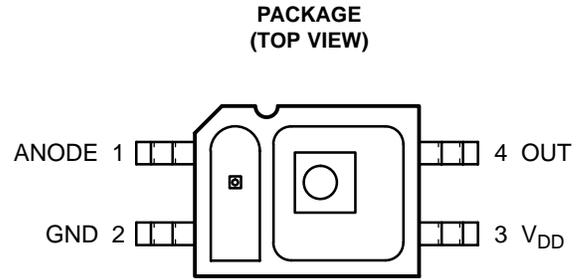


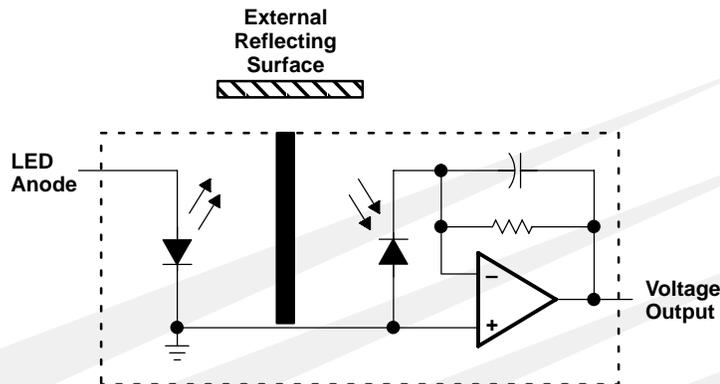
- Converts Reflected Light Intensity to Output Voltage
- Integral Color LEDs and Matching Color Filters on Sensors
- Sensor is a Monolithic Silicon IC Containing a Photodiode, Operational Amplifier, Feedback Components, and Color Filter
- High-Output LEDs and High-Sensitivity Sensors
- Single Voltage Supply Operation
- Surface-Mount Package



### Description

The TRS1722, TRS1755, and TRS1766 are high-sensitivity reflective color sensors in red (630 nm), green (567 nm), and blue (470 nm) — respectively — with light-to-voltage converters. Each device consists of a colored LED light source, a photodiode light sensor with matching optical color filter, a transimpedance amplifier, and on-board signal conditioning. Output voltage is directly proportional to the reflected light intensity on the photodiode plus any ambient light (which may be considered noise).

### Functional Block Diagram



# TRS1722, TRS1755, TRS1766 HIGH SENSITIVITY REFLECTIVE COLOR SENSOR WITH LIGHT-TO-VOLTAGE CONVERTERS

TAOS034 – NOVEMBER 2002

## Terminal Functions

TERMINAL NAME NO.	DESCRIPTION
GND 2	Ground. LED cathode and sensor ground. All voltages are referenced to GND.
ANODE 1	LED anode drive input
OUT 4	Output voltage
V <sub>DD</sub> 3	Supply voltage

## Absolute Maximum Ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V <sub>DD</sub> (see Note 1)	6 V
Output current, I <sub>O</sub>	±10 mA
Duration of short-circuit current at (or below) 25°C	5 s
LED DC forward current	30 mA
LED peak forward current (5% duty cycle @ 1 kHz or more)	100 mA
LED junction temperature, LED T <sub>J</sub>	125°C
Operating free-air temperature range, T <sub>A</sub>	-25°C to 85°C
Storage temperature range, T <sub>stg</sub>	-25°C to 85°C
Lead temperature in solder contact zone for 10 seconds	240°C

† 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.

NOTE 1: All voltages are with respect to GND.

