TSL12T, TSL13T

Light-to-Voltage Converters

General Description

The TSL12T and TSL13T are cost-optimized, highly integrated light-to-voltage optical sensors, each combining a photodiode and a transimpedance amplifier (feedback resistor = 80MΩ and 20MΩ, 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 low-profile surface-mount package (T).

Ordering Information and Content Guide appear at end of datasheet.

Key Benefits & Features

The benefits and features of the TSL12T and TSL13T, Light-to-Voltage Converters, are listed below:

Figure 1:
Added Value of Using TSL12T and TSL13T

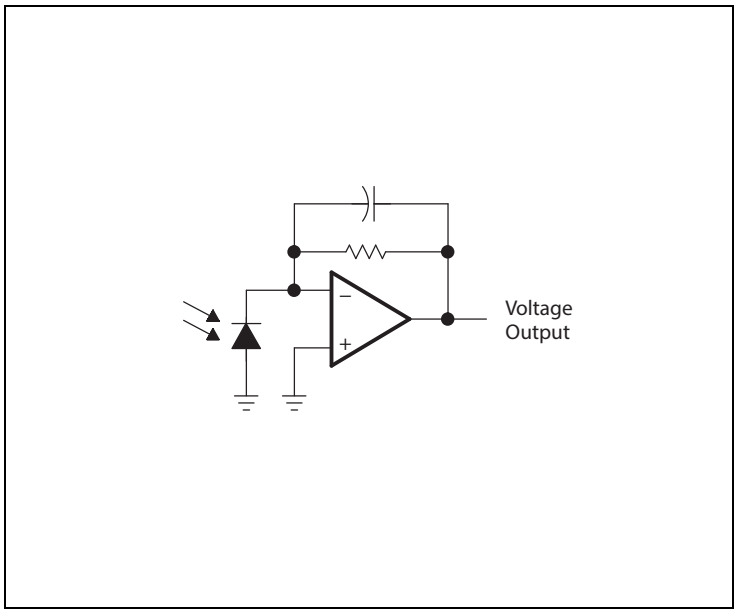
Benefits	Features
• Enables extremely fast response to change	• Single photo-diode and transimpedance architecture
• Enables fast response to visible light in range of 400nm to 700nm wavelengths	• 6.5µs output rise-time response
• Provides for high sensitivity to detect a small change in light	• High irradiance responsivity 96mV/(µW/cm^2) @ λp = 640nm (TSL12T)
• Reduces board space requirements while simplifying designs	• 2.6mm x 3.8mm 4-lead SMD (T) package

- 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
- Low-profile surface-mount package

Block Diagram

The functional blocks of this device are shown below:

Figure 2:
TSL12T and TSL13T Block Diagram



Pin Assignments

The TSL12T and TSL13T pin assignments are described below:

Figure 3:
Pin Diagram of Package T 4-LEAD SMD (Top View)

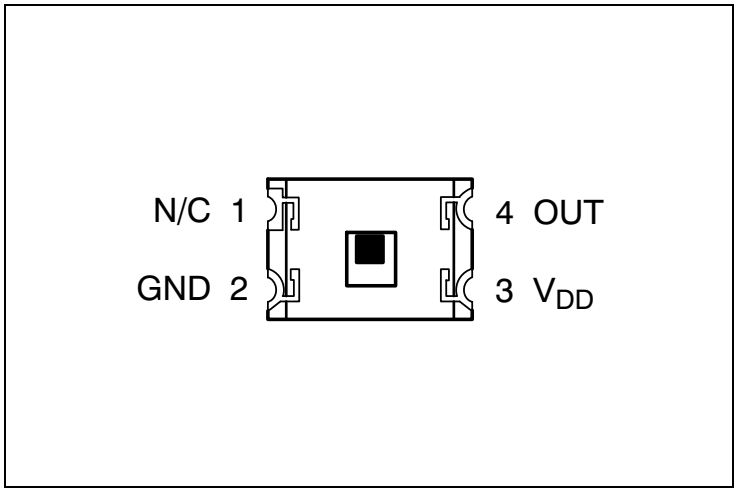


Figure 4:
Terminal Functions

Terminal		Description
Name	T PKG No.	
N/C	1	No connection
GND	2	Power supply ground (substrate). All voltages are referenced to GND.
V_{DD}	3	Supply voltage
OUT	4	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 Recommended 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	-25	85	°C
T_{strg}	Storage temperature range	-25	85	°C
	Solder conditions in accordance with JEDEC J-STD-020A, maximum temperature		260	°C

Note(s):

1. All voltages 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.

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 range	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	TSL12T			TSL13T			Unit
			Min	Typ	Max	Min	Typ	Max	
V_{OM}	Maximum output voltage		4.6	4.9		4.6	4.9		V
V_O	Output voltage	E_e = 20.5µW/cm^2	1.5	2	2.5				V
		E_e = 83µW/cm^2				1.5	2	2.5	
		E_e = 41µW/cm^2		4					
		E_e = 166µW/cm^2					4		
R_e	Irradiance responsivity	See note (4)		96			24		mV/(µW/cm^2)
V_{OS}	Extrapolated offset voltage	See note (4)	-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	V
I_d	Supply current	E_e = 20.5µW/cm^2		1.1	1.7				mA
		E_e = 83µW/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) (see Figure 9, Figure 10)

Symbol	Parameter	Test Conditions	TSL12T			TSL13T			Unit
			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		µs
		Min V_O = 0.5V; Peak V_O = 2V		2.3			1.2		
t_r	Output pulse rise time (10% to 90%)	Min V_O = 0V; Peak V_O = 2V		20			7.2		µs
		Min V_O = 0.5V; Peak V_O = 2V		10			6.5		
t_{df}	Output pulse delay time for rising edge (100% to 90%)	Min V_O = 0V; Peak V_O = 2V		2.3			1.2		µs
		Min V_O = 0.5V; Peak V_O = 2V		2.2			1.1		
t_f	Output pulse rise time (90% to 10%)	Min V_O = 0V; Peak V_O = 2V		10			6.8		µs
		Min V_O = 0.5V; Peak V_O = 2V		9			6.4		

