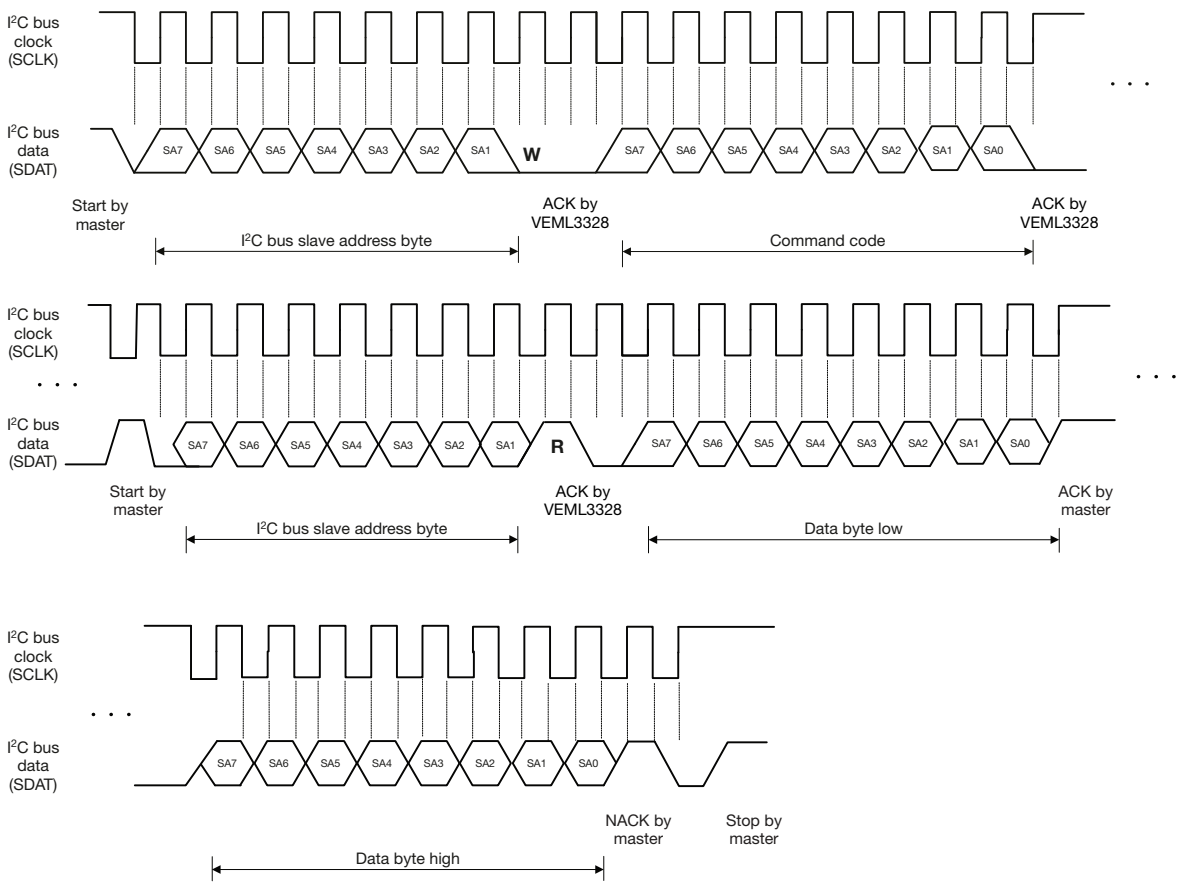


Fig. 3 - I²C Bus Timing for Receiving Word Command Format

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

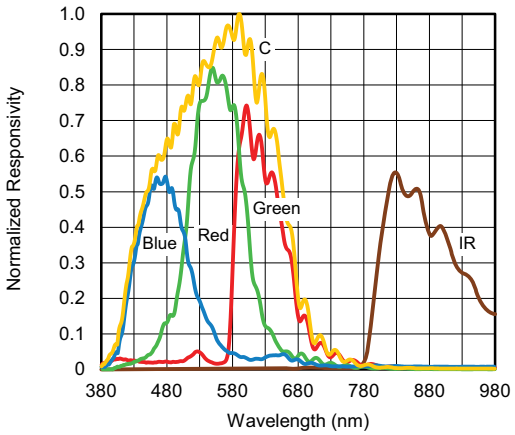


Fig. 4 - Normalized Responsivity vs. Wavelength

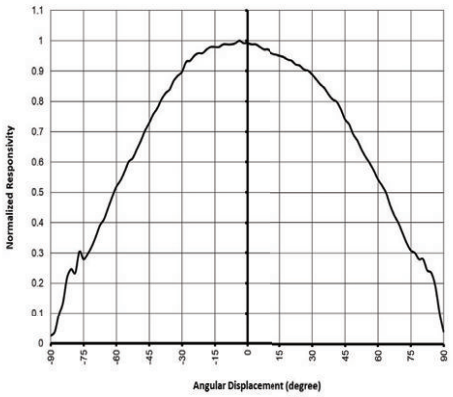


Fig. 5 - Normalized Responsivity vs. Angular Displacement

APPLICATION INFORMATION

Pin Connection With the Host

The VEML3328 is a cost effective solution color and IR sensor with an I²C interface. All possible settings and result data can be accessed via the standard I²C interface.

A typical application circuit is shown in Fig. 6 below. The additional 0.1 µF capacitor near the V_{DD} pin in the circuit is used for power supply noise rejection. Pull-up resistors for the I²C bus design are recommended to be 2.2 kΩ.

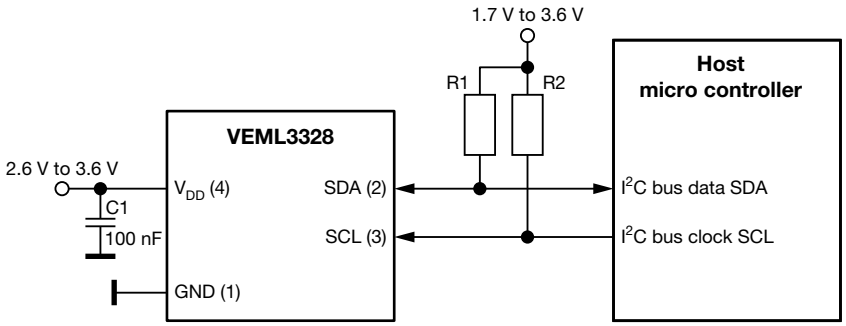


Fig. 6 - Hardware Pin Connection Diagram (Slave Address 0x10)

Digital Interface

The VEML3328 contains a command register accessible via the I²C bus. All settings can be controlled via this register. The 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. 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.

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	BIT	FUNCTION DESCRIPTION	R / W
0x00	SD1	15	Shutdown setting (1) 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 (1) SD0 = 0 power on; SD0 = 1 shutdown (default)	

Note

(1) 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 3 - 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

