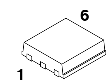
NOA1212

Ambient Light Sensor with Dark Current Compensation

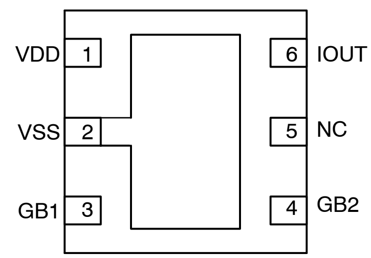
ON Semiconductor®

http://onsemi.com



CUDFN6
CU SUFFIX
CASE 505AE

PIN ASSIGNMENT



(Top View)

ORDERING INFORMATION

Device	Package	Shipping†
NOA1212CUTAG*	CUDFN6 (Pb−Free)	2500 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.
*Temperature Range: −40°C to 85°C.

Description

The NOA1212 is a very low power ambient light sensor (ALS) with an analog current output and a power down mode to conserve power. Designed primarily for handheld device applications, the active power dissipation of this chip is less than 8 μA at dark and its quiescent current consumption is less than 200 pA in power down mode. The device can operate over a very wide range of voltages from 2 V to 5.5 V. The NOA1212 employs proprietary CMOS image sensing technology from ON Semiconductor, including built−in dynamic dark current compensation to provide large signal to noise ratio (SNR) and wide dynamic range (DR) over the entire operating temperature range. The photopic optical filter provides a light response similar to that of the human eye. Together the photopic light response and dark current compensation insures accurate light level detection.

Features

- Senses Ambient Light and Provides an Output Current Proportional to the Ambient Light Intensity
- Photopic Spectral Response
- Dynamic Dark Current Compensation
- Three Selectable Output Current Gain Modes in 10x Steps
- Power Down Mode
- Less than 18 μA at 100 lux Active Power Consumption in Medium Gain Mode (Less than 8 μA at Dark)
- Less than 200 pA Quiescent Power Dissipation in Power Down Mode at All Light Levels
- Linear Response Over the Full Operating Range
- Senses Intensity of Ambient Light from ~0 lux to Over 100,000 lux
- Wide Operating Voltage range (2 V to 5.5 V)
- Wide operating temperature range (−40°C to 85°C)
- Drop−in Replacement Device in 1.6 x 1.6 mm Package
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

Applications

- Saves display power in applications such as:
  - Cell Phones, PDAs, MP3 players, GPS
  - Cameras, Video Recorders
  - Mobile Devices with Displays or Backlit Keypads
  - Laptops, Notebooks, Digital Signage
  - LCD TVs and Monitors, Digital Picture Frames
  - Automobile Dashboard Displays and Infotainment
  - LED Indoor/Outdoor Residential and Street Lights

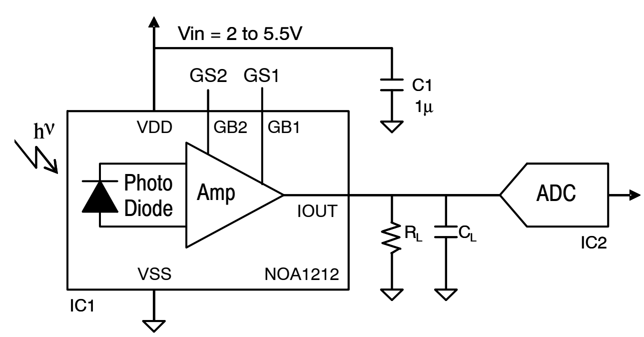


Figure 1. Typical Application Circuit

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Publication Order Number:
NOA1212/D