Parameter Measurement Information

Figure 9:
Switching Times: Test Circuit

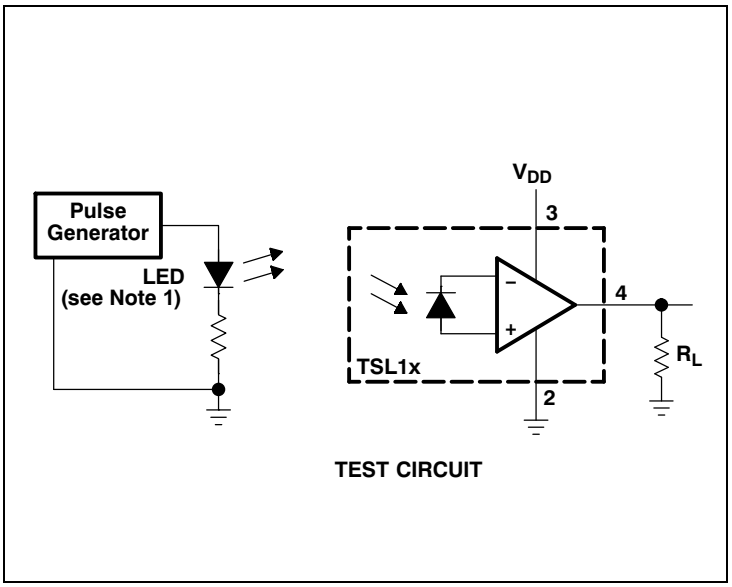
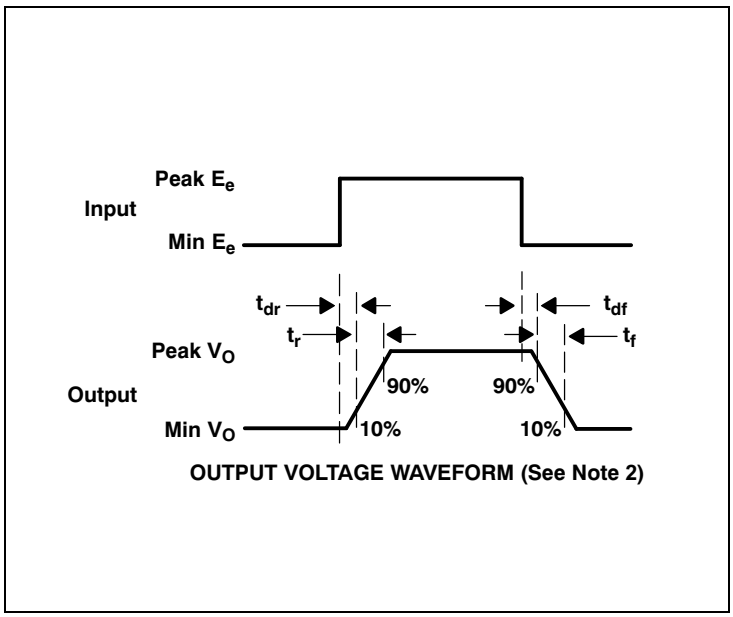


Figure 10:
Switching Times: Output Voltage Waveform

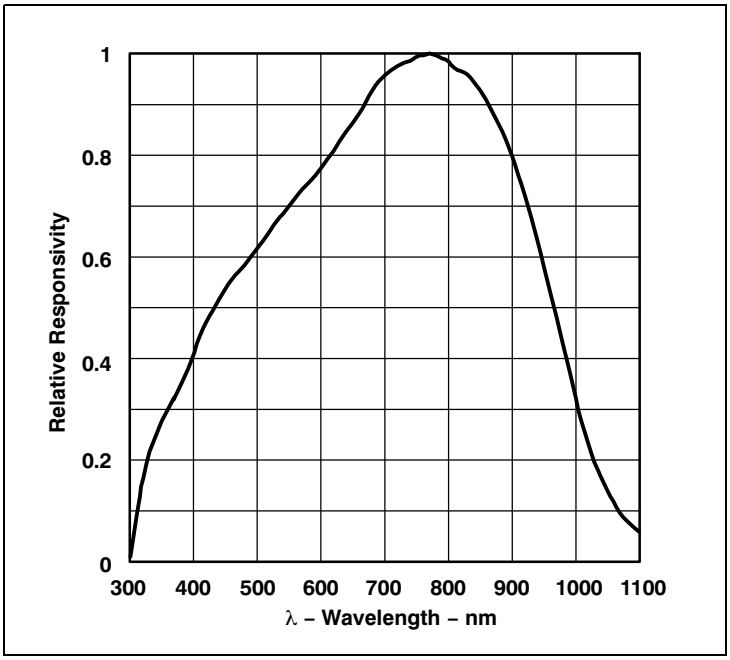


Note(s):

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 ≥ 1MΩ, C_i ≤ 20pF.

