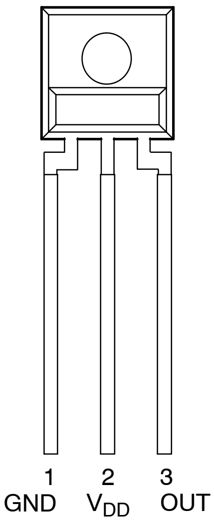
TEXAS
ADVANCED
OPTOELECTRONIC
SOLUTIONS®

TSL12S, TSL13S, TSL14S LIGHT-TO-VOLTAGE CONVERTERS

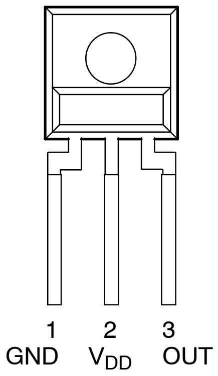
TAOS051E – SEPTEMBER 2007

- **Converts Light Intensity to Output Voltage**
- **Monolithic Silicon IC Containing Photodiode, Transconductance Amplifier, and Feedback Components**
- **Single-Supply Operation . . . 2.7 V to 5.5 V**
- **High Irradiance Responsivity . . . Typical 246 mV/(μW/cm^2) at λ_p = 640 nm (TSL12S)**
- **Low Supply Current . . . 1.1 mA Typical**
- **Sidelooker 3-Lead Plastic Package**
- **RoHS Compliant (–LF Package Only)**

PACKAGE S
SIDELOOKER
(FRONT VIEW)



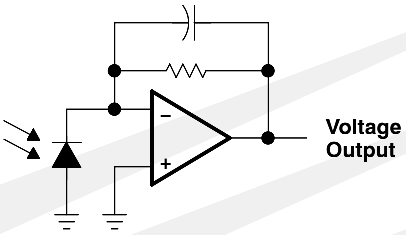
PACKAGE SM
SURFACE MOUNT
SIDELOOKER
(FRONT VIEW)



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 = 80 MΩ, 20 MΩ, and 5 MΩ, respectively) on a single monolithic integrated circuit. The photodiode active area is 0.5 mm × 0.5 mm and the sensors respond to light in the range of 320 nm to 1050 nm. 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). When supplied in the lead (Pb) free package, the device is RoHS compliant.

Functional Block Diagram



Available Options

DEVICE	T_A	PACKAGE − LEADS	PACKAGE DESIGNATOR	ORDERING NUMBER
TSL12S	0°C to 70°C	3-lead Sidelooker	S	TSL12S
TSL12S	0°C to 70°C	3-lead Sidelooker — Lead (Pb) Free	S	TSL12S−LF
TSL12S	0°C to 70°C	3-lead Surface-Mount Sidelooker — Lead (Pb) Free	SM	TSL12SM−LF
TSL13S	0°C to 70°C	3-lead Sidelooker	S	TSL13S
TSL13S	0°C to 70°C	3-lead Sidelooker — Lead (Pb) Free	S	TSL13S−LF
TSL13S	0°C to 70°C	3-lead Surface-Mount Sidelooker — Lead (Pb) Free	SM	TSL13SM−LF
TSL14S	0°C to 70°C	3-lead Sidelooker	S	TSL14S
TSL14S	0°C to 70°C	3-lead Sidelooker — Lead (Pb) Free	S	TSL14S−LF
TSL14S	0°C to 70°C	3-lead Surface-Mount Sidelooker — Lead (Pb) Free	SM	TSL14SM−LF

Terminal Functions

TERMINAL NAME	TERMINAL NO.	TYPE	DESCRIPTION
GND	1		Power supply ground (substrate). All voltages are referenced to GND.
OUT	3	O	Output voltage.
V_{DD}	2		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 (see Note 2)	5 s
Operating free-air temperature range, T_A	−25°C to 85°C
Storage temperature range, T_{stg}	−25°C to 85°C
Lead temperature 1,6 mm (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

† 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.

NOTES: 1. All voltages are with respect to GND.
2. Output may be shorted to supply.

