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Change of the datasheet and application note for the VEML6031 family

For further information, please contact your regional Vishay office.

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Description of Change: Detailed description of the change can be found in Datasheet__VEML6031xx - Change log from Rev. 1.3 26-May-2023 to Rev. 1.4 18-Dec-2025_Final.pdf and VEML6031X00 -AppNote _ Change from Revision 14-Jun-2021 to Revision 08-Dec-2025.pdf in the document attached to the PIN

Reason for Change: All changes are based on latest measurements from our characterization team and will ONLY correct the data from the previous version

Expected Influence on Quality/Reliability/Performance: • No influence on quality, reliability and performance expected, nevertheless we request the customer to verify the resolution in the application.

- In case the resolution was taken from the datasheet or Application Note, the customer must verify the resolution on a system level.
- As there is no change in the performance of the component, no recalibration is necessary on a component level.
- Depending on the required accuracy of the application, the customer is advised to verify and test if an adjustment in the system resolution is necessary.

Part Numbers/Series/Families Affected: Please see materials list on the succeeding page.

Vishay Brand(S): Vishay General Semiconductor

Time Schedule:

Start Shipment Date: Monday February 23, 2026

Sample Availability: available

Product Identification: label

Qualification Data: NO CHANGES ON THE PRODUCT; no new qualification is required

Issued By: Elena Foddi, elena.foddi@vishay.com



Product Information Notification



Product Group: OPT/Monday February 23, 2026/PIN-OPT-10696-2026-REV-2

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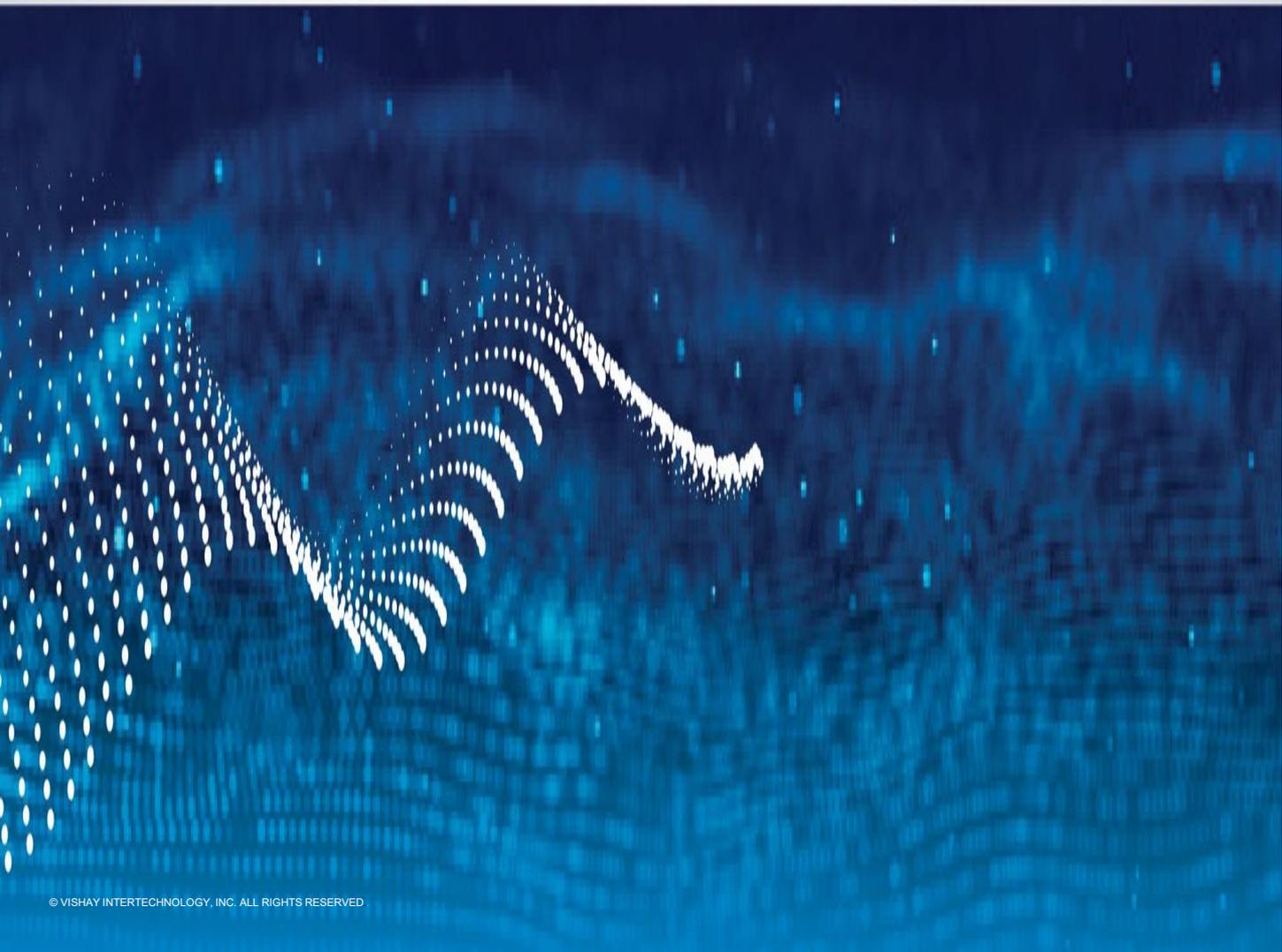
VEML60311HX00	VEML60311HX00-GS15	VEML60311X00	VEML60311X00-GS15	VEML60311X01
VEML6031HX00	VEML6031HX00-GS15	VEML6031LT	VEML6031X00	VEML6031X00-GS15
VEML6031X01				



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VEML6031xx - DCN

Change from Rev. 1.3, 26-May-2023 to Rev. 1.4, 18-Dec-2025



DCN - Summary

- No performance change of the part. All changes are based on latest measurements from our characterization team and will only correct the data from the previous version
 - 1) Corrected resolution to match the actual component resolution. No change in the component performance.
 - 2) Removed figure 9 due to duplicated information, Fig 8 covers all necessary information
 - 3) Renamed bit naming for readability purpose
 - 4) Revised block diagram for readability purpose
 - 5) Rearranged part handling information in separate chapter for readability purpose
 - 6) Added Revision History
- Affected documents
 - VEML6031X00 (Document Number: 80007)
 - VEML6031X01 (Document Number: 80008)

Expected Influence on Quality/Reliability/Performance

- No influence on quality, reliability and performance expected, nevertheless we request the customer to verify the resolution in the application.
- In case the resolution was taken from the datasheet or ApplicationNote, the customer must verify the resolution on a system level.
- As there is no change in the performance of the component, no recalibration is necessary on a component level.
- Depending on the required accuracy of the application, the customer is advised to verify and test if an adjustment in the system resolution is necessary.

Rev. 1.3, 26-May-2023

Rev. 1.4, 18-Dec-2025

AMBIENT LIGHT FUNCTION

- Filtron™ technology adaption: close to real human eye response
- Typical ALS output tolerance of $\leq 10\%$ under different light sources

16-bit dynamic range for ambient light detection from 0 lx to about 228 klx with resolution down to 0.0034 lx/ct, supports low transmittance (dark) lens design

- Excellent temperature compensation
- High dynamic detection resolution

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- Filtron™ technology adaption: close to real human eye response
- Typical ALS output tolerance of $\leq 10\%$ under different light sources

16-bit dynamic range for ambient light detection from 0 lx to about 172 klx with resolution down to 0.0026 lx/ct, supports low transmittance (dark) lens design

- Excellent temperature compensation
- High dynamic detection resolution

PRODUCT SUMMARY						
PART NUMBER	OPERATING VOLTAGE RANGE (V)	IC BUS VOLTAGE RANGE (V)	AMBIENT LIGHT RANGE (lx)	AMBIENT LIGHT RESOLUTION (lx)	OUTPUT CODE	ADC RESOLUTION PROXIMITY / AMBIENT LIGHT
VEML6031X00	2.5 to 3.6	1.7 to 3.6	0 to 228 000	0.0034	16 bit, I ² C	- / 16 bit

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VEML6031X00	2.5 to 3.6	1.7 to 3.6	0 to 172 000	0.0026	16 bit, I ² C	- / 16 bit

ORDERING INFORMATION				
ORDERING CODE	PACKAGING	VOLUME (1)	REMARKS	
VEML6031X00	Tape and reel	MOQ: 3000	2.67 mm x 2.45 mm x 0.6 mm	
VEML6031X00-GS15	Tape and reel	MOQ: 10 000	2.67 mm x 2.45 mm x 0.6 mm	
VEML60311X00	Tape and reel	MOQ: 3000	2.67 mm x 2.45 mm x 0.6 mm	
VEML60311X00-GS15	Tape and reel	MOQ: 10 000	2.67 mm x 2.45 mm x 0.6 mm	

ORDERING INFORMATION					
ORDERING CODE	SLAVE ADDRESS (7 BIT)	PACKAGING	VOLUME (1)	REMARKS	
VEML6031X00	0x29	Tape and reel	MOQ: 3000	2.67 mm x 2.45 mm x 0.6 mm	
VEML6031X00-GS15	0x29	Tape and reel	MOQ: 10 000	2.67 mm x 2.45 mm x 0.6 mm	
VEML60311X00	0x10	Tape and reel	MOQ: 3000	2.67 mm x 2.45 mm x 0.6 mm	
VEML60311X00-GS15	0x10	Tape and reel	MOQ: 10 000	2.67 mm x 2.45 mm x 0.6 mm	

Note
(1) MOQ: minimum order quantity

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Remark: See item 1 for resolution
Included information in table ORDERING INFORMATION on page 1

Rev. 1.3, 26-May-2023

Rev. 1.4, 18-Dec-2025



SLAVE ADDRESS OPTIONS	
ORDERING CODE	SLAVE ADDRESS (7 bit)
VEML6031X00	0x29
VEML6031X00	0x10

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	+110	°C
Storage temperature range		T _{stg}	-40	+110	°C
Total power dissipation	T _{amb} ≤ 25 °C	P _{tot}	-	50	mW
Junction temperature		T _j	-	110	°C



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Remark:
Included information in table ORDERING INFORMATION on page 1

Rev. 1.3, 26-May-2023

Rev. 1.4, 18-Dec-2025

BASIC CHARACTERISTICS (T _{amb} = 25 °C, unless otherwise specified)						
PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage		V _{DD}	2.5	3.3	3.6	V
Shut down current ⁽¹⁾	V _{DD} = V _{BUS}	I _{sd}	-	0.5	-	µA
	V _{DD} = V _{BUS} = 3.0 V		-	1.2		
	V _{DD} is 3.6 V and V _{BUS} = 1.7 V		-	3.1		
Active mode current	V _{DD} is 3.3 V	I _{DD}	-	280	-	µA
PC clock rate range		f _{CLK}	10	-	400	kHz
PC bus input H-level range	V _{BUS} = V _{DD}	V _H	0.7 x V _{DD}	-	3.6	V
	V _{BUS} = V _{DD}		0.85 x V _{BUS}	-	3.6	V
PC bus input L-level range	V _{BUS} = V _{DD}	V _L	-0.3	-	0.3 x V _{DD}	V
	V _{BUS} = V _{DD}		-0.3	-	0.2 x V _{BUS}	V
Digital current out (low, current sink)		I _{OL}	3	-	-	mA
Digital resolution (LSB count) ⁽²⁾	With ALS_GAIN = x 2, ALS_IT = 400 ms, PD_DIV4 = 4/4 PD		-	0.0034	-	lx/step
Detectable maximum illuminance	With ALS_GAIN = x 0.5, ALS_IT = 6.25 ms, PD_DIV4 = 1/4 PD	E _{V,max}	-	228 000	-	lx
ALS dark offset ⁽¹⁾	With ALS_GAIN = x 2, IT = 200 ms, PD_DIV4 = 4/4 PD		-	4	-	step
IR dark offset ⁽¹⁾	With ALS_GAIN = x 2, IT = 200 ms, PD_DIV4 = 4/4 PD		-	4	-	step

Notes
⁽¹⁾ Light conditions: dark
⁽²⁾ Light conditions: E_v = 100 lx with 4300K white LED

BASIC CHARACTERISTICS (T _{amb} = 25 °C, unless otherwise specified)						
PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage		V _{DD}	2.5	3.3	3.6	V
Supply current	Shut down current ⁽¹⁾ , V _{DD} = V _{BUS}	I _{DD}	-	0.5	-	µA
	Shut down current ⁽¹⁾ , V _{DD} = V _{BUS} = 3.0 V		-	1.2		
	Shut down current ⁽¹⁾ , V _{DD} = 3.6 V, V _{BUS} = 1.7 V		-	3.1		
	Active state, V _{DD} = 3.3 V		-	280		
PC clock rate range		f _{CLK}	10	-	400	kHz
PC bus input H-level range	V _{BUS} = V _{DD}	V _H	0.7 x V _{DD}	-	3.6	V
	V _{BUS} = V _{DD}		0.85 x V _{BUS}	-	3.6	V
PC bus input L-level range	V _{BUS} = V _{DD}	V _L	-0.3	-	0.3 x V _{DD}	V
	V _{BUS} = V _{DD}		-0.3	-	0.2 x V _{BUS}	V
Digital current out (low, current sink)		I _{OL}	3	-	-	mA
Digital resolution (LSB count) ⁽²⁾	With ALS_GAIN = x 2, ALS_IT = 400 ms, ALS_PDDIV = 4/4 PD		-	0.0026	-	lx/step
Detectable maximum illuminance	With ALS_GAIN = x 0.5, ALS_IT = 6.25 ms, ALS_PDDIV = 1/4 PD	E _{V,max}	-	172 000	-	lx
ALS dark offset ⁽¹⁾	With ALS_GAIN = x 2, ALS_IT = 200 ms, ALS_PDDIV = 4/4 PD		-	4	-	step
IR dark offset ⁽¹⁾	With ALS_GAIN = x 2, ALS_IT = 200 ms, ALS_PDDIV = 4/4 PD		-	4	-	step

Notes
⁽¹⁾ Light conditions: dark
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Remark: See item 1 for resolution
 Rearranged supply current statement, no change in the values

CIRCUIT BLOCK DIAGRAM

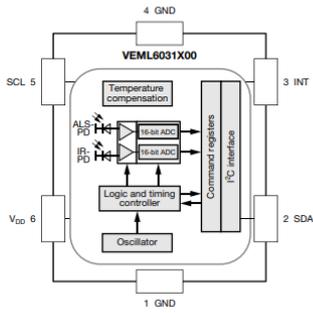


Fig. 1 - Block Diagram

CIRCUIT BLOCK DIAGRAM

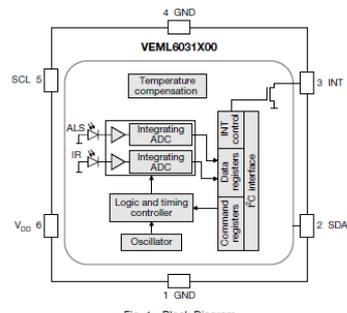


Fig. 1 - Block Diagram

Remark: See item 4 for block diagram

Rev. 1.3, 26-May-2023

Rev. 1.4, 18-Dec-2025

- Removed this figure

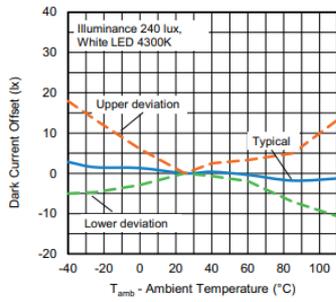


Fig. 9 - Dark Current Offset vs. Ambient Temperature

Remark: See item 2

APPLICATION INFORMATION

Special care must be taken into consideration when handling the VEML6031X00. VEML6031X00 is sensitive to dust and scratches, proper optical device handling procedures are recommended.

The optical surface of the device must be kept clean for optimal performance in both prototyping with the device and mass production manufacturing procedures. Tweezers with plastic or rubber contact surfaces are recommended to avoid scratches on the optical surface. Avoid manipulation with metal tools when possible. The optical surface must be kept clean of fingerprints, dust, and other optical-inhibiting contaminants.

If the device optical surface requires cleaning, the use of isopropyl alcohol is recommended. A few gentle brushes with a soft swab are appropriate. Avoid potentially abrasive cleaning and manipulating tools and excessive force that can scratch the optical surface.

If the VEML6031X00 performs less than optimally, inspect the optical surface for dirt, scratches, or other optical artifacts. VEML6031X00 is a cost effective solution of ambient light sensor with I²C bus interface. The standard serial digital interface is easy to access "Ambient Light Signal" without complex calculation and programming by external controller. Beside the digital output also a flexible programmable interrupt pin is available.

1. Application Circuit

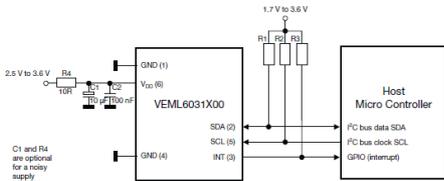


Fig. 11 - Application Circuit
(X) = Pin Number

Notes

- The interrupt pin is an open drain output. Proposed values for the pull-up resistors should be > 1 kΩ, e.g. 2.2 kΩ to 4.7 kΩ for the R1 and R2 (at SDA and SCL) and 10 kΩ to 100 kΩ for R3 (at interrupt).
- Normally just one decoupling capacitor is needed. This should be > 100 nF and placed close to the V_{DD} pin.

For detailed description about set-up and use of the interrupt as well as more application related information see AN: "Designing VEML6031X00 into an Application".

APPLICATION INFORMATION

1. Application Circuit

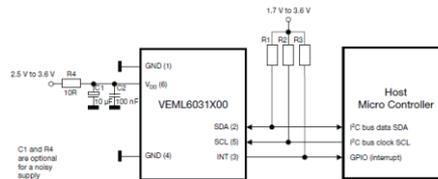


Fig. 10 - Application Circuit
(X) = Pin Number

Notes

- The interrupt pin is an open drain output. Proposed values for the pull-up resistors should be > 1 kΩ, e.g. 2.2 kΩ to 4.7 kΩ for the R1 and R2 (at SDA and SCL) and 10 kΩ to 100 kΩ for R3 (at interrupt).
- Normally just one decoupling capacitor is needed. This should be > 100 nF and placed close to the V_{DD} pin.

For detailed description about set-up and use of the interrupt as well as more application related information see AN: "Designing VEML6031X00 into an Application".

Remark: See item 5

Device Address

The VEML6031X00 is available in two different pre-configured slave addresses.
 For one version the predefined 7 bit I²C bus address is set to 0101001 = 0x29. The least significant bit (LSB) defines read or write mode. Accordingly the bus address is set to 0101 0010 = 0x52 for write and 0101 0011 = 0x53 for read.
 The second version comes with predefined 7 bit I²C bus address of 0010000 = 0x10, so, here the write address is 0010 0000 = 0x20 for write and 0010 0001 = 0x21 for read.

Register Addresses

The VEML6031X00 has eighteen registers, accessible through there respective 8-bit command codes.
 The registers are 0x00 to 0x17 (0x02 and 0x03, 0x08 to 0x0F and 0x16 are not defined / reserved). Note that due to the location of the two shutdown bits (SD and ALS_IR_SD), one in register 0x00 and the other in 0x01, it is necessary to always write to both registers at once when configuring the device.

Auto-Memorization

The VEML6031X00 stores the last measured ambient data before the device is shutdown, keeping the data accessible.
 When VEML6031X00 is in shutdown mode, the host can freely read this data via read command directly.

REGISTER INFORMATION

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TABLE 1 - SLAVE ADDRESS TABLE

ORDERING CODE	7 BIT SLAVE ADDRESS		8 BIT SLAVE ADDRESS	
	Write	Read	Write	Read
VEML6031X00	0x29	0x53	0x52 (Write)	0x53 (Read)
VEML6031X00	0x10	0x21	0x20 (Write)	0x21 (Read)

Auto-Memorization

The VEML6031X00 stores the last measured ambient data before the device is shutdown, keeping the data accessible.
 When VEML6031X00 is in shutdown mode, the host can freely read this data via read command directly.
 When VEML6031X00 wakes up, the data will be refreshed once a new measurement is made.

Register Addresses

The VEML6031X00 has eighteen registers, accessible through there respective 8-bit command codes.
 The registers are 0x00 to 0x17 (0x02 and 0x03, 0x08 to 0x0F and 0x16 are not defined / reserved). Note that due to the location of the bits ALS_ON_0 and ALS_ON_1, one in register 0x00 and the other in 0x01, it is necessary to always write to both registers at once when configuring the device.

Remark: See item 3

COMMAND REGISTER FORMAT					
COMMAND CODE	REGISTER NAME	BIT	DEFAULT VALUE	FUNCTION / DESCRIPTION	R / W
0x00	ALS_CONF_0	0 : 7	0x01	ALS integration time, measurement mode, shutdown	R/W
0x01	ALS_CONF_1	0 : 7	0x00	ALS and IR shutdown, ALS gain, interrupt persistence	R/W
0x04	ALS_WH_L	0 : 7	0x00	ALS high threshold window setting (LSB)	R/W
0x05	ALS_WH_H	0 : 7	0x00	ALS high threshold window setting (MSB)	R/W
0x06	ALS_WL_L	0 : 7	0x00	ALS low threshold window setting (LSB)	R/W
0x07	ALS_WL_H	0 : 7	0x00	ALS low threshold window setting (MSB)	R/W
0x10	ALS_DATA_L	0 : 7	0x00	Low byte of 16-bit ALS result DATA	R
0x11	ALS_DATA_H	0 : 7	0x00	High byte of 16-bit ALS result DATA	R
0x12	IR_DATA_L	0 : 7	0x00	Low byte of 16-bit IR result DATA	R
0x13	IR_DATA_H	0 : 7	0x00	High byte of 16-bit IR result DATA	R
0x14	ID_L	0 : 7	0x01	ID code	R
0x15	ID_H	0 : 7	0x00	Package and version code	R
0x17	ALS_INT	0 : 7	0x00	ALS INT trigger event	R

- Notes**
- Command code 0x00 default value is 0x01 = device is shutdown
 - Command 0x00 and command 0x01 must be executed together, they cannot be executed independently

TABLE 2 - COMMAND CODE AND REGISTER DESCRIPTION					
COMMAND CODE	DATA BYTE LOW / HIGH	REGISTER NAME	DEFAULT VALUE	FUNCTION	ACCESS
0x00	-	ALS_CONF_0	0x01	Set the integration time	Write and read
				Measurement mode of the sensor	
				Enable interrupt function of the ALS channel	
				Switch the sensor on / off	
0x01	-	ALS_CONF_1	0x80	Switch the sensor on / off	Write and read
				GAIN and photodiode size setting	
				Interrupt persistence counter	
0x04	Low	ALS_THDH_L	0x00	ALS channel high threshold window setting (low byte)	Read only
0x05	High	ALS_THDH_H	0x00	ALS channel high threshold window setting (high byte)	
0x06	Low	ALS_THDL_L	0x00	ALS channel low threshold window setting (low byte)	
0x07	High	ALS_THDL_H	0x00	ALS channel low threshold window setting (high byte)	
0x10	Low	ALS_DATA_L	0x00	Low byte of 16-bit ALS channel result data	
0x11	High	ALS_DATA_H	0x00	High byte of 16-bit ALS channel result data	
0x12	Low	IR_DATA_L	0x00	Low byte of 16-bit IR channel result data	
0x13	High	IR_DATA_H	0x00	High byte of 16-bit IR channel result data	
0x14	Low	VEML6031X00_ID_L	0x01	ID code	
0x15	High	VEML6031X00_ID_H	0x00	ID code	
0x16	Low	INT_FLAG_L	0x00	Reserved	
0x17	High	INT_FLAG_H	0x00	Interrupt and active force mode event flag	

- Notes**
- Command code 0x00 default value is 0x01 = device is shutdown
 - Command 0x00 and command 0x01 must be executed together, they cannot be executed independently

Remark: See item 3

Rev. 1.3, 26-May-2023

Rev. 1.4, 18-Dec-2025

TABLE 1 - REGISTER: ALS_CONF_0 - 0x00			
REGISTER NAME	BIT	FUNCTION / DESCRIPTION	R / W
Reserved	7	Must be set to "0"	R / W
ALS_IT	6 : 4	ALS integration time setting 000 = 3.125 ms 001 = 6.25 ms 010 = 12.5 ms 011 = 25 ms 100 = 50 ms 101 = 100 ms 110 = 200 ms 111 = 400 ms	R / W
ALS_AF	3	Active force mode enable setting 0 = AF disable 1 = AF enable Once enabled, a single measurement can be triggered with the "ALS_TRIG" bit	R / W
ALS_TRIG	2	ALS active force trigger setting 0 = no active force mode trigger 1 = trigger active force mode This bit resets to "0" automatically after every trigger	R / W
ALS_INT_EN	1	ALS interrupt setting 0 = interrupt disable 1 = interrupt enable	R / W
SD	0	Band gap and LDO shutdown setting 0 = band gap and LDO on 1 = band gap and LDO shutdown (default)	R / W

Note
 • Command code 0x00 default value is 0x01 = device is shutdown

TABLE 3 - REGISTER NAME: ALS_CONF_0							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	ALS_IT	ALS_MODE	ALS_TRIG	ALS_INT	ALS_ON_0		
COMMAND CODE							
0x00							
BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION			
Reserved	Reserved	7	0x0 (0b0)	Should be kept default			
ALS_IT	Set the integration time	6 : 4	0x0 (0b000)	3.125 ms (default)			
			0x1 (0b001)	6.25 ms			
			0x2 (0b010)	12.5 ms			
			0x3 (0b011)	25 ms			
			0x4 (0b100)	50 ms			
			0x5 (0b101)	100 ms			
			0x6 (0b110)	200 ms			
			0x7 (0b111)	400 ms			
ALS_MODE	Set the measurement mode of the sensor	3	0x0 (0b0)	Auto mode (default)			
			0x1 (0b1)	Active force mode			
ALS_TRIG	Set the active force mode trigger; this bit will be reset to 0 after the measurement cycle	2	0x0 (0b0)	Off (default)			
			0x1 (0b1)	Trigger			
ALS_INT	Enable / disable the interrupt function of the ALS channel	1	0x0 (0b0)	Disable (default)			
			0x1 (0b1)	Enable			
ALS_ON_0	Switch the sensor on / off (ALS_ON_0 and ALS_ON_1 must be executed together to start the sensor)	0	0x0 (0b0)	Turn on the sensor			
			0x1 (0b1)	Turn off the sensor (shutdown) (default)			

Note
 • Command Code 0x00 default value is 0x01 = device shutdown

Remark: See item 3

TABLE 2 - REGISTER: ALS_CONF_1 - 0x01

REGISTER NAME	BIT	FUNCTION / DESCRIPTION	R / W
ALS_IR_SD	7	ALS and IR channel shutdown setting 0 = ALS and IR channels on 1 = ALS and IR channels shutdown	R / W
PD_DIV4	6	Effective photodiode size ALS and IR 0 = 4/4 PD used 1 = 1/4 PD used	R / W
Reserved	5	Reserved	R / W
ALS_GAIN	4 : 3	Gain selection 00 = ALS gain x1 01 = ALS gain x2 10 = ALS gain x 0.66 11 = ALS gain x 0.5	R / W
ALS_PERS	2 : 1	ALS persistence protect number setting Number of persistent measurements above threshold to trigger the interrupt 00 = 1 01 = 2 10 = 4 11 = 8	R / W
ALS_CAL	0	Must be set to "1" when power on ready	R / W