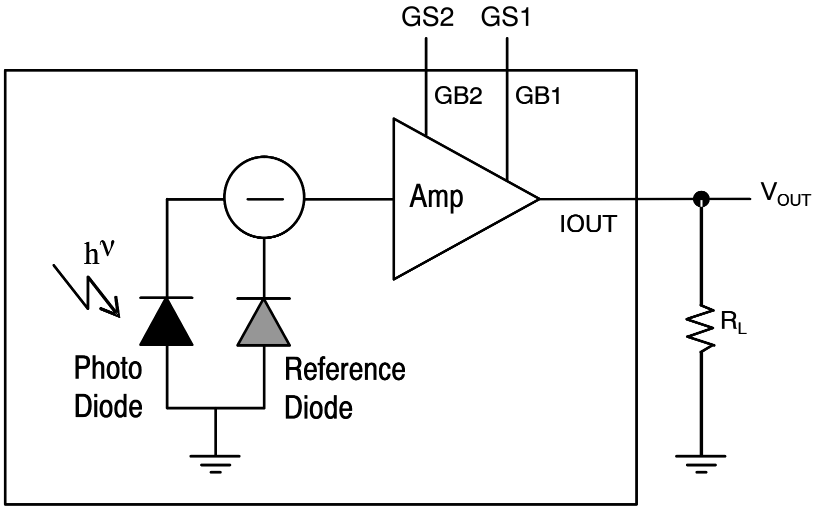


Figure 2. Simplified Block Diagram

Table 1. PIN FUNCTION DESCRIPTION

Pin	Pin Name	Description
1	VDD	Power pin.
2	VSS	Ground pin.
3	GB1	In conjunction with GB2, selects between three gain modes and power down.
4	GB2	In conjunction with GB1, selects between three gain modes and power down.
5	NC	Not connected. This may be connected to ground or left floating.
6	IOUT	Analog current output.
EP	VSS	Exposed pad, internally connected to ground. Should be connected to ground.

Table 2. ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input power supply	V_{DD}	6	V
Input voltage range	V_{IN}	−0.3 to V_{DD} + 0.3	V
Output voltage range	V_{OUT}	−0.3 to V_{DD} + 0.2	V
Output current range	I_o	0 to 15	mA
Maximum Junction Temperature	$T_{J(max)}$	−40 to 85	°C
Storage Temperature	T_{STG}	−40 to 85	°C
ESD Capability, Human Body Model (Note 1)	ESD_{HBM}	2	kV
ESD Capability, Charged Device Model (Note 1)	ESD_{CDM}	750	V
ESD Capability, Machine Model (Note 1)	ESD_{MM}	150	V
Moisture Sensitivity Level	MSL	5	–
Lead Temperature Soldering (Note 2)	T_{SLD}	260	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. This device incorporates ESD protection and is tested by the following methods:
   ESD Human Body Model tested per EIA/JESD22−A114
   ESD Charged Device Model tested per ESD−STM5.3.1−1999
   ESD Machine Model tested per EIA/JESD22−A115
   Latchup Current Maximum Rating: ≤ 100 mA per JEDEC standard: JESD78
2. For information, please refer to our Soldering and Mounting Techniques Reference Manual, SOLDERRM/D

Table 3. ELECTRICAL CHARACTERISTICS (Unless otherwise specified, these specifications apply over VDD = 5.5 V, −40°C < T_A < 85°C)

Rating	Test Conditions	Symbol	Min	Typ	Max	Unit
Power supply voltage		V_{DD}	2	3.0	5.5	V
Power supply current	V_{DD} = 3.0 V, Ev = 0 lux, H−Gain	I_{DD_0}	6	8	12	μA
Power supply current	V_{DD} = 3.0 V, Ev = 100 lux, H−Gain	I_{DD_100}	32	64	96	μA
Power down current	All light levels	I_{DD_PD}		0.2	5	nA
Output current, high−gain	Ev = 100 lux, White LED	I_{o_high}	41	51	61.5	μA
Dark output current, high−gain	V_{DD} = 3.0 V, Ev = 0 lux	I_{o_dark}		10		nA
Wavelength of maximum response		λ_m		540		nm
White LED/fluorescent current ratio	Ev = 100 lux	r_{LE}		1.0		
Incandescent/fluorescent current ratio	Ev = 100 lux	r_{IF}		1.45		
Maximum output voltage	Ev = 100 lux, R_L = 220 kΩ, H−Gain	V_{OMAX}	V_{DD}–0.4	V_{DD}–0.1	V_{DD}	V
Power down time	Ev = 100 lux, H−Gain to PD	t_{PD}	1.5			ms
Wake up time	Ev = 100 lux, PD to H−Gain	t_{wu}			300	μs
Low level input voltage		V_{IL}	−0.2		0.25 V_{DD}	V
High level input voltage		V_{IH}	0.75 V_{DD}		V_{DD}+0.2	V
Operating free−air temperature range		T_A	−40		85	°C

