SMV2019 to SMV2023: Silicon Hyperabrupt Junction Varactor Bondable Planar Chips
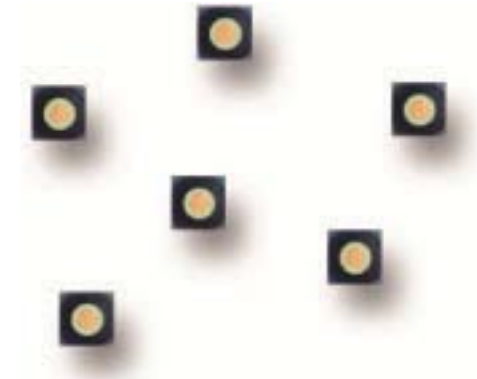
Applications

• VCOs

Features

• High Q for low-loss resonators
• Low leakage current
• High tuning ratio for wideband VCOs
• SPICE model parameters
• Small footprint chip design

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

Description

Skyworks silicon hyperabrupt junction varactor diodes are processed using established ion-implantation technology resulting in low series resistance, wide tuning ratio devices with high Q values. The planar chips have a small outline size (12 x 12 mils, nominal) and are fully passivated, which results in low leakage current and high reliability. These varactor chips are intended for assembly in hybrid integrated circuit resonators used in Voltage Controlled Oscillators (VCOs) and analog tuned filters.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SMV2019 to SMV2023 varactors are provided in Table 1. Electrical specifications are specified in Table 2. Typical capacitance values are listed in Table 3.

The SPICE model is shown in Figure 1. SPICE parameters are listed in Table 4. Typical performance characteristics are provided in Figures 2 and 3.

Table 1. SMV2019-SMV2023 Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Minimum	Typical	Maximum	Units
Power dissipation	P_{DIS}			250	mW
Reverse voltage	V_R			22	V
Forward current	I_F			100	mA
Operating temperature	T_{OP}	−55		+150	°C
Storage temperature	T_{STG}	−65		+200	°C

Note 1: 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.

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. SMV2019-SMV2023 Electrical Specifications (Note 1)
(T_{OP} = +25 °C, C_J Measured at 1 MHz, Unless Otherwise Noted)

Part Number	C_J @ 0 V (pF)	C_J @ 4 V (pF)		C_J @ 20 V (pF)		Q @ 4 V, 50 MHz (Note 2)	1 GHz R_S @ 4 V (Ω)	I_R @ 17.6 V (nA) (Note 3)
	Typical	Minimum	Maximum	Minimum	Maximum	Minimum	Typical	Maximum
SMV2019-000	2.3	0.68	0.88	0.13	0.23	500	4.8	50
SMV2020-000	3.1	1.13	1.43	0.23	0.33	500	4.1	50
SMV2021-000	4.5	1.58	1.98	0.32	0.44	500	2.8	50
SMV2022-000	7.1	2.48	3.08	0.48	0.68	400	2.2	50
SMV2023-000	10.8	4.28	5.28	0.78	1.08	400	1.4	50

Note 1: Performance is guaranteed only under the conditions listed in this Table and is not guaranteed over the full operating or storage temperature ranges. Exceeding any of the conditions listed here may result in permanent damage to the device. Operation at elevated temperatures may reduce reliability of the device.

Note 2: 50 MHz Q calculated from 1 GHz R_S and 1 MHz C_J.

Note 3: V_B at 10 µA specified at 22 V, minimum.

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Table 3. Typical Capacitance Values

Reverse Voltage, V_R (V)	Junction Capacitance, C_J (pF)				
	SMV2019	SMV2020	SMV2021	SMV2022	SMV2023
0	2.25	3.14	4.48	7.08	10.76
0.5	1.79	2.50	3.57	5.66	8.76
1	1.53	2.16	3.09	4.88	7.67
2	1.19	1.72	2.45	3.89	6.31
3	0.99	1.44	2.09	3.19	5.38
4	0.89	1.24	1.83	2.71	4.75
5	0.71	1.07	1.60	2.30	4.21
6	0.57	0.90	1.37	1.87	3.66
7	0.46	0.74	1.17	1.52	3.17
8	0.38	0.61	0.97	1.25	2.68
9	0.33	0.52	0.81	1.07	2.25
10	0.29	0.46	0.69	0.94	1.89
11	0.26	0.42	0.61	0.85	1.66
12	0.24	0.38	0.56	0.78	1.49
13	0.23	0.36	0.51	0.73	1.35
14	0.21	0.34	0.48	0.69	1.24
15	0.20	0.32	0.45	0.65	1.16
16	0.19	0.31	0.43	0.62	1.10
17	0.19	0.29	0.41	0.59	1.04
18	0.18	0.28	0.39	0.57	0.99
19	0.17	0.27	0.38	0.55	0.95
20	0.16	0.26	0.36	0.54	0.91

PORT
P_anode
port = 1

RES
R_S
R = R_S

DIODE
Varactor_Diode
AREA = 1
MODEL = Diode_Model
MODE = nonlinear

DIODEM	F_C = 0.5
Diode_Model	B_V = 22
I_S = 1.00e-14	I_{BV} = 1e-5
R_S = R_S	I_{SR} = 0
N = 1, 2	N_R = 2
T_T = 0	I_{KF} = 0
C_{JO} = C_{JO}	N_{BV} = 1
M = M	I_{BVL} = 0
V_J = V_J	N_{BVL} = 1
E_G = 1.11	T_{BV1} = 0
X_{TI} = 3	T_{NOM} = 27
K_F =0	F_{FE} = 1
A_F =1	