TABLE 4 - REGISTER NAME: ALS_CONF_1

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_ON_1	ALS_PDDIV	Reserved	ALS_GAIN		ALS_PERS		ALS_CAL
COMMAND CODE							
0x01							
BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION			
ALS_ON_1	Switch the sensor on / off (ALS_ON_0 and ALS_ON_1 must be executed together to start the sensor)	7	0x0 (0b0)	Turn on the sensor			
			0x1 (0b1)	Turn off the sensor (shutdown) (default)			
ALS_PDDIV	Set the effective photodiode size for the ALS and IR channel	6	0x0 (0b0)	4/4 PD used			
			0x1 (0b1)	1/4 PD used			
Reserved	Reserved	5	0x0 (0b0)	Should be kept default			
ALS_GAIN	Set the gain of the ALS	4 : 3	0x0 (0b00)	Gain x1			
			0x1 (0b01)	Gain x2			
			0x2 (0b10)	Gain x0.66			
			0x3 (0b11)	Gain x0.5			
ALS_PERS	Set the amount of consecutive threshold crossing events necessary to trigger interrupt	2 : 1	0x0 (0b00)	1 time (default)			
			0x1 (0b01)	2 times			
			0x2 (0b10)	4 times			
			0x3 (0b11)	8 times			
ALS_CAL	Enable / disable internal calibration after power on	0	0x1 (0b1)	Enable (must be set to "1" when power on ready)			
			0x0 (0b0)	Disable (default)			

Remark: See item 3

TABLE 3 - REGISTER: ALS_WH - 0x04, 0x05

COMMAND CODE	REGISTER NAME	BIT	FUNCTION / DESCRIPTION	R / W
0x04	ALS_WH_L	7 : 0	ALS high threshold window setting (data byte low)	R / W
0x05	ALS_WH_H	7 : 0	ALS high threshold window setting (data byte high)	R / W

TABLE 4 - REGISTER: ALS_WL - 0x06, 0x07

COMMAND CODE	REGISTER NAME	BIT	FUNCTION / DESCRIPTION	R / W
0x06	ALS_WL_L	7 : 0	ALS low threshold window setting (data byte low)	R / W
0x07	ALS_WL_H	7 : 0	ALS low threshold window setting (data byte high)	R / W

TABLE 5 - REGISTER NAME: ALS_THDH

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDH_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDH_H							
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x04	ALS_THDH_L	Set the high threshold interrupt value	7 : 0	0 to 65 535	Low byte		
0x05	ALS_THDH_H		7 : 0		High byte		

TABLE 6 - REGISTER NAME: ALS_THDL

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDL_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDL_H							
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x06	ALS_THDL_L	Set the low threshold interrupt value	7 : 0	0 to 65 535	Low byte		
0x07	ALS_THDL_H		7 : 0		High byte		

Remark: See item 3

Rev. 1.3, 26-May-2023

Rev. 1.4, 18-Dec-2025

TABLE 5 - REGISTER: ALS_DATA - 0x10, 0x11				
COMMAND CODE	REGISTER NAME	BIT	FUNCTION / DESCRIPTION	R / W
0x10	ALS_DATA_L	7:0	ALS result channel (data byte low)	R
0x11	ALS_DATA_H	7:0	ALS result channel (data byte high)	R

TABLE 6 - REGISTER: IR_DATA - 0x12, 0x13				
COMMAND CODE	REGISTER NAME	BIT	FUNCTION / DESCRIPTION	R / W
0x12	IR_DATA_L	7:0	IR result channel (data byte low)	R
0x13	IR_DATA_H	7:0	IR result channel (data byte high)	R

TABLE 7 - REGISTER: ID - 0x14, 0x15				
COMMAND CODE	REGISTER NAME	BIT	FUNCTION / DESCRIPTION	R / W
0x14	ID_L	7:0	ID code: 0x01	R
0x15	ID_H	7:6	Package code: 00	R
		5:4	Slave address: 00 = 0x29; 01 = 0x10	
		3:0	Version code: 0000 = A01	

TABLE 7 - REGISTER NAME: ALS_DATA							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_DATA_L							
ALS_DATA_H							
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x10	ALS_DATA_L	Read the ALS channel	7:0	0 to 65 535	Low byte		
0x11	ALS_DATA_H	output data	7:0		High byte		

TABLE 8 - REGISTER NAME: IR_DATA							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
IR_DATA_L							
IR_DATA_H							
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x12	IR_DATA_L	Read the IR channel	7:0	0 to 65 535	Low byte		
0x13	IR_DATA_H	output data	7:0		High byte		

TABLE 9 - REGISTER NAME: VEML6031X00 ID							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
VEML6031X00_ID_L							
VEML6031X00_ID_H							
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x14	VEML6031X00_ID_L	Read the device ID	7:0	0x01 (0b00000001)	Should be kept default		
				0x00 (0b00000000)	Device with a slave address of 0x29		
0x15	VEML6031X00_ID_H	Read the device ID	7:0	0x10 (0b00010000)	Device with a slave address of 0x10		

Remark: See item 3

REGISTER NAME	BIT	FUNCTION / DESCRIPTION	R / W
Reserved	7 : 4	Reserved	R
ALS_AF_DATA_READY	3	ALS active force mode data ready flag	R
ALS_IF_L	2	ALS low threshold INT flag	R
ALS_IF_H	1	ALS high threshold INT flag	R
Reserved	0	Reserved	R

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved				AF_DATA_READY	ALS_IF_L	ALS_IF_H	Reserved
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x16	Reserved	Reserved	7 : 0	0x00 (0b00000000)	Should be kept default		
	Reserved	Reserved	7 : 4	0x0 (0b0000)	Should be kept default		
0x17	AF_DATA_READY	Data ready flag	3	0x1 (0b1)	Data ready flag available		
		active force mode		0x0 (0b0)	Data ready flag not available		
	ALS_IF_L	Low threshold interrupt flag	2	0x1 (0b1)	Low threshold crossing interrupt event flag for the ALS channel		
				0x0 (0b0)	No low threshold crossing		
	ALS_IF_H	High threshold interrupt flag	1	0x1 (0b1)	High threshold crossing interrupt event flag for the ALS channel		
				0x0 (0b0)	No high threshold crossing		
Reserved	Reserved	0	0x0 (0b0)	Should be kept default			

Remark: See item 3

Rev. 1.3, 26-May-2023

Rev. 1.4, 18-Dec-2025

CALCULATING THE LUX LEVEL

Command code 0x10 and 0x11 contain the results of the ALS measurement. This 16-bit code needs to be converted to a decimal value to determine the corresponding lux value. The calculation of the corresponding lux level is dependent on the programmed gain setting and the chosen integration time.

The component is most sensitive with ALS_GAIN = x2, PD_DIV4 = 4/4 and an integration time of 400 ms, specified to 0.0034 lux/step.

Every time the integration time is halved, the resolution is doubled but also the possible detection range is doubled. The same principle is valid for the gain setting. For ALS_GAIN = x1 it is doubled. For PD_DIV4 = 1/4 the size of the photodiode is just 1/4, so, also the sensitivity is just 1/4, resolution and max. possible detection range is times 4, to allow for higher illuminations up to about 228 lx.

IT (ms)	TYPICAL RESOLUTION (lx/cent)				MAXIMUM POSSIBLE ILLUMINATION (lx)			
	GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5	GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5
400	0.0034	0.0068	0.0103	0.0136	223	446	675	891
200	0.0068	0.0136	0.0206	0.0272	446	891	1350	1783
100	0.0136	0.0272	0.0412	0.0544	891	1783	2701	3565
50	0.0272	0.0544	0.0824	0.1088	1783	3565	5402	7130
25	0.0544	0.1088	0.1648	0.2176	3565	7130	10803	14260
12.5	0.1088	0.2176	0.3297	0.4352	7130	14260	21607	28521
6.25	0.2176	0.4352	0.6594	0.8704	14260	28521	43213	57042
3.125	0.4352	0.8704	1.3188	1.7408	(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾

IT (ms)	TYPICAL RESOLUTION (lx/cent)				MAXIMUM POSSIBLE ILLUMINATION (lx)			
	GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5	GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5
400	0.0136	0.0272	0.0412	0.0544	891	1783	2701	3565
200	0.0272	0.0544	0.0824	0.1088	1783	3565	5402	7130
100	0.0544	0.1088	0.1648	0.2176	3565	7130	10803	14260
50	0.1088	0.2176	0.3297	0.4352	7130	14260	21607	28521
25	0.2176	0.4352	0.6594	0.8704	14260	28521	43213	57042
12.5	0.4352	0.8704	1.3188	1.7408	28521	57042	86427	114263
6.25	0.8704	1.7408	2.6376	3.4816	57042	114083	172854	228167
3.125	1.7408	3.4816	5.2752	6.9632	(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾

Note
⁽¹⁾ For integration time of 3.125 ms the maximum count level is no longer 16 bit, so, half the integration time no longer leads to double the max. lux level.
 Example:
 If the 16-bit word of the ALS data shows: 00001011 1100 1000 = 1480 (dec.), the programmed ALS_GAIN = x1, PD_DIV4 = 4/4 (= x1) and ALS_IT = 100 ms, the corresponding lux level is: light level (lx) = 1480 x 0.0272 = 40.256 lx.

CALCULATING THE LUX LEVEL

Command code 0x10 and 0x11 contain the results of the ALS measurement. This 16-bit code needs to be converted to a decimal value to determine the corresponding lux value. The calculation of the corresponding lux level is dependent on the programmed gain setting and the chosen integration time.

IT (ms)	TYPICAL RESOLUTION (lx/cent)				MAXIMUM POSSIBLE ILLUMINATION (lx)			
	ALS_GAIN				ALS_GAIN			
	x2	x1	x0.66	x0.5	x2	x1	x0.66	x0.5
400	0.0026	0.0051	0.0078	0.0103	168	337	510	673
200	0.0051	0.0103	0.0156	0.0206	337	673	1020	1346
100	0.0103	0.0206	0.0311	0.0411	673	1346	2040	2693
50	0.0206	0.0411	0.0623	0.0822	1346	2693	4080	5385
25	0.0411	0.0822	0.1245	0.1644	2693	5385	8160	10 771
12.5	0.0822	0.1644	0.2490	0.3287	5385	10 771	16 319	21 542
6.25	0.1644	0.3287	0.4980	0.6574	10 771	21 542	32 639	43 083
3.125	0.3287	0.6574	0.9961	1.3148	(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾

IT (ms)	TYPICAL RESOLUTION (lx/cent)				MAXIMUM POSSIBLE ILLUMINATION (lx)			
	ALS_GAIN				ALS_GAIN			
	x2	x1	x0.66	x0.5	x2	x1	x0.66	x0.5
400	0.0103	0.0206	0.0311	0.0411	673	1346	2040	2693
200	0.0206	0.0411	0.0623	0.0822	1346	2693	4080	5385
100	0.0411	0.0822	0.1245	0.1644	2693	5385	8160	10 771
50	0.0822	0.1644	0.2490	0.3287	5385	10 771	16 319	21 542
25	0.1644	0.3287	0.4980	0.6574	10 771	21 542	32 639	43 083
12.5	0.3287	0.6574	0.9961	1.3148	21 542	43 083	65 278	86 166
6.25	0.6574	1.3148	1.9921	2.6296	43 083	86 166	130 555	172 333
3.125	1.3148	2.6296	3.9843	5.2593	(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾

Note
⁽¹⁾ For integration time of 3.125 ms the maximum count level is no longer 16 bit, so, half the integration time no longer leads to double the max. lux level.

Remark: See item 1



VEML6031X00
Vishay Semiconductors

HANDLING INSTRUCTION

Special care must be taken into consideration when handling the VEML6031X00. VEML6031X00 is sensitive to dust and scratches, proper optical device handling procedures are recommended.

The optical surface of the device must be kept clean for optimal performance in both prototyping with the device and mass production manufacturing procedures. Tweezers with plastic or rubber contact surfaces are recommended to avoid scratches on the optical surface. Avoid manipulation with metal tools when possible. The optical surface must be kept clean of fingerprints, dust, and other optical-inhibiting contaminants.

If the device optical surface requires cleaning, the use of isopropyl alcohol is recommended. A few gentle brushes with a soft swab are appropriate. Avoid potentially abrasive cleaning and manipulating tools and excessive force that can scratch the optical surface.

If the VEML6031X00 performs less than optimally, inspect the optical surface for dirt, scratches, or other optical artifacts.

Remark: See item 5

Rev. 1.3, 26-May-2023

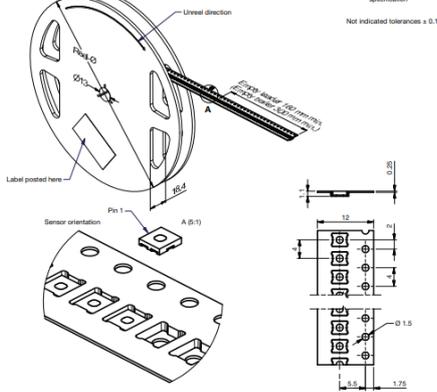
Rev. 1.4, 18-Dec-2025

TAPE AND REEL DIMENSIONS in millimeters

Reel size:
 VEML6031: $\varnothing 180 \text{ mm} \pm 2 \text{ mm} = 3000 \text{ pcs.}$
 VEML6031-GS 15: $\varnothing 330 \text{ mm} \pm 2 \text{ mm} = 10\,000 \text{ pcs.}$
 Reel design is representative for different types.



Technical drawings according to DIN specification
 Not indicated tolerances ± 0.1



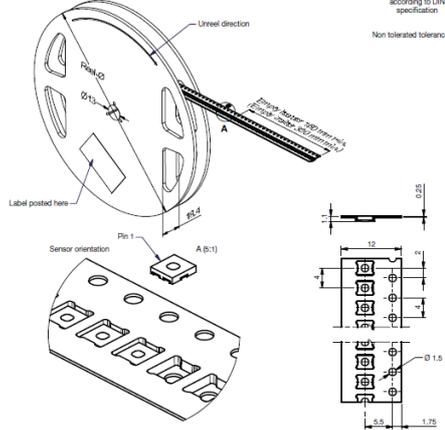
Drawing No.: 9.800-5148.01-4
 Issue: preliminary, 16.12.19

TAPE AND REEL DIMENSIONS in millimeters

Reel size:
 VEML6031: $\varnothing 180 \text{ mm} \pm 2 \text{ mm} = 3000 \text{ pcs.}$
 VEML6031-GS 15: $\varnothing 330 \text{ mm} \pm 2 \text{ mm} = 10\,000 \text{ pcs.}$
 Reel design is representative for different types.



Technical drawings according to DIN specification
 Non tolerated tolerances $\pm 0.1 \text{ mm}$



Drawing No.: 9.800-5148.01-4
 Issue: 2, 28.05.21

Updated data code. No change in tape & reel drawing.

Rev. 1.3, 26-May-2023

Rev. 1.4, 18-Dec-2025

REVISION HISTORY		
DATASHEET VERSION	REVISION DATE	CHANGE
1.4	18-Dec-2025	Corrected resolution, removed "Dark Current Offset vs. Ambient Temperature" figure, revised bit naming, revised block diagram, rearranged part handling information

Remark: See item 6



High Accuracy Ambient Light Sensor With I²C Interface



FEATURES

- Package type: surface-mount
- Dimensions (L x W x H in mm): 2.67 x 2.45 x 0.6
- AEC-Q100 qualified
- Integrated modules: ambient light sensor (ALS)
- Supply voltage range V_{DD}: 2.5 V to 3.6 V
- Communication via I²C interface
- I²C bus H-level range: 1.7 V to 3.6 V
- Floor life: 4 weeks, MSL 2a, according to J-STD-020
- Low shut down current consumption: typ. 0.5 μA
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

LINKS TO ADDITIONAL RESOURCES



DESCRIPTION

VEML6031X00 is a high accuracy ambient light digital 16-bit resolution sensor in a miniature opaque 2.67 mm x 2.45 mm package. It includes a high sensitive photodiode, a low noise amplifier, a 16-bit A/D converter and supports an easy to use I²C bus communication interface and additional interrupt feature.

The ambient light result is as digital value available.

APPLICATIONS

[Ambient light sensor in automotive](#) for

- Display backlight controls
- Infotainment systems
- Rear view mirror dimming
- Interior lighting control systems
- [Head-up displays](#)

AMBIENT LIGHT FUNCTION

- Filtron™ technology adaption: close to real human eye response
- Typical ALS output tolerance of ≤ 10 % under different light sources
- 16-bit dynamic range for ambient light detection from 0 lx to about 172 klx with resolution down to 0.0026 lx/ct, supports low transmittance (dark) lens design
- Excellent temperature compensation
- High dynamic detection resolution

PRODUCT SUMMARY						
PART NUMBER	OPERATING VOLTAGE RANGE (V)	I ² C BUS VOLTAGE RANGE (V)	AMBIENT LIGHT RANGE (lx)	AMBIENT LIGHT RESOLUTION (lx)	OUTPUT CODE	ADC RESOLUTION PROXIMITY / AMBIENT LIGHT
VEML6031X00	2.5 to 3.6	1.7 to 3.6	0 to 172 000	0.0026	16 bit, I ² C	- / 16 bit

ORDERING INFORMATION				
ORDERING CODE	SLAVE ADDRESS (7 BIT)	PACKAGING	VOLUME ⁽¹⁾	REMARKS
VEML6031X00	0x29	Tape and reel	MOQ: 3000	2.67 mm x 2.45 mm x 0.6 mm
VEML6031X00-GS15	0x29	Tape and reel	MOQ: 10 000	2.67 mm x 2.45 mm x 0.6 mm
VEML60311X00	0x10	Tape and reel	MOQ: 3000	2.67 mm x 2.45 mm x 0.6 mm
VEML60311X00-GS15	0x10	Tape and reel	MOQ: 10 000	2.67 mm x 2.45 mm x 0.6 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	+110	°C
Storage temperature range		T _{stg}	-40	+110	°C
Total power dissipation	T _{amb} ≤ 25 °C	P _{tot}	-	50	mW
Junction temperature		T _j	-	110	°C

BASIC CHARACTERISTICS (T _{amb} = 25 °C, unless otherwise specified)						
PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage		V _{DD}	2.5	3.3	3.6	V
Supply current	Shut down current ⁽¹⁾ , V _{DD} = V _{BUS}	I _{DD}	-	0.5	-	µA
	Shut down current ⁽¹⁾ , V _{DD} = V _{BUS} = 3.0 V		-	-	1.2	
	Shut down current ⁽¹⁾ , V _{DD} = 3.6 V, V _{BUS} = 1.7 V		-	3.1	-	
	Active state, V _{DD} = 3.3 V		-	280	-	
I ² C clock rate range		f _{SCL}	10	-	400	kHz
I ² C bus input H-level range	V _{BUS} = V _{DD}	V _{ih}	0.7 x V _{DD}	-	3.6	V
	V _{BUS} ≠ V _{DD}	V _{ih}	0.85 x V _{BUS}	-	3.6	V
I ² C bus input L-level range	V _{BUS} = V _{DD}	V _{il}	-0.3	-	0.3 x V _{DD}	V
	V _{BUS} ≠ V _{DD}	V _{il}	-0.3	-	0.2 x V _{BUS}	V
Digital current out (low, current sink)		I _{ol}	3	-	-	mA
Digital resolution (LSB count) ⁽²⁾	With ALS_GAIN = x 2, ALS_IT = 400 ms, ALS_PDDIV = 4/4 PD		-	0.0026	-	lx/step
Detectable maximum illuminance	With ALS_GAIN = x 0.5, ALS_IT = 6.25 ms, ALS_PDDIV = 1/4 PD	E _{v max.}	-	172 000	-	lx
ALS dark offset ⁽¹⁾	With ALS_GAIN = x 2, ALS_IT = 200 ms, ALS_PDDIV = 4/4 PD		-	4	-	step
IR dark offset ⁽¹⁾	With ALS_GAIN = x 2, ALS_IT = 200 ms, ALS_PDDIV = 4/4 PD		-	4	-	step

Notes

- ⁽¹⁾ Light conditions: dark
- ⁽²⁾ Light conditions: E_v = 100 lx with 4300K white LED

CIRCUIT BLOCK DIAGRAM

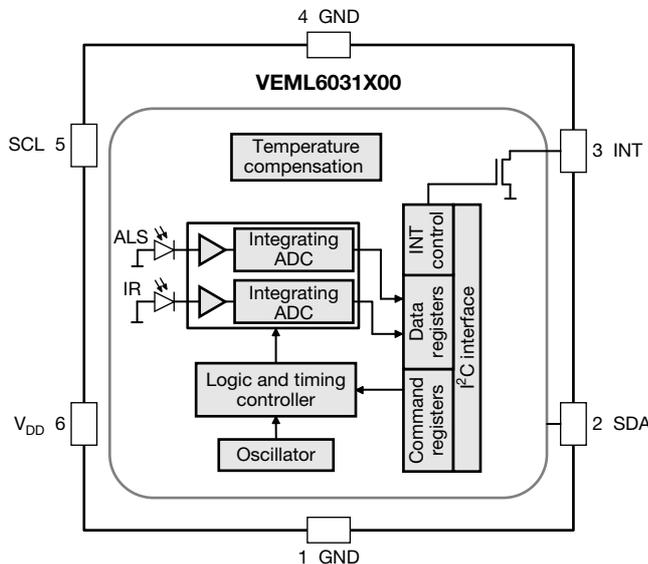
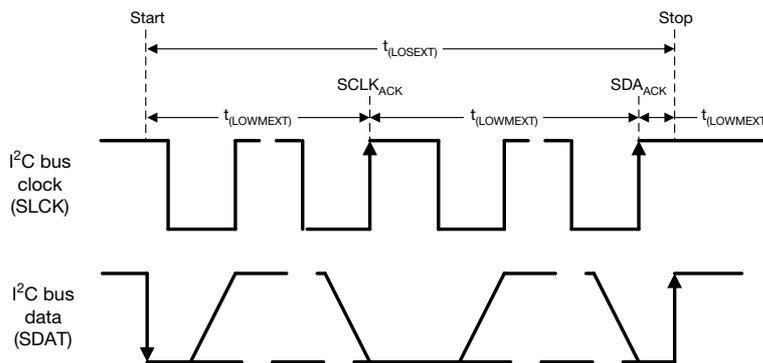
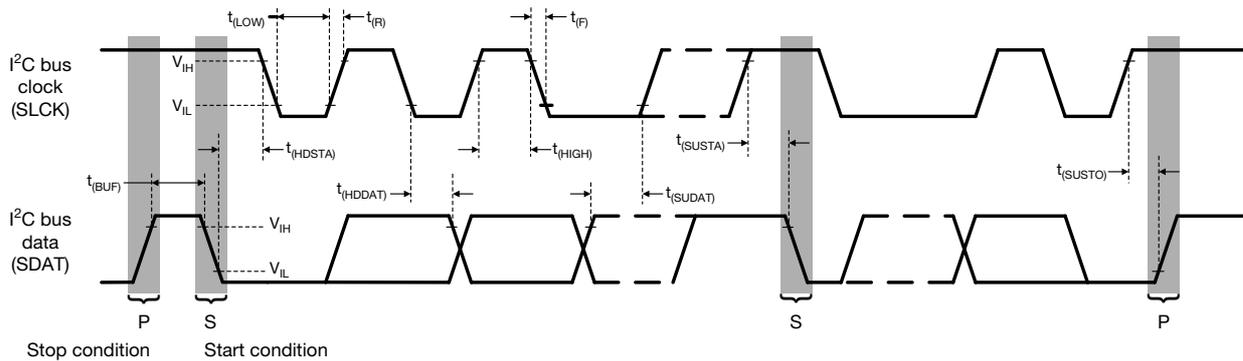


Fig. 1 - Block Diagram

I²C TIMING CHARACTERISTICS ($T_{amb} = 25\text{ }^{\circ}\text{C}$, 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	$t_{(HDDAT)}$	0	3450	0	900	ns
Data setup time	$t_{(SUDAT)}$	250	-	100	-	ns
I ² C clock (SCK) low period	$t_{(LOW)}$	4.7	-	1.3	-	μs
I ² C clock (SCK) high period	$t_{(HIGH)}$	4.0	-	0.6	-	μs
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

Note

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

 Fig. 2 - I²C Timing Diagram



PARAMETER TIMING INFORMATION

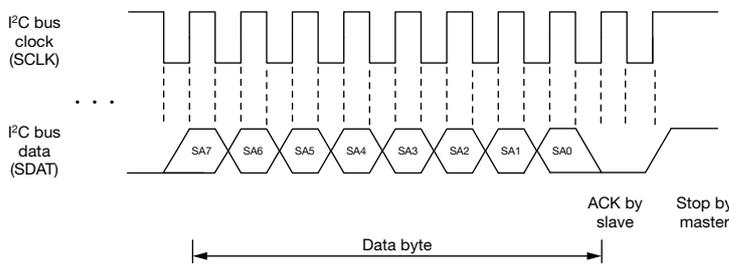
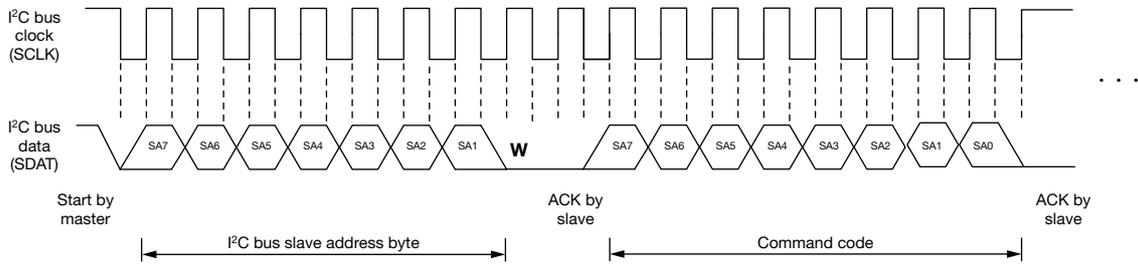


Fig. 3 - I²C Bus Timing for Sending Word Command Format

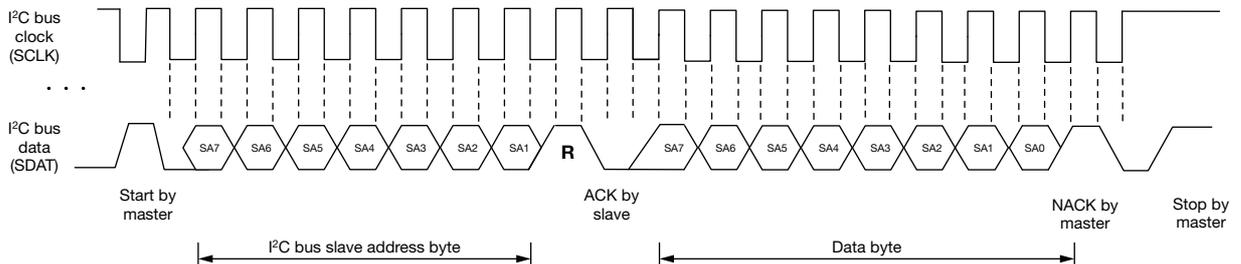
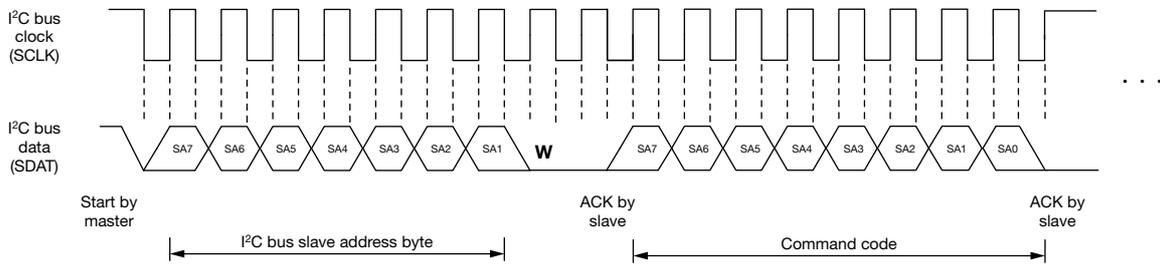


