SPST Switch Using PIN Diode NSDP301MX2W

AND90067/D

Overview

This application note explains about SPST switch using PIN diode. NSDP301MX2W is low series resistance PIN diode. It is suitable for SPST switch.

For information about the performance, please refer to the datasheet of this product.

Since the evaluation board is adjusted to achieve optimal performance in Sub GHz, the product can provide 0.52 dB Insertion loss at turn off and 21.3 dB Isolation at turn on at 500 MHz.

A standard material FR4 is used for the printed circuit board (PCB). Please note that the losses of the PCB and the SMA connector are not excluded.

Theory

The equivalent circuit of PIN diode at forward bias is shown in Figure 1. Rs is the series resistance and Ls is the series inductance. On the other hand, under reverse bias, equivalent circuit is shown in Figure 1b. Rp is parallel resistance and Cj is the junction capacitance.
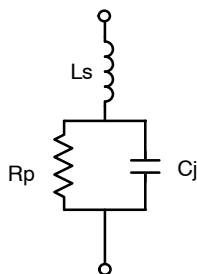

Figure1a. Equivalent Circuit at Forward Bias

Figure1b. Equivalent Circuit at Reverse Bias

When using a PIN Diode in an RF application, it applies a forward bias to transfer the RF signal. At that time, it is important to select a device with a small Rs to reduce the signal loss.

When blocking the RF signal, apply a reverse bias to the diode. To reduce signal leakage, it is important to select a device with a high impedance given by Rp and Cj.
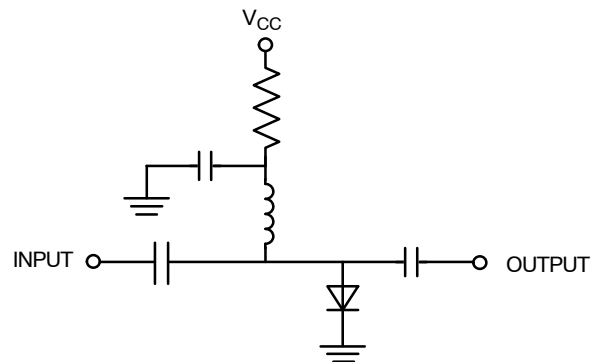
RF Switch Circuit

Figure 2. Shunt Type Switch

There are two ways to use the PIN Diode as a switch. One is the shunt type switch shown in Figure 2. In this application, when no bias is applied the PIN Diode is off and the RF signal is transmitted from Input to Output. On the other hand, when the Vcc is applied, the diode is turned on. As a result, the RF signal is transmitted to GND and not to the Output terminal.
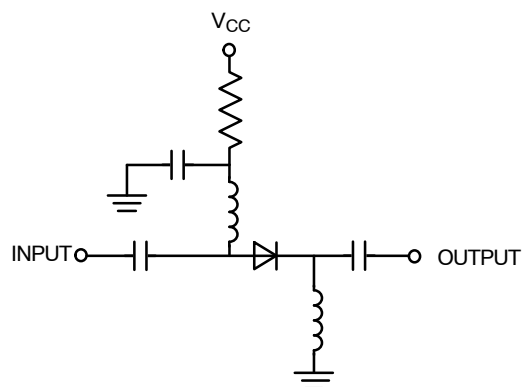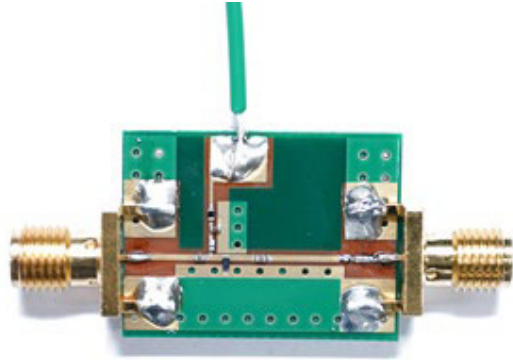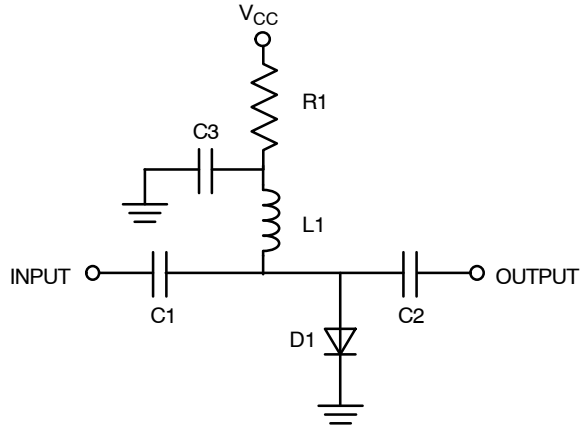

Figure 3. Series Type Switch

The other is a series type switch. In this case, when no bias is applied, the PIN Diode is in the off state and no signal is transmitted. When bias is applied, the PIN diode is turned on and the signal is transmitted from the input to the output.