Recommended Operating Conditions

	MIN	NOM	MAX	UNIT
Supply voltage, V_{DD}	2.7		5.5	V
Operating free-air temperature, T_A	0		70	°C

Electrical Characteristics at V_{DD} = 5 V, T_A = 25°C, λ_p = 640 nm, R_L = 10 kΩ (unless otherwise noted) (see Notes 3, 4, 5)

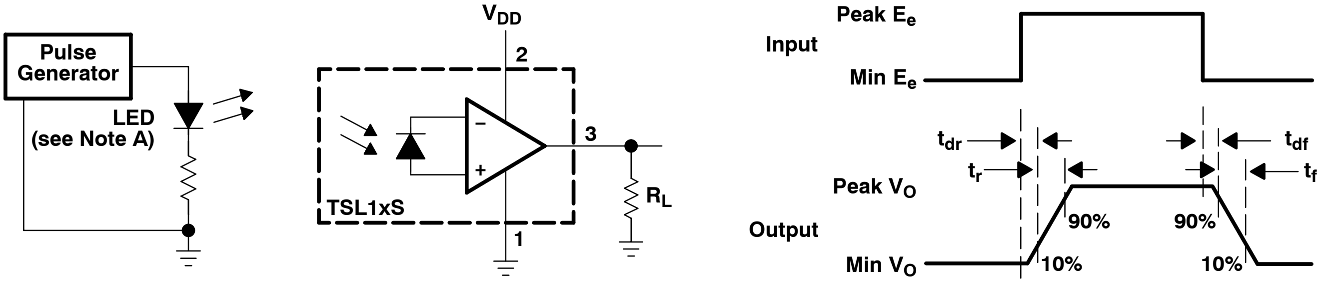
PARAMETER		TEST CONDITIONS	TSL12S			TSL13S			TSL14S			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{OM}	Maximum output voltage		4.6	4.9		4.6	4.9		4.6	4.9		V
V_O	Output voltage	$E_e = 8\ \mu W/cm^2$	1.5	2	2.5							V
		$E_e = 31\ \mu W/cm^2$				1.5	2	2.5				
		$E_e = 120\ \mu W/cm^2$							1.5	2	2.5	
		$E_e = 16\ \mu W/cm^2$		4								
		$E_e = 62\ \mu W/cm^2$					4					
		$E_e = 240\ \mu W/cm^2$								4		
R_e	Irradiance responsivity	Note 6		248			64			16		$mV/(\mu W/cm^2)$
V_{OS}	Extrapolated offset voltage	Note 6	−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
I_D	Supply current	$E_e = 8\ \mu W/cm^2$		1.1	1.7							mA
		$E_e = 31\ \mu W/cm^2$					1.1	1.7				
		$E_e = 120\ \mu W/cm^2$								1.1	1.7	

NOTES: 3. Measurements are made with R_L = 10 kΩ between output and ground.
4. Optical measurements are made using small-angle incident radiation from an LED optical source.
5. The 640 nm input irradiance E_e is supplied by an AlInGaP LED with peak wavelength λ_p = 640 nm.
6. Irradiance responsivity is characterized over the range V_O = 0.2 to 4 V. 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.

Dynamic Characteristics at V_{DD} = 5 V, T_A = 25°C, λ_p = 640 nm, R_L = 10 kΩ (unless otherwise noted) (see Figure 1)

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

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT

OUTPUT VOLTAGE WAVEFORM (See Note B)

NOTES: A. The input irradiance is supplied by a pulsed AlInGaP light-emitting diode with the following characteristics: $\lambda_p = 640$ nm, $t_r < 1$ μs, $t_f < 1$ μs.

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.