Typical Operating Characteristics

Figure 11:
Photodiode Spectral Responsivity



TSL12T

Figure 12:
Rising Edge Dynamic Characteristics vs. Peak Output Voltage

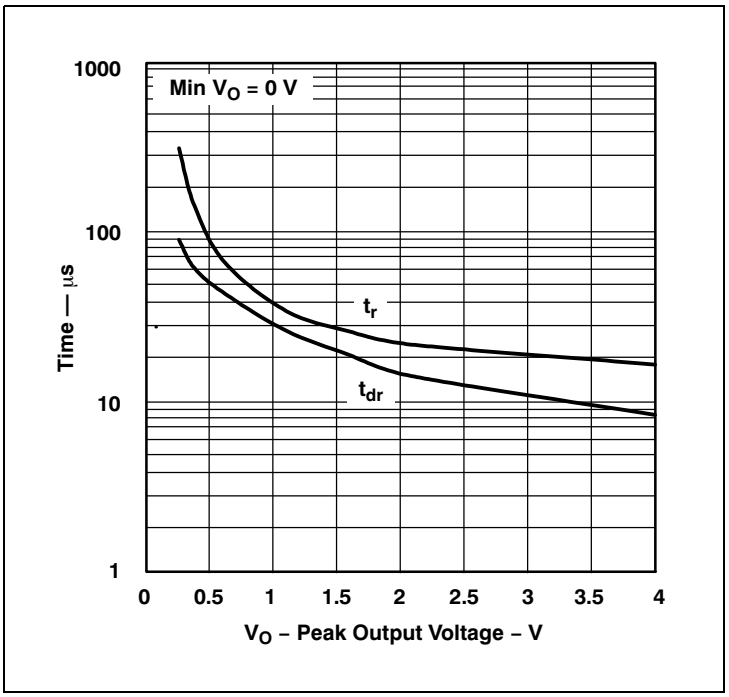


Figure 13:
Rising Edge Dynamic Characteristics vs. Peak Output Voltage

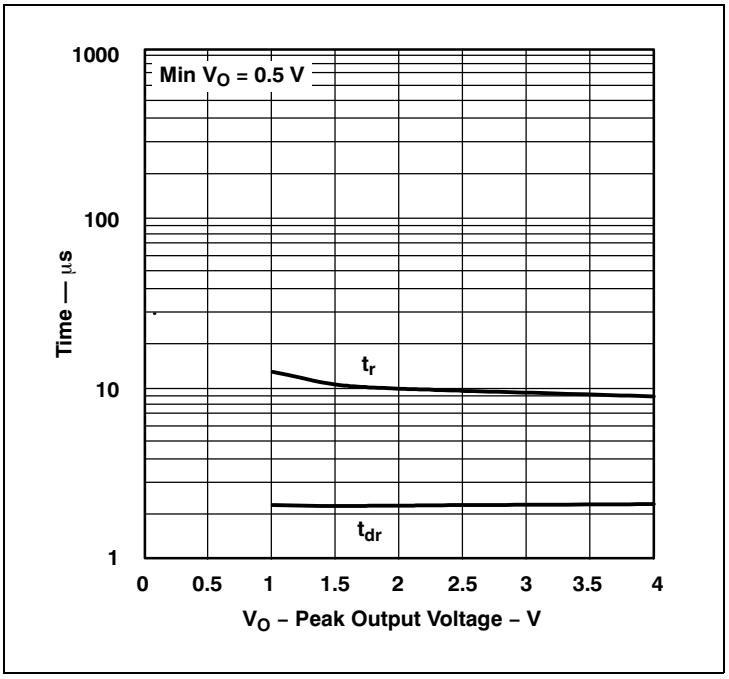


Figure 14:
