TSL12S, TSL13S, TSL14S

Light-to-Voltage Converters

General Description

The TSL12S, TSL13S, and TSL14S are cost-optimized, highly integrated light-to-voltage optical sensors, each combining a photodiode and a transimpedance amplifier (feedback resistor = 80MΩ, 20MΩ, and 5MΩ, respectively) on a single monolithic integrated circuit. The photodiode active area is 0.5mm × 0.5mm and the sensors respond to light in the range of 320nm to 1050nm. Output voltage is linear with light intensity (irradiance) incident on the sensor over a wide dynamic range. These devices are supplied in a 3-lead clear plastic sidelooker package (S).

Ordering Information and Content Guide appear at end of datasheet.

Key Benefits & Features

The benefits and features of TSL12S, TSL13S, and TSL14S Light-to-Voltage Converters are listed below:

Figure 1:
Added Value of Using TSL12S, TSL13S, and TSL14S

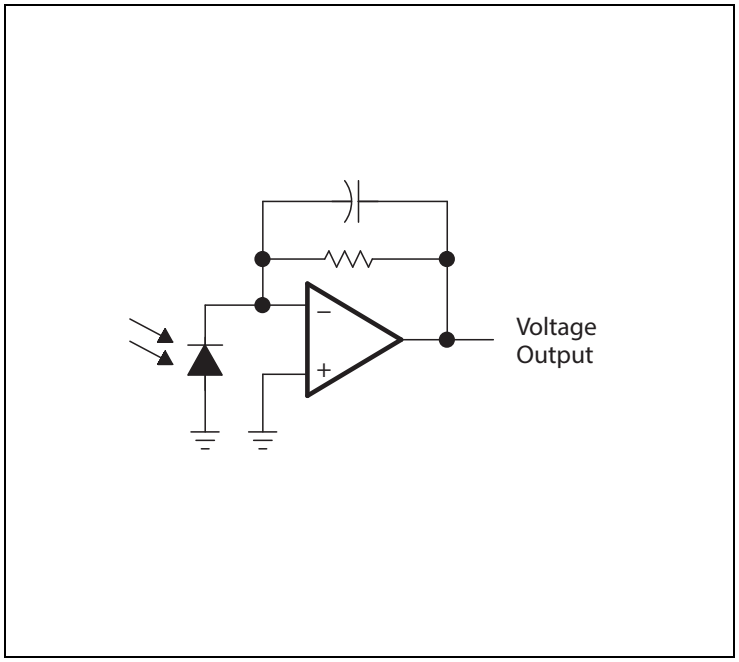
Benefits	Features
• Enables extremely fast response to change	• Single photo-diode and transimpedance architecture
• Enables fast response to visible light in range of 400nm to 700nm wavelengths	• 10µs output rise-time response (TSL12S)
• Provides for high sensitivity to detect a small change in light	• High irradiance responsivity 246mV/(µW/cm^2) @ λp = 640nm (TSL12S)
• Provides additional sensitivity advantages	• 2x gain lense

- Converts light intensity to output voltage
- Monolithic silicon IC containing photodiode, transconductance amplifier, and feedback components
- Single-supply operation: 2.7V to 5.5V
- Low supply current: 1.1mA typical
- Sidelooker 3-lead plastic package

Block Diagram

The functional blocks of this device are shown below:

Figure 2:
TSL12S, TSL13S, and TSL14 Block Diagram



Pin Assignment

The TSL12S, TSL13S, and TSL14S pin assignments are described below.

Figure 3:
Pin Diagram

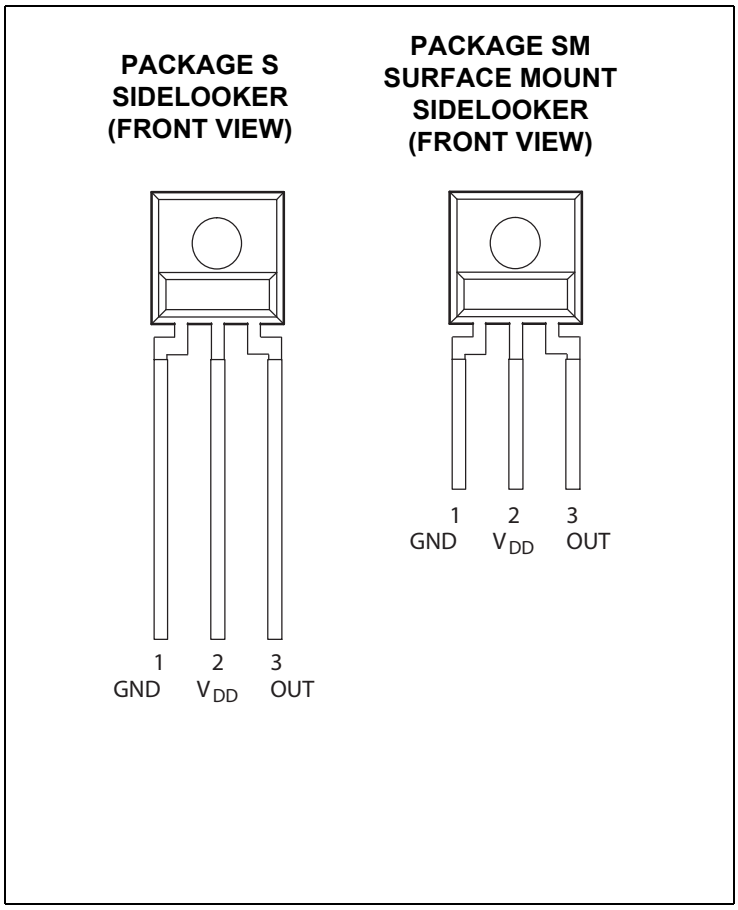


Figure 4:
Terminal Functions

Terminal		Type	Description
No.	Name		
1	GND		Power supply ground (substrate). All voltages are referenced to GND.
2	V_{DD}		Supply voltage.
3	OUT	O	Output voltage.

