# HDJD-S831-QT333
Color Sensor Module

## Data Sheet



### Description

Avago Color Sensor is a high performance, small in size, cost effective light to voltage converting sensor. The sensor combines a photodiode array and three trans-impedance amplifiers in a single monolithic CMOS IC solution. With Red (R), Green (G), and Blue (B) color filters coated over the photodiode array, the sensor converts RGB light to analog voltage outputs, denoted by $VR_{OUT}$, $VG_{OUT}$ and $VB_{OUT}$, respectively. The sensor is driven by a single 5 V supply and incorporates an internal 5 V to 3.3 V voltage regulator. The color sensor module consists of a color sensor packaged in a 5 x 5 x 2 [mm] surface mount QFN-16, flat flexible cable connector and a decoupling capacitor mounted on a PCB.

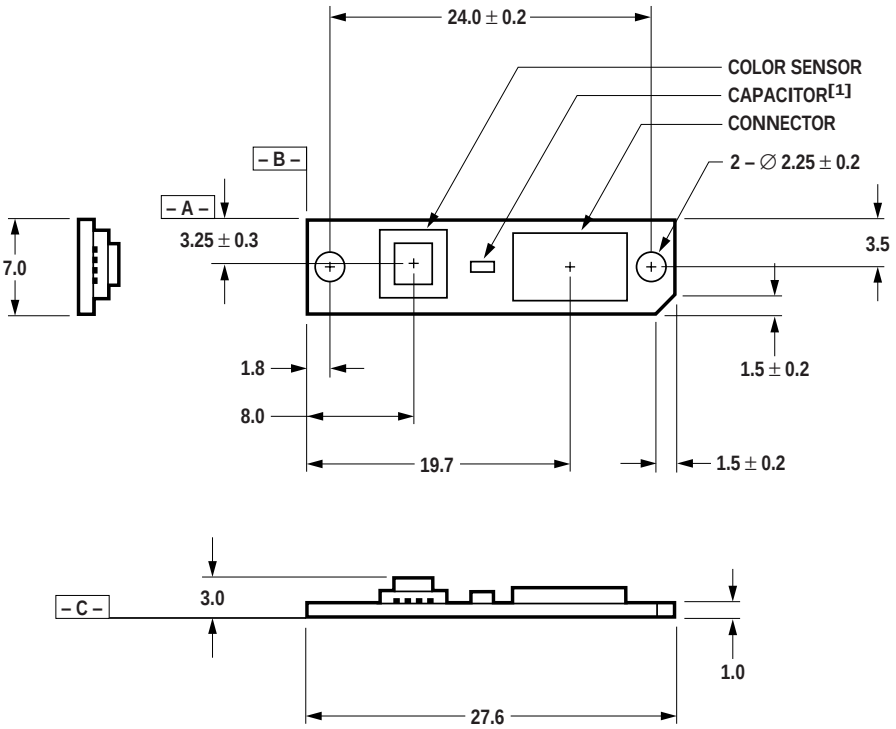
### Applications

Avago Color Sensor is ideal for open-loop color identification and closed-loop color point control. The spectral sensitivity response of the sensor is optimized for RGB-LED backlight applications. The sensor has good detection ability in light output chromaticity drift, when used with closed-loop feedback controller, manages to bring the backlight system to realize good du'v' performance. Potential applications include white point control in emissive display, environmental lighting, color control in industrial processes, and many more.

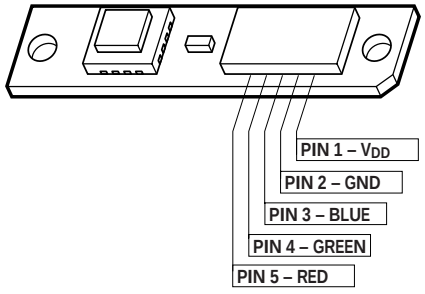
### Features

- **Converts light to R,G,B voltage output**
- **Monolithic CMOS IC solution with integrated R,G,B color filter, photodiode array, trans-impedance amplifier in one chip**
- **12x12 photodiode array design minimizes the effect of contamination and optical aperture misalignment**
- **Spectral sensitivity response optimized for RGB-LED backlight application: good detection capability in light chromaticity drift**
- **Small module size (27.6 mm x 7 mm x 3 mm)**
- **Internal 5 V to 3.3 V voltage regulator**

## Package Dimensions

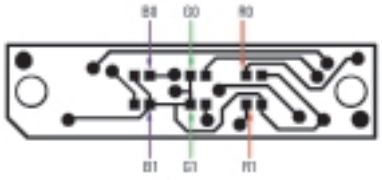



NOTE: 1. A 100nF CAPACITOR IS CONNECTED BETWEEN VDD3 AND GND FOR BETTER NOISE IMMUNITY.




