

SKYWORKS™

DATA SHEET

# SKY16601-555LF: Integrated Single-Stage PIN Diode Limiter Module 0.50 to 6.0 GHz

## Applications

- Cellular infrastructure
- WLAN, WiMAX
- Receiver LNA protection
- Test instruments

## Features

- Optimized for 0.50 to 6.0 GHz operation
- Low insertion loss
- Low distortion
- Integrated PIN limiter, RF choke inductor, and DC blocks
- MLP (2-pin, 2.5 x 2.5 mm) Pb-free package, (MSL1, 260 °C per JEDEC J-STD-020)



Skyworks Green™ products are compliant with all applicable legislation and are halogen-free. For additional information, refer to *Skyworks Definition of Green™*, document number SQ04-0074.

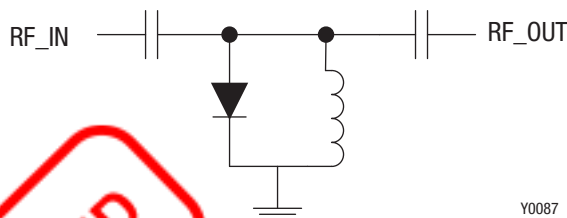


Figure 1. SKY16601-555LF Block Diagram

## Description

The SKY16601-555LF is a fully integrated PIN diode low-threshold limiter module in a surface-mount package. It is designed for use as a passive receiver protector in wireless or other RF systems for frequencies up to 6 GHz. It features low-insertion loss and low distortion in a single MLP package.

The SKY16601-555LF module is comprised of a PIN limiter diode, an RF choke inductor, and 2 DC blocking caps at the RF ports in a 2-lead MLP package. The small package design reduces printed circuit board area.

The module can operate over the temperature range of -40 °C to +85 °C.

A functional block diagram is shown in Figure 1. The pin configuration and package are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.

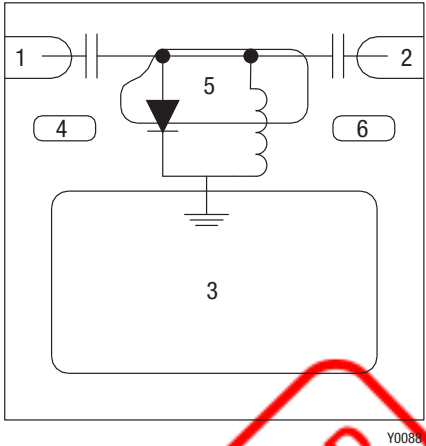


Figure 2. SKY16601-555LF Pinout, 2-Pin MLP (Top View)

Table 1. SKY16601-555LF Signal Descriptions

Pin	Name	Description
1	RF_IN	RF Input, AC coupled
2	RF_OUT	RF Output, AC coupled
3	GND	Must be connected to chassis ground
4	PAD	Exposed pad (must be isolated from ground)
5	PAD	Exposed pad (must be isolated from ground)
6	PAD	Exposed pad (must be isolated from ground)

### Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY16601-555LF are provided in Table 2. Electrical specifications for the limiter

module are provided in Table 3, and RF electrical specifications for the 2.6 GHz limiter module are provided in Table 4.

Table 2. SKY16601-555LF Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Minimum	Maximum	Unit
Reverse voltage	$V_R$		45	V
Forward current @ 25 °C	$I_F$		1.5	A
RF input power (CW) at $T_{CASE} = 85\text{ °C}$	$P_{IN}$		23	W
RF input power (1 $\mu$ s pulse, 10% duty cycle) at $T_{CASE} = 85\text{ °C}$	$P_{IN}$		230	W
CW power dissipation at $T_{CASE} = 85\text{ °C}$	$P_{DIS}$		1	W
Storage temperature	$T_{STG}$	−65	+150	°C
Operating temperature	$T_{OP}$	−40	+85	°C
Electrostatic discharge:	ESD			
Charged Device Model (CDM), Class 4			1000	V
Human Body Model (HBM), Class1A			250	V
Machine Model (MM), Class A			150	V

**Note 1:** Exposure to maximum rating conditions for extended periods may reduce device reliability. There is no damage to device with only one parameter set at the limit and all other parameters set at or below their nominal value. Exceeding any of the limits listed here may result in permanent damage to the device.

**CAUTION:** Although these devices are designed to be as robust as possible, Electrostatic Discharge (ESD) can damage them. These devices must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions should be employed at all times.

