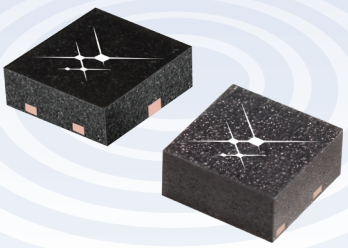
Applications

- Series/shunt elements in high power HF/VHF/UHF transmit/receive (T/R) switches

Features

- Very low thermal resistance for excellent power handling: 40 Ω C/W typical
- Low series resistance
  - SMP1324-087LF: 0.4 Ω @ 50 mA
  - SMP1371-087LF: 0.5 Ω @ 10 mA
  - SMP1302-085LF: 1.5 Ω @ 100 mA
- Suitable as series elements in high power switches
  - SMP1324-087LF: 35 W CW
  - SMP1371-087LF: 23 W CW
  - SMP1345-087LF: 10W CW
- Suitable as shunt elements in high power switches
  - SMP1302-085LF: 50 W CW
- Excellent distortion performance
- Lead (Pb)-free, RoHS-compliant, Green™ QFN 2 x 2 mm packages
- ESD Class 1 C, human body model



High Power PIN Diodes

Description

Skyworks' SMP1324-087LF, SMP1371-087LF and SMP1302-085LF PIN diodes are designed for use in high-power-handling switches from 1–900 MHz. SMP1324-087LF and SMP1371-087LF are optimized for use as series diodes. SMP1302-085LF is optimized for use as a shunt diode. Due to their thermally-enhanced package designs, these diodes have very low thermal resistance which enables them to handle very large input power.

WEB The SMP1345-087LF is ideally suited for use as a high isolation, series switching element. The SMP1345-087LF has a 10 micron nominal I layer thickness, which enables it to switch impedance very rapidly while handling large input signals, when the exposed paddle of the diode is connected to a printed circuit board which provides an adequately large thermal conductance to a heatsink to maintain the die temperature to be less than 150 °C. Minority carrier lifetime is 100 ns typical, series resistance at 10 mA bias current is 1.5 Ω typical and total capacitance is less than 0.2 pF maximum.

WEB The SMP1371-087LF has a 12 micron nominal I layer thickness, which enables it to handle input signals up to 23 W CW when the device is mounted as a series element in a switch built on a printed circuit board which has a relatively high thermal conductance, such as Rogers 5880. In the identical circuit constructed on FR4 printed circuit board material the maximum input power is 20 W CW. Minority carrier lifetime is 200 ns minimum, series resistance at 10 mA bias current is 0.5 Ω maximum and total capacitance is 0.9 pF typical. The SMP1371-087LF is rated to dissipate 2 W maximum.

WEB The SMP1324-087LF has a 100 micron nominal I layer thickness, which enables it to handle input signals up to 35 W CW when the device is mounted as a series element in a switch built on a printed circuit board which has a relatively high thermal conductance, such as Rogers 5880. In the identical circuit constructed on FR4 printed circuit board material the maximum input power is 30 W CW. Minority carrier lifetime is 6 µs typical, series resistance at 50 mA bias current is 0.4 Ω typical and total capacitance is 0.9 pF typical. The SMP1324-087LF is rated to dissipate 2 W maximum.

WEB The SMP1302-085LF is ideally suited for use as a shunt switching element. The SMP1302-085LF has a 50 micron nominal I layer thickness, which enables it to handle input signals as large as 50 W CW when the exposed paddle of the diode is connected to a printed circuit board which provides an adequately large thermal conductance to a heat sink to maintain the die temperature to be less than 150 °C. Minority carrier lifetime is 700 ns typical, series resistance at 100 mA bias current is 1 Ω typical and total capacitance is less than 0.3 pF.

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

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

Package Characteristics

The 087LF package is a 2 x 2 x 0.9 mm surface mount QFN package with an exposed paddle. The die is mounted directly onto this solid metal paddle, which provides a very low thermal resistance path from the die to the environment external to the die. This low thermal resistance permits the die to maintain low junction temperature when dissipating significant power, thereby enabling the die to handle high power input signals.