FLAT FLEXIBLE CABLE TO BE USED WITH THE CONNECTOR.

RECOMMENDED DIMENSIONS:
CABLE WIDTH: 3.0 ± 0.1 mm
CONDUCTOR PITCH: 0.5 ± 0.1 mm
INSERT THICKNESS: 0.3 ± 0.03 mm



NOTE:
BACK VIEW OF PCB

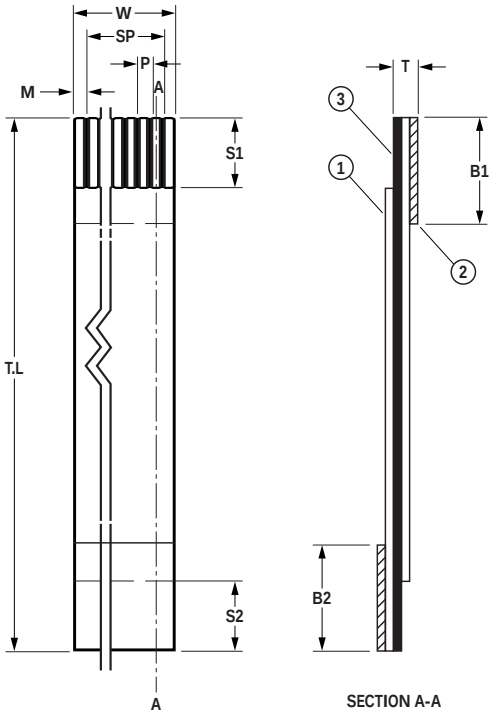
SHORT THE 2 PADS WITH JUMPER FOR 0; LEAVE THE 2 PADS OPEN FOR 1.

DEFAULT GAIN SELECTIONS ARE GS:11 FOR RED, GREEN AND BLUE.

REFER TO GAIN SELECTION FEEDBACK RESISTOR TABLE ON PAGE 8.

NOTES:
1. DIMENSIONS ARE IN MILLIMETERS (mm).
2. UNLESS OTHERWISE SPECIFIED, ±0.3 mm TOLERANCE IS APPLICABLE.

## Recommended Flat Flexible Cable to be used with the Connector




| NO. | ITEM NAME | SPECIFICATION | REMARK |
|---|---|---|---|
| 1 | INSULATION | 20696(42 μ) | |
| 2 | P/TAPE | 223 μ | |

| | | | | |
|---|---|---|---|---|
| 3 | CONDUCTOR | THICKNESS | 0.035 | ± 0.1 |
| | | WIDTH | 0.32 | ± 0.03 |
| | | PLATED | TIN (1 μ) | MIN. |

| | | | |
|---|---|---|---|
| PITCH | P | 0.5 | ± 0.1 |
| SPAN | SP | 2.0 | ± 0.1 |
| WIDTH | W | 3.0 | ± 0.1 |
| MARGIN | M | 0.5 | ± 0.1 |
| INSERT THICKNESS | T | 0.3 | ± 0.03 |
| PROTECTOR LENGTH | B1 | 6.0 | ± 1.5 |
| | B2 | 6.0 | ± 1.5 |
| STRIP LENGTH | S1 | 4.0 | ± 1.0 |
| | S2 | 4.0 | ± 1.0 |
| TOTAL LENGTH | T.L | OPTIONAL | |
| NO. OF PIN | | 5P | |



NOTE: DIMENSIONS ARE IN MILLIMETERS (mm)

## Part Numbering System

HDJD-S 8 X X - X X X X X

**Gain Selection (GS) Option**

| | Red | Green | Blue GS |
|---|---|---|---|
| 333: | 11 | 11 | 11 |

**Packaging Type**
T: Tray Standard Pack

**Product Packaging**
Q: QFN

**Config ID/Filter Attachment**
1: With IR Filter

**Product Type**
3: Module Level

**Pin Out for HDJD-S831-QT333 Color Sensor Module**

Pin Descriptions for Flat Flexible Cable Connector

| Pin | Name | Description |
|---|---|---|
| 1 | VDD5 | 5 V DC Supply |
| 2 | GND | Ground |
| 3 | $VB_{OUT}$ | Analog Output Voltage for Blue |
| 4 | $VG_{OUT}$ | Analog Output Voltage for Green |
| 5 | $VR_{OUT}$ | Analog Output Voltage for Red |



