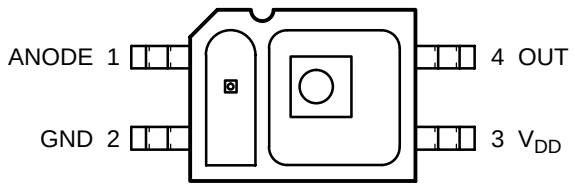
TRS1722, TRS1755, TRS1766
HIGH SENSITIVITY REFLECTIVE COLOR SENSOR WITH LIGHT-TO-VOLTAGE CONVERTERS

TAOS034 – NOVEMBER 2002

- **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**

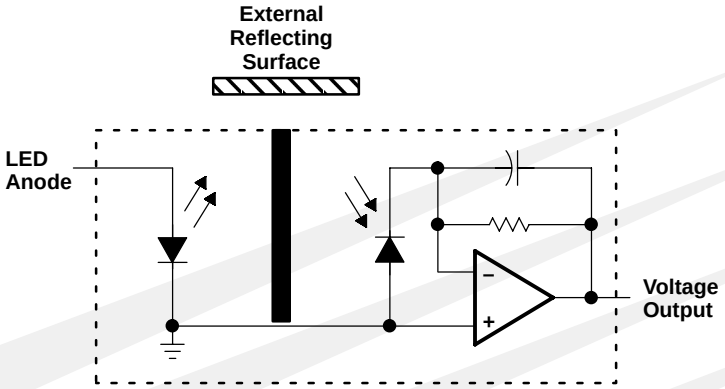
PACKAGE
(TOP VIEW)



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



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Terminal Functions

TERMINAL NAME	TERMINAL 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_{DD}	3	Supply voltage

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

Supply voltage, V_{DD} (see Note 1) . . . . . 6 V
Output current, I_O . . . . . ±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_J . . . . . 125°C
Operating free-air temperature range, T_A . . . . . –25°C to 85°C
Storage temperature range, T_{stg} . . . . . –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_{DD}	3	5.5	V
LED forward current	0	10	mA
Operating free-air temperature, T_A	0	70	°C

LED

PARAMETER		TEST CONDITIONS	TRS1722			TRS1755			TRS1766			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_f	Forward voltage	I_f = 20 mA		2.2	3		2.3	3		2.7	4	V
I_r	Reverse leakage	V_r = 5 V			10			10			10	µA
P_o	Radiant flux	I_f = 5 mA		14			5			300		µW
λ	Wavelength	I_f = 5 mA		630			567			468		nm
BW	Bandwidth	I_f = 5 mA		40			26			26		nm

Electrical Characteristics at V_{DD} = 5 V, T_A = 25°C, R_L = 10 kΩ (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 kΩ	4	4.2		4	4.2		4	4.2		
α_{VD}	Temperature coefficient of dark voltage (V_D)	T_A = 0°C to 70°C		–15			–15			–15		µV/°C
R_e	Irradiance responsivity	λ_p = 470 nm, see Notes 4 and 7		20			90			300		mV/(µW/cm^2)
		λ_p = 524 nm, see Notes 5 and 7		35			300			130		
		λ_p =565 nm, see Notes 7 and 8		90			300			22		
		λ_p = 635 nm, see Notes 6 and 7		460			35			13		
R_V	Illuminance responsivity	λ_p = 470 nm, see Notes 4 and 7		0.12			0.47			1.57		V/lx
		λ_p = 524 nm, see Notes 5 and 7		0.027			0.24			0.10		
		λ_p = 565 nm, see Notes 7 and 8		0.06			0.20			0.015		
		λ_p = 635 nm, see Notes 6 and 7		1.21			0.093			0.033		
PSRR	Power supply rejection ratio	f_{ac} = 100 Hz, see Note 10		55			55			55		dB
		f_{ac} = 1 kHz, see Note 10		35			35			35		
I_{DD}	Supply current	V_O = 2 V (typical)		1.9	3.5		1.9	3.5		1.9	3.5	mA