Absolute Maximum Ratings

Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated under Operating Conditions is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Figure 5:
Absolute Maximum Ratings over Operating Free-Air Temperature Range (unless otherwise noted)

Symbol	Parameter	Min	Max	Unit
V_{DD}	Supply voltage (1)		6	V
I_O	Output current		±10	mA
	Duration of short-circuit current at (or below) 25°C (2)		5	s
T_A	Operating free-air temperature range (2)	-25	85	°C
T_{strg}	Storage temperature range	-25	85	°C
	Lead temperature 1.6mm (1/16 inch) from case for 10 seconds (S Package)		260	°C
	Reflow solder, in accordance with J-STD-020C or J-STD-020D (SM Package)		260	°C

Note(s):

1. All voltage values are with respect to GND.
2. Output may be shorted to supply.

Electrical Characteristics

All limits are guaranteed. The parameters with min and max values are guaranteed with production tests or SQC (Statistical Quality Control) methods.

Operating Conditions

All defined tolerances for external components in this specification need to be assured over the whole operation condition range and also over lifetime.

Figure 6:
Recommended Operating Conditions

Symbol	Parameter	Min	Nom	Max	Unit
V_{DD}	Supply voltage	2.7		5.5	V
T_A	Operating free-air temperature	0		70	°C

Figure 7:
Electrical Characteristics at V_{DD} = 5V, T_A = 25°C, λ_p = 640nm, R_L = 10kΩ (unless otherwise noted)(1), (2), (3)

Symbol	Parameter	Test Conditions	TSL12S			TSL13S			TSL14S			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
V_{OM}	Maximum output voltage		4.6	4.9		4.6	4.9		4.6	4.9		V
V_O	Output voltage	E_e = 8µW/cm^2	1.5	2	2.5							V
		E_e = 31µW/cm^2				1.5	2	2.5				
		E_e = 120µW/cm^2							1.5	2	2.5	
		E_e = 16µW/cm^2		4								
		E_e = 62µW/cm^2					4					
		E_e = 240µW/cm^2								4		
R_e	Irradiance responsivity	See note (4)		248			64			16		mV/(µW/cm^2)
V_{OS}	Extrapolated offset voltage	See note (4)	-0.02	0.03	0.08	-0.02	0.03	0.08	-0.02	0.03	0.08	V
V_d	Dark voltage	E_e = 0	0		0.08	0		0.08	0		0.08	V

Symbol	Parameter	Test Conditions	TSL12S			TSL13S			TSL14S			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
I_D	Supply current	E_e = 8µW/cm^2		1.1	1.7							mA
		E_e = 31µW/cm^2					1.1	1.7				
		E_e = 120µW/cm^2								1.1	1.7	

Note(s):

1. Measurements are made with R_L = 10kΩ between output and ground.
2. Optical measurements are made using small-angle incident radiation from an LED optical source.
3. The 640nm input irradiance E_e is supplied by an AlInGaP LED with peak wavelength λ_p = 640nm.
4. Irradiance responsivity is characterized over the range V_O = 0.2 to 4V. The best-fit straight line of Output Voltage V_O versus irradiance E_e over this range may have a positive or negative extrapolated V_O value for E_e = 0. For low irradiance values, the output voltage V_O versus irradiance E_e characteristic is non linear with a deviation toward V_O = 0, E_e = 0 origin from the best-fit straight line referenced above.

Figure 8:
Dynamic Characteristics at V_{DD} = 5V, T_A = 25°C, λ_p = 640nm, R_L = 10kΩ (unless otherwise noted) (9), (10)

Symbol	Parameter	Test Conditions	TSL12S			TSL13S			TSL14S			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
t_{dr}	Output pulse delay time for rising edge (0% to 10%)	Min V_O = 0V; Peak V_O = 2V		13			1.7			0.9		µs
		Min V_O = 0.5V; Peak V_O = 2V		2.3			1.2			0.6		
t_r	Output pulse rise time (10% to 90%)	Min V_O = 0V; Peak V_O = 2V		20			7.2			2.6		µs
		Min V_O = 0.5V; Peak V_O = 2V		10			6.5			2.9		
t_{df}	Output pulse delay time for falling edge (100% to 90%)	Min V_O = 0V; Peak V_O = 2V		2.3			1.2			0.8		µs
		Min V_O = 0.5V; Peak V_O = 2V		2.2			1.1			0.7		
t_f	Output pulse fall time (90% to 10%)	Min V_O = 0V; Peak V_O = 2V		10			6.8			2.9		µs
		Min V_O = 0.5V; Peak V_O = 2V		9			6.4			2.8		

Parameter Measurement Information

Figure 9:
Switching Times: Test Circuit

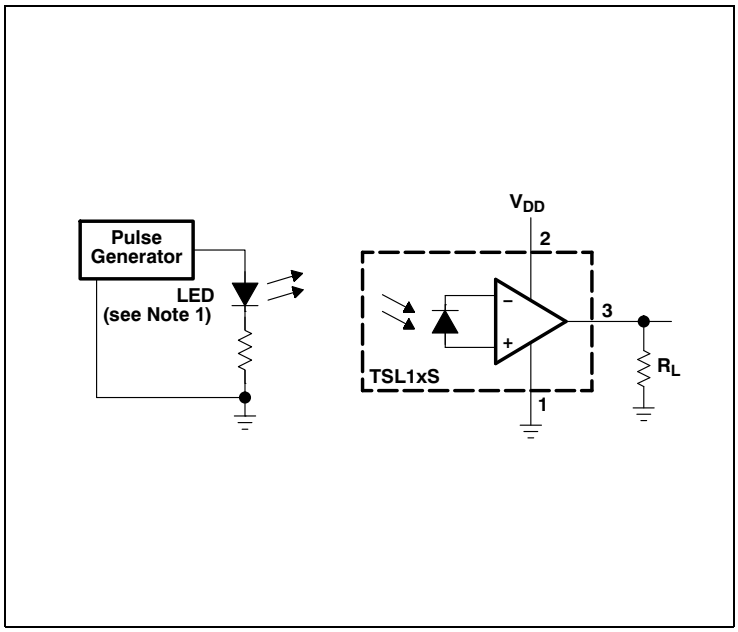
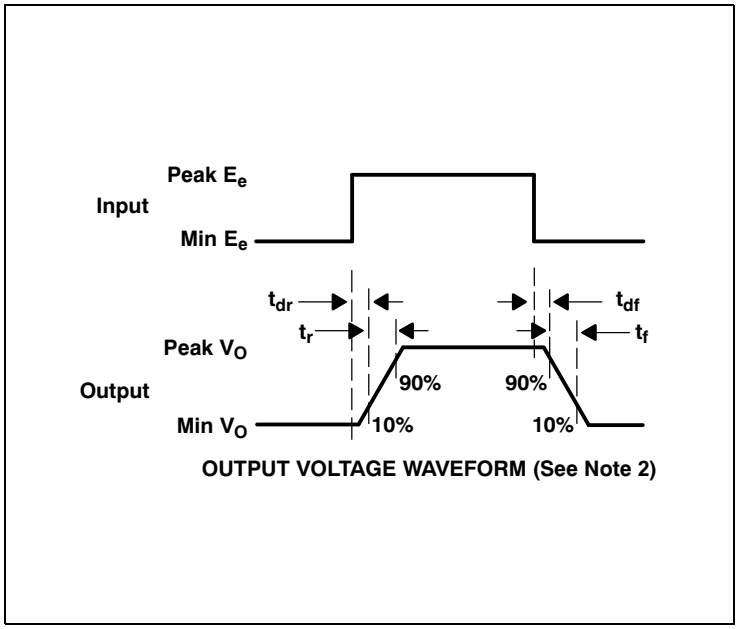


