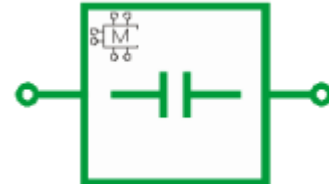# surface mount chip capacitor model

Model Features

- Broadband validation: DC – 20GHz
- Equivalent circuit based
- Substrate scalable: (1 ≤ H/Er ≤ 16)
- Part value scalable (0.1 to 100 pF)
- Land Pattern (Pad) scalable
- Accurate effective series resistance
- Developed for microstrip interconnects

CAP-PPI-0201N-001
0.1 to 100 pF
0201 Body Style

Model Description

The CAP-PPI-0201N-001 is a substrate scalable Global Model™ for the Passive Plus P/N 0201N surface mount chip capacitor family (additional information is available at www.passiveplus.com). The models are for use with microstrip applications and account for substrate (or printed circuit board) related parasitic effects. Substrate height, dielectric constant, loss tangent, interconnect metal thickness, component tolerance, pad width, pad length and pad gap are model input parameters. Models account for up to two higher-order resonant frequency pairs beyond the fundamental series resonant frequency. Accurate effective series resistance (ESR) is modeled over the frequency range. A single, substrate scalable and pad scalable Global Model™ is available that accurately emulate all capacitor values within the valid capacitance range. A Sim_mode switch allows pad stack effects to be disabled.
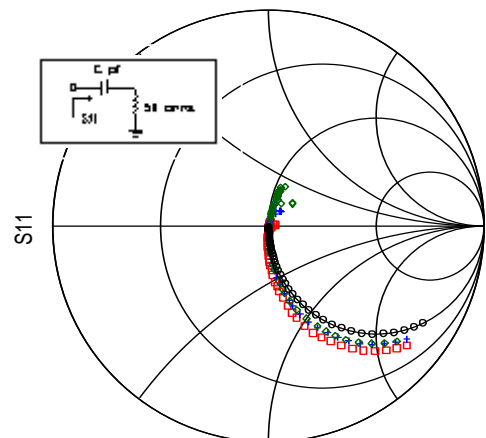
The pad dimensions used to develop datasheet plots for the model are: length = 0.28 mm, width = 0.3 mm, gap = 0.28 mm.

Frequency Sweep
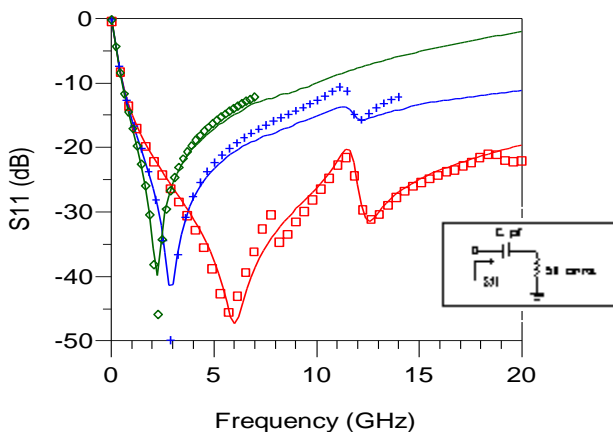
Legend: □ 4mil Rogers 4350B, + 14mil FR4, ◊ 59mil FR4, Lines - Model, Symbols - Measured data. Measured data stops at highest valid frequency for each substrate.
S11 for 8.2 pF capacitor mounted on various substrates from 0.04 to 20 GHz.

Part Value Sweep

Legend: □ 4mil Rogers 4350B, + 14mil FR4, ◊ 59mil FR4, O Ideal Model S11 at 5 GHz for capacitor values from 0.1 to 100 pF on various substrates compared to an ideal capacitor response.

Technical Notes

- Two–port S-parameters were measured using a vector network analyzer and on-board probing with calibration referenced to the outside edges of the component pad stack.
- Capacitors were measured in a series microstrip configuration. Models for alternative interconnect configurations (e.g. coplanar waveguide) are available upon request.
- Substrates used to extract the models: 4 mil Rogers 4350B, 14mil FR4, and 59mil FR4.
- Typical range of valid substrate types (substrate height H in mils and dielectric constant Er):
  $1 \leq H/Er \leq 16$.
- Effective series resistance (ESR) was measured using a 34A Boonton Coaxial Resonator Line.
- Highest frequency for measurement validation: 6GHz (59mil FR4), 14 GHz (14mil FR4), and 20 GHz (4 mil RO4350B)
- Multiple simulation modes (Sim_mode) are available - full mode, ideal mode and no pad stack.

