

DATA SHEET

SKY16602-632LF: Low-Threshold PIN Diode Limiter 0.2 to 4.0 GHz

Applications

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

Features

- Optimized for 0.2 to 4.0 GHz operation
- Low limiting threshold (+5 dBm typical)
- Low insertion loss
- Low distortion
- Integrated PIN limiter and Schottky diodes, and DC blocks
- DFN (2-pin, 2.3 x 2.3 mm) Pb-free package, (MSL1, 260°C per JEDEC J-STD-020)

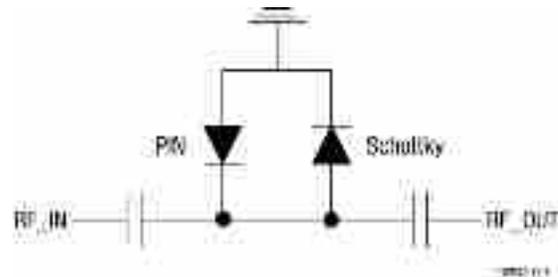


Figure 1. SKY16602-632LF Block Diagram

Description

The SKY16602-632LF 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 4 GHz. It features a low limiting threshold, low-insertion loss, and low distortion in a Dual Flat No Lead (DFN) package.

The SKY16602-632LF module is comprised of a PIN limiter diode, a Schottky diode, and 2 DC blocking caps at the RF ports in a 2-lead DFN. The small package design reduces printed circuit board area. The module can be tuned using external surface mount technology (SMT) components for optimal narrow band performance over the 0.2 to 4.0 GHz operating range.

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.



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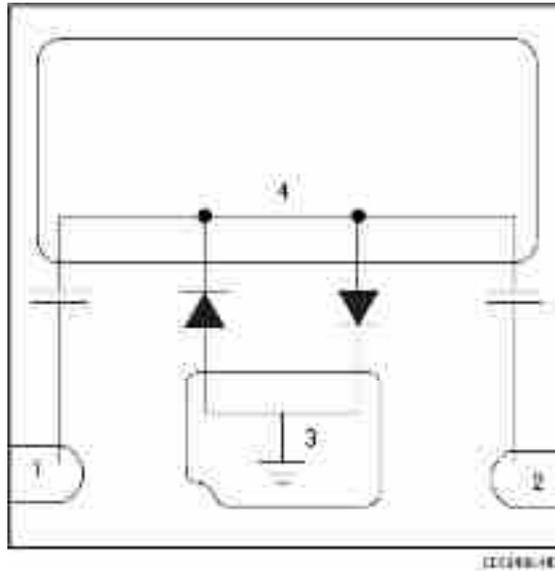


Figure 2. SKY16602-632LF Pinout (Top View)

Table 1. SKY16602-632LF 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) |

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY16602-632LF are provided in Table 2. Electrical specifications for the un-tuned limiter module are provided in Table 3, and typical performance characteristics are illustrated in Figures 4 and 5. Electrical specifications for the 2.45 GHz tuned limiter module are provided in Table 4, and typical performance characteristics are illustrated in Figures 6 and 7.

Figures 8 and 9 show the power derating curves for the limiter. In Figure 8, the temperature is referenced to the bottom of the DFN package. The power derating curve with the temperature referenced to the bottom of the printed circuit board is shown in Figure 9.

Table 2. SKY16602-632LF Absolute Maximum Ratings¹

| Parameter | Symbol | Minimum | Maximum | Unit |
|---|------------------|---------|---------|------|
| RF input power (CW) at T _{CASE} = 85°C | P _{IN} | | 12 | W |
| RF input power (1 μs pulse, 10% duty cycle) at T _{CASE} = 85°C | P _{IN} | | 120 | W |
| CW power dissipation at T _{CASE} = 85°C | P _{DIS} | | 0.4 | 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), Class 1B | | | 250 | V |
| Machine Model (MM), Class A | | | 150 | V |

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.