Figure 10:
Switching Times: Output Voltage Waveform



Note(s):

1. The input irradiance is supplied by a pulsed AlInGaP light-emitting diode with the following characteristics: λ_p = 640nm, t_r < 1µs, t_f <1µs.
2. The output waveform is monitored on an oscilloscope with the following characteristics: t_r < 100ns, $Z_i \geq 1M\Omega$, $C_i \leq 20pF$.

Typical Operating Characteristics

Figure 11:
Photodiode Spectral Responsivity

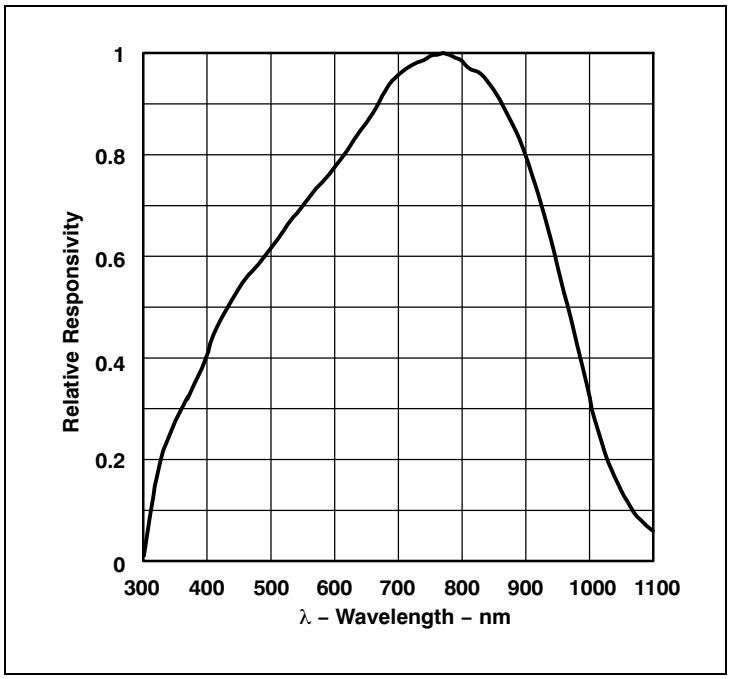
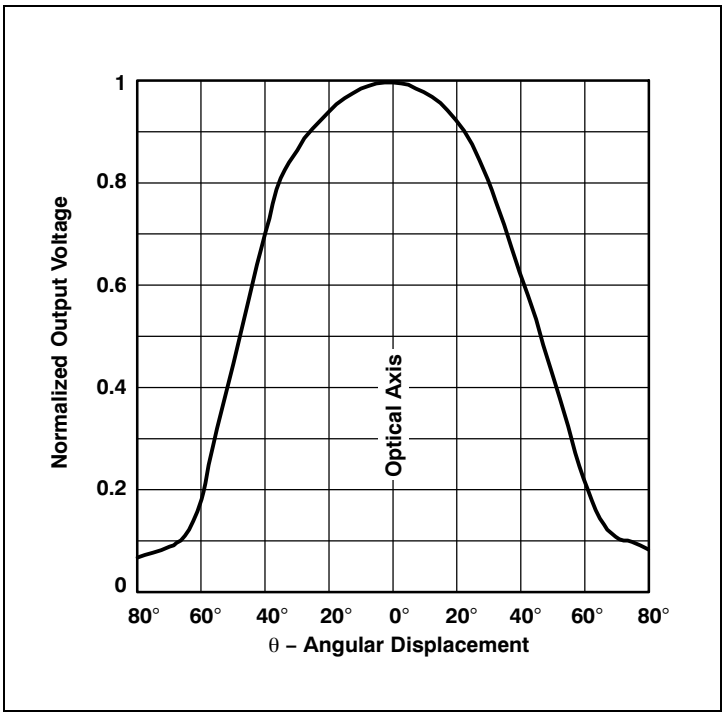