Capacitor Values (pF)
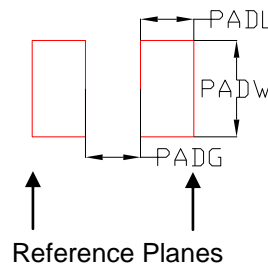
0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
0.9	1	1.1	1.2	1.3	1.4	1.5	1.6
1.7	1.8	1.9	2	2.1	2.2	2.4	2.7
3	3.3	3.6	3.9	4.3	4.7	5.1	5.6
6.2	6.8	7.5	8.2	9.1	10	11	12
13	15	16	18	20	22	24	27
30	33	36	39	43	47	51	56
62	68	75	82	91	100		

Highlighted capacitor values are measurement-based models. Other models found via interpolation. Table shows 62 part values in the model range based on manufacturer's datasheet.

PC Board Footprint

9.84(0.25) ≤ PADL ≤ 22.05(0.56)
11.81(0.3) ≤ PADW ≤ 20.47(0.52)
5.91(0.15) ≤ PADG ≤ 11.81(0.3)

Units in mils (mm)

Reference Planes
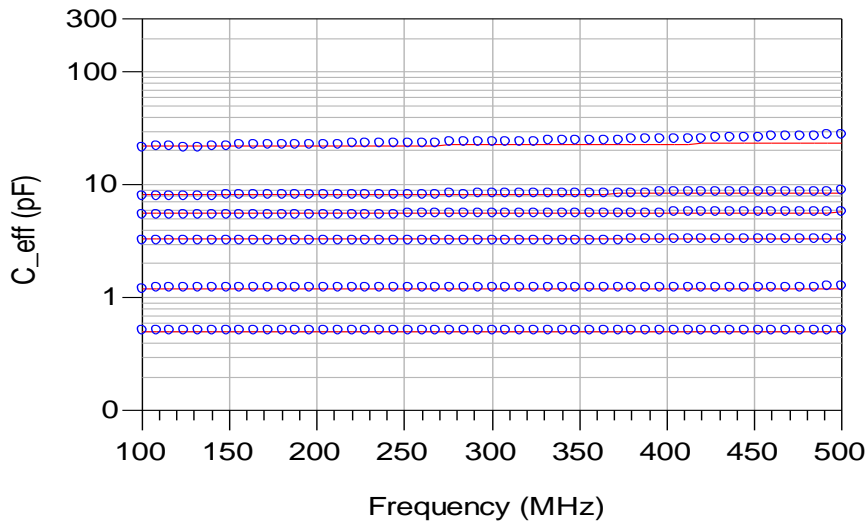
Device in Position

Model Input Parameters

- C - Nominal component value in pF. The full parasitic model is invoked if the part value is within the valid limits of the model, otherwise an ideal element model is used.
- Subst - Microstrip substrate instance name. The model will reference the named substrate instance to obtain values for H, Er, T and TanD.
- Sim_mode - 0 for full parasitic model, 1 for ideal element, 2 for removing pad effects.
- Pad_mode – 0 for default to Sim_mode, 1 for pads always in layout, 2 for pads never in layout
- Tolerance - Tolerance of the part value. The nominal value for this parameter should be set to 1. Use for statistical distribution.
- Pad_Width - Width of land patter footprint
- Pad_Length - Length of land pattern footprint
- Pad_Gap - Gap between land pattern footprint