**Device Selection Guide**

| | Gain Selection[2] | | | | | |
|---|---|---|---|---|---|---|
| | Red | | Green | | Blue | |
| Part Number | GS: Bit 1 | Bit 0 | GS: Bit 1 | Bit 0 | GS: Bit 1 | Bit 0 |
| HDJD-S831-QT333[1] | 1 | 1 | 1 | 1 | 1 | 1 |

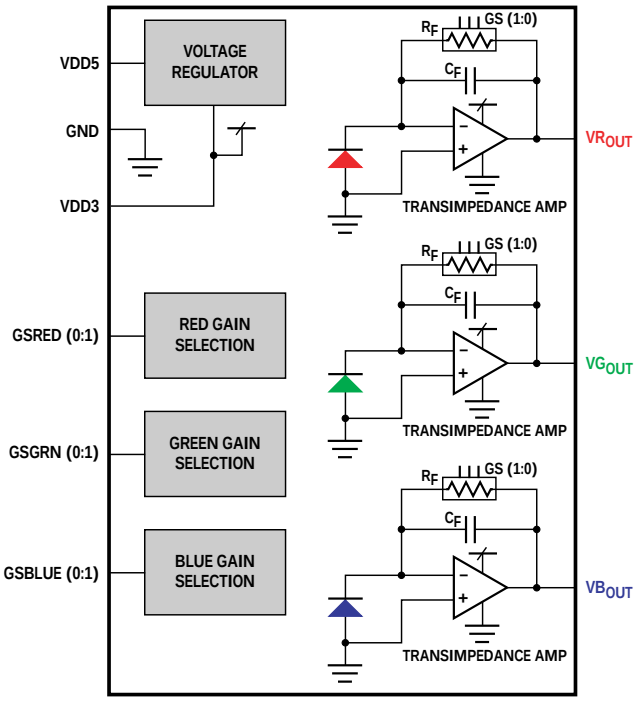
**Note:**

1. HDJD-S831-QT333 a is gain selections selectable. Please refer to gain Selection Feedback Resistor Table for different feedback resistor setting for different gain selections.
2. 0 indicates that the pin is connected to ground. 1 indicates no connection.

**Theory of Operation**

The integral R,G,B color filters on the photodiode array detect the R,G,B components of the light falling on the sensor. The photodiode converts the R,G,B light components into photocurrents. The integrated transimpedence amplifiers for R,G,B components then convert the photocurrent to analog voltage outputs. The voltage output of each R,G,B channel increases linearly with increasing light intensity.

## Sensor IC Block Diagram






## Absolute Maximum Ratings[1,2]

| Parameter | Symbol | Min. | Max. | Unit | Notes |
|---|---|---|---|---|---|
| Supply Voltage | $V_{DD5}$ | 4.5 | 5.5 | V | |
| Storage Temperature | $T_S$ | -20 | 85 | °C | |
| Operating Temperature | $T_A$ | -20 | 85 | °C | |
| Human Body Model ESD Rating | $ESD_{HBM}$ | | 2 | kV | Reference to JESD22-A114-B |

**Notes:**

1. Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
2. Unless otherwise specified, voltages are referenced to ground.

## Recommended Operating Conditions

| Parameter | Symbol | Min. | Typ. | Max. | Units | Notes |
|---|---|---|---|---|---|---|
| Operating Temperature | $T_A$ | 0 | 25 | 70 | °C | A decoupling capacitor of 100 nF between VDD5 and ground is recommended. |
| Supply Voltage | $V_{DD5}$ | 4.5 | 5.0 | 5.5 | V | |