TYPICAL CHARACTERISTICS

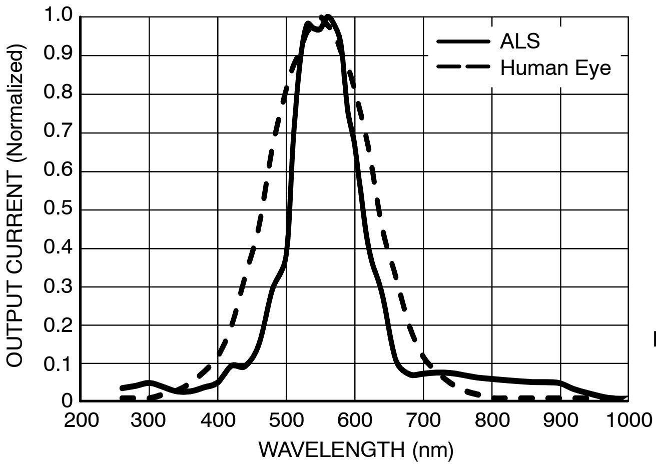


Figure 3. Spectral Response (Normalized)

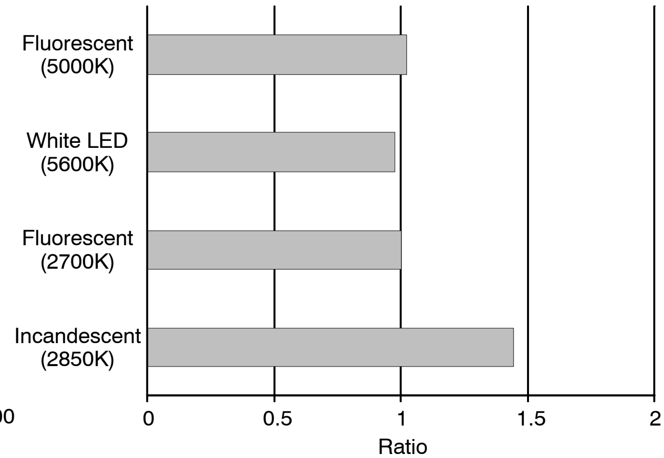


Figure 4. Light Source Dependency (Normalized to Fluorescent Light)