ESD HANDLING: *Although this device is designed to be as robust as possible, electrostatic discharge (ESD) can damage this device. This device must be protected at all times from ESD when handling or transporting. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD handling precautions should be used at all times.*

Table 3. SKY16602-632LF Electrical Specifications (Untuned Circuit, Reference Figure 1)
(T_{OP} = 25°C, Z₀ = 50 Ω, as Measured in Skyworks Evaluation Board Optimized for Operation at 0.2 to 4.0 GHz, Unless Otherwise Noted)

| Parameter | Symbol | Condition | Frequency | Min | Typ | Max | Units |
|---------------------------------------|--------------------|---------------------------|-----------|-----|-----|-----|-------|
| Reverse voltage | V _R | | | | | 20 | V |
| Forward current | I _F | | | | | 50 | mA |
| Insertion loss | I _L | P _{IN} = 0 dBm | 0.90 GHz | | 0.3 | 0.5 | dB |
| Return loss | R _L | P _{IN} = 0 dBm | 0.90 GHz | | 14 | | dB |
| Threshold level | T _L | P _{1dB} | 0.90 GHz | 5.3 | 6.0 | 6.7 | dBm |
| Saturated CW input power ¹ | P _{IN_CW} | | 0.90 GHz | | 30 | | dBm |
| Flat leakage power ² | F _L | P _{IN} = +10 dBm | 0.90 GHz | | 6 | | dBm |
| Recovery time ³ | t _R | | 0.90 GHz | | 5 | | ns |
| Thermal resistance | θ _{JC} | Junction-to-case | | | 114 | | °C/W |

¹ Saturated CW input power is defined as the point where the diode series resistance does not change with the rectified current. As the input power increases past this point, output power will increase until the diode reaches its max power limit.

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.

³ 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 μs pulse width and 0.1% duty factor.

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 SKY16602-632LF has a lower threshold level over a traditional self-bias limiter circuit with an inductor for a ground return. It accomplishes this by adding a basic PIN limiter diode (pin 1) in parallel to a Schottky diode (pin 2). The low turn on voltage of the Schottky diode reduces the threshold level while the PIN limiter diode protects the Schottky diode at higher power levels. Therefore, for maximum RF power handling, the RF input signal is required to be connected to Pin 1. The two internal DC input/output capacitors provide DC blocking needed for most applications.

Tuned Circuit

The module may be RF tuned for optional RF match and insertion loss centered at a target frequency within its normal band of operation. This is done with the use of external surface mount components. The schematic diagram in Figure 3 shows the SKY16602-632LF limiter with a shunt connected capacitor and inductor tuned for 2.45 GHz. The Bill of Materials for the 2.45 GHz tuned circuit is shown in Table 4. Electrical specifications for the 2.45 GHz tuned limiter module are provided in Table 5.

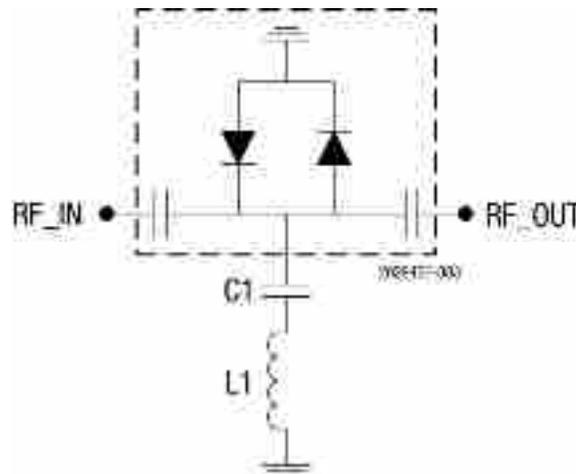


Figure 3. SKY16602-632LF Schematic with External Tuning Networks Optimized for 2.45 GHz

Table 4. Evaluation Board Bill of Materials for EN33-D946-001 (2.45 GHz Tuned Circuit)

| Component | Value | Size | Manufacturer | Mfr. Part Number | Characteristics |
|-----------|--------|------|--------------|------------------|---------------------------|
| C1 | 15 pF | 0402 | Murata | GRM1555C1H150J | COG, 50 V |
| L1 | 2.2 nH | 0402 | Taiyo Uden | HK10052N2S | 300 mA, R = 0.13 Ω |