Falling Edge Dynamic Characteristics vs. Peak Output Voltage

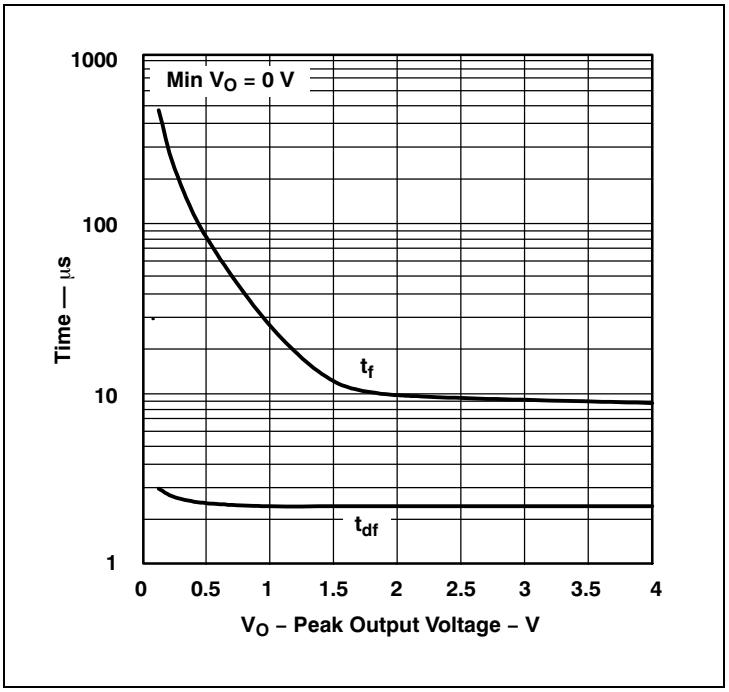


Figure 15:
Falling Edge Dynamic Characteristics vs. Peak Output Voltage

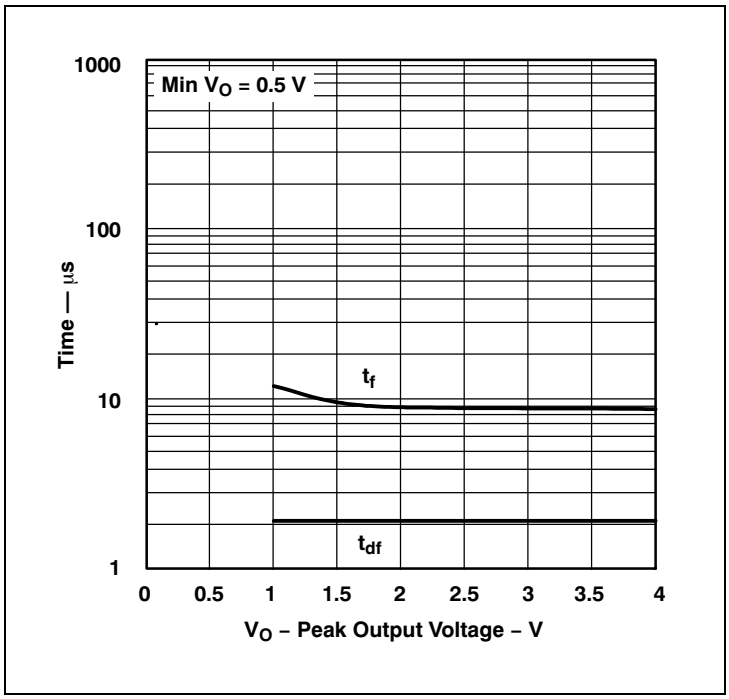


Figure 16:
Normalized Output Voltage vs. Angular Displacement

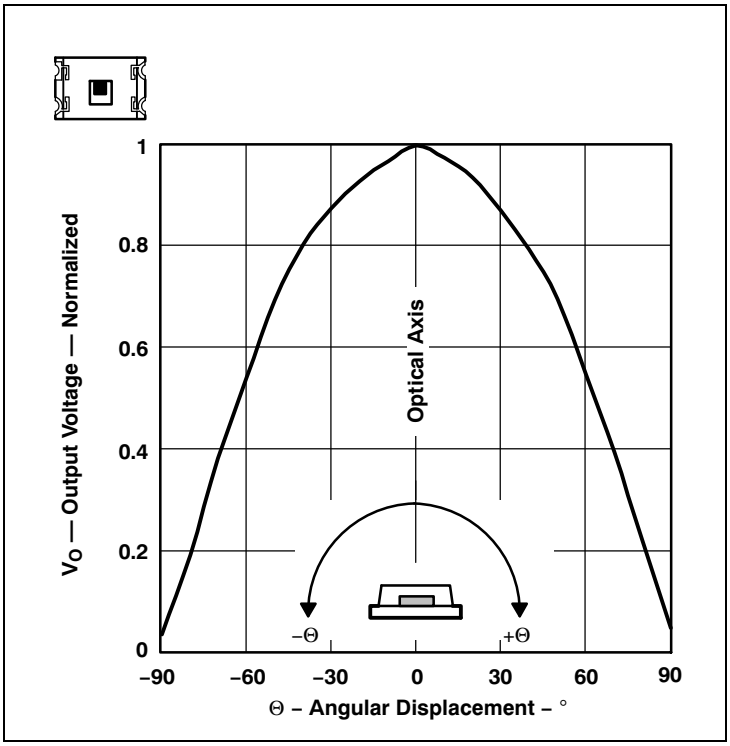
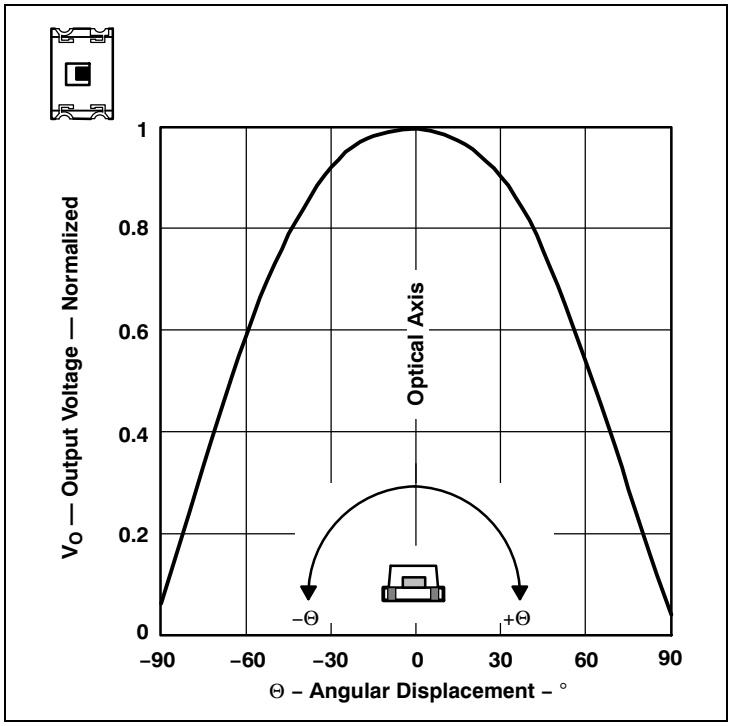