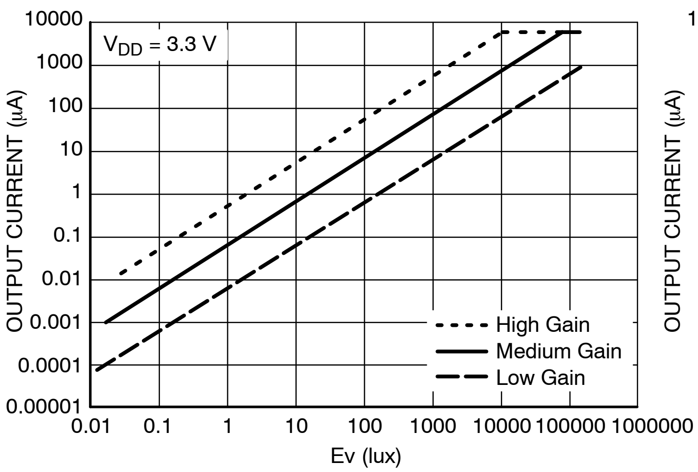


Figure 5. Output Current vs. Ev

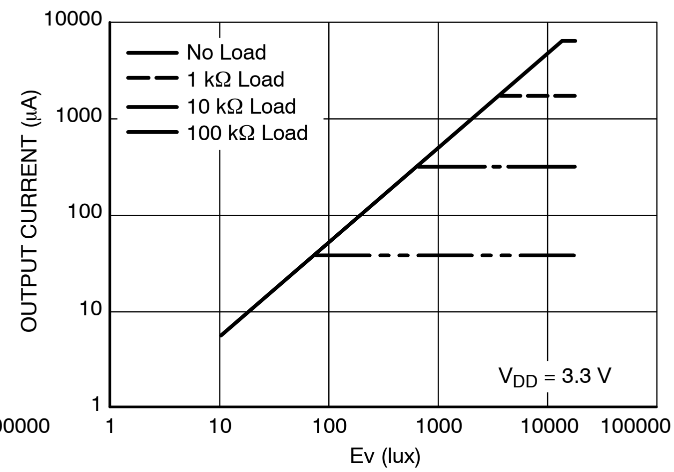


Figure 6. Output Current vs. Ev (High Gain Mode)

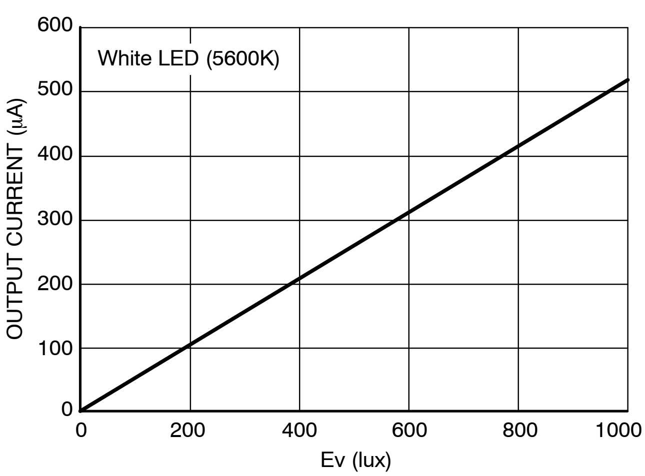


Figure 7. Output Current vs. Ev, 0−1000 lux (High Gain Mode)

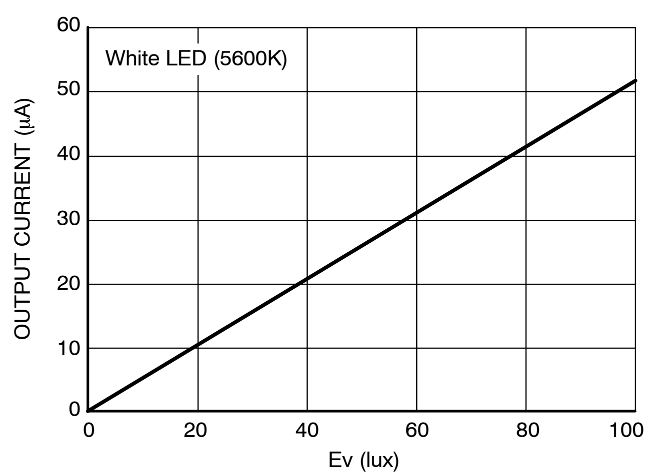


Figure 8. Output Current vs. Ev, 0−100 lux (High Gain Mode)