Fig. 4 - I²C Bus Timing for Receive Word Command Format

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

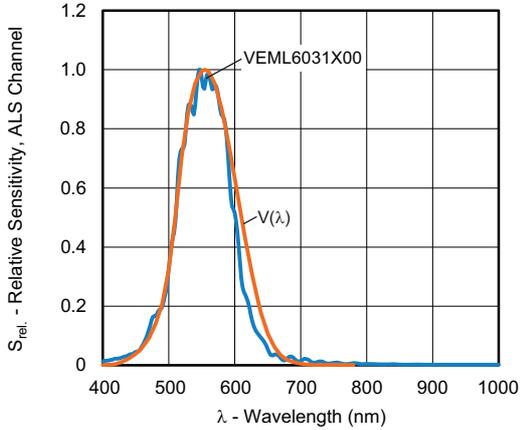


Fig. 5 - Relative Sensitivity, ALS Channel vs. Wavelength

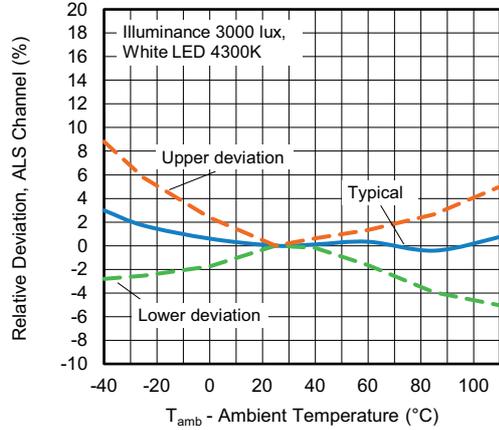


Fig. 8 - Relative Deviation, ALS Channel vs. Temperature (at lux levels lower than ~200 lux, dark current effects should be taken into account)

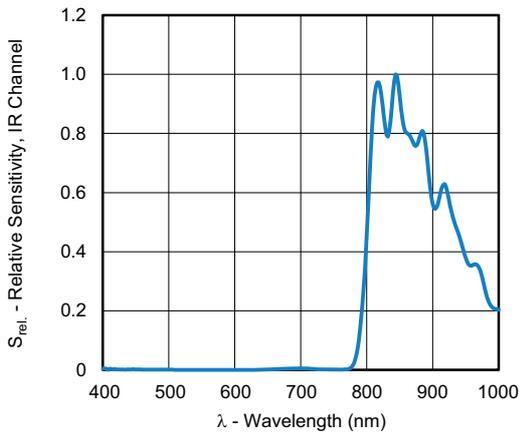


Fig. 6 - Relative Sensitivity, IR Channel vs. Wavelength

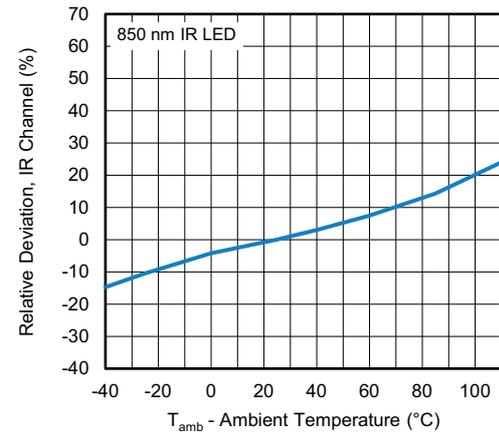


Fig. 9 - Relative Deviation IR Channel vs. Ambient Temperature

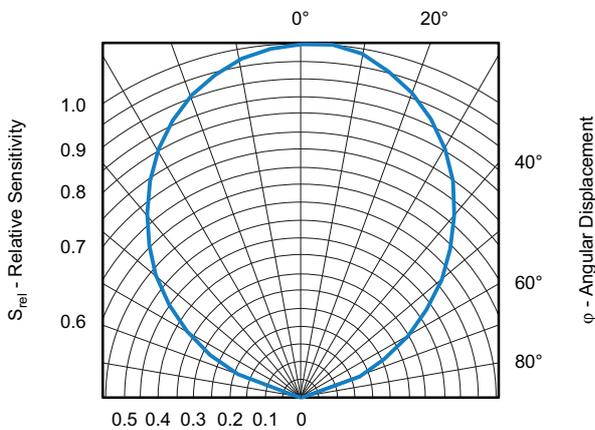


Fig. 7 - Relative Sensitivity vs. Angular Displacement

APPLICATION INFORMATION

1. Application Circuit

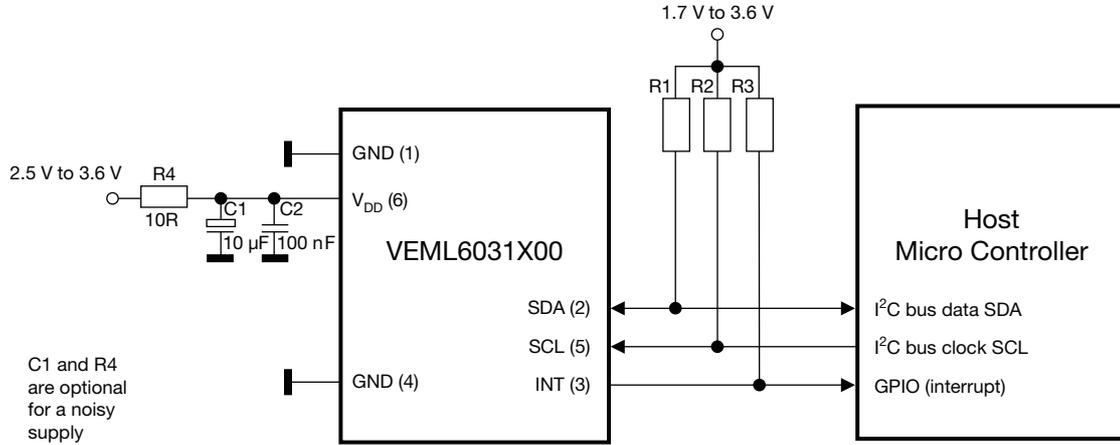


Fig. 10 - Application Circuit
(x) = Pin Number

Notes

- The interrupt pin is an open drain output. Proposed values for the pull-up resistors should be > 1 kΩ, e.g. 2.2 kΩ to 4.7 kΩ for the R1 and R2 (at SDA and SCL) and 10 kΩ to 100 kΩ for R3 (at interrupt).
- Normally just one decoupling capacitor is needed. This should be ≥ 100 nF and placed close to the V_{DD} pin.
For detailed description about set-up and use of the interrupt as well as more application related information see AN: “Designing VEM6031X00 into an Application”.

2. I²C Write and Read Protocol

The VEM6031X00 has eighteen register addresses responsible for operation control, parameter setup and result buffering. All registers are accessible via I²C communication. Fig. 9 shows the basic I²C communication with VEM6031X00.

The built in I²C interface is compatible with I²C modes “standard” and “fast”: 10 kHz to 400 kHz.

Please refer to the I²C specification from NXP for details.

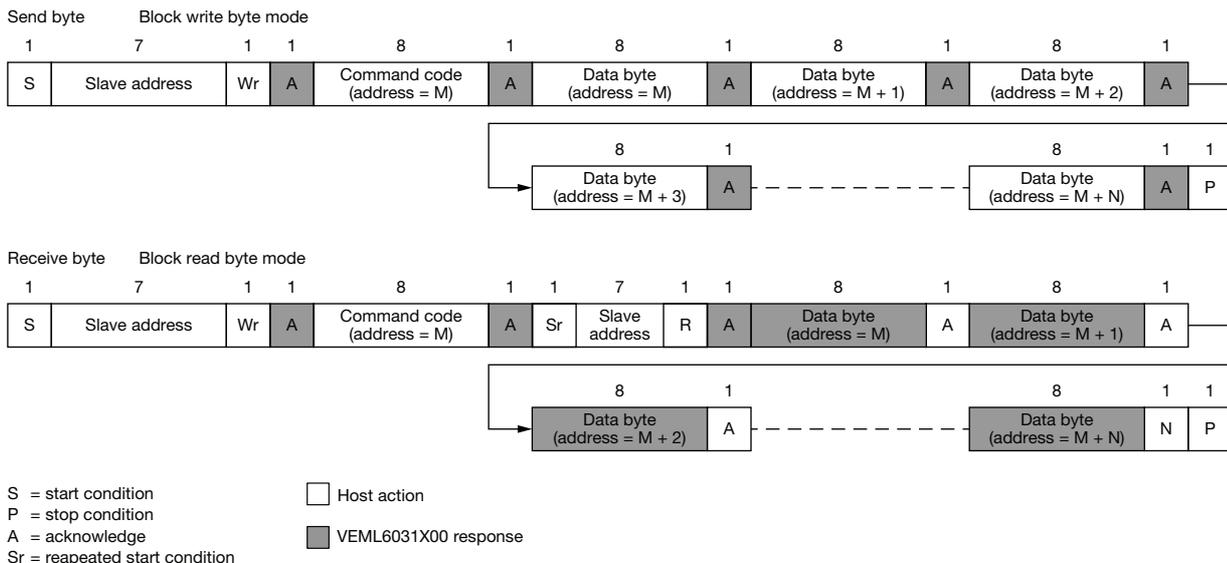


Fig. 11 - Send Byte / Receive Byte Protocol



REGISTER INFORMATION

Device Address

The VEML6031X00 is available in two different pre-configured slave addresses.

For one version the predefined 7 bit I2C bus address is set to 0101001 = 0x29. The least significant bit (LSB) defines read or write mode. Accordingly the bus address is set to 0101 0010 = 0x52 for write and 0101 0011 = 0x53 for read. The second version comes with predefined 7 bit I2C bus address of 0010000 = 0x10, so, here the write address is 0010 0000 = 0x20 for write and 0010 0001 = 0x21 for read.

TABLE 1 - SLAVE ADDRESS TABLE. Table with 4 columns: ORDERING CODE, 7 BIT SLAVE ADDRESS, 8 BIT SLAVE ADDRESS (split into two sub-columns). Rows include VEML6031X00 and VEML60311X00.

Auto-Memorization

The VEML6031X00 stores the last measured ambient data before the device is shutdown, keeping the data accessible.

When VEML6031X00 is in shutdown mode, the host can freely read this data via read command directly.

When VEML6031X00 wakes up, the data will be refreshed once a new measurement is made.

Register Addresses

The VEML6031X00 has eighteen registers, accessible through their respective 8-bit command codes.

The registers are 0x00 to 0x17 (0x02 and 0x03, 0x08 to 0x0F and 0x16 are not defined / reserved). Note that due to the location of the bits ALS_ON_0 and ALS_ON_1, one in register 0x00 and the other in 0x01, it is necessary to always write to both registers at once when configuring the device.

TABLE 2 - COMMAND CODE AND REGISTER DESCRIPTION. Table with 6 columns: COMMAND CODE, DATA BYTE LOW / HIGH, REGISTER NAME, DEFAULT VALUE, FUNCTION, ACCESS. Rows describe registers 0x00 through 0x17.

Notes

- Command code 0x00 default value is 0x01 = device is shutdown
• Command 0x00 and command 0x01 must be executed together, they cannot be executed independently



TABLE 3 - REGISTER NAME: ALS_CONF_0							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	ALS_IT			ALS_MODE	ALS_TRIG	ALS_INT	ALS_ON_0
COMMAND CODE					0x00		
BIT NAME	FUNCTION		BIT	VALUE	DESCRIPTION		
Reserved	Reserved		7	0x0 (0b0)	Should be kept default		
ALS_IT	Set the integration time		6 : 4	0x0 (0b000)	3.125 ms (default)		
				0x1 (0b001)	6.25 ms		
				0x2 (0b010)	12.5 ms		
				0x3 (0b011)	25 ms		
				0x4 (0b100)	50 ms		
				0x5 (0b101)	100 ms		
				0x6 (0b110)	200 ms		
				0x7 (0b111)	400 ms		
ALS_MODE	Set the measurement mode of the sensor		3	0x0 (0b0)	Auto mode (default)		
				0x1 (0b1)	Active force mode		
ALS_TRIG	Set the active force mode trigger; this bit will be reset to 0 after the measurement cycle		2	0x0 (0b0)	Off (default)		
				0x1 (0b1)	Trigger		
ALS_INT	Enable / disable the interrupt function of the ALS channel		1	0x0 (0b0)	Disable (default)		
				0x1 (0b1)	Enable		
ALS_ON_0	Switch the sensor on / off (ALS_ON_0 and ALS_ON_1 must be executed together to start the sensor)		0	0x0 (0b0)	Turn on the sensor		
				0x1 (0b1)	Turn off the sensor (shutdown) (default)		

Note

- Command Code 0x00 default value is 0x01 = device shutdown

TABLE 4 - REGISTER NAME: ALS_CONF_1							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_ON_1	ALS_PDDIV	Reserved	ALS_GAIN		ALS_PERS		ALS_CAL
COMMAND CODE					0x01		
BIT NAME	FUNCTION		BIT	VALUE	DESCRIPTION		
ALS_ON_1	Switch the sensor on / off (ALS_ON_0 and ALS_ON_1 must be executed together to start the sensor)		7	0x0 (0b0)	Turn on the sensor		
				0x1 (0b1)	Turn off the sensor (shutdown) (default)		
ALS_PDDIV	Set the effective photodiode size for the ALS and IR channel		6	0x0 (0b0)	4/4 PD used		
				0x1 (0b1)	1/4 PD used		
Reserved	Reserved		5	0x0 (0b0)	Should be kept default		
ALS_GAIN	Set the gain of the ALS		4 : 3	0x0 (0b00)	Gain x1		
				0x1 (0b01)	Gain x2		
				0x2 (0b10)	Gain x0.66		
				0x3 (0b11)	Gain x0.5		
ALS_PERS	Set the amount of consecutive threshold crossing events necessary to trigger interrupt		2 : 1	0x0 (0b00)	1 time (default)		
				0x1 (0b01)	2 times		
				0x2 (0b10)	4 times		
				0x3 (0b11)	8 times		
ALS_CAL	Enable / disable internal calibration after power on		0	0x1 (0b1)	Enable (must be set to "1" when power on ready)		
				0x0 (0b0)	Disable (default)		



TABLE 5 - REGISTER NAME: ALS_THDH							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDH_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDH_H							
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x04	ALS_THDH_L	Set the high threshold interrupt value	7 : 0	0 to 65 535	Low byte		
0x05	ALS_THDH_H		7 : 0		High byte		

TABLE 6 - REGISTER NAME: ALS_THDL							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDL_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDL_H							
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x06	ALS_THDL_L	Set the low threshold interrupt value	7 : 0	0 to 65 535	Low byte		
0x07	ALS_THDL_H		7 : 0		High byte		

TABLE 7 - REGISTER NAME: ALS_DATA							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_DATA_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_DATA_H							
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x10	ALS_DATA_L	Read the ALS channel output data	7 : 0	0 to 65 535	Low byte		
0x11	ALS_DATA_H		7 : 0		High byte		

TABLE 8 - REGISTER NAME: IR_DATA							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
IR_DATA_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
IR_DATA_H							
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x12	IR_DATA_L	Read the IR channel output data	7 : 0	0 to 65 535	Low byte		
0x13	IR_DATA_H		7 : 0		High byte		

TABLE 9 - REGISTER NAME: VEML6031X00_ID							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
VEML6031X00_ID_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
VEML6031X00_ID_H							
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x14	VEML6031X00_ID_L	Read the device ID	7 : 0	0x01 (0b00000001)	Should be kept default		
0x15	VEML6031X00_ID_H		7 : 0	0x00 (0b00000000)	Device with a slave address of 0x29		
			7 : 0	0x10 (0b00010000)	Device with a slave address of 0x10		



TABLE 10 - REGISTER NAME: INT_FLAG							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved				AF_DATA_READY	ALS_IF_L	ALS_IF_H	Reserved
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x16	Reserved	Reserved	7 : 0	0x00 (0b00000000)	Should be kept default		
0x17	Reserved	Reserved	7 : 4	0x0 (0b0000)	Should be kept default		
	AF_DATA_READY	Data ready flag active force mode	3	0x1 (0b1)	Data ready flag available		
				0x0 (0b0)	Data ready flag not available		
	ALS_IF_L	Low threshold interrupt flag	2	0x1 (0b1)	Low threshold crossing interrupt event flag for the ALS channel		
				0x0 (0b0)	No low threshold crossing		
	ALS_IF_H	High threshold interrupt flag	1	0x1 (0b1)	High threshold crossing interrupt event flag for the ALS channel		
0x0 (0b0)				No high threshold crossing			
Reserved	Reserved	0	0x0 (0b0)	Should be kept default			

CALCULATING THE LUX LEVEL

Command code 0x10 and 0x11 contain the results of the ALS measurement. This 16-bit code needs to be converted to a decimal value to determine the corresponding lux value. The calculation of the corresponding lux level is dependent on the programmed gain setting and the chosen integration time.

TABLE 11 - RESOLUTION AND MAXIMUM DETECTION RANGE AT ALS_PDDIV (4/4 PD USED)									
IT (ms)	TYPICAL RESOLUTION (lx/cnt)					MAXIMUM POSSIBLE ILLUMINATION (lx)			
	ALS_GAIN					ALS_GAIN			
	x2	x1	x0.66	x0.5		x2	x1	x0.66	x0.5
400	0.0026	0.0051	0.0078	0.0103		168	337	510	673
200	0.0051	0.0103	0.0156	0.0205		337	673	1020	1346
100	0.0103	0.0205	0.0311	0.0411		673	1346	2040	2693
50	0.0205	0.0411	0.0623	0.0822		1346	2693	4080	5385
25	0.0411	0.0822	0.1245	0.1644		2693	5385	8160	10 771
12.5	0.0822	0.1644	0.2490	0.3287		5385	10 771	16 319	21 542
6.25	0.1644	0.3287	0.4980	0.6574		10 771	21 542	32 639	43 083
3.125	0.3287	0.6574	0.9961	1.3148		(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾

TABLE 12 - RESOLUTION AND MAXIMUM DETECTION RANGE AT ALS_PDDIV (1/4 PD USED)									
IT (ms)	TYPICAL RESOLUTION (lx/cnt)					MAXIMUM POSSIBLE ILLUMINATION (lx)			
	ALS_GAIN					ALS_GAIN			
	x2	x1	x0.66	x0.5		x2	x1	x0.66	x0.5
400	0.0103	0.0205	0.0311	0.0411		673	1346	2040	2693
200	0.0205	0.0411	0.0623	0.0822		1346	2693	4080	5385
100	0.0411	0.0822	0.1245	0.1644		2693	5385	8160	10 771
50	0.0822	0.1644	0.2490	0.3287		5385	10 771	16 319	21 542
25	0.1644	0.3287	0.4980	0.6574		10 771	21 542	32 639	43 083
12.5	0.3287	0.6574	0.9961	1.3148		21 542	43 083	65 278	86 166
6.25	0.6574	1.3148	1.9921	2.6296		43 083	86 166	130 555	172 333
3.125	1.3148	2.6296	3.9843	5.2593		(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾

Note

⁽¹⁾ For integration time of 3.125 ms the maximum count level is no longer 16 bit, so, half the integration time no longer leads to double the max. lux level



HANDLING INSTRUCTION

Special care must be taken into consideration when handling the VEML6031X00. VEML6031X00 is sensitive to dust and scratches, proper optical device handling procedures are recommended.

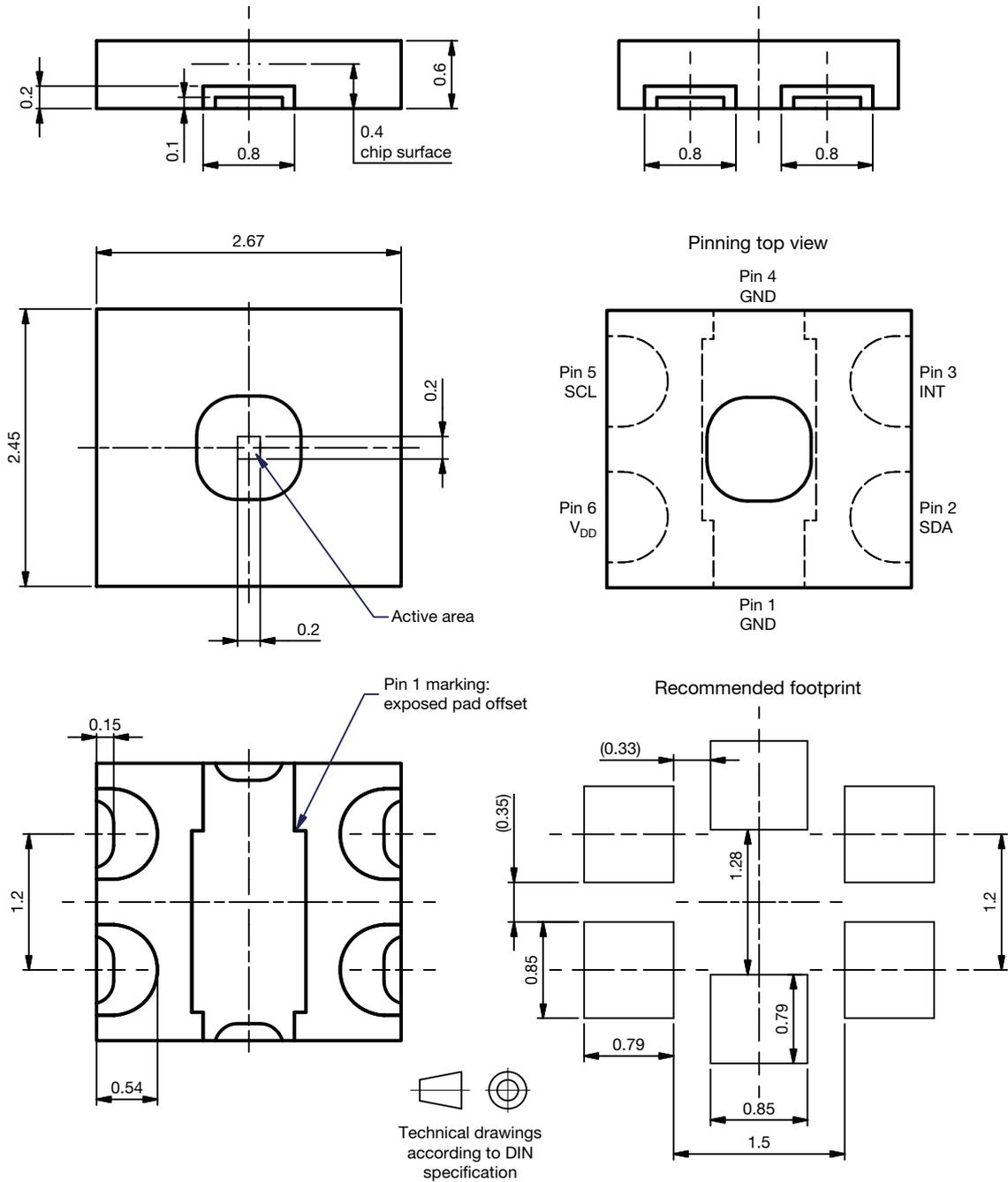
The optical surface of the device must be kept clean for optimal performance in both prototyping with the device and mass production manufacturing procedures. Tweezers with plastic or rubber contact surfaces are recommended to avoid scratches on the optical surface. Avoid manipulation with metal tools when possible. The optical surface must be kept clean of fingerprints, dust, and other optical-inhibiting contaminants.

If the device optical surface requires cleaning, the use of isopropyl alcohol is recommended. A few gentle brushes with a soft swab are appropriate. Avoid potentially abrasive cleaning and manipulating tools and excessive force that can scratch the optical surface.

If the VEML6031X00 performs less than optimally, inspect the optical surface for dirt, scratches, or other optical artifacts.



PACKAGE DIMENSIONS in millimeters

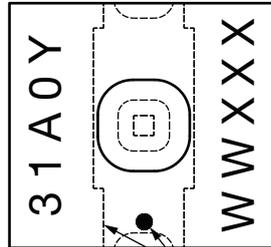


Drawing No.: 6.550-5357.01-4
Issue: 1; 14.04.2021

All dimensions in mm incl. burrs
Not indicated tolerances ± 0.1



MARKING AND PIN 1 IDENTIFICATION

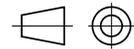


31: device type
 A: address option (0, 1)
 0: qualification (0 = AEC-Q100)
 Y: year
 WW: week
 XXX: lot number

Pin 1 marking
 dot marking on top side
 elongated feature on bottom side

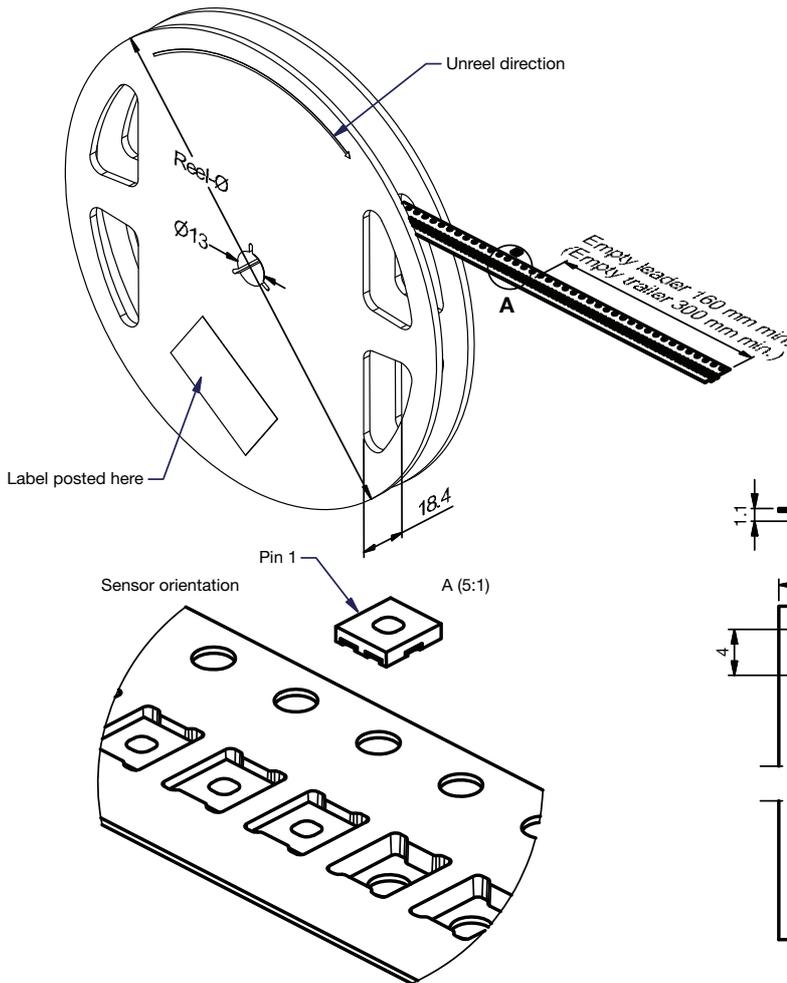
TAPE AND REEL DIMENSIONS in millimeters

Reel size:
 VEML6031: \varnothing 180 mm \pm 2 mm = 3000 pcs.
 VEML6031-GS 15: \varnothing 330 mm \pm 2 mm = 10 000 pcs.
 Reel design is representative for different types.