**Table 5. SKY16602-632LF Electrical Specifications (Tuned to 2.45 GHz Operation, Reference Figure 3)
(T_{OP} = 25°C, Z₀ = 50 Ω , as Measured in Skyworks Evaluation Board Optimized for Operation at 2.45 GHz, Unless Otherwise Noted)**

| Parameter | Symbol | Condition | Frequency | Min | Typ | Max | Units |
|---------------------------------------|--------------------|--|-----------|-----|-----|-----|-------|
| Insertion loss | I _L | P _{IN} = 0 dBm | 2.45 GHz | | 0.5 | | dB |
| Return loss | R _L | P _{IN} = 0 dBm | 2.45 GHz | | 25 | | dB |
| Threshold level | T _L | P1dB | 2.45 GHz | | 5 | | dBm |
| Saturated CW input power ¹ | P _{IN_CW} | | 2.45 GHz | | 23 | | dBm |
| Flat leakage power ² | F _L | P _{IN} = +10 dBm | 2.45 GHz | | 4 | | dBm |
| Input third order intercept | IIP3 | P _{IN} = -10 dBm/tone, spacing = 10 MHz | 2.45 GHz | | 21 | | dBm |
| Recovery time ³ | t _R | | 2.45 GHz | | 5 | | ns |
| Thermal resistance | θ_{JC} | Junction to case | | | 114 | | °C/W |

¹ Saturated CW input power is defined as the point where the diode series resistance does not change with the rectified current. As the input power increases past this point, output power will increase until the diode reaches its max power limit.

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.

³ 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 μ s pulse width and 0.1% duty factor.

Typical Performance Characteristics
 (TOP=25 °C, Characteristic Impedance = 50 Ω)

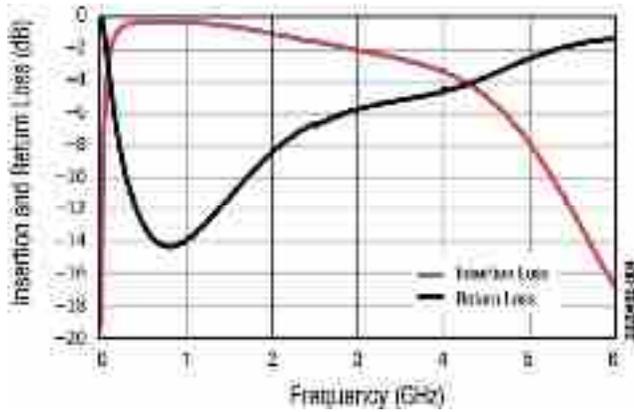


Figure 4. Small Signal Performance without External Tuning

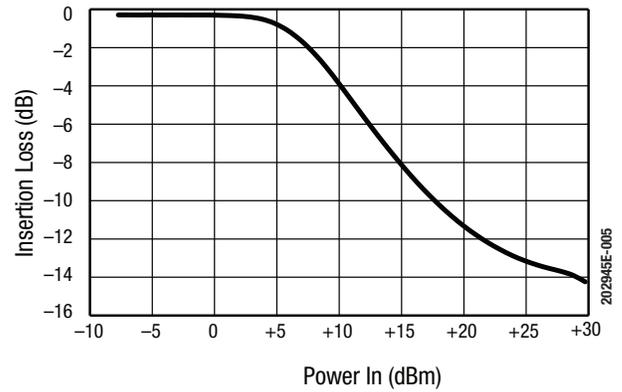


Figure 5. Insertion Loss vs CW Input Power at 0.90 GHz without External Tuning

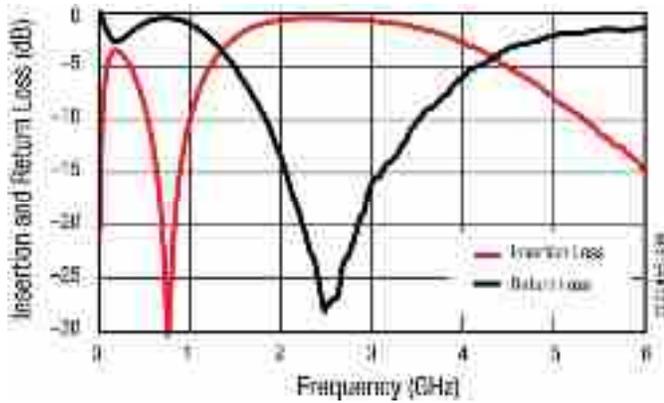


Figure 6. Small Signal Performance with External Tuning Networks Optimized for 2.45 GHz

