

PRELIMINARY DATA SHEET

# SMP1302-087LF: Surface-Mount PIN Diode

## Applications

- Low-loss, high-power switches
- Low-distortion attenuators

## Features

- High RF power handling: 125 W
- Low thermal resistance: 22 °C/W
- Low series resistance: 1.5  $\Omega$  maximum @ 100 mA
- Low total capacitance: 0.35 pF maximum @ 30 V
- Small QFN (2 x 2 mm) package (MSL1, 260 °C per JEDEC J-STD-020)



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## Description

The SMP1302-087LF is a surface-mountable, low-capacitance silicon PIN diode designed as a series-connected PIN diode for high-power, high-volume switch and attenuator applications from 10 MHz to beyond 6 GHz.

Maximum resistance at 100 mA is 1.5  $\Omega$  and maximum capacitance at 30 V is 0.35 pF. The combination of low capacitance, low parasitic inductance, and nominal 50  $\mu$ m I-region width, makes the SMP1302-087LF useful in large signal switches and attenuator applications.

The device has a 1 W dissipation power rating, which makes it capable of handling up to 125 W @ 25 °C Continuous Wave (CW) in a series-connected transmit/receive (T/R) switch.

Design information for high power switches may be found in the Skyworks Application Note, *Design With PIN Diodes* (document number 200312).

**Table 1. SMP1302-087LF Absolute Maximum Ratings**

| Parameter  | Symbol           | Minimum | Maximum             | Units       |
|--|------------------|---------|---------------------|-------------|
| Forward current  | I <sub>F</sub>   |         | 200                 | mA          |
| Reverse voltage  | V <sub>R</sub>   |         | 200                 | V           |
| Dissipated power @ 85 °C   | P <sub>D</sub>   |         | 1                   | W           |
| Peak pulse power dissipation @ 85 °C (10% duty cycle)  |                  |         | 10                  | W           |
| Operating temperature  | T <sub>A</sub>   | -55     | +85                 | °C          |
| Storage temperature  | T <sub>STG</sub> | -55     | +200                | °C          |
| Junction temperature   | T <sub>J</sub>   | -55     | +175                | °C          |
| Electrostatic discharge:<br>Charged-Device Model (CDM), Class 4<br>Human Body Model (HBM), Class 1C<br>Machine Model (MM), Class C | ESD              |         | 1100<br>1000<br>400 | V<br>V<br>V |

**Note:** 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 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. 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 used at all times.

**Table 2. SMP1302-087LF Electrical Specifications (Note 1)**  
(T<sub>A</sub> = +25 °C, Unless Otherwise Noted)

| Parameter                   | Symbol            | Test Condition  | Min | Typical | Max  | Units |
|-----------------------------|-------------------|---|-----|---------|------|-------|
| Forward voltage             | V <sub>F</sub>    | I <sub>F</sub> = 10 mA                                      |     | 0.80    |      | V     |
| Reverse leakage current     | I <sub>R</sub>    | V <sub>R</sub> = 200 V                                      |     |         | 10   | μA    |
| Series resistance           | R <sub>s1</sub>   | I <sub>F</sub> = 1 mA, f = 100 MHz                          |     | 18.0    |      | Ω     |
|                             | R <sub>s10</sub>  | I <sub>F</sub> = 10 mA, f = 100 MHz                         |     | 2.75    | 3.0  | Ω     |
|                             | R <sub>s100</sub> | I <sub>F</sub> = 100 mA, f = 100 MHz                        |     | 0.95    | 1.5  | Ω     |
| Total capacitance           | C <sub>T30</sub>  | V <sub>R</sub> = 30 V, f = 1 MHz                            |     | 0.25    | 0.35 | pF    |
| Series inductance           | L <sub>s</sub>    |   |     | 0.65    |      | nH    |
| Minority carrier lifetime   | T <sub>L</sub>    | I <sub>F</sub> = 10 mA                                      |     | 700     |      | ns    |
| I region width              | W                 |   |     | 50      |      | μm    |
| Thermal resistance (Note 2) | Θ <sub>JC</sub>   | Junction-to-case  |     | 22      |      | °C/W  |
| Peak thermal resistance     | Θ <sub>P</sub>    | Single, 1 μs pulse width, junction-to-case (10% duty cycle) |     | 2.2     |      | °C/W  |

**Note 1:** Performance is guaranteed only under the conditions listed in this Table.

**Note 2:** Assume a thermal resistance of 90 °C/W for the junction-to-bottom of the circuit board.

### Electrical and Mechanical Specifications

The absolute maximum ratings of the SMP1302-087LF are provided in Table 1. Electrical specifications are provided in Tables 2 and 3.