## Recommended Operating Conditions

	MIN	MAX	UNIT
Supply voltage, V <sub>DD</sub>	3	5.5	V
LED forward current	0	10	mA
Operating free-air temperature, T <sub>A</sub>	0	70	°C

## LED

PARAMETER	TEST CONDITIONS	TRS1722			TRS1755			TRS1766			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>f</sub> Forward voltage	I <sub>f</sub> = 20 mA	2.2	3		2.3	3		2.7	4		V
I <sub>r</sub> Reverse leakage	V <sub>r</sub> = 5 V			10			10			10	μA
P <sub>o</sub> Radiant flux	I <sub>f</sub> = 5 mA		14			5			300		μW
λ Wavelength	I <sub>f</sub> = 5 mA		630			567			468		nm
BW Bandwidth	I <sub>f</sub> = 5 mA		40			26			26		nm



**TRS1722, TRS1755, TRS1766**  
**HIGH SENSITIVITY REFLECTIVE COLOR SENSOR**  
**WITH LIGHT-TO-VOLTAGE CONVERTERS**

TAOS034 – NOVEMBER 2002

**Electrical Characteristics at  $V_{DD} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{ k}\Omega$  (unless otherwise noted) (continued)**

**Detector (see Notes 2 and 3)**

PARAMETER	TEST CONDITIONS	TRS1722			TRS1755			TRS1766			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
$V_D$ Dark voltage	$E_e = 0$	0		20	0		20	0		20	mV
$V_{OM}$ Maximum output voltage swing	No Load	4.49			4.49			4.49			V
	$R_L = 10\text{ k}\Omega$	4	4.2		4	4.2		4	4.2		
$\alpha_{VD}$ Temperature coefficient of dark voltage ( $V_D$ )	$T_A = 0^\circ\text{C}$ to $70^\circ\text{C}$	-15			-15			-15			$\mu\text{V}/^\circ\text{C}$
$R_e$ Irradiance responsivity	$\lambda_p = 470\text{ nm}$ , see Notes 4 and 7	20			90			300			mV/ ( $\mu\text{W}/\text{cm}^2$ )
	$\lambda_p = 524\text{ nm}$ , see Notes 5 and 7	35			300			130			
	$\lambda_p = 565\text{ nm}$ , see Notes 7 and 8	90			300			22			
	$\lambda_p = 635\text{ nm}$ , see Notes 6 and 7	460			35			13			
$R_V$ Illuminance responsivity	$\lambda_p = 470\text{ nm}$ , see Notes 4 and 7	0.12			0.47			1.57			V/lx
	$\lambda_p = 524\text{ nm}$ , see Notes 5 and 7	0.027			0.24			0.10			
	$\lambda_p = 565\text{ nm}$ , see Notes 7 and 8	0.06			0.20			0.015			
	$\lambda_p = 635\text{ nm}$ , see Notes 6 and 7	1.21			0.093			0.033			
PSRR Power supply rejection ratio	$f_{ac} = 100\text{ Hz}$ , see Note 10	55			55			55			dB
	$f_{ac} = 1\text{ kHz}$ , see Note 10	35			35			35			
$I_{DD}$ Supply current	$V_O = 2\text{ V}$ (typical)	1.9	3.5		1.9	3.5		1.9	3.5		mA

- NOTES:
2. Measured with  $R_L = 10\text{ k}\Omega$  between output and ground.
  3. Optical measurements are made using small-angle incident radiation from a light-emitting diode (LED) optical source.
  4. The input irradiance is supplied by an InGaN light-emitting diode with the following characteristics: peak wavelength  $\lambda_p = 470\text{ nm}$ , spectral halfwidth  $\Delta\lambda_{1/2} = 35\text{ nm}$ , luminous efficacy =  $75\text{ lm/W}$ .
  5. The input irradiance is supplied by an InGaN light-emitting diode with the following characteristics: peak wavelength  $\lambda_p = 524\text{ nm}$ , spectral halfwidth  $\Delta\lambda_{1/2} = 47\text{ nm}$ , luminous efficacy =  $520\text{ lm/W}$ .
  6. The input irradiance is supplied by an AlInGaP light-emitting diode with the following characteristics: peak wavelength  $\lambda_p = 635\text{ nm}$ , spectral halfwidth  $\Delta\lambda_{1/2} = 17\text{ nm}$ , luminous efficacy =  $150\text{ lm/W}$ .
  7. Responsivity is characterized over the range  $V_O = 0.1\text{ V}$  to  $4.5\text{ V}$ . The best-fit straight line of Output Voltage  $V_O$  versus Irradiance  $E_e$  over this range will typically have a positive extrapolated  $V_O$  value for  $E_e = 0$ .
  8. The input irradiance is supplied by a GaP light-emitting diode with the following characteristics: peak wavelength  $\lambda_p = 565\text{ nm}$ , spectral halfwidth  $\Delta\lambda_{1/2} = 28\text{ nm}$ , luminous efficacy =  $595\text{ lm/W}$ .
  9. Illuminance responsivity  $R_V$  is calculated from the irradiance responsivity by using the LED luminous efficacy values stated in Notes 4, 5, 6, and 8, and using  $1\text{ lx} = 1\text{ lm/m}^2$ .
  10. Power supply rejection ratio PSRR is defined as  $20\log(\Delta V_{DD}(f)/\Delta V_O(f))$  with  $V_{DD}(f=0) = 5\text{ V}$  and  $V_O(f=0) = 2\text{ V}$ .