Table 3. SKY16601-555LF Electrical Specifications ( $T_A = 25^\circ\text{C}$ , Unless Otherwise Noted)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Units
Breakdown voltage	VB	IR = 10 $\mu\text{A}$	20		45	V
Reverse current	IR	VR = 16 V			1	$\mu\text{A}$
Capacitance	CT	f = 1 MHz, VR = 6 V		0.33	0.40	pF
Series resistance	RS	f = 500 MHz, IF = 10 mA		1.7	2.0	$\Omega$
Series inductance	LS			0.3		nH
Carrier lifetime	TL	IF = 10 mA		10		ns
I region width	W			1.5		$\mu\text{m}$

Table 4. SKY16601-555LF RF Electrical Specifications ( $T_{\text{op}} = 25^\circ\text{C}$ ,  $Z_0 = 50 \Omega$ , as Measured in the Skyworks Evaluation Board)

Parameter	Symbol	Condition	Frequency	Min.	Typ.	Max.	Units
Insertion loss	IL	PIN = 0 dBm	2.5 GHz		0.1	0.5	dB
Return loss	RL	PIN = 0 dBm	2.5 GHz		27.5		dB
Threshold level	TL	P1dB	2.5 GHz	10	11	12	dBm
Saturated CW input power	PIN CW		2.5 GHz		29		dBm
Input third order intercept	IIP3	PIN = -10 dBm/tone, spacing = 10 MHz	2.5 GHz		32		dBm
Recovery time (Note 1)	TR		2.5 GHz		5		ns
Thermal resistance	$\Theta_{\text{JC}}$	Junction-to-case			88		$^\circ\text{C/W}$
Flat leakage power (Note 2)	FL	PIN = +20 dBm			13		dBm

**Note 1:** Recovery time represents the transition time from the high-loss to low-loss state following the removal of high-power input. RF pulse modulation: 1  $\mu\text{s}$  pulse width and 0.1% duty factor.

**Note 2:** Flat leakage power is defined as the power level after the limiter has fully turned on and the output pulse reaches a constant level.

## Theory of Operation

A limiter prevents overload by allowing RF signals that are below a certain threshold to pass through, but larger signals exceeding the threshold are increasingly attenuated. The SKY16601-555LF is a single-stage limiter module, comprised of a shunt-connected PIN diode that biases itself in the presence of large signals. The PIN diode performs the dual functions of rectifying the incoming RF signal and then using the rectified current to bias itself to a low effective series resistance. An inductor completes the loop for the bias current flow while presenting a high impedance path to RF. The SKY16601-555LF includes input/output DC blocking capacitors needed for most applications.

## Typical Performance Characteristics

( $T_{OP}=25^{\circ}\text{C}$ , Characteristic Impedance = 50  $\Omega$ )

Typical performance characteristics are illustrated in Figures 3 and 4. Figures 5 and 6 show the power derating curves for the limiter module. In Figure 5, the temperature is referenced to the bottom of the MLP package. The power derating curve with the temperature referenced to the bottom of the printed circuit board is shown in Figure 6.