Figure 1. Switching Times

TYPICAL CHARACTERISTICS

PHOTODIODE SPECTRAL RESPONSIVITY

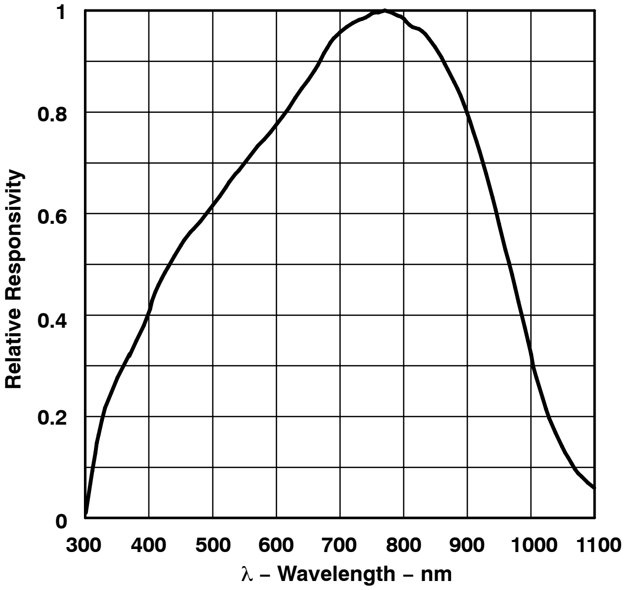


Figure 2

NORMALIZED OUTPUT VOLTAGE
vs
ANGULAR DISPLACEMENT

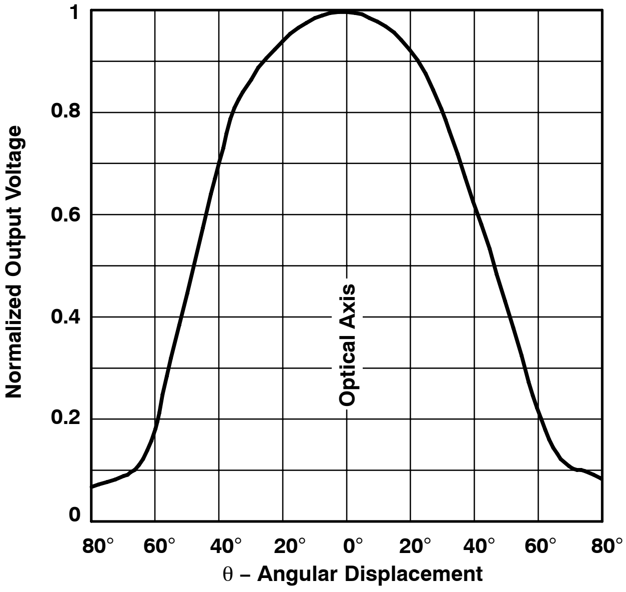


Figure 3

TYPICAL CHARACTERISTICS

TSL12S

RISING EDGE DYNAMIC CHARACTERISTICS
vs.
PEAK OUTPUT VOLTAGE

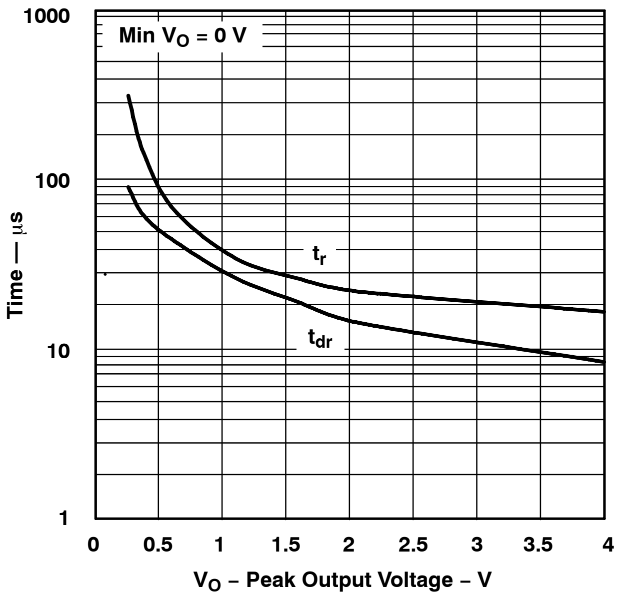


Figure 4

RISING EDGE DYNAMIC CHARACTERISTICS
vs.
PEAK OUTPUT VOLTAGE

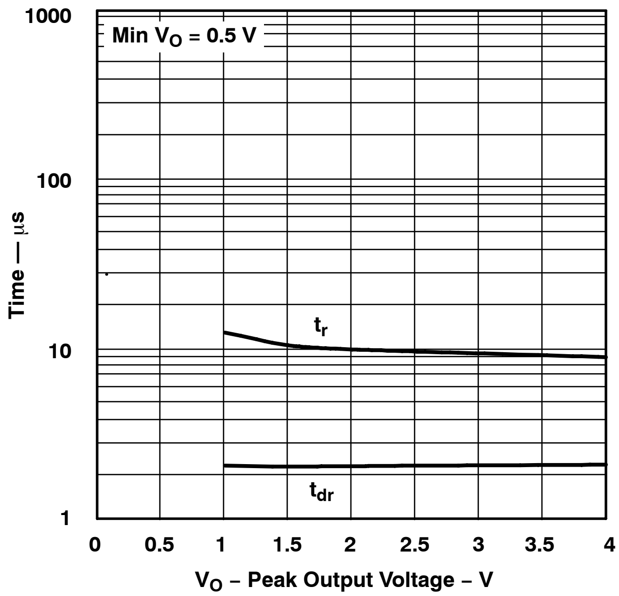