The 085LF package is a 2 x 2 x 0.9 mm, surface mount plastic package. This package has three terminals, one of which is an exposed paddle which is the cathode contact, the remaining two of which are each connected to the anode of the diode. The exposed paddle provides a very low thermal resistance path from the cathode of the diode to the environment external to the die. The two anode contacts are situated on opposite sides of the exposed paddle, which is optimal for connecting two transmission line sections together via a shunt PIN diode.

SMP1324-087LF Electrical Characteristics

SMP1324-087LF Absolute Maximum Ratings

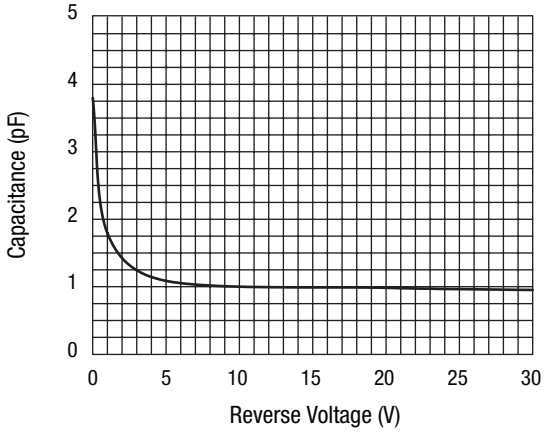
Parameter	Symbol	Min.	Max.	Units
Forward current	I_F	–	200	mA
Dissipated power @ 25 °C	P_D	–	2	W
Operating temperature	T_A	–55	+85	°C
Storage temperature	T_{STG}	–55	+200	°C
Junction temperature	T_J	–55	+175	°C

SMP1324-087LF Electrical Specifications[1] (T_A = +25 °C, Unless Otherwise Noted)

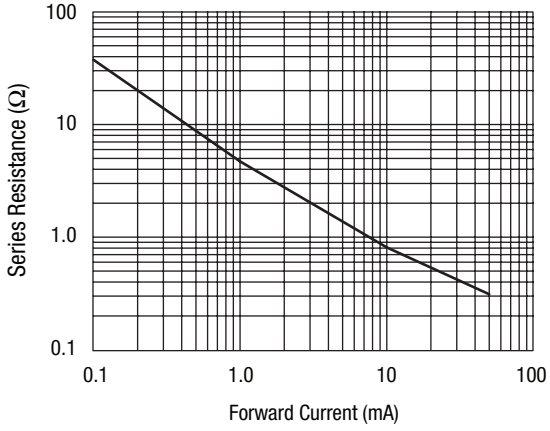
Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Units
Forward voltage	V_F	I_F = 50 mA	–	0.9	1.2	V
Reverse leakage current	I_R	V_R = 200 V	–		10	µA
Series resistance	R_S	I_F = 50 mA, f = 100 MHz	–	0.40	0.75	Ω
Total capacitance	C_{T0} C_{T30}	V_R = 0 V, f = 100 MHz V_R = 30 V, f = 1 MHz	–	0.9 0.9	1.5 1.5	pF pF
Minority carrier lifetime	T_L	I_F = 10 mA	2	6	–	µs
Parallel resistance	R_P	V_R = 0 V, f = 100 MHz	5	6	–	kΩ
I region width	W	–	–	100	–	µm

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

SMP1324-087LF Typical Performance Data @ 25 °C (Unless Otherwise Noted)



Capacitance vs. Reverse Voltage @ 1 MHz



Series Resistance vs. Forward Current @ 100 MHz

SMP1371-087LF Electrical Characteristics

SMP1371-087LF Absolute Maximum Ratings

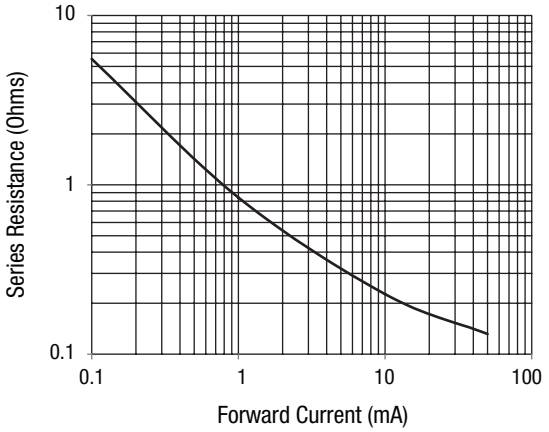
Parameter	Symbol	Min.	Max.	Units
Forward current	I_F	–	200	mA
Reverse voltage	V_R		35	V
Dissipated power @ 25 °C	P_D	–	2	W
Operating temperature	T_A	–40	+85	°C
Storage temperature	T_{STG}	–55	+200	°C
Junction temperature	T_J	–55	+175	°C

