

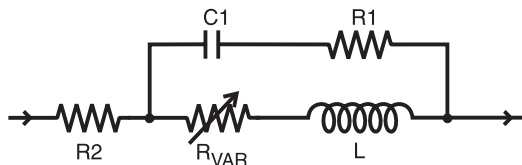
SPICE Model – xx413RAD

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.

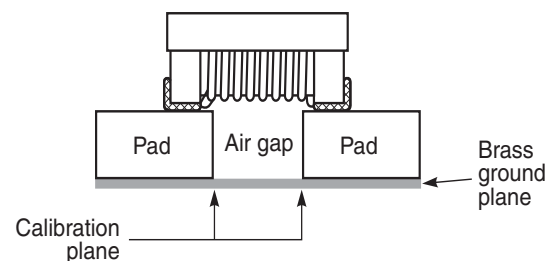


Figure 1. Test Setup

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 xx413RAD Chip Inductors

Part number	R1 (Ω)	R2 (Ω)	C (pF)	L (nH)	k	Upper limit (MHz)
xx413RAD3N0	7	0.04	0.052	3.0	7.60E-06	14100
xx413RAD4N1	8	0.05	0.057	4.1	1.00E-05	11500
xx413RAD7N8	8	0.05	0.102	7.8	1.07E-05	6800
xx413RAD10N	6	0.06	0.079	10	1.69E-05	6800
xx413RAD12N	8	0.06	0.119	12	1.81E-05	5100
xx413RAD18N	10	0.07	0.096	18	2.53E-05	4600
xx413RAD22N	10	0.07	0.156	22	3.09E-05	3300
xx413RAD33N	9	0.09	0.138	33	3.99E-05	2900
xx413RAD39N	13	0.09	0.191	39	4.65E-05	2300
xx413RAD47N	11	0.12	0.140	47	5.61E-05	2400
xx413RAD56N	13	0.12	0.185	56	6.51E-05	1900
xx413RAD68N	10	0.13	0.154	68	7.50E-05	1900
xx413RAD82N	11	0.16	0.130	82	9.40E-05	1900
xx413RADR10	14	0.16	0.210	100	1.31E-04	1400