**Operating Conditions and Electrical Requirements**

Electrical Characteristics at $V_{DD}$ = 5 V, $T_A$ = 25°C, $R_L$ = 68 kΩ

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Dark Voltage | $V_D$ | Ee = 0 | | | 15 | mV |
| Maximum Output Voltage Swing | $V_{O\ MAX}$ | | | 3 | | V |
| Supply Current | $I_{DD}$ | Ee = 0 | | 3 | | mA |
| Output Rise Time | tr | Min Vo = 0 V, Peak Vo = 2.0 V | | | 15 | µs |
| Output Fall Time | tf | Min Vo = 0 V, Peak Vo = 2.0 V | | | 15 | µs |
| Irradiance Responsivity | Re | GS:00 $\lambda_P$ = 460 nm[1] (Blue Channel) | | 3.10 | | V/(mW/cm²) |
| | | GS:00 $\lambda_P$ = 542 nm[2] (Green Channel) | | 3.90 | | |
| | | GS:00 $\lambda_P$ = 622 nm[3] (Red Channel) | | 1.10 | | |
| | | GS:00 $\lambda_P$ = 645 nm[4] (Red Channel) | | 0.85 | | |
| Irradiance Responsivity | Re | GS:11 $\lambda_P$ = 460 nm[1] (Blue Channel) | | 1.55 | | V/(mW/cm²) |
| | | GS:11 $\lambda_P$ = 542 nm[2] (Green Channel) | | 1.95 | | |
| | | GS:11 $\lambda_P$ = 622 nm[3] (Red Channel) | | 0.55 | | |
| | | GS:11 $\lambda_P$ = 645 nm[4] (Red Channel) | | 0.43 | | |
| Irradiance Responsivity | Re | GS:01 $\lambda_P$ = 460 nm[1] (Blue Channel) | | 0.78 | | V/(mW/cm²) |
| | | GS:01 $\lambda_P$ = 542 nm[2] (Green Channel) | | 0.98 | | |
| | | GS:01 $\lambda_P$ = 622 nm[3] (Red Channel) | | 0.28 | | |
| | | GS:01 $\lambda_P$ = 645 nm[4] (Red Channel) | | 0.21 | | |
| Irradiance Responsivity | Re | GS:10 $\lambda_P$ = 460 nm[1] (Blue Channel) | | 0.41 | | V/(mW/cm²) |
| | | GS:10 $\lambda_P$ = 542 nm[2] (Green Channel) | | 0.52 | | |
| | | GS:10 $\lambda_P$ = 622 nm[3] (Red Channel) | | 0.15 | | |
| | | GS:10 $\lambda_P$ = 645 nm[4] (Red Channel) | | 0.11 | | |

**Operating Conditions and Electrical Requirements (cont'd.)**

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Saturation Irradiance[5] | | GS:00 $\lambda_P$ = 460 nm[1] (Blue Channel) | | 1.0 | | mW/cm$^2$ |
| | | GS:00 $\lambda_P$ = 542 nm[2] (Green Channel) | | 0.8 | | |
| | | GS:00 $\lambda_P$ = 622 nm[3] (Red Channel) | | 2.7 | | |
| | | GS:00 $\lambda_P$ = 645 nm[4] (Red Channel) | | 3.5 | | |
| Saturation Irradiance[5] | | GS:11 $\lambda_P$ = 460 nm[1] (Blue Channel) | | 1.9 | | mW/cm$^2$ |
| | | GS:11 $\lambda_P$ = 542 nm[2] (Green Channel) | | 1.5 | | |
| | | GS:11 $\lambda_P$ = 622 nm[3] (Red Channel) | | 5.5 | | |
| | | GS:11 $\lambda_P$ = 645 nm[4] (Red Channel) | | 7.0 | | |
| Saturation Irradiance[5] | | GS:01 $\lambda_P$ = 460 nm[1] (Blue Channel) | | 3.9 | | mW/cm$^2$ |
| | | GS:01 $\lambda_P$ = 542 nm[2] (Green Channel) | | 3.1 | | |
| | | GS:01 $\lambda_P$ = 622 nm[3] (Red Channel) | | 10.7 | | |
| | | GS:01 $\lambda_P$ = 645 nm[4] (Red Channel) | | 14.3 | | |
| Saturation Irradiance[5] | | GS:10 $\lambda_P$ = 460 nm[1] (Blue Channel) | | 7.3 | | mW/cm$^2$ |
| | | GS:10 $\lambda_P$ = 542 nm[2] (Green Channel) | | 5.8 | | |
| | | GS:10 $\lambda_P$ = 622 nm[3] (Red Channel) | | 20.0 | | |
| | | GS:10 $\lambda_P$ = 645 nm[4] (Red Channel) | | 27.3 | | |

**Notes:**

1. Test condition: using blue diffuse light of peak wavelength ($\lambda_p$) 460 nm and spectral half width ($\Delta\lambda^1/_2$) 20 nm as light source.
2. Test condition: using green diffuse light of peak wavelength ($\lambda_p$) 542 nm and spectral half width ($\Delta\lambda^1/_2$) 35 nm as light source.
3. Test condition: using red diffuse light of peak wavelength ($\lambda_p$) 622 nm and spectral half width ($\Delta\lambda^1/_2$) 20 nm as light source.
4. Test condition: using red diffuse light of peak wavelength ($\lambda_p$) 645 nm and spectral half width ($\Delta\lambda^1/_2$) 20 nm as light source.
5. Saturation irradiance = (max output voltage swing)/(irradiance responsivity).