SMP1371-087LF Electrical Specifications[1] (T_A = +25 °C, Unless Otherwise Noted)

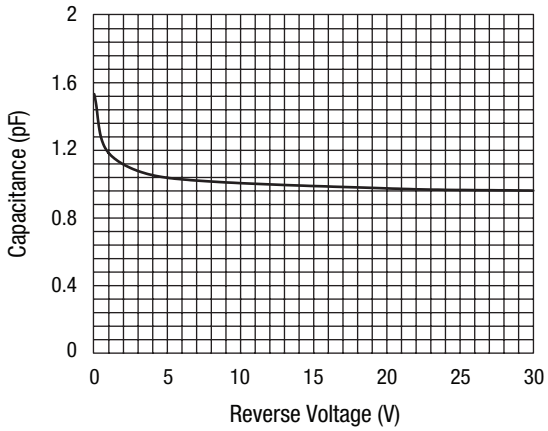
Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Units
Forward voltage	V_F	I_F = 50 mA	–	–	1.0	V
Reverse leakage current	I_R	V_R = 35 V	–	–	10	µA
Series resistance	R_S	I_F = 10 mA, f = 100 MHz	–	–	0.5	Ω
Total capacitance	C_{T20}	V_R = 20 V, f = 1 MHz	–	–	1.2	pF
Minority carrier lifetime	T_L	I_F = 10 mA	200	–	–	µs
Parallel resistance	R_P	V_R = 0 V, f = 100 MHz	2.5	–	–	kΩ
I region width	W	–	–	12	–	µm

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

SMP1371-087LF Typical Performance Data @ 25 °C (Unless Otherwise Noted)



Series Resistance vs. Forward Current



Capacitance vs. Reverse Voltage @ 1 MHz

SMP1302-085LF Electrical Characteristics

SMP1302-085LF Absolute Maximum Ratings

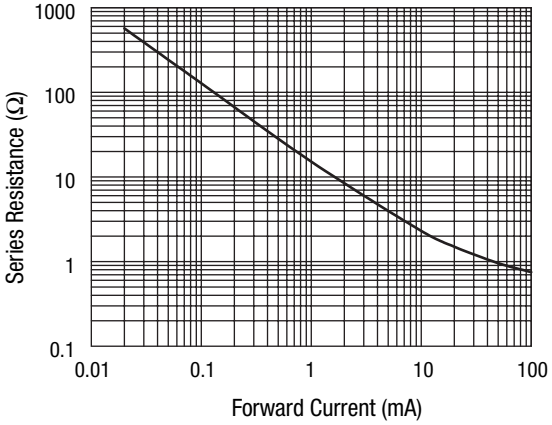
Parameter	Symbol	Min.	Max.	Unit
Reverse voltage	V_R	–	200	V
Forward current at 25 °C	I_F	–	200	mA
CW power dissipation at 25 °C	P_D	–	3	W
1 µs pulse power dissipation	P_D	–	30	W
Storage temperature range	T_{STORE}	–65	+200	°C
Operating temperature range	T_{OP}	–40	+150	°C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