# TRS1722, TRS1755, TRS1766 HIGH SENSITIVITY REFLECTIVE COLOR SENSOR WITH LIGHT-TO-VOLTAGE CONVERTERS

TAOS034 – NOVEMBER 2002

Electrical Characteristics at  $V_{DD} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{ k}\Omega$  (unless otherwise noted) (continued)

Coupled (see Note 2)

PARAMETER	TEST CONDITIONS	TRS1722			TRS1755			TRS1766			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
$I_F$ LED forward current	$V_O = 2\text{ V}$ , $d = 1\text{ mm}$ (Note 11)	0.5	2.1	4	2	5	8	0.1	0.4	1.75	mA
$V_O$ Output voltage	$I_f = 2.5\text{ mA}$ , $d = 1\text{ mm}$ (Note 11)	2.4									V
	$I_f = 5\text{ mA}$ , $d = 1\text{ mm}$ (Note 11)				2						
	$I_f = 0.25\text{ mA}$ , $d = 1\text{ mm}$ (Note 11)							1.3			
$V_{ox}$ Crosstalk	$I_f = 5\text{ mA}$ , no surface (see Note 12)	0	80	300	0	30	200				mV
	$I_f = 1\text{ mA}$ , no surface (see Note 12)							0	130	500	

NOTES: 11. Measured using Eastman Kodak neutral white test card having 90% diffuse reflectance located a distance from the front surface of the reflective sensors. Reference: Eastman Kodak catalog number #1257795.

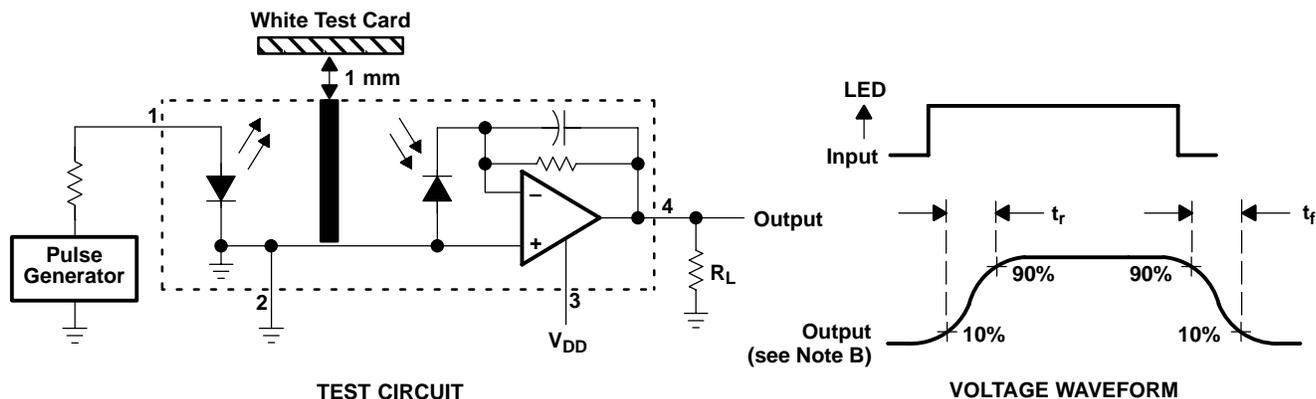
12. Crosstalk is the output voltage measured with the indicated current on the LED and with no reflecting surface. Ambient light is excluded with a black box approximately 20 cm in each dimension.