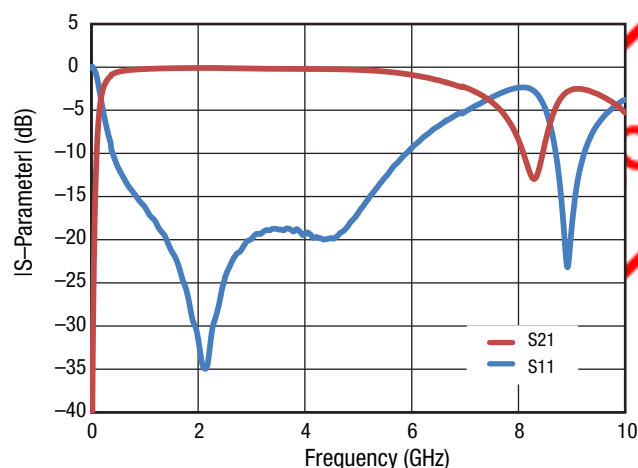


Figure 3. Small Signal Performance

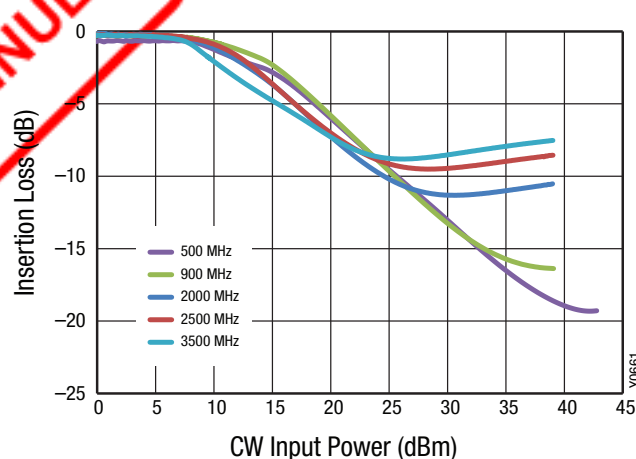


Figure 4. Insertion Loss vs CW Input Power vs Frequency

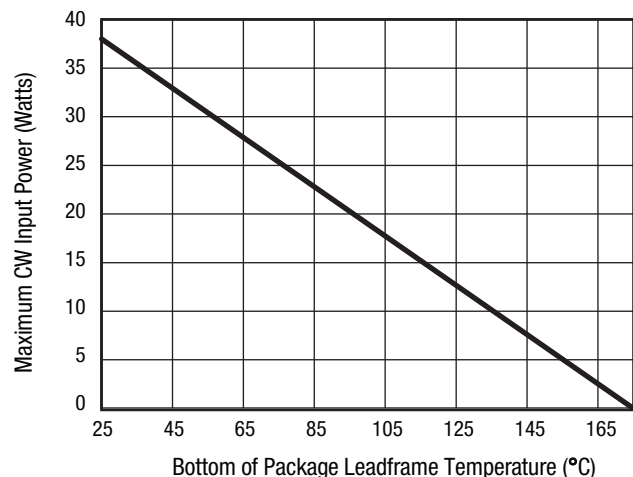


Figure 5. Power De-rating Curve (Insertion Loss = 0.2 dB) vs Temperature on Bottom of Package Leadframe

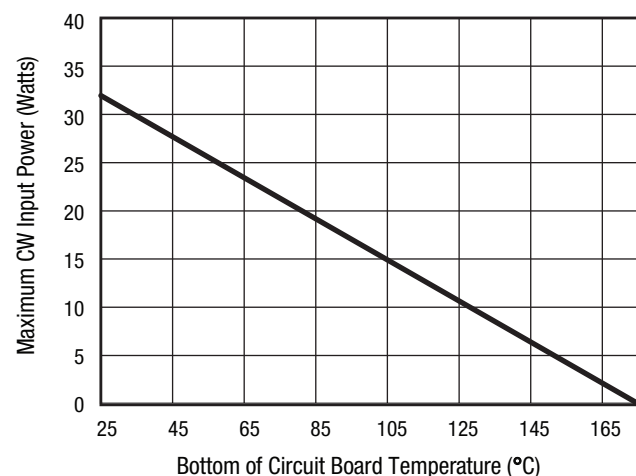


Figure 6. Power De-rating Curve (Insertion Loss = 0.2 dB) vs Temperature on Bottom of EVB Circuit Board

## Evaluation Board Description

The SKY16601-555LF evaluation board is used to test the performance of the limiter module. An assembly drawing for the evaluation board is shown in Figure 7. The evaluation board layer detail is provided in Figure 8.

## Package Dimensions

The PCB layout footprint for the SKY16601-555LF is shown in Figure 9. Typical case markings are noted in Figure 10. Package dimensions for the 2 pin MLP are shown in Figure 11, and tape and reel dimensions are provided in Figure 12.

## Package and Handling Information

Instructions on the shipping container label regarding exposure to moisture after the container seal is broken must be followed. Otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

The SKY16601-555LF is rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, Solder Reflow Information, document number 200164.

Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. Production quantities of this product are shipped in a standard tape and reel format.

