

**DATA SHEET**

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

**Applications**

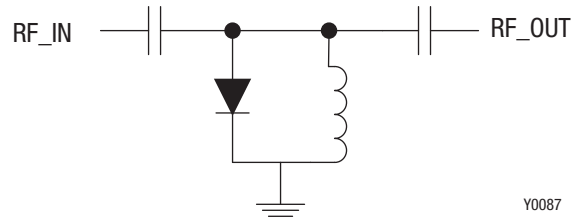
- Cellular infrastructure
- WLAN, WiMAX
- Receiver LNA protection
- Test instruments

**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)



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**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.

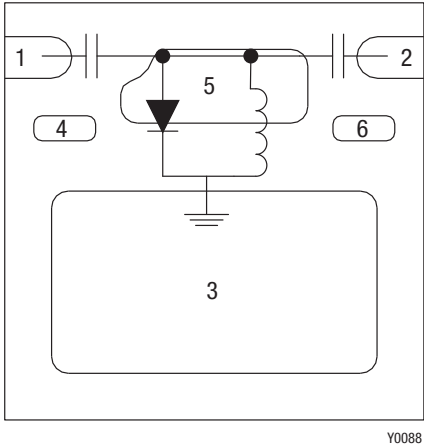


Figure 2. SKY16601-555LF Pinout, 2-Pin MLP (Top View)

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 <sub>R</sub>   |         | 45      | V    |
| Forward current @ 25 °C  | I <sub>F</sub>   |         | 1.5     | A    |
| RF input power (CW) at T <sub>CASE</sub> = 85 °C                         | P <sub>IN</sub>  |         | 23      | W    |
| RF input power (1 μs pulse, 10% duty cycle) at T <sub>CASE</sub> = 85 °C | P <sub>IN</sub>  |         | 230     | W    |
| CW power dissipation at T <sub>CASE</sub> = 85 °C                        | P <sub>DIS</sub> |         | 1       | W    |
| Storage temperature  | T <sub>STG</sub> | −65     | +150    | °C   |
| Operating temperature  | T <sub>OP</sub>  | −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 ( $T_{op} = 25^\circ\text{C}$ ,  $Z_0 = 50 \Omega$ , 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          | $\Theta_{JC}$ | 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.