Figure 12:
Normalized Output Voltage vs. Angular Displacement



TSL12S

Figure 13:
Rising Edge Dynamic Characteristics vs. Peak Output Voltage

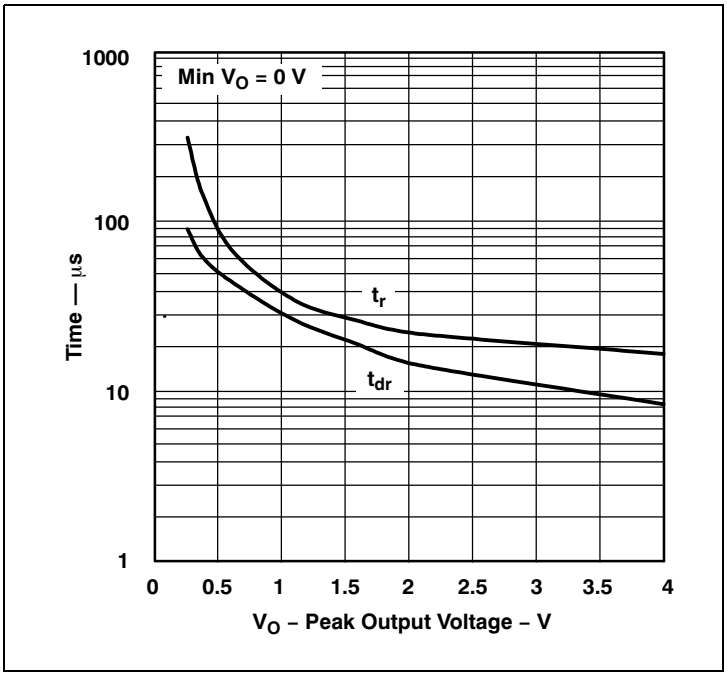


Figure 14:
Rising Edge Dynamic Characteristics vs. Peak Output Voltage

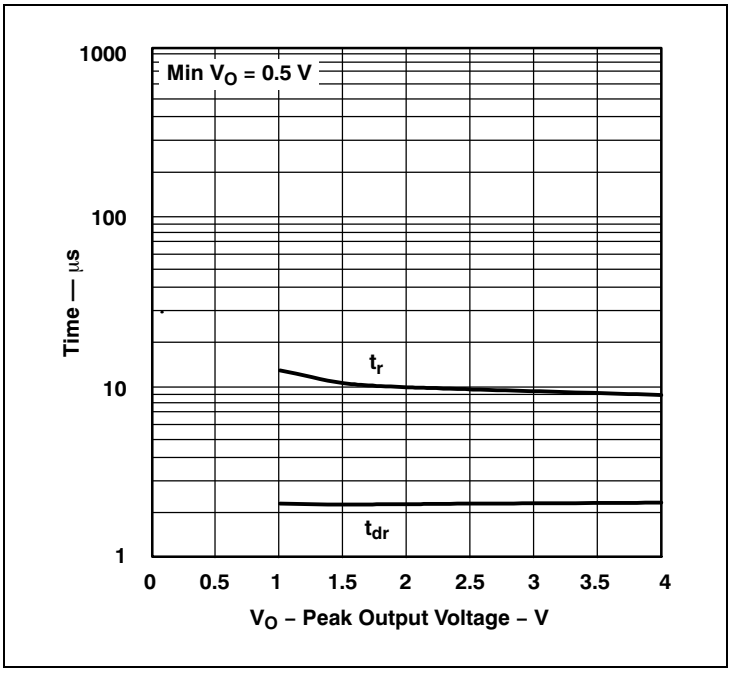


Figure 15:
Falling Edge Dynamic Characteristics vs. Peak Output Voltage

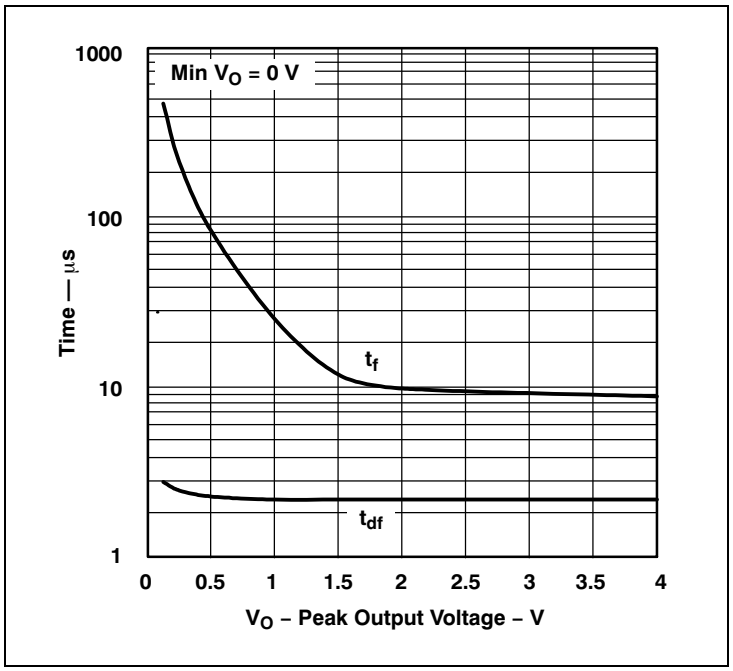
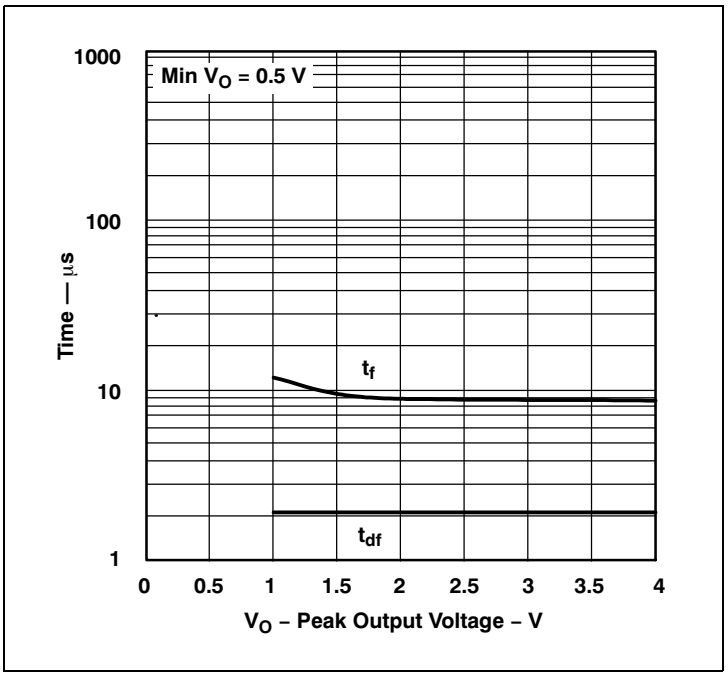