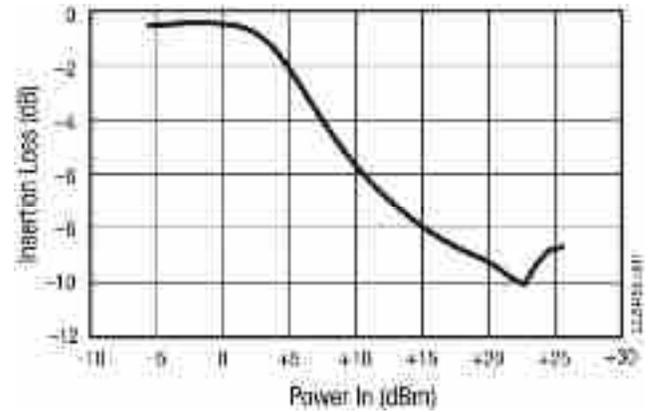


Figure 7. Insertion Loss vs CW Input Power at 2.45 GHz (Tuned Circuit)

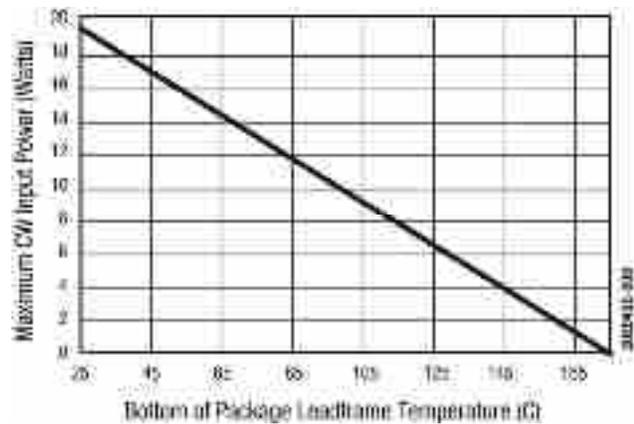


Figure 8. Power Derating Curve (Insertion Loss = 0.3 dB) vs Temperature on Bottom of Package Leadframe

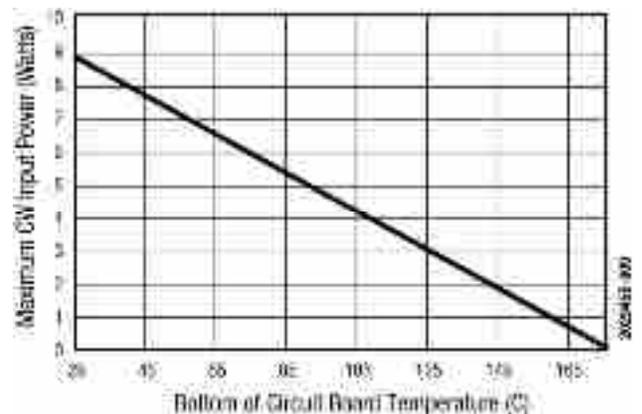


Figure 9. Power Derating Curve (Insertion Loss = 0.3 dB) vs Temperature on Bottom of EVB Circuit Board

Evaluation Board Description

The SKY16602-632LF Evaluation Boards are used to test the performance of the limiter. Assembly drawings for the Evaluation Boards are shown in Figures 10 and 11. The Evaluation Board layer detail is provided in Figure 12.

Package Dimensions

The PCB layout footprint for the SKY16602-632LF is shown in Figure 13. Typical part markings are noted in Figure 14. Package dimensions are shown in Figure 15, and tape and reel dimensions are provided in Figure 16.

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 SKY16602-632LF 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.