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

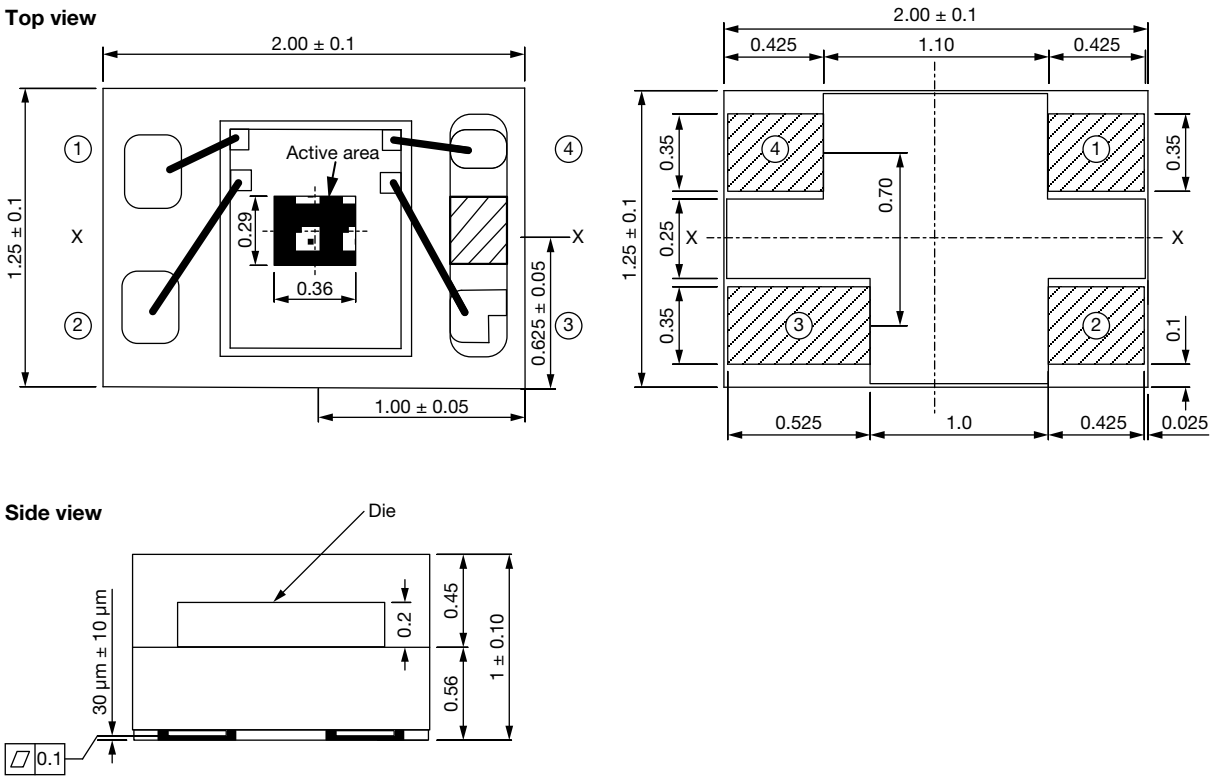


Fig. 8 - VEML3328A3OG Package Dimensions

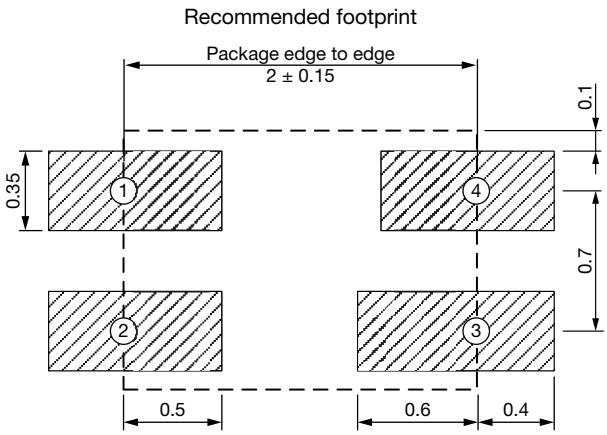


Fig. 9 - VEML3328A3OG PCB Layout Footprint

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

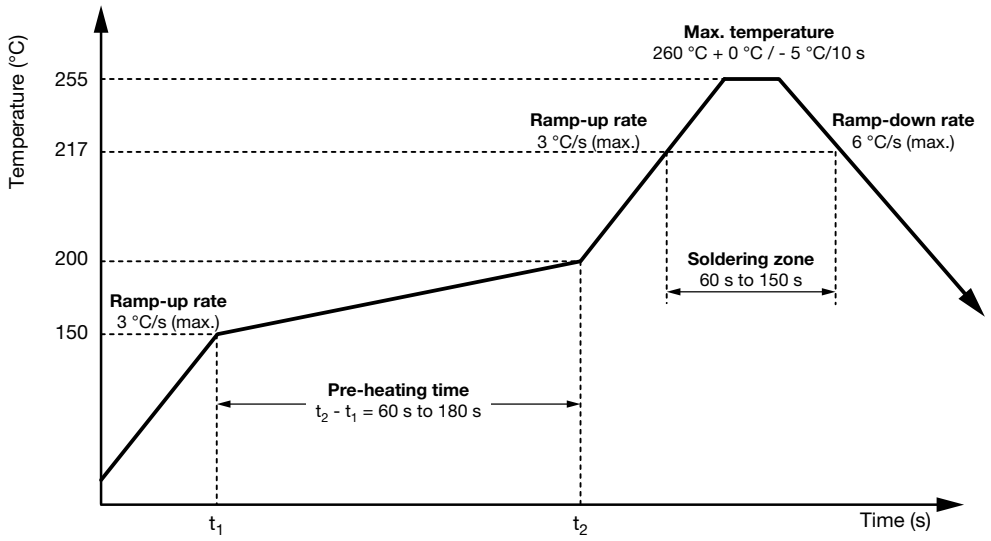


Fig. 10 - VEML3328 OPLGA Solder Reflow Profile Chart

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

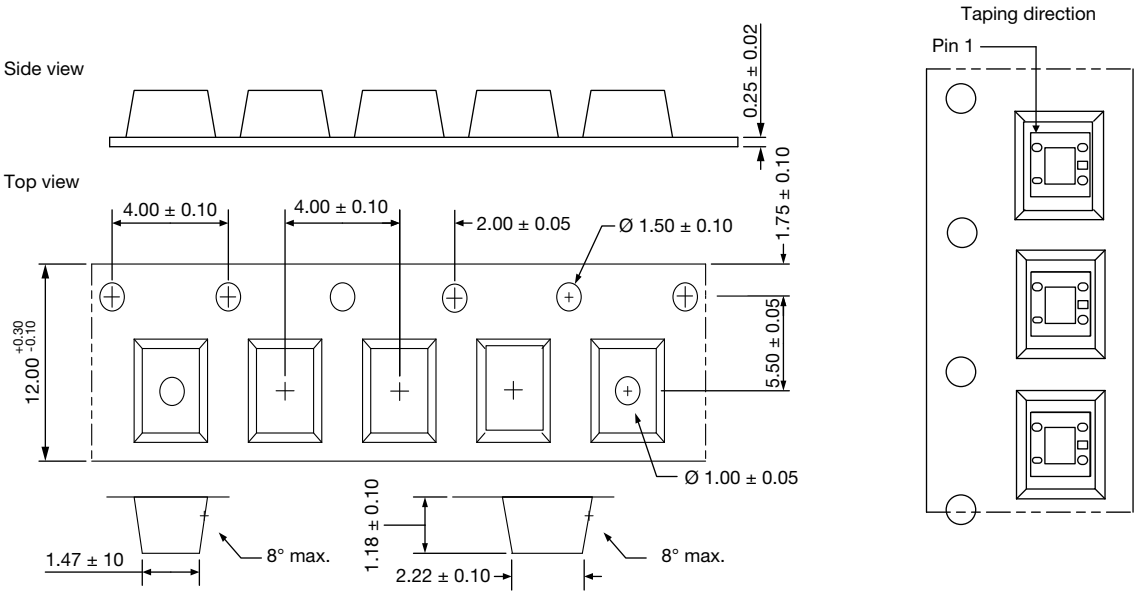


Fig. 11 - VEML3328 A3OG Package Carrier Tape

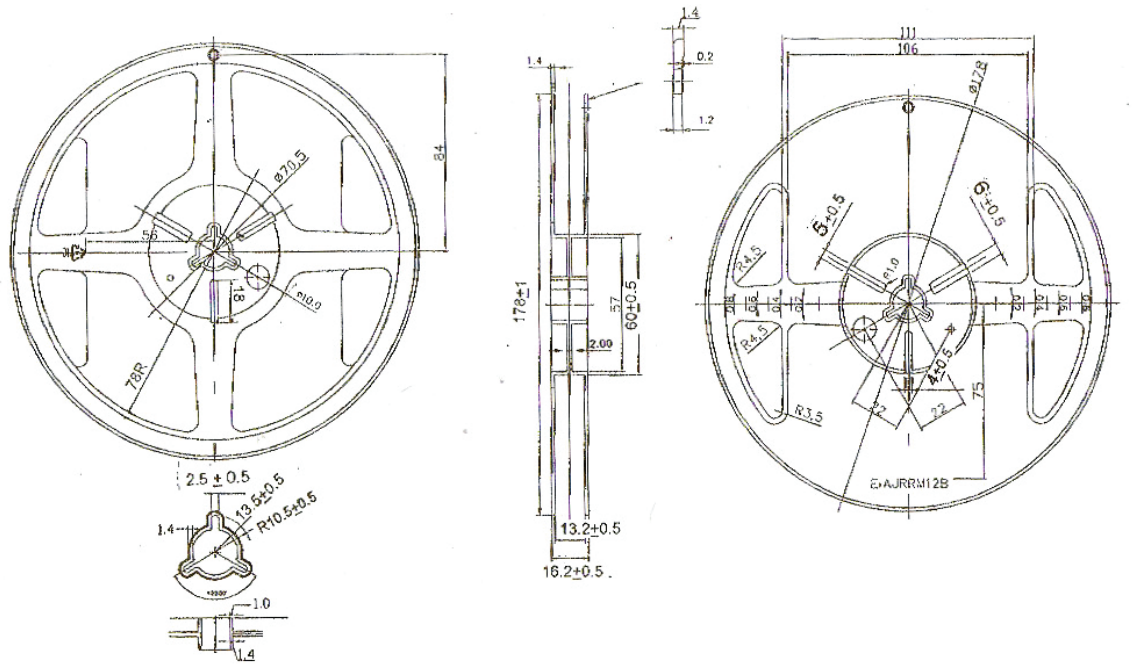


Fig. 12 - Reel Dimensions

RGBCIR Color Sensor With I²C Interface

LINKS TO ADDITIONAL RESOURCES

Design Tools | Related Documents | 3D Models | Application Notes

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 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

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HALOGEN FREE
GREEN (5-2008)

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)	I²C 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, I²C

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

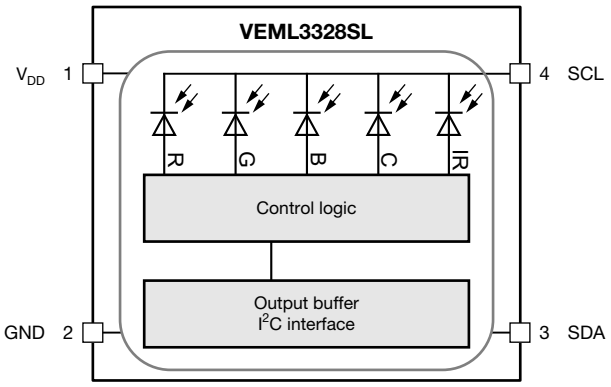
Note
(1) MOQ: minimum order quantity

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 °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	°C
I^2C 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^2C digital bus data input / output
	SCL	I	I^2C digital bus clock input

BLOCK DIAGRAM



BASIC CHARACTERISTICS (T_{amb} = 25 °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^2C signal input (1) Logic high		V_{IH}	1.2	-	-	V
I^2C signal input (1) Logic low		V_{IL}	-	-	0.4	V
Peak sensitivity wavelength		λ_{PC}	-	590	-	nm
		λ_{PR}	-	610	-	nm
		λ_{PG}	-	560	-	nm
		λ_{PB}	-	470	-	nm
		λ_{PIR}	-	825	-	nm
Irradiance responsivity	520 nm LED (1)(2)	C	-	57	-	counts/(µW/cm²)
	850 nm LED (1)(2)	IR	-	25	-	counts/(µW/cm²)
	643 nm LED (1)(2)	R	-	41	-	counts/(µW/cm²)
	520 nm LED (1)(2)	G	-	39	-	counts/(µW/cm²)
	460 nm LED (1)(2)	B	-	34	-	counts/(µW/cm²)
Sensitivity	5000 K WLED (1)(3)	G	-	0.003	-	lx/count
Dark offset (1)(3)		R, G, B, C, IR	0	-	3	counts
Operating temperature range		T_{amb}	-40	-	+85	°C
Shutdown current (1)	Light condition = dark	I_{DD}	0	800	1000	nA

