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The technical content of this TAOS datasheet is still valid.

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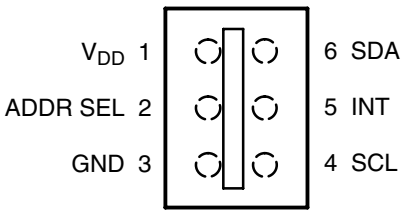
TSL2562, TSL2563
LOW-VOLTAGE
LIGHT-TO-DIGITAL CONVERTER

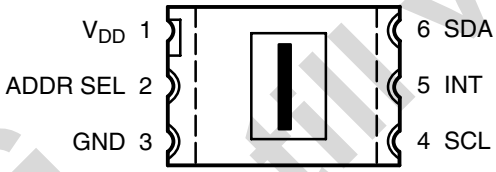
TAOS066N – AUGUST 2010

- **Approximates Human Eye Response**
- **Programmable Interrupt Function with User-Defined Upper and Lower Threshold Settings**
- **16-Bit Digital Output with SMBus (TSL2562) at 100 kHz or I²C (TSL2563) Fast-Mode at 400 kHz**
- **Programmable Analog Gain and Integration Time Supporting 1,000,000-to-1 Dynamic Range**
- **Automatically Rejects 50/60-Hz Lighting Ripple**
- **Low 2.5-V Input Voltage and 1.8-V Digital Output**
- **Low Active Power (0.6 mW Typical) with Power Down Mode**
- **RoHS Compliant**

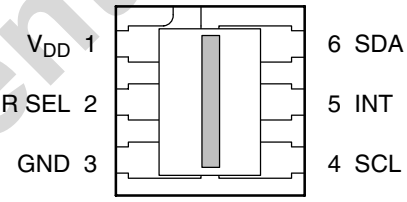
PACKAGE CS
6-LEAD CHIPSCALE
(TOP VIEW)



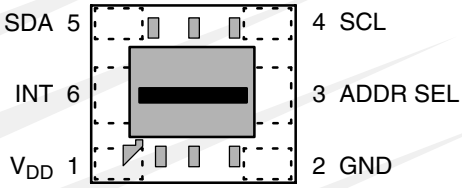
PACKAGE T
6-LEAD TMB
(TOP VIEW)



PACKAGE FN
DUAL FLAT NO-LEAD
(TOP VIEW)



PACKAGE CL
6-LEAD ChipLED
(TOP VIEW)



Package Drawings are Not to Scale

Description

The TSL2562 and TSL2563 are low-voltage light-to-digital converters that transform light intensity to a digital signal output capable of direct I²C (TSL2563) or SMBus (TSL2562) interface. Each device combines one broadband photodiode (visible plus infrared) and one infrared-responding photodiode on a single CMOS integrated circuit capable of providing a near-photopic response over an effective 20-bit dynamic range (16-bit resolution). Two integrating ADCs convert the photodiode currents to a digital output that represents the irradiance measured on each channel. This digital output can be input to a microprocessor where illuminance (ambient light level) in lux is derived using an empirical formula to approximate the human eye response. The TSL2562 device permits an SMB-Alert style interrupt, and the TSL2563 device supports a traditional level style interrupt that remains asserted until the firmware clears it.

While useful for general purpose light sensing applications, the TSL2562/63 devices are designed particularly for display panels (LCD, OLED, etc.) with the purpose of extending battery life and providing optimum viewing in diverse lighting conditions. Display panel backlighting, which can account for up to 30 to 40 percent of total platform power, can be automatically managed. Both devices are also ideal for controlling keyboard illumination based upon ambient lighting conditions. Illuminance information can further be used to manage exposure control in digital cameras. The TSL2562/63 devices are ideal in notebook/tablet PCs, LCD monitors, flat-panel televisions, cell phones, and digital cameras. In addition, other applications include street light control, security lighting, sunlight harvesting, machine vision, and automotive instrumentation clusters.