Shunt Type SPST Switch Circuit Design
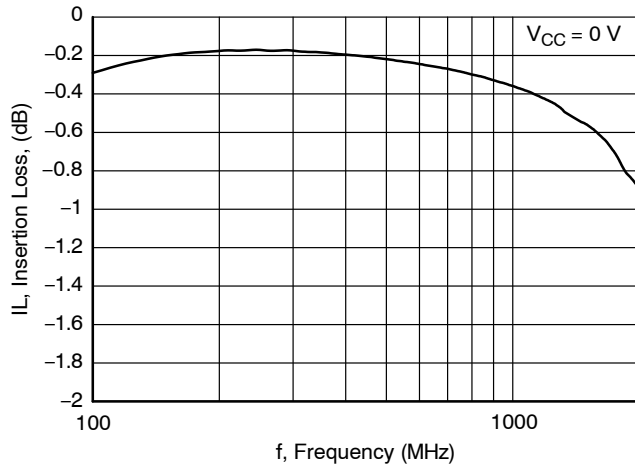

BILL OF MATERIALS

Item	Symbol	Value	Manufacturer	Size
PIN Diode	D1	NSDP301MX2W	**onsemi**	X2DFN2W
Capacitor	C1	100 pF	Various	1005
	C2	100 pF	Various	1005
	C3	0.1 μF	Various	1005
Resistor	R1	120 Ω	Various	1005
Inductor	L1	270 nH	Various	1005
Material	–	FR4	–	25 x 18 mm

SUMMARY OF DATA (Ta = 25°C, Input Power = −5 dBm, Zo = 50 Ω)

Parameter	Parameter	Condition	Result	Unit
DC Current	Icc	Vcc = 3 V	17.2	mA
Insertion Loss	IL	Vcc = 0 V, f = 100 MHz	−0.29	dB
		Vcc = 0 V, f = 500 MHz	−0.22	
		Vcc = 0 V, f = 1.000 MHz	−0.36	
		Vcc = 0 V, f = 1.500 MHz	−0.56	
Isolation	ISO	Vcc = 3 V, f = 100 MHz	−28.0	dB
		Vcc = 3 V, f = 500 MHz	−21.8	
		Vcc = 3 V, f = 1.000 MHz	−17.0	
		Vcc = 3 V, f = 1.500 MHz	−13.9	

*Include Board Loss

ON State

Figure 4. Insertion Loss
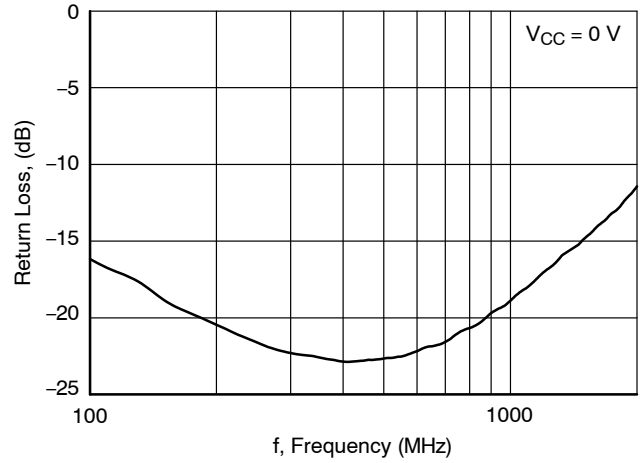
Figure 5. Return Loss