Notes

(2) Test condition: V_{DD} = 3 V, temperature: 25 °C

(3) IT: 100 ms, SENS = (0) = x 1, DG = (0 : 0) = x 1, GAIN = (0 : 0) = x 1

(4) IT: 400 ms, SENS = (0) = x 1, DG = (1 : 0) = x 4, GAIN = (1 : 0) = x 4

I²C BUS TIMING CHARACTERISTICS (T_{amb} = 25 °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
I²C clock (SCK) low period	$t_{(LOW)}$	4.7	-	1.3	-	µs
I²C 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

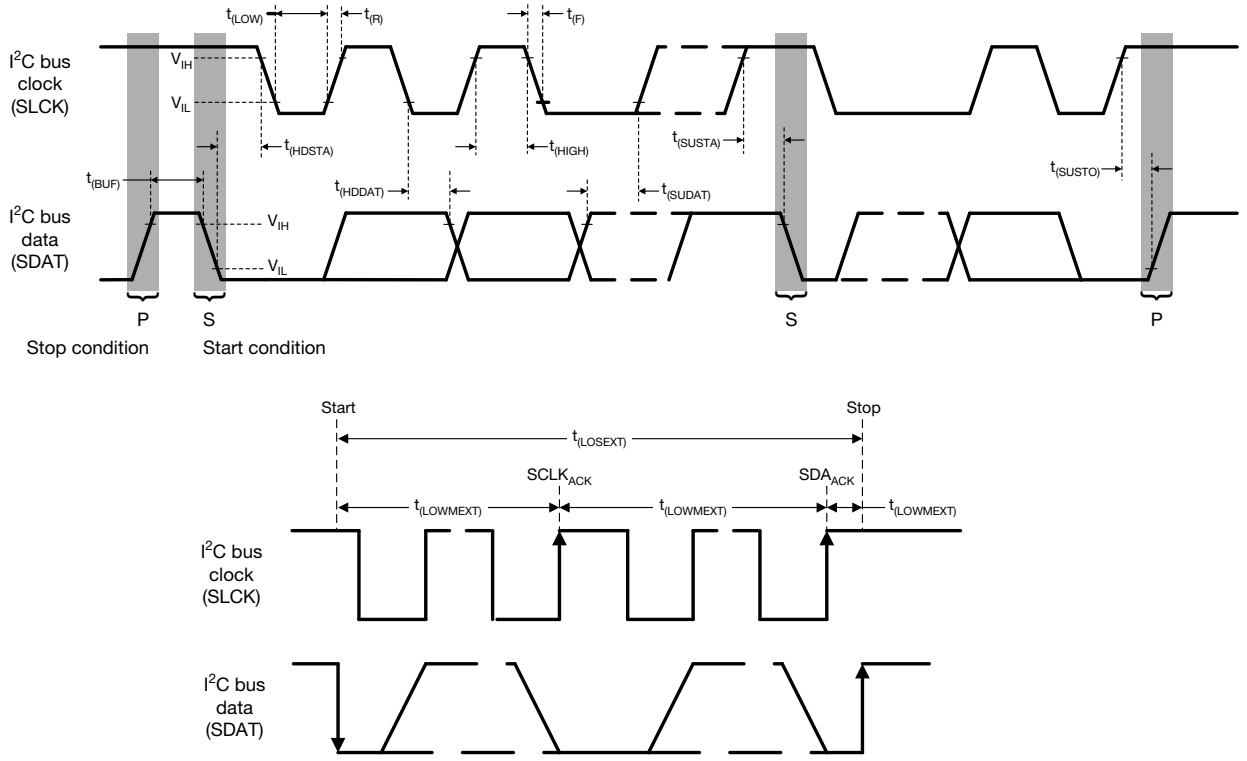


Fig. 1 - I²C Bus Timing Diagram

PARAMETER TIMING INFORMATION

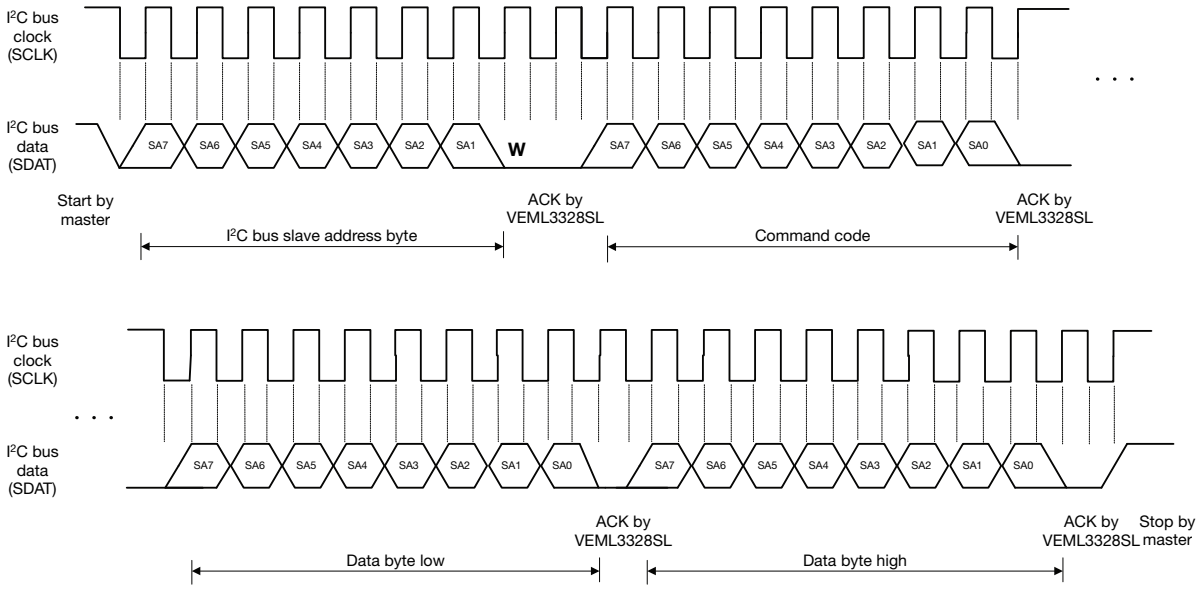


Fig. 2 - I²C Bus Timing for Sending Word Command Format

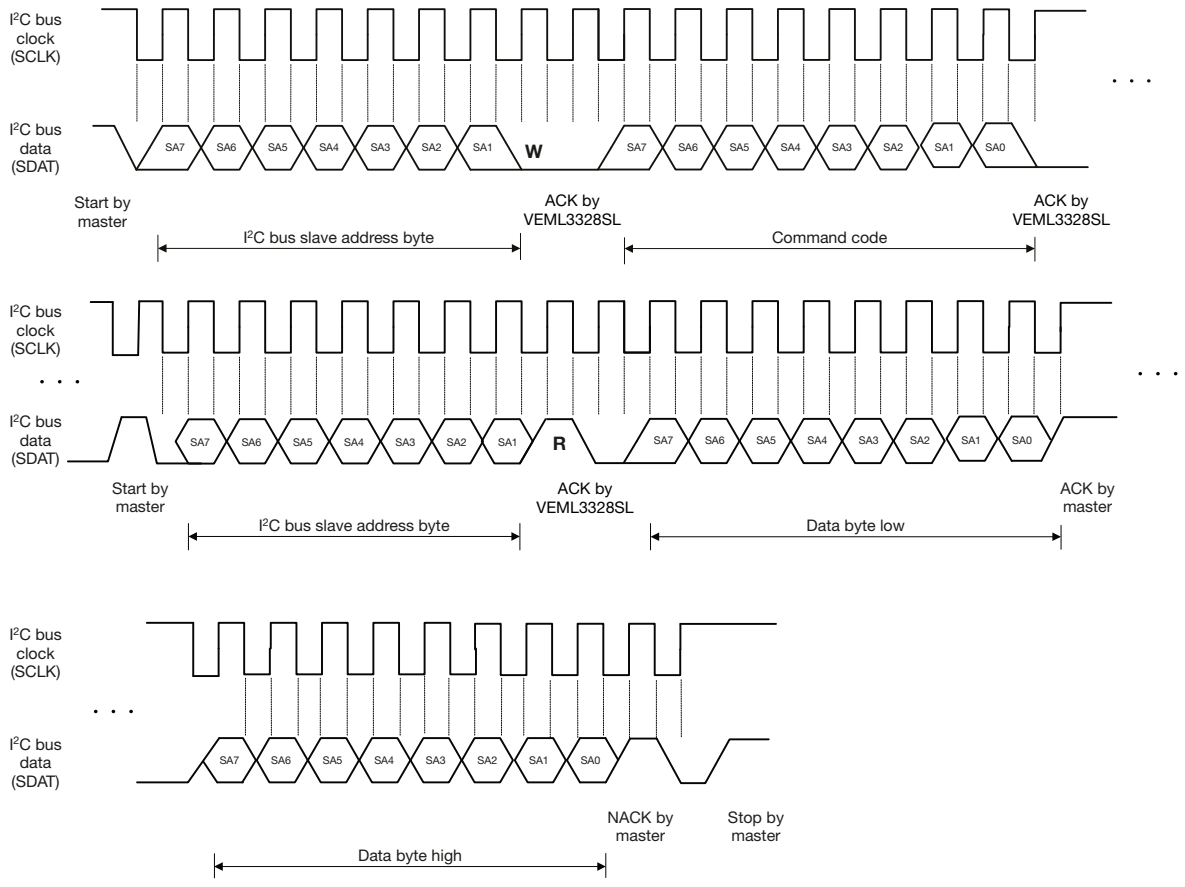


Fig. 3 - I²C Bus Timing for Receiving Word Command Format

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

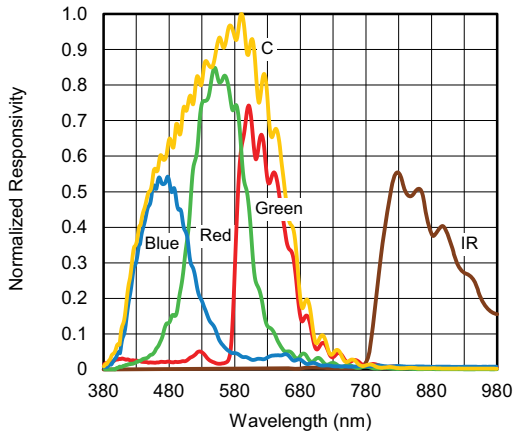


Fig. 4 - Normalized Responsivity vs. Wavelength

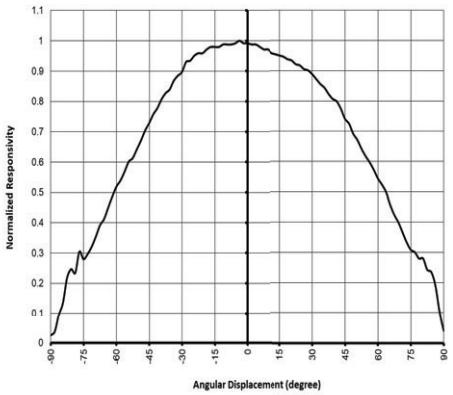


Fig. 5 - Normalized Responsivity vs. Angular Displacement

APPLICATION INFORMATION

Pin Connection With the Host

The VEML3328SL is a cost effective solution color and IR sensor with an I²C interface. All possible settings and result data can be accessed via the standard I²C interface.