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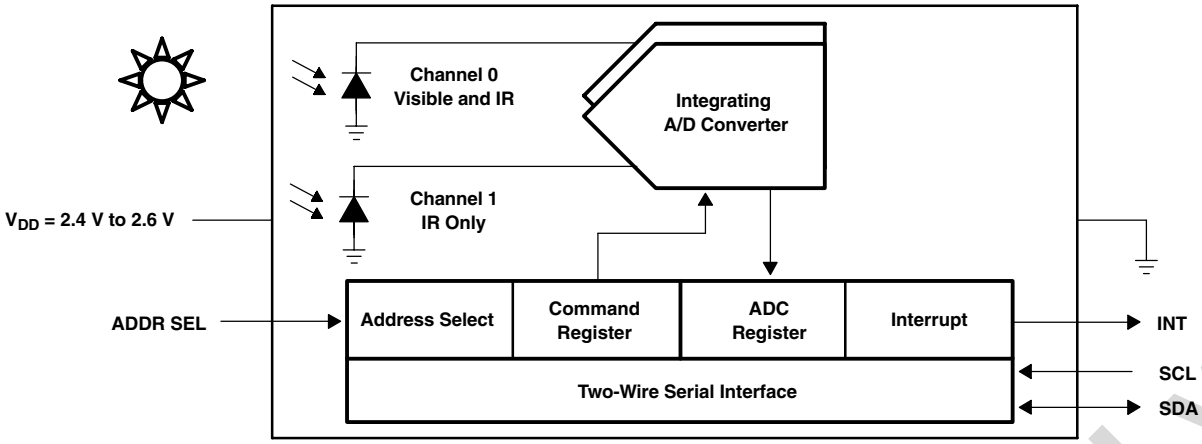
Functional Block Diagram



Detailed Description

The TSL2562 and TSL2563 are second-generation ambient light sensor devices. Each contains two integrating analog-to-digital converters (ADC) that integrate currents from two photodiodes. Integration of both channels occurs simultaneously. Upon completion of the conversion cycle, the conversion result is transferred to the Channel 0 and Channel 1 data registers, respectively. The transfers are double-buffered to ensure that the integrity of the data is maintained. After the transfer, the device automatically begins the next integration cycle.

Communication to the device is accomplished through a standard, two-wire SMBus or I^2C serial bus. Consequently, the TSL256x device can be easily connected to a microcontroller or embedded controller. No external circuitry is required for signal conditioning, thereby saving PCB real estate as well. Since the output of the TSL256x device is digital, the output is effectively immune to noise when compared to an analog signal.

The TSL256x devices also support an interrupt feature that simplifies and improves system efficiency by eliminating the need to poll a sensor for a light intensity value. The primary purpose of the interrupt function is to detect a meaningful change in light intensity. The concept of a *meaningful change* can be defined by the user both in terms of light intensity and time, or persistence, of that change in intensity. The TSL256x devices have the ability to define a threshold above and below the current light level. An interrupt is generated when the value of a conversion exceeds either of these limits.

Available Options

DEVICE	INTERFACE	PACKAGE – LEADS	PACKAGE DESIGNATOR	ORDERING NUMBER
TSL2562	SMBus	Chipscale	CS	TSL2562CS
TSL2562	SMBus	TMB-6	T	TSL2562T
TSL2562	SMBus	Dual Flat No-Lead – 6	FN	TSL2562FN
TSL2562	SMBus	ChipLED-6	CL	TSL2562CL
TSL2563	I^2C	Chipscale	CS	TSL2563CS
TSL2563	I^2C	TMB-6	T	TSL2563T
TSL2563	I^2C	Dual Flat No-Lead – 6	FN	TSL2563FN
TSL2563	I^2C	ChipLED-6	CL	TSL2563CL

Terminal Functions

TERMINAL NAME	CS, T, FN PKG NO.	CL PKG NO.	TYPE	DESCRIPTION
ADDR SEL	2	3	I	SMBus device select — three-state
GND	3	2		Power supply ground. All voltages are referenced to GND.
INT	5	6	O	Level or SMB Alert interrupt — open drain.
SCL	4	4	I	SMBus serial clock input terminal — clock signal for SMBus serial data.
SDA	6	5	I/O	SMBus serial data I/O terminal — serial data I/O for SMBus.
V_{DD}	1	1		Supply voltage.