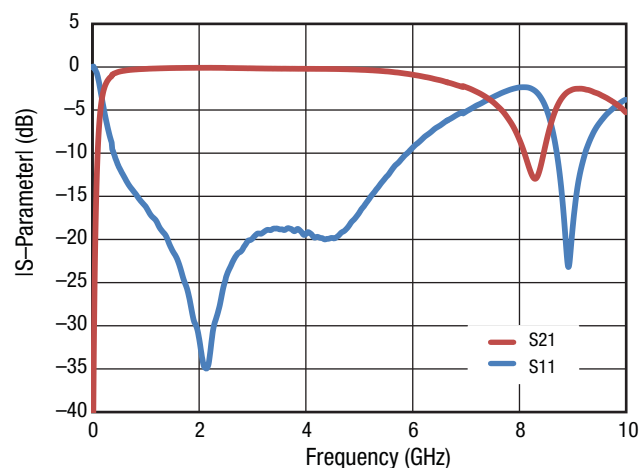


Figure 3. Small Signal Performance

## 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.

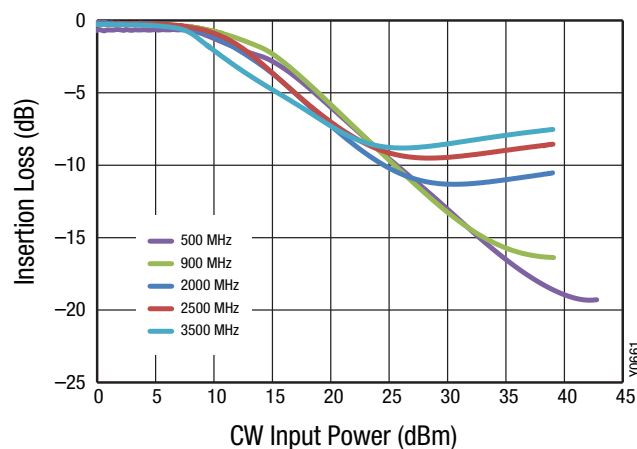


Figure 4. Insertion Loss vs CW Input Power vs Frequency

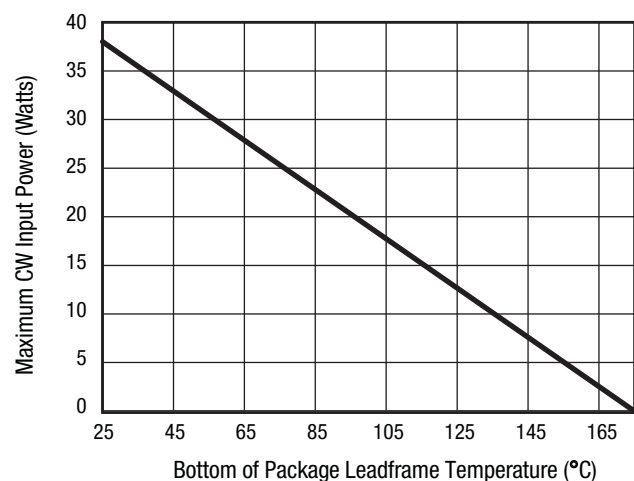


Figure 5. Power De-rating Curve (Insertion Loss = 0.2 dB) vs Temperature on Bottom of Package Leadframe

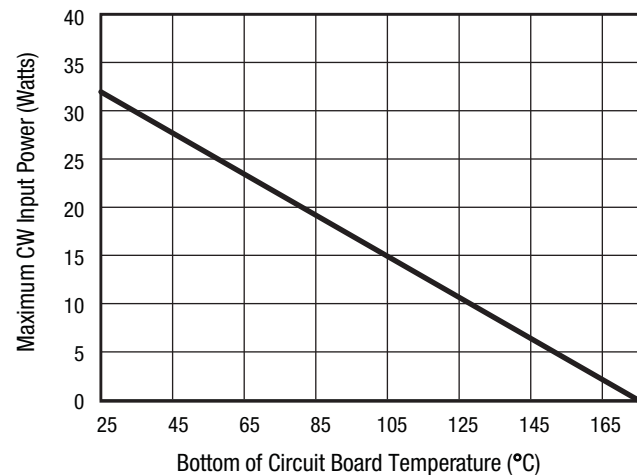


Figure 6. Power De-rating Curve (Insertion Loss = 0.2 dB) vs Temperature on Bottom of EVB Circuit Board