Figure 5

FALLING EDGE DYNAMIC CHARACTERISTICS
vs.
PEAK OUTPUT VOLTAGE

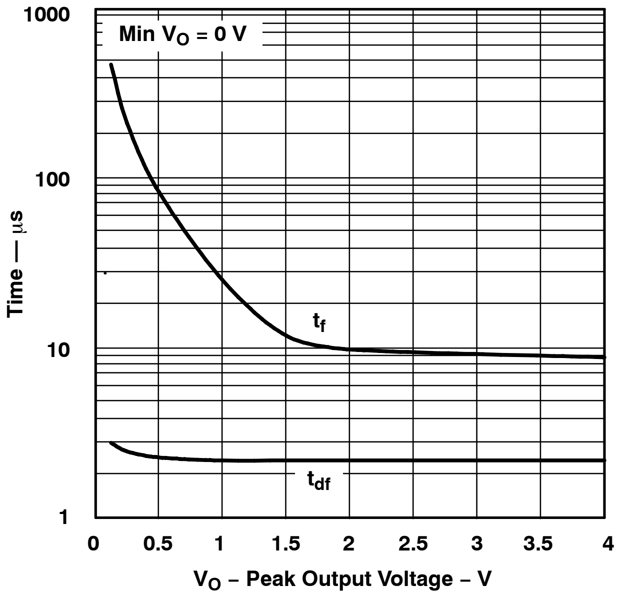


Figure 6

FALLING EDGE DYNAMIC CHARACTERISTICS
vs.
PEAK OUTPUT VOLTAGE

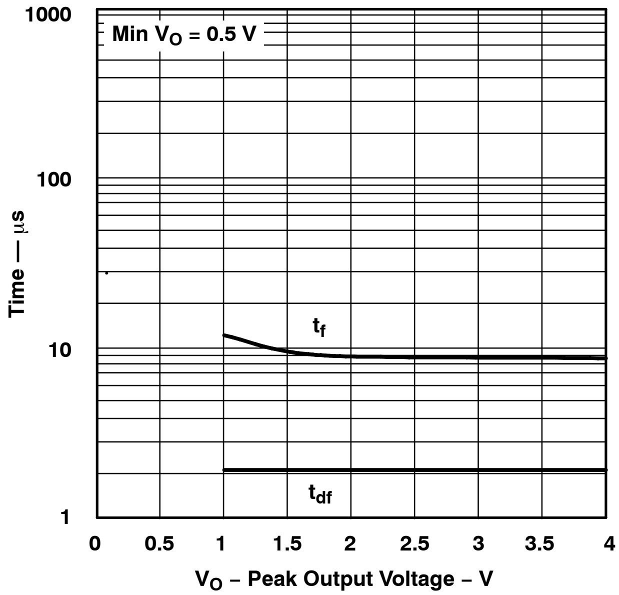


Figure 7

TYPICAL CHARACTERISTICS

TSL13S

RISING EDGE DYNAMIC CHARACTERISTICS vs. PEAK OUTPUT VOLTAGE

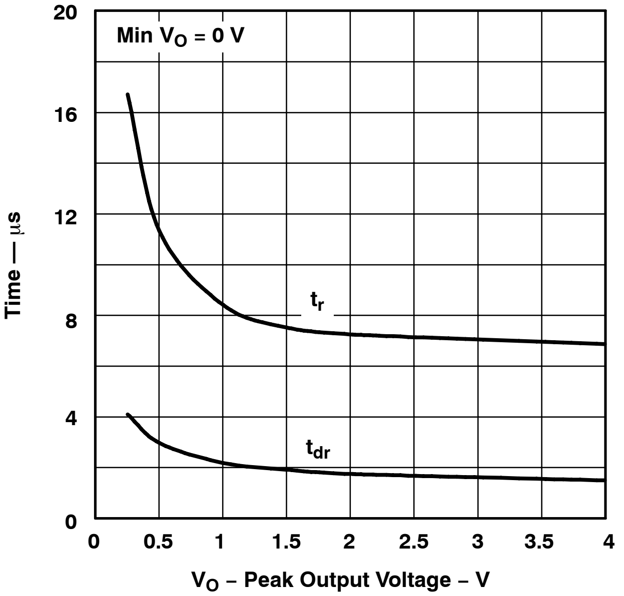


Figure 8

RISING EDGE DYNAMIC CHARACTERISTICS vs. PEAK OUTPUT VOLTAGE