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

Supply voltage, V_{DD} (see Note 1) . . . . . 3.8 V
Digital output voltage range, V_O . . . . . –0.5 V to 3.8 V
Digital output current, I_O . . . . . –1 mA to 20 mA
Storage temperature range, T_{stg} . . . . . –40°C to 85°C
ESD tolerance, human body model . . . . . 2000 V

† 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	NOM	MAX	UNIT
Supply voltage, V_{DD}		2.38	2.5	3	V
Operating free-air temperature, T_A		–30		70	°C
SCL, SDA input low voltage, V_{IL}		–0.5		0.58	V
SCL, SDA input high voltage, V_{IH}	$2.38 \le V_{DD} \le 2.62$	1.13		3.6	V
	$2.38 \le V_{DD} \le 3$	1.25		3.6	V

Electrical Characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{DD}	Supply current	Active		0.24	0.6	mA
		Power down		3.2	15	µA
V_{OL}	INT, SDA output low voltage	3 mA sink current	0		0.4	V
		6 mA sink current	0		0.6	V
I_{LEAK}	Leakage current		–5		5	µA

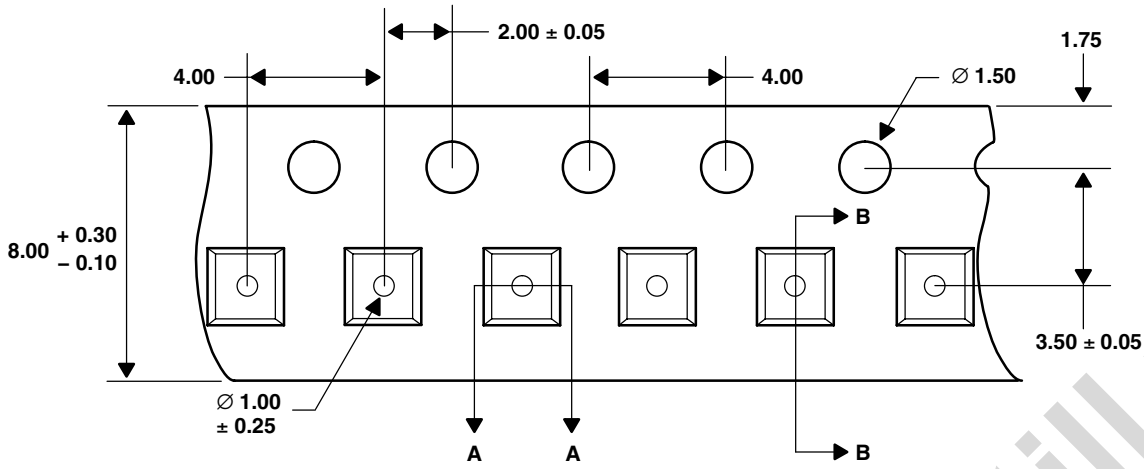
Operating Characteristics, High Gain (16×), V_{DD} = 2.5 V, T_A = 25°C, (unless otherwise noted) (see Notes 2, 3, 4, 5)

