

APPLICATION NOTE

SKY12212-478LF: Low Frequency Tuning

Introduction

The SKY12212-478LF is a high power handling, Single-Pole, Double-Throw (SPDT) silicon PIN diode switch. The device operates over the 50 MHz to 2.7 GHz band. It features low insertion loss, excellent power handling, and superb linearity with low DC power consumption. The SKY12212-478LF is well-suited for use as a high power transmit/receive switch in a variety of telecommunication systems such as Sat-Com, Cable TV, WiMAX, TD-SCDMA, or LTE base stations. The device is provided in a 4 x 4 mm, 16-pin Quad Flat No-Lead (QFN) package. The SKY12212-478LF block diagram is shown in Figure 1.

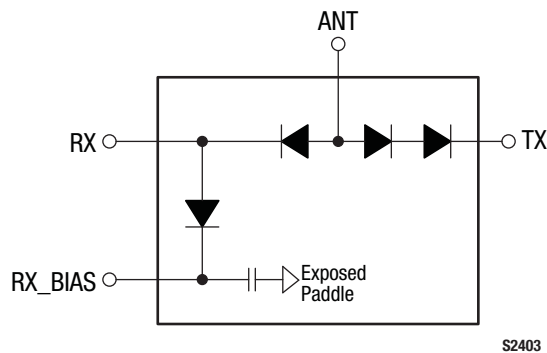


Figure 1. SKY12212-478LF Block Diagram



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Abstract

The operating range specified in the standard data sheet for the SKY12212-478LF is 50 MHz to 2.7 GHz. The part has the capability to operate at lower frequencies with high input power. With modifications to the external bias circuitry, the SKY12212-478LF can operate from 20 MHz to 2700 MHz with low insertion loss, high isolation and 100 W power handling capability.

Theory of Operation

Operating at frequencies below 200 MHz presents problems not seen at higher frequencies. The series transmit diode has a characteristic to self-rectify at low RF frequencies and high power levels. In the transmit mode, high harmonic content is observed at input power levels above 42 dBm. This requires an innovative solution to reduce harmonic levels and maintain low TX insertion loss and high RX isolation up to 100 Watts.

The solution is to create an innovative bias decoupling network that reduces the harmonic distortion at low frequencies and high power levels.

At high power levels, a high harmonic content occurs because the RF input frequency is close to the SRF of the RF choke/ DC bias inductors. As a result, the switch goes into an early compression state at power levels > 42 dBm. The bias inductors provide the RF choking on the DC bias lines without degrading the input and output VSWR. The inductor value must be selected properly as it affects the RF match. The solution is to modify the bias network by adding an additional inductor that has an SRF above the RF input.

The inductors are positioned in series to each other with the highest value inductor placed next to the switch. This provides the highest RF reactance for the best RF blocking and best match at lower operating frequencies. The evaluation board schematic diagram for the SKY12212-478LF for low frequency operation is shown in Figure 2. The low frequency tuned evaluation board is shown in Figure 3. The bill of materials is shown in Table 1.

Table 1. SKY12212-478LF Evaluation Board Bill of Materials

Component	Value	Units	Size	Manufacturer	Mfr Part Number	Characteristics
C1, C2, C7, C9, C10, C11, C12	10000	pF	0603	Murata	GRM188R7H103K	X7R, 50 V, ±5%
C13	1	μF	0603	Murata	GRM188R71C105K	X7R, 16 V, ±10%
L3, L8, L9	1800	nH	0805	Coil Craft	0805LS-182XJLB	±5%, SRF 246 MHz
L4, L7, L10	390	nH	0805	TOKO	LL2012-FR39K	±10%, SRF 330 MHz
L6	820	nH	0603	Coil Craft	00603LS-821XJLB	±5%, SRF 410 MHz
R1	33	Ω	1206	Panasonic	ERJ8ENF33R0V	250 mW, 1%
R2, R3	560	Ω	2512	Multicomp	MCPWR12FTEA5600	1.5 W, 1%
U1			4 x 4 x 1.5 mm	Skyworks	SKY12212-478LF	
EVB				Skyworks	EN33-D785-001	

Typical Performance Characteristics

($T_{OP} = +25^{\circ}C$, $P_{IN} = 0$ dBm, ANT_DC = 5 V, TX_DC, RX_BIAS and RX_DC= 0/28 V, Characteristic Impedance [Z_0] = 50 Ω, Unless Otherwise Noted)