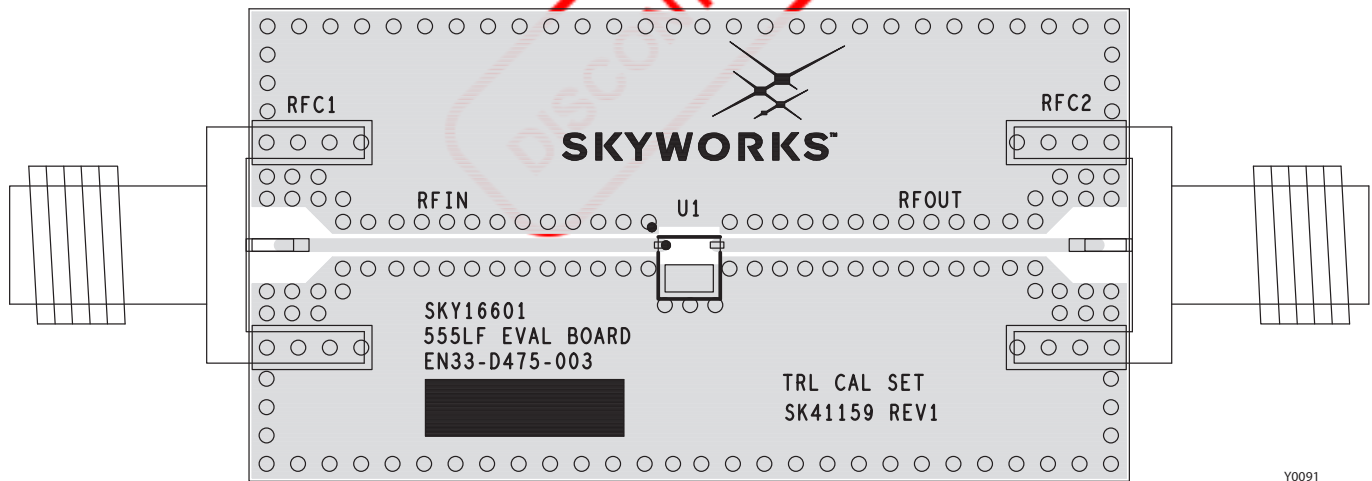
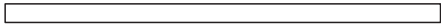
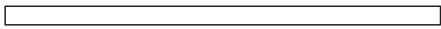









Figure 7. SKY16601-555LF Evaluation Board Assembly Diagram

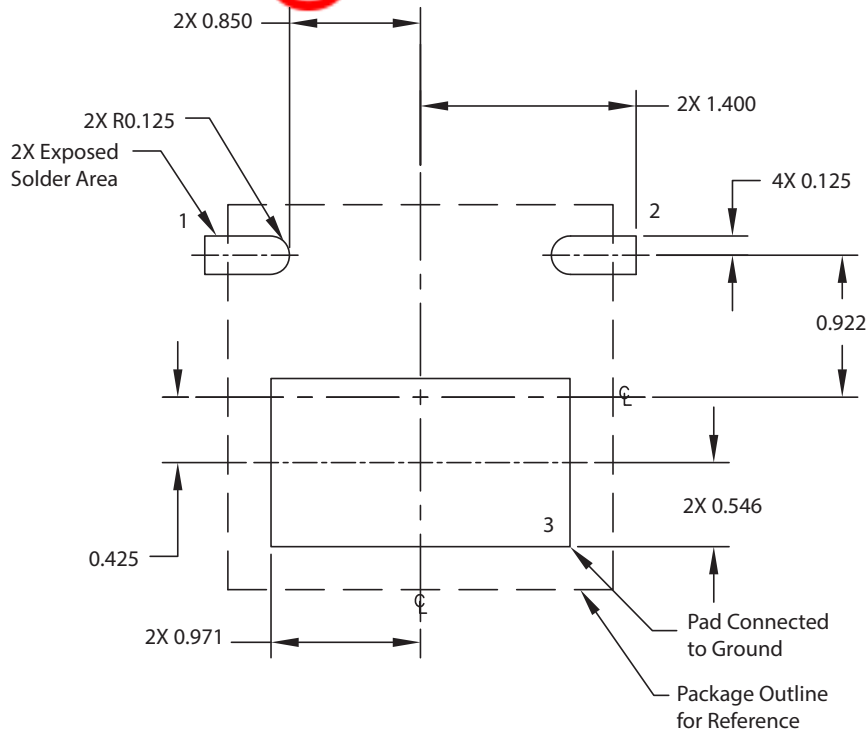
Y0091

Cross Section	Name	Thickness (in)	Material
	Top Soldermask		
	L1	(0.0028)	Cu foil
	Laminate	0.012 ± 0.0006	Rogers R04003C Core
	L2	(0.0014)	Cu foil
	Laminate	(Note 1)	FR4 Prepreg
	L3	(0.0014)	Cu foil
	Laminate	0.010 ± 0.0006	FR4 Core
	L4	(0.0028)	Cu foil
	Bottom Soldermask		