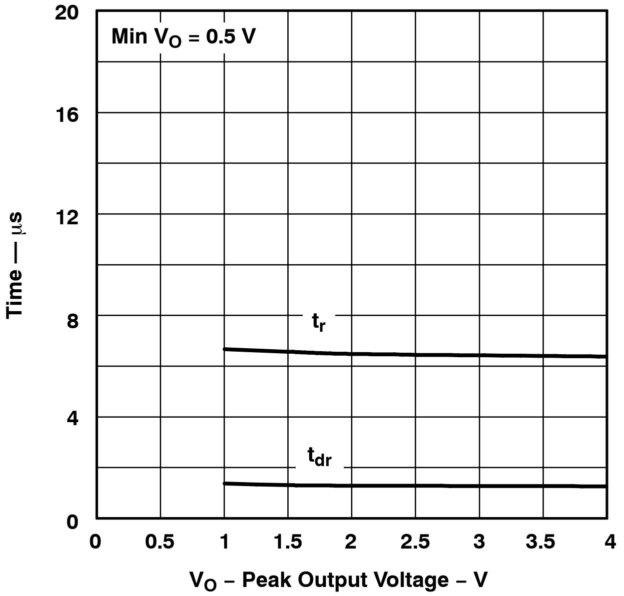


Figure 9

FALLING EDGE DYNAMIC CHARACTERISTICS vs. PEAK OUTPUT VOLTAGE

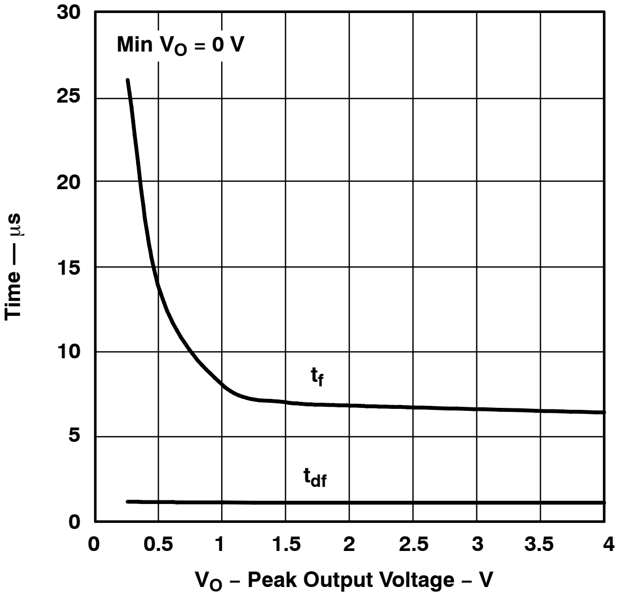


Figure 10

FALLING EDGE DYNAMIC CHARACTERISTICS vs. PEAK OUTPUT VOLTAGE

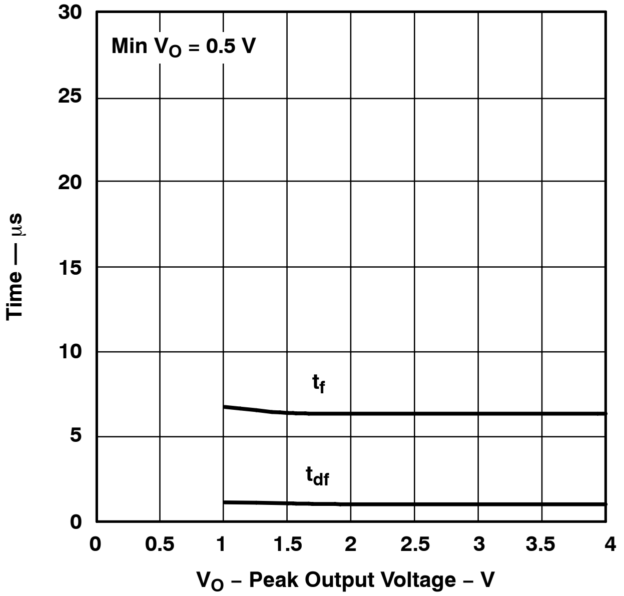


Figure 11

TYPICAL CHARACTERISTICS

TSL14S

RISING EDGE DYNAMIC CHARACTERISTICS vs. PEAK OUTPUT VOLTAGE

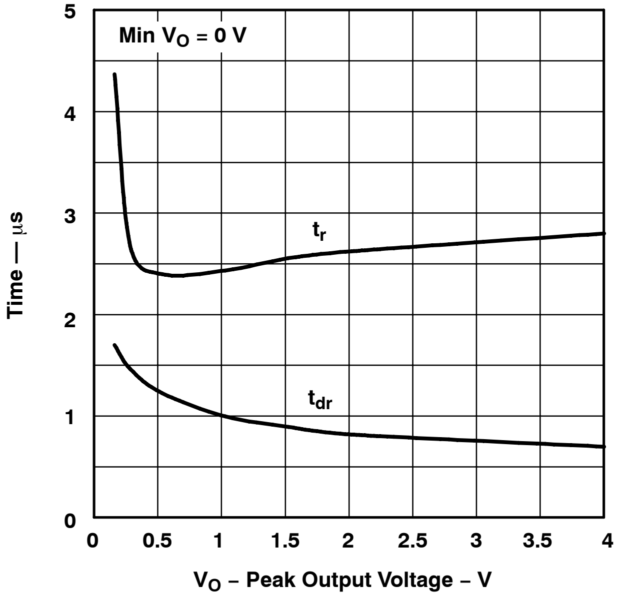


Figure 12

RISING EDGE DYNAMIC CHARACTERISTICS vs. PEAK OUTPUT VOLTAGE