Figure 16:
Falling Edge Dynamic Characteristics vs. Peak Output Voltage



TSL13S

Figure 17:
Rising Edge Dynamic Characteristics vs. Peak Output Voltage

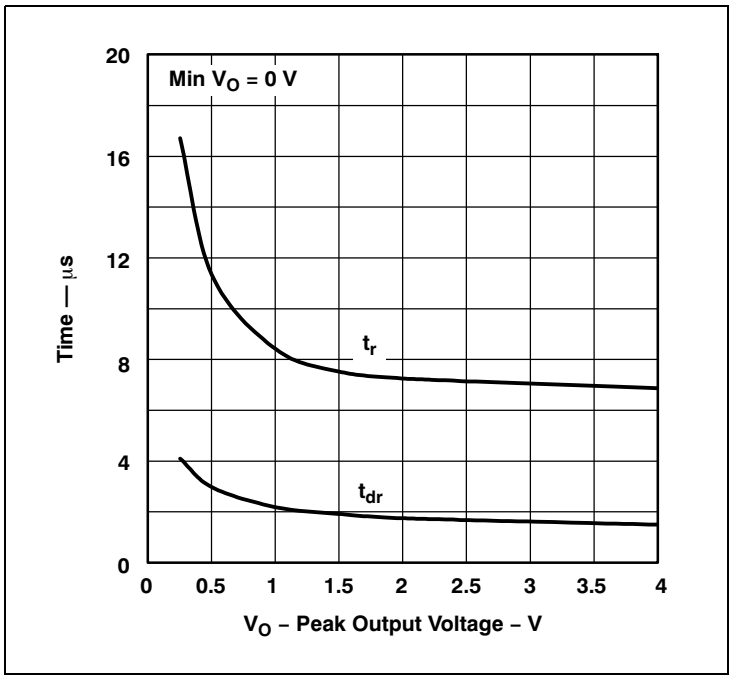


Figure 18:
Rising Edge Dynamic Characteristics vs. Peak Output Voltage

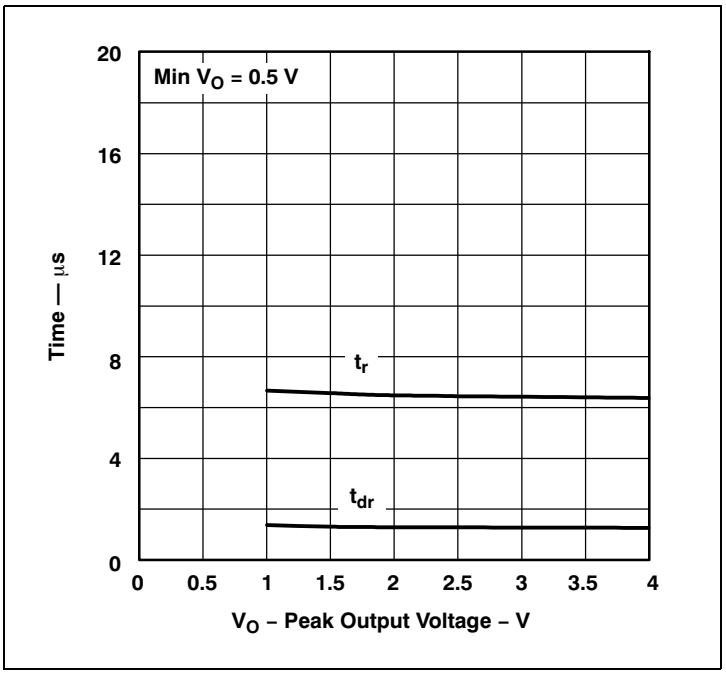


Figure 19:
Falling Edge Dynamic Characteristics vs. Peak Output Voltage

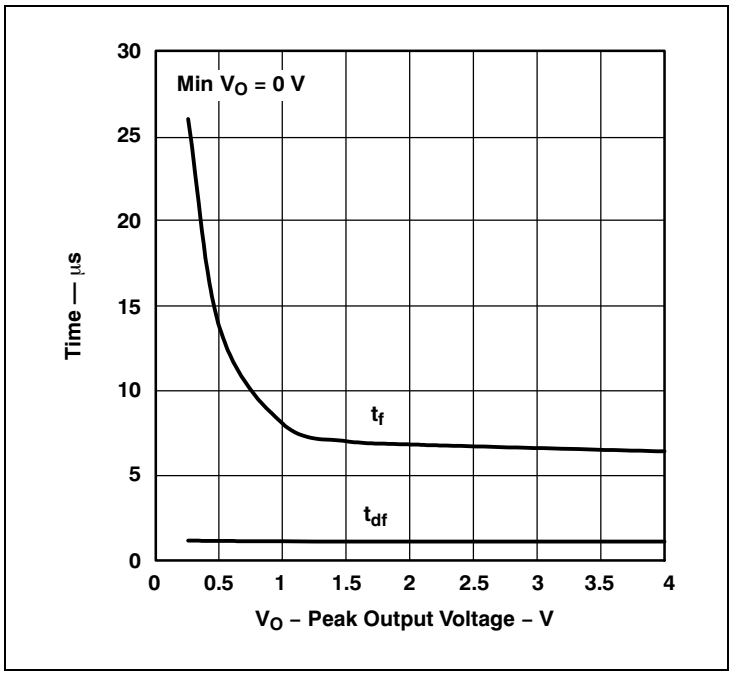
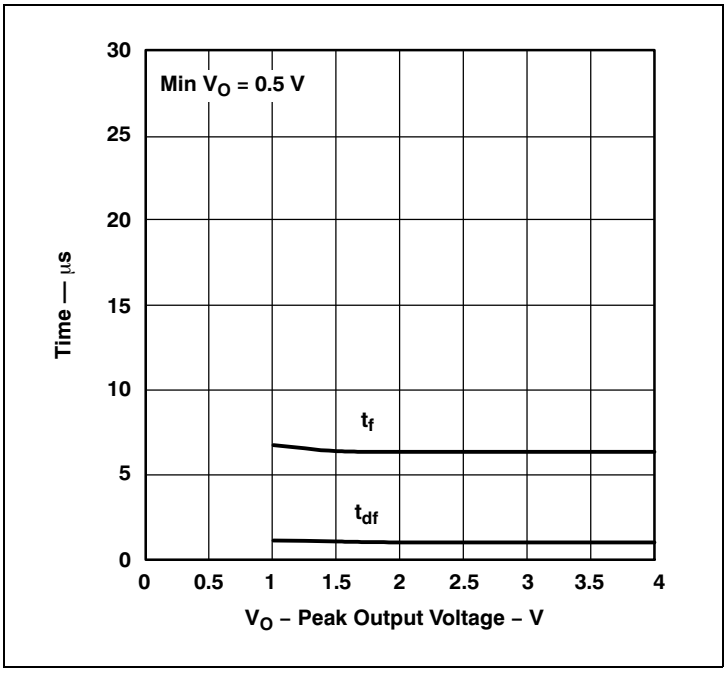


