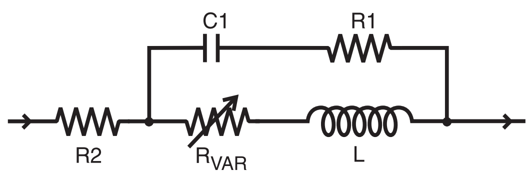
SPICE Model – xx413RAE

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.

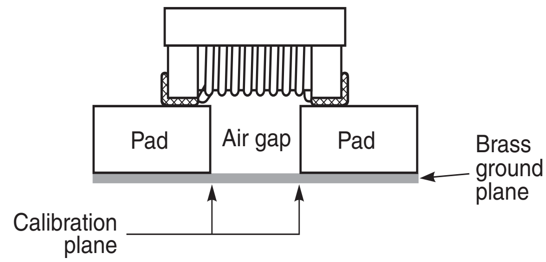


Figure 1. Test Setup

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 xx413RAE Chip Inductors

Part number	R1 (Ω)	R2 (Ω)	C (pF)	L (nH)	k	Upper limit (MHz)
xx413RAE100	8	0.10	0.065	9.8	1.96E-05	6700
xx413RAE120	7	0.10	0.100	12.0	2.40E-05	4900
xx413RAE150	7	0.10	0.153	15.0	3.12E-05	3700
xx413RAE180	7	0.10	0.083	18.0	3.16E-05	4600
xx413RAE220	8	0.10	0.124	22.0	3.69E-05	3400
xx413RAE270	8	0.10	0.185	27.0	4.41E-05	2500
xx413RAE330	9	0.10	0.117	33.0	5.18E-05	2900
xx413RAE390	9	0.20	0.149	39.0	5.50E-05	2300
xx413RAE470	9	0.20	0.118	47.0	6.40E-05	2400
xx413RAE560	7	0.20	0.160	56.0	7.40E-05	1900
xx413RAE680	6	0.20	0.137	68.0	9.20E-05	1900
xx413RAE820	12	0.20	0.179	81.0	1.15E-04	1500
xx413RAE101	13	0.60	0.135	100	1.25E-04	1600
xx413RAE121	13	0.60	0.136	120	1.51E-04	1400

Part number	R1 (Ω)	R2 (Ω)	C (pF)	L (nH)	k	Upper limit (MHz)
xx413RAE151	14	0.70	0.136	150	1.10E-04	1300
xx413RAE181	18	0.80	0.130	180	1.40E-04	1200
xx413RAE221	18	0.80	0.147	224	1.90E-04	1000
xx413RAE271	19	0.90	0.144	265	2.32E-04	900
xx413RAE331	20	1.10	0.132	330	2.84E-04	900
xx413RAE391	27	1.10	0.138	380	3.49E-04	800
xx413RAE471	31	1.20	0.156	465	4.27E-04	700
xx413RAE561	36	1.30	0.172	550	5.18E-04	600
xx413RAE621	37	1.40	0.143	615	5.74E-04	600
xx413RAE681	37	1.50	0.139	665	6.10E-04	600
xx413RAE751	44	1.50	0.138	740	6.90E-04	600
xx413RAE821	41	1.60	0.135	810	8.10E-04	600
xx413RAE911	53	1.70	0.155	895	7.80E-04	500
xx413RAE102	90	1.80	0.209	975	8.20E-04	400

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