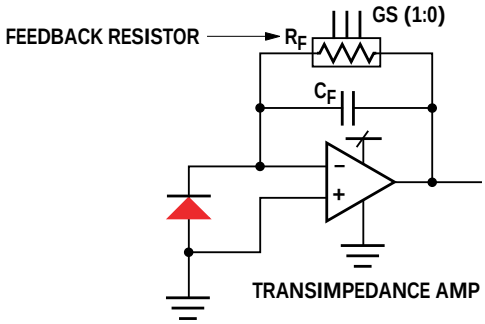
### Gain Selection Feedback Resistor Table

| GSRED1 | GSRED0 | GSGRN1 | GSGRN0 | GSBLUE1 | GSBLUE0 | Feedback Resistor |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 3.0 MΩ |
| 0 | 1 | 0 | 1 | 0 | 1 | 0.75 MΩ |
| 1 | 0 | 1 | 0 | 1 | 0 | 0.4 MΩ |
| 1 | 1 | 1 | 1 | 1 | 1 | 1.5 MΩ |

**Notes:**

1. Gains selections, GS: Bit 1 Bit 0 are applicable for each Red, Green and Blue Channel.
2. Gain selections for each channel can be selected independently of each other.
3. Feedback resistor value is proportional to responsivity. Refer to block diagram below.
4. 0 indicates that the pin is connected to ground. 1 indicates no connection.





## Typical Characteristics

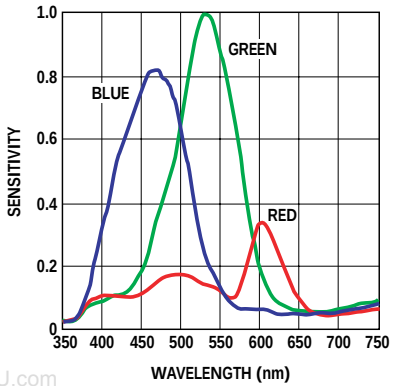





**Figure 1. Spectral responsivity.**

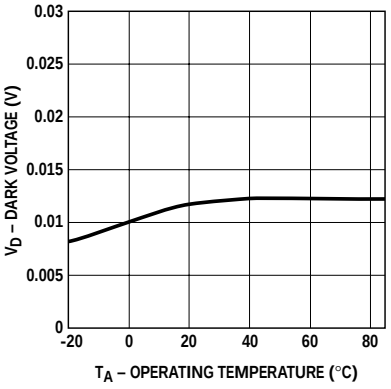



**Figure 2. Dark voltage vs. operating temperature.**

**Note:**
Test condition is when Gain Selection Jumpers are set to
GSBLUE1 = 0 GSGRN1 = 0 GSRED1 = 0
GSBLUE0 = 0 GSGRN0 = 0 GSRED0 = 0
in which 0 = connect to Ground, 1 = no connection.
Refer to Gain Selection Feedback Resistor Table.