Technical drawings according to DIN specification

Non tolerated tolerances \pm 0.1 mm



Drawing No.: 9.800-5148.01-4
 Issue: 2; 28.05.21



DRYPACK

Devices are packed in moisture barrier bags (MBB) to prevent the products from moisture absorption during transportation and storage. Each bag contains a desiccant.

FLOOR LIFE

Floor life (time between soldering and removing from MBB) must not exceed the time indicated on MBB label:

Floor life: 4 weeks

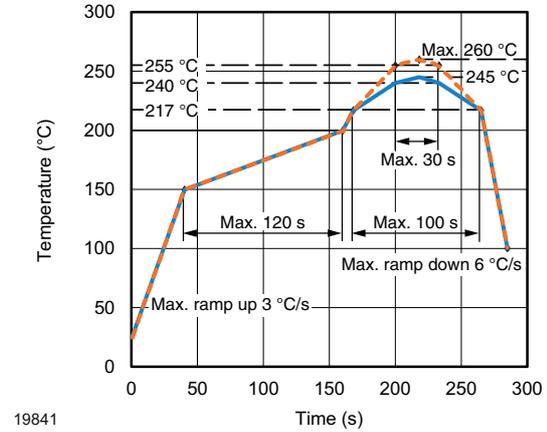
Conditions: $T_{amb} < 30\text{ }^{\circ}\text{C}$, $\text{RH} < 60\%$

Moisture sensitivity level 2a, according to J-STD-020.

DRYING

In case of moisture absorption devices should be baked before soldering. Conditions see J-STD-020 or label. Devices taped on reel dry using recommended conditions 192 h at $40\text{ }^{\circ}\text{C}$ (+ $5\text{ }^{\circ}\text{C}$), $\text{RH} < 5\%$.

REFLOW SOLDER PROFILE



19841

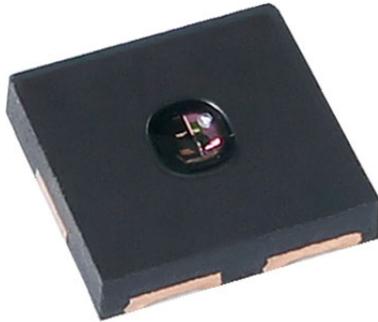
Fig. 12 - Lead (Pb)-free Reflow Solder Profile According to J-STD-020



REVISION HISTORY		
DATASHEET VERSION	REVISION DATE	CHANGE
1.4	18-Dec-2025	Corrected resolution, removed "Dark Current Offset vs. Ambient Temperature" figure, revised bit naming, revised block diagram, rearranged part handling information



High Accuracy Ambient Light Sensor With I²C Interface



FEATURES

- Package type: surface-mount
- Dimensions (L x W x H in mm): 2.67 x 2.45 x 0.6
- AEC-Q101 qualified
- Integrated modules: ambient light sensor (ALS)
- Supply voltage range V_{DD}: 2.5 V to 3.6 V
- Communication via I²C interface
- I²C bus H-level range: 1.7 V to 3.6 V
- Floor life: 4 weeks, MSL 2a, according to J-STD-020
- Low shut down current consumption: typ. 0.5 μA
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912



LINKS TO ADDITIONAL RESOURCES



DESCRIPTION

VEML6031X01 is a high accuracy ambient light digital 16-bit resolution sensor in a miniature opaque 2.67 mm x 2.45 mm package. It includes a high sensitive photodiode, a low noise amplifier, a 16-bit A/D converter and supports an easy to use I²C bus communication interface and additional interrupt feature.

The ambient light result is as digital value available.

APPLICATIONS

[Ambient light sensor in automotive](#) for

- Display backlight controls
- Infotainment systems
- Rear view mirror dimming
- Interior lighting control systems
- [Head-up displays](#)

AMBIENT LIGHT FUNCTION

- Filtron™ technology adaption: close to real human eye response
- Typical ALS output tolerance of ≤ 10 % under different light sources
- 16-bit dynamic range for ambient light detection from 0 lx to about 172 klx with resolution down to 0.0026 lx/ct, supports low transmittance (dark) lens design
- Excellent temperature compensation
- High dynamic detection resolution

PRODUCT SUMMARY						
PART NUMBER	OPERATING VOLTAGE RANGE (V)	I ² C BUS VOLTAGE RANGE (V)	AMBIENT LIGHT RANGE (lx)	AMBIENT LIGHT RESOLUTION (lx)	OUTPUT CODE	ADC RESOLUTION PROXIMITY / AMBIENT LIGHT
VEML6031X01	2.5 to 3.6	1.7 to 3.6	0 to 172 000	0.0026	16 bit, I ² C	- / 16 bit

ORDERING INFORMATION				
ORDERING CODE	SLAVE ADDRESS (7 BIT)	PACKAGING	VOLUME ⁽¹⁾	REMARKS
VEML6031X01	0x29	Tape and reel	MOQ: 3000	2.67 mm x 2.45 mm x 0.6 mm
VEML6031X01-GS15	0x29	Tape and reel	MOQ: 10 000	2.67 mm x 2.45 mm x 0.6 mm
VEML60311X01	0x10	Tape and reel	MOQ: 3000	2.67 mm x 2.45 mm x 0.6 mm
VEML60311X01-GS15	0x10	Tape and reel	MOQ: 10 000	2.67 mm x 2.45 mm x 0.6 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	+125	°C
Storage temperature range		T _{stg}	-40	+125	°C
Total power dissipation	T _{amb} ≤ 25 °C	P _{tot}	-	50	mW
Junction temperature		T _j	-	125	°C

BASIC CHARACTERISTICS (T _{amb} = 25 °C, unless otherwise specified)						
PARAMETER	TEST CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply voltage		V _{DD}	2.5	3.3	3.6	V
Supply current	Shutdown state ⁽¹⁾ , V _{DD} = V _{BUS}	I _{DD}	-	0.5	-	µA
	Shutdown state ⁽¹⁾ , V _{DD} = V _{BUS} = 3.0 V		-	-	1.2	
	Shutdown state ⁽¹⁾ , V _{DD} = 3.6 V, V _{BUS} = 1.7 V		-	3.1	-	
	Active state, V _{DD} = 3.3 V		-	280	-	
I ² C clock rate range		f _{SCL}	10	-	400	kHz
I ² C bus input H-level range	V _{BUS} = V _{DD}	V _{ih}	0.7 x V _{DD}	-	3.6	V
	V _{BUS} ≠ V _{DD}	V _{ih}	0.85 x V _{BUS}	-	3.6	V
I ² C bus input L-level range	V _{BUS} = V _{DD}	V _{il}	-0.3	-	0.3 x V _{DD}	V
	V _{BUS} ≠ V _{DD}	V _{il}	-0.3	-	0.2 x V _{BUS}	V
Digital current out (low, current sink)		I _{ol}	3	-	-	mA
Digital resolution (LSB count) ⁽²⁾	With ALS_GAIN = x 2, ALS_IT = 400 ms, PD_DIV = 4/4 PD		-	0.0026	-	lx/step
Detectable maximum illuminance	With ALS_GAIN = x 0.5, ALS_IT = 6.25 ms, PD_DIV = 1/4 PD	E _{v max.}	-	172 000	-	lx
ALS dark offset ⁽¹⁾	With ALS_GAIN = x 2, IT = 200 ms, PD_DIV = 4/4 PD		-	4	-	step
IR dark offset ⁽¹⁾	With ALS_GAIN = x 2, IT = 200 ms, PD_DIV = 4/4 PD		-	4	-	step

Notes

- ⁽²⁾ Light conditions: dark
- ⁽³⁾ Light conditions: E_v = 100 lx with 4300K white LED

CIRCUIT BLOCK DIAGRAM

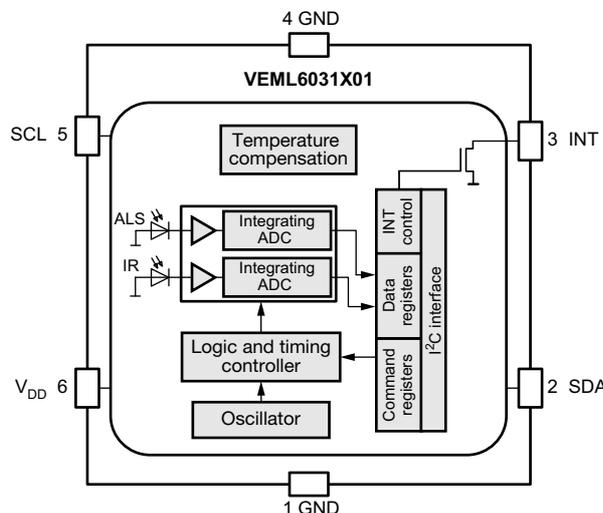


Fig. 1 - Block Diagram



I ² C 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)	0	3450	0	900	ns
Data setup time	t _(SUDAT)	250	-	100	-	ns
I ² C clock (SCK) low period	t _(LOW)	4.7	-	1.3	-	µs
I ² C clock (SCK) high period	t _(HIGH)	4.0	-	0.6	-	µs
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

Note

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

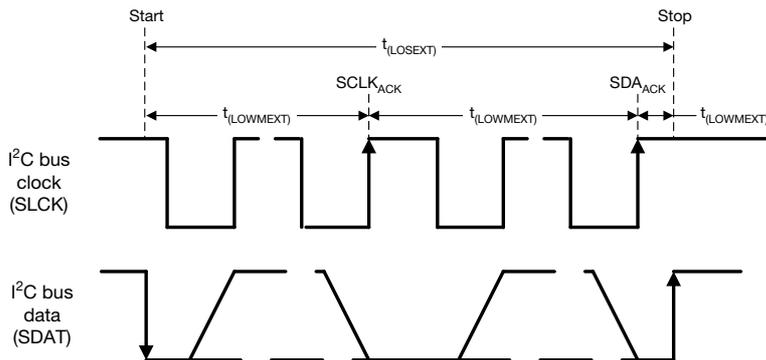
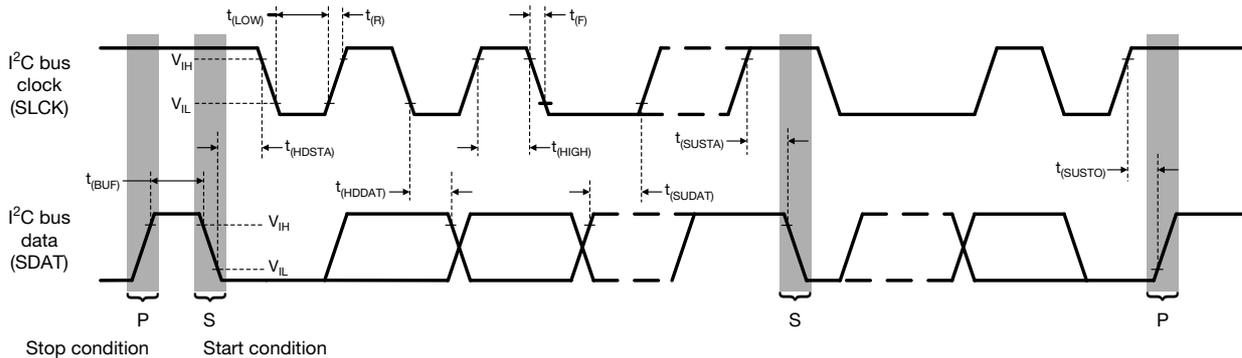


Fig. 2 - I²C Timing Diagram



PARAMETER TIMING INFORMATION

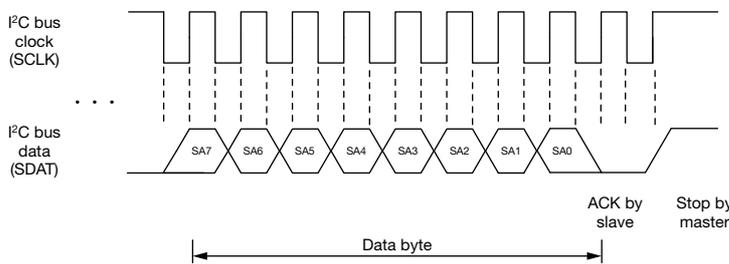
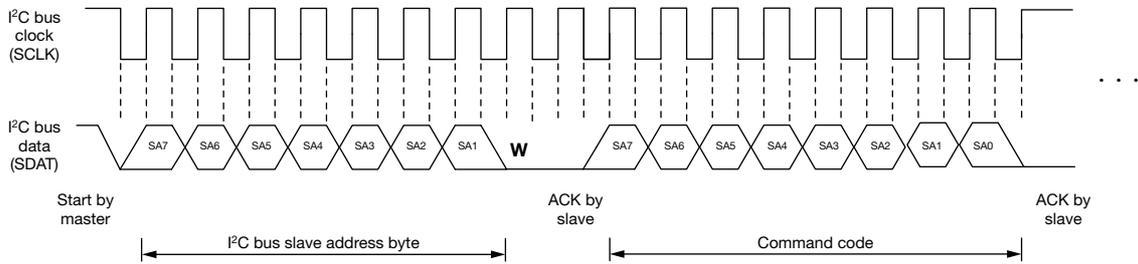


Fig. 3 - I²C Bus Timing for Sending Word Command Format

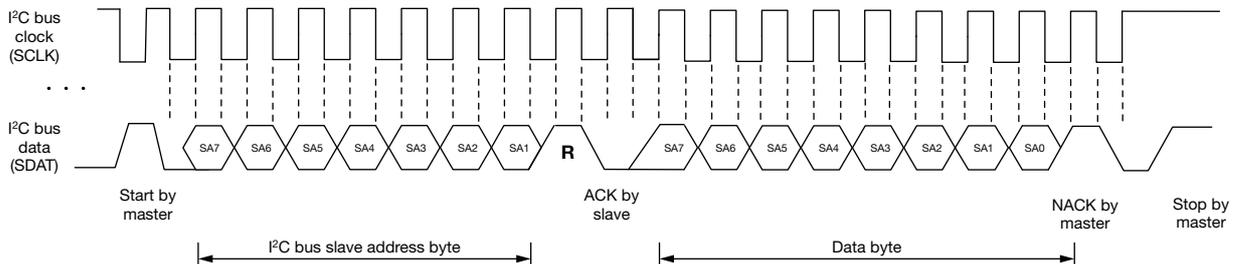
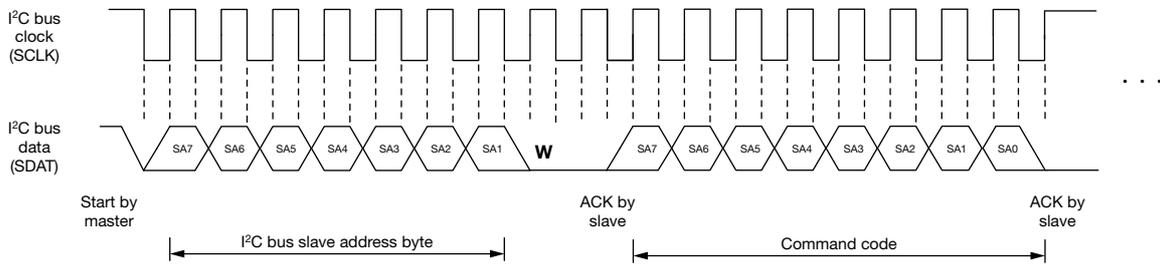


Fig. 4 - I²C Bus Timing for Receive Word Command Format

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

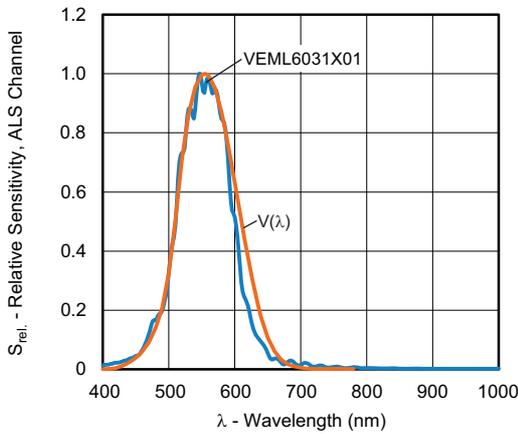


Fig. 5 - Relative Sensitivity, ALS Channel vs. Wavelength

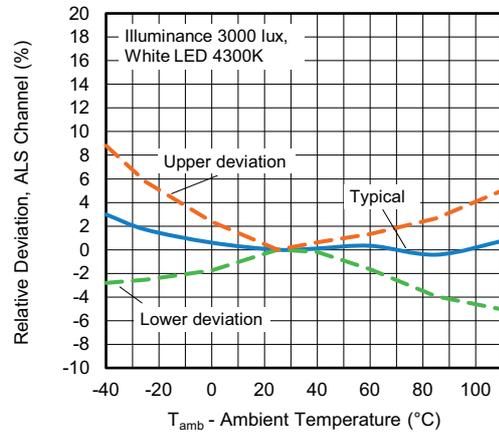


Fig. 8 - Relative Deviation, ALS Channel vs. Temperature (at lux levels lower than ~200 lux, dark current effects should be taken into account)

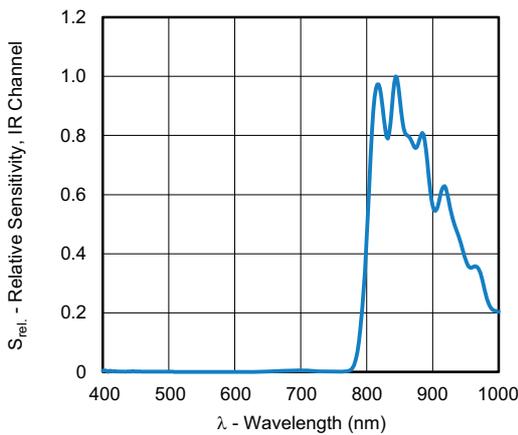


Fig. 6 - Relative Sensitivity, IR Channel vs. Wavelength

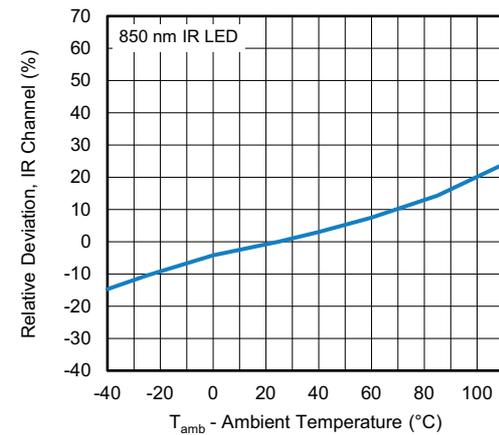


Fig. 9 - Relative Deviation IR Channel vs. Ambient Temperature

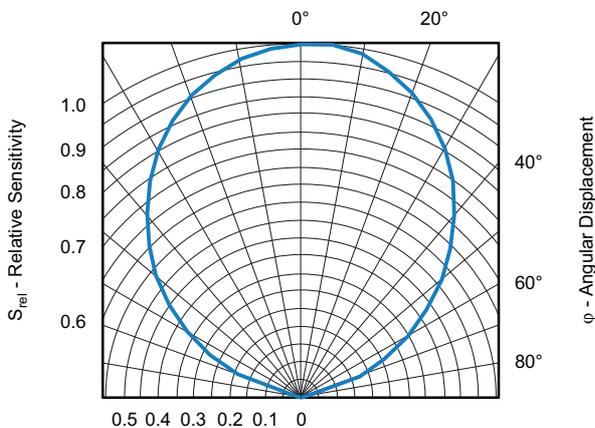


Fig. 7 - Relative Sensitivity vs. Angular Displacement

APPLICATION INFORMATION

1. Application Circuit

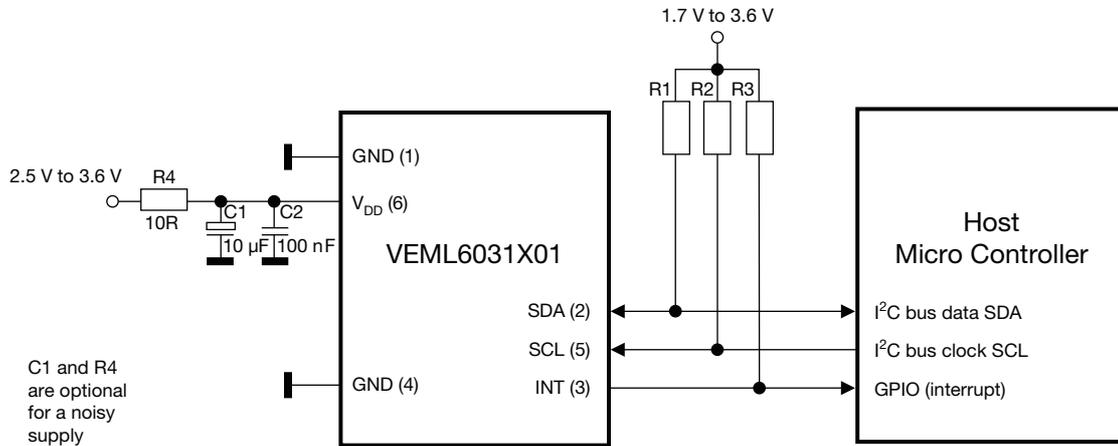


Fig. 10 - Application Circuit
(x) = Pin Number

Notes

- The interrupt pin is an open drain output. Proposed values for the pull-up resistors should be > 1 kΩ, e.g. 2.2 kΩ to 4.7 kΩ for the R1 and R2 (at SDA and SCL) and 10 kΩ to 100 kΩ for R3 (at interrupt).
- Normally just one decoupling capacitor is needed. This should be ≥ 100 nF and placed close to the V_{DD} pin.

For detailed description about set-up and use of the interrupt as well as more application related information see AN: “Designing VEML6031X01 into an Application”

2. I²C Interface

The VEML6031X01 has eighteen register addresses responsible for operation control, parameter setup and result buffering. All registers are accessible via I²C communication. Fig. 9 shows the basic I²C communication with VEML6031X01.

The built in I²C interface is compatible with I²C modes “standard” and “fast”: 10 kHz to 400 kHz.

Please refer to the I²C specification from NXP for details.

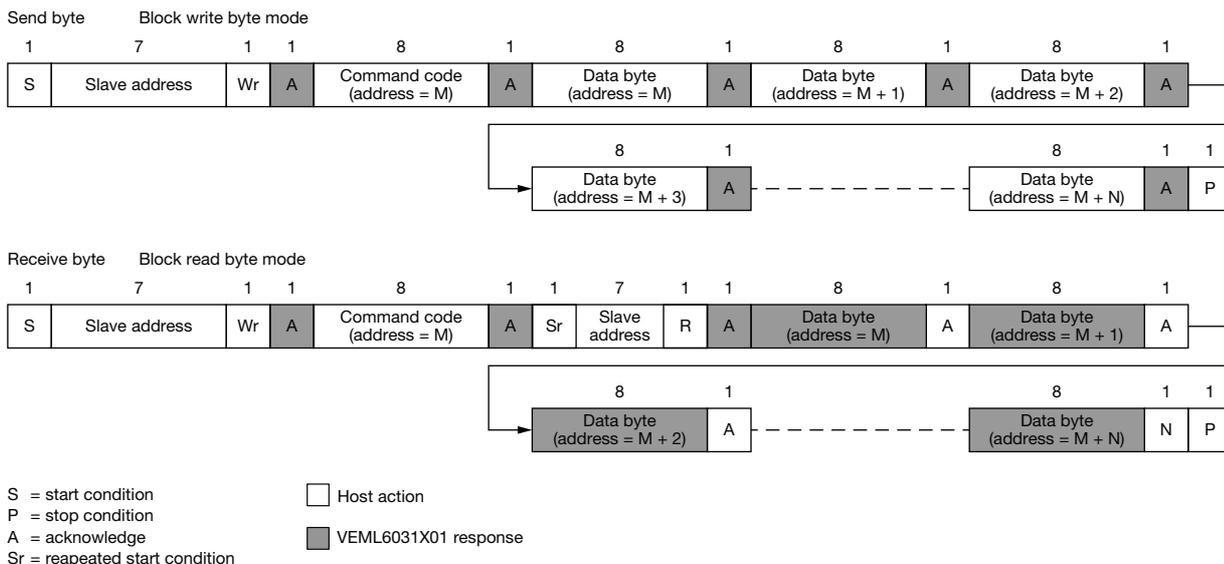


Fig. 11 - Send Byte / Receive Byte Protocol



REGISTER INFORMATION

Device Address

The VEML6031X01 is available in two different pre-configured slave addresses.

For one version the predefined 7 bit I2C bus address is set to 0101001 = 0x29. The least significant bit (LSB) defines read or write mode. Accordingly the bus address is set to 0101 0010 = 0x52 for write and 0101 0011 = 0x53 for read. The second version comes with predefined 7 bit I2C bus address of 0010000 = 0x10, so, here the write address is 0010 0000 = 0x20 for write and 0010 0001 = 0x21 for read.

TABLE 1 - SLAVE ADDRESS TABLE			
ORDERING CODE	7 BIT SLAVE ADDRESS	8 BIT SLAVE ADDRESS	
VEML6031X01	0x29	0x52 (Write)	0x53 (Read)
VEML60311X01	0x10	0x20 (Write)	0x21 (Read)

Register Addresses

The VEML6031X01 has eighteen registers, accessible through there respective 8-bit command codes.

The registers are 0x00 to 0x17 (0x02 and 0x03, 0x08 to 0x0F and 0x16 are not defined / reserved). Note that due to the location of the bits ALS_ON_0 and ALS_ON_1, one in register 0x00 and the other in 0x01, it is necessary to always write to both registers at once when configuring the device.

Auto-Memorization

The VEML6031X01 stores the last measured ambient data before the device is shutdown, keeping the data accessible.

When VEML6031X01 is in shutdown mode, the host can freely read this data via read command directly.

When VEML6031X01 wakes up, the data will be refreshed once a new measurement is made.