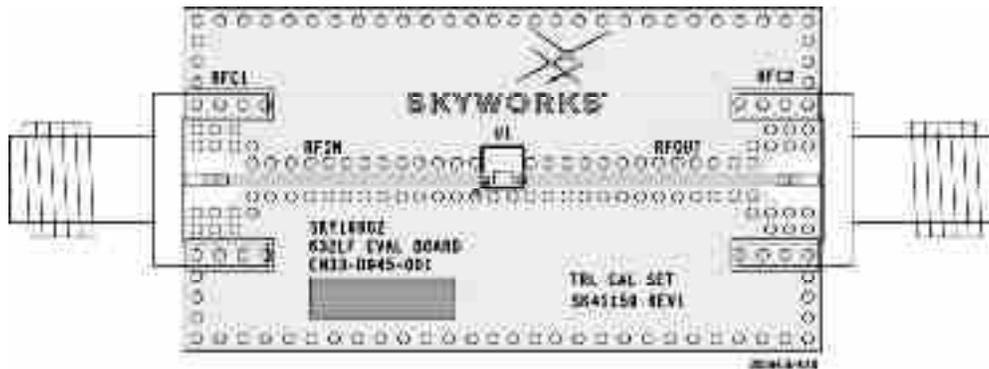


Figure 10. SKY16602-632LF Evaluation Board Assembly Diagram

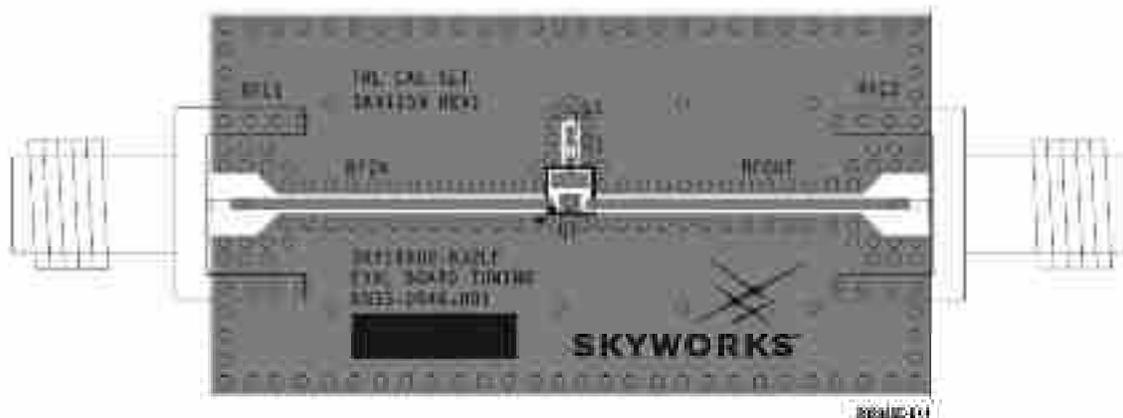
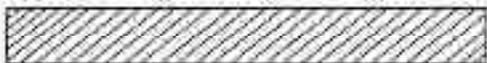
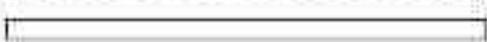


Figure 11. SKY16602-632LF Evaluation Board Assembly Diagram (Tuned Circuit)

| Cross Section | Name | Thickness (in) | Material |
|---|--------------------|----------------|---------------------|
|  | Top Solder mask | | |
|  | L1 | (0.0020) | Cu foil |
|  | Laminate | 0.012 ± 0.0005 | Rogers RO4003C Core |
|  | L2 | (0.0014) | Cu foil |
|  | Laminate | (Note 1) | FRI Prepreg |
|  | L3 | (0.0014) | Cu foil |
|  | Laminate | 0.010 ± 0.0005 | FRI Core |
|  | L4 | (0.0020) | Cu foil |
|  | Bottom Solder mask | | |

Note 1: Adjust the thickness to meet total thickness goal of 0.562 ± 0.005 inches.

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Figure 12. Board Layer Detail Physical Characteristics