A typical application circuit is shown in Fig. 6 below. The additional 0.1 µF capacitor near the V_{DD} pin in the circuit is used for power supply noise rejection. Pull-up resistors for the I²C bus design are recommended to be 2.2 kΩ.

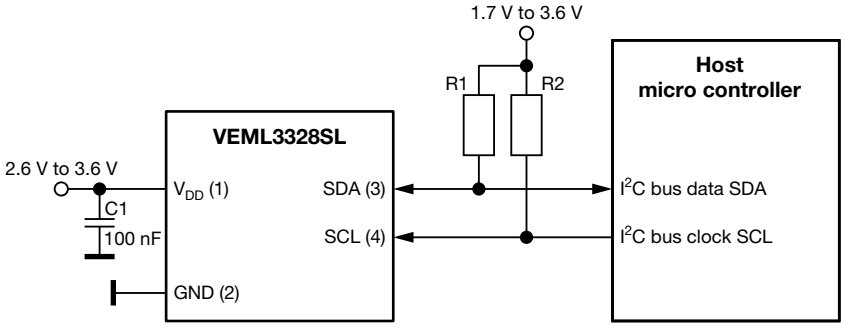


Fig. 6 - Hardware Pin Connection Diagram (Slave Address 0x10)

Digital Interface

The VEML3328SL contains a command register accessible via the I²C bus. All settings can be controlled via this register. The VEML3328SL's I²C 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.

Fig. 7 - Command Protocol Format

Command Register Format

VEML3328SL uses 0x10 slave address for 7-bit I²C 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 (1) 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 (1) SD0 = 0 power on; SD0 = 1 shutdown (default)	