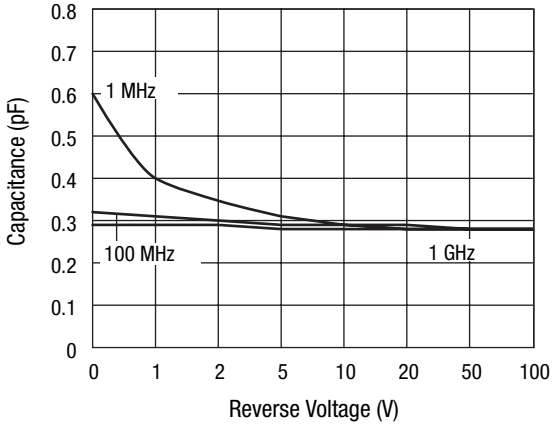
SMP1302-085LF Electrical Specifications (T_A = +25 °C, Unless Otherwise Noted)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Reverse current	I_R	V_R = 200 V	–	–	10	µA
Capacitance	C_{T30}	V_R = 30 V, f = 1 MHz	–	–	0.3	pF
Resistance	R_{S10}	I_F = 10 mA, f = 100 MHz	–	–	3	Ω
Resistance	R_{S100}	I_F = 100 mA, f = 100 MHz	–	1.0	1.5	Ω
Forward voltage	V_F	I_F = 10 mA	–	0.8	–	V
Carrier lifetime	T_L	I_F = 10 mA	–	700	–	ns
I-Region width	W		–	50	–	µm
CW thermal resistance	Θ_{JC}		–		40	°C/W
Pulse thermal resistance	Θ_P	Single 1 µs pulse	–	3.5	–	°C/W

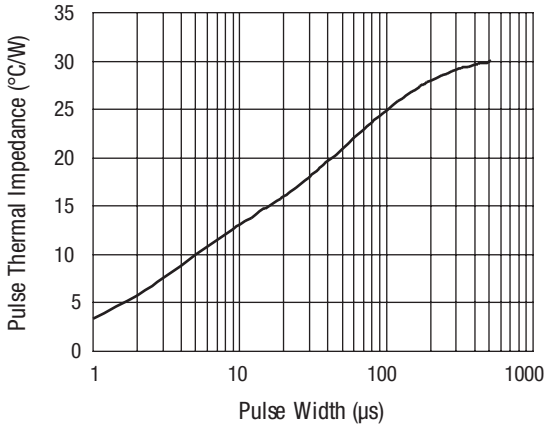
SMP1302-085LF Typical Performance Data @ 25 °C (Unless Otherwise Noted)



Series Resistance vs. Current @ 100 MHz



Capacitance vs. Reverse Voltage



Typical Pulse Thermal Impedance

SMP1345-087LF Electrical Characteristics

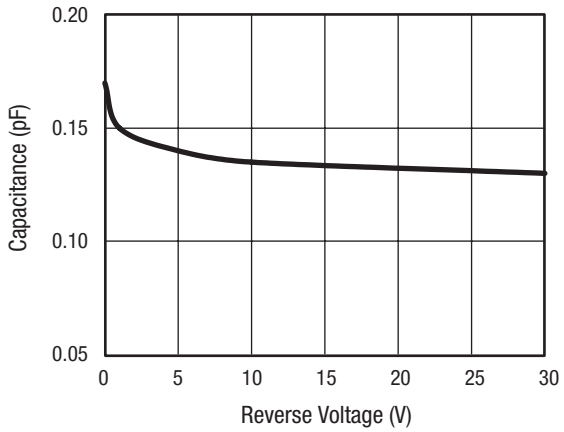
SMP1345-087LF Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit
Reverse voltage	V_R	–	50	V
Forward current at 25 °C	I_F	–	200	mA
CW power dissipation at 25 °C	P_D	–	3	W
1 µs pulse power dissipation	P_D	–	30	W
Storage temperature range	T_{STORE}	–65	+200	°C
Operating temperature range	T_{OP}	–55	+150	°C

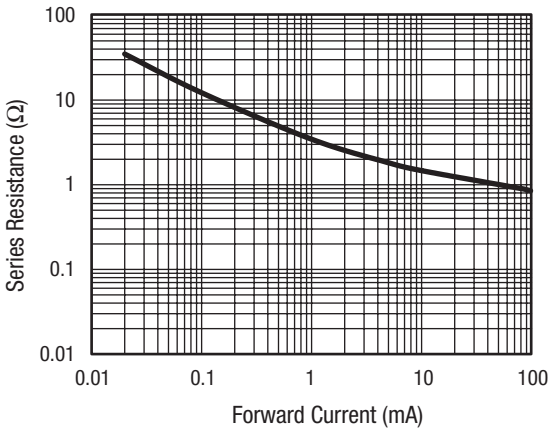
Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