*Note 1: Adjust this thickness to meet total thickness goal of 0.062 ± 0.005 inches.*

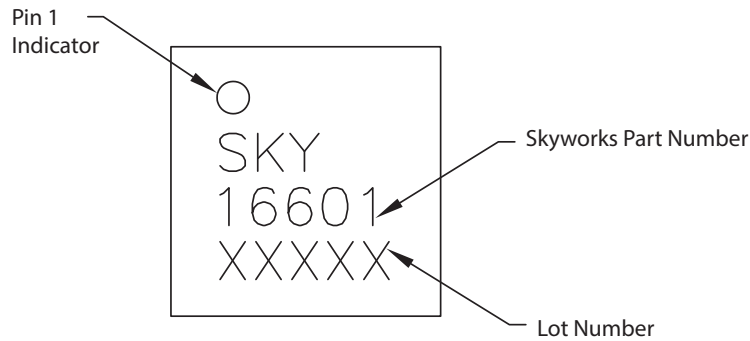
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Figure 8. Board Layer Detail Physical Characteristics



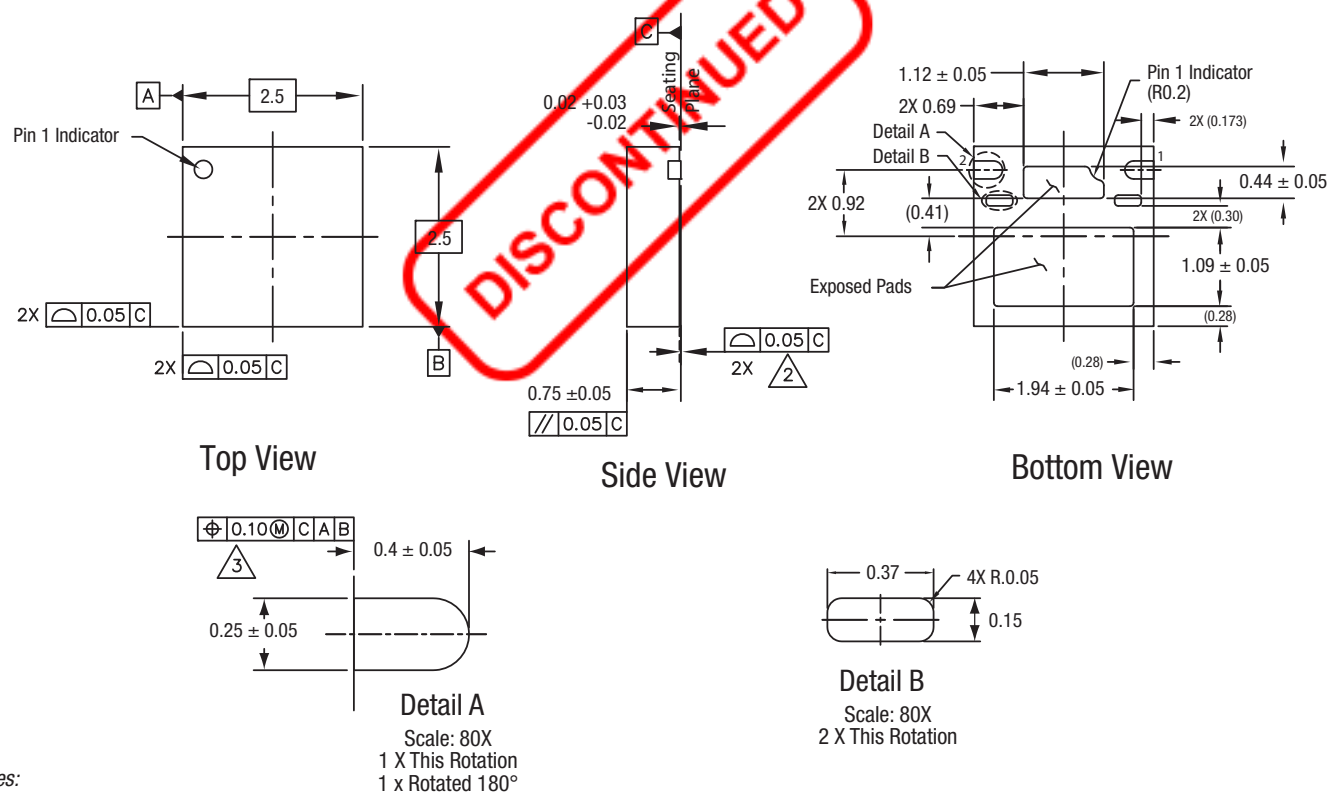
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Figure 9. SKY16601-555LF PCB Layout Footprint