## 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

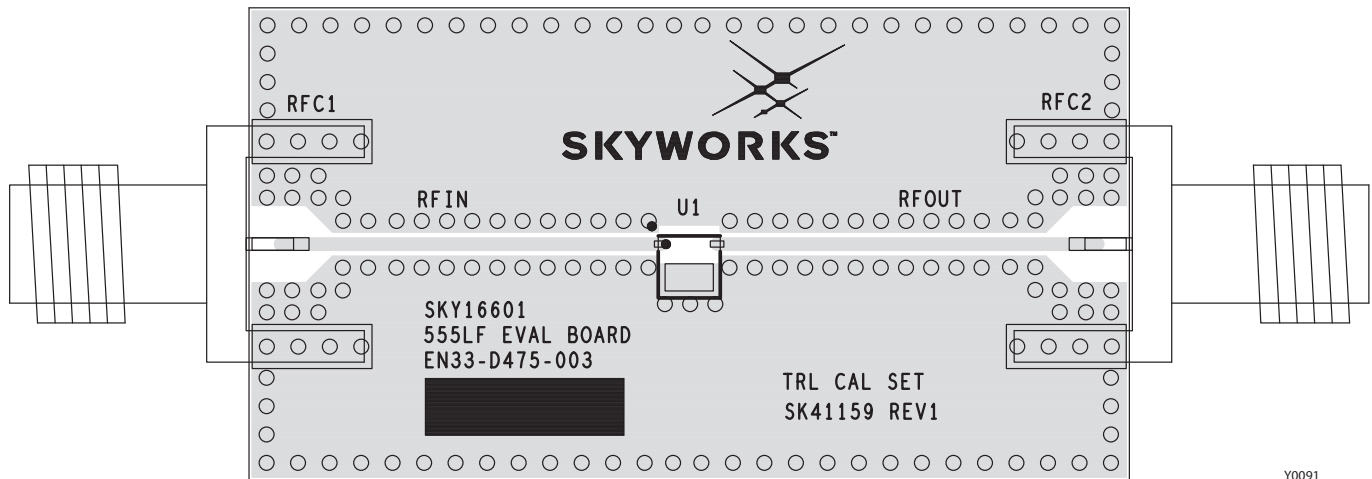
The PCB layout footprint for the SKY16601-555LF is shown in Figure 9. Typical case markings are noted in Figure 10. Package dimensions for the 2 pin MLP are shown in Figure 11, and tape and reel dimensions are provided in Figure 12.

## 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.

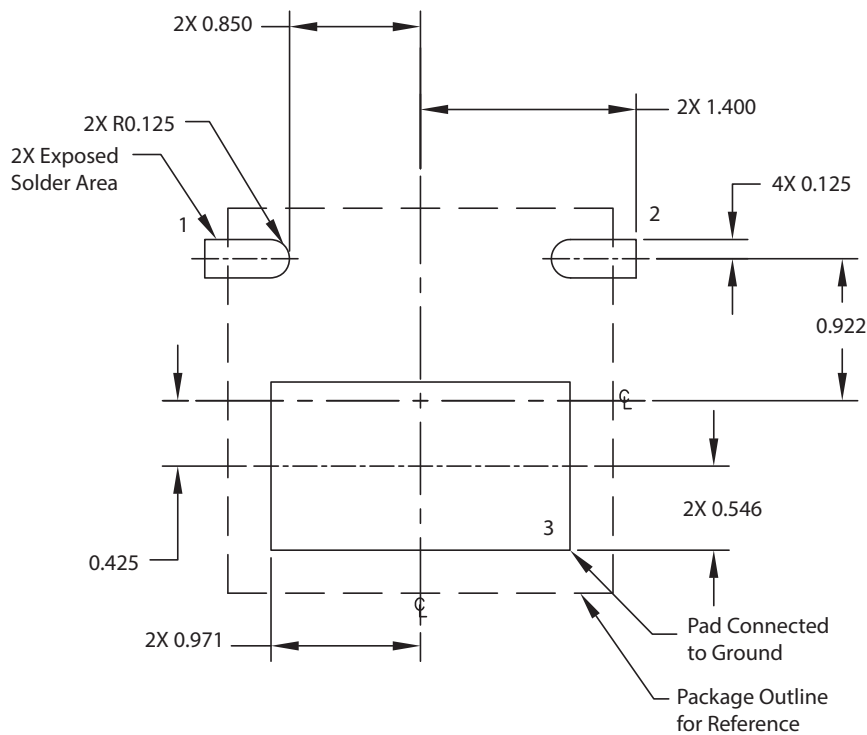


**Figure 7. SKY16601-555LF Evaluation Board Assembly Diagram**

| 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 |                |                     |