Switching Characteristics at  $V_{DD} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{ k}\Omega$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_r$ Output pulse rise time, 10% to 90% of final value	See Note 13 and Figure 1		160	250	$\mu\text{s}$
$t_f$ Output pulse fall time, 10% to 90% of final value	See Note 13 and Figure 1		150	250	$\mu\text{s}$
$t_s$ Output settling time to 1% of final value	See Note 13 and Figure 1		330		$\mu\text{s}$
Integrated noise voltage	$f = \text{dc to } 1\text{ kHz}$ $E_e = 0$		200		$\mu\text{Vrms}$
$V_n$ Output noise voltage, rms	$f = 10\text{ Hz}$ $E_e = 0$		6		$\mu\text{V}/\sqrt{\text{Hz}}$ rms
	$f = 100\text{ Hz}$ $E_e = 0$		6		
	$f = 1\text{ kHz}$ $E_e = 0$		7		

NOTE 13: Switching characteristics apply over the range  $V_O = 0.1\text{ V}$  to  $4.5\text{ V}$ .

PARAMETER MEASUREMENT INFORMATION



- NOTES: A. The input irradiance is supplied by pulsing the LED with a white test card positioned 1 mm from the face of the device.  
 B. The output waveform is monitored on an oscilloscope with the following characteristics:  $t_r < 100$  ns,  $Z_i \geq 1$  M $\Omega$ ,  $C_i \leq 20$  pF.  
 C. The pulse generator output drive is adjusted until the sensor output voltage reaches 2 volts.