PARAMETER		TEST CONDITIONS	CHANNEL	TSL2562T, FN, & CL TSL2563T, FN, & CL			TSL2562CS, TSL2563CS			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
f_{osc}	Oscillator frequency			690	735	780	690	735	780	kHz
	Dark ADC count value	E_e = 0, T_{int} = 402 ms	Ch0	0		4	0		4	counts
			Ch1	0		4	0		4	
	Full scale ADC count value (Note 6)	T_{int} > 178 ms	Ch0			65535			65535	counts
			Ch1			65535			65535	
		T_{int} = 101 ms	Ch0			37177			37177	
			Ch1			37177			37177	
		T_{int} = 13.7 ms	Ch0			5047			5047	
			Ch1			5047			5047	
	ADC count value	λ_p = 640 nm, T_{int} = 101 ms, E_e = 36.3 µW/cm²	Ch0	750	1000	1250				counts
			Ch1		200					
		λ_p = 940 nm, T_{int} = 101 ms, E_e = 119 µW/cm²	Ch0	700	1000	1300				
			Ch1		820					
		λ_p = 640 nm, T_{int} = 101 ms, E_e = 41 µW/cm²	Ch0				750	1000	1250	counts
			Ch1					190		
		λ_p = 940 nm, T_{int} = 101 ms, E_e = 135 µW/cm²	Ch0				700	1000	1300	
			Ch1					850		
	ADC count value ratio: Ch1/Ch0	λ_p = 640 nm, T_{int} = 101 ms		0.15	0.20	0.25	0.14	0.19	0.24	
		λ_p = 940 nm, T_{int} = 101 ms		0.69	0.82	0.95	0.70	0.85	1	
R_e	Irradiance responsivity	λ_p = 640 nm, T_{int} = 101 ms	Ch0		27.5			24.4		counts/(µW/cm²)
			Ch1		5.5			4.6		
		λ_p = 940 nm, T_{int} = 101 ms	Ch0		8.4			7.4		
			Ch1		6.9			6.3		
R_v	Illuminance responsivity	Fluorescent light source: T_{int} = 402 ms	Ch0		36			35		counts/lux
			Ch1		4			3.8		
		Incandescent light source: T_{int} = 402 ms	Ch0		144			129		
			Ch1		72			67		
	ADC count value ratio: Ch1/Ch0	Fluorescent light source: T_{int} = 402 ms			0.11			0.11		
		Incandescent light source: T_{int} = 402 ms			0.5			0.52		
R_v	Illuminance responsivity, low gain mode (Note 7)	Fluorescent light source: T_{int} = 402 ms	Ch0		2.3			2.2		counts/lux
			Ch1		0.25			0.24		
		Incandescent light source: T_{int} = 402 ms	Ch0		9			8.1		
			Ch1		4.5			4.2		
	(Sensor Lux) / (actual Lux), high gain mode (Note 8)	Fluorescent light source: T_{int} = 402 ms		0.65	1	1.35	0.65	1	1.35	
		Incandescent light source: T_{int} = 402 ms		0.60	1	1.40	0.60	1	1.40	