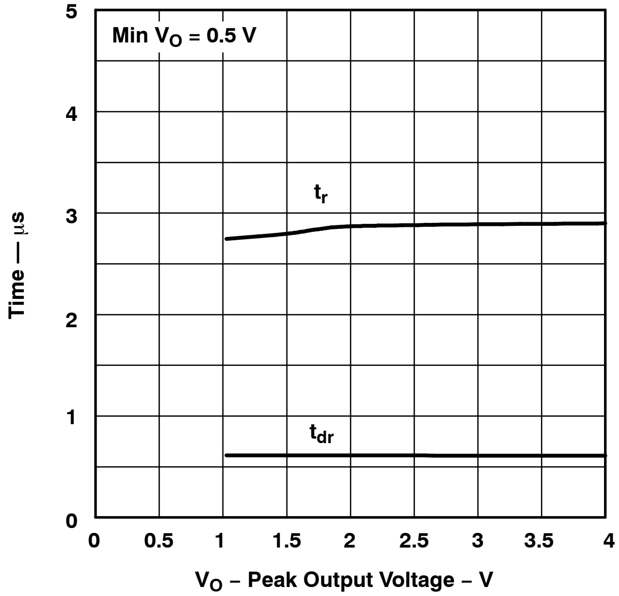


Figure 13

FALLING EDGE DYNAMIC CHARACTERISTICS vs. PEAK OUTPUT VOLTAGE

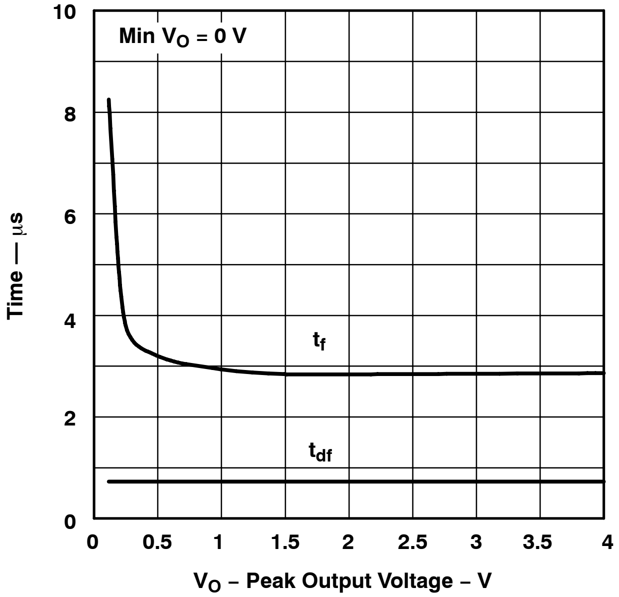


Figure 14

FALLING EDGE DYNAMIC CHARACTERISTICS vs. PEAK OUTPUT VOLTAGE

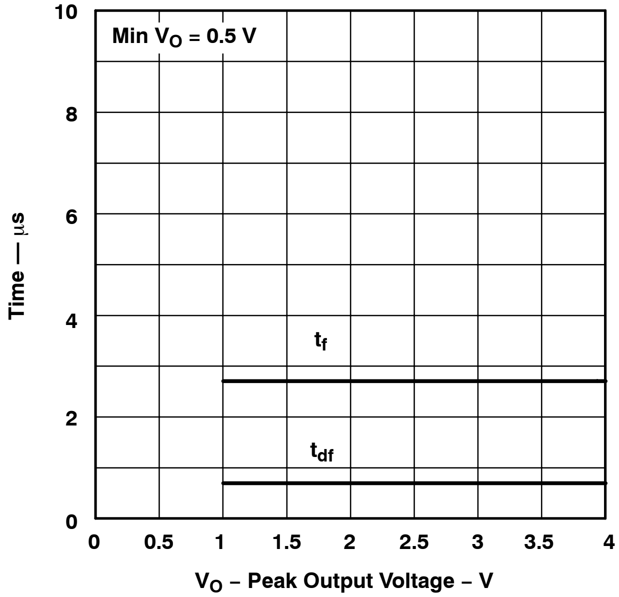
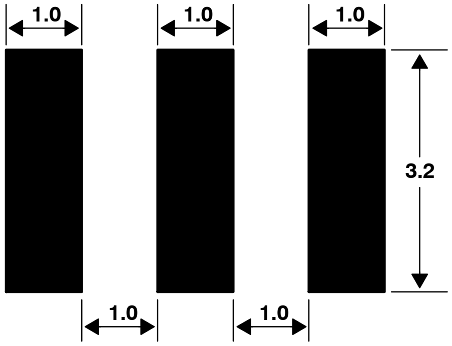


Figure 15

APPLICATION INFORMATION

PCB Pad Layout

Suggested PCB pad layout guidelines for the SM surface mount package are shown in Figure 16.