Figure 1. Switching Times

TYPICAL CHARACTERISTICS

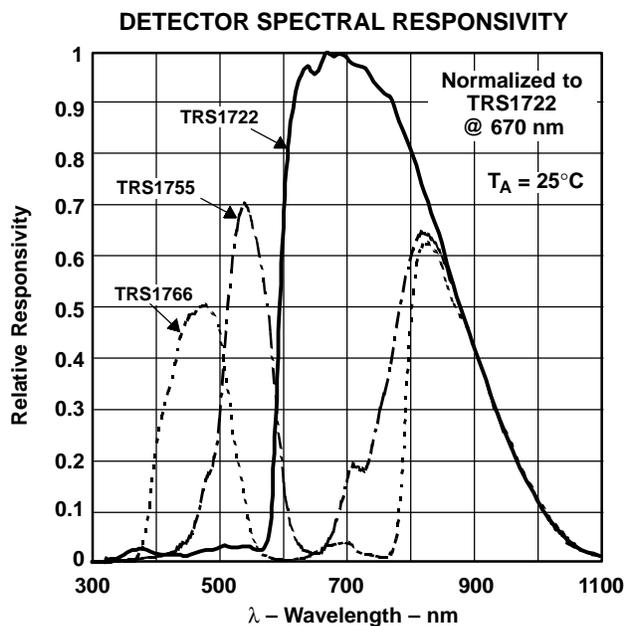


Figure 2

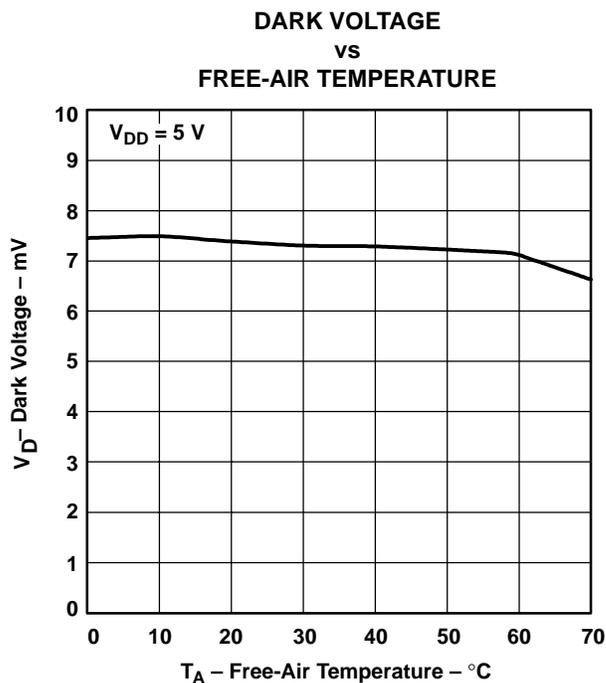


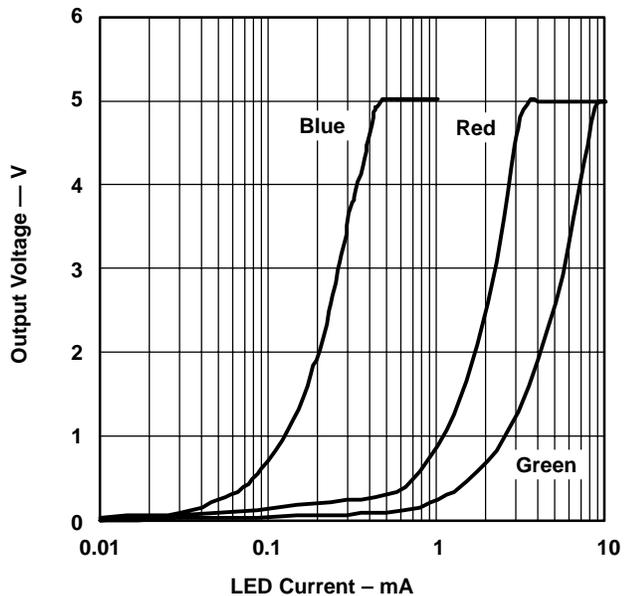
Figure 3

**TRS1722, TRS1755, TRS1766  
HIGH SENSITIVITY REFLECTIVE COLOR SENSOR  
WITH LIGHT-TO-VOLTAGE CONVERTERS**