Note

(1) 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

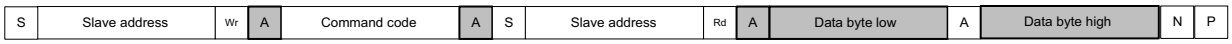
Data Access

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



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

PACKAGE INFORMATION in millimeters

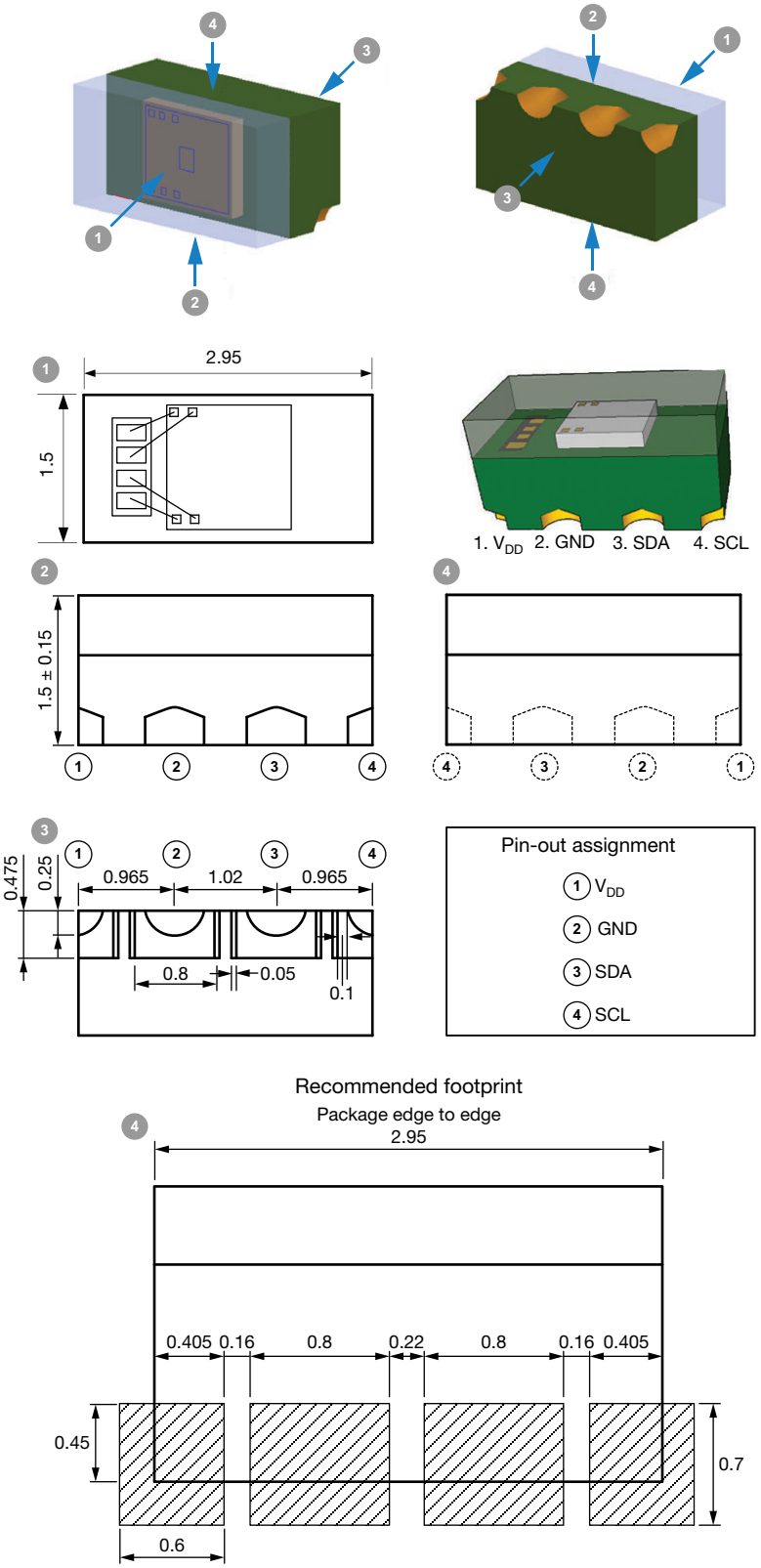


Fig. 8 - VEML3328SL Package Dimensions

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

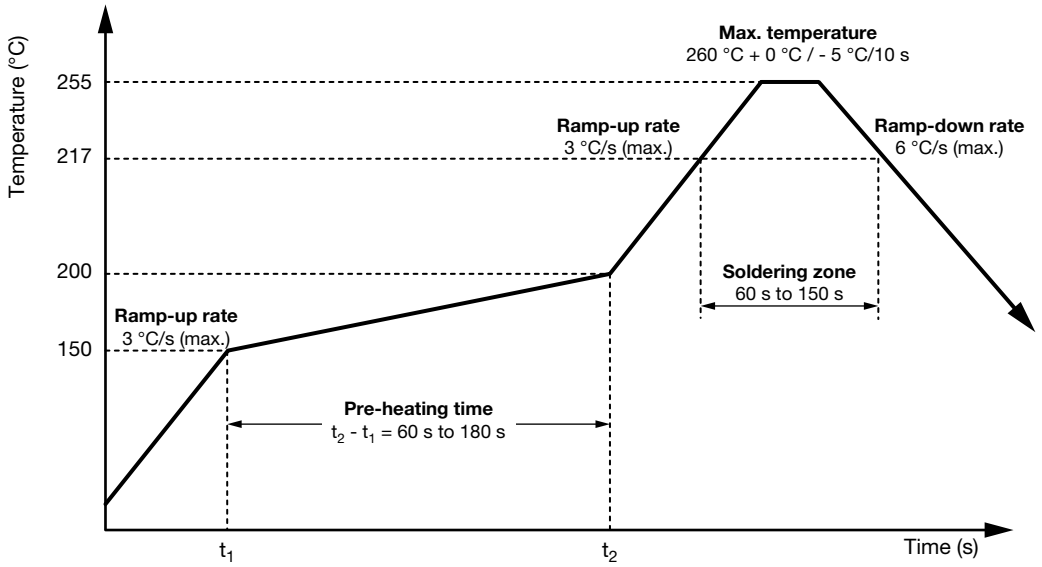


Fig. 9 - VEML3328SL OPLGA Solder Reflow Profile Chart

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

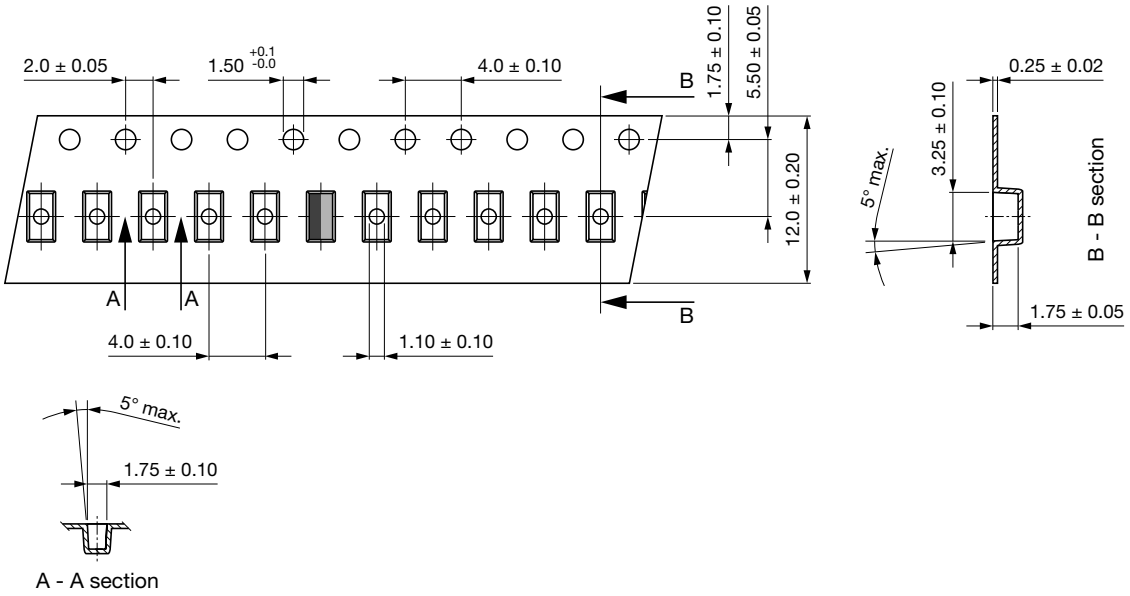


Fig. 10 - VEML3328SL Package Carrier Tape

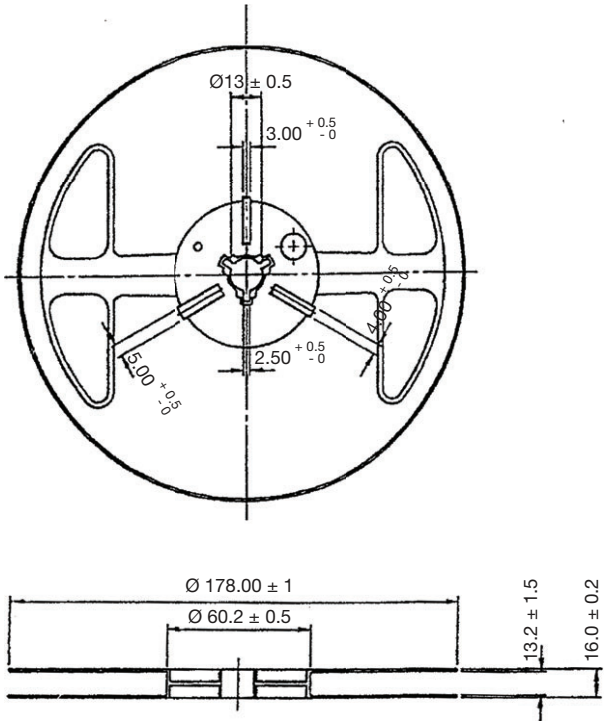
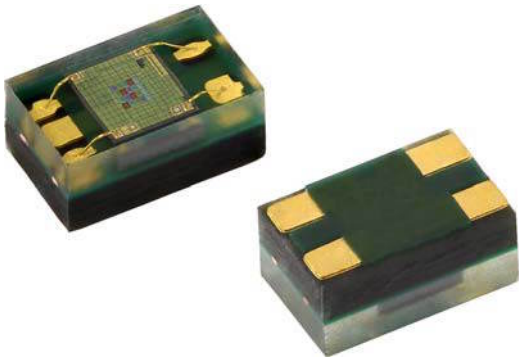


Fig. 11 - Reel Dimensions

RGBW Color Sensor with I²C Interface



DESCRIPTION

VEML6040 color sensor senses red, green, blue, and white light and incorporates photodiodes, amplifiers, and analog / digital circuits into a single chip using CMOS process. With the color sensor applied, the brightness, and color temperature of backlight can be adjusted base on ambient light source that makes panel looks more comfortable for end user's eyes. VEML6040's adoption of Filtron™ technology achieves the closest ambient light spectral sensitivity to real human eye responses.

VEML6040 provides excellent temperature compensation capability for keeping the output stable under changing temperature. VEML6040's function are easily operated via the simple command format of I²C (SMBus compatible) interface protocol. VEML6040's operating voltage ranges from 2.5 V to 3.6 V. VEML6040 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: color sensor (RGBW) and signal conditioning IC
- Filtron™ technology provides a spectrum matching real human eye responses
- Supports low transmittance (dark) lens design
- Fluorescent light flicker immunity
- Provides 16-bit resolution for each channel (R, G, B, W)
- Selectable maximum detection range (515.4, 1031, 2062, 4124, 8248, or 16 496) lux with highest sensitivity 0.007865 lux/step
- Package: OPLGA
- 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: 2.5 V to 3.6 V

Pb-free

e4

RoHS COMPLIANT

HALOGEN FREE

GREEN (5-2008)

APPLICATIONS

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

PRODUCT SUMMARY

PART NUMBER	OPERATING VOLTAGE RANGE (V)	I²C BUS VOLTAGE RANGE (V)	PEAK SENSITIVITY (nm)	RANGE OF SPECTRAL BANDWIDTH $\lambda_{0.5}$ (nm)	OUTPUT CODE
VEML6040	2.5 to 3.6	1.7 to 3.6	650, 550, 450 (R, G, B)	± 35, ± 35, ± 40 (R, G, B)	16 bit, I²C

Note

(1) Adjustable through I²C interface

ORDERING INFORMATION

ORDERING CODE	PACKAGING	VOLUME (1)	REMARKS
VEML6040A3OG	Tape and reel	MOQ: 2500 pcs	2.0 mm x 1.25 mm x 1.0 mm

Note

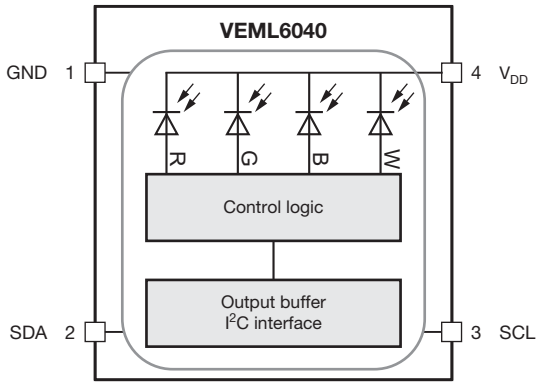
(1) MOQ: minimum order quantity

ABSOLUTE MAXIMUM RATINGS (T_{amb} = 25 °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	°C
Storage temperature range		T_{stg}	-40	+85	°C

RECOMMENDED OPERATING CONDITIONS (T_{amb} = 25 °C, unless otherwise specified)					
PARAMETER	**TEST CONDITION**	**SYMBOL**	**MIN.**	**MAX.**	**UNIT**
Supply voltage		V_{DD}	2.5	3.6	V
Operation temperature range		T_{amb}	-40	+85	°C
I^2C 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^2C data bus data input / output
3	SCLK	I	I^2C digital bus clock input
4	V_{DD}	I	Power supply input

BLOCK DIAGRAM



BASIC CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)							
PARAMETER		**TEST CONDITION**	**SYMBOL**	**MIN.**	**TYP.**	**MAX.**	**UNIT**
Supply voltage			V_{DD}	2.5	-	3.6	V
Supply current			I_{DD}	-	200	-	µA
I^2C signal input	Logic high	V_{DD} = 3.3 V	V_{IH}	1.5	-	-	V
	Logic low		V_{IL}	-	-	0.8	
	Logic high	V_{DD} = 2.6 V	V_{IH}	1.4	-	-	V
	Logic low		V_{IL}	-	-	0.6	
Peak sensitivity wavelength			λ_{PR}	-	650	-	nm
			λ_{PG}	-	550	-	nm
			λ_{PB}	-	450	-	nm
Irradiance responsivity		λ_{PR} = 619 nm (3)		-	96	-	counts/(µW/cm²)
		λ_{PG} = 518 nm (3)		-	74	-	
		λ_{PB} = 467 nm (3)		-	56	-	
Detectable intensity	Minimum	G channel, I_T = 1280 ms (1)(2)		-	0.007865	-	lx
	Maximum	G channel, I_T = 40 ms (1)(2)		-	16 496	-	
Dark offset		G channel, I_T = 80 ms (1)		0	-	3	
Operating temperature range			T_{amb}	-40	-	+85	°C
Shutdown current		Light condition = dark, V_{DD} = 3.6 V	I_{DD}	-	800	-	nA

Notes

(1) Test condition: V_{DD} = 3.3 V, temperature: 25 °C

(2) Light source: white LED

(3) LED spectrum given in fig. 1; IT = 160 ms

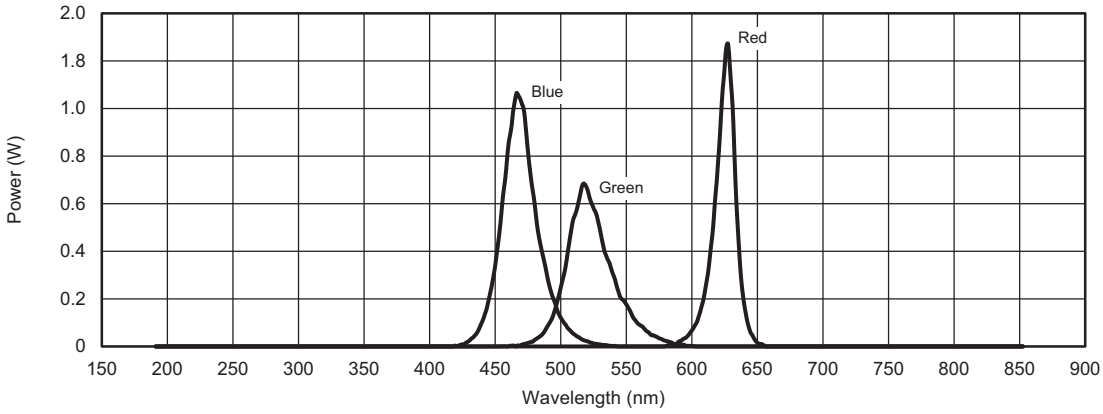


Fig. 1 - Normalized Spectral Response of Used LEDs for Measuring the Irradiance Responsivity

I²C BUS TIMING CHARACTERISTICS (T_{amb} = 25 °C, unless otherwise specified)						
PARAMETER	**SYMBOL**	**STANDARD MODE**		**FAST MODE**		**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	$t_{(HDDAT)}$	300	-	90	-	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