Figure 20:
Falling Edge Dynamic Characteristics vs. Peak Output Voltage



TSL14S

Figure 21:
Rising Edge Dynamic Characteristics vs. Peak Output Voltage

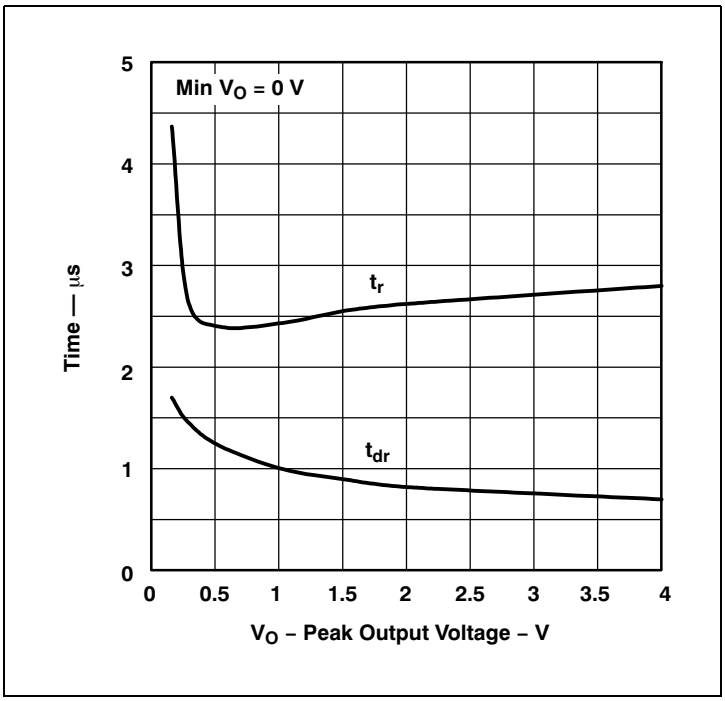


Figure 22:
Rising Edge Dynamic Characteristics vs. Peak Output Voltage

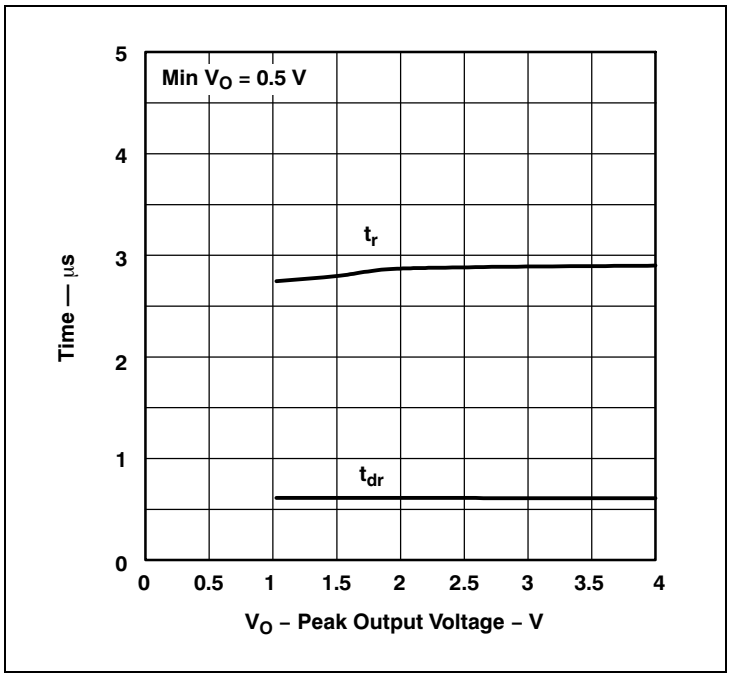


Figure 23:
Falling Edge Dynamic Characteristics vs. Peak Output Voltage

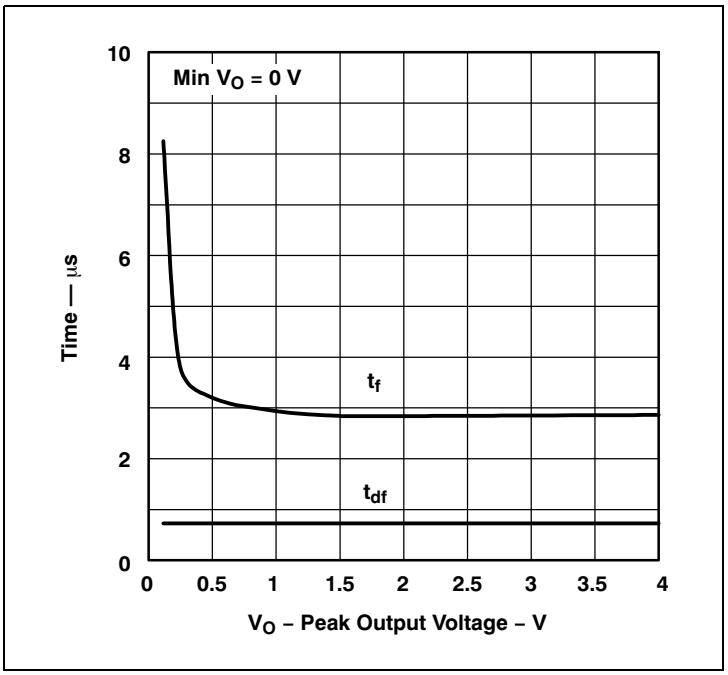
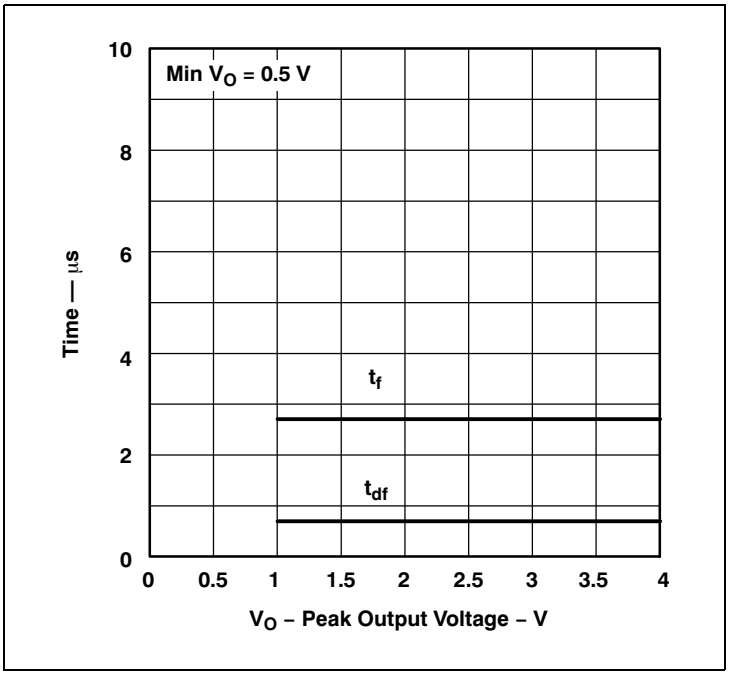


