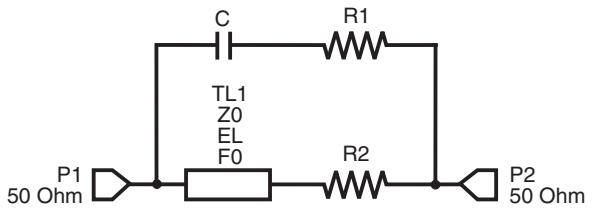
Transmission Line Model

1515SQ, 2222SQ, 2929SQ Air Core Inductors

These transmission line models accurately simulate the frequency-dependent behavior of Coilcraft surface mount "Spring" air core inductors within the frequency limits shown in the accompanying table for each individual inductor. They are based on de-embedded measurements using a 2-port network analyzer.

The model schematic, shown below, combines an ideal transmission line model with lumped elements. Each model should be analyzed only as a whole at the input and output ports. Conclusions based on individual lumped element values may be erroneous. The individual element values R1, R2, C, Z0, EL, and F0 are listed in the table for each individual spring inductor.



Effects due to different circuit board traces, board materials, ground planes or interactions with other components are not included. They *will* have a significant effect when comparing the simulation to measurements of the individual inductors using other production verification instruments and fixtures.

Typically, the Self-Resonant Frequency (SRF) of the inductor model will be higher than a 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. Data sheet specifications are based on typical production measurements. These models are based on de-embedded 2-port measurements as described below, so 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 of the parts is shown in the following table. The test pads were 30 mil (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.

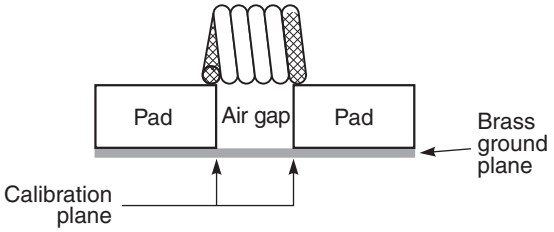


Figure 1. Test Setup

Part number	Air gap (inches/mm)	Part number	Air gap (inches/mm)
1515SQ-47N	0.100 / 2.540	2222SQ-xxx	0.140 / 3.556
1515SQ-68N	0.120 / 3.048	2929SQ-xxx	0.257 / 6.528
1515SQ-82N	0.140 / 3.556		

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 within the specified frequency limits of the model. The lumped element models were used to generate our 2-port S-parameters and therefore give identical results with the same number of simulation frequency points. The S-parameters are available on our web site at **http://www.coilcraft.com/models.cfm**.

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Transmission Line Model for Coilcraft 1515SQ, 2222SQ, 2929SQ

Part number	Frequency limit of Model (MHz)					TL1		
	Lower	Upper	R1 (Ω)	R2 (Ω)	C (pF)	Z0 (Ω)	EL (degrees)	F0 (MHz)
1515SQ-47N	10	2000	26.74	0.253	0.1886	308	48.6	940
1515SQ-68N	10	2250	21.52	0.463	0.1066	460	51.3	1000
1515SQ-82N	10	2000	10.76	0.607	0.1186	448	60.9	950
2222SQ-90N	10	1400	93.6	0.203	0.1796	604	56.4	1050
2222SQ-111	10	1200	234.6	0.248	0.1352	920	44.4	1030
2222SQ-131	10	1200	438.6	0.293	0.0842	1030	44.4	970
2222SQ-161	10	900	828.8	0.357	0.0558	1230	49.2	1040
2222SQ-181	10	800	1179	0.362	0.1506	1370	49.2	1040
2222SQ-221	10	850	4375	0.488	0.0508	1190	65.3	980
2222SQ-271	10	800	4855	0.600	0.0438	1430	65.3	960
2222SQ-301	10	500	5107	0.608	0.0026	1650	74.0	1140
2929SQ-331	10	650	10009	0.561	0.0365	2035	81.0	1390
2929SQ-361	10	600	9697	0.607	0.0355	2220	81.0	1390
2929SQ-391	10	550	9594	0.659	0.0360	2405	81.0	1390
2929SQ-431	10	500	3647	0.741	0.0365	2650	81.0	1390
2929SQ-501	10	400	2847	1.031	0.0385	3090	81.0	1390

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