NOTES:
2. Measured with R_L = 10 kΩ 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 λ_p = 470 nm, spectral halfwidth $\Delta\lambda$½ = 35 nm, luminous efficacy = 75 lm/W.
5. The input irradiance is supplied by an InGaN light-emitting diode with the following characteristics: peak wavelength λ_p = 524 nm, spectral halfwidth $\Delta\lambda$½ = 47 nm, luminous efficacy = 520 lm/W.
6. The input irradiance is supplied by an AlInGaP light-emitting diode with the following characteristics: peak wavelength λ_p = 635 nm, spectral halfwidth $\Delta\lambda$½ = 17 nm, luminous efficacy = 150 lm/W.
7. Responsivity is characterized over the range V_O = 0.1 V to 4.5 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 λ_p = 565 nm, spectral halfwidth $\Delta\lambda$½ = 28 nm, luminous efficacy = 595 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 lx = 1 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 V and $V_O(f = 0)$ = 2 V.

Electrical Characteristics at V_{DD} = 5 V, T_A = 25°C, R_L = 10 kΩ (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 V, d = 1 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 mA, d = 1 mm (Note 11)		2.4								V
		I_f = 5 mA, d = 1 mm (Note 11)					2					
		I_f = 0.25 mA, d = 1 mm (Note 11)								1.3		
V_{ox}	Crosstalk	I_f = 5 mA, no surface (see Note 12)	0	80	300	0	30	200				mV
		I_f = 1 mA, no surface (see Note 12)							0	130	500	

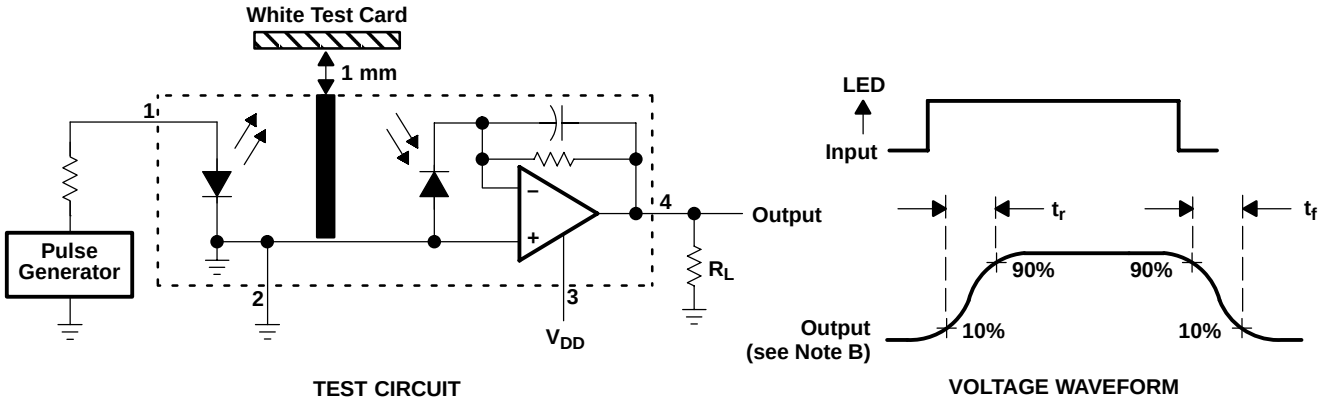
NOTES: 11. Measured using Eastman Kodak neutral white test card having 90% diffuse reflectance located a distance from the front surface of the reflective sensors. Reference: Eastman Kodak catalog number #1257795.
12. Crosstalk is the output voltage measured with the indicated current on the LED and with no reflecting surface. Ambient light is excluded with a black box approximately 20 cm in each dimension.