Figure 24:
Falling Edge Dynamic Characteristics vs. Peak Output Voltage

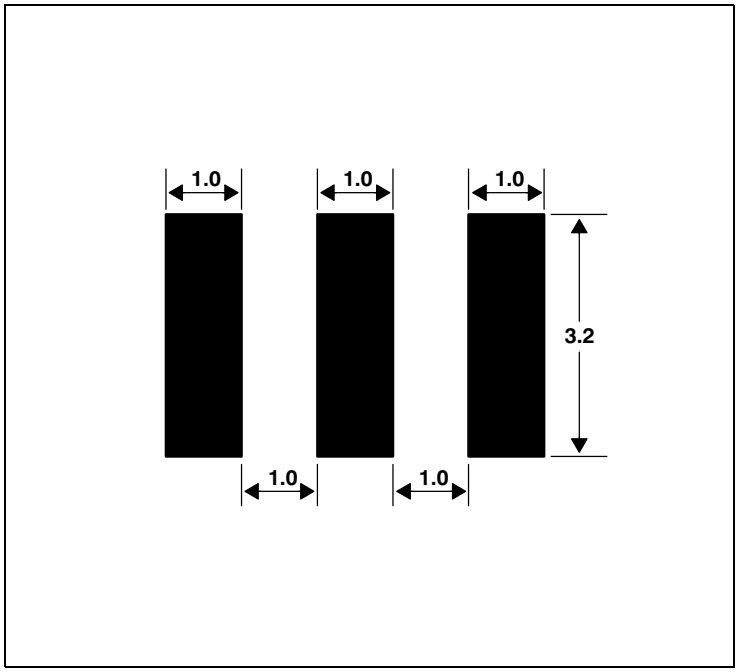


Application Information

PCB Pad Layout

Suggested PCB pad layout guidelines for the SM surface mount package are shown in Figure 25.

Figure 25:
Suggested SM Package PCB Layout



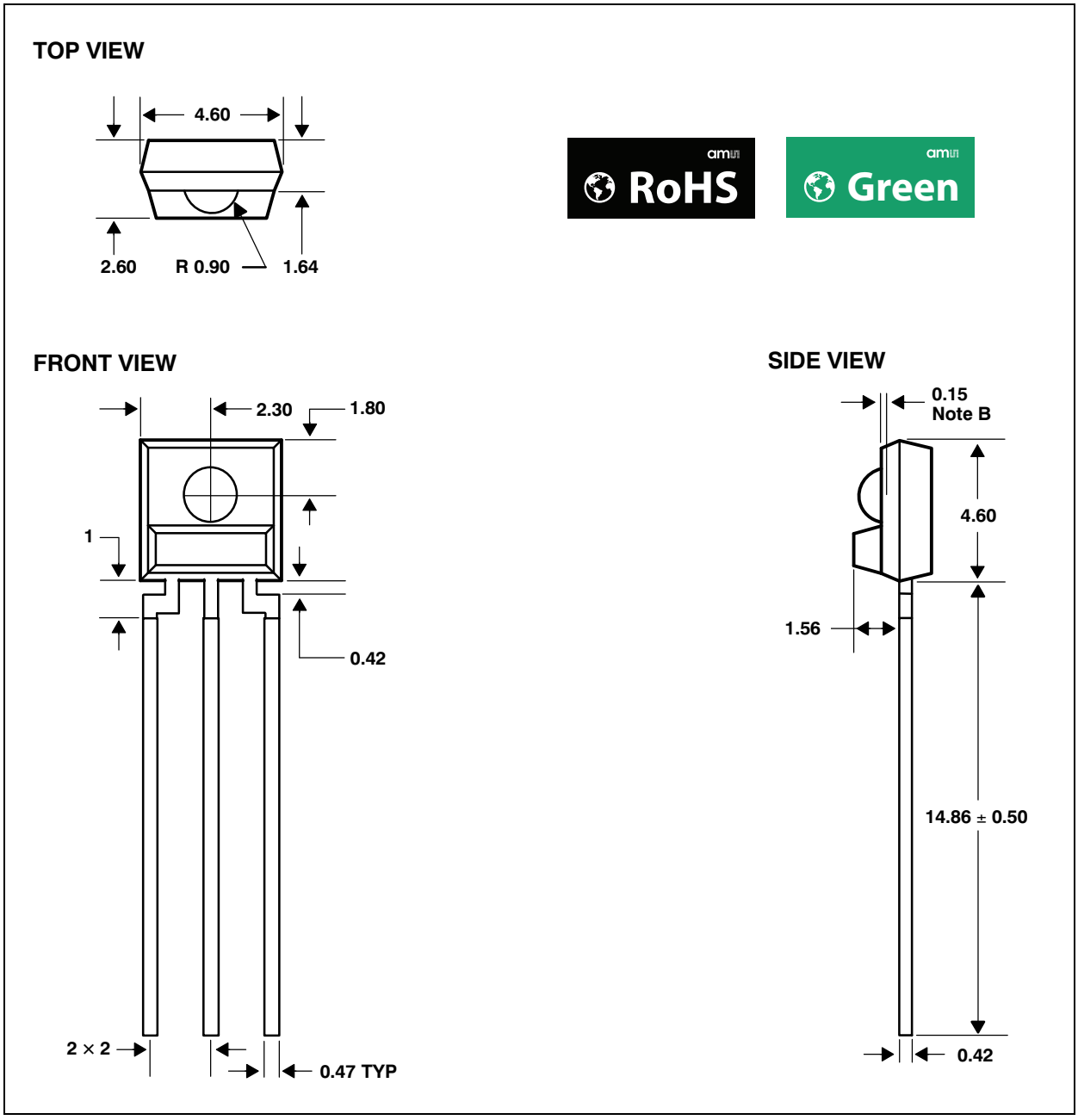
Note(s):

1. All linear dimensions are in millimeters.
2. This drawing is subject to change without notice.

Packaging Mechanical Data

The TSL12S, TSL13S, and TSL14S are supplied in a clear 3-lead through-hole package with a molded lens.

