# SPICE Model – xx336RAF

This lumped-element (SPICE) model data simulates the frequency-dependent behavior of Coilcraft RF surface mount inductors from 1 MHz to the upper frequency limit shown in the accompanying table.

The equivalent lumped element model schematic is shown below. The element values R1, R2, C, and L are listed for each component value. The value of the frequency-dependent variable resistor R_{VAR} relates to the skin effect and is calculated from:

$$R_{VAR} = k * \sqrt{f}$$

- k is shown for each value in the accompanying table.
- f is the frequency in Hz
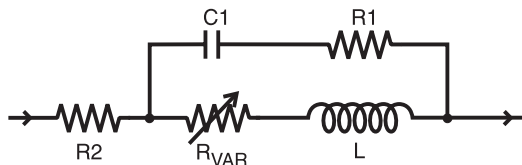
The data represents de-embedded measurements, as described below. Effects due to different customer circuit board traces, board materials, ground planes or interactions with other components are not included and can have a significant effect when comparing the simulation to measurements of the inductors using typical production verification instruments and fixtures.

Each model should only be analyzed at the input and output ports. Individual elements of the model are not determined by parameter measurement. The elements are determined by the overall performance of the lumped element model compared to the measurements taken of the component.

Typically, the Self-Resonant Frequency (SRF) of the component model will be higher than the measurement of the component mounted on a circuit board. The parasitic reactive elements of a circuit board or fixture will effectively lower the circuit resonant frequency, especially for very small inductance values. Since data sheet specifications are based on typical production measurements, and the SPICE models are based on de-embedded measurements as described below, the model results may be different from the data sheet specifications.

Lumped Element Modeling Method

The measurements were made over a brass ground plane with each component centered over an air gap, as illustrated in Figure 1. The gap width for each size component is given in Table 1. The test pads were 30 mil

Table 1. Test Gap

Size	Gap Width (inch / mm)
0302	0.017 / 0.432
0402,0403	0.017 / 0.432
0603	0.026 / 0.660
0805	0.040 / 1.016
1008	0.060 / 1.524
1206	0.080 / 2.032
1812	0.120 / 3.048

(50 Ohm) wide traces of tinned gold over 25 mil thick alumina, and were not included in the gap. The TRL* calibration plane is also illustrated in Figure 1.
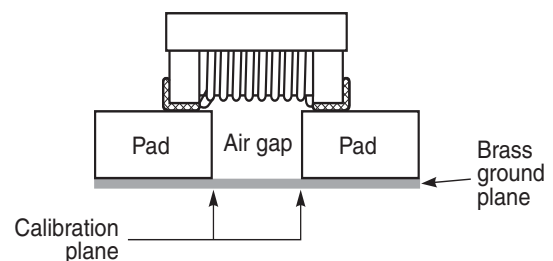

Figure 1. Test Setup

The lumped element values were determined by matching the simulation model to an average of the measurements. This method results in a model that represents as closely as possible the typical frequency-dependent behavior of the component up to a frequency just above the self-resonant frequency of the model.

The lumped element models were used to generate our 2-port S-parameters and therefore give identical results. The S-parameters are available on our web site at **http://www.coilcraft.com/models.cfm**.

Disclaimer

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SPICE Model for Coilcraft xx336RAF Chip Inductors

Part number	R1 (Ω)	R2 (Ω)	C (pF)	L (nH)	k	Upper limit (MHz)
xx336RAF1N8	6	0.03	0.072	1.8	6.04E-06	14700
xx336RAF3N9	7	0.05	0.045	4.0	1.22E-05	12500
xx336RAF4N7	8	0.06	0.048	4.5	1.36E-05	11400
xx336RAF6N8	8	0.08	0.045	6.9	2.11E-05	9500
xx336RAF8N2	9	0.08	0.052	8.2	2.50E-05	8100
xx336RAF10N	9	0.08	0.088	9.9	2.34E-05	5700
xx336RAF12N	10	0.10	0.047	12.0	2.86E-05	7100
xx336RAF15N	10	0.10	0.076	14.6	3.14E-05	5100
xx336RAF18N	11	0.13	0.053	17.6	3.74E-05	5500
xx336RAF22N	11	0.15	0.040	22	4.79E-05	5400
xx336RAF27N	16	0.19	0.065	27	5.59E-05	4000
xx336RAF33N	20	0.19	0.058	33	6.31E-05	3900
xx336RAF39N	24	0.27	0.050	40	7.21E-05	3800
xx336RAF47N	28	0.30	0.048	47	1.01E-04	3600

Part number	R1 (Ω)	R2 (Ω)	C (pF)	L (nH)	k	Upper limit (MHz)
xx336RAF56N	20	0.39	0.050	56	1.17E-04	3200
xx336RAF68N	16	0.40	0.061	68	1.44E-04	2600
xx336RAF82N	18	0.44	0.051	81	1.72E-04	2600
xx336RAFR10	20	0.64	0.059	101	1.84E-04	2200
xx336RAFR12	22	0.68	0.056	120	1.96E-04	2100
xx336RAFR15	25	0.80	0.054	146	1.98E-04	1900
xx336RAFR18	24	0.86	0.054	179	3.17E-04	1700
xx336RAFR22	34	1.29	0.064	215	2.44E-04	1500
xx336RAFR27	25	1.40	0.034	268	4.32E-04	1500
xx336RAFR33	36	1.93	0.048	326	4.85E-04	1300
xx336RAFR39	36	2.80	0.047	384	6.05E-04	1200
xx336RAFR47	145	3.10	0.043	462	7.37E-04	1100
xx336RAFR50	7	3.20	0.045	491	1.27E-03	1050