Switching Characteristics at V_{DD} = 5 V, T_A = 25°C, R_L = 10 kΩ (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	µs
t_f	Output pulse fall time, 10% to 90% of final value	See Note 13 and Figure 1			150	250	µs
t_s	Output settling time to 1% of final value	See Note 13 and Figure 1			330		µs
	Integrated noise voltage	f = dc to 1 kHz	E_e = 0		200		µVrms
V_n	Output noise voltage, rms	f = 10 Hz	E_e = 0		6		µV/√Hz rms
		f = 100 Hz	E_e = 0		6		
		f = 1 kHz	E_e = 0		7		

NOTE 13: Switching characteristics apply over the range V_O = 0.1 V to 4.5 V.

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT VOLTAGE WAVEFORM

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, $Z_i \geq 1$ MΩ, $C_i \leq 20$ pF.
C. The pulse generator output drive is adjusted until the sensor output voltage reaches 2 volts.

Figure 1. Switching Times

TYPICAL CHARACTERISTICS

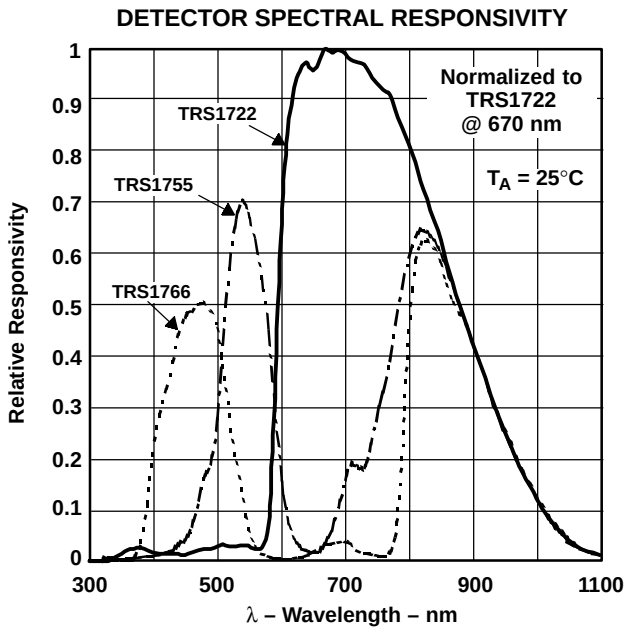


Figure 2

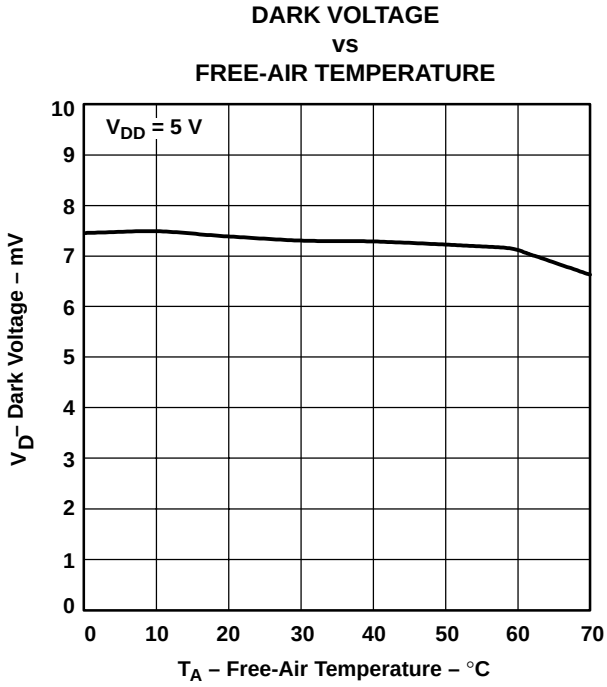