TYPICAL CHARACTERISTICS

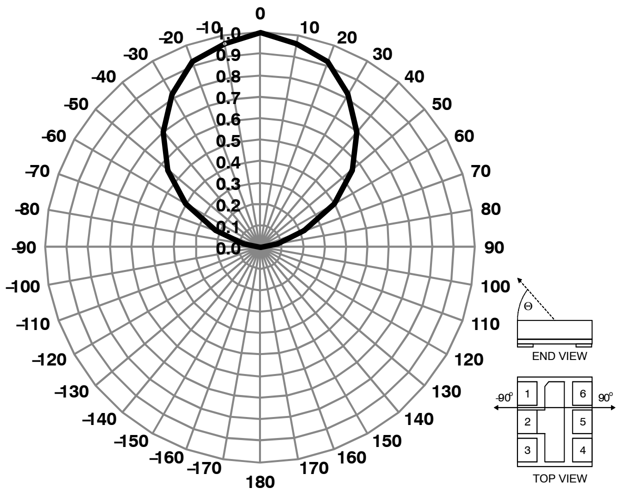


Figure 9. Output Current vs. Angle (End View, Normalized)

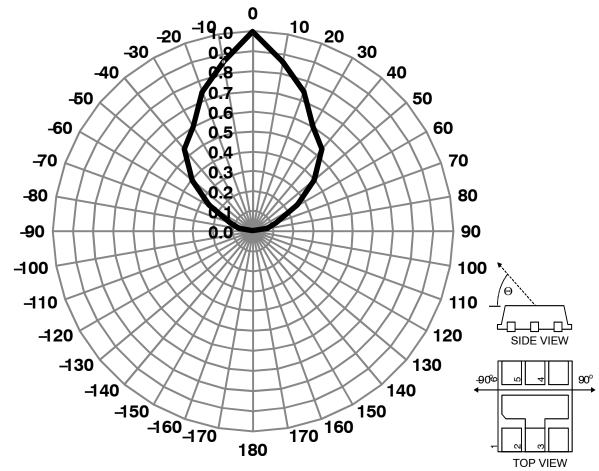


Figure 10. Output Current vs. Angle (Side View, Normalized)

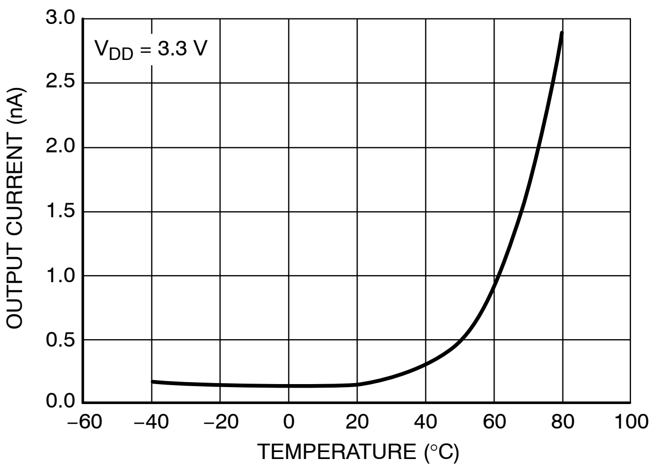


Figure 11. Output Current at 0 lux vs. Temperature (High Gain Mode)