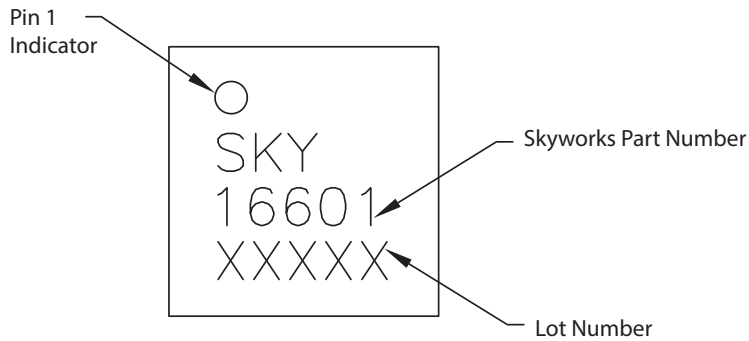
Note 1: Adjust this thickness to meet total thickness goal of 0.062 ± 0.005 inches. S2531

Figure 8. Board Layer Detail Physical Characteristics



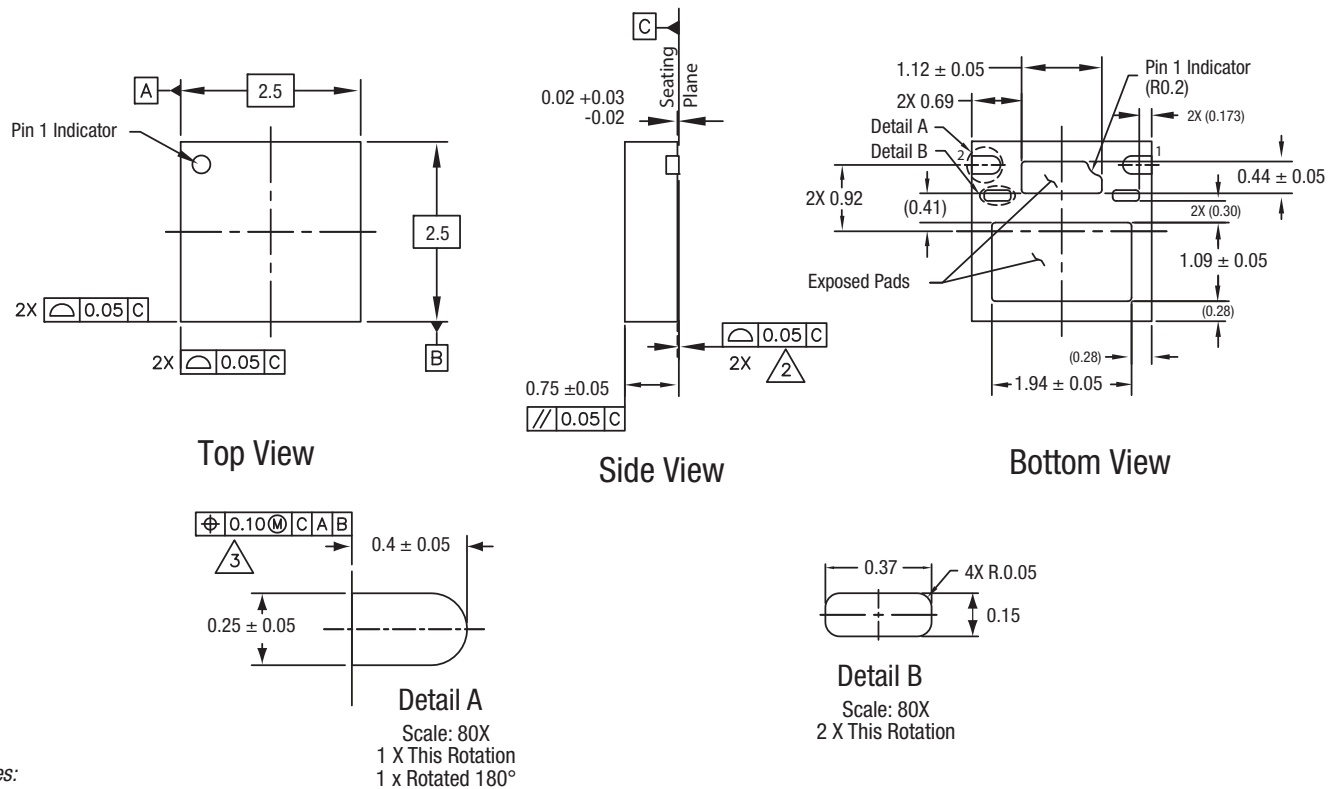
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Figure 9. SKY16601-555LF PCB Layout Footprint