TAOS034 – NOVEMBER 2002

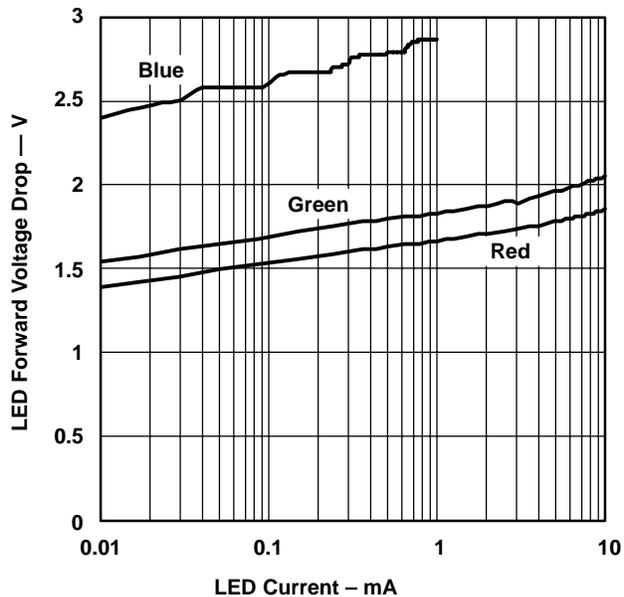
**TYPICAL CHARACTERISTICS**

**TYPICAL OUTPUT VOLTAGE  
vs.  
LED CURRENT**



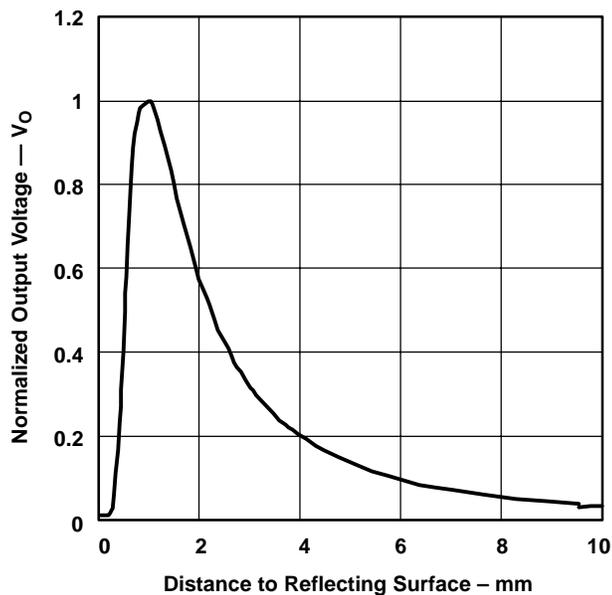
**Figure 4**

**TYPICAL LED VOLTAGE  
vs.  
LED CURRENT**



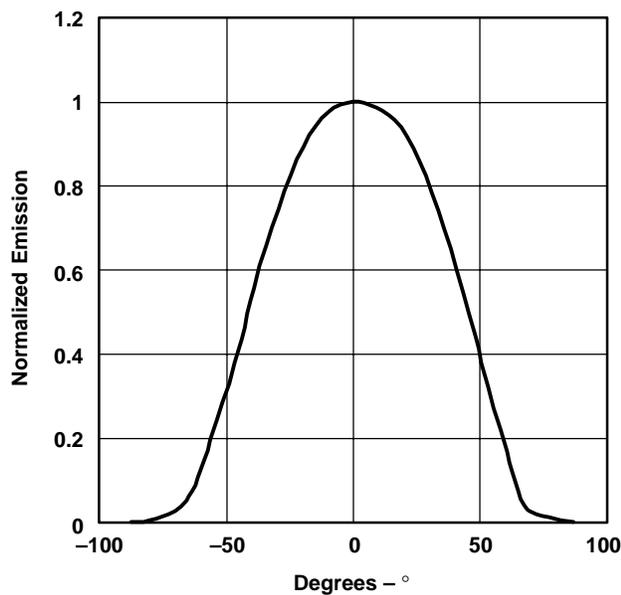
**Figure 5**

**TYPICAL NORMALIZED OUTPUT  
vs.  