OFF State
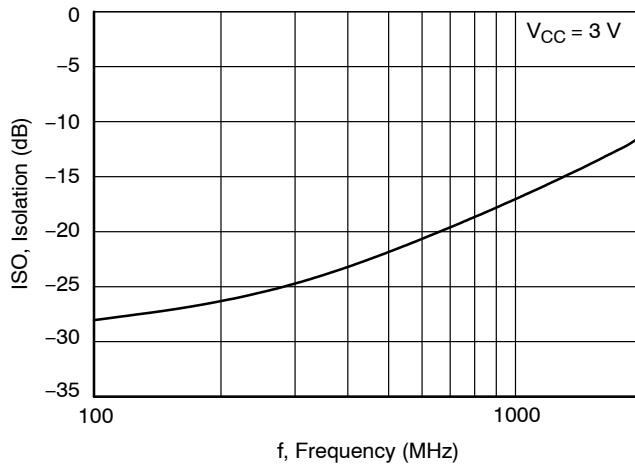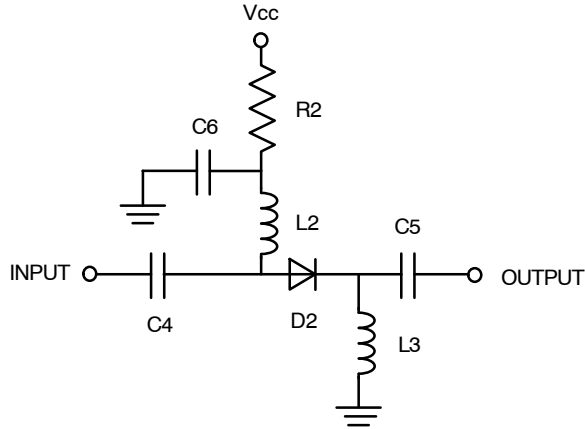

Figure 6. Isolation

DC Characteristics
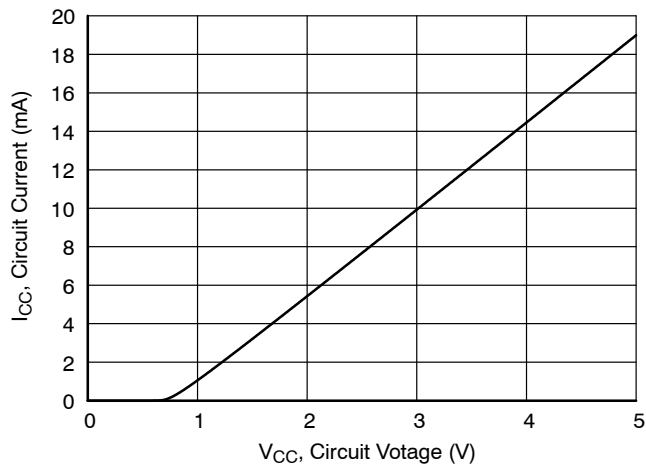
Figure 7. I$_{CC}$ − V$_{CC}$

**Series Type SPST Switch Circuit Design**
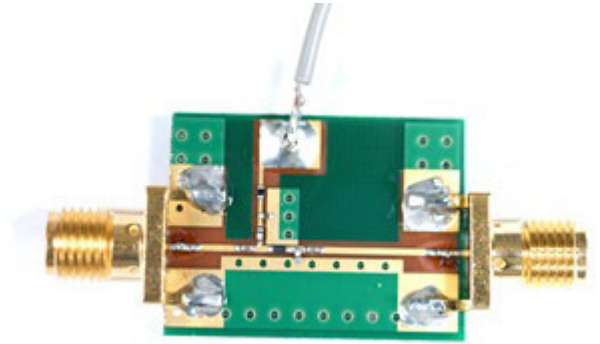
BILL OF MATERIALS

Item	Symbol	Value	Manufacturer	Size
PIN diode	D2	NSDP301MX2W	**onsemi**	X2DFN2W
Capacitor	C4	100 pF	Various	1005
	C5	100 pF	Various	1005
	C6	0.1 µF	Various	1005
Resistor	R2	120 Ω	Various	1005
Inductor	L2	270 nH	Various	1005
	L3	270 nH	Various	1005
Material	–	FR4	–	25 x 18 mm

SUMMARY OF DATA (Ta = 25°C, Input Power = −5 dBm, Zo = 50 Ω)

Parameter	Symbol	Condition	Result	Unit
DC Current	Icc	Vcc = 3 V	16.7	mA
Insertion Loss	IL	Vcc = 3 V, f = 100 MHz	−0.37	dB
		Vcc = 3 V, f = 500 MHz	−0.24	
		Vcc = 3 V, f = 1.000 MHz	−0.35	
		Vcc = 3 V, f = 1.500 MHz	−0.57	
Isolation	ISO	Vcc = 0 V, f = 100 MHz	−29.9	dB
		Vcc = 0 V, f = 500 MHz	−21.8	
		Vcc = 0 V, f = 1.000 MHz	−18.2	
		Vcc = 0 V, f = 1.500 MHz	−16.4	