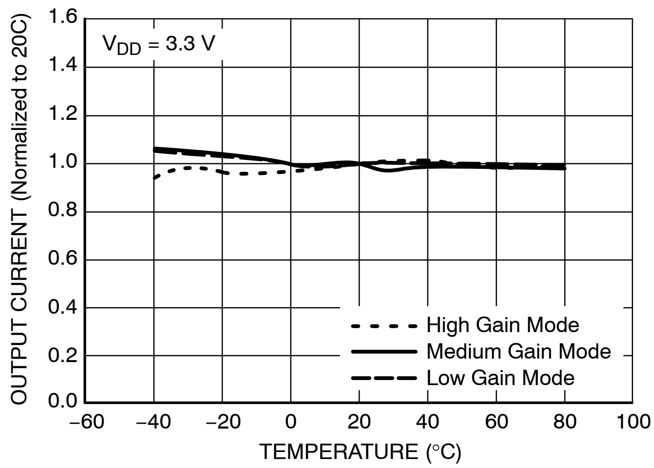


Figure 12. Output Current at 100 lux vs. Temperature

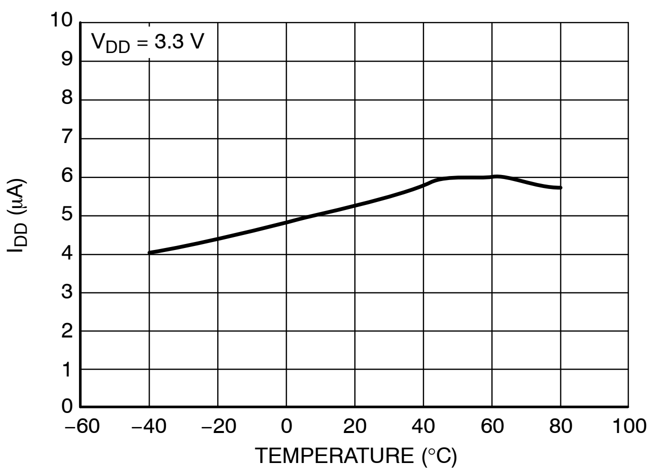


Figure 13. Supply Current at 0 lux vs. Temperature (High Gain Mode)

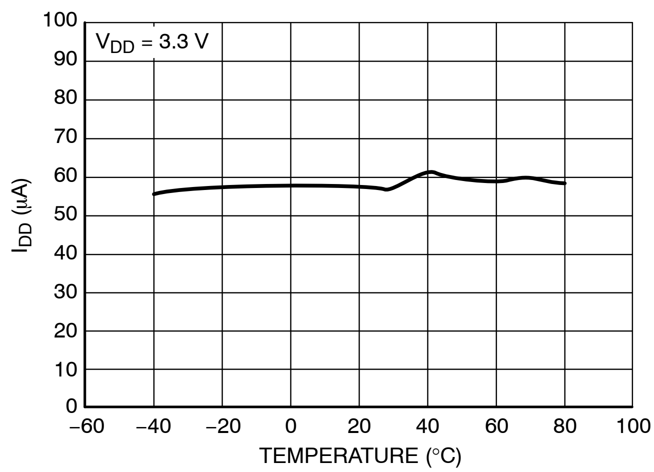


Figure 14. Supply Current at 100 lux vs. Temperature (High Gain Mode)

TYPICAL CHARACTERISTICS

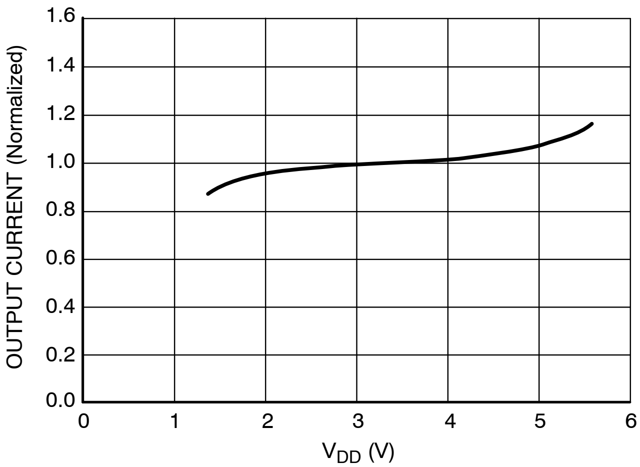


Figure 15. Output Current at 100 lux vs. Supply Voltage (High Gain Mode)