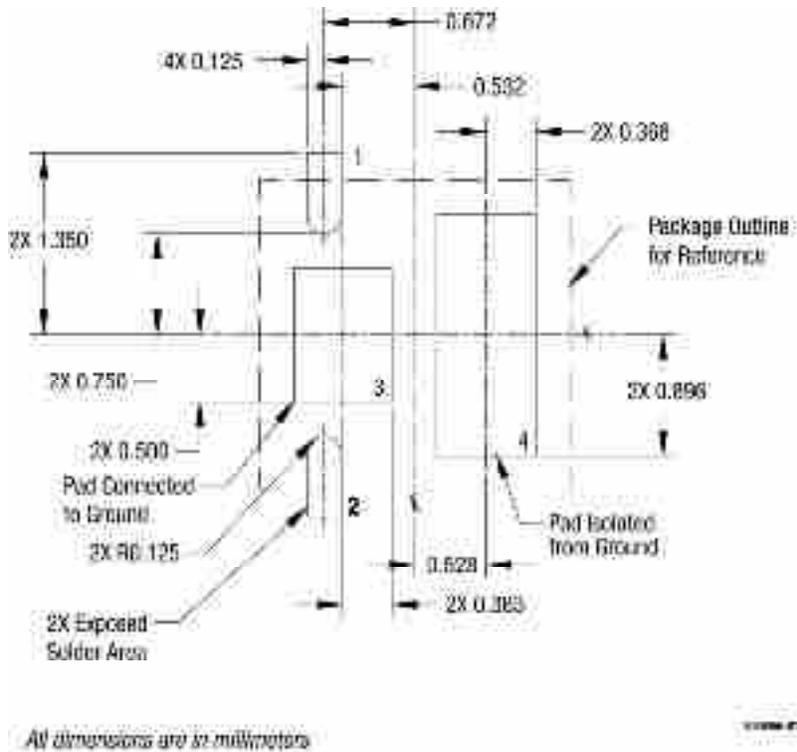


Figure 13. SKY16602-632LF PCB Layout Footprint



Figure 14. SKY16602-632LF Typical Part Markings

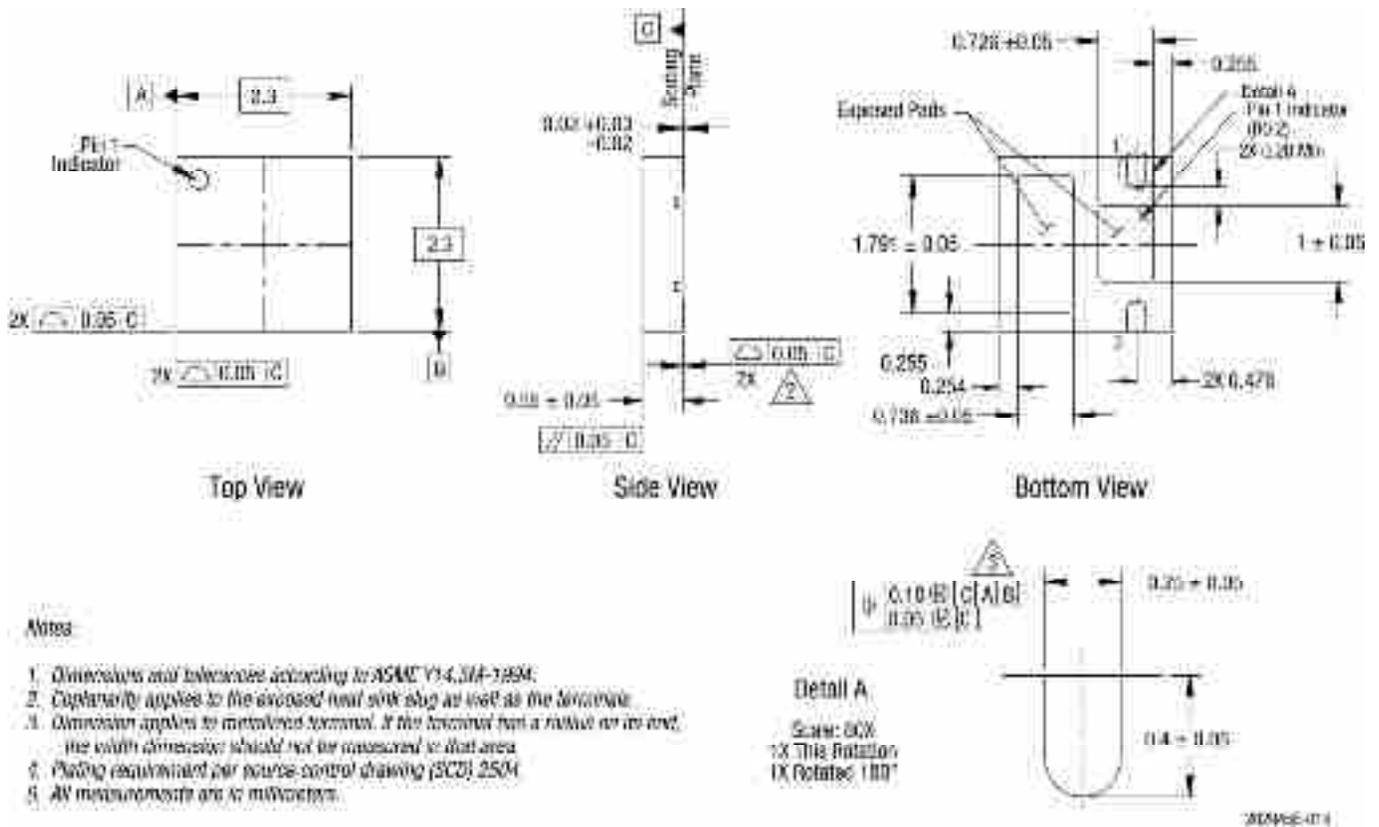


Figure 15. SKY16602-632LF Package Dimensions

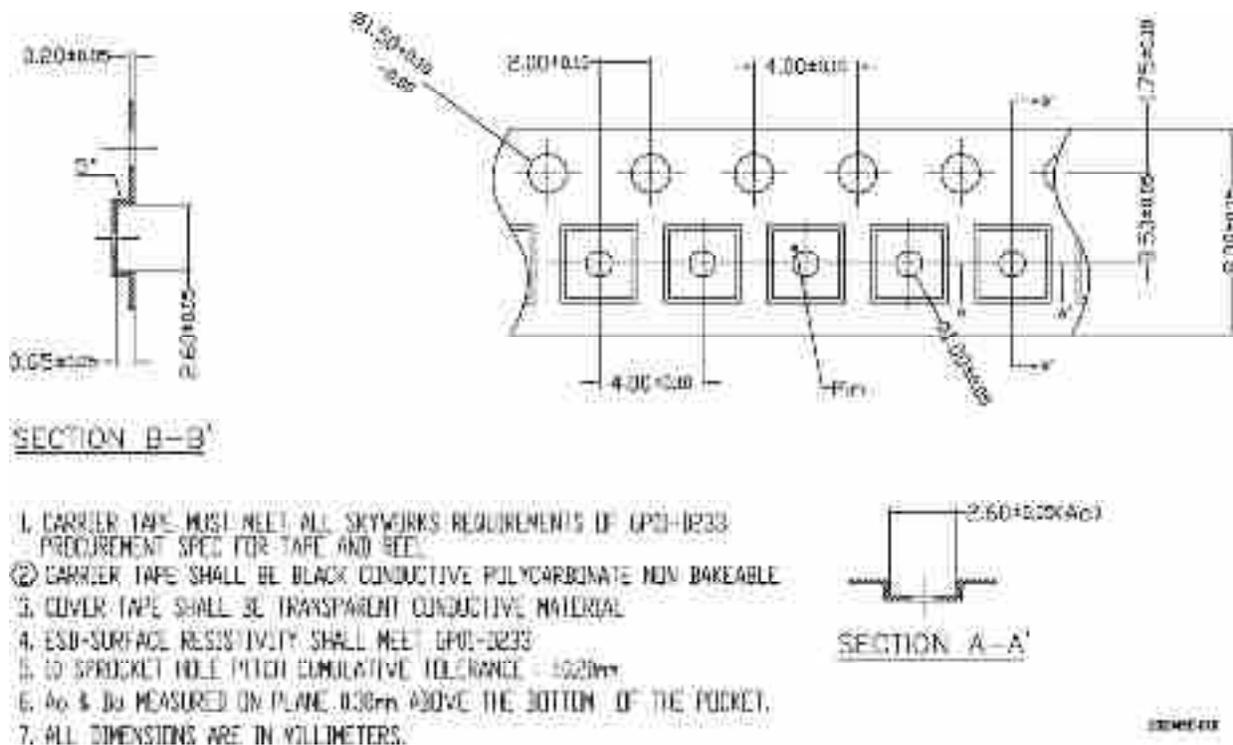


Figure 16. SKY16602-632LF Tape and Reel Dimensions

Ordering Information

| Part Number | Product Description | Evaluation Board Part Number |
|----------------|---------------------------------|------------------------------|
| SKY16602-632LF | Low-Threshold PIN Diode Limiter | SKY16602-632LF-EVB |

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