SMP1345-087LF Electrical Specifications (T_A = +25 °C, Unless Otherwise Noted)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Reverse current	I_R	V_R = 50 V	–	–	10	µA
Capacitance	C_{T5}	V_R = 5 V, f = 1 MHz	–	0.16	0.2	pF
Resistance	R_{S1}	I_F = 1 mA, f = 100 MHz	–	3.5	–	Ω
Resistance	R_{S10}	I_F = 10 mA, f = 100 MHz	–	1.5	2.0	Ω
Forward voltage	V_F	I_F = 10 mA	–	0.89	–	V
Carrier lifetime	T_L	I_F = 10 mA	–	100	–	ns
I-Region width	W		–	10	–	µm
CW thermal resistance	Θ_{JC}		–		45	°C/W
Pulse thermal resistance	Θ_P	Single 1 µs pulse	–	4.0	–	°C/W



Capacitance vs. Reverse Voltage



Series Resistance vs. Current

High Power T/R Switch Design Applications

Two SPDT T-R switches were fabricated utilizing PIN diodes, as shown in the schematic diagram below. Both switches utilize a single, series PIN diode on the transmit side of the switch, as well as a series-shunt PIN diode pair on the receive side of the switch. One of the switches contains SMP1324-087LF PIN diodes in the series diode positions. The other switch has SMP1371-087LF PIN diodes in these positions. Both switch assemblies use an SMP1302-085LF in the shunt position on the receive side of the switch.

Power Handling

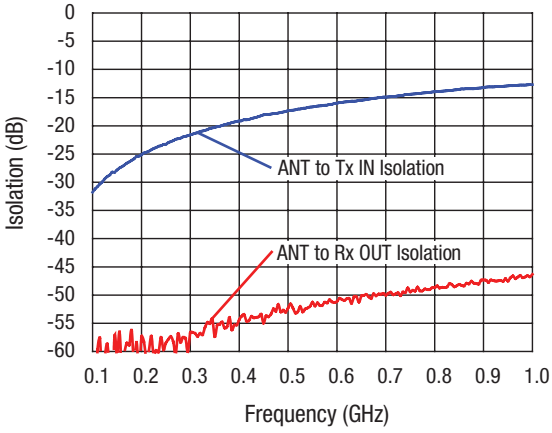
These switches were each built using two different printed circuit board (PCB) substrates: Rogers 5880 and FR4, each of which had dielectric thickness of 0.010 inches. The bottom-most layer of each PCB assembly was FR4 material of approximately 0.052 inches thickness, utilized as a carrier and PCB stiffener. Both types of PCBs had metal heat sinks attached to their undersides.

With the Rogers 5880 PCBs, the switches were subjected to the power levels listed below for the durations also listed below, with no degradation:

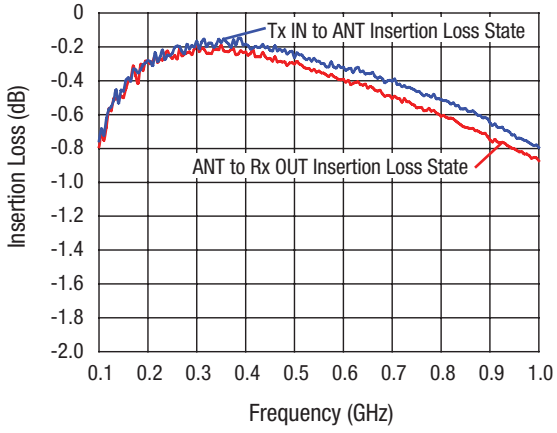
Part Number	Incident Power	Duration
SMP1324-087LF	35 W	24 hours
SMP1371-087LF	23 W	24 hours

For the PCBs entirely comprising FR4, these power levels were as shown below, due to the higher thermal resistance of the FR4.