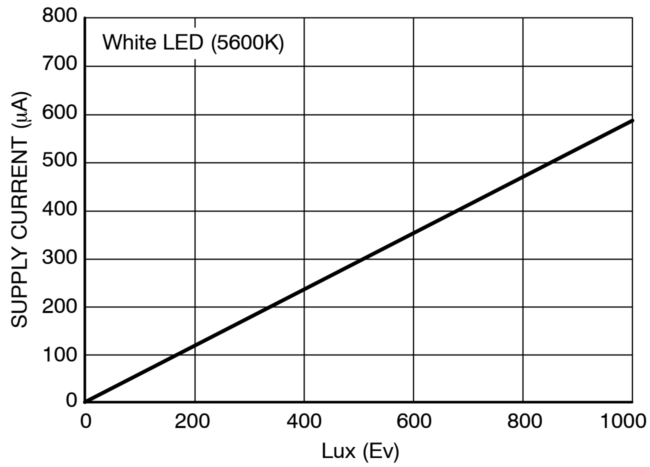


Figure 16. Supply Current vs. Ev (High Gain Mode)

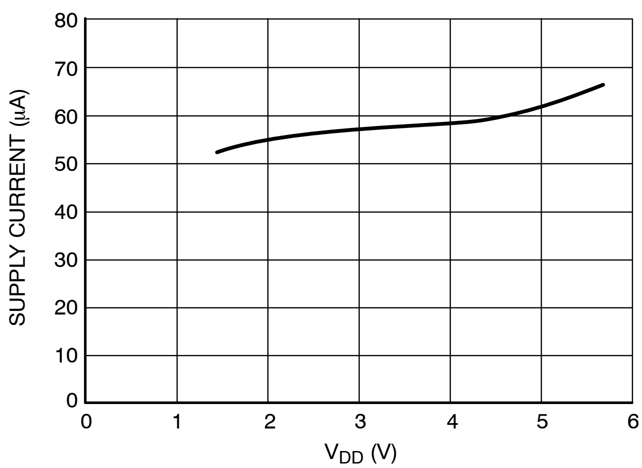


Figure 17. Supply Current vs. Supply Voltage (High Gain Mode)

DESCRIPTION OF OPERATION

Ambient Light Sensor Architecture

The NOA1212 employs a sensitive photo diode fabricated in ON Semiconductor's standard CMOS process technology. The major components of this sensor are as shown in Figure 2 . The photons which are to be detected pass through an ON Semiconductor proprietary color filter limiting extraneous photons and thus performing as a band pass filter on the incident wave front. The filter only transmits photons in the visible spectrum which are primarily detected by the human eye and exhibits excellent IR rejection. The photo response of this sensor is as shown in Figure 3.

The ambient light signal detected by the photo diode is converted to an analog output current by an amplifier with programmable gain. Table 4 shows the gain setting and the corresponding light sensitivity.

Table 4. PROGRAMMABLE GAIN SETTINGS

GB2	GB1	Mode	Approximate Output Current @ 100 lux	Approximate Output Current @ 1000 lux	Saturation
0	0	Power Down	–	–	–
0	1	High Gain	51 μA	510 μA	~10,000 lux
1	0	Medium Gain	5.1 μA	51 μA	~100,000 lux
1	1	Low Gain	0.51 μA	5.1 μA	> 100,000 lux

Power Down Mode

This device can be placed in a power down mode by setting GB1 and GB2 to logic low level.

In order for proper operation of this mode GB1 and GB2 should stay low 1.5 ms.

External Component Selection

The NOA1212 outputs a current in direct response to the incident illumination. In many applications it is desirable to convert the output current into voltage. It may also be desirable to filter the effects of 50/60 Hz flicker or other light source transients.

Conversion from current to voltage may be accomplished by adding load resistor R_L to the output. The value of R_L is bounded on the high side by the potential output saturation of the amplifier at high ambient light levels. R_L is bounded on the low side by the output current limiting of the internal amplifier and to minimize power consumption.