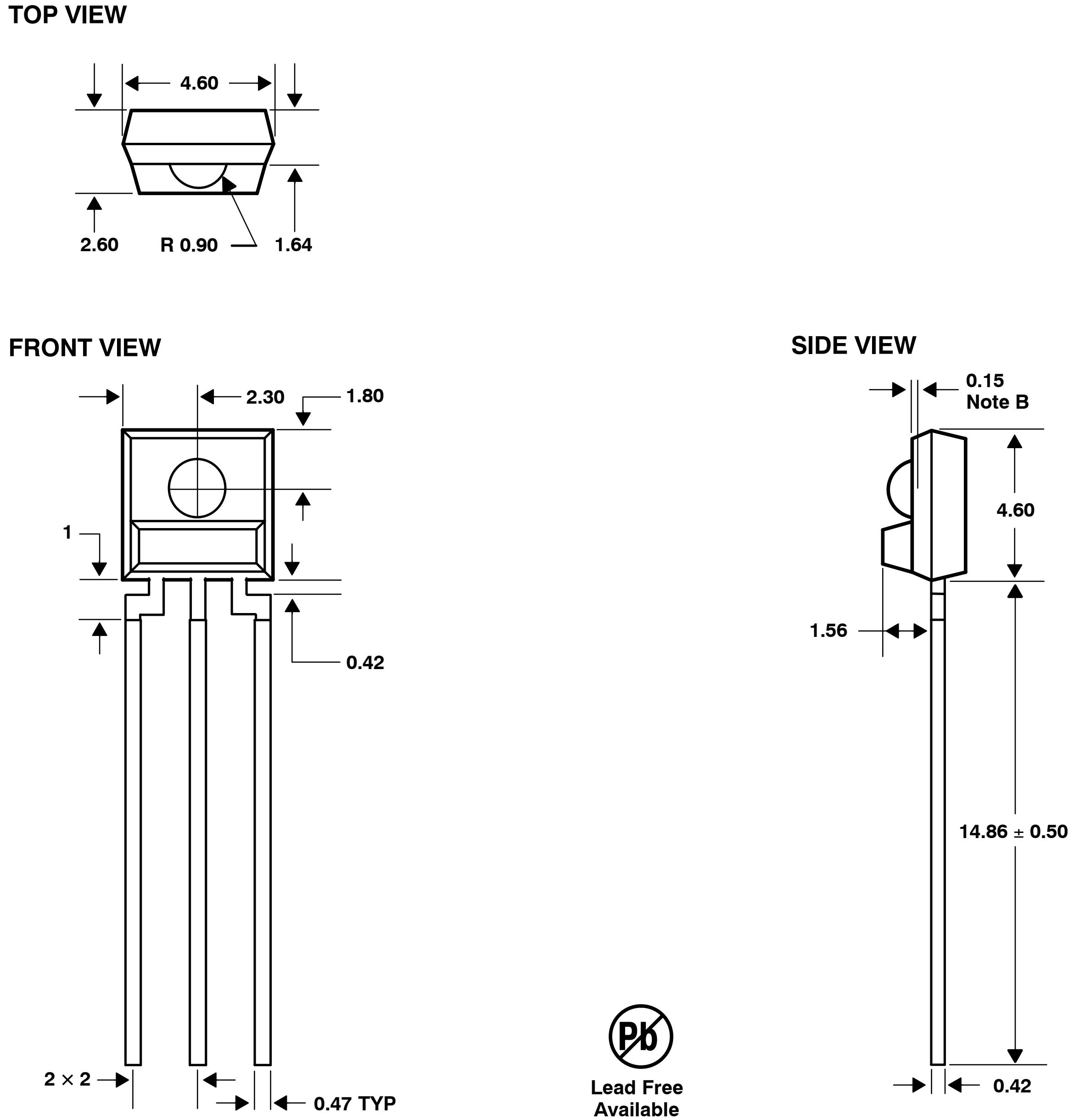
NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.