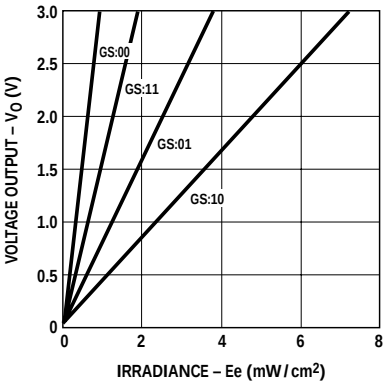



**Figure 3. Voltage output of blue channel vs. irradiance ($\lambda$p = 460 nm).**

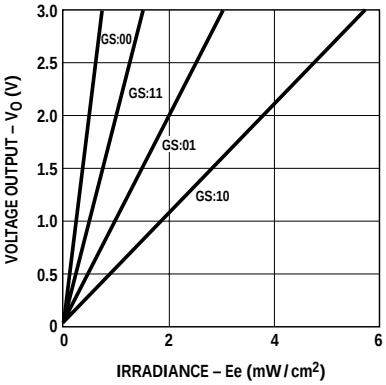



**Figure 4. Voltage output of green channel vs. irradiance ($\lambda$p = 542 nm).**

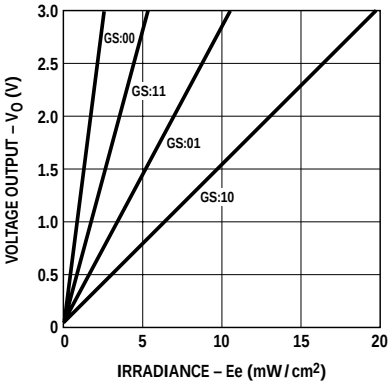
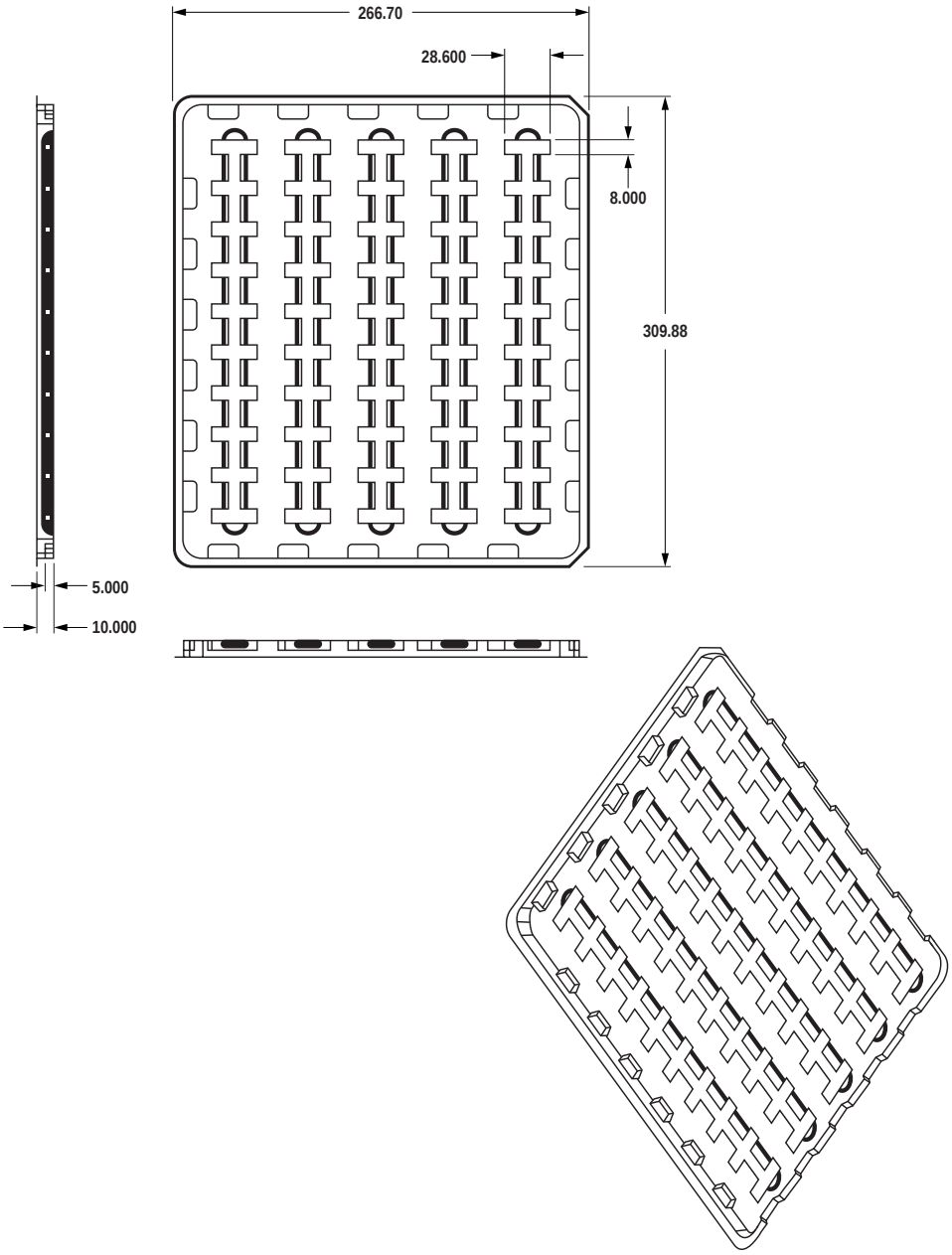



**Figure 5. Voltage output of red channel vs. irradiance ($\lambda$p = 622 nm).**

## Package Tray Standard Pack Dimensions






For product information and a complete list of distributors, please go to our website: **www.avagotech.com**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