DATA SHEET

SMP1304-085LF: Surface Mount PIN Diode for High Power Switch Applications

Applications

- Low loss, high power switches
- Low distortion attenuators

Features

- Low-thermal resistance: 35 °C/W
- Suitable for 100 W Continuous Wave T/R switches
- Low capacitance: 0.3 pF
- Low distortion performance
- QFN (3-pin, 2 x 2 mm) package (MSL1, 260 °C per JEDEC J-STD-020)

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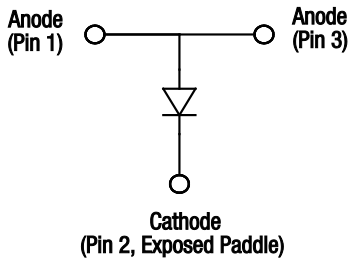


Figure 1. SMP1304-085LF Block Diagram

Description

The SMP1304-085LF is a surface mountable, low capacitance silicon PIN diode designed as a shunt 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 2 Ω and maximum capacitance at 30 V is 0.3 pF. The combination of low junction capacitance, low parasitic inductance, low thermal resistance, and nominal 100 μm I-region width, makes the SMP1304-085LF useful in large signal switches and attenuator applications.

The device has a 2.5 W dissipation power rating, making it capable of handling more than 100 W Continuous Wave (CW) and 1000 W peak (1 μs pulse, 1 percent duty cycle) in a shunt-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).

A block diagram of the SMP1304-085LF is shown in Figure 1.

Table 1. SMP1304-085LF Absolute Maximum Ratings

Parameter	Symbol	Minimum	Maximum	Units
Reverse voltage	V_R		200	V
Forward current @ 25 °C	I_F		1.5	A
CW power dissipation @ 85 °C	P_D		2.5	W
Storage temperature	T_{STG}	–65	+200	°C
Operating temperature	T_A	–40	+150	°C

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. The SMP1304-085LF has been tested as a Class 1C, Human Body Model (HBM) device.*

Table 2. SMP1304-085LF Electrical Specifications (Note 1)
(T_A = +25 °C Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Reverse current	I_R	V_R = 200 V			10	µA
Capacitance	C_T	f = 1 MHz, V_R = 30 V		0.23	0.30	pF
Resistance	R_S	f = 100 MHz				
		I_F = 1 mA		40.00	50.00	Ω
		I_F = 10 mA		5.50	7.00	Ω
		I_F = 100 mA		1.22	2.00	Ω
Forward voltage	V_F	I_F = 10 mA		0.8		V
Carrier lifetime	T_L	I_F = 10 mA		1		µs
I region width	W			100		µm
CW thermal resistance	θ_{JC}	Based on thermal resistance = 92 °C/W for junction-to-bottom of circuit board		35		°C/W

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

Electrical and Mechanical Specifications

The absolute maximum ratings of the SMP1304-085LF are provided in Table 1. Electrical specifications are provided in Table 2.

Typical performance characteristics of the SMP1304-085LF are illustrated in Figures 2 and 3.

Typical Performance Characteristics

(T_A = 25 °C, Unless Otherwise Noted)