Equation 1 describes the relationship of light input to current output for the High−Gain mode.

$$I_{OUT} = (51\ \mu A/100\ lux) * E_V \qquad \text{(eq. 1)}$$

By adding R_L to the output, I_{OUT} is converted into a voltage according to Equation 2.

$$V_{OUT} = I_{OUT} * R_L = (51\ \mu A/100\ lux) * E_V * R_L \qquad \text{(eq. 2)}$$

The range of the output voltage is limited by the output stage to the V_{OMAX} parameter value of V_{DD} – 0.4 V at the maximum desired E_V as shown in Equation 3. Equation 4 computes the value for R_L (High−Gain mode).

$$V_{OMAX} = (51\ \mu A/100\ lux) * E_{VMAX} * R_L \qquad \text{(eq. 3)}$$

$$R_L = (V_{DD} - 0.4\ V)/E_{VMAX} * (100\ lux/51\ \mu A) \qquad \text{(eq. 4)}$$

For example, consider a 5 V supply with a desired E_{VMAX} = 1000 lux, the value of R_L would be 8.85 kΩ. The value for R_L can easily be computed for different NOA1212 gain ranges by substituting the appropriate output current at 100 lux from Table 4.

The optional capacitor C_L can be used to form a low−pass filter to remove 50/60 Hz filter or other unwanted noise sources as computed with Equation 5.

$$C_L = 1/2\pi f_c R_L \qquad \text{(eq. 5)}$$

For our example, to filter out 60Hz flicker the value of C_L would be 300 nF.

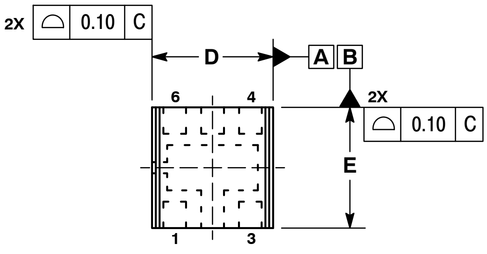
Power Supply Bypassing and Printed Circuit Board Design

Power supply bypass and decoupling can typically be handled with a low cost 0.1 μF to 1.0 μF capacitor.

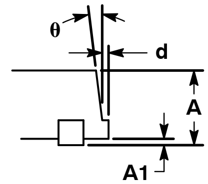
The exposed pad on the bottom of the package is internally connected to VSS pin 2 and should be soldered to the printed circuit board.

PACKAGE DIMENSIONS

CUDFN6, 1.6x1.6
CASE 505AE
ISSUE B



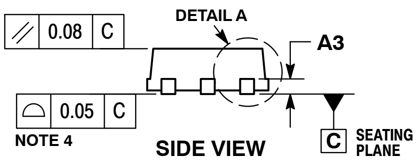
TOP VIEW



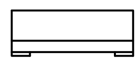
DETAIL A

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30mm FROM THE TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

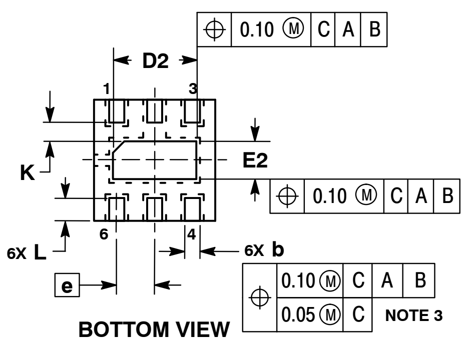
	MILLIMETERS	
DIM	MIN	MAX
A	0.55	0.65
A1	0.00	0.05
A3	0.20 REF	
b	0.15	0.25
D	1.60 BSC	
d	---	0.10
D2	1.00	1.20
E	1.60 BSC	
E2	0.40	0.60
e	0.50 BSC	
K	0.20	---
L	0.25	0.35
θ	4°	10°



SIDE VIEW

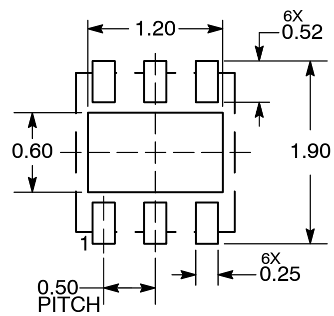


END VIEW



BOTTOM VIEW

MOUNTING FOOTPRINT



DIMENSIONS: MILLIMETERS

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
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