Typical Measured Series 2-port S–parameter Data vs. Simulated Data

4 mil Rogers Substrate

4 mil Rogers Substrate

59 mil FR4 Substrate

59 mil FR4 Substrate
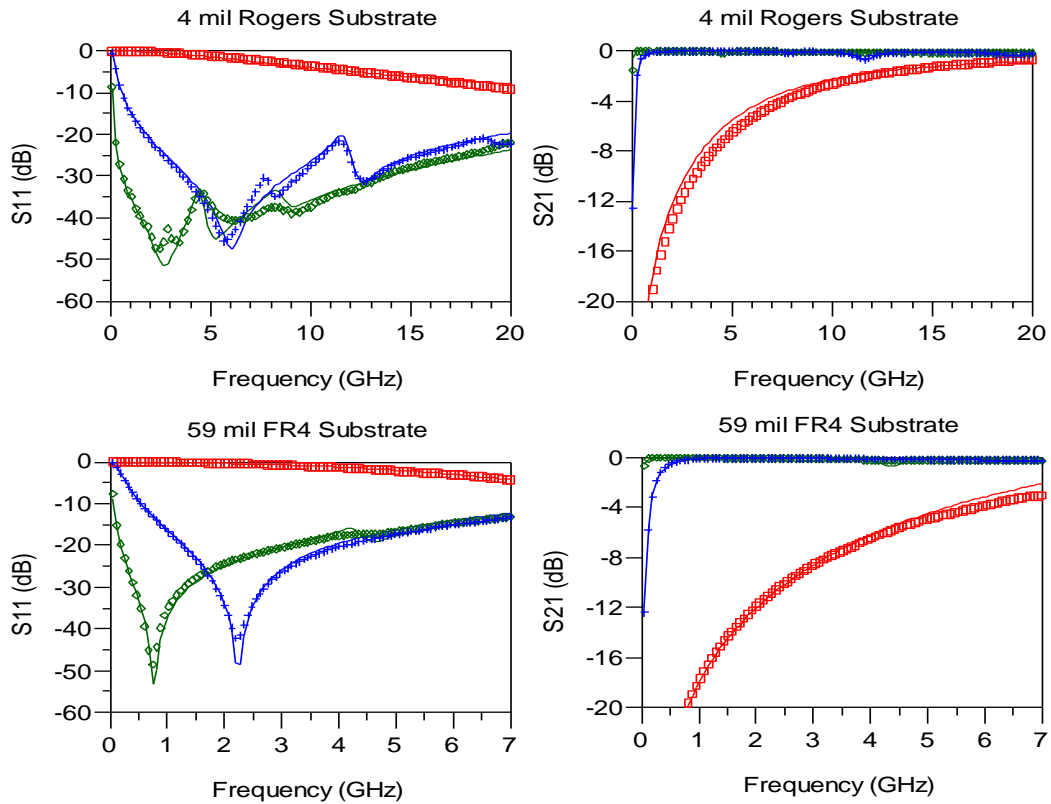
Legend: □ 0.2 pF, + 8.2 pF, ◊ 82 pF, Solid lines - Model data, Symbols - Measured data

Effective Capacitance

Legend: Red solid lines - Model response on 60 mil Rogers 4003
Blue symbols - Measurement on 60 mil Rogers 4003
Note: Plot is based on selected part values from 0.1-100pF from the manufacturer's Q-factor plot in their part's datasheet.

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Simulated Q-Factor
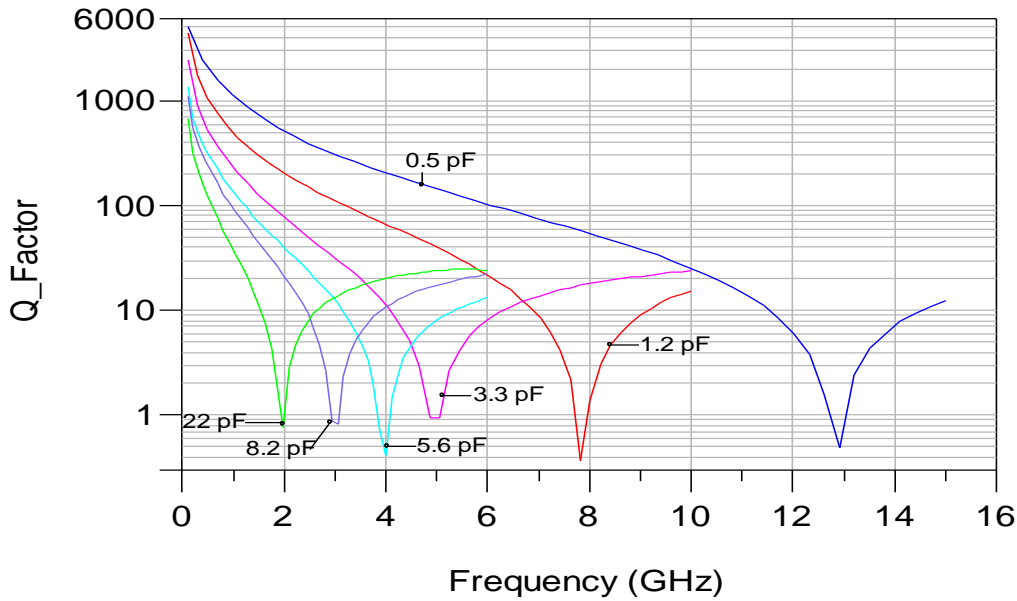
Legend: solid lines - Model response on 60 mil Rogers 4003
Note: Plot is based on selected part values from 0.1-100pF from the manufacturer's Q-factor plot in their part's datasheet.

Model and Datasheet Revision Notes

12/17/2012   Original model and datasheet development

01/30/2013   Datasheet format change