TABLE 2 - COMMAND CODE AND REGISTER DESCRIPTION					
COMMAND CODE	DATA BYTE LOW / HIGH	REGISTER NAME	DEFAULT VALUE	FUNCTION	ACCESS
0x00	-	ALS_CONF_0	0x01	Set the integration time	Write and read
				Measurement mode of the sensor	
				Enable interrupt function of the ALS channel	
				Switch the sensor on / off	
0x01	-	ALS_CONF_1	0x80	Switch the sensor on / off	
				GAIN and photodiode size setting	
				Interrupt persistence counter	
0x04	Low	ALS_THDH_L	0x00	ALS channel high threshold window setting (low byte)	
0x05	High	ALS_THDH_H	0x00	ALS channel high threshold window setting (high byte)	
0x06	Low	ALS_THDL_L	0x00	ALS channel low threshold window setting (low byte)	
0x07	High	ALS_THDL_H	0x00	ALS channel low threshold window setting (high byte)	
0x10	Low	ALS_DATA_L	0x00	Low byte of 16-bit ALS channel result data	
0x11	High	ALS_DATA_H	0x00	High byte of 16-bit ALS channel result data	
0x12	Low	IR_DATA_L	0x00	Low byte of 16-bit IR channel result data	
0x13	High	IR_DATA_H	0x00	High byte of 16-bit IR channel result data	
0x14	Low	VEML6031X01_ID_L	0x01	ID code	
0x15	High	VEML6031X01_ID_H	0x00	ID code	
0x16	Low	INT_FLAG_L	0x00	Reserverd	
0x17	High	INT_FLAG_H	0x00	Interrupt and active force mode event flag	

Notes

- Command code 0x00 default value is 0x01 = device is shutdown
- Command 0x00 and command 0x01 must be executed together, they cannot be executed independently



TABLE 3 - REGISTER NAME: ALS_CONF_0							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	ALS_IT			ALS_MODE	ALS_TRIG	ALS_INT	ALS_ON_0
COMMAND CODE					0x00		
BIT NAME	FUNCTION		BIT	VALUE	DESCRIPTION		
Reserved	Reserved		7	0x0 (0b0)	Should be kept default		
ALS_IT	Set the integration time		6 : 4	0x0 (0b000)	3.125 ms (default)		
				0x1 (0b001)	6.25 ms		
				0x2 (0b010)	12.5 ms		
				0x3 (0b011)	25 ms		
				0x4 (0b100)	50 ms		
				0x5 (0b101)	100 ms		
				0x6 (0b110)	200 ms		
				0x7 (0b111)	400 ms		
ALS_MODE	Set the measurement mode of the sensor		3	0x0 (0b0)	Auto mode (default)		
				0x1 (0b1)	Active force mode		
ALS_TRIG	Set the active force mode trigger; this bit will be reset to 0 after the measurement cycle		2	0x0 (0b0)	Off (default)		
				0x1 (0b1)	Trigger		
ALS_INT	Enable / disable the interrupt function of the ALS channel		1	0x0 (0b0)	Disable (default)		
				0x1 (0b1)	Enable		
ALS_ON_0	Switch the sensor on / off (ALS_ON_0 and ALS_ON_1 must be executed together to start the sensor)		0	0x0 (0b0)	Turn on the sensor		
				0x1 (0b1)	Turn off the sensor (shutdown) (default)		

Note

- Command Code 0x00 default value is 0x01 = device shutdown

TABLE 4 - REGISTER NAME: ALS_CONF_1							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_ON_1	ALS_PDDIV	Reserved	ALS_GAIN		ALS_PERS		ALS_CAL
COMMAND CODE					0x01		
BIT NAME	FUNCTION		BIT	VALUE	DESCRIPTION		
ALS_ON_1	Switch the sensor on / off (ALS_ON_0 and ALS_ON_1 must be executed together to start the sensor)		7	0x0 (0b0)	Turn on the sensor		
				0x1 (0b1)	Turn off the sensor (shutdown) (default)		
ALS_PDDIV	Set the effective photodiode size for the ALS and IR channel		6	0x0 (0b0)	4/4 PD used		
				0x1 (0b1)	1/4 PD used		
Reserved	Reserved		5	0x0 (0b0)	Should be kept default		
ALS_GAIN	Set the gain of the ALS		4 : 3	0x0 (0b00)	Gain x1		
				0x1 (0b01)	Gain x2		
				0x2 (0b10)	Gain x0.66		
				0x3 (0b11)	Gain x0.5		
ALS_PERS	Set the amount of consecutive threshold crossing events necessary to trigger interrupt		2 : 1	0x0 (0b00)	1 time (default)		
				0x1 (0b01)	2 times		
				0x2 (0b10)	4 times		
				0x3 (0b11)	8 times		
ALS_CAL	Enable / disable internal calibration after power on		0	0x1 (0b1)	Enable (must be set to "1" when power on ready)		
				0x0 (0b0)	Disable (default)		



TABLE 5 - REGISTER NAME: ALS_THDH							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDH_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDH_H							
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x04	ALS_THDH_L	Set the high threshold interrupt value	7 : 0	0 to 65 535	Low byte		
0x05	ALS_THDH_H		7 : 0		High byte		

TABLE 6 - REGISTER NAME: ALS_THDL							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDL_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDL_H							
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x06	ALS_THDL_L	Set the low threshold interrupt value	7 : 0	0 to 65 535	Low byte		
0x07	ALS_THDL_H		7 : 0		High byte		

TABLE 7 - REGISTER NAME: ALS_DATA							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_DATA_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_DATA_H							
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x10	ALS_DATA_L	Read the ALS channel output data	7 : 0	0 to 65 535	Low byte		
0x11	ALS_DATA_H		7 : 0		High byte		

TABLE 8 - REGISTER NAME: IR_DATA							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
IR_DATA_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
IR_DATA_H							
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x12	IR_DATA_L	Read the IR channel output data	7 : 0	0 to 65 535	Low byte		
0x13	IR_DATA_H		7 : 0		High byte		

TABLE 9 - REGISTER NAME: VEML6031X01_ID							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
VEML6031X01_ID_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
VEML6031X01_ID_H							
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x14	VEML6031X01_ID_L	Read the device ID	7 : 0	0x01 (0b00000001)	Should be kept default		
0x15	VEML6031X01_ID_H		7 : 0	0x00 (0b00000000)	Device with a slave address of 0x29		
			7 : 0	0x10 (0b00010000)	Device with a slave address of 0x10		



TABLE 10 - REGISTER NAME: INT_FLAG							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved				AF_DATA_READY	ALS_IF_L	ALS_IF_H	Reserved
COMMAND	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x16	Reserved	Reserved	7 : 0	0x00 (0b00000000)	Should be kept default		
0x17	Reserved	Reserved	7 : 4	0x0 (0b0000)	Should be kept default		
	AF_DATA_READY	Data ready flag active force mode	3	0x1 (0b1)	Data ready flag available		
				0x0 (0b0)	Data ready flag not available		
	ALS_IF_L	Low threshold interrupt flag	2	0x1 (0b1)	Low threshold crossing interrupt event flag for the ALS channel		
				0x0 (0b0)	No low threshold crossing		
	ALS_IF_H	High threshold interrupt flag	1	0x1 (0b1)	High threshold crossing interrupt event flag for the ALS channel		
0x0 (0b0)				No high threshold crossing			
Reserved	Reserved	0	0x0 (0b0)	Should be kept default			

CALCULATING THE LUX LEVEL

Command code 0x10 and 0x11 contain the results of the ALS measurement. This 16-bit code needs to be converted to a decimal value to determine the corresponding lux value.

The calculation of the corresponding lux level is dependent on the programmed gain setting and the chosen integration time.

TABLE 11 - RESOLUTION AND MAXIMUM DETECTION RANGE AT ALS_PDDIV (4/4 PD USED)									
IT (ms)	TYPICAL RESOLUTION (lx/cnt)					MAXIMUM POSSIBLE ILLUMINATION (lx)			
	ALS_GAIN					ALS_GAIN			
	x2	x1	x0.66	x0.5		x2	x1	x0.66	x0.5
400	0.0026	0.0051	0.0078	0.0103		168	337	510	673
200	0.0051	0.0103	0.0156	0.0205		337	673	1020	1346
100	0.0103	0.0205	0.0311	0.0411		673	1346	2040	2693
50	0.0205	0.0411	0.0623	0.0822		1346	2693	4080	5385
25	0.0411	0.0822	0.1245	0.1644		2693	5385	8160	10 771
12.5	0.0822	0.1644	0.2490	0.3287		5385	10 771	16 319	21 542
6.25	0.1644	0.3287	0.4980	0.6574		10 771	21 542	32 639	43 083
3.125	0.3287	0.6574	0.9961	1.3148		(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾

TABLE 12 - RESOLUTION AND MAXIMUM DETECTION RANGE AT ALS_PDDIV (1/4 PD USED)									
IT (ms)	TYPICAL RESOLUTION (lx/cnt)					MAXIMUM POSSIBLE ILLUMINATION (lx)			
	ALS_GAIN					ALS_GAIN			
	x2	x1	x0.66	x0.5		x2	x1	x0.66	x0.5
400	0.0103	0.0205	0.0311	0.0411		673	1346	2040	2693
200	0.0205	0.0411	0.0623	0.0822		1346	2693	4080	5385
100	0.0411	0.0822	0.1245	0.1644		2693	5385	8160	10 771
50	0.0822	0.1644	0.2490	0.3287		5385	10 771	16 319	21 542
25	0.1644	0.3287	0.4980	0.6574		10 771	21 542	32 639	43 083
12.5	0.3287	0.6574	0.9961	1.3148		21 542	43 083	65 278	86 166
6.25	0.6574	1.3148	1.9921	2.6296		43 083	86 166	130 555	172 333
3.125	1.3148	2.6296	3.9843	5.2593		(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾

Note

⁽¹⁾ For integration time of 3.125 ms the maximum count level is no longer 16 bit, so, half the integration time no longer leads to double the max. lux level



HANDLING INSTRUCTION

Special care must be taken into consideration when handling the VEML6031X01. VEML6031X01 is sensitive to dust and scratches, proper optical device handling procedures are recommended.

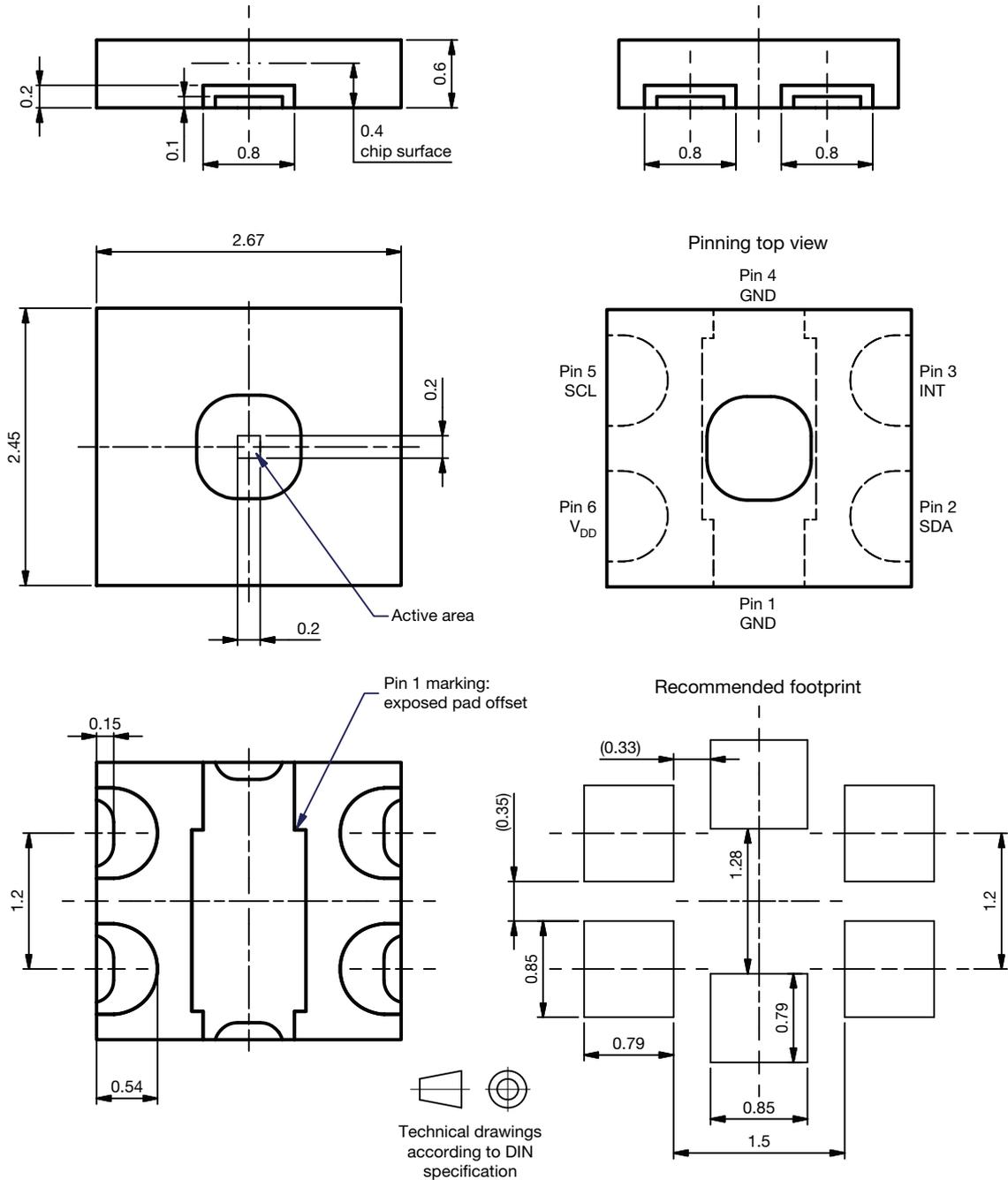
The optical surface of the device must be kept clean for optimal performance in both prototyping with the device and mass production manufacturing procedures. Tweezers with plastic or rubber contact surfaces are recommended to avoid scratches on the optical surface. Avoid manipulation with metal tools when possible. The optical surface must be kept clean of fingerprints, dust, and other optical-inhibiting contaminants.

If the device optical surface requires cleaning, the use of isopropyl alcohol is recommended. A few gentle brushes with a soft swab are appropriate. Avoid potentially abrasive cleaning and manipulating tools and excessive force that can scratch the optical surface.

If the VEML6031X01 performs less than optimally, inspect the optical surface for dirt, scratches, or other optical artifacts.



PACKAGE DIMENSIONS in millimeters

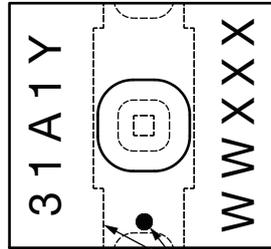


Drawing No.: 6.550-5357.01-4
Issue: 1; 14.04.2021

All dimensions in mm incl. burrs
Not indicated tolerances ± 0.1



MARKING AND PIN 1 IDENTIFICATION



31: device type
 A: address option (0, 1)
 1: qualification (1 = AEC-Q101)
 Y: year
 WW: week
 XXX: lot number

Pin 1 marking
 dot marking on top side
 elongated feature on bottom side

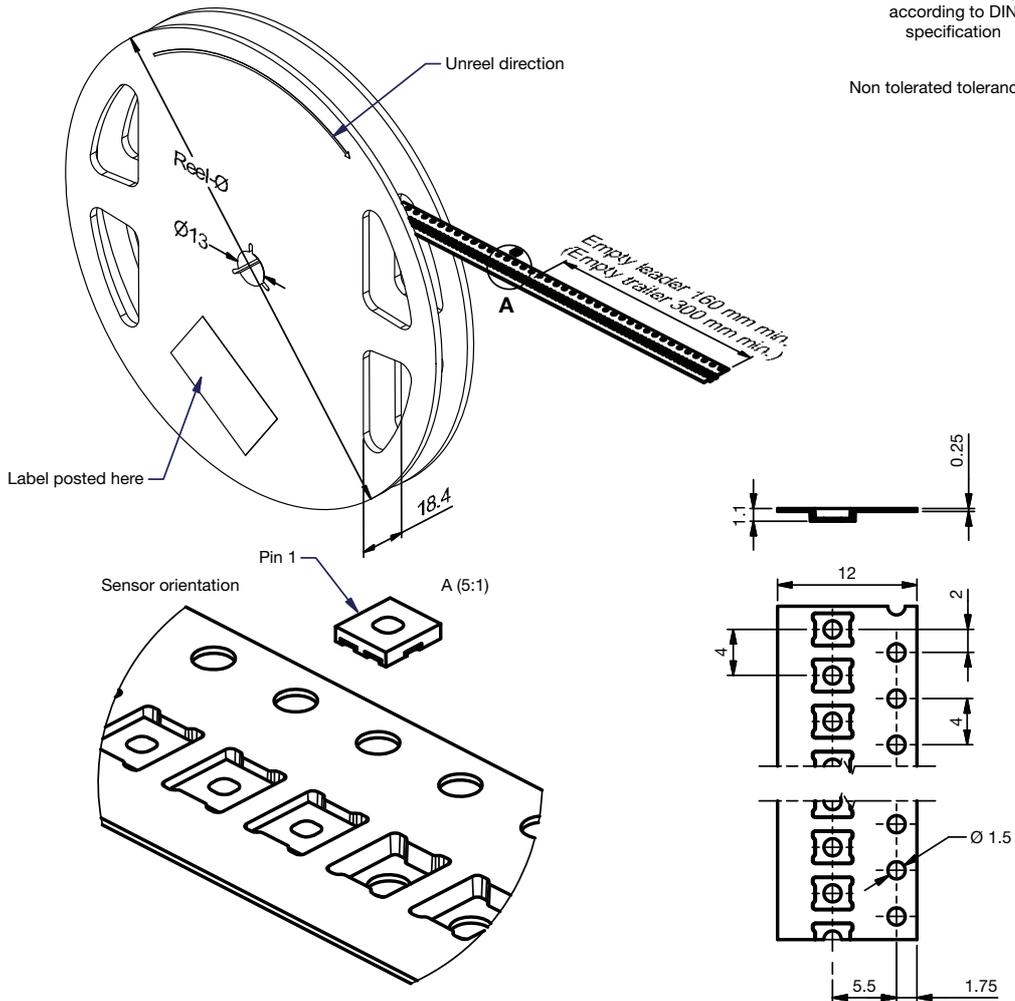
TAPE AND REEL DIMENSIONS in millimeters

Reel size:
 VEML6031: \varnothing 180 mm \pm 2 mm = 3000 pcs.
 VEML6031-GS 15: \varnothing 330 mm \pm 2 mm = 10 000 pcs.
 Reel design is representative for different types.



Technical drawings according to DIN specification

Non tolerated tolerances \pm 0.1 mm



Drawing No.: 9.800-5148.01-4
 Issue: 2; 28.05.21



DRYPACK

Devices are packed in moisture barrier bags (MBB) to prevent the products from moisture absorption during transportation and storage. Each bag contains a desiccant.

FLOOR LIFE

Floor life (time between soldering and removing from MBB) must not exceed the time indicated on MBB label:

Floor life: 4 weeks

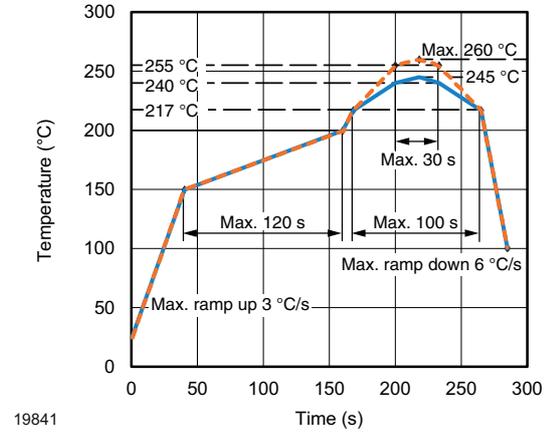
Conditions: $T_{amb} < 30\text{ }^{\circ}\text{C}$, $RH < 60\%$

Moisture sensitivity level 2a, according to J-STD-020.

DRYING

In case of moisture absorption devices should be baked before soldering. Conditions see J-STD-020 or label. Devices taped on reel dry using recommended conditions 192 h at $40\text{ }^{\circ}\text{C}$ (+ $5\text{ }^{\circ}\text{C}$), $RH < 5\%$.

REFLOW SOLDER PROFILE



19841

Fig. 12 - Lead (Pb)-free Reflow Solder Profile According to J-STD-020



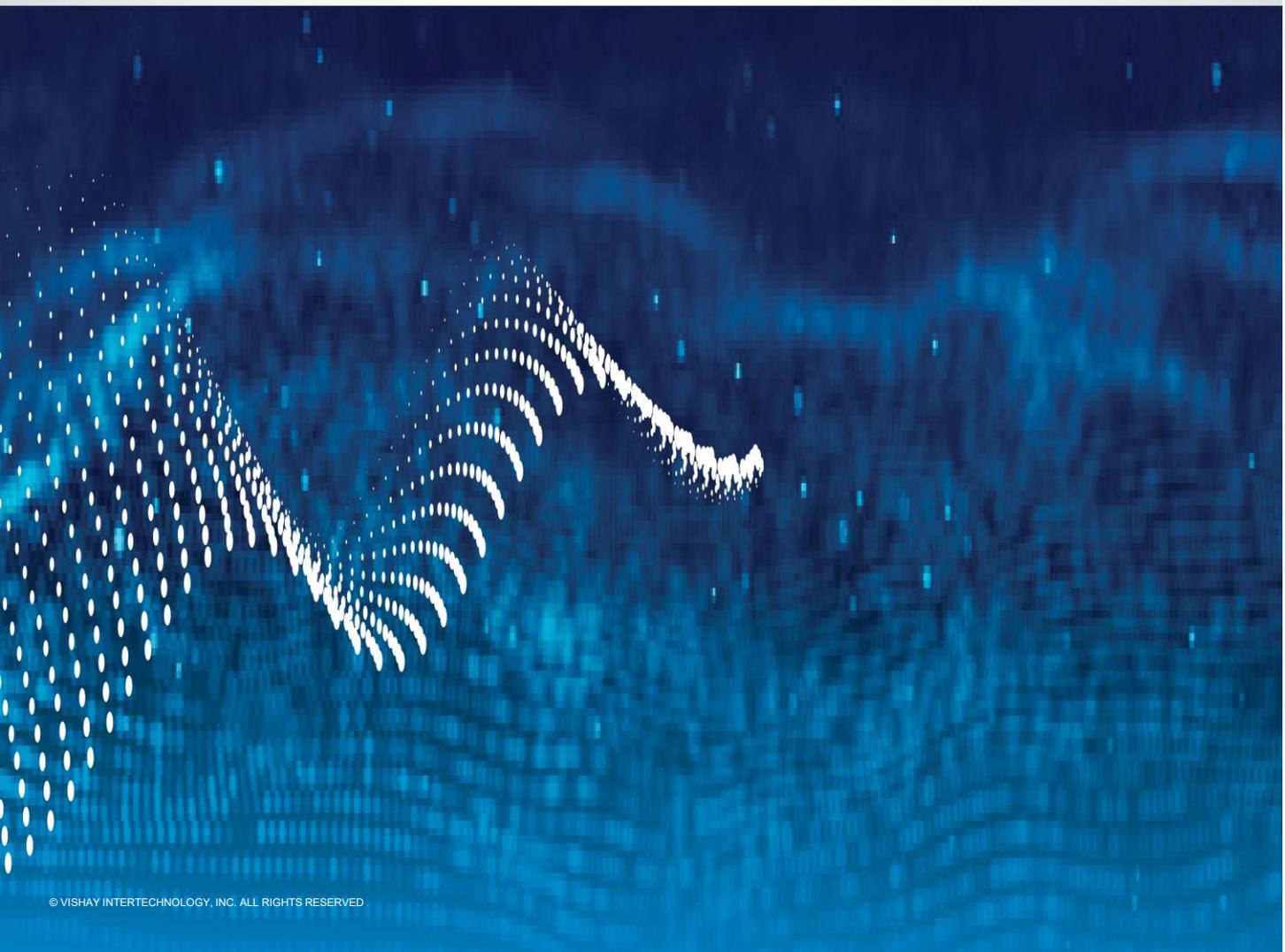
REVISION HISTORY		
DATASHEET VERSION	REVISION DATE	CHANGE
1.1	18-Dec-2025	Corrected resolution, removed "Dark Current Offset vs. Ambient Temperature" figure, revised bit naming, revised block diagram, rearranged part handling information



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VEML6031X00 AppNote Update

Change from Revision: 14-Jun-2021 to Revision: 08-Dec-2025



- Updated the fig 13 - Lux Error diagram over different light sources as it contains an algebraic sign error. Values shown as positive where negative and vice versa.
- Updated resolution & bit naming in accordance to the updates in the corresponding datasheet (VEMML6031X00 - Rev. 1.4, 18-Dec-2025)

Summary

By Reinhard Schaar

HIGH ACCURACY AMBIENT LIGHT SENSOR: VEML6031X00

The VEML6031X00 is a high accuracy digital ambient light sensor with 16-bit resolution in a miniature opaque 2.67 mm x 2.45 mm package. It includes a high sensitivity photodiode, low noise amplifier, and 16-bit A/D converter, and supports an easy to use I²C bus communication interface and additional interrupt feature.

The ambient light read-out is available as a digital value, and the built-in photodiode response is near that of the human eye. The 16-bit dynamic range offers ambient light detection up to about 228 klx, with a resolution down to 0.0034 lx/counts.

Besides 100 Hz and 120 Hz flicker noise rejection and a low temperature coefficient, the device consumes just 0.5 µA in shutdown mode. The sensor is AEC-Q100 qualified and has a operating range from -40 °C to +110 °C.



The high sensitivity of 0.0034 lx/counts allows the sensor to be placed behind very dark cover glasses that will dramatically reduce the total light reaching it. The sensor will also work behind clear cover glass, because even high illumination - such as daylight and all indoor lights - will not saturate the device and read-outs up to 228 klx are possible.

By Reinhard Schaar

HIGH ACCURACY AMBIENT LIGHT SENSOR: VEML6031X00

The VEML6031X00 is a high accuracy digital ambient light sensor with 16-bit resolution in a miniature opaque 2.67 mm x 2.45 mm package. It includes a high sensitivity photodiode, low noise amplifier, and 16-bit A/D converter, and supports an easy to use I²C bus communication interface and additional interrupt feature.

The ambient light read-out is available as a digital value, and the built-in photodiode response is near that of the human eye. The 16-bit dynamic range offers ambient light detection up to about 172 klx with a resolution down to 0.0026 lx/counts.

Besides 100 Hz and 120 Hz flicker noise rejection and a low temperature coefficient, the device consumes just 0.5 µA in shutdown mode. The sensor is AEC-Q100 qualified and has a operating range from -40 °C to +110 °C.



The high sensitivity of 0.0026 lx/counts allows the sensor to be placed behind very dark cover glasses that will dramatically reduce the total light reaching it. The sensor will also work behind clear cover glass, because even high illumination - such as daylight and all indoor lights - will not saturate the device and read-outs up to 172 klx are possible.

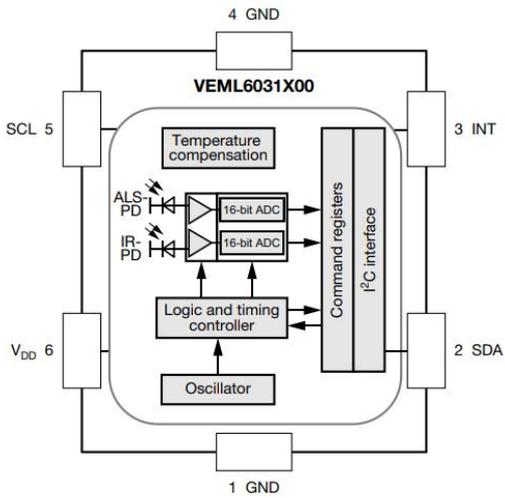


Fig. 1 - VEML6031X00 Block Diagram

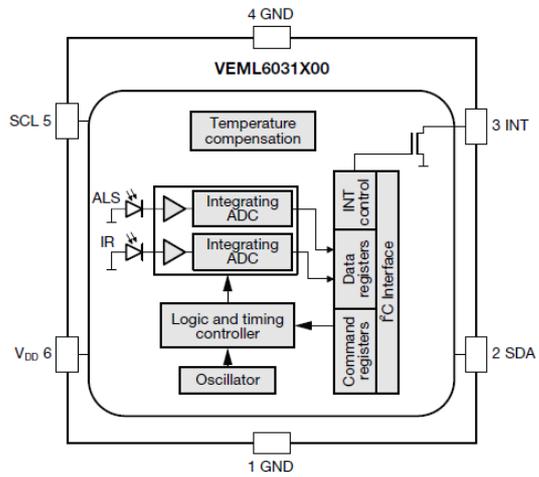


Fig. 1 - VEML6031X00 Block Diagram



www.vishay.com

Application Note
Vishay Semiconductors

Designing the VEML6031X00 Into an Application

DEVICE ADDRESS

The VEML6031X00 is available in two different pre-configured slave addresses. For one version the predefined 7-bit I²C bus address is set to 0101001 = 0x29. The least significant bit (LSB) defines read or write mode. Accordingly, the bus address is set to 0101 0010 = 0x2E for write and 0101 0011 = 0x2F for read. The second version comes with a predefined 7-bit I²C bus address of 0010000 = 0x10. So, here the write address is 0010 0000 = 0x20 for write and 0010 0001 = 0x21 for read.