Typical DC performance characteristics of the SMP1302-087LF are illustrated in Figures 1, 2, and 3. Typical RF performance of the SMP1302-087LF using the schematic shown in Figure 4 is summarized in Table 4 and illustrated in Figures 5, 6, and 7.

The SMP1302-087LF Evaluation Board is used to test the performance of the SMP1302-087LF PIN Diode. An assembly drawing for the Evaluation Board is shown in Figure 8. The layer detail physical characteristics are provided in Figure 9. Refer to Table 3 for the Evaluation Board Bill of Materials.

### Package Dimensions

The PCB layout footprint for the SMP1302-087LF is provided in Figure 10. Typical case markings are shown in Figure 11.

### Typical DC Performance Characteristics

(T<sub>A</sub> = 25 °C, Unless Otherwise Noted)

Package dimensions for the SMP1302-087LF are provided in Figure 12, and tape and reel dimensions are provided in Figure 13.

### 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 SMP1302-087LF 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.

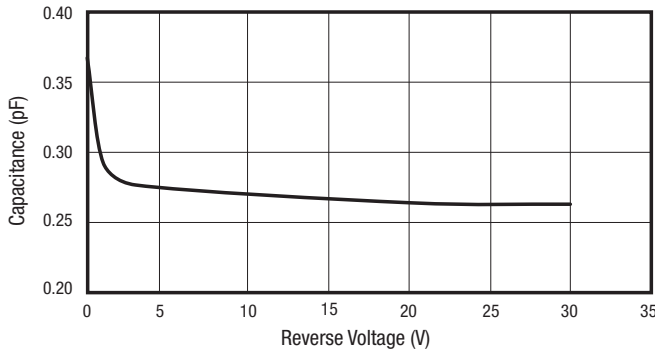


Figure 1. Capacitance vs Reverse Voltage @ 1 MHz

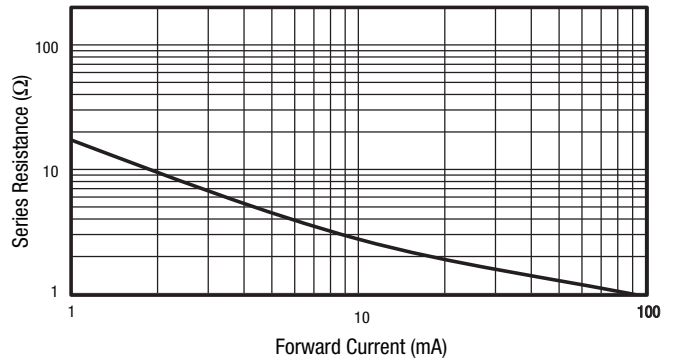


Figure 2. Series Resistance vs Forward Current @ 100 MHz

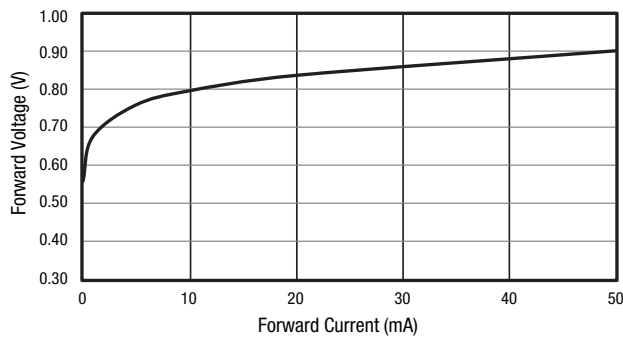


Figure 3. Forward Voltage vs Forward Current

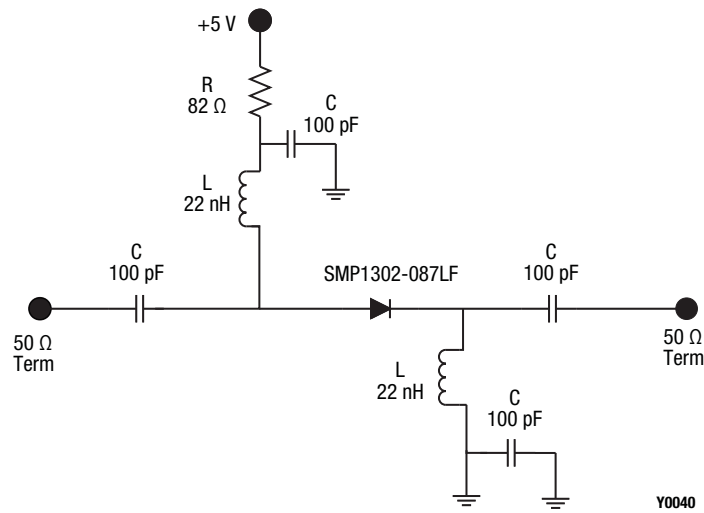


Figure 4. SMP1302-087LF Bias Schematic

Table 3. Evaluation Board Bill of Materials for EN33-D515-01\_V3 (Tuned Circuit)