Figure 17:
Normalized Output Voltage vs. Angular Displacement



TSL13T

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

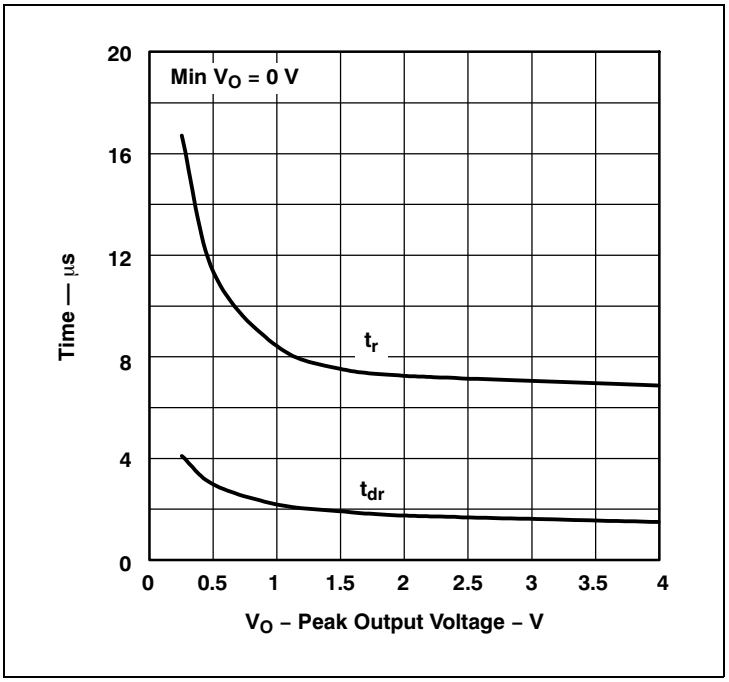


Figure 19:
Rising Edge Dynamic Characteristics vs. Peak Output Voltage

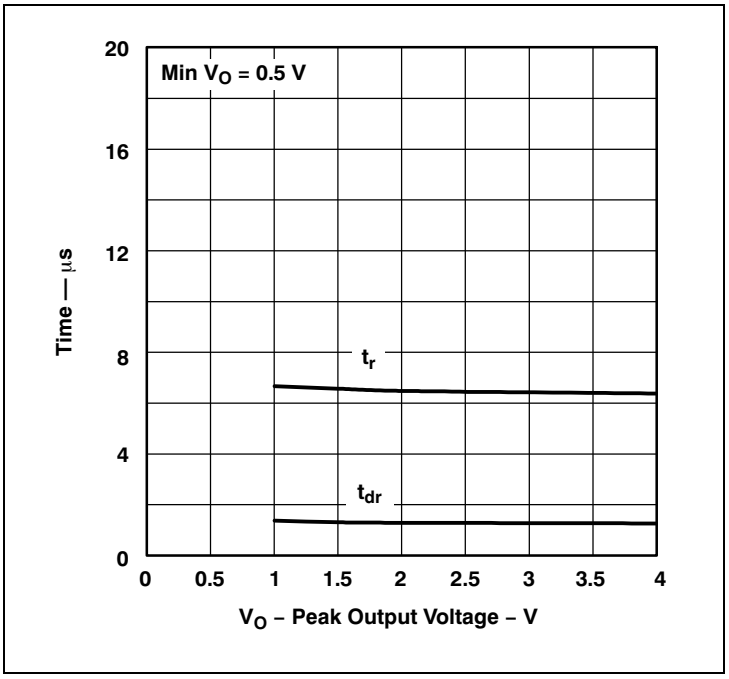


Figure 20:
Falling Edge Dynamic Characteristics vs. Peak Output Voltage

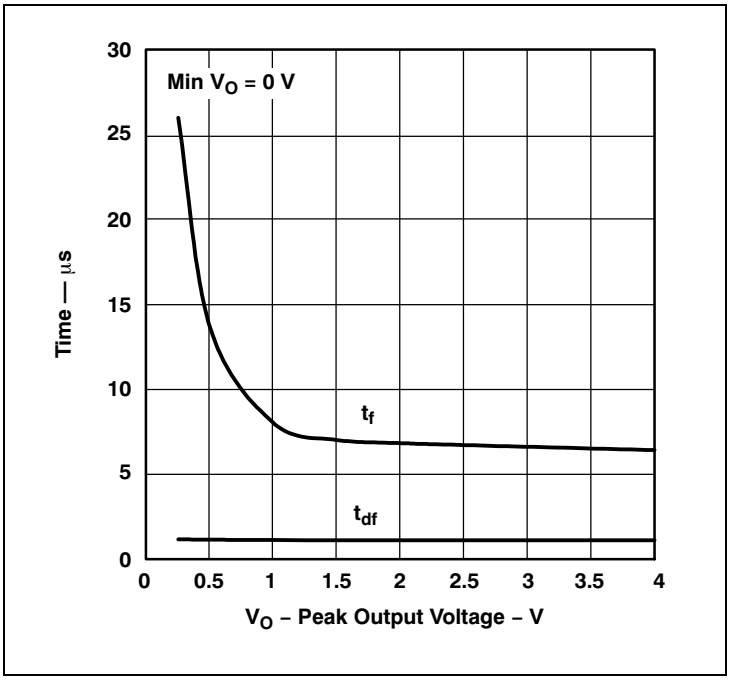


Figure 21:
Falling Edge Dynamic Characteristics vs. Peak Output Voltage