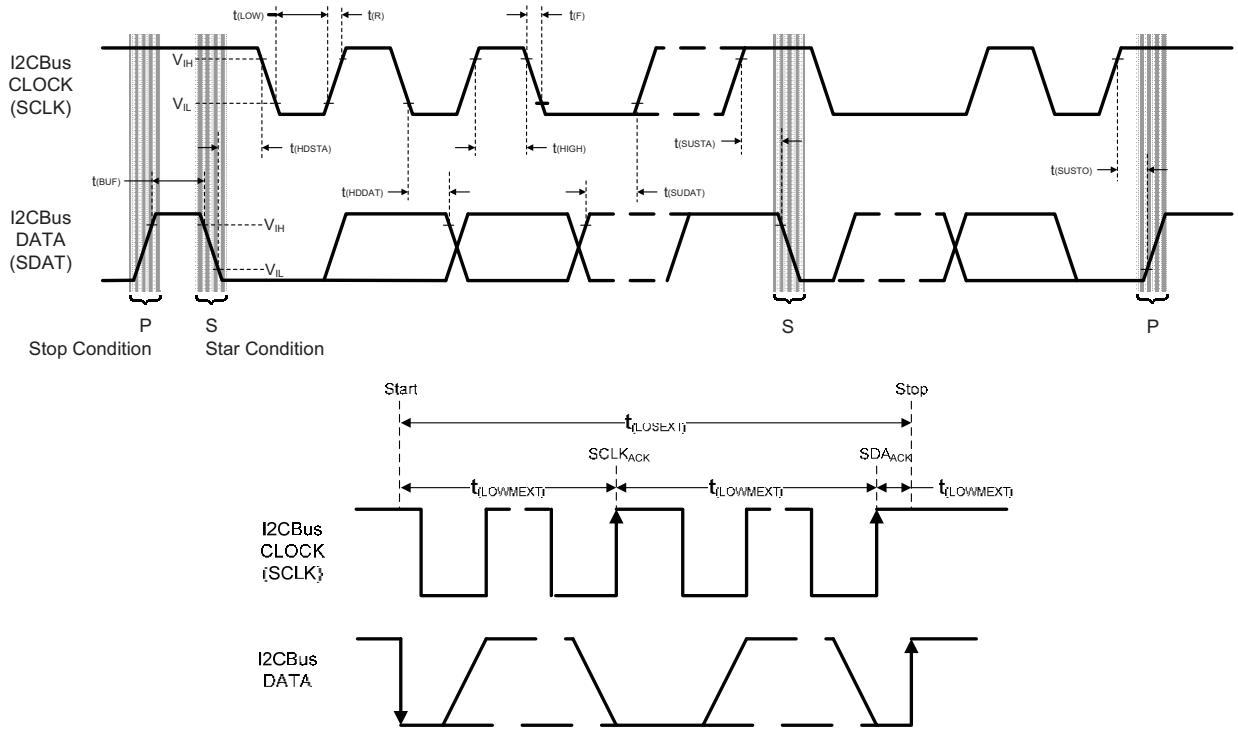


Fig. 2 - I²C Bus Timing Diagram

PARAMETER TIMING INFORMATION

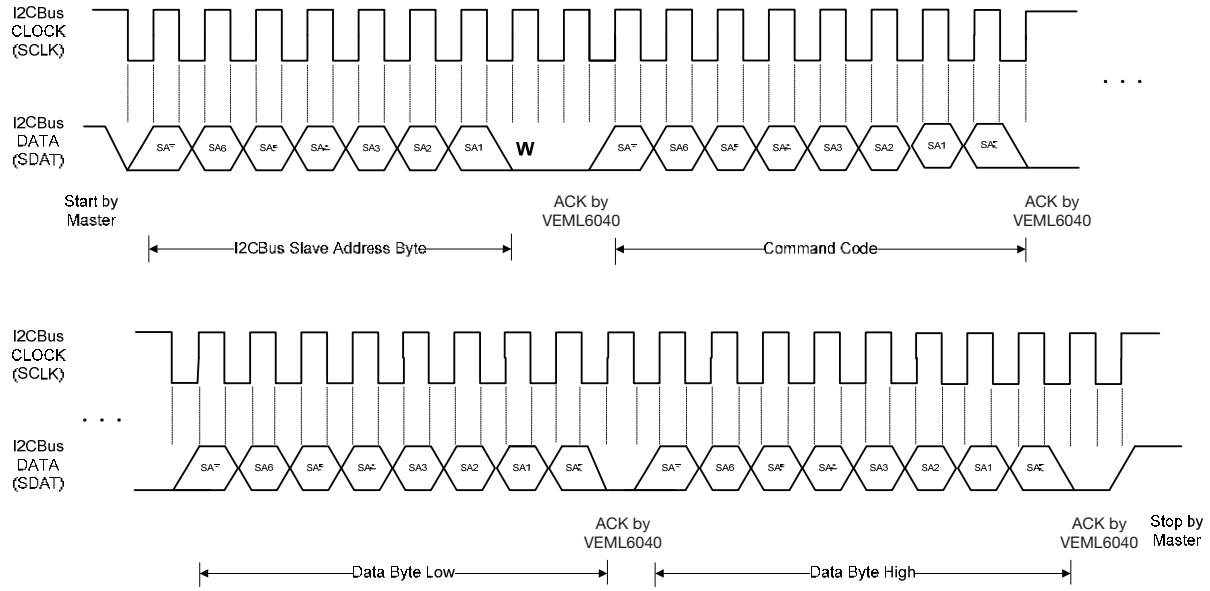


Fig. 3 - I²C Bus Timing for Sending Word Command Format

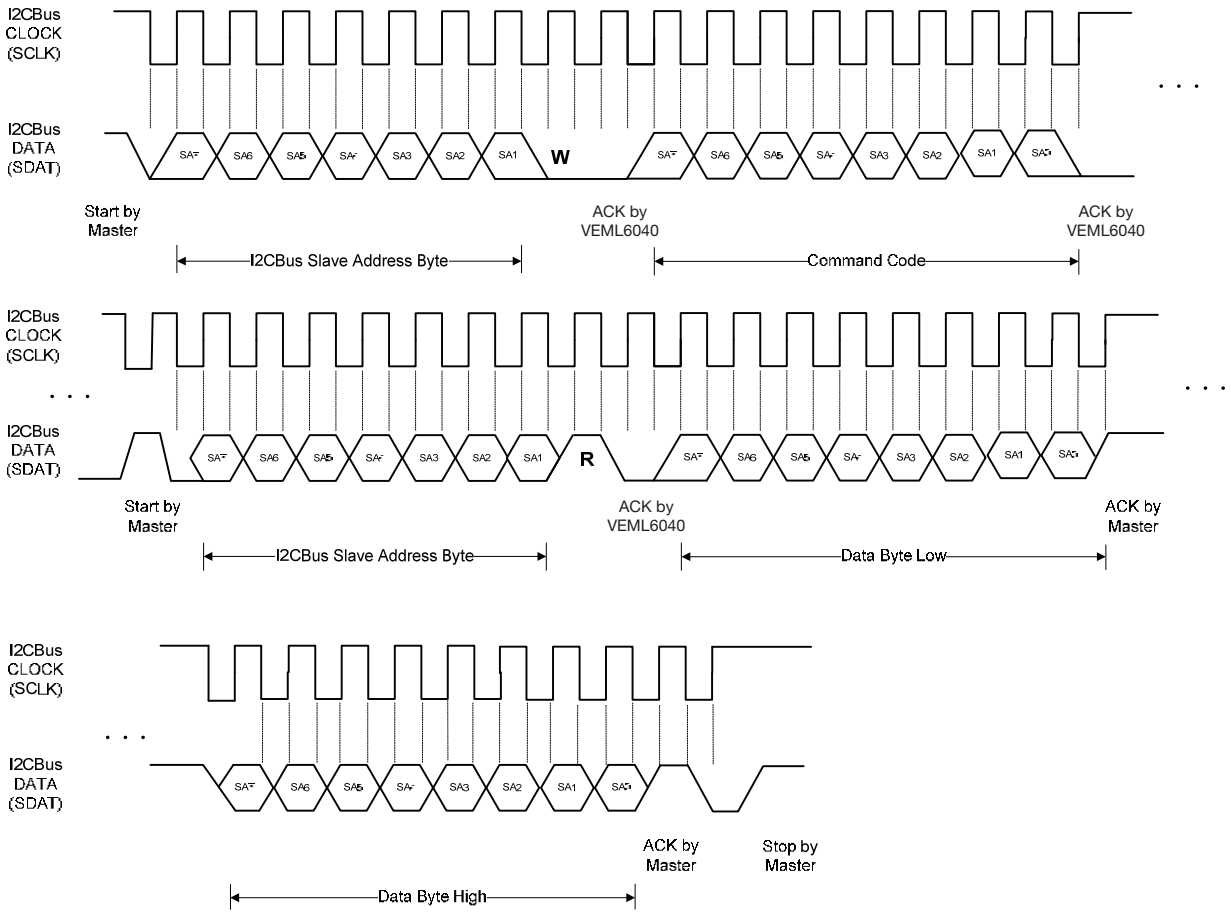


Fig. 4 - I²C Bus Timing for Receiving Word Command Format

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

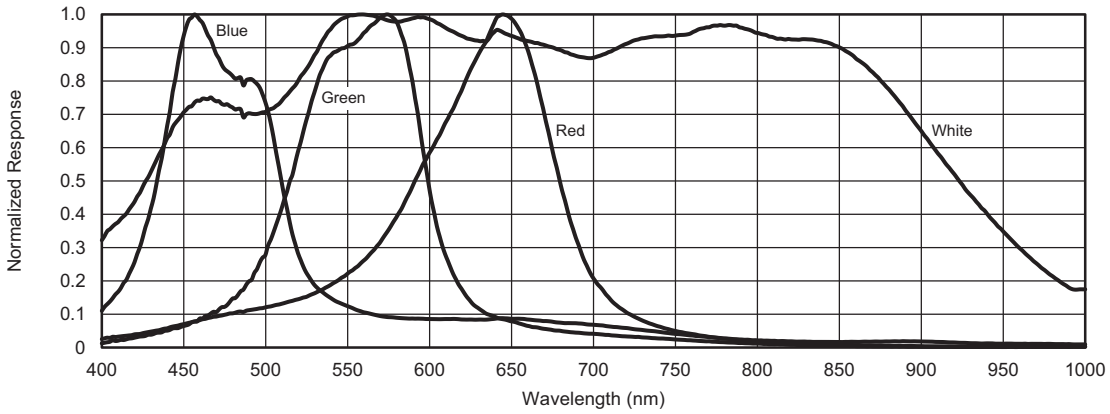


Fig. 5 - Normalized Spectral Response

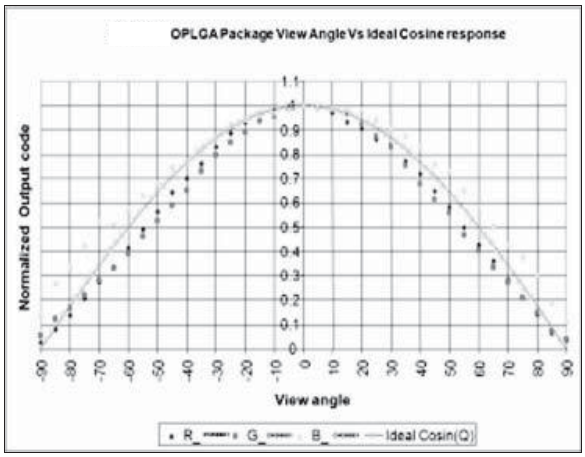


Fig. 6 - Normalized Output vs. View Angle

APPLICATION INFORMATION

Pin Connection with the Host

VEML6040 integrates R, G, B, and W sensor together with I²C interface. It is very easy for the baseband (CPU) to access VEML6040 output data via I²C interface without extra software algorithms. The hardware schematic is shown in the following diagram.

The 0.1 µF capacitor near the V_{DD} pin is used for power supply noise rejection. The 2.2 kΩs are suitable for the pull-up resistors of I²C.

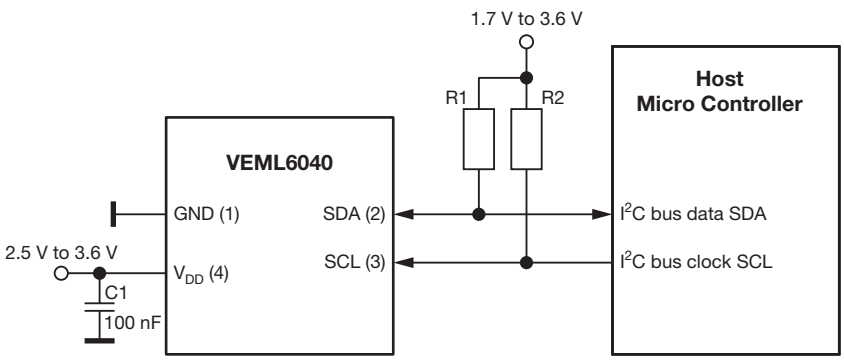


Fig. 7 - Hardware Pin Connection Diagram

Digital Interface

The VEML6040 contains a CONF register (00h) used for operation control and parameter setup. Measurement results are stored in four separate registers, one each for red, green, blue, and white respectively (08h to 0Bh). All registers are accessible via I²C communication. Figure 8 shows the basic I²C communication with the VEML6040. Each of the registers in the VEML6040 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 I²C interface is compatible with I²C modes “standard” and “fast”: 100 kHz to 400 kHz

S = start condition
P = stop condition
A = acknowledge
Shaded area = VEML6040 acknowledge

Fig. 8 - 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

VEML6040 uses 10h slave address for 7-bit I²C addressing protocol. VEML6040 has 16-bit resolution for each channel (R, G, B, and W) that provides sensitivity up to 0.0056 lux/step for G, which is advantageous under a low transmittance lens design (dark lens).

TABLE 1 - SLAVE ADDRESS AND COMMAND CODE DESCRIPTION

SLAVE ADDRESS 0x10											
COMMAND CODE	DATE BYTE LOW / HIGH	REGISTER NAME	R / W	BIT							
				7	6	5	4	3	2	1	0
00h	L	CONF	R / W	0	IT (2 : 0)			0	TRIG	AF	SD
	H	Reserved	R / W	Reserved							
01h to 07h	L	Reserved	R / W	Reserved							
	H	Reserved	R / W	Reserved							
08h	L	R_DATA	R	R_Data (7 : 0)							
	H	R_DATA	R	R_Data (15 : 8)							
09h	L	G_DATA	R	G_Data (7 : 0)							
	H	G_DATA	R	G_Data (15 : 8)							
0Ah	L	B_DATA	R	B_Data (7 : 0)							
	H	B_DATA	R	B_Data (15 : 8)							
0Bh	L	W_DATA	R	W_Data (7 : 0)							
	H	W_DATA	R	W_Data (15 : 8)							

Note

- Slave address is 7-bit addressing protocol

Configuration Register Format