SLAVE ADDRESS OPTIONS	
ORDERING CODE	SLAVE ADDRESS (7 bit)
VEML6031X00	0x29
VEML6031X00	0x10

REGISTERS OF THE VEML6031X00

The sensor has thirteen user-accessible registers from 0x00 to 0x17 (0x02 and 0x03, 0x08 to 0x0F, and 0x16 are not defined / reserved) with different functionalities. Note that due to the location of the two shutdown bits (SD and ALS_IR_SD), one in register 0x00 and the other in 0x01, it is necessary to always write to both registers at once when configuring the device.

COMMAND REGISTER FORMAT					
COMMAND CODE	REGISTER NAME	BIT	DEFAULT VALUE	FUNCTION / DESCRIPTION	R / W
0x00	ALS_CONF_0	0: 7	0x01	ALS integration time, measurement mode, shutdown	R / W
0x01	ALS_CONF_1	0: 7	0x00	ALS and IR shutdown, ALS gain, interrupt persistence	R / W
0x04	ALS_WL_L	0: 7	0x00	ALS high threshold window setting (LSB)	R / W
0x05	ALS_WH_H	0: 7	0x00	ALS high threshold window setting (MSB)	R / W
0x06	ALS_WL_L	0: 7	0x00	ALS low threshold window setting (LSB)	R / W
0x07	ALS_WL_H	0: 7	0x00	ALS low threshold window setting (MSB)	R / W
0x10	ALS_DATA_L	0: 7	0x00	Low byte of 16-bit ALS result DATA	R
0x11	ALS_DATA_H	0: 7	0x00	High byte of 16-bit ALS result DATA	R
0x12	IR_DATA_L	0: 7	0x00	Low byte of 16-bit IR result DATA	R
0x13	IR_DATA_H	0: 7	0x00	High byte of 16-bit IR result DATA	R
0x14	ID_L	0: 7	0x01	ID code	R
0x15	ID_H	0: 7	0x00	Package and version code	R
0x17	ALS_INT	0: 7	0x00	ALS INT trigger event	R

- Notes**
- Command code 0x00 default value is 0x01 = device is shutdown
 - Command 0x00 and command 0x01 must be executed together, they cannot be executed independently



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DEVICE ADDRESS

The VEML6031X00 is available in two different pre-configured slave addresses. For one version the predefined 7-bit I²C bus address is set to 0101001 = 0x29. The least significant bit (LSB) defines read or write mode. Accordingly, the bus address is set to 0101 0010 = 0x2E for write and 0101 0011 = 0x2F for read. The second version comes with a predefined 7-bit I²C bus address of 0010000 = 0x10. So, here the write address is 0010 0000 = 0x20 for write and 0010 0001 = 0x21 for read.

TABLE 1 - REGISTER NAME: DEVICE ADDRESS			
ORDERING CODE	7 BIT SLAVE ADDRESS (7 bit)	8 BIT SLAVE ADDRESS	
VEML6031X00	0x29	0x2E (write)	0x2F (read)
VEML6031X00	0x10	0x20 (write)	0x21 (read)

REGISTERS OF THE VEML6031X00

The sensor has thirteen user-accessible registers from 0x00 to 0x17 (0x02 and 0x03, 0x08 to 0x0F, and 0x16 are not defined / reserved) with different functionalities. Note that due to the location of the bits ALS_CN_0 and ALS_CN_1, one in register 0x00 and the other in 0x01, it is necessary to always write to both registers at once when configuring the device.

TABLE 2 - COMMAND REGISTER FORMAT					
COMMAND CODE	DATA BYTE LOW / HIGH	REGISTER NAME	DEFAULT VALUE	FUNCTION	ACCESS
0x00	-	ALS_CONF_0	0x01	Set the integration time	Write and read
				Measurement mode of the sensor	
				Enable interrupt function of the ALS channel	
				Switch the sensor on / off	
0x01	-	ALS_CONF_1	0x00	Switch the sensor on / off	Write and read
				Gain and photodiode size setting	
				Interrupt persistence counter	
				Interrupt persistence counter	
0x04	Low	ALS_THCH_L	0x00	ALS channel high threshold window setting (low byte)	Read only
0x05	High	ALS_THCH_H	0x00	ALS channel high threshold window setting (high byte)	
0x06	Low	ALS_THCL_L	0x00	ALS channel low threshold window setting (low byte)	
0x07	High	ALS_THCL_H	0x00	ALS channel low threshold window setting (high byte)	
0x10	Low	ALS_DATA_L	0x00	Low byte of 16-bit ALS channel result data	
0x11	High	ALS_DATA_H	0x00	High byte of 16-bit ALS channel result data	
0x12	Low	IR_DATA_L	0x00	Low byte of 16-bit IR channel result data	
0x13	High	IR_DATA_H	0x00	High byte of 16-bit IR channel result data	
0x14	Low	VEML6031X00_ID_L	0x01	ID code	
0x15	High	VEML6031X00_ID_H	0x00	ID code	
0x16	Low	INT_FLAGS_L	0x00	Reserved	
0x17	High	INT_FLAGS_H	0x00	Interrupt and active mode event flag	

- Notes**
- Command code 0x00 default value is 0x01 = device is shutdown
 - Command 0x00 and command 0x01 must be executed together, they cannot be executed independently



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Designing the VEML6031X00 Into an Application

INTEGRATION TIME AND GAIN SETTING OF THE ALS AND IR CHANNEL

The resolution of the ALS and IR channel can be determined by the setting of the integration time, the gain factor, and the PD size. The IT, GAIN factor, and PD size cannot be determined individually for each channel.

To achieve the highest resolution of 0.0034 lx/counts for the ALS channel, the max. integration time (400 ms), max. GAIN (ALS gain x 2), and the complete photodiode size (PD_DIV4 = 0, 4/4 PD used) need to be applied. Accordingly, with the lowest resolution of 3.48 lx/counts for the ALS channel, at the min. integration time (6.25 ms), min. GAIN (ALS gain x 0.5), and one quarter of the photodiode size (PD_DIV4 = 1, 1/4 PD), the max. illumination level of 228 klx is achievable.

Integration Time Setting

Within the command register 0x00 (ALS_CONF_0) bit 4 to 6 determine the applied integration time for the ALS and the IR channel.

REGISTER NAME	BIT	FUNCTION / DESCRIPTION	R / W
ALS_IT	6 : 4	ALS integration time setting	R / W
		000 = 3.125 ms	
		001 = 6.25 ms	
		010 = 12.5 ms	
		011 = 25 ms	
		100 = 50 ms	
		101 = 100 ms	
110 = 200 ms			
111 = 400 ms			

Remark: The default integration time is 3.125 ms.
For the integration time of 3.125 ms, the max. available resolution of the output channel is around 15 bit, which accordingly no longer leads to a doubling of the achievable illumination level.
The integration time mainly determines the sampling time of the data from the sensor.
If you would like to increase your sampling rate, you have to decrease your integration time.



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Designing the VEML6031X00 Into an Application

INTEGRATION TIME AND GAIN SETTING OF THE ALS AND IR CHANNEL

The resolution of the ALS and IR channel can be determined by the setting of the integration time, the gain factor, and the PD size. The IT, GAIN factor, and PD size cannot be determined individually for each channel.

To achieve the highest resolution of 0.0026 lx/counts for the ALS channel, the max. integration time (400 ms), max. GAIN (ALS gain x 2), and the complete photodiode size (PD_DIV4 = 0, 4/4 PD used) need to be applied. Accordingly, with the lowest resolution of 2.63 lx/counts for the ALS channel, at the min. integration time (6.25 ms), min. GAIN (ALS gain x 0.5), and one quarter of the photodiode size (PD_DIV4 = 1, 1/4 PD), the max. illumination level of 172 klx is achievable.

Integration Time Setting

Within the command register 0x00 (ALS_CONF_0) bit 4 to 6 determine the applied integration time for the ALS and the IR channel.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	ALS_IT	ALS_IT	ALS_IT	ALS_MODE	ALS_TRIG	ALS_INT	ALS_CN_0
COMMAND CODE							
BIT NAME				FUNCTION			
Reserved				Reserved			
				7			
				0x0 (0b0)			
				Should be kept default			
				0x0 (0b000)			
				3.125 ms (default)			
				0x1 (0b001)			
				6.25 ms			
				0x2 (0b010)			
				12.5 ms			
				0x3 (0b011)			
				25 ms			
				0x4 (0b100)			
				50 ms			
				0x5 (0b101)			
				100 ms			
				0x6 (0b110)			
				200 ms			
				0x7 (0b111)			
				400 ms			

Remark: The default integration time is 3.125 ms.
For the integration time of 3.125 ms, the max. available resolution of the output channel is around 15 bit, which accordingly no longer leads to a doubling of the achievable illumination level.
The integration time mainly determines the sampling time of the data from the sensor.
If you would like to increase your sampling rate, you have to decrease your integration time.

GAIN and PD Size Setting

Within the command register 0x01 (ALS_CONF_1), bit 4 and 5 determine the applied ALS_GAIN for the ALS and IR channel, whereby bit 6 determines the used size of the photodiode for the ALS and IR measurement.

TABLE 2 - REGISTER: ALS_CONF_1 - 0x01			
REGISTER NAME	BIT	FUNCTION / DESCRIPTION	R / W
PD_DIV4	6	Effective photodiode size ALS and IR 0 = 4/4 PD used 1 = 1/4 PD used	R / W
ALS_GAIN	4 : 3	Gain selection 00 = ALS gain x1 01 = ALS gain x2 10 = ALS gain x 0.66 11 = ALS gain x 0.5	R / W

Remark: Possible saturation effects during the measurement start can be avoided if the application starts with the lowest gain setting: ALS_GAIN x 0.5, PD_DIV4 = 1 (1/4 PD used).
The setting ALS_GAIN x2 and PD_DIV4 = 0 (4/4 PD used) should only be used if a high resolution is necessary. For example, if the sensor is placed under a dark cover glass where the illumination level is reduced to a low level. Please refer to Table 9 and Table 10 from the datasheet to get the best settings for the expected illumination level.

GAIN and PD Size Setting

Within the command register 0x01 (ALS_CONF_1), bit 4 and 5 determine the applied ALS_GAIN for the ALS and IR channel, whereby bit 6 determines the used size of the photodiode for the ALS and IR measurement.

TABLE 4 - REGISTER NAME: ALS_CONF_1					
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2
ALS_ON_1	ALS_PDDIV	Reserved	ALS_GAIN		ALS_PERS
					ALS_CAL
COMMAND CODE					
0x01					
BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION	
ALS_PDDIV	Set the effective photodiode size for the ALS and IR channel	6	0x0 (0b0)	4/4 PD used	
			0x1 (0b1)	1/4 PD used	
ALS_GAIN	Set the gain of the ALS	4 : 3	0x0 (0b00)	Gain x1	
			0x1 (0b01)	Gain x2	
			0x2 (0b10)	Gain x0.66	
			0x3 (0b11)	Gain x0.5	

Remark: Possible saturation effects during the measurement start can be avoided if the application starts with the lowest gain setting: ALS_GAIN x 0.5, PD_DIV4 = 1 (1/4 PD used).
The setting ALS_GAIN x2 and PD_DIV4 = 0 (4/4 PD used) should only be used if a high resolution is necessary. For example, if the sensor is placed under a dark cover glass where the illumination level is reduced to a low level. Please refer to Table 9 and Table 10 from the datasheet to get the best settings for the expected illumination level.

Designing the VEML6031X00 Into an Application

READ OUT THE MEASUREMENT RESULTS

The ambient light measurement results are stored in the register ALS_DATA, which can be accessed over the command codes 0x10 and 0x11.

The infrared measurement results are stored in the IR_DATA register, which can be accessed over the command codes 0x12 and 0x13.

The VEML6031X00 stores the last measured ambient as well as infrared data before the device is shut down, keeping the data accessible. When the VEML6031X00 is in shutdown mode, the host can freely read this data via the read command directly.

ALS MEASUREMENT RESULTS

The command codes 0x10 and 0x11 (ALS_DATA) contain the ambient light measurement results. The low byte is stored in the command code 0x10 (ALS_DATA_L) while the command code 0x11 (ALS_DATA_H) accesses the ALS results from the high byte.

COMMAND CODE	REGISTER NAME	BIT	FUNCTION / DESCRIPTION	R / W
0x10	ALS_DATA_L	7:0	ALS result channel (data byte low)	R
0x11	ALS_DATA_H	7:0	ALS result channel (data byte high)	R

IR MEASUREMENT RESULTS

The command codes 0x12 and 0x13 (IR_DATA) contain the ambient light measurement results. The low byte is stored in the command code 0x12 (IR_DATA_L) while the command code 0x13 (IR_DATA_H) accesses the high byte of the infrared measurement results.

The measurement results are stored in the register IR_DATA, which can be accessed over the command codes 0x12 and 0x13.

COMMAND CODE	REGISTER NAME	BIT	FUNCTION / DESCRIPTION	R / W
0x12	IR_DATA_L	7:0	IR result channel (data byte low)	R
0x13	IR_DATA_H	7:0	IR result channel (data byte high)	R

INTERRUPT HANDLING

To avoid too many interactions with the microcontroller, the interrupt feature may be used. The interrupt mode can be enabled with the ALS_INT_EN bit in register ALS_CONF_0 - 0x00.

REGISTER NAME	BIT	FUNCTION / DESCRIPTION	R / W
Reserved	7	Must be set to "0"	R / W
ALS_INT_EN	1	ALS interrupt setting 0 = interrupt disable 1 = interrupt enable	R / W

Designing the VEML6031X00 Into an Application

READ OUT THE MEASUREMENT RESULTS

The ambient light measurement results are stored in the register ALS_DATA, which can be accessed over the command codes 0x10 and 0x11.

The stored measurement results are stored in the IR_DATA register, which can be accessed over the command codes 0x12 and 0x13.

The VEML6031X00 stores the last measured ambient as well as infrared data before the device is shut down, keeping the data accessible. When the VEML6031X00 is in shutdown mode, the host can freely read this data via the read command directly.

ALS MEASUREMENT RESULTS

The command codes 0x10 and 0x11 (ALS_DATA) contain the ambient light measurement results. The low byte is stored in the command code 0x10 (ALS_DATA_L) while the command code 0x11 (ALS_DATA_H) accesses the ALS results from the high byte.

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
ALS_DATA_L							
ALS_DATA_H							

COMMAND CODE	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION
0x10	ALS_DATA_L	Read the ALS channel output data	7:0	0 to 65 535	Low byte
0x11	ALS_DATA_H	Read the ALS channel output data	7:0	0 to 65 535	High byte

IR MEASUREMENT RESULTS

The command codes 0x12 and 0x13 (IR_DATA) contain the ambient light measurement results. The low byte is stored in the command code 0x12 (IR_DATA_L) while the command code 0x13 (IR_DATA_H) accesses the high byte of the infrared measurement results.

The measurement results are stored in the register IR_DATA, which can be accessed over the command codes 0x12 and 0x13.

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
IR_DATA_L							
IR_DATA_H							

COMMAND CODE	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION
0x12	IR_DATA_L	Read the IR channel output data	7:0	0 to 65 535	Low byte
0x13	IR_DATA_H	Read the IR channel output data	7:0	0 to 65 535	High byte

INTERRUPT HANDLING

To avoid too many interactions with the microcontroller, the interrupt feature may be used. The interrupt mode can be enabled with the ALS_INT_EN bit in register ALS_CONF_0 - 0x00.

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
Reserved	Reserved	Reserved	ALS_IT	ALS_MODE	ALS_TRIG	ALS_INT	ALS_ON_0

COMMAND CODE	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION
Reserved	Reserved	Should be kept default	7	0x0 (0x0)	
ALS_INT	ALS_INT	Enable / disable the interrupt function of the ALS channel	1	0x0 (0x0) 0x1 (0x1)	Disable (default) Enable

Persistence Settings

The persistence function ALS_PERS determines the number of measurements that have to remain above or below the chosen threshold level to activate the interrupt pin.

TABLE 8 - REGISTER: ALS_CONF_1 - 0x01			
REGISTER NAME	BIT	FUNCTION / DESCRIPTION	R / W
ALS_PERS	2 : 1	ALS persistence protect number setting Number of persistent measurements above the threshold to trigger the interrupt 00 = 1 01 = 2 10 = 4 11 = 8	R / W

Interrupt Thresholds

The high and low threshold levels for the interrupt level can be determined individually.
In register ALS_WH - 0x04, the 0x05 high threshold window can be determined.

TABLE 9 - REGISTER: ALS_WH - 0x04, 0x05				
COMMAND CODE	REGISTER NAME	BIT	FUNCTION / DESCRIPTION	R / W
0x04	ALS_WH_L	7 : 0	ALS high threshold window setting (data byte low)	R / W
0x05	ALS_WH_H	7 : 0	ALS high threshold window setting (data byte high)	R / W

In register ALS_WL - 0x06, the 0x07 low threshold window can be determined.

TABLE 10 - REGISTER: ALS_WL - 0x06, 0x07				
COMMAND CODE	REGISTER NAME	BIT	FUNCTION / DESCRIPTION	R / W
0x06	ALS_WL_L	7 : 0	ALS low threshold window setting (data byte low)	R / W
0x07	ALS_WL_H	7 : 0	ALS low threshold window setting (data byte high)	R / W

Persistence Settings

The persistence function ALS_PERS determines the number of measurements that have to remain above or below the chosen threshold level to activate the interrupt pin.

TABLE 8 - REGISTER NAME: ALS_CONF_1							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_ON_1	ALS_PDDIV	Reserved	ALS_GAIN		ALS_PERS		ALS_CAL
COMMAND CODE			0x01				
BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION			
ALS_PERS	Set the amount of consecutive threshold crossing events necessary to trigger interrupt	2 : 1	0x1 (0b00)	1 time (default)			
			0x2 (0b01)	2 times			
			0x3 (0b10)	4 times			
			0x4 (0b11)	8 times			

Interrupt Thresholds

The high and low threshold levels for the interrupt level can be determined individually.
In register ALS_WH - 0x04, the 0x05 high threshold window can be determined.

TABLE 9 - REGISTER NAME: ALS_THDH							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDH_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDH_H							
COMMAND CODE	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x04	ALS_THDH_L	Set the high threshold interrupt value	7 : 0	0 to 65 535	Low byte		
0x05	ALS_THDH_H		7 : 0		High byte		

In register ALS_WL - 0x06, the 0x07 low threshold window can be determined.

TABLE 10 - REGISTER NAME: ALS_THDL							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDL_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDL_H							
COMMAND CODE	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x06	ALS_THDL_L	Set the low threshold interrupt value	7 : 0	0 to 65 535	Low byte		
0x07	ALS_THDL_H		7 : 0		High byte		

CALCULATING THE LUX LEVEL

Command codes 0x10 and 0x11 contain the results of the ALS measurement. This 16-bit code needs to be converted to a decimal value to determine the corresponding lux value. The calculation of the corresponding lux level is dependent on the programmed gain setting and the chosen integration time.

The component is most sensitive with ALS_GAIN = x2, PD_DIV4 = 4/4, and an integration time of 400 ms, specified to a resolution of 0.0034 lx/step.

Every time the integration time is halved, the resolution is doubled, but the possible detection range is also doubled.

The same principle is valid for the gain setting. For ALS_GAIN = x1, it is doubled. For PD_DIV4 = 1/4, the size of the photodiode is just 1/4, the sensitivity is also just 1/4, and the resolution and max. possible detection range is x 4 to allow for higher illuminations up to about 228 klx.

IT (ms)	TYPICAL RESOLUTION (lx/count)				MAXIMUM POSSIBLE ILLUMINATION (lx)			
	GAIN x 2	GAIN x 1	GAIN x 0.56	GAIN x 0.5	GAIN x 2	GAIN x 1	GAIN x 0.56	GAIN x 0.5
400	0.0034	0.0068	0.0103	0.0136	223	446	675	891
200	0.0068	0.0136	0.0206	0.0272	446	891	1350	1783
100	0.0136	0.0272	0.0412	0.0544	891	1783	2701	3565
50	0.0272	0.0544	0.0804	0.1068	1783	3565	5402	7130
25	0.0544	0.1088	0.1648	0.2176	3565	7130	10803	14260
12.5	0.1088	0.2176	0.3297	0.4352	7130	14260	21607	28521
6.25	0.2176	0.4352	0.6594	0.8704	14260	28521	43213	57042
3.125	0.4352	0.8704	1.3188	1.7408	(*) ⁽¹⁾	(*) ⁽¹⁾	(*) ⁽¹⁾	(*) ⁽¹⁾

IT (ms)	TYPICAL RESOLUTION (lx/count)				MAXIMUM POSSIBLE ILLUMINATION (lx)			
	GAIN x 2	GAIN x 1	GAIN x 0.56	GAIN x 0.5	GAIN x 2	GAIN x 1	GAIN x 0.56	GAIN x 0.5
400	0.0136	0.0272	0.0412	0.0544	891	1783	2701	3565
200	0.0272	0.0544	0.0804	0.1068	1783	3565	5402	7130
100	0.0544	0.1088	0.1648	0.2176	3565	7130	10803	14260
50	0.1088	0.2176	0.3297	0.4352	7130	14260	21607	28521
25	0.2176	0.4352	0.6594	0.8704	14260	28521	43213	57042
12.5	0.4352	0.8704	1.3188	1.7408	28521	57042	86427	114083
6.25	0.8704	1.7408	2.6376	3.4816	57042	114083	172854	228167
3.125	1.7408	3.4816	5.2752	6.9632	(*) ⁽¹⁾	(*) ⁽¹⁾	(*) ⁽¹⁾	(*) ⁽¹⁾

Note
⁽¹⁾ For an integration time of 3.125 ms, the maximum count level is no longer 16 bit, so, half the integration time no longer leads to double the max. lux level

Example

If the 16-bit word of the ALS data shows: 0000 0101 1100 1000 = 1480 (dec.), the programmed ALS_GAIN = x 1, PD_DIV4 = 4/4 (= x 1) and ALS_IT = 100 ms, the corresponding lux level is: light level (lx) = 1480 x 0.0272 = 40.256 lx.

CALCULATING THE LUX LEVEL

Command codes 0x10 and 0x11 contain the results of the ALS measurement. This 16-bit code needs to be converted to a decimal value to determine the corresponding lux value. The calculation of the corresponding lux level is dependent on the programmed gain setting and the chosen integration time.

The component is most sensitive with ALS_GAIN = x2, ALS_PDDIV = 4/4, and an integration time of 400 ms, specified to a resolution of 0.0026 lx/step.

Every time the integration time is halved, the resolution is doubled, but the possible detection range is also doubled.

The same principle is valid for the gain setting. For ALS_GAIN = x1, it is doubled. For ALS_PDDIV = 1/4, the size of the photodiode is just 1/4, the sensitivity is also just 1/4, and the resolution and max. possible detection range is x 4 to allow for higher illuminations up to about 172 klx.

IT (ms)	TYPICAL RESOLUTION (lx/count)				MAXIMUM POSSIBLE ILLUMINATION (lx)			
	GAIN x 2	GAIN x 1	GAIN x 0.56	GAIN x 0.5	GAIN x 2	GAIN x 1	GAIN x 0.56	GAIN x 0.5
400	0.0026	0.0051	0.0078	0.0103	166	337	510	673
200	0.0051	0.0103	0.0156	0.0205	337	673	1020	1346
100	0.0103	0.0205	0.0311	0.0411	673	1346	2040	2693
50	0.0205	0.0411	0.0623	0.0822	1346	2693	4080	5385
25	0.0411	0.0822	0.1245	0.1644	2693	5385	8160	10771
12.5	0.0822	0.1644	0.2490	0.3287	5385	10771	16319	21542
6.25	0.1644	0.3287	0.4980	0.6574	10771	21542	32639	43083
3.125	0.3287	0.6574	0.9961	1.3148	(*) ⁽¹⁾	(*) ⁽¹⁾	(*) ⁽¹⁾	(*) ⁽¹⁾

IT (ms)	TYPICAL RESOLUTION (lx/count)				MAXIMUM POSSIBLE ILLUMINATION (lx)			
	GAIN x 2	GAIN x 1	GAIN x 0.56	GAIN x 0.5	GAIN x 2	GAIN x 1	GAIN x 0.56	GAIN x 0.5
400	0.0103	0.0205	0.0311	0.0411	673	1346	2040	2693
200	0.0205	0.0411	0.0623	0.0822	1346	2693	4080	5385
100	0.0411	0.0822	0.1245	0.1644	2693	5385	8160	10771
50	0.0822	0.1644	0.2490	0.3287	5385	10771	16319	21542
25	0.1644	0.3287	0.4980	0.6574	10771	21542	32639	43083
12.5	0.3287	0.6574	0.9961	1.3148	21542	43083	65278	86166
6.25	0.6574	1.3148	1.9921	2.6296	43083	86166	130555	172333
3.125	1.3148	2.6296	3.9843	5.2593	(*) ⁽¹⁾	(*) ⁽¹⁾	(*) ⁽¹⁾	(*) ⁽¹⁾

Note
⁽¹⁾ For integration time of 3.125 ms the maximum count level is no longer 16 bit, so, half the integration time no longer leads to double the max. lux level

Example

If the 16-bit word of the ALS data shows: 0000 0101 1100 1000 = 1480 (dec.), the programmed ALS_GAIN = x 1, ALS_PDDIV = 4/4 PD used, and -ALS_IT = 100 ms, the corresponding lux level is: light level (lx) = 1480 x 0.0205 = 30.34 lx.

LUX LEVEL MATCHING FOR DIFFERENT LIGHT SOURCES
The VEMLE6031X00 shows very good matching for all kinds of light sources.

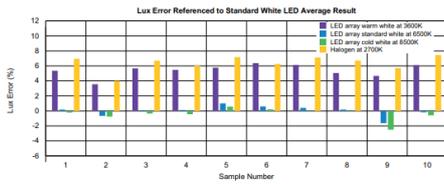


Fig. 13 - Tolerances for Different Light Sources

LUX LEVEL MATCHING FOR DIFFERENT LIGHT SOURCES
The VEMLE6031X00 shows very good matching for all kinds of light sources.



Fig. 13 - Tolerances for Different Light Sources

Revision: 14-Jun-2021

Revision: 08-Dec-2025

APPLICATION-DEPENDENT LUX CALCULATION

If the application uses a darkened / tinted cover glass, just 10 % - or even just 1 % - of the ambient light will reach the sensor. For a tinted cover glass where there is 1 lx up to 100 klx of light outside, just 0.01 lx to 1 klx is reaching the sensor, and the application software may always stay with ALS_GAIN x2 and full PD size (PD_DIV4 = 0).

If the application uses a clear cover glass, nearly all ambient light will reach the sensor. This means up to about 228 klx may be possible. For this clear cover where < 1 lx to ≥ 100 klx is possible, the application software will need to adapt the gain steps, and for very high illumination, also reduce the size of the photodiode to just 1/4.