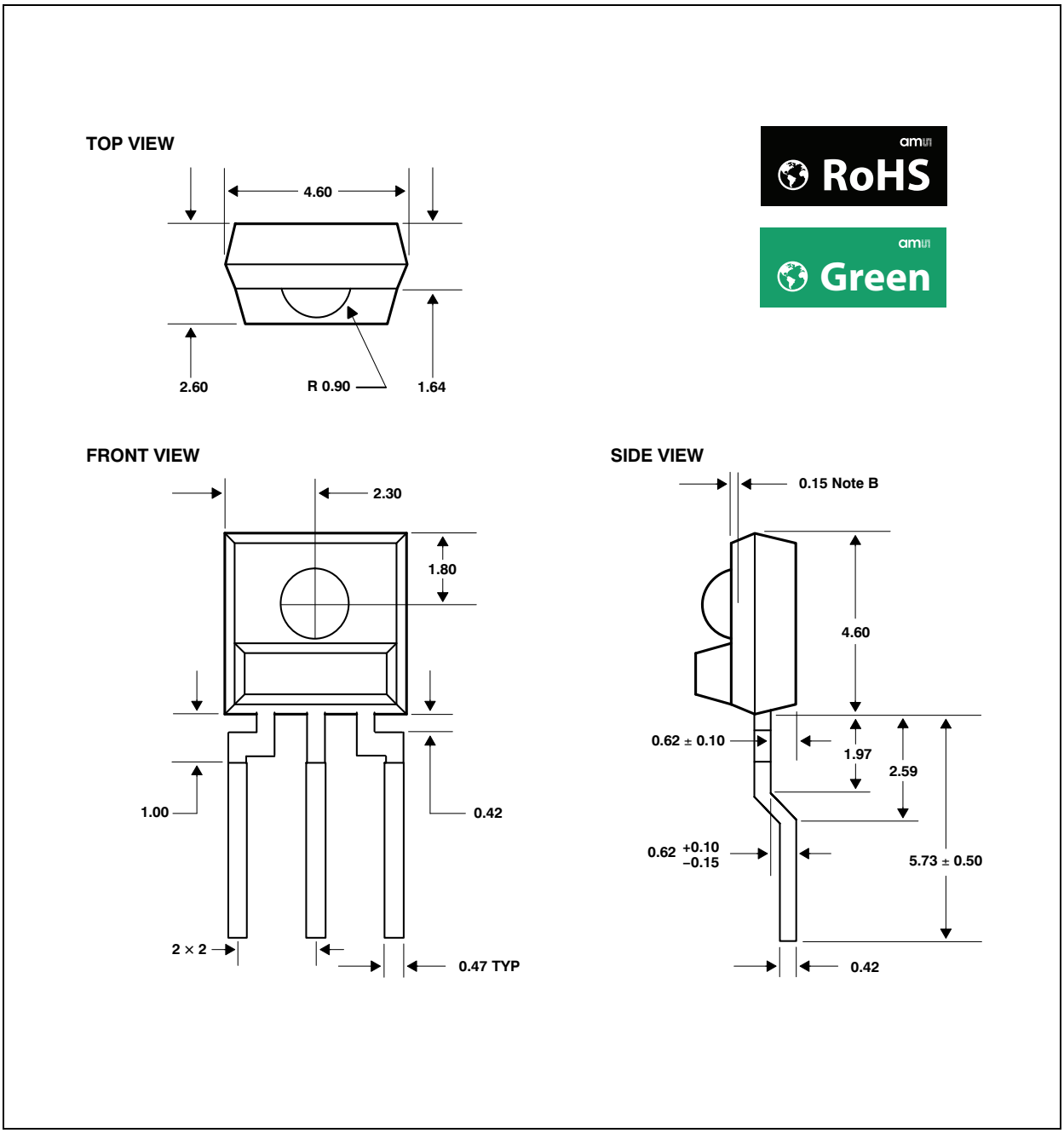
Figure 26:
Package S - Plastic Single-In-Line Side-Looker Package Configuration



Note(s):

1. All linear dimensions are in millimeters; tolerance is ±0.25mm unless otherwise stated.
2. Dimension is to center of lens arc, which is located below the package face.
3. The 0.50mm × 0.50mm integrated photodiode active area is typically located in the center of the lens and 0.97mm below the top of the lens surface.
4. Index of refraction of clear plastic is 1.55.
5. Lead finish for TSL1xS-LF: solder dipped, 100% Sn.
6. This drawing is subject to change without notice.

Figure 27:
Package SM - Surface Mount Side-Looker Package Configuration



Note(s):

1. All linear dimensions are in millimeters; tolerance is ±0.25mm unless otherwise stated.
2. Dimension is to center of lens arc, which is located below the package face.
3. The integrated photodiode active area is typically located in the center of the lens and 0.97mm below the top of the lens surface.
4. Index of refraction of clear plastic is 1.55.
5. Lead finish for TSL1xSM-LF: solder dipped, 100% Sn.
6. This drawing is subject to change without notice.

Ordering & Contact Information

Figure 28:
Ordering Information

Ordering Code	Device	Package Designator	Package-Leads	T_A
TSL12S-LF	TSL12S	S	3-lead Sidelooker - Lead (Pb) Free	0°C to 70°C
TSL12SM-LF	TSL12S	SM	3-lead Surface-Mount Sidelooker - Lead (Pb) Free	0°C to 70°C
TSL13S-LF	TSL13S	S	3-lead Sidelooker - Lead (Pb) Free	0°C to 70°C
TSL13SM-LF	TSL13S	SM	3-lead Surface-Mount Sidelooker - Lead (Pb) Free	0°C to 70°C
TSL14S-LF	TSL14S	S	3-lead Sidelooker - Lead (Pb) Free	0°C to 70°C
TSL14SM-LF	TSL14S	SM	3-lead Surface-Mount Sidelooker - Lead (Pb) Free	0°C to 70°C

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Document Status

Document Status	Product Status	Definition
Product Preview	Pre-Development	Information in this datasheet is based on product ideas in the planning phase of development. All specifications are design goals without any warranty and are subject to change without notice
Preliminary Datasheet	Pre-Production	Information in this datasheet is based on products in the design, validation or qualification phase of development. The performance and parameters shown in this document are preliminary without any warranty and are subject to change without notice
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Revision Information

Changes from TAOS051E (2007-Sep) to current revision 1-00 (2016-May-02)	Page
Content of TAOS datasheet was converted to the latest **ams** design	
Added Figure 1	1
Updated note under Figure 26	18
Updated Figure 28	20

Note(s):

1. Page and figure numbers for the previous version may differ from page and figure numbers in the current revision
2. Correction of typographical errors is not explicitly mentioned.

Content Guide

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