| Component | Value  | Size | QTY | Manufacturer | Mfg. Part Number  | Characteristics |
|-----------|--------|------|-----|--------------|-------------------|-----------------|
| C         | 100 pF | 0402 | 4   | Murata       | GRM1555C1H101JZ01 | 5% COG 50 V     |
| L         | 22 nH  | 0402 | 2   | Murata       | HK100522NJ-T      | 5%              |
| R         | 82 Ω   | 0402 | 1   | Panasonic    | ERJ2GEJ820X       | 5%, 0.1 W       |

Table 4. Typical RF Performance @ 25 °C, f = 2.6 GHz

| Parameter                      | Typical | Units |
|--------------------------------|---------|-------|
| <b>Un-tuned</b>                |         |       |
| Insertion Loss                 | 0.26    | dB    |
| Return Loss                    | 15.5    | dB    |
| Isolation                      | -10     | dB    |
| <b>With 22 nH Bias Circuit</b> |         |       |
| Insertion Loss                 | 0.38    | dB    |
| Return Loss                    | 10.3    | dB    |
| Isolation                      | -12.6   | dB    |
| Max Power                      | +47     | dBm   |

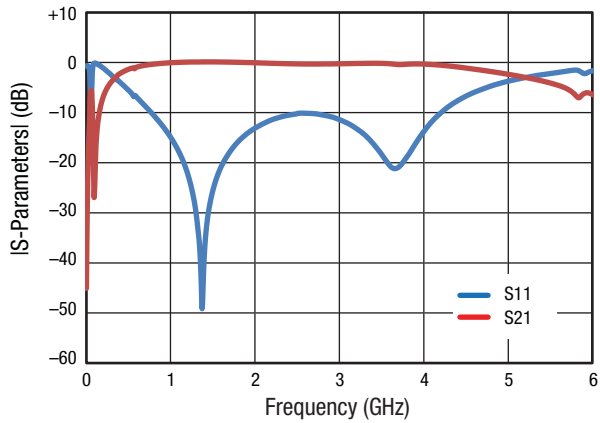


Figure 5. S-Parameter Magnitude vs Frequency  $I_f = 50 \text{ mA}$

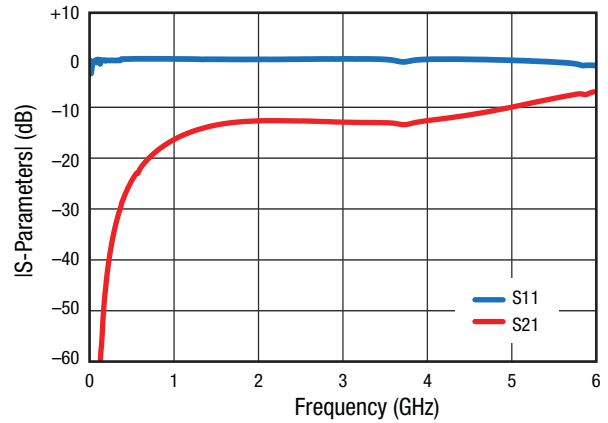


Figure 6. S-Parameter Magnitude vs Frequency  $V_{REV} = -30 \text{ V}$

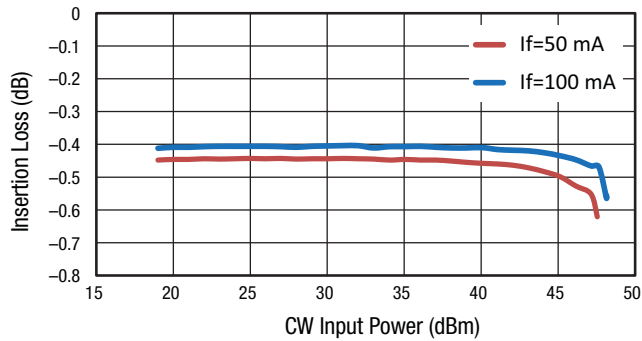


Figure 7. Insertion Loss vs CW Input Power  $f = 2.6 \text{ GHz}$

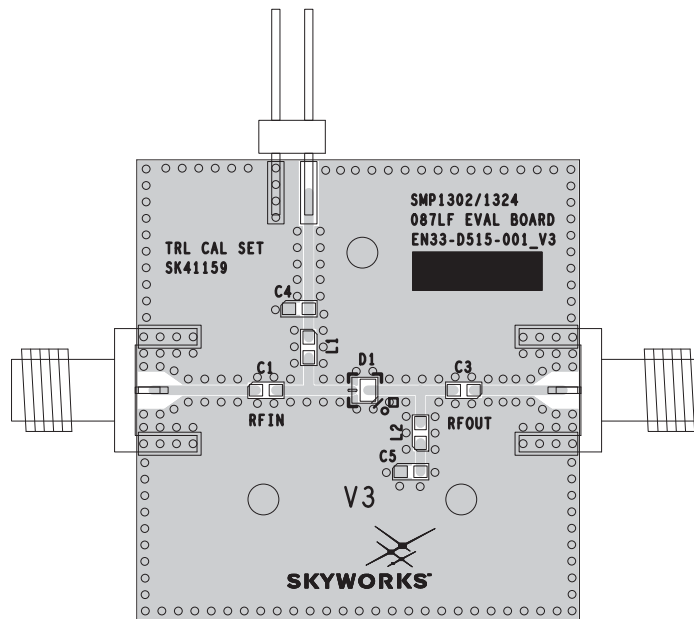


Figure 8. SMP1302-087LF Evaluation Board

| 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 9. Board Layer Detail Physical Characteristics

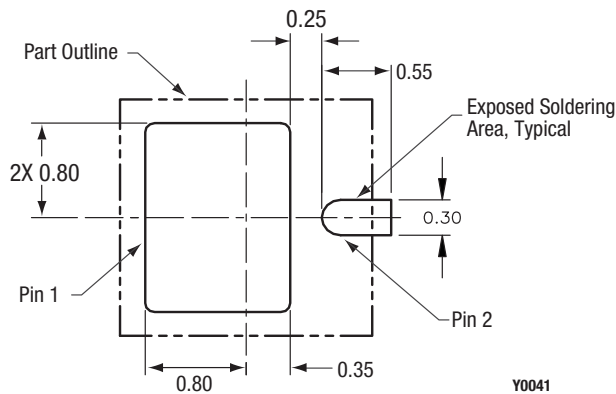


Figure 10. SMP1302-087LF PCB Layout Footprint (Top View)

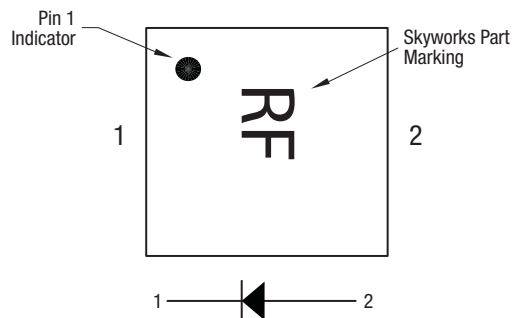
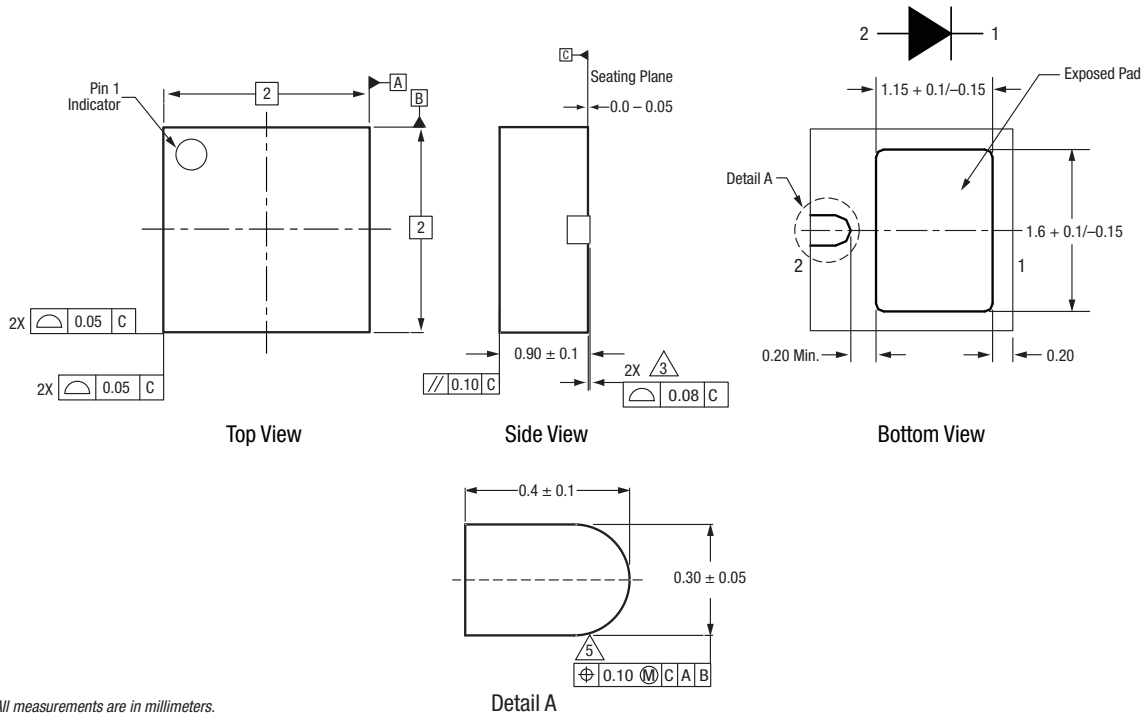