For unknown brightness conditions, the application should always start with the lowest gain: ALS_GAIN x 0.5 and PD_DIV4 = 1 (1/4 PD size). This avoids possible overload / saturation if, for example, direct sunlight suddenly reaches the sensor.

The VEML6031X00 shows very good linear behavior for all levels from 0.0034 lx to about 228 klx.

A software flow may look like the flow chart diagram at the end of this note:

- Starting with the lowest sensitivity (ALS_GAIN = 0.5 and PD_DIV4 = 1), check the ALS counts. If ≤ 100 counts, increase sensitivity with PD_DIV4 = 0, full PD size
- Check the ALS counts again. If they are still ≤ 100 counts, increase up to 2
- Check the ALS counts again. If they are still ≤ 100 counts, increase the integration time from 100 ms to 200 ms, and continue the procedure up to the longest integration time of 400 ms. If a very dark cover glass is used and one knows that just few percent of outside light is reaching the sensor, one may directly start with higher gain

APPLICATION-DEPENDENT LUX CALCULATION

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If the application uses a clear cover glass, nearly all ambient light will reach the sensor. This means up to about 172 klx may be possible. For this clear cover where < 1 lx to ≥ 100 klx is possible, the application software will need to adapt the gain steps, and for very high illumination, also reduce the size of the photodiode to just 1/4.

For unknown brightness conditions, the application should always start with the lowest gain: ALS_GAIN x 0.5 and ALS_PDDIV = 1 (1/4 PD used). This avoids possible overload / saturation if, for example, direct sunlight suddenly reaches the sensor.

The VEML6031X00 shows very good linear behavior for all levels from 0.0026 lx to about 172 klx.

A software flow may look like the flow chart diagram at the end of this note:

- Starting with the lowest sensitivity (ALS_GAIN = 0.5 and ALS_PDDIV = 1), check the ALS counts. If ≤ 100 counts, increase sensitivity with ALS_PDDIV = 0, 4/4 PD used
- Check the ALS counts again. If they are still ≤ 100 counts, increase up to 2
- Check the ALS counts again. If they are still ≤ 100 counts, increase the integration time from 100 ms to 200 ms, and continue the procedure up to the longest integration time of 400 ms. If a very dark cover glass is used and one knows that just few percent of outside light is reaching the sensor, one may directly start with higher gain

THANK YOU



Designing the VEML6031X00 Into an Application

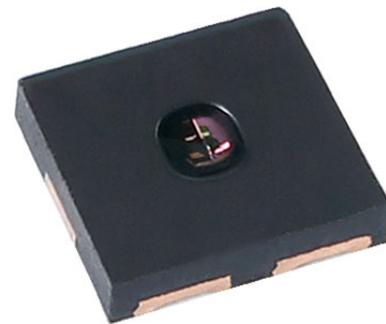
By Reinhard Schaar

HIGH ACCURACY AMBIENT LIGHT SENSOR: VEML6031X00

The VEML6031X00 is a high accuracy digital ambient light sensor with 16-bit resolution in a miniature opaque 2.67 mm x 2.45 mm package. It includes a high sensitivity photodiode, low noise amplifier, and 16-bit A/D converter, and supports an easy to use I²C bus communication interface and additional interrupt feature.

The ambient light read-out is available as a digital value, and the built-in photodiode response is near that of the human eye. The 16-bit dynamic range offers ambient light detection up to about 172 klx, with a resolution down to 0.0026 lx/counts.

Beside 100 Hz and 120 Hz flicker noise rejection and a low temperature coefficient, the device consumes just 0.5 µA in shutdown mode. The sensor is AEC-Q100 qualified and has a operating range from -40 °C to +110 °C.



The high sensitivity of 0.0026 lx/counts allows the sensor to be placed behind very dark cover glasses that will dramatically reduce the total light reaching it. The sensor will also work behind clear cover glass, because even high illumination - such as daylight and all indoor lights - will not saturate the device and read-outs up to 172 klx are possible.

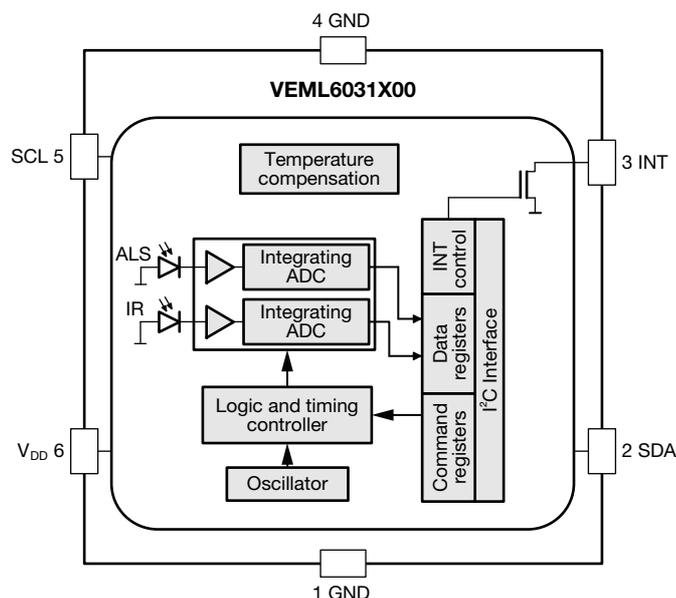


Fig. 1 - VEML6031X00 Block Diagram



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APPLICATION CIRCUITRY FOR THE VEML6031X00

The power supply for the sensor has a defined range from 2.5 V to 3.6 V. The SCL and SDA, as well as the interrupt line, need pull-up resistors. The resistor values depend on the application and on the I²C bus speed. Common values are about 2.2 kΩ to 4.7 kΩ for the SDA and SCL, and about 8.2 kΩ to 22 kΩ for the interrupt line. The interrupt pin is an open drain output.

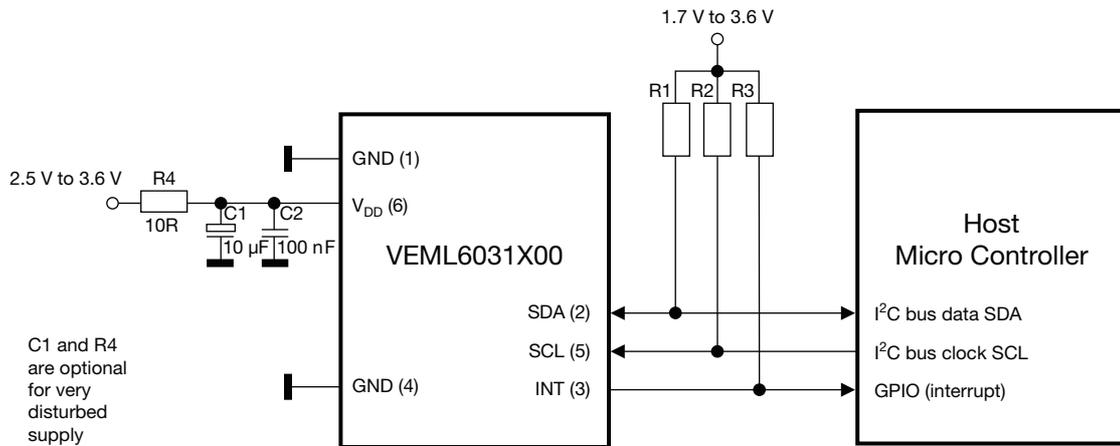


Fig. 2 - VEML6031X00 Application Circuit
(x) = Pin Number

For decoupling purposes, a 100 nF ceramic capacitor (C2) should be placed close to the V_{DD} (pin 4).

If the supply voltage contains a lot of noise and the supply voltage range is close to the low limit of 2.5 V, an RC (R4 and C1) decoupling should be used, as depicted in Fig. 2.



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MECHANICAL CONSIDERATIONS AND WINDOW CALCULATION FOR THE VEML6031X00

The ambient light sensor will be placed behind a window or cover. The window material should be completely transmissive to visible light (400 nm to 700 nm). For optimal performance the window size should be large enough to maximize the light irradiating the sensor. In calculating the window size, the only dimensions that the design engineer needs to consider are the distance from the top surface of the sensor to the outside surface of the window and the size of the window. These dimensions will determine the size of the detection zone.

First, the center of the sensor and center of the window should be aligned. The VEML6031X00 has an angle of half sensitivity of about $\pm 55^\circ$, as shown in the figure below.

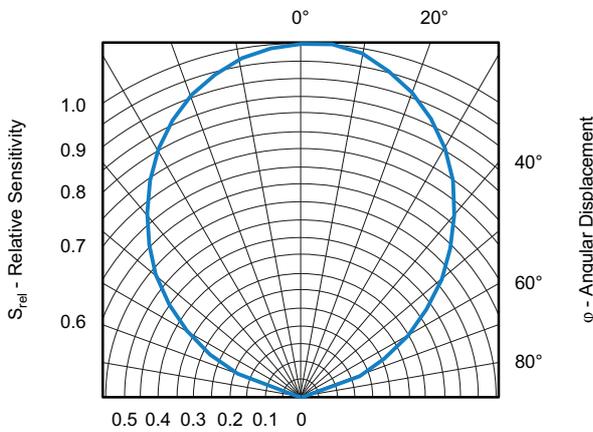


Fig. 3 - Relative Sensitivity vs. Angular Displacement

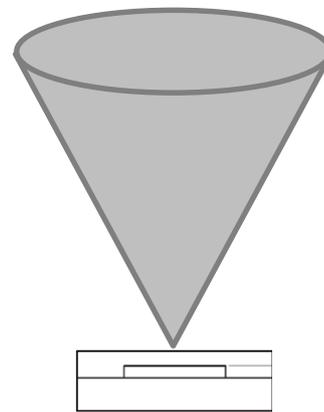


Fig. 4 - Angle of Half Sensitivity: Cone

Remark:

This wide angle and the placement of the sensor as close as possible to the cover is needed if it should show comparable results to an optometer, which also detects light reflections from the complete surroundings.

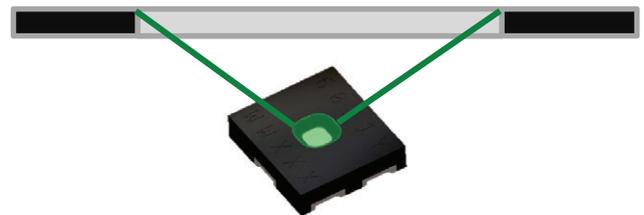


Fig. 5 - Windows Above Sensitive Area

The size of the window is simply calculated according to triangular rules. The dimensions of the device are shown within the datasheet, and with the known distance below the window's upper surface and the specified angle below the given window diameter (w), the best results are achieved.



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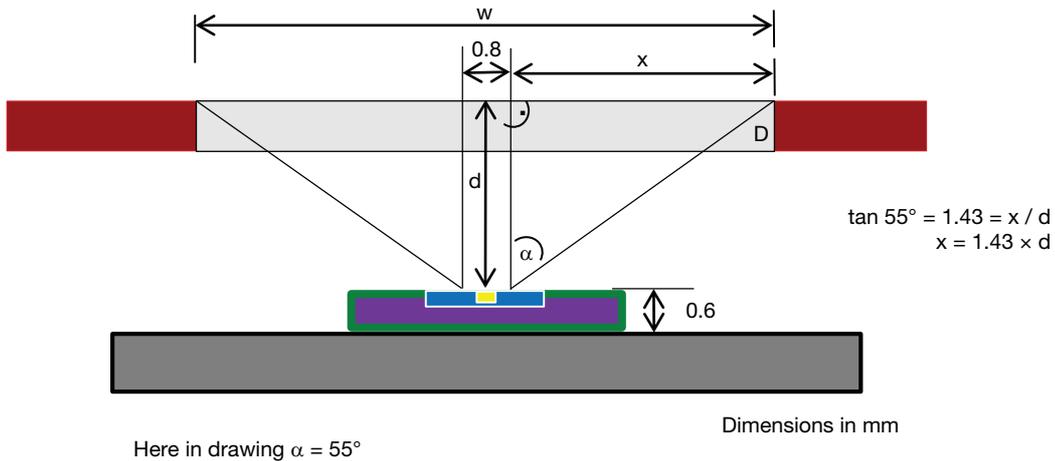


Fig. 6 - Window Area for an Opening Angle of $\pm 55^\circ$

The calculation is then: $\tan \alpha = x / d \rightarrow$ with $\alpha = 55^\circ$ and $\tan 55^\circ = 1.43 = x / d \rightarrow x = 1.43 \times d$
Then the total width is $w = 0.5 \text{ mm} + 2 \times x$.

- $d = 0.5 \text{ mm} \rightarrow x = 0.72 \text{ mm} \rightarrow w = 0.8 \text{ mm} + 1.44 \text{ mm} = 2.24 \text{ mm}$
- $d = 1.0 \text{ mm} \rightarrow x = 1.43 \text{ mm} \rightarrow w = 0.8 \text{ mm} + 2.86 \text{ mm} = 3.66 \text{ mm}$
- $d = 1.5 \text{ mm} \rightarrow x = 2.15 \text{ mm} \rightarrow w = 0.8 \text{ mm} + 4.30 \text{ mm} = 5.10 \text{ mm}$
- $d = 2.0 \text{ mm} \rightarrow x = 2.86 \text{ mm} \rightarrow w = 0.8 \text{ mm} + 5.72 \text{ mm} = 6.52 \text{ mm}$
- $d = 2.5 \text{ mm} \rightarrow x = 3.58 \text{ mm} \rightarrow w = 0.8 \text{ mm} + 7.16 \text{ mm} = 7.96 \text{ mm}$
- $d = 3.0 \text{ mm} \rightarrow x = 4.29 \text{ mm} \rightarrow w = 0.8 \text{ mm} + 8.58 \text{ mm} = 9.38 \text{ mm}$

A smaller window is also sufficient if reference measurements can be done and / or if the output result does not need to be as exact as an optometer.

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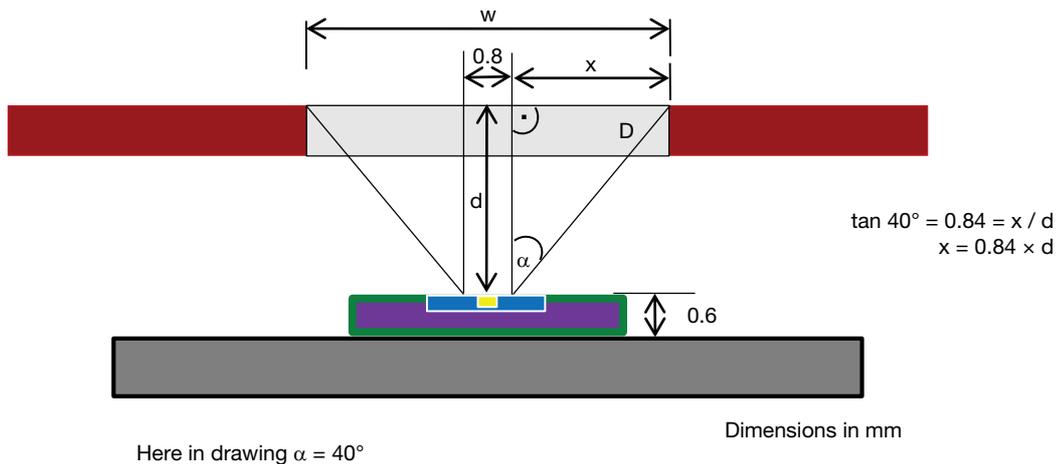


Fig. 7 - Window Area for an Opening Angle of $\pm 40^\circ$

The calculation is then: $\tan \alpha = x / d \rightarrow$ with $\alpha = 40^\circ$ and $\tan 40^\circ = 0.84 = x / d \rightarrow x = 0.84 \times d$
 Then the total width is $w = 0.5 \text{ mm} + 2 \times x$.

$d = 0.5 \text{ mm}$	\rightarrow	$x = 0.42 \text{ mm}$	\rightarrow	$w = 0.8 \text{ mm} + 0.84 \text{ mm}$	$=$	1.64 mm
$d = 1.0 \text{ mm}$	\rightarrow	$x = 0.84 \text{ mm}$	\rightarrow	$w = 0.8 \text{ mm} + 1.68 \text{ mm}$	$=$	2.48 mm
$d = 1.5 \text{ mm}$	\rightarrow	$x = 1.28 \text{ mm}$	\rightarrow	$w = 0.8 \text{ mm} + 2.56 \text{ mm}$	$=$	3.36 mm
$d = 2.0 \text{ mm}$	\rightarrow	$x = 1.68 \text{ mm}$	\rightarrow	$w = 0.8 \text{ mm} + 3.36 \text{ mm}$	$=$	4.16 mm
$d = 2.5 \text{ mm}$	\rightarrow	$x = 2.10 \text{ mm}$	\rightarrow	$w = 0.8 \text{ mm} + 4.20 \text{ mm}$	$=$	5.00 mm
$d = 3.0 \text{ mm}$	\rightarrow	$x = 2.52 \text{ mm}$	\rightarrow	$w = 0.8 \text{ mm} + 5.04 \text{ mm}$	$=$	5.84 mm



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DEVICE ADDRESS

The VEML6031X00 is available in two different pre-configured slave addresses. For one version the predefined 7-bit I²C bus address is set to 0101001 = 0x29. The least significant bit (LSB) defines read or write mode. Accordingly, the bus address is set to 0101 0010 = 0x52 for write and 0101 0011 = 0x53 for read. The second version comes with a predefined 7-bit I²C bus address of 0010000 = 0x10. So, here the write address is 0010 0000 = 0x20 for write and 0010 0001 = 0x21 for read.

TABLE 1 - REGISTER NAME: DEVICE ADDRESS			
ORDERING CODE	7 BIT SLAVE ADDRESS (7 bit)	8 BIT SLAVE ADDRESS	
VEML6031X00	0x29	0x52 (write)	0x53 (read)
VEML60311X00	0x10	0x20 (write)	0x21 (read)

REGISTERS OF THE VEML6031X00

The sensor has thirteen user-accessible registers from 0x00 to 0x17 (0x02 and 0x03, 0x08 to 0x0F, and 0x16 are not defined / reserved) with different functionalities. Note that due to the location of the bits ALS_ON_0 and ALS_ON_1, one in register 0x00 and the other in 0x01, it is necessary to always write to both registers at once when configuring the device.

TABLE 2 - COMMAND REGISTER FORMAT						
COMMAND CODE	DATA BYTE LOW / HIGH	REGISTER NAME	DEFAULT VALUE	FUNCTION	ACCESS	
0x00	-	ALS_CONF0	0x01	Set the integration time	Write and read	
				Measurement mode of the sensor		
				Enable interrupt function of the ALS channel		
				Switch the sensor on / off		
0x01	-	ALS_CONF_1	0x80	Switch the sensor on / off		
				GAIN and photodiode size setting		
				Interrupt persistence counter		
0x04	Low	ALS_THDH_L	0x00	ALS channel high threshold window setting (low byte)		
0x05	High	ALS_THDH_H	0x00	ALS channel high threshold window setting (high byte)		
0x06	Low	ALS_THDL_L	0x00	ALS channel low threshold window setting (low byte)		
0x07	High	ALS_THDL_H	0x00	ALS channel low threshold window setting (high byte)		
0x10	Low	ALS_DATA_L	0x00	Low byte of 16-bit ALS channel result data		Read only
0x11	High	ALS_DATA_H	0x00	High byte of 16-bit ALS channel result data		
0x12	Low	IR_DATA_L	0x00	Low byte of 16-bit IR channel result data		
0x13	High	IR_DATA_H	0x00	High byte of 16-bit IR channel result data		
0x14	Low	VEML6031X00_ID_L	0x01	ID code		
0x15	High	VEML6031X00_ID_H	0x00	ID code		
0x16	Low	INT_FLAG_L	0x00	Reserved		
0x17	High	INT_FLAG_H	0x00	Interrupt and active force mode event flag		

Notes

- Command code 0x00 default value is 0x01 = device is shutdown
- Command 0x00 and command 0x01 must be executed together, they cannot be executed independently



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INTEGRATION TIME AND GAIN SETTING OF THE ALS AND IR CHANNEL

The resolution of the ALS and IR channel can be determined by the setting of the integration time, the gain factor, and the PD size. The IT, GAIN factor, and PD size cannot be determined individually for each channel.

To achieve the highest resolution of 0.0026 lx/counts for the ALS channel, the max. integration time (400 ms), max. GAIN (ALS gain x 2), and the complete photodiode size (ALS_PDDIV = 0, 4/4 PD used) need to be applied. Accordingly, with the lowest resolution of 2.63 lx/counts for the ALS channel, at the min. integration time (6.25 ms), min. GAIN (ALS gain x 0.5), and one quarter of the photodiode size (ALS_PDDIV = 1, 1/4 PD used), the max. illumination level of 172 klx is achievable.

Integration Time Setting

Within the command register 0x00 (ALS_CONF_0) bit 4 to 6 determine the applied integration time for the ALS and the IR channel.

TABLE 3 - REGISTER NAME: ALS_CONF_0							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	ALS_IT			ALS_MODE	ALS_TRIG	ALS_INT	ALS_ON_0
COMMAND CODE					0x00		
BIT NAME	FUNCTION		BIT	VALUE	DESCRIPTION		
Reserved	Reserved		7	0x0 (0b0)	Should be kept default		
ALS_IT	Set the integration time		6 : 4	0x0 (0b000)	3.125 ms (default)		
				0x1 (0b001)	6.25 ms		
				0x2 (0b010)	12.5 ms		
				0x3 (0b011)	25 ms		
				0x4 (0b100)	50 ms		
				0x5 (0b101)	100 ms		
				0x6 (0b110)	200 ms		
				0x7 (0b111)	400 ms		

Remark: The default integration time is 3.125 ms.

For the integration time of 3.125 ms, the max. available resolution of the output channel is around 15 bit, which accordingly no longer leads to a doubling of the achievable illumination level.

The integration time mainly determines the sampling time of the data from the sensor.

If you would like to increase your sampling rate, you have to decrease your integration time.

GAIN and PD Size Setting

Within the command register 0x01 (ALS_CONF_1), bit 4 and 5 determine the applied ALS_GAIN for the ALS and IR channel, whereby bit 6 determines the used size of the photodiode for the ALS and IR measurement.

TABLE 4 - REGISTER NAME: ALS_CONF_1							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_ON_1	ALS_PDDIV	Reserved	ALS_GAIN		ALS_PERS		ALS_CAL
COMMAND CODE					0x01		
BIT NAME	FUNCTION		BIT	VALUE	DESCRIPTION		
ALS_PDDIV	Set the effective photodiode size for the ALS and IR channel		6	0x0 (0b0)	4/4 PD used		
				0x1 (0b1)	1/4 PD used		
ALS_GAIN	Set the gain of the ALS		4 : 3	0x0 (0b00)	Gain x1		
				0x1 (0b01)	Gain x2		
				0x2 (0b10)	Gain x0.66		
				0x3 (0b11)	Gain x0.5		

Remark: Possible saturation effects during the measurement start can be avoided if the application starts with the lowest gain setting: ALS_GAIN x 0.5, ALS_PDDIV = 1 (1/4 PD used).

The setting ALS_GAIN x2 and ALS_PDDIV = 0 (4/4 PD used) should only be used if a high resolution is necessary. For example, if the sensor is placed under a dark cover glass where the illumination level is reduced to a low level.

Please refer to Table 9 and Table 10 from the datasheet to get the best settings for the expected illumination level.



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READ OUT THE MEASUREMENT RESULTS

The ambient light measurement results are stored in the register ALS_DATA, which can be accessed over the command codes 0x10 and 0x11.

The infrared measurement results are stored in the IR_DATA register, which can be accessed over the command codes 0x12 and 0x13.

The VEML6031X00 stores the last measured ambient as well as infrared data before the device is shut down, keeping the data accessible. When the VEML6031X00 is in shutdown mode, the host can freely read this data via the read command directly.

ALS MEASUREMENT RESULTS

The command codes 0x10 and 0x11 (ALS_DATA) contain the ambient light measurement results. The low byte is stored in the command code 0x10 (ALS_DATA_L) while the command code 0x11 (ALS_DATA_H) accesses the ALS results from the high byte.

TABLE 5 - REGISTER NAME: ALS_DATA							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_DATA_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_DATA_H							
COMMAND CODE	BIT NAME	FUNCTION		BIT	VALUE	DESCRIPTION	
0x10	ALS_DATA_L	Read the ALS channel output data		7 : 0	0 to 65 535	Low byte	
0x11	ALS_DATA_H			7 : 0		High byte	

IR MEASUREMENT RESULTS

The command codes 0x12 and 0x13 (IR_DATA) contain the ambient light measurement results. The low byte is stored in the command code 0x12 (IR_DATA_L) while the command code 0x13 (IR_DATA_H) accesses the high byte of the infrared measurement results.

The measurement results are stored in the register IR_DATA, which can be accessed over the command codes 0x12 and 0x13.

TABLE 6 - REGISTER NAME: IR_DATA							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
IR_DATA_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
IR_DATA_H							
COMMAND CODE	BIT NAME	FUNCTION		BIT	VALUE	DESCRIPTION	
0x12	IR_DATA_L	Read the IR channel output data		7 : 0	0 to 65 535	Low byte	
0x13	IR_DATA_H			7 : 0		High byte	

INTERRUPT HANDLING

To avoid too many interactions with the microcontroller, the interrupt feature may be used. The interrupt mode can be enabled with the ALS_INT_EN bit in register ALS_CONF_0 - 0x00.

TABLE 7 - REGISTER NAME: ALS_CONF_0							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	ALS_IT			ALS_MODE	ALS_TRIG	ALS_INT	ALS_ON_0
COMMAND CODE					0x00		
BIT NAME		FUNCTION		BIT	VALUE	DESCRIPTION	
Reserved		Reserved		7	0x0 (0b0)	Should be kept default	
ALS_INT		Enable / disable the interrupt function of the ALS channel		1	0x0 (0b0)	Disable (default)	
					0x1 (0b1)	Enable	



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Persistence Settings

The persistence function ALS_PERS determines the number of measurements that have to remain above or below the chosen threshold level to activate the interrupt pin.

TABLE 8 - REGISTER NAME: ALS_CONF_1							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_ON_1	ALS_PDDIV	Reserved	ALS_GAIN		ALS_PERS		ALS_CAL
COMMAND CODE					0x01		
BIT NAME	FUNCTION		BIT	VALUE	DESCRIPTION		
ALS_PERS	Set the amount of consecutive threshold crossing events necessary to trigger interrupt		2 : 1	0x1 (0b00)	1 time (default)		
				0x2 (0b01)	2 times		
				0x3 (0b10)	4 times		
				0x4 (0b11)	8 times		

Interrupt Thresholds

The high and low threshold levels for the interrupt level can be determined individually.

In register ALS_WH - 0x04, the 0x05 high threshold window can be determined.

TABLE 9 - REGISTER NAME: ALS_THDH							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDH_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDH_H							
COMMAND CODE	BIT NAME	FUNCTION		BIT	VALUE	DESCRIPTION	
0x04	ALS_THDH_L	Set the high threshold interrupt value		7 : 0	0 to 65 535	Low byte	
0x05	ALS_THDH_H			7 : 0		High byte	

In register ALS_WL - 0x06, the 0x07 low threshold window can be determined.

TABLE 10 - REGISTER NAME: ALS_THDL							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDL_L							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
ALS_THDL_H							
COMMAND CODE	BIT NAME	FUNCTION		BIT	VALUE	DESCRIPTION	
0x06	ALS_THDL_L	Set the low threshold interrupt value		7 : 0	0 to 65 535	Low byte	
0x07	ALS_THDL_H			7 : 0		High byte	



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Interrupt Results

With bit 1 and 2 in register ALS_INT - 0x17, the interrupt flags for the high and low thresholds can be checked.