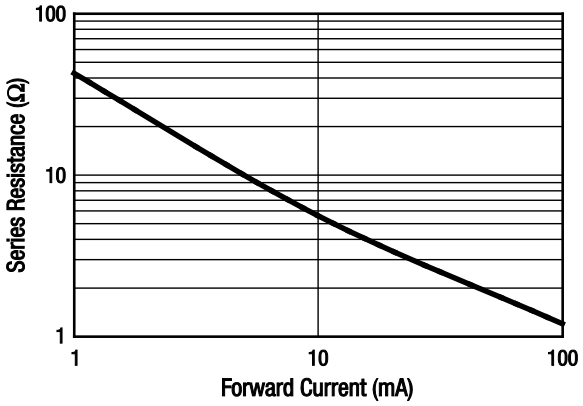


Figure 2. Series Resistance vs Current @ 100 MHz

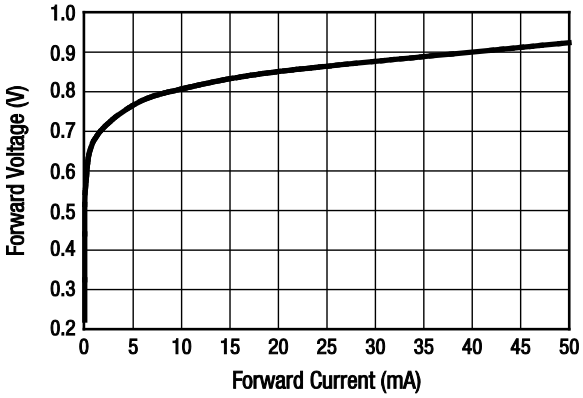


Figure 3. Forward Voltage vs Forward Current

High Power Switch Design Application

The SMP1304-085LF PIN diode is designed for shunt applications such as reflective switches or shunt-diode attenuator circuits. Compared to other surface mount packages, the design of the QFN package produces lower thermal resistance and also reduces the effects of the parasitic inductance of the anode bond wires.

A cross-sectional view of the SMP1304-085LF PIN diode is shown in Figure 4. The cathode of the die is soldered directly to the top of the exposed paddle. This paddle is composed of copper, so its thermal resistance is very low.

The copper ground paddle minimizes the total thermal resistance between the I layer, which is the location where most heat is generated under normal operation, and the surface to which the package is mounted. Minimal thermal resistance between the I layer and the external environment minimizes junction temperature.

The electrically equivalent circuit of the SMP1304-085LF PIN diode is shown in Figure 5. The inductances of pins 1 and 2, as well as the inductances of the bond wires are in series with the input and output transmission lines of the external circuit rather than the portion of the circuit that contains the shunt PIN diode.

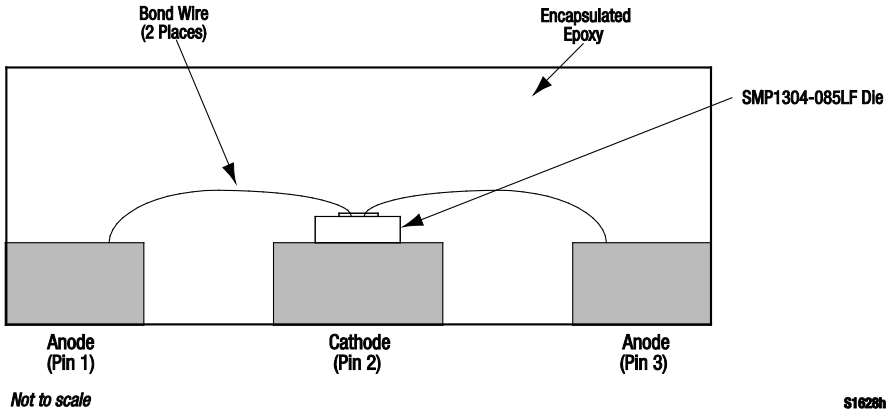


Figure 4. Cross-Sectional View of the SMP1304-085LF

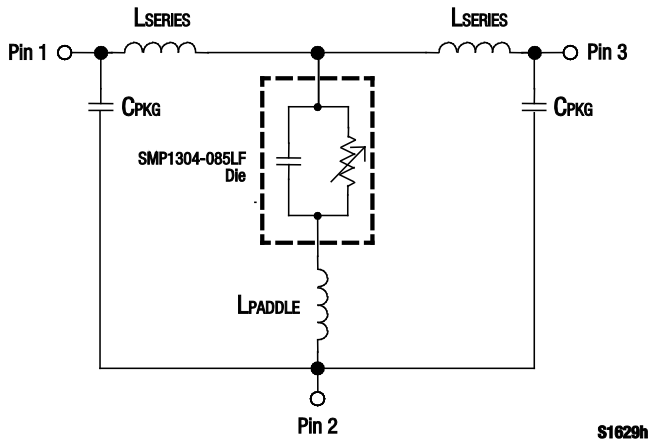


Figure 5. SMP1304-085LF Electrically Equivalent Circuit

The effects of these parasitic series inductances are negligible, since they add a very small insertion loss to the shunt PIN but have no effect on the isolation that the diode produces when it is forward biased.

A cross section of the suggested printed circuit board design is shown in Figure 6. The via shown in this view is critical, both for electrical performance and for thermal performance. It is recommended that several vias should be placed under the entire footprint of the exposed paddle (pin 2) to minimize both electrical inductance to the system ground and thermal resistance to the system heat sink.