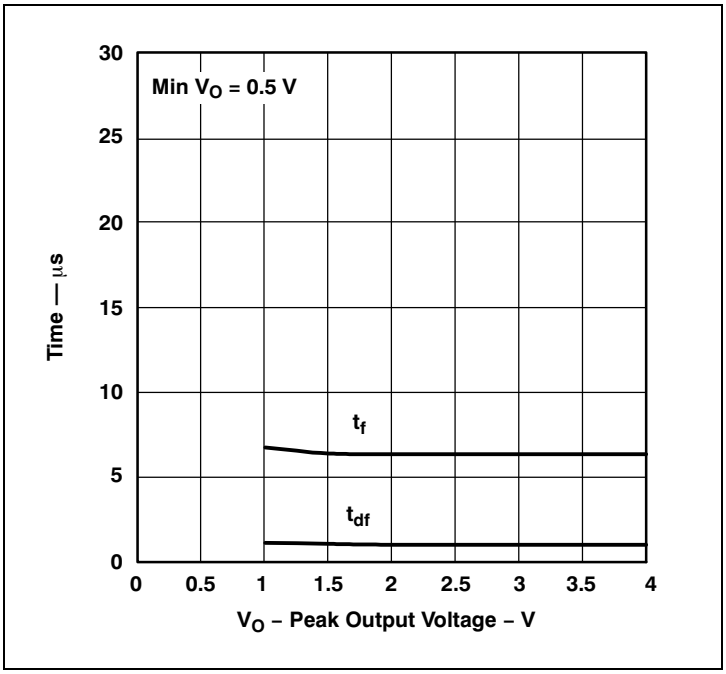


Figure 22:
Normalized Output Voltage vs. Angular Displacement

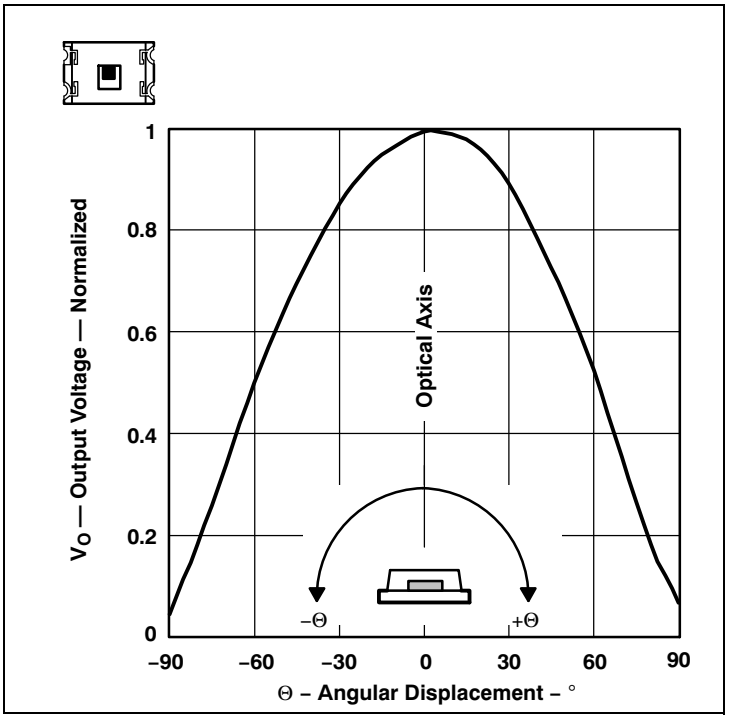
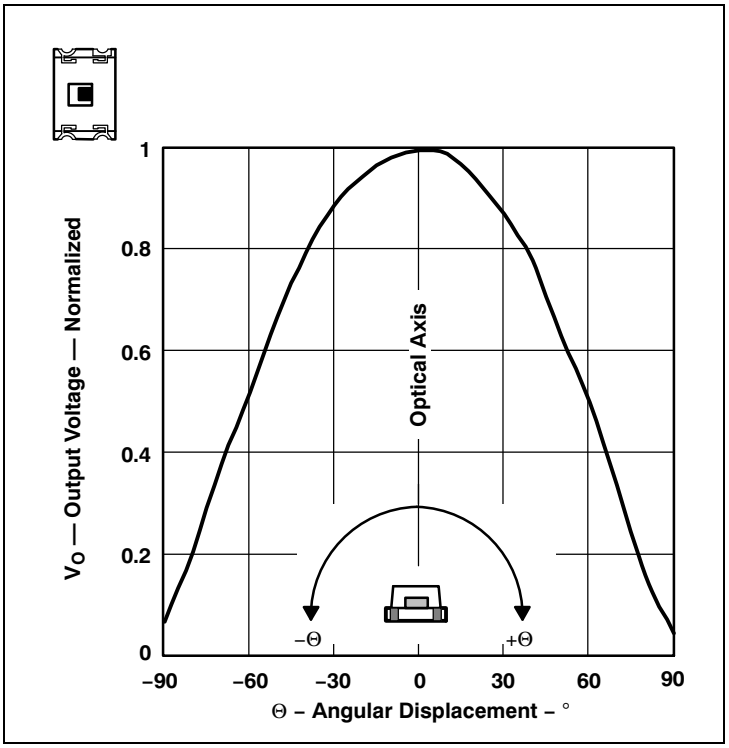


Figure 23:
Normalized Output Voltage vs. Angular Displacement

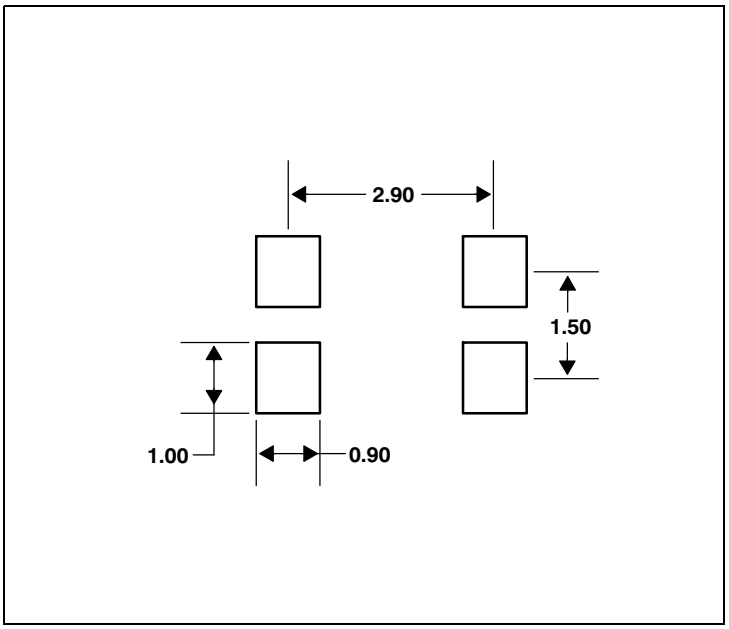


Application Information

PCB Pad Layout

Suggested PCB pad layout guidelines for the T package are shown in Figure 24.

Figure 24:
Suggested T Package PCB Layout



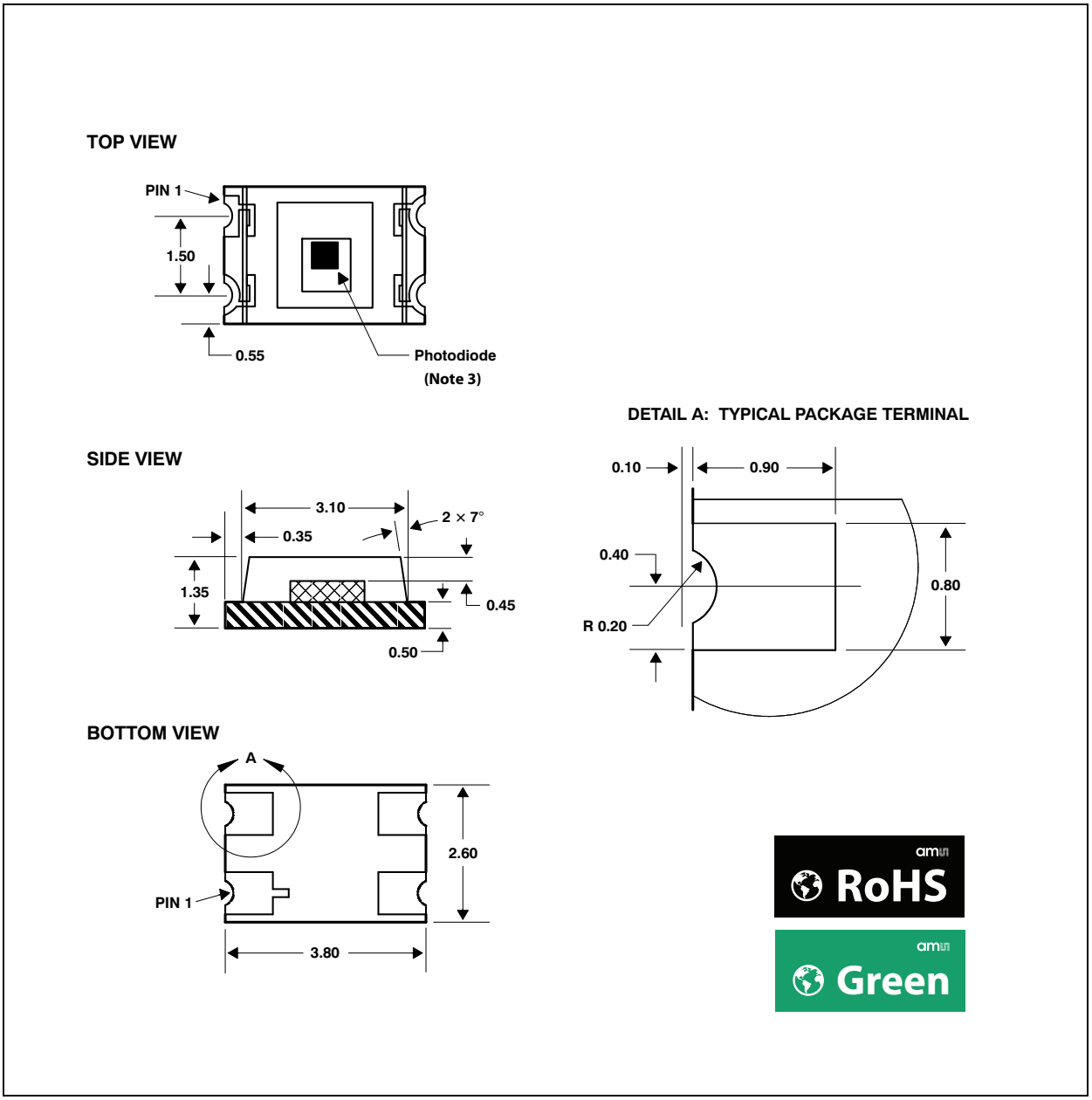
Note(s):