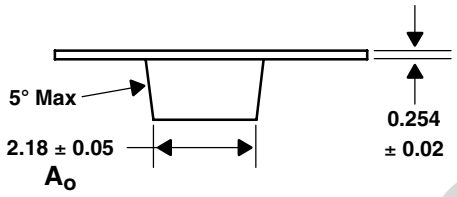
NOTES:
2. Optical measurements are made using small-angle incident radiation from light-emitting diode optical sources. Visible 640 nm LEDs and infrared 940 nm LEDs are used for final product testing for compatibility with high-volume production.
3. The 640 nm irradiance E_e is supplied by an AlInGaP light-emitting diode with the following characteristics: peak wavelength λp = 640 nm and spectral halfwidth $\Delta\lambda ½$ = 17 nm.
4. The 940 nm irradiance E_e is supplied by a GaAs light-emitting diode with the following characteristics: peak wavelength λp = 940 nm and spectral halfwidth $\Delta\lambda ½$ = 40 nm.
5. Integration time T_{int}, is dependent on internal oscillator frequency (f_{osc}) and on the integration field value in the timing register as described in the *Register Set* section. For nominal f_{osc} = 735 kHz, nominal T_{int} = (number of clock cycles)/f_{osc}.
   Field value 00: $T_{int} = (11 \times 918)/f_{osc}$ = 13.7 ms
   Field value 01: $T_{int} = (81 \times 918)/f_{osc}$ = 101 ms
   Field value 10: $T_{int} = (322 \times 918)/f_{osc}$ = 402 ms
   Scaling between integration times vary proportionally as follows: 11/322 = 0.034 (field value 00), 81/322 = 0.252 (field value 01), and 322/322 = 1 (field value 10).
6. Full scale ADC count value is limited by the fact that there is a maximum of one count per two oscillator frequency periods and also by a 2-count offset.
   Full scale ADC count value = ((number of clock cycles)/2 – 2)
   Field value 00: Full scale ADC count value = $((11 \times 918)/2 - 2)$ = 5047
   Field value 01: Full scale ADC count value = $((81 \times 918)/2 - 2)$ = 37177
   Field value 10: Full scale ADC count value = 65535, which is limited by 16 bit register. This full scale ADC count value is reached for 131074 clock cycles, which occurs for T_{int} = 178 ms for nominal f_{osc} = 735 kHz.
7. Low gain mode has 16× lower gain than high gain mode: (1/16 = 0.0625).
8. The sensor Lux is calculated using the empirical formula shown on p. 22 of this data sheet based on measured Ch0 and Ch1 ADC count values for the light source specified. Actual Lux is obtained with a commercial luxmeter. The range of the (sensor Lux) / (actual Lux) ratio is estimated based on the variation of the 640 nm and 940 nm optical parameters. Devices are not 100% tested with fluorescent or incandescent light sources.