A Transmit/Receive Switch Design

A T/R switch incorporating a pair of SMP1304-085LF PIN diodes is shown in Figure 7.

The circuit is based on a quarter wave design using two shunt-connected SMP1304-085LF diodes. In the transmit state, Bias 1 is set at 0 mA and Bias 2 is set at 50 mA. Under these conditions, D1 is held out of conduction so its impedance remains high and a very small insertion loss is introduced to the path between the transmitter port and the antenna port.

D2 is forced into conduction, which lowers its series resistance towards its minimum value of $<1\ \Omega$. In this state, energy that propagates from either the transmitter port or the antenna port is reflected, which isolates the receiver port from the remainder of the circuit.

The quarter wave line connected between D2 and the antenna port transforms the very low impedance of the diode to a very high impedance looking from the antenna port towards the receive port. This produces minimal insertion loss in the transmitter-to-antenna path.

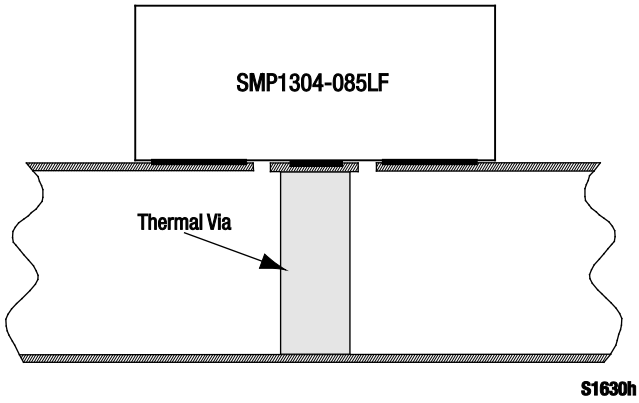


Figure 6. Cross-Sectional View of Suggested Printed Circuit Board

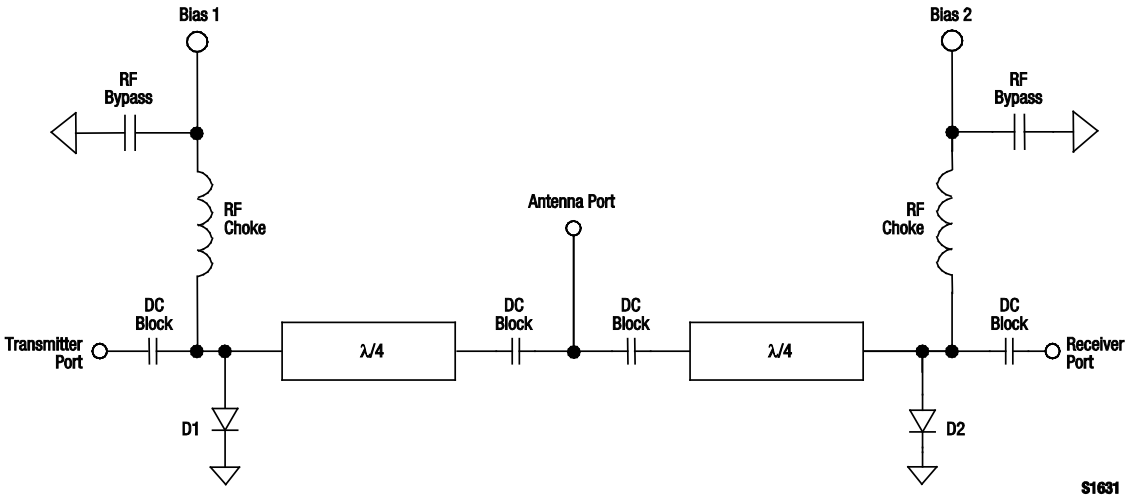


Figure 7. T/R Switch Design

The operation of the T/R switch in the receive state is the converse of the operation in the transmit state: the transmitter port is isolated from the antenna port and the antenna and receive ports are connected to each other using a low-insertion-loss path.

Package Dimensions

The PCB layout footprint for the SMP1304-085LF is shown in Figure 8. Typical case markings are shown in Figure 9. Package dimensions for the 3-pin QFN are provided in Figure 10, and Figure 11 provides the tape and reel dimensions.

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 SMP1304-085LF 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.