DISTANCE**



**Figure 6**

**REFLECTIVE SENSOR LED ANGULAR  
NORMALIZED EMISSION SWING  
PERPENDICULAR TO LED DETECTOR AXIS**



**Figure 7**

TYPICAL CHARACTERISTICS

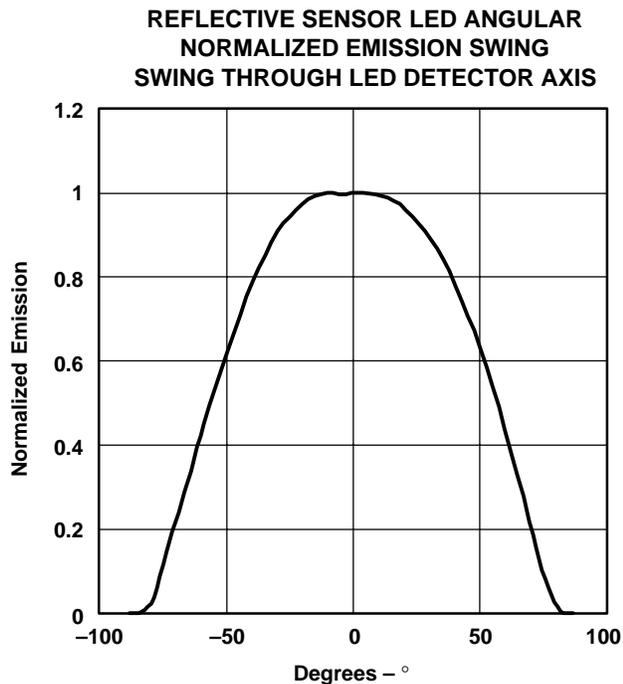


Figure 8

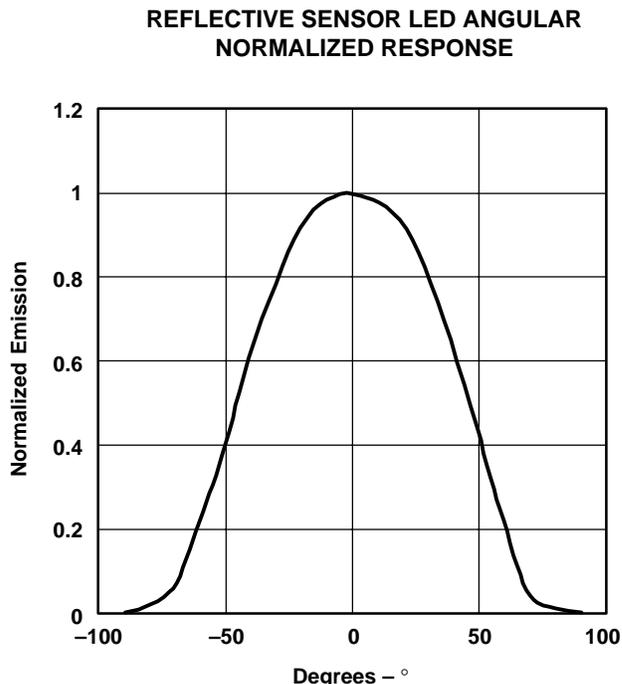
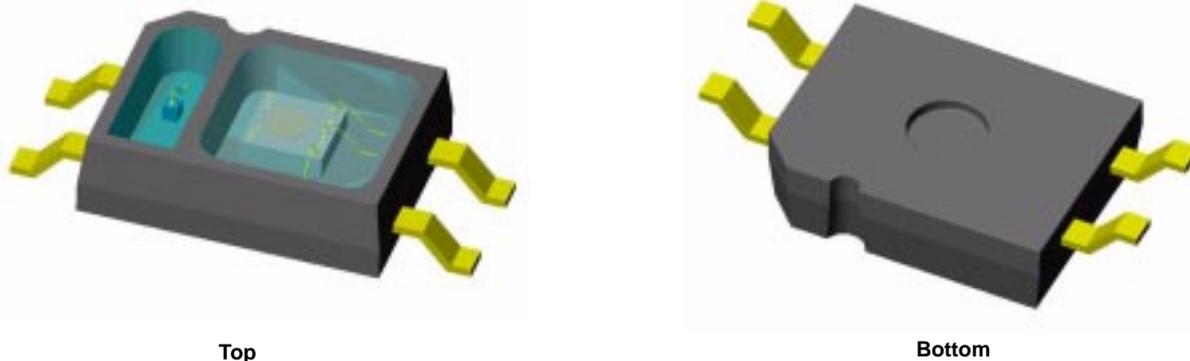