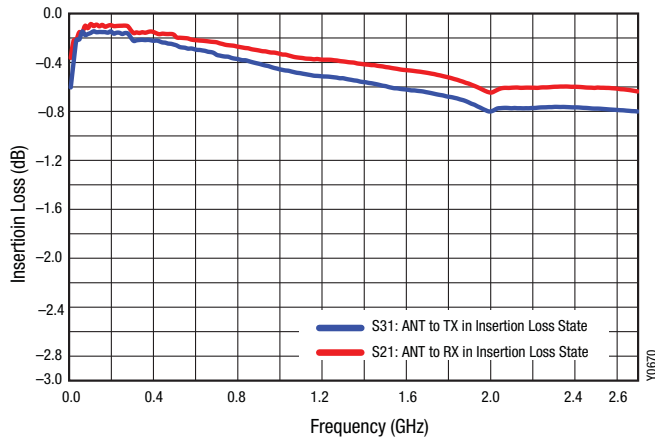


Figure 4. Insertion Loss vs Frequency

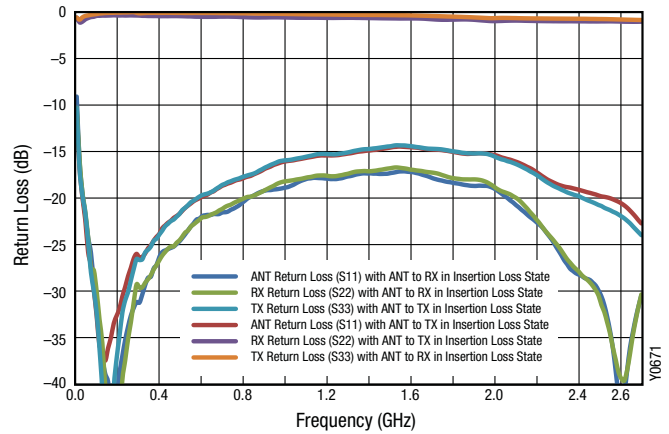


Figure 5. Return Loss vs Frequency

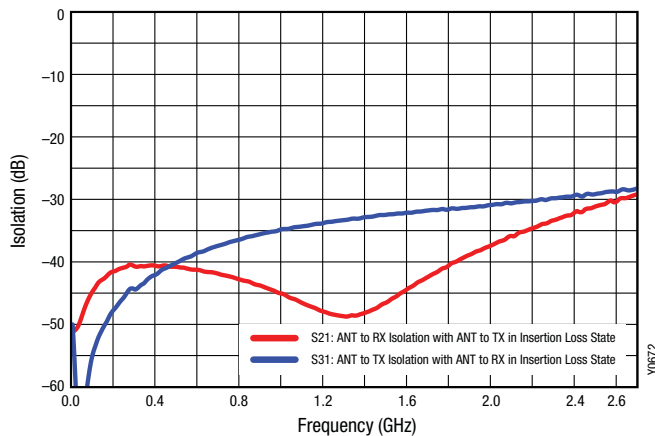


Figure 6. Isolation vs Frequency

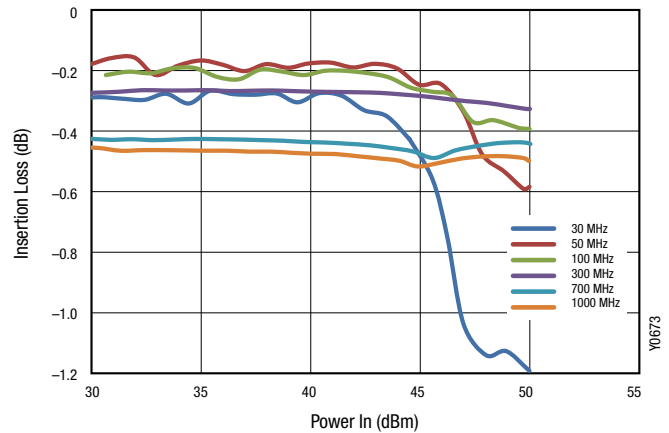


Figure 7. Insertion Loss vs CW Input Power vs Frequency

Summary

Operating high power PIN diode switches at frequencies below 200 MHz presents problems not seen at higher frequencies. In the transmit mode, high harmonic content is observed at input

power levels above 42 dBm. The solution is to create an innovative bias decoupling network with two series RF chokes to reduce the harmonic distortion observed at low frequencies and high power levels.

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