The interrupt flag is triggered as soon as the threshold level is exceeded. Reading the interrupt flag bit automatically resets it. To trigger the interrupt again, the applied threshold value must be exceeded again.

TABLE 11 - REGISTER NAME: INT_FLAG							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved				AF_DATA_READY	ALS_IF_L	ALS_IF_H	Reserved
COMMAND CODE	BIT NAME	FUNCTION	BIT	VALUE	DESCRIPTION		
0x16	Reserved	Reserved	7 : 0	0x00 (0b00000000)	Should be kept default		
0x17	Reserved	Reserved	7 : 4	0x0 (0b0000)	Should be kept default		
	AF_DATA_READY	Data ready flag active force mode	3	0x1 (0b1)	Data ready flag available		
				0x0 (0b0)	Data ready flag not available		
	ALS_IF_L	Low threshold interrupt flag	2	0x1 (0b1)	Low threshold crossing interrupt event flag for the ALS channel		
				0x0 (0b0)	No low threshold crossing		
	ALS_IF_H	High threshold interrupt flag	1	0x1 (0b1)	High threshold crossing interrupt event flag for the ALS channel		
			0x0 (0b0)	No high threshold crossing			
Reserved	Reserved		0	0x0 (0b0)	Should be kept default		

ALS CHANNEL

The responsivity of the ALS channel is close to the human eye curve, also called $V(\lambda)$.

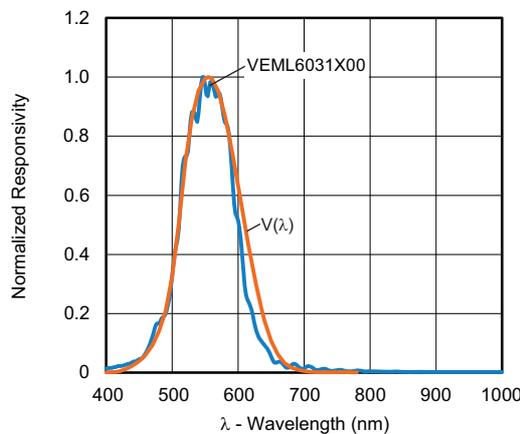


Fig. 8 - Spectral Response

Command codes 0x10 and 0x11 contain the results of the ALS measurement. This 16-bit code needs to be converted to a decimal value to determine the corresponding lux value. The calculation of the corresponding lux level is dependent on the applied resolution (lx/counts), which is determined by the programmed gain setting and the chosen integration time.



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CALCULATING THE LUX LEVEL

Command codes 0x10 and 0x11 contain the results of the ALS measurement. This 16-bit code needs to be converted to a decimal value to determine the corresponding lux value. The calculation of the corresponding lux level is dependent on the programmed gain setting and the chosen integration time.

The component is most sensitive with ALS_GAIN = x2, ALS_PDDIV = 4/4, and an integration time of 400 ms, specified to a resolution of 0.0026 lx/step.

Every time the integration time is halved, the resolution is doubled, but the possible detection range is also doubled.

The same principle is valid for the gain setting. For ALS_GAIN = x1, it is doubled. For ALS_PDDIV = 1/4, the size of the photodiode is just 1/4, the sensitivity is also just 1/4, and the resolution and max. possible detection range is x 4 to allow for higher illuminations up to about 172 klx.

	GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5		GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5
IT (ms)	TYPICAL RESOLUTION (lx/count)					MAXIMUM POSSIBLE ILLUMINATION (lx)			
400	0.0026	0.0051	0.0078	0.0103		168	337	510	673
200	0.0051	0.0103	0.0156	0.0205		337	673	1020	1346
100	0.0103	0.0205	0.0311	0.0411		673	1346	2040	2693
50	0.0205	0.0411	0.0623	0.0822		1346	2693	4080	5385
25	0.0411	0.0822	0.1245	0.1644		2693	5385	8160	10 771
12.5	0.0822	0.1644	0.2490	0.3287		5385	10 771	16 319	21 542
6.25	0.1644	0.3287	0.4980	0.6574		10 771	21 542	32 639	43 083
3.125	0.3287	0.6574	0.9961	1.3148		(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾

	GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5		GAIN x 2	GAIN x 1	GAIN x 0.66	GAIN x 0.5
IT (ms)	TYPICAL RESOLUTION (lx/count)					MAXIMUM POSSIBLE ILLUMINATION (lx)			
400	0.0103	0.0205	0.0311	0.0411		673	1346	2040	2693
200	0.0205	0.0411	0.0623	0.0822		1346	2693	4080	5385
100	0.0411	0.0822	0.1245	0.1644		2693	5385	8160	10 771
50	0.0822	0.1644	0.2490	0.3287		5385	10 771	16 319	21 542
25	0.1644	0.3287	0.4980	0.6574		10 771	21 542	32 639	43 083
12.5	0.3287	0.6574	0.9961	1.3148		21 542	43 083	65 278	86 166
6.25	0.6574	1.3148	1.9921	2.6296		43 083	86 166	130 555	172 333
3.125	1.3148	2.6296	3.9843	5.2593		(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾	(-) ⁽¹⁾

Note

⁽¹⁾ For integration time of 3.125 ms the maximum count level is no longer 16 bit, so, half the integration time no longer leads to double the max. lux level

Example

If the 16-bit word of the ALS data shows: 0000 0101 1100 1000 = 1480 (dec.), the programmed ALS_GAIN = x 1, ALS_PDDIV = 4/4 PD used, and <ALS_IT = 100 ms, the corresponding lux level is: light level (lx) = 1480 x 0.0205 = 30.34 lx.



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IT, GAIN, and PD Size Settings

The output value of the sensor is linear across the integration (ALS_IT), gain (ALS_GAIN), or photodiode size (ALS_PDDIV) settings, respectively.

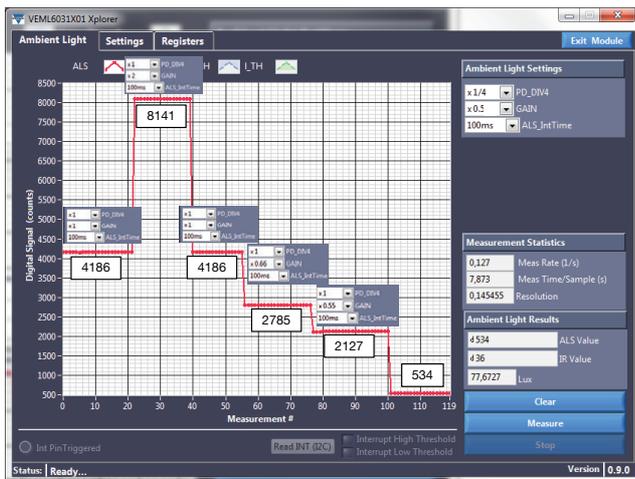


Fig. 9 - Linearity of Gain Steps

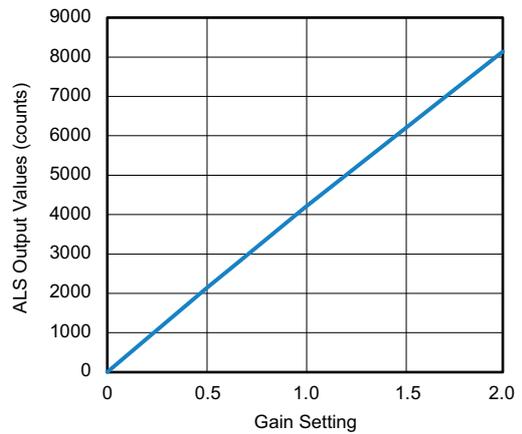


Fig. 10 - Linearity of the Gain

The integration time has a linear relationship to the output value in counts. A doubling in the integration time leads to a doubling in counts.

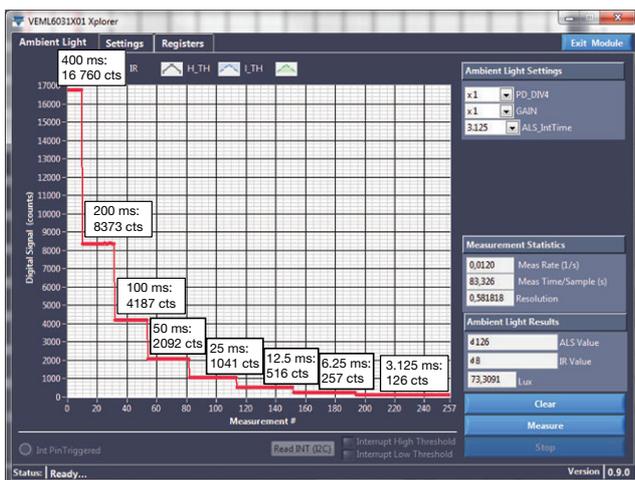


Fig. 11 - Linearity of Integration Times

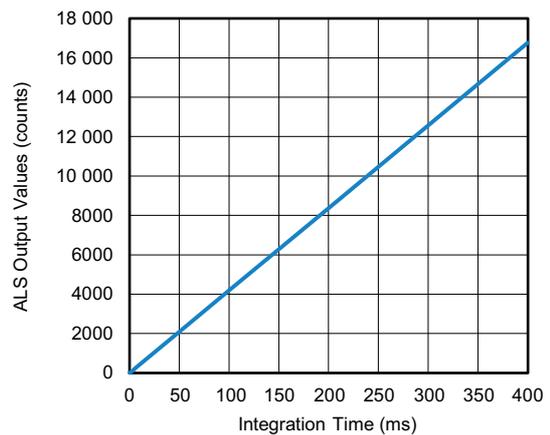


Fig. 12 - Linearity of the Integration Time



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LUX LEVEL MATCHING FOR DIFFERENT LIGHT SOURCES

The VEML6031X00 shows very good matching for all kinds of light sources.

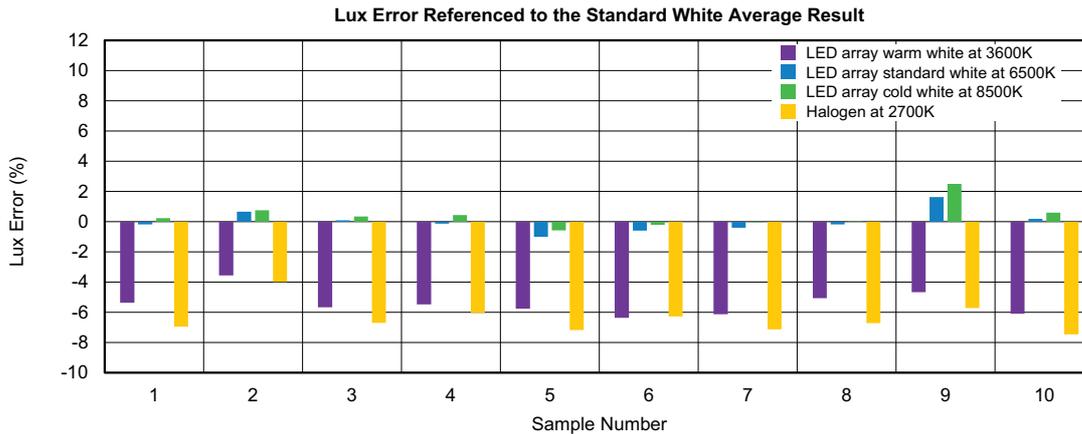


Fig. 13 - Tolerances for Different Light Sources

APPLICATION-DEPENDENT LUX CALCULATION

If the application uses a darkened / tinted cover glass, just 10 % - or even just 1 % - of the ambient light will reach the sensor. For a tinted cover glass where there is 1 lx up to 100 klx of light outside, just 0.01 lx to 1 klx is reaching the sensor, and the application software may always stay with ALS_GAIN x2 and full PD size (ALS_PDDIV = 0).

If the application uses a clear cover glass, nearly all ambient light will reach the sensor. This means up to about 172 klx may be possible. For this clear cover where < 1 lx to ≥ 100 klx is possible, the application software will need to adapt the gain steps, and for very high illumination, also reduce the size of the photodiode to just 1/4.

For unknown brightness conditions, the application should always start with the lowest gain: ALS_GAIN x 0.5 and ALS_PDDIV = 1 (1/4 PD used). This avoids possible overload / saturation if, for example, direct sunlight suddenly reaches the sensor.

The VEML6031X00 shows very good linear behavior for all levels from 0.0026 lx to about 172 klx.

A software flow may look like the flow chart diagram at the end of this note:

- Starting with the lowest sensitivity (ALS_GAIN = 0.5 and ALS_PDDIV = 1), check the ALS counts. If ≤ 100 counts, increase sensitivity with ALS_PDDIV = 0, 4/4 PD used
- Check the ALS counts again. If they are still ≤ 100 counts, increase up to 2
- Check the ALS counts again. If they are still ≤ 100 counts, increase the integration time from 100 ms to 200 ms, and continue the procedure up to the longest integration time of 400 ms. If a very dark cover glass is used and one knows that just few percent of outside light is reaching the sensor, one may directly start with higher gain



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IR CHANNEL

In addition to the ALS channel that follows the so-called human eye curve very well, there is also an IR channel available, which offers a much higher responsivity for light with wavelengths > 800 nm.

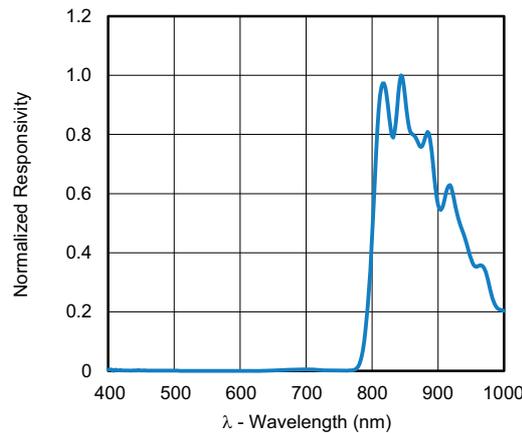


Fig. 14 - IR Channel Response

Since the light sources the sensor is exposed to can have different spectrums, it can be helpful for an application to be able to differentiate between light sources and react accordingly. The additional IR channel offers the possibilities to do a light source differentiation based on the IR content measured with the IR channel. A ratio between the IR and ALS channel can be calculated to determine the amount of IR light within the light source's spectrum. This easily allows, for example halogen bulb to be kept apart from an LED light.

Example

The below measurement result shows the sensor output values under several different light sources at 1000 lx. Based on the IR / ALS channel ratio, a clear differentiation between the three light sources is possible, even though the detected illuminance is the same.



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The measurements were done with the evaluation tool as shown below:

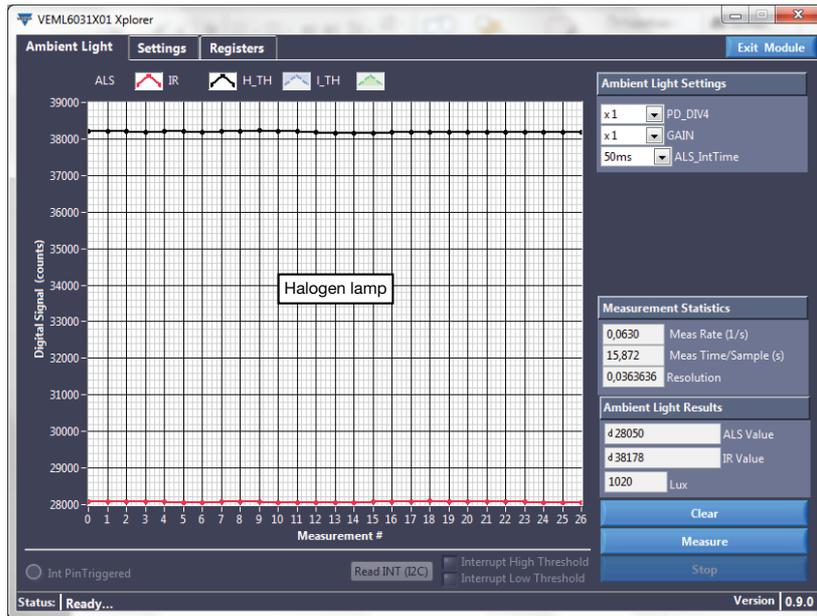


Fig. 15 - Measurement Results With a Halogen Lamp at About 1000 lx

The following results were measured with a fluorescent, sunlight, and halogen light source:

SETTINGS: PD_DIV 4/4 USED, ALS_GAIN x 1, ALS IT = 50 ms			
LIGHT SOURCE	ALS	IR	RATIO IR-CHANNEL / ALS-CHANNEL (%)
Fluorescent	27 490	2652	10
Daylight	28 299	9765	35
Halogen	28 050	38 178	136

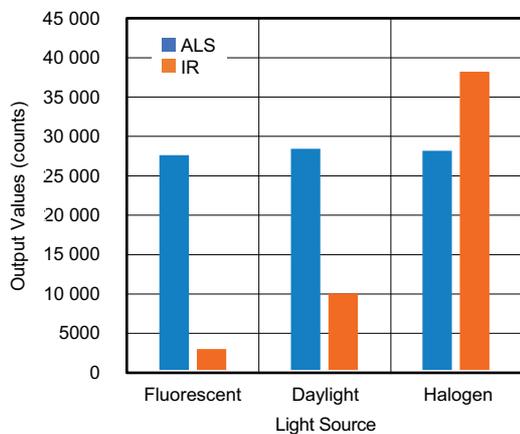


Fig. 16 - ALS and IR Channel - Absolute

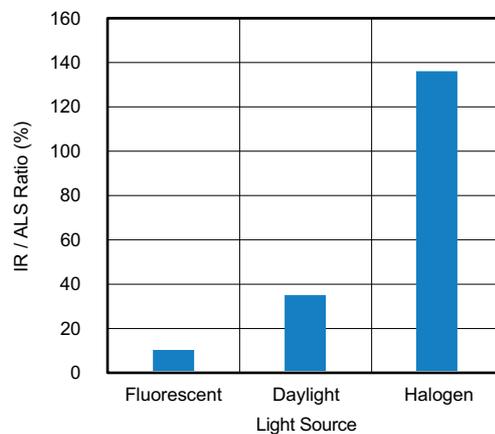


Fig. 17 - Ratio IR / ALS Channel

The IR / ALS channel ratios show that a clear differentiation of light sources can be made.



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TYPICAL SOFTWARE FLOW CHART

For a wide light detection range it is necessary to adjust the sensor. This is done with the help of the gain steps, the sensitivity, and the steps for the integration time.

Whereas the programmed gain begins with the lowest possible value (ALS_GAIN x 0.5 and 1/4 PD used), in order to avoid any saturation effect, the integration time starts with 100 ms: IT = 0.

With this about 10 klx is possible. To determine the optimal gain and sensitivity settings for an application, it is advisable to first increase the sensitivity via the ALS_PDDIV bit (ALS_PDDIV = 0), followed by the ALS_GAIN bits.

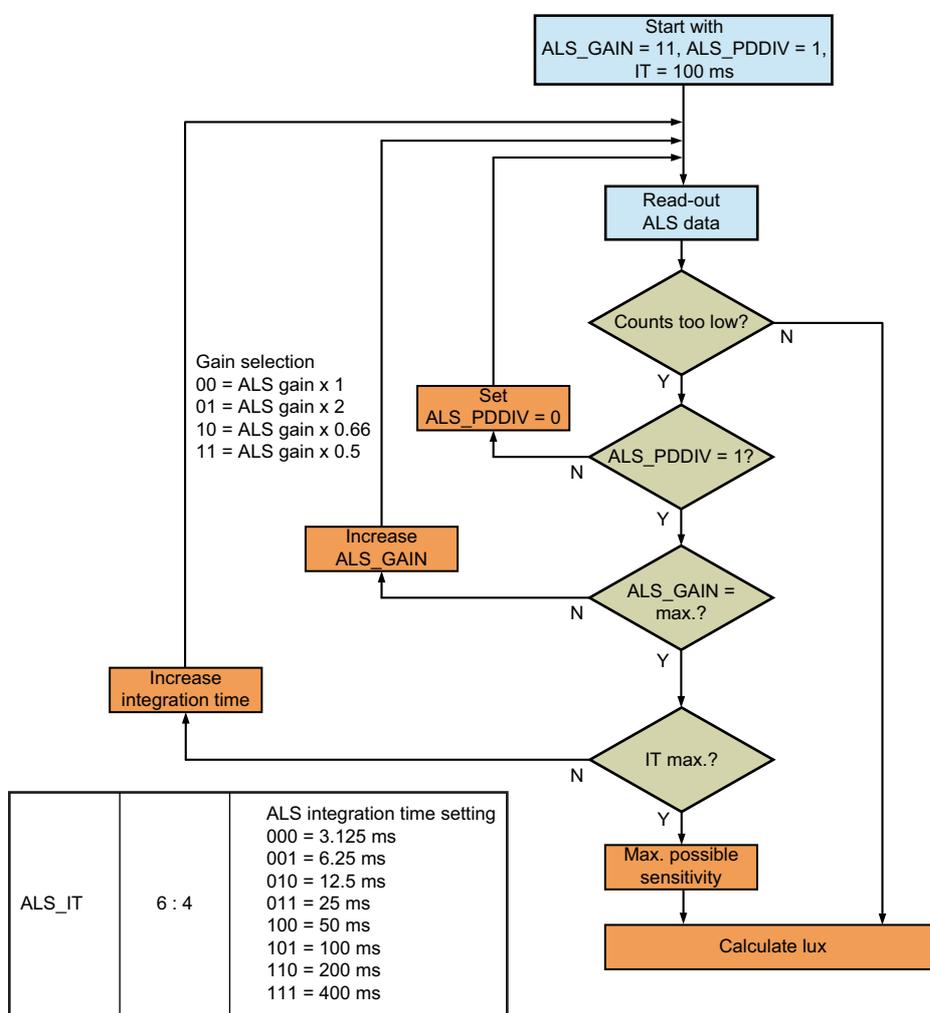


Fig. 18 - Simple Flow Chart View



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HOW TO USE THE DEMO SOFTWARE

The small blue VEML6031X00 sensor board is compatible with the SensorXplorer. The software module and further information for the demo board can be found here: www.vishay.com/optoelectronics/SensorXplorer.

When evaluating the sensor, please connect the SensorXplorer and the VEML6031X00 sensor board and then open the software.

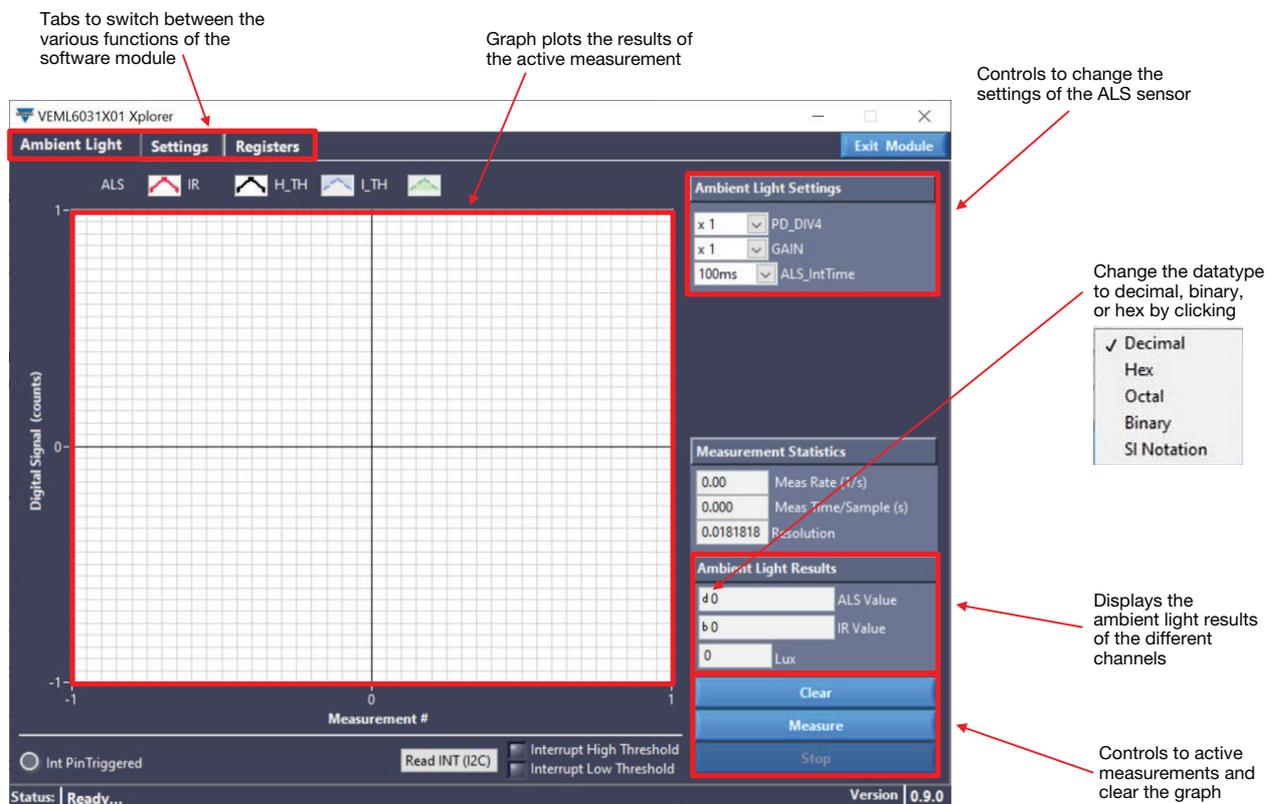


Fig. 19 - Demo Software GUI

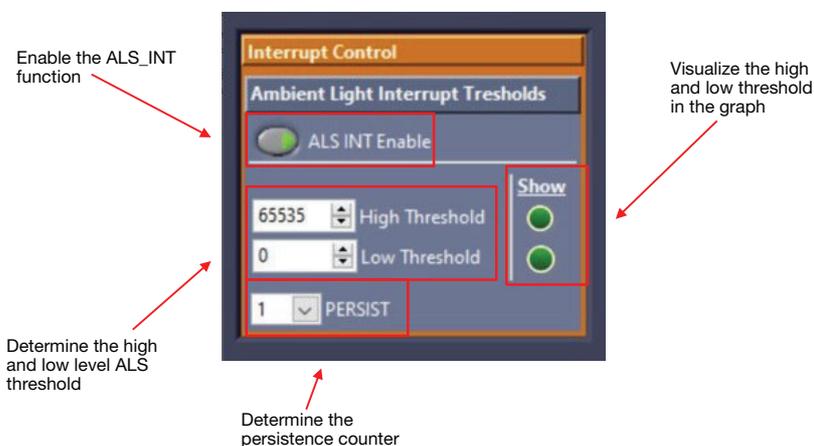


Fig. 20 - Interrupt Control in the Demo Software GUI



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TYPICAL ILLUMINANCE VALUES

illuminance	Example
10 ⁻⁵ lx	Light from Sirius, the brightest star in the night sky
10 ⁻⁴ lx	Total starlight, overcast sky
0.002 lx	Moonless clear night sky with airglow
0.01 lx	Quarter moon, 0.27 lx; full moon on a clear night
1 lx	Full moon overhead at tropical latitudes
3.4 lx	Dark limit of civil twilight under a clear sky
50 lx	Family living room
80 lx	Hallway / bathroom
100 lx	Very dark overcast day
320 lx to 500 lx	Office lighting
400 lx	Sunrise or sunset on a clear day
1000 lx	Overcast day; typical TV studio lighting
10 000 lx to 25 000 lx	Full daylight (not direct sun)
32 000 lx to 130 000 lx	Direct sunlight