PORT
P_Cathode
port = 2

$$C_V = \frac{C_{JO}}{\left(1 + \dfrac{V_R}{V_J}\right)^M}$$
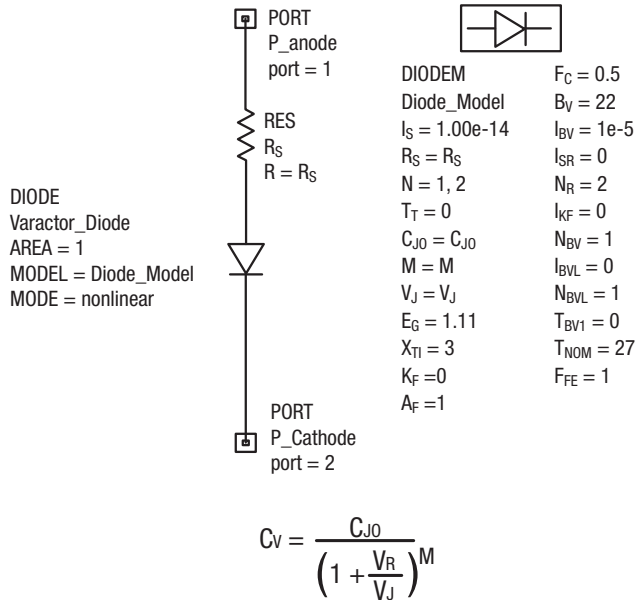
Figure 1. SPICE Model

Table 4. SPICE Model Parameters

Part Number	C_{JO} (pF)	V_J (V)	M	R_S (Ω)
SMV2019	2.3	3.5	1.40	4.80
SMV2020	3.05	4.46	1.51	4.10
SMV2021	4.3	5.09	1.59	2.80
SMV2022	6.9	4.92	1.69	2.20
SMV2023	10.26	7.61	1.93	1.40

Typical Performance Characteristics at 25 °C
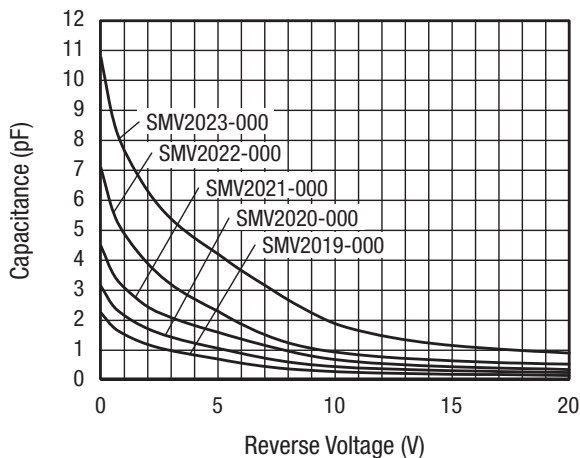
Figure 2. Capacitance vs Reverse Voltage
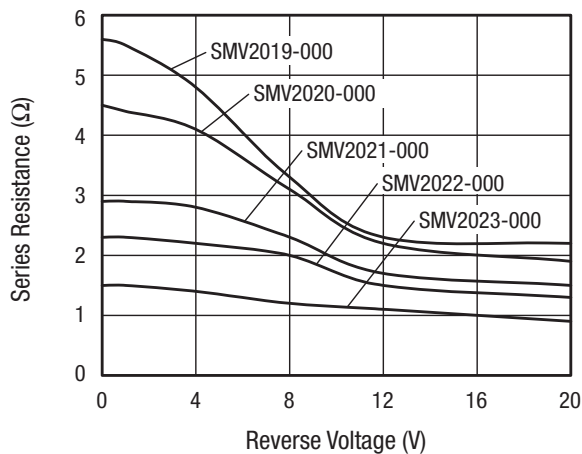
Figure 3. Series Resistance vs Voltage @ 1 GHz

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.

Table 5 identifies the die part numbers with their corresponding top contact diameters and die outline drawings. The outline die drawing for the SMV2019 to SMV2023 varactors is shown in Figure 4.

Additional bonding and handling methods are contained in the Skyworks Application Notes, *Waffle Pack Chip Carrier Handling/Opening Procedure* (document #200146) and *Diode Chips, Beam-Lead Diodes, Capacitors: Bonding Methods and Packaging* (document #200532).

Table 5. SMV2019 to SMV2023 Part Number Information

Part Number	NominalTop Contact Diameter (mils)	Die Drawing
SMV2019-000	2.00	149-801
SMV2020-000	2.50	149-801
SMV2021-000	3.00	149-801
SMV2022-000	3.75	149-801
SMV2023-000	5.00	149-801

Anode Metallized Gold Dot
0.002 (0.051 mm) Dia. Min.

0.010 (0.254 mm) Min.
0.014 (0.356 mm) Max. Sq.

Silicon

0.004 (0.127 mm) Min.
0.006 (0.152 mm) Max.

Cathode Metallized Back
Contact: Gold

S1571

Figure 4. 149-801 Package

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