MECHANICAL DATA

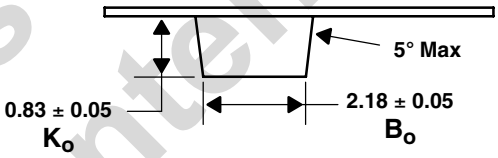
TOP VIEW

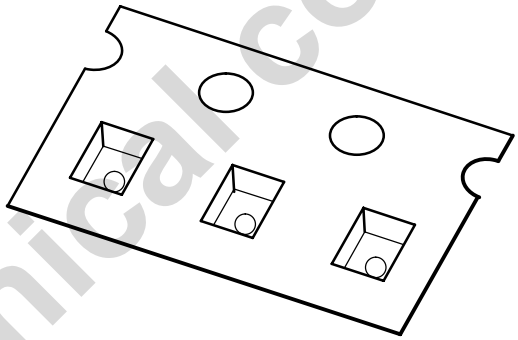


DETAIL A



DETAIL B



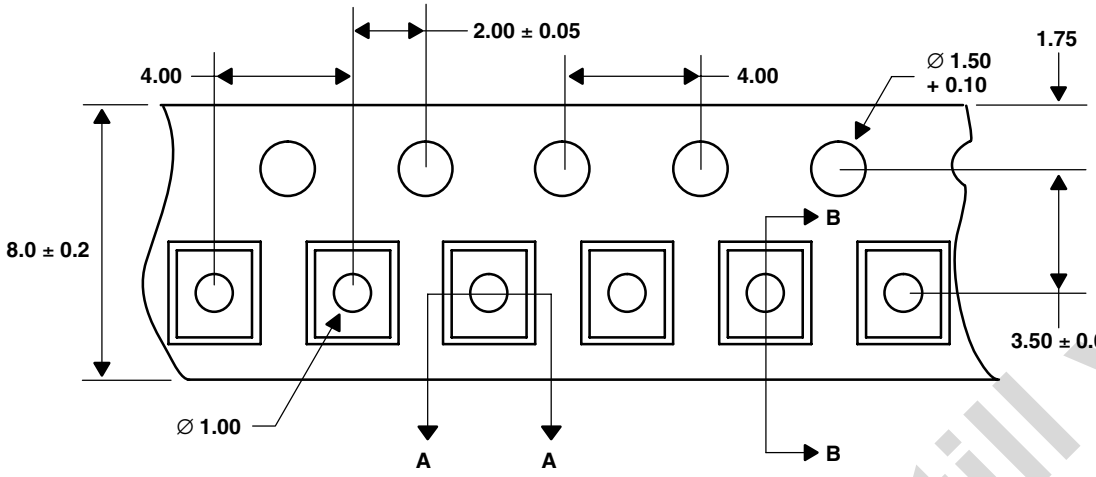


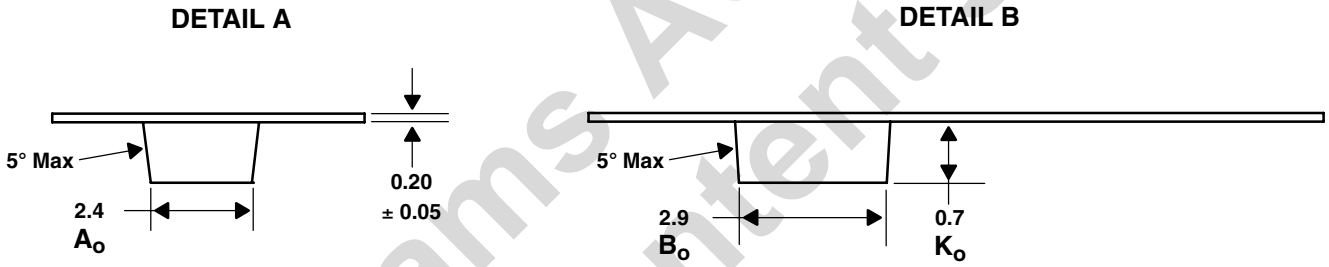
NOTES: H. All linear dimensions are in millimeters. Dimension tolerance is ± 0.10 mm unless otherwise noted.
I. The dimensions on this drawing are for illustrative purposes only. Dimensions of an actual carrier may vary slightly.
J. Symbols on drawing A_o, B_o, and K_o are defined in ANSI EIA Standard 481–B 2001.
K. Each reel is 178 millimeters in diameter and contains 3500 parts.
L. TAOS packaging tape and reel conform to the requirements of EIA Standard 481–B.
M. In accordance with EIA standard, device pin 1 is located next to the sprocket holes in the tape.
N. This drawing is subject to change without notice.

Figure 29. TSL2562/TSL2563 FN Carrier Tape

MECHANICAL DATA

TOP VIEW





NOTES: A. All linear dimensions are in millimeters. Dimension tolerance is ± 0.10 mm unless otherwise noted.
B. The dimensions on this drawing are for illustrative purposes only. Dimensions of an actual carrier may vary slightly.
C. Symbols on drawing A_o, B_o, and K_o are defined in ANSI EIA Standard 481–B 2001.
D. Each reel is 178 millimeters in diameter and contains 2500 parts.
E. TAOS packaging tape and reel conform to the requirements of EIA Standard 481–B.
F. In accordance with EIA standard, device pin 1 is located next to the sprocket holes in the tape.
G. This drawing is subject to change without notice.

Figure 30. TSL2562/TSL2563 CL Carrier Tape

MANUFACTURING INFORMATION

The CS, T, FN, and CL packages have been tested and have demonstrated an ability to be reflow soldered to a PCB substrate. The process, equipment, and materials used in these test are detailed below.

The solder reflow profile describes the expected maximum heat exposure of components during the solder reflow process of product on a PCB. Temperature is measured on top of component. The components should be limited to a maximum of three passes through this solder reflow profile.