Y0090

Figure 10. SKY16601-555LF Typical Case Markings



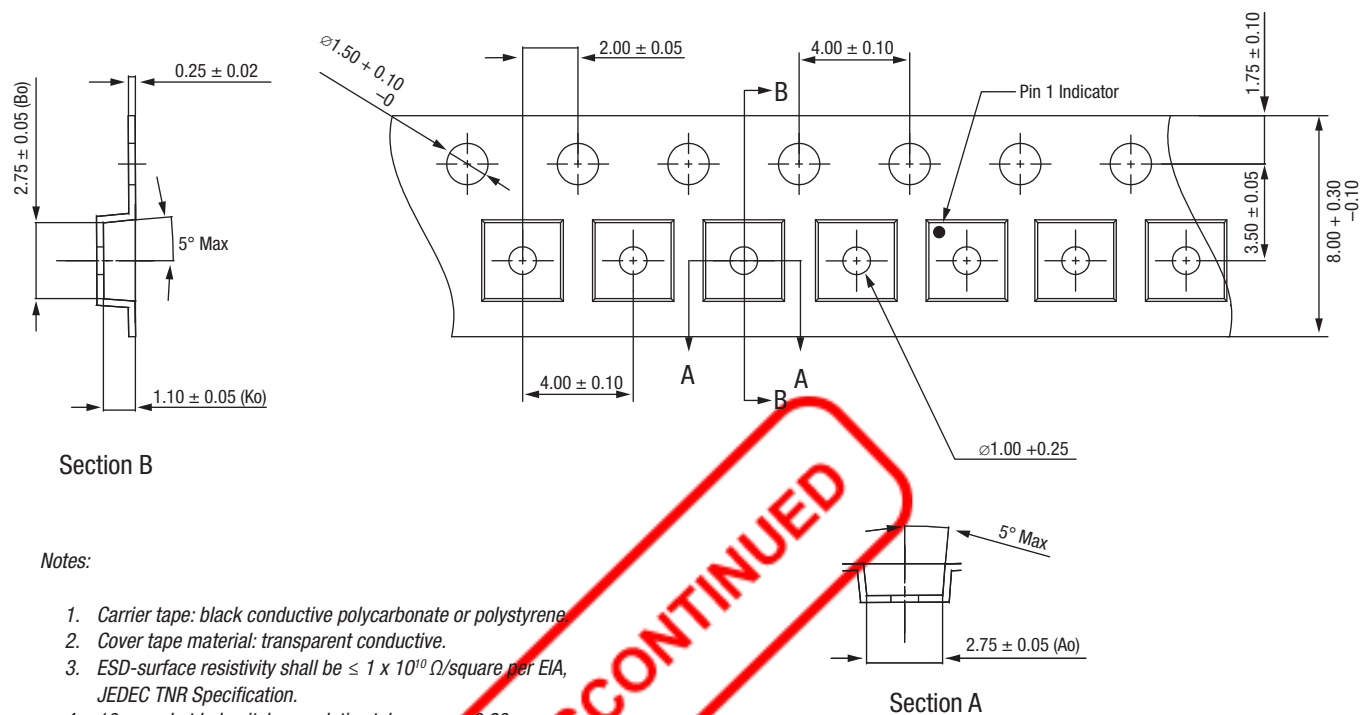
**Notes:**

All measurements are in millimeters.  
Dimensioning and tolerancing according to ASME Y14.5M-1994.  
Coplanarity applies to the exposed heat sink ground pad as well as the terminals.  
Dimension applies to metalized terminal. If the terminal has a radius on its end, the dimension should not be measured in that area.  
Plating requirement per source control drawing (SCD) 2504.

Y0093

Figure 11. SKY16601-555LF 2-PIN MLP Package Dimensions

# DATA SHEET • SKY16601-555LF: INTEGRATED SINGLE-STAGE PIN DIODE LIMITER MODULE



Y0796



## Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY16601-555LF: Low Threshold PIN Diode Limiter Module	SKY16601-555LF	SKY16601-555LF-EVB



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