Figure 9

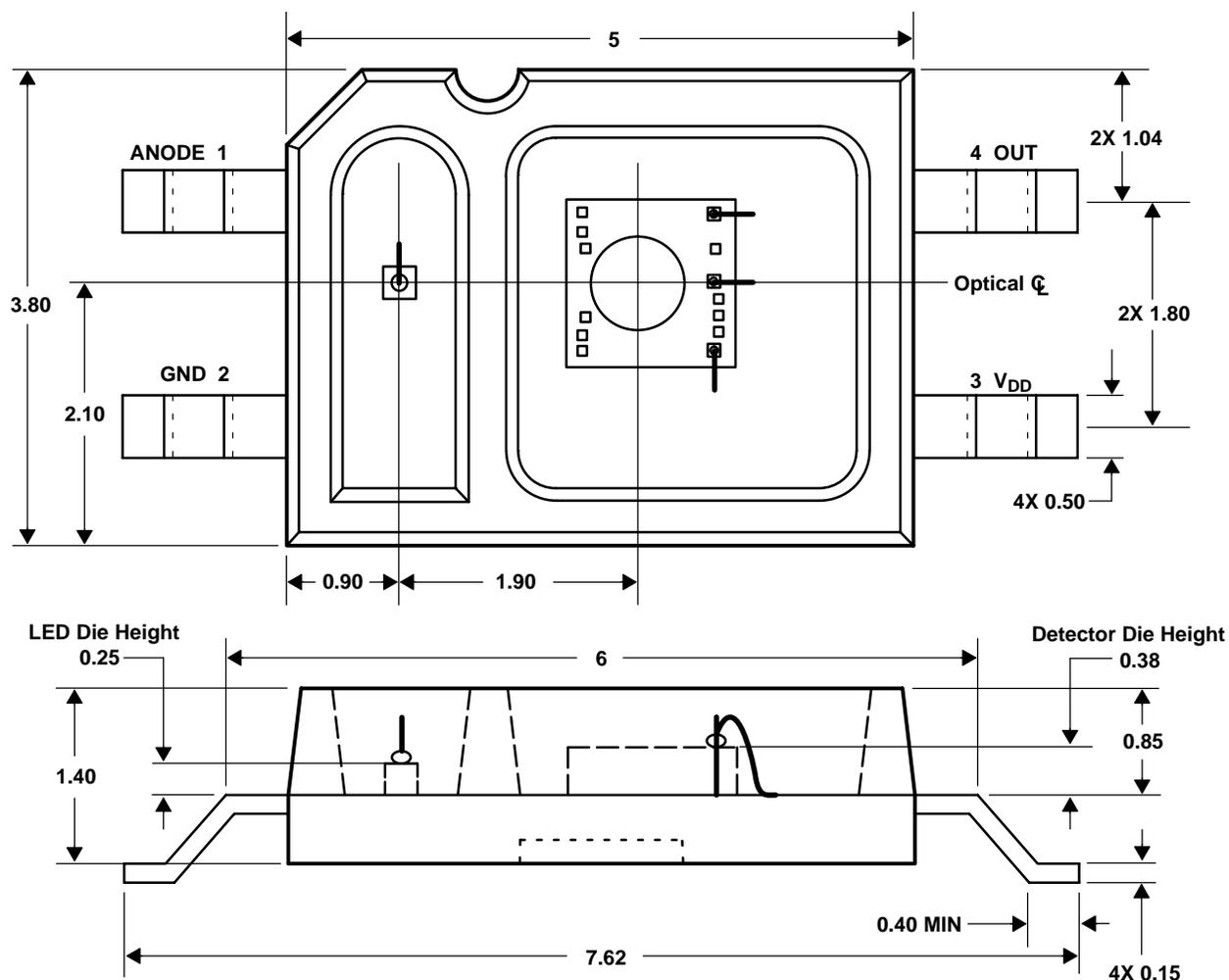
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HIGH SENSITIVITY REFLECTIVE COLOR SENSOR  
WITH LIGHT-TO-VOLTAGE CONVERTERS**

TAOS034 – NOVEMBER 2002

**MECHANICAL DATA**



**Figure 10. Device Pictorial**



- NOTES: A. All linear dimensions are in millimeters.  
 B. Tolerances: die placement:  $\pm 0.2$ , plastic package:  $\pm 0.4$ , leads:  $\pm 0.8$ .  
 C. This drawing is subject to change without notice.

**Figure 11. Package Configuration**

**TRS1722, TRS1755, TRS1766  
HIGH SENSIVITY REFLECTIVE COLOR SENSOR  
WITH LIGHT-TO-VOLTAGE CONVERTERS**

TAOS034 – NOVEMBER 2002

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HIGH SENSITIVITY REFLECTIVE COLOR SENSOR  
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TAOS034 – NOVEMBER 2002

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