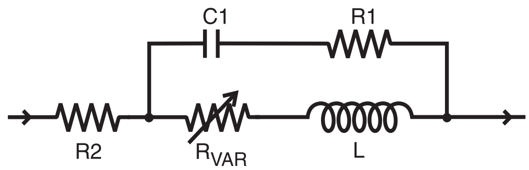
SPICE Model – xx413RAF

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.

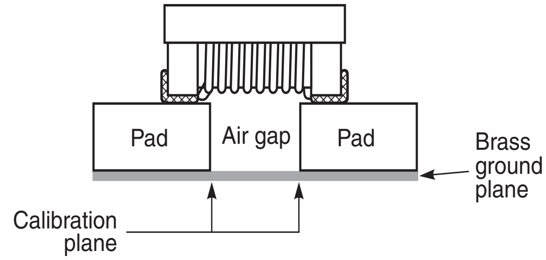


Figure 1. Test Setup

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 xx413RAF Chip Inductors

Part number	R1 (Ω)	R2 (Ω)	C (pF)	L (nH)	k	Upper limit (MHz)
xx413RAF3N3	4	0.05	0.042	3.3	9.80E-06	14200
xx413RAF6N8	5	0.05	0.052	6.8	1.96E-05	8900
xx413RAF7N2	6	0.05	0.069	7.2	2.00E-05	7500
xx413RAF12N	6	0.07	0.075	12.2	2.84E-05	5800
xx413RAF15N	9	0.08	0.111	15	3.54E-05	4300
xx413RAF18N	7	0.09	0.056	18	3.49E-05	5100
xx413RAF22N	11	0.11	0.099	22	4.27E-05	3800
xx413RAF27N	14	0.13	0.065	27	5.25E-05	4200
xx413RAF33N	10	0.14	0.110	33	5.11E-05	3000
xx413RAF39N	12	0.17	0.089	39	6.19E-05	3000
xx413RAF47N	11	0.18	0.128	47	7.59E-05	2300
xx413RAF56N	10	0.18	0.096	56	8.89E-05	2400
xx413RAF68N	15	0.23	0.094	68	1.08E-04	2200

Part number	R1 (Ω)	R2 (Ω)	C (pF)	L (nH)	k	Upper limit (MHz)
xx413RAF82N	10	0.35	0.094	82	1.38E-04	2000
xx413RAFR10	10	0.64	0.084	100	1.60E-04	2000
xx413RAFR12	10	0.55	0.083	120	1.76E-04	1800
xx413RAFR14	14	0.70	0.081	140	2.06E-04	1700
xx413RAFR15	14	0.75	0.098	150	2.18E-04	1500
xx413RAFR18	20	1.02	0.075	185	2.63E-04	1500
xx413RAFR22	19	1.15	0.083	225	2.21E-04	1300
xx413RAFR24	25	1.15	0.078	245	2.63E-04	1300
xx413RAFR27	18	1.25	0.077	275	3.11E-04	1300
xx413RAFR33	28	1.35	0.094	340	4.07E-04	1000
xx413RAFR39	30	1.45	0.108	390	4.98E-04	900
xx413RAFR47	38	1.65	0.091	485	6.15E-04	900
xx413RAFR56	42	1.90	0.077	595	6.85E-04	900

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