Part Number	Incident Power	Duration
SMP1324-087LF	35 W	24 hours
SMP1371-087LF	23 W	24 hours

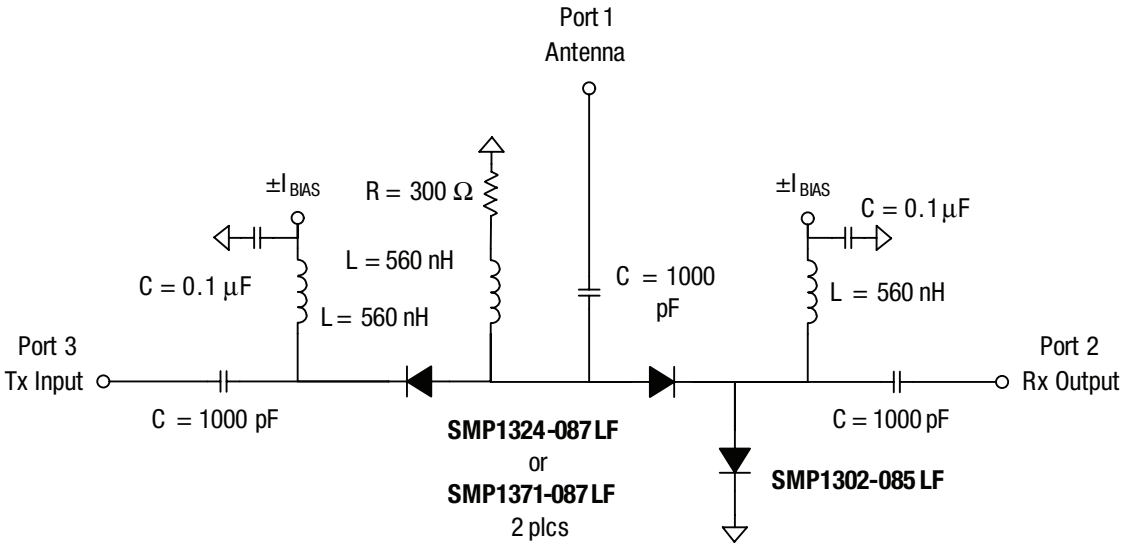


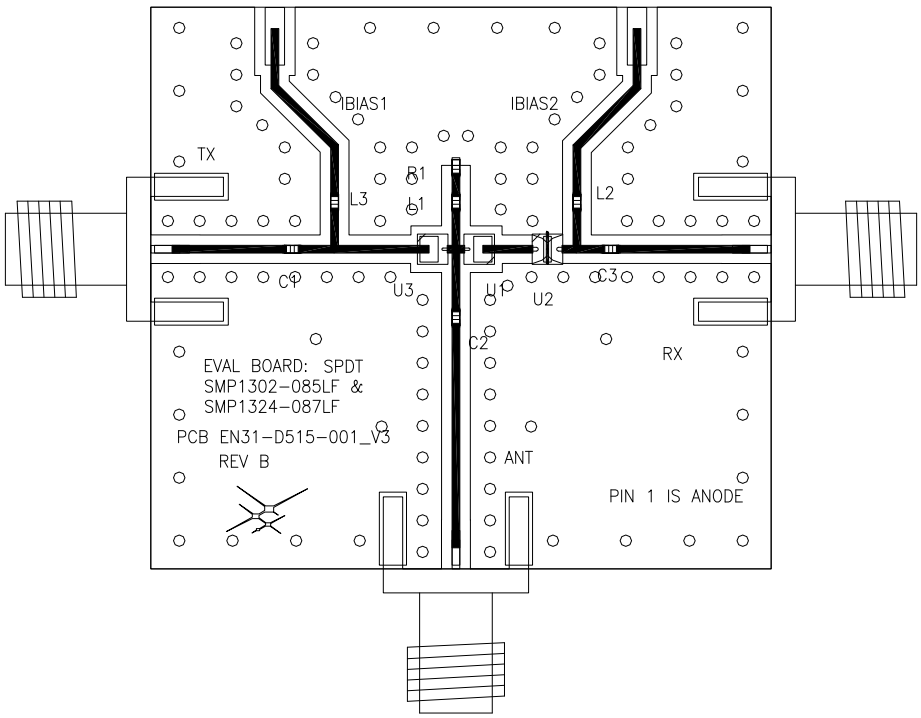
Forward Voltage vs. Forward Current