Figure 3

TYPICAL CHARACTERISTICS

TYPICAL OUTPUT VOLTAGE vs. LED CURRENT

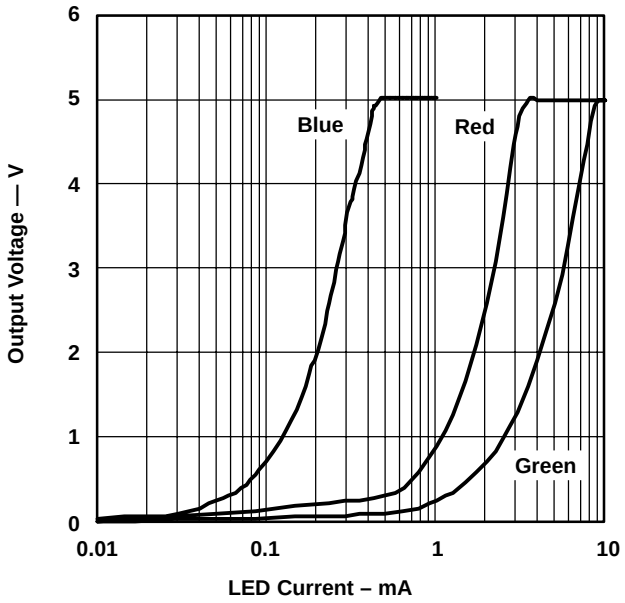


Figure 4

TYPICAL LED VOLTAGE vs. LED CURRENT

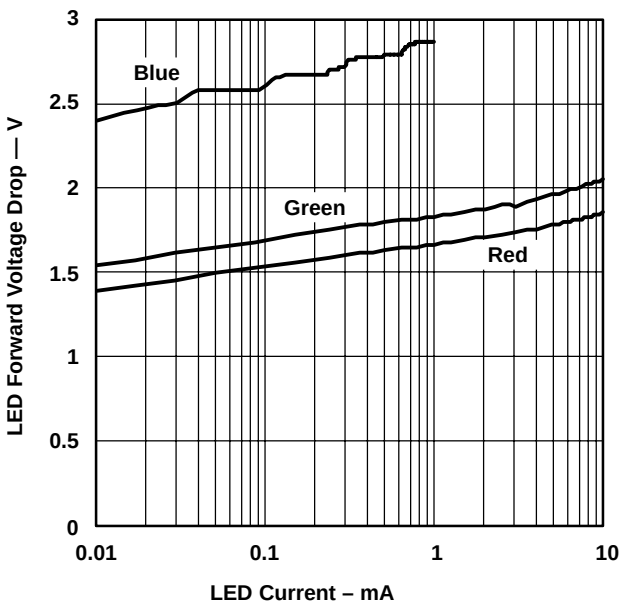


Figure 5

TYPICAL NORMALIZED OUTPUT vs. DISTANCE

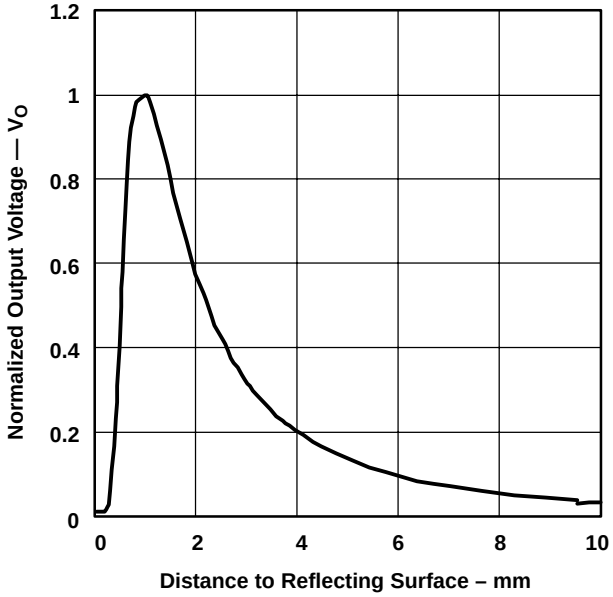


Figure 6

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

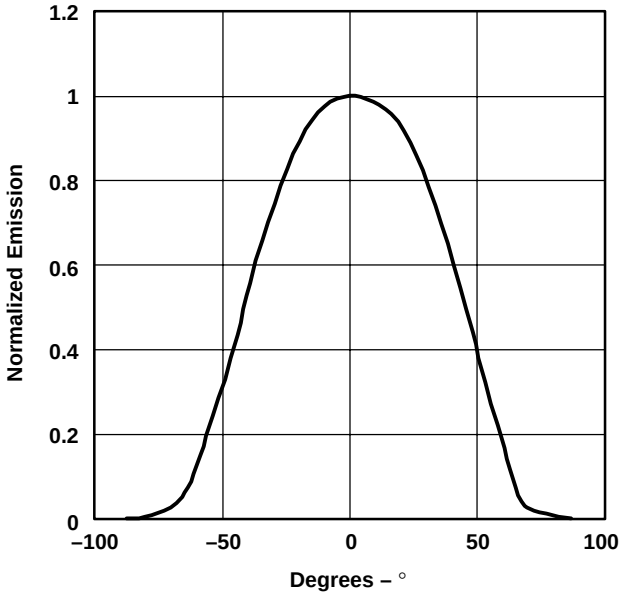


Figure 7

TYPICAL CHARACTERISTICS