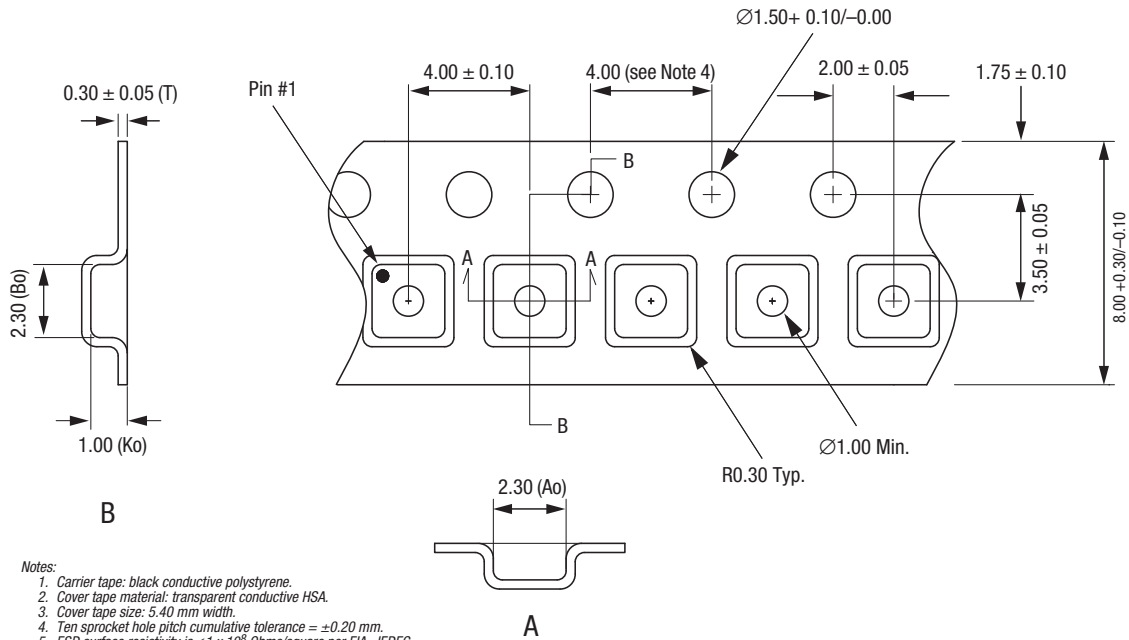
Figure 11. Typical Case Markings (Top View)



All measurements are in millimeters.  
 Dimensioning and tolerancing according to ASME Y14.5M-1994.  
 Coplanarity applies to the exposed heat sink slug as well as the terminals.  
 Dimension applies to metalized terminal and is measured between 0.10 mm and 0.30 mm from terminal tip.

S1989

Figure 12. SMP1302-087LF Package Dimensions



Notes:  
 1. Carrier tape: black conductive polystyrene.  
 2. Cover tape material: transparent conductive HSA.  
 3. Cover tape size: 5.40 mm width.  
 4. Ten sprocket hole pitch cumulative tolerance = ±0.20 mm.  
 5. ESD surface resistivity is  $\leq 1 \times 10^8$  Ohms/square per EIA, JEDEC tape and reel specification.  
 6. Ao and Bo measurement point to be 0.30 mm from bottom pocket.  
 7. All measurements are in millimeters.

S1601

Figure 13. SMP1302-087LF Tape and Reel Dimensions

## Ordering Information

| Model Name                            | Manufacturing Part Number | Evaluation Board Part Number |
|---------------------------------------|---------------------------|------------------------------|
| SMP1302-087LF Surface Mount PIN Diode | SMP1302-087LF             | SMP1302-087LF EVB            |

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