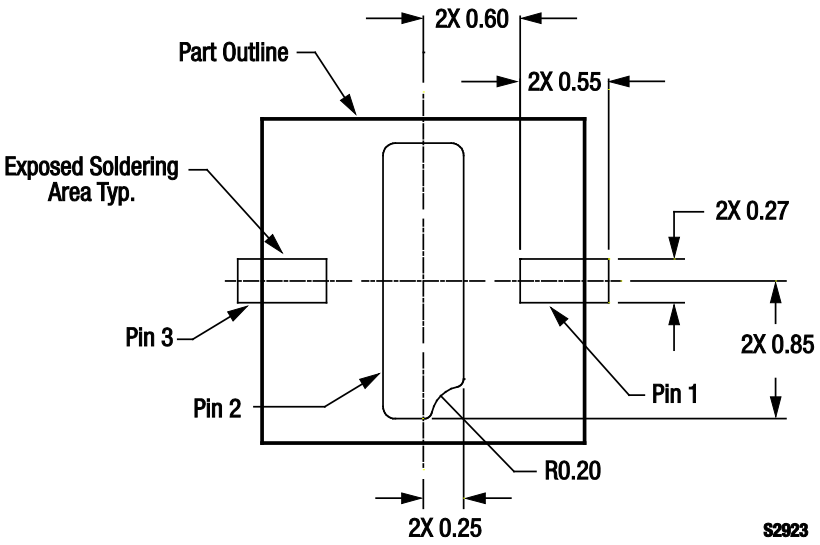


Figure 8. SMP1304-085LF PCB Layout Footprint

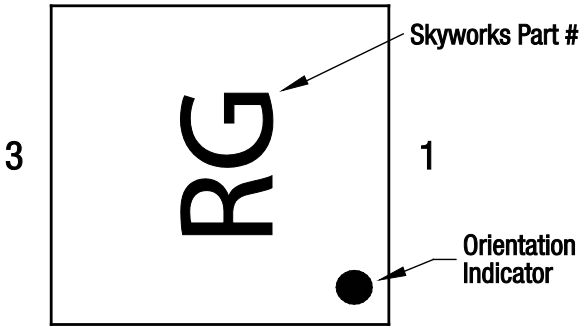


Figure 9. Typical Case Markings
(Top View)