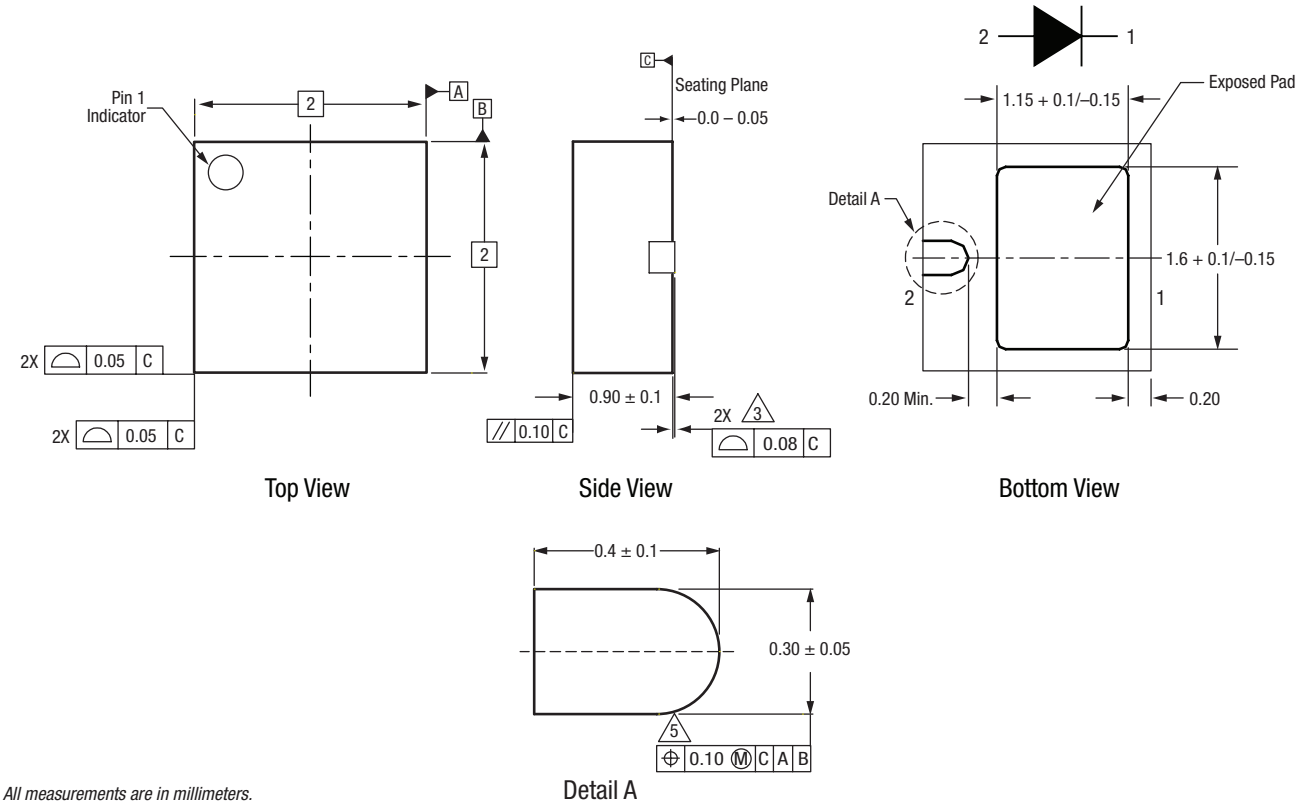
Typical Pulse Thermal Impedance

T/R Switch Circuit Diagram





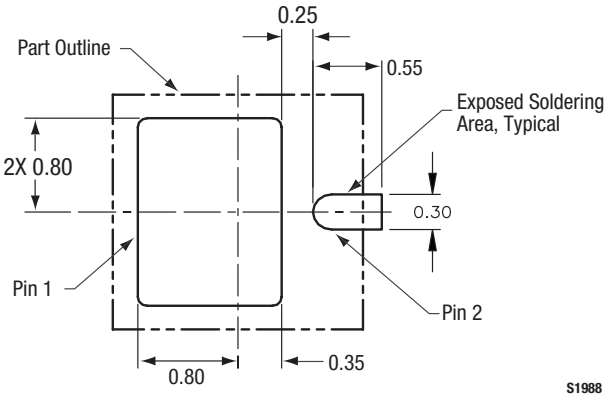
-087LF Outline Drawing



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.