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

Packaging Mechanical Data

The TSL12T and TSL13T are supplied in a low-profile surface-mount package. This package contains no lead (Pb).

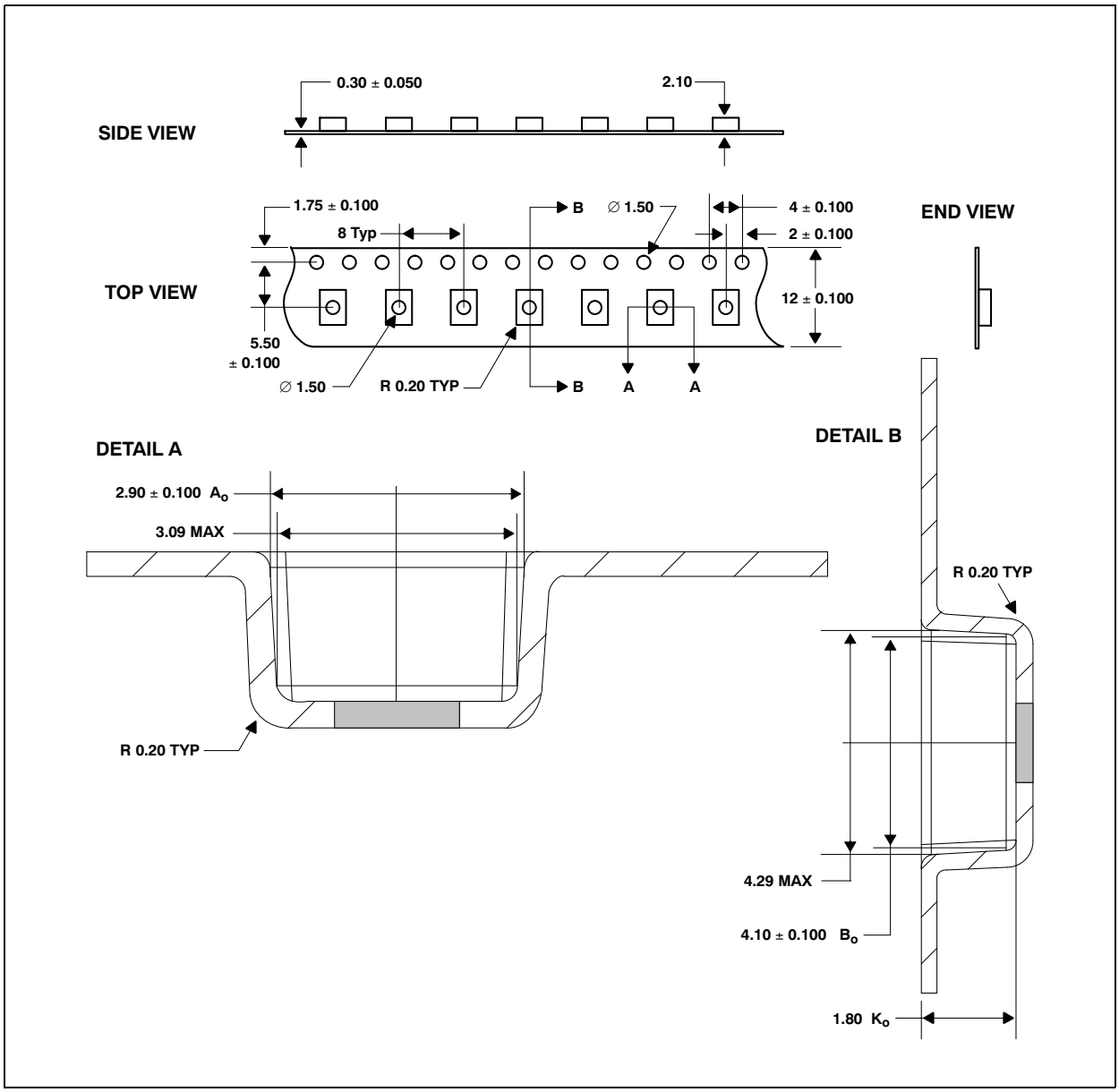
Figure 25:
Package T - Four-Lead Surface Mount Device Packaging Configuration



Note(s):

1. All linear dimensions are in millimeters.
2. Terminal finish is gold.
3. The center of the 0.50mm × 0.50mm integrated photodiode active area is typically located in the center of the package.
4. Dimension tolerance is ±0.15mm.
5. This drawing is subject to change without notice.