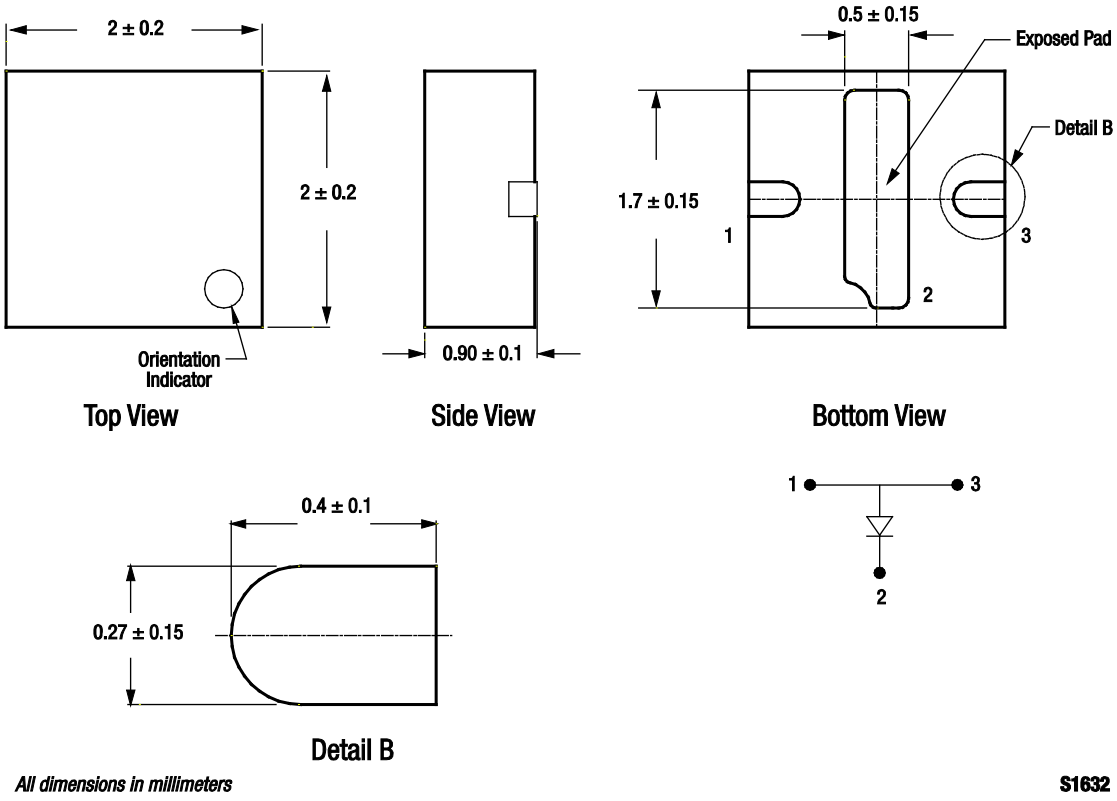
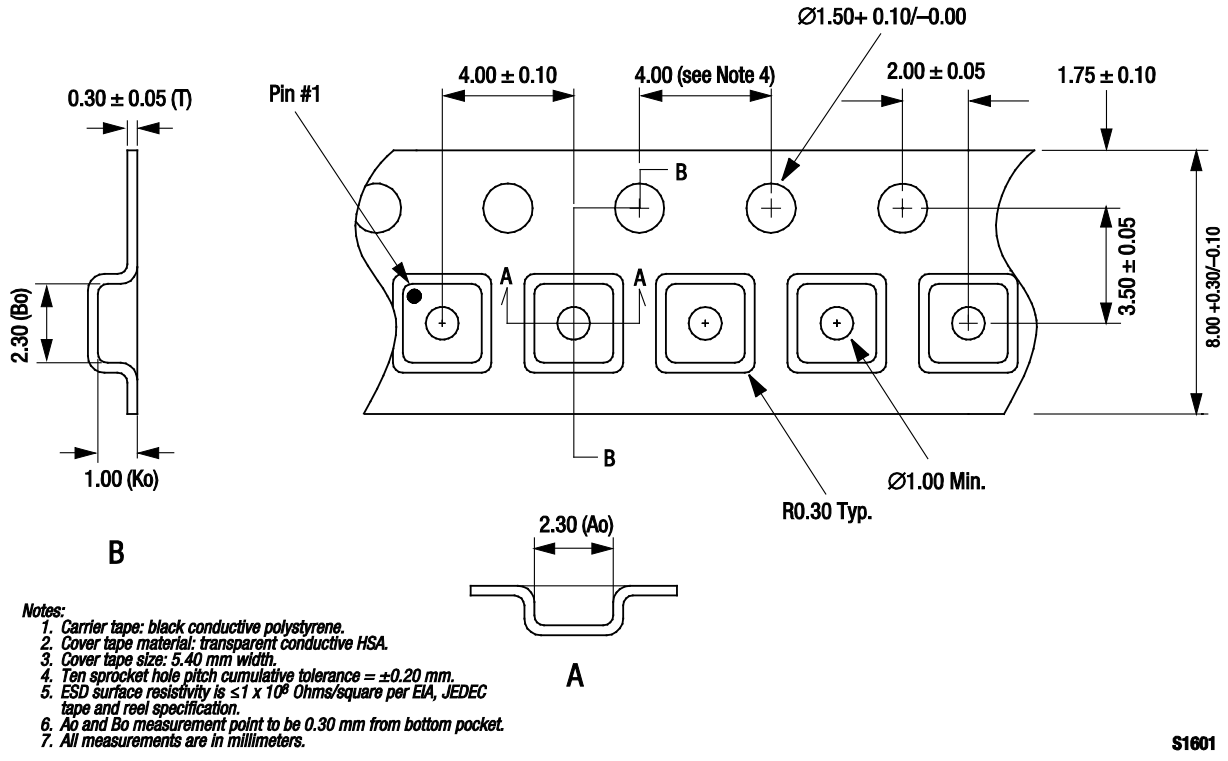


Figure 10. SMP1304-085LF QFN Package Dimension Drawing



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 ≤1 x 10^6 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.*

Figure 11. SMP1304-085LF Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number
SMP1304-085LF Surface Mount PIN Diode	SMP1304-085LF

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