Y0090

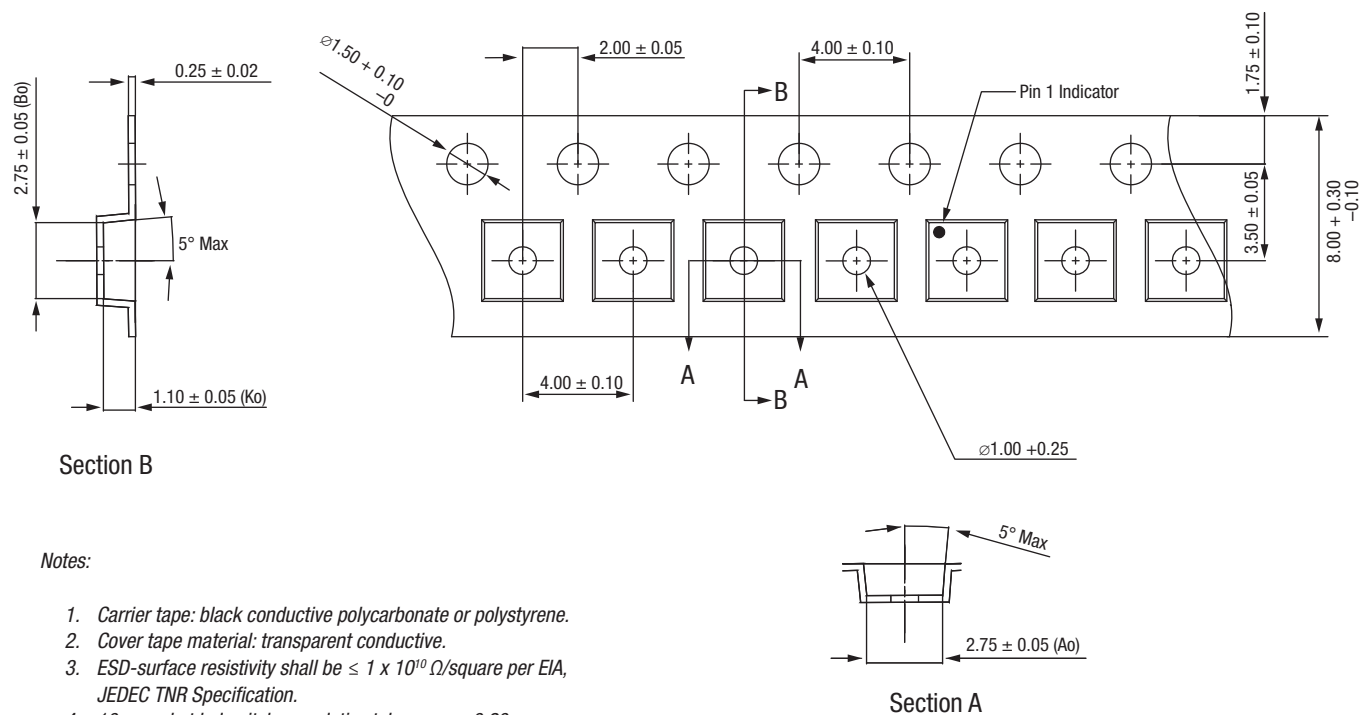
**Figure 10. SKY16601-555LF Typical Case Markings**



Y0093

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

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Y0796

**Figure 12. SKY16601-555LF Tape and Reel Dimensions**

**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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