Figure 16. Suggested SM Package PCB Layout

MECHANICAL DATA

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

PACKAGE S **PLASTIC SINGLE-IN-LINE SIDE-LOOKER PACKAGE**



TOP VIEW

FRONT VIEW

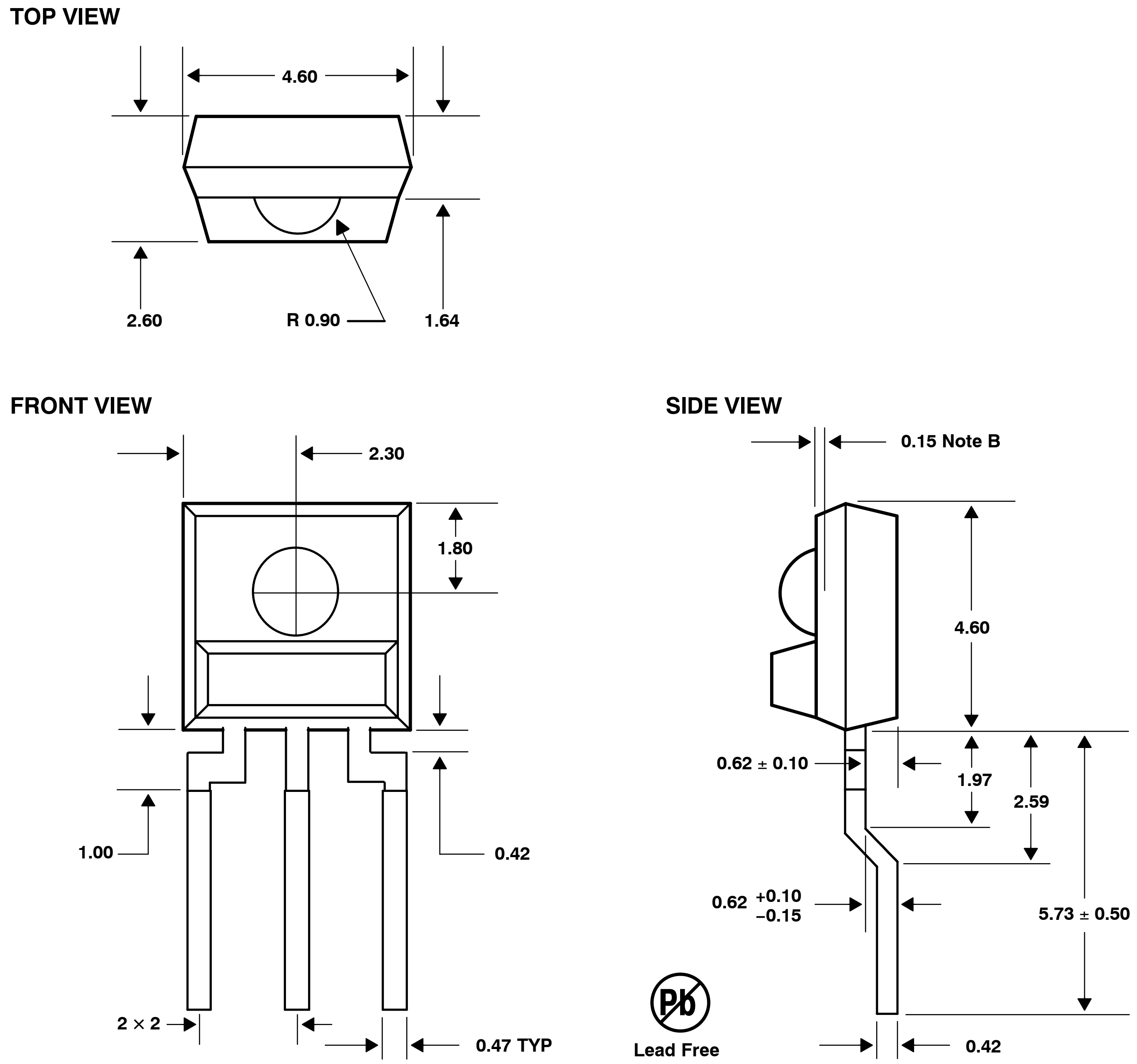
SIDE VIEW

NOTES:
- A. All linear dimensions are in millimeters; tolerance is ± 0.25 mm unless otherwise stated.
- B. Dimension is to center of lens arc, which is located below the package face.
- C. The 0.50 mm × 0.50 mm integrated photodiode active area is typically located in the center of the lens and 0.97 mm below the top of the lens surface.
- D. Index of refraction of clear plastic is 1.55.
- E. Lead finish for TSL1xS: solder dipped, 63% Sn/37% Pb. Lead finish for TSL1xS−LF: solder dipped, 100% Sn.
- F. This drawing is subject to change without notice.

Figure 17. Package S — Single-In-Line Side-Looker Package Configuration

MECHANICAL DATA

PACKAGE SM **PLASTIC SURFACE MOUNT SIDE-LOOKER PACKAGE**



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

Figure 18. Package SM — Surface Mount Side-Looker Package Configuration

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