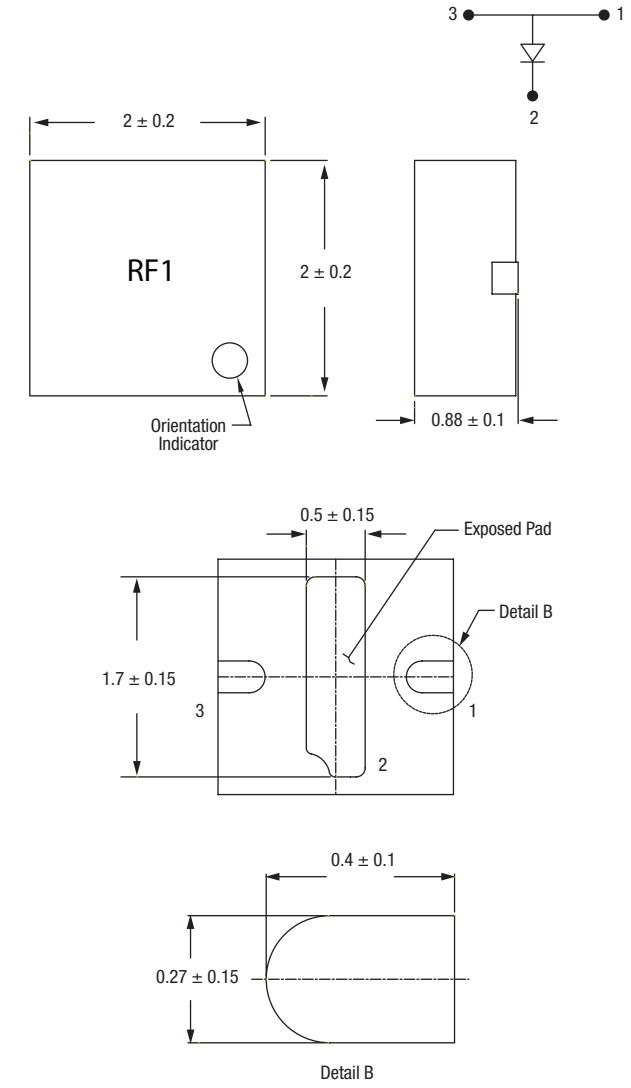
S1989

-087LF Suggested Land Pattern



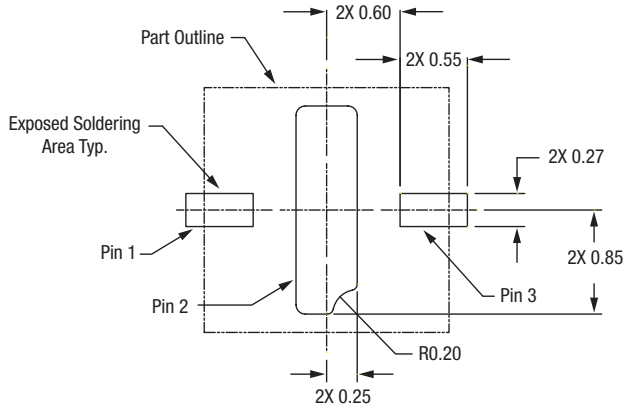
S1988

-085LF Outline Drawing



Note: Dimensions are in millimeters.

-085LF Suggested Land Pattern



Application Notes

For additional information, please refer to the following Application Notes.

Solder Reflow Information

Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation

Design with PIN Diodes

Brochures

RF Diode Design Guide

Published Articles

RF/Microwave Solid State Switches: Part 1

Solid State RF/Microwave Switch Technology: Part 2

PIN Diodes for High Power T/R Switches

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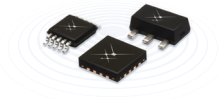

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