VEML6040 has a 16-bit configuration register for controlling. The description of each command format is shown in the following tables.

TABLE 2-1 - COMMAND CODE 00H BITS DESCRIPTION

SLAVE ADDRESS: 0x10; REGISTER NAME: CONF; COMMAND CODE: 00H / DATA BYTE LOW							
X	IT			X	TRIG	AF	SD
BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
0	IT2	IT1	IT0	0	TRIG	AF	SD

DESCRIPTION	
IT	Integration time setting
TRIG	Proceed one detecting cycle at manual force mode
AF	Auto / manual force mode
SD	Chip shutdown setting

TABLE 2-2 - COMMAND CODE 00H REGISTER SETTING

BITS SETTING	DESCRIPTION		BITS SETTING	DESCRIPTION
BIT 7	Default = 0		BIT 3	Default = 0
BIT 6, 5, 4 IT (2 : 0)	(0 : 0 : 0) = 40 ms		BIT 2 TRIG	0 = no trigger
	(0 : 0 : 1) = 80 ms			1 = trigger one time detect cycle
	(0 : 1 : 0) = 160 ms		BIT 1 AF	0 = auto mode
	(0 : 1 : 1) = 320 ms			1 = force mode
	(1 : 0 : 0) = 640 ms		BIT 0 SD	0 = enable color sensor
	(1 : 0 : 1) = 1280 ms			1 = disable color sensor

TABLE 3-1 - RESERVE COMMAND CODE DESCRIPTION

RESERVED		COMMAND CODE: 00H / DATA BYTE HIGH
Command	Bit	Description
Reserved	7 : 0	Default = 0x00

TABLE 3-2 - RESERVE COMMAND CODE DESCRIPTION

RESERVED		COMMAND CODE: 01H TO 07H
Command	Bit	Description
Reserved	7 : 0	Default = 0x00

TABLE 4 - READ OUT COMMAND CODE DESCRIPTION

REGISTER	COMMAND CODE	BIT	DESCRIPTION
R_DATA	0x08_L (08H data byte low)	7 : 0	0x00 to 0xFF, R channel LSB output data
	0x08_H (08H data byte high)	7 : 0	0x00 to 0xFF, R channel MSB output data
G_DATA	0x09_L (09H data byte low)	7 : 0	0x00 to 0xFF, G channel LSB output data
	0x09_H (09H data byte high)	7 : 0	0x00 to 0xFF, G channel MSB output data
B_DATA	0x0A_L (0AH data byte low)	7 : 0	0x00 to 0xFF, B channel LSB output data
	0x0A_H (0AH data byte high)	7 : 0	0x00 to 0xFF, B channel MSB output data
W_DATA	0x0B_L (0BH data byte low)	7 : 0	0x00 to 0xFF, W channel LSB output data
	0x0B_H (0BH data byte high)	7 : 0	0x00 to 0xFF, W channel MSB output data

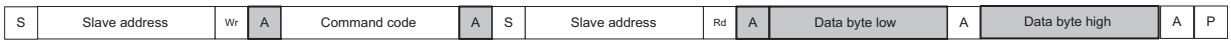
Data Access

Each of the R, G, B, and W 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 figure 7. The data format shows as below.

TABLE 5 - 16-BIT DATA FORMAT

	VEML6040 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.

The integration time settings result in the corresponding resolutions that are shown in table 6.

TABLE 6 - G CHANNEL RESOLUTION AND MAXIMUM DETECTION RANGE

IT SETTINGS		G SENSITIVITY	MAX. DETECTABLE LUX
IT (2 : 0)	INTEGRATION TIME		
(0 : 0 : 0)	40 ms	0.25168	16 496
(0 : 0 : 1)	80 ms	0.12584	8248
(0 : 1 : 0)	160 ms	0.06292	4124
(0 : 1 : 1)	320 ms	0.03146	2062
(1 : 0 : 0)	640 ms	0.01573	1031
(1 : 0 : 1)	1280 ms	0.007865	515.4

Data Auto-Memorization

VEML6040 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.