REFLECTIVE SENSOR LED ANGULAR NORMALIZED EMISSION SWING SWING THROUGH LED DETECTOR AXIS

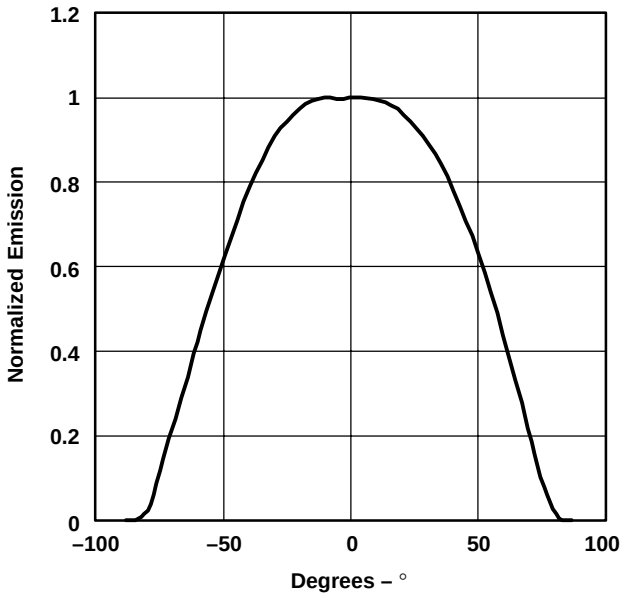


Figure 8

REFLECTIVE SENSOR LED ANGULAR NORMALIZED RESPONSE

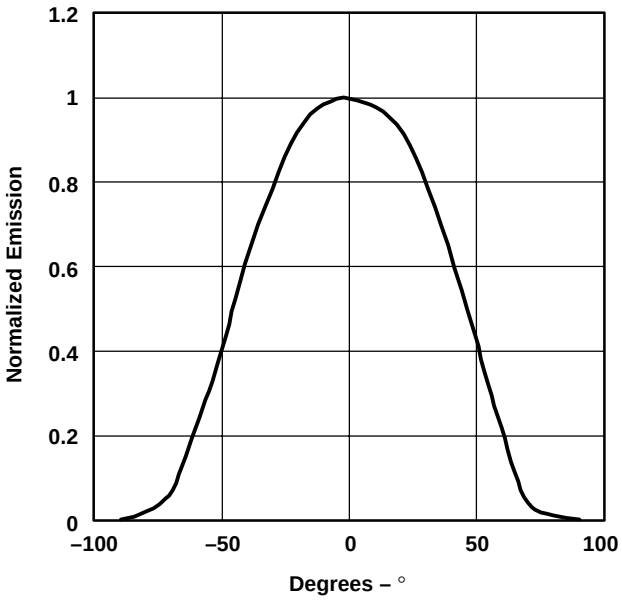
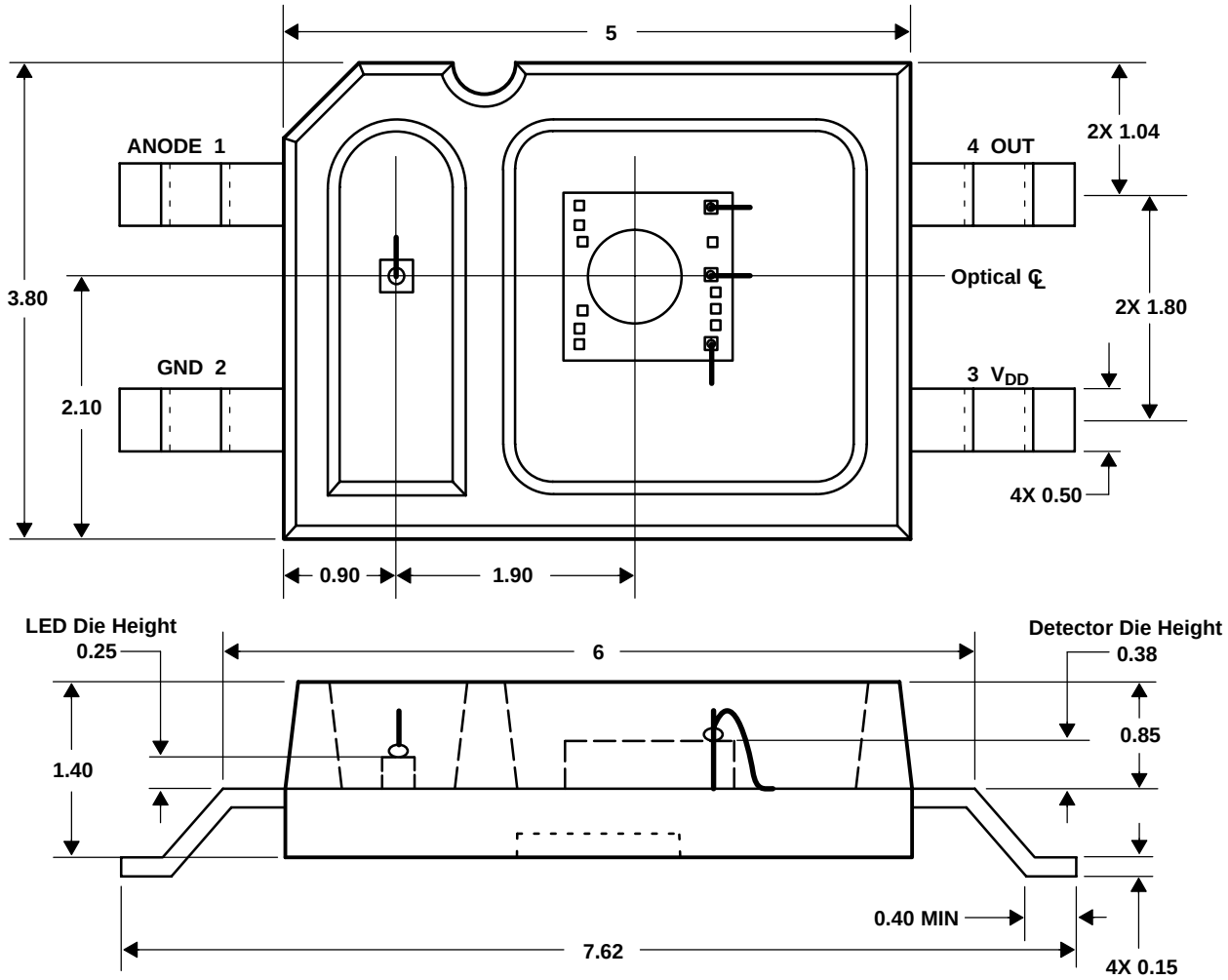


Figure 9

MECHANICAL DATA

Top Bottom

Figure 10. Device Pictorial



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

Figure 11. Package Configuration

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