*Include Board Loss

ON State
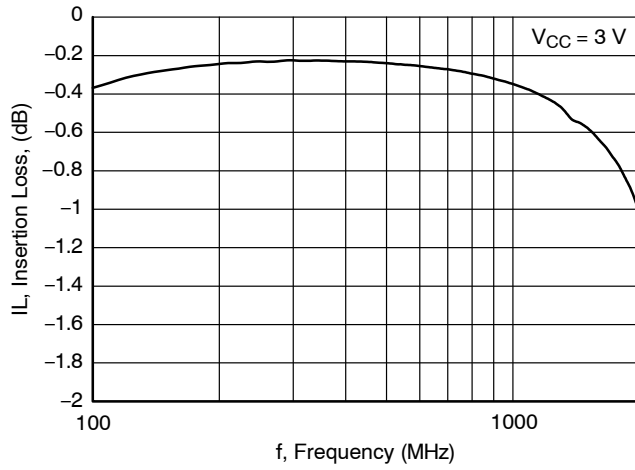
Figure 8. Insertion Loss
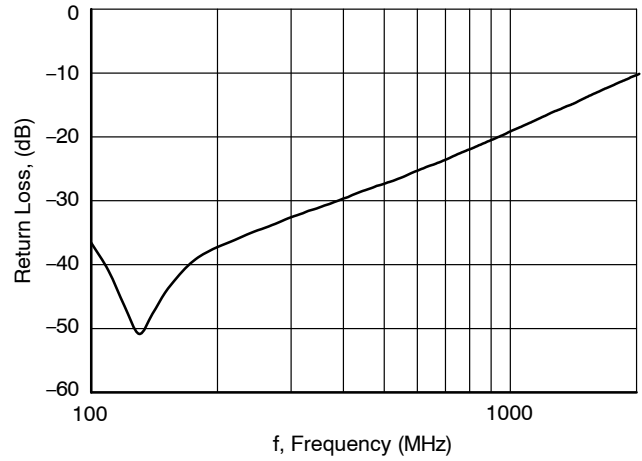
Figure 9. Return Loss

OFF State
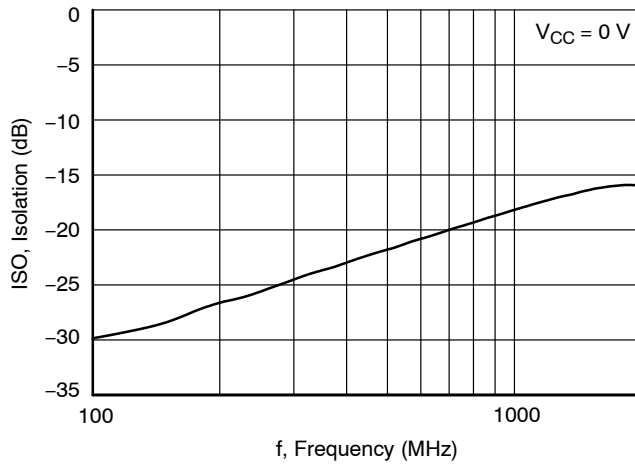
Figure 10. Isolation

DC Characteristics
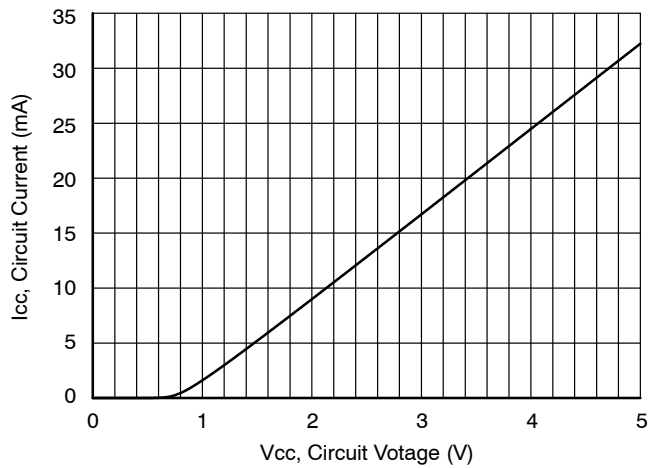
Figure 11. Circuit Current

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