Figure 26:
Four-Lead Surface Mount Package Carrier Tape



Note(s):

1. All linear dimensions are in millimeters.
2. The dimensions on this drawing are for illustrative purposes only. Dimensions of an actual carrier may vary slightly.
3. Symbols on drawing A_o, B_o, and K_o are defined in ANSI EIA Standard 481-B 2001.
4. Each reel is 178 millimeters in diameter and contains 1000 parts.
5. **ams** packaging tape and reel conform to the requirements of EIA Standard 481-B.
6. In accordance with EIA standard, device pin 1 is located next to the sprocket holes in the tape.
7. This drawing is subject to change without notice.

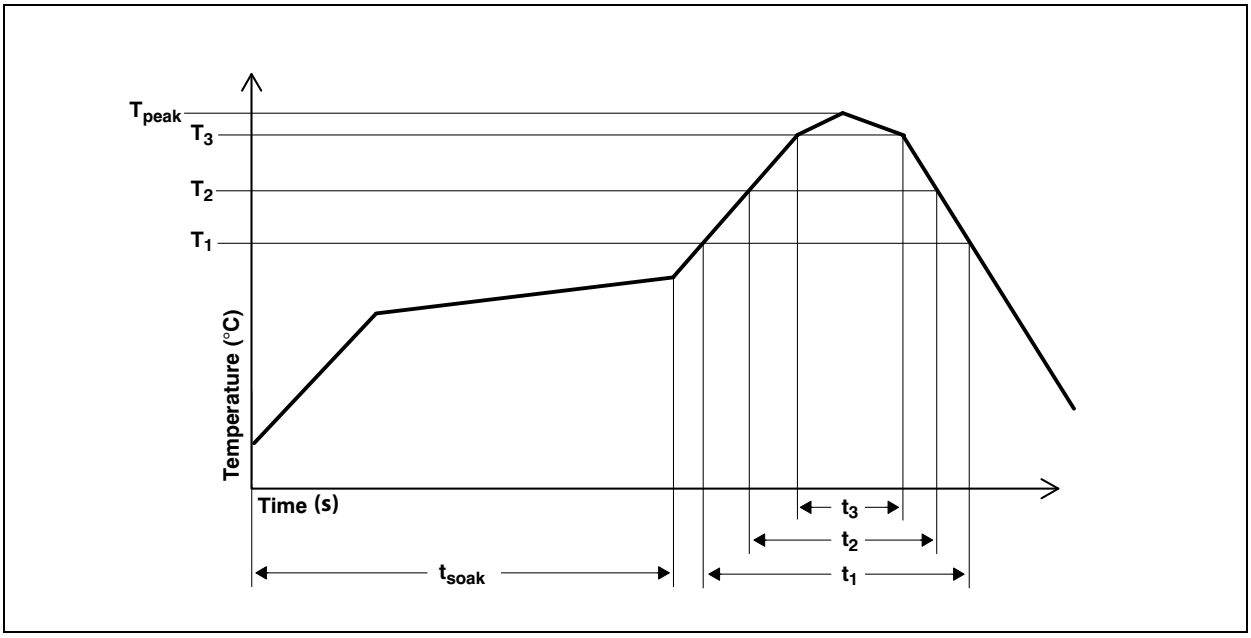
Manufacturing Information

The reflow profile specified here describes expected maximum heat exposure of devices during the solder reflow process of the device on a PWB. Temperature is measured at the top of the device. Devices should be limited to one pass through the solder reflow profile.

Figure 27:
TSL12T, TSL13T Solder Reflow Profile

Parameter	Reference	TSL12T, TSL13T
Average temperature gradient in preheating		2.5°C/s
Soak time	t_{soak}	2 to 3 minutes
Time above T_1, 217°C	t_1	Max 60 s
Time above T_2, 230°C	t_2	Max 50 s
Time above T_3, (T_{peak} - 10°C)	t_3	Max 10 s
Peak temperature in reflow	T_{peak}	260°C (-0°C/+5°C)
Temperature gradient in cooling		Max -5°C/s

Figure 28:
TSL12T, TSL13T Solder Reflow Profile Graph



Note(s):

1. Not to scale - for reference only.

Moisture Sensitivity

Optical characteristics of the device can be adversely affected during the soldering process by the release and vaporization of moisture that has been previously absorbed into the package. To ensure the package contains the smallest amount of absorbed moisture possible, each device is dry-baked prior to being packed for shipping. Devices are packed in a sealed aluminized envelope called a moisture barrier bag with silica gel to protect them from ambient moisture during shipping, handling, and storage before use.

This package has been assigned a moisture sensitivity level of MSL 3 and the devices should be stored under the following conditions:

- Temperature Range: 5°C to 50°C
- Relative Humidity: 60% maximum
- Total Time: 6 months from the date code on the aluminized envelope - if unopened
- Opened Time: 168 hours or fewer

Rebaking will be required if the devices have been stored unopened for more than 6 months or if the aluminized envelope has been open for more than 168 hours. If rebaking is required, it should be done at 90°C for 4 hours.

Ordering & Contact Information

Figure 29:
Ordering Information

Ordering Code	Device	T_A	Package - Leads	Package Designator
TSL12T	TSL12	0°C to 70°C	4-lead Low-Profile Surface-Mount	T
TSL13T	TSL13	0°C to 70°C	4-lead Low-Profile Surface-Mount	T

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ams Green (RoHS compliant and no Sb/Br): ams Green defines that in addition to RoHS compliance, our products are free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material).

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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
Datasheet	Production	Information in this datasheet is based on products in ramp-up to full production or full production which conform to specifications in accordance with the terms of ams AG standard warranty as given in the General Terms of Trade
Datasheet (discontinued)	Discontinued	Information in this datasheet is based on products which conform to specifications in accordance with the terms of ams AG standard warranty as given in the General Terms of Trade, but these products have been superseded and should not be used for new designs

Revision Information

Changes from TAOS062D (2007-Apr) to current revision 1-00 (2016-Apr-12)	Page
Content of TAOS datasheet was converted to the latest **ams** design	
Added Figure 1	1

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