Table 13. TSL2562/63 Solder Reflow Profile

PARAMETER	REFERENCE	TSL2562/63
Average temperature gradient in preheating		2.5°C/sec
Soak time	t_{soak}	2 to 3 minutes
Time above 217°C	t_1	Max 60 sec
Time above 230°C	t_2	Max 50 sec
Time above T_{peak} –10°C	t_3	Max 10 sec
Peak temperature in reflow	T_{peak}	260° C (–0°C/+5°C)
Temperature gradient in cooling		Max –5°C/sec

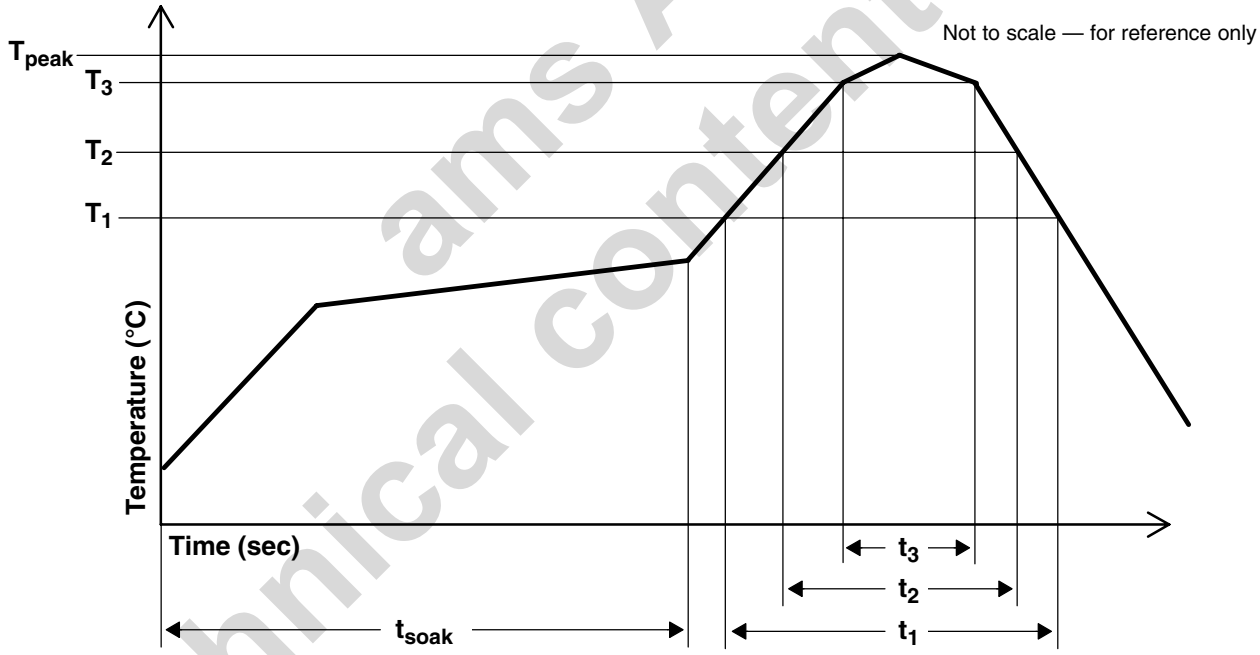


Figure 31. TSL2562/TSL2563 Solder Reflow Profile Graph

MANUFACTURING INFORMATION

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 molding compound. To ensure the package molding compound 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 with silica gel to protect them from ambient moisture during shipping, handling, and storage before use.

The CS package has been assigned a moisture sensitivity level of MSL 2 and the devices should be stored under the following conditions:

Temperature Range	5°C to 50°C
Relative Humidity	60% maximum
Floor Life	1 year out of bag at ambient < 30°C / 60% RH

Rebaking will be required if the aluminized envelope has been open for more than 1 year. If rebaking is required, it should be done at 90°C for 3 hours.

The T, FN, and CL packages have 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	12 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 12 months or if the aluminized envelope has been open for more than 168 hours. If rebaking is required, it should be done at 50°C for 12 hours.

PRODUCTION DATA — information in this document is current at publication date. Products conform to specifications in accordance with the terms of Texas Advanced Optoelectronic Solutions, Inc. standard warranty. Production processing does not necessarily include testing of all parameters.

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Green (RoHS & no Sb/Br) TAOS defines *Green* to mean Pb-Free (RoHS compatible), and 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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