PACKAGE INFORMATION in millimeters

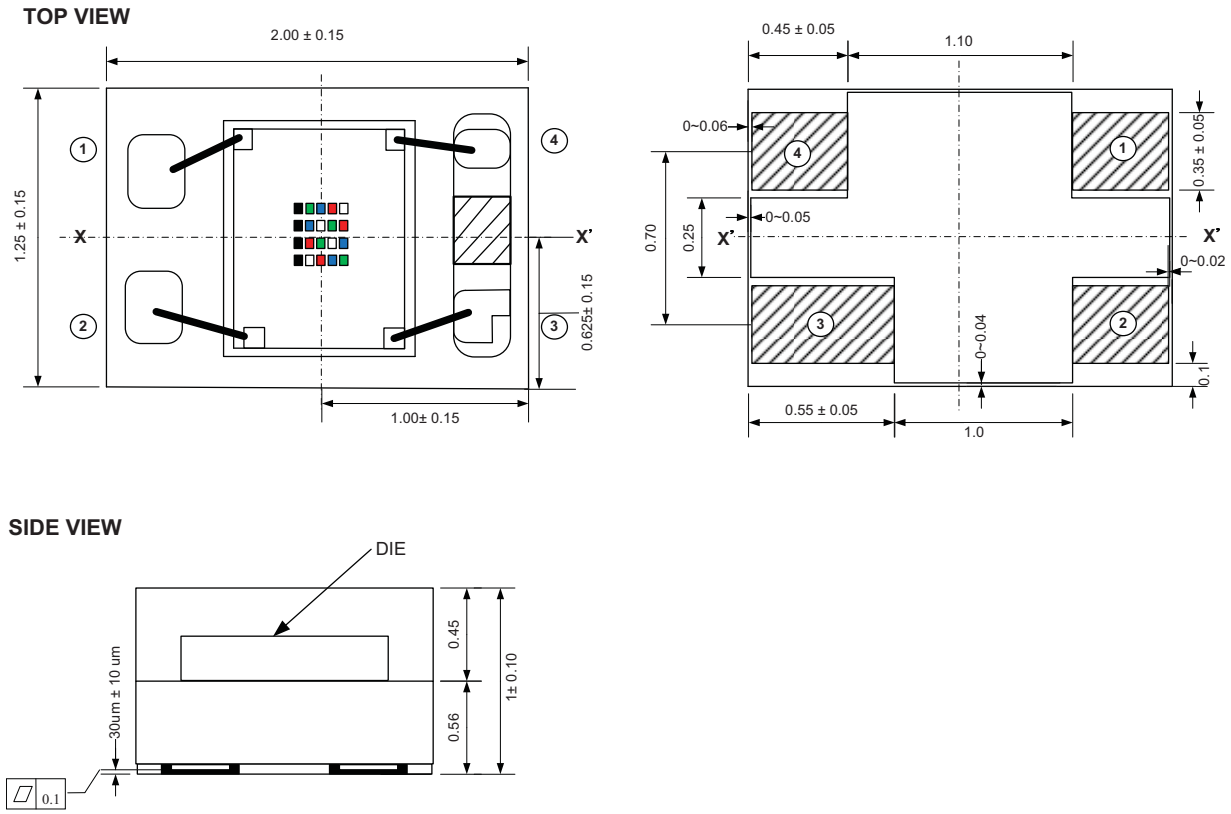


Fig. 9 - VEML6040 A3OG Package Dimensions

LAYOUT NOTICE AND REFERENCE CIRCUIT in millimeters

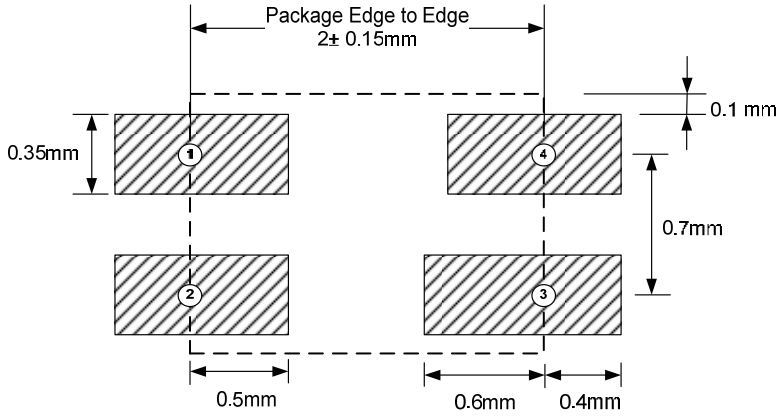


Fig. 10 - VEML6040 PCB Layout Footprint

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 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

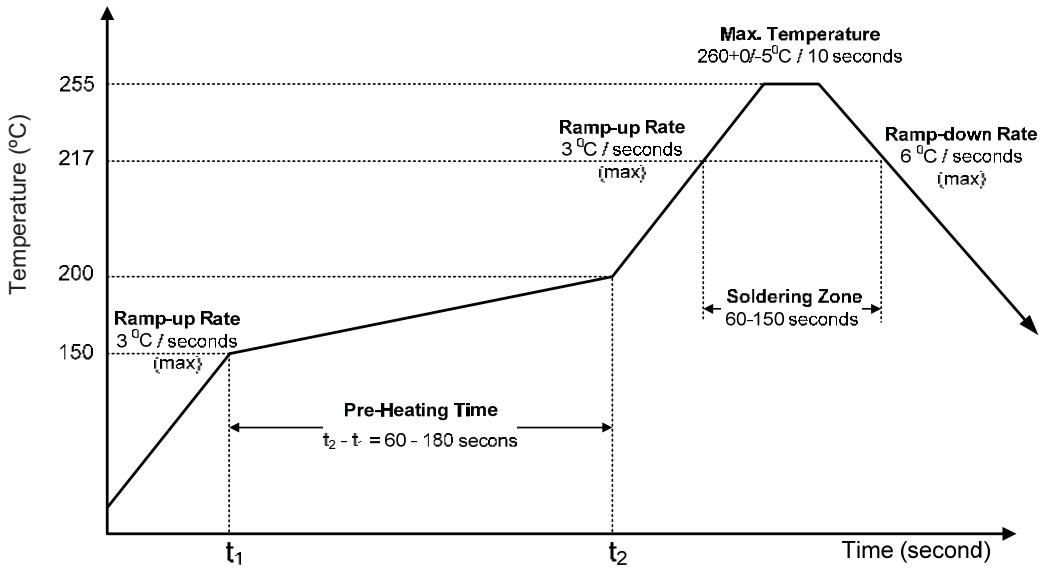


Fig. 11 - VEML6040 OPLGA Solder Reflow Profile Chart

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

DIMENSION OF CARRIER TAPE

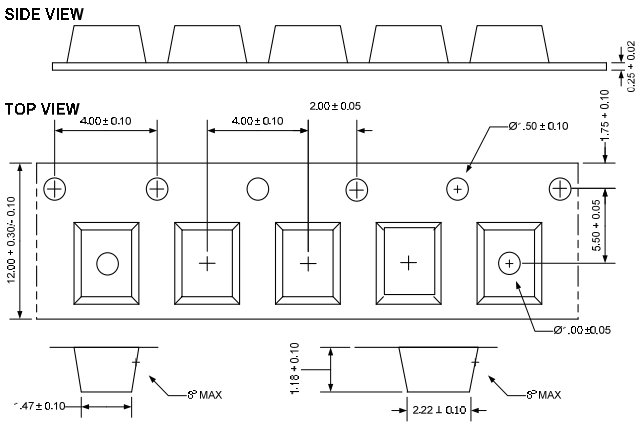


Fig. 12 - VEML6040 A3OG Package Carrier Tape

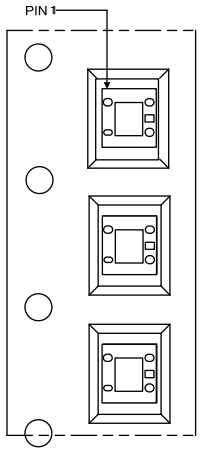


Fig. 13 - Taping Direction

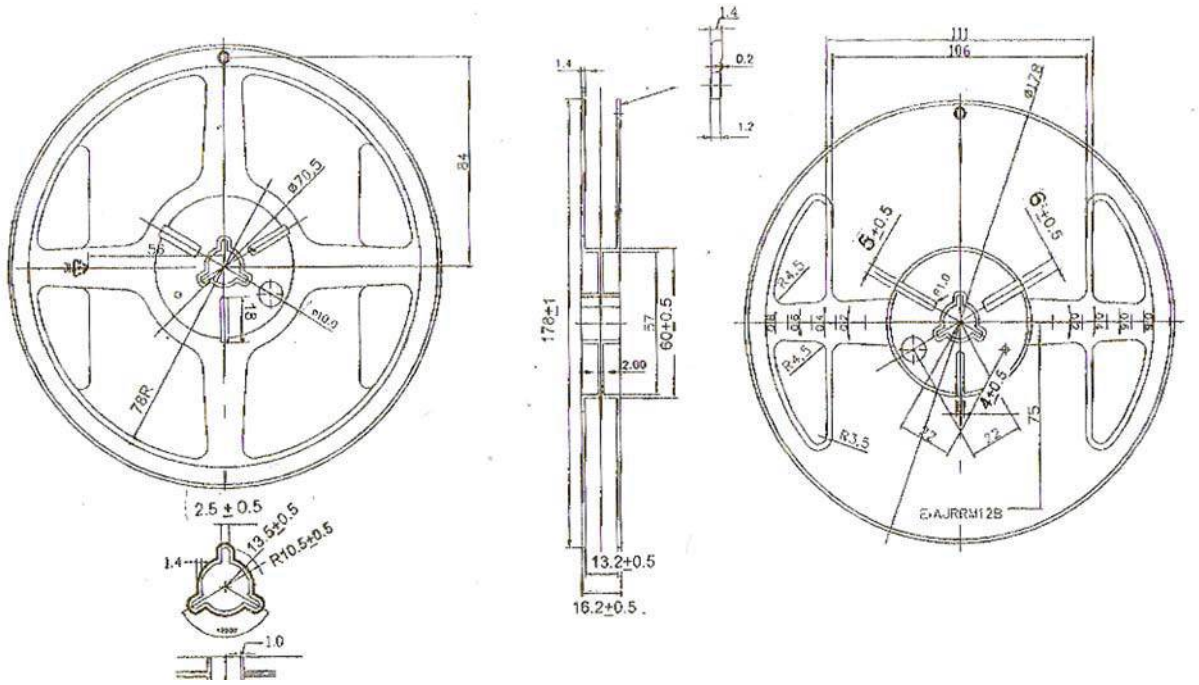


Fig. 14 - Reel Dimensions

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Барнаул (3852)73-04-60
Белгород (4722)40-23-64
Брянск (4832)59-03-52
Владивосток (423)249-28-31
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Смоленск (4812)29-41-54
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Сургут (3462)77-98-35
Тверь (4822)63-31-35
Томск (3822)98-41-53
Тула (4872)74-02-29
Тюмень (3452)66-21-18
Ульяновск (8422)24-23-59
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