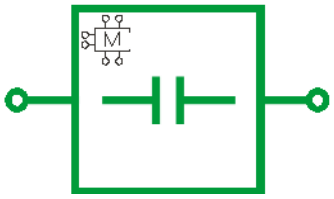
surface mount chip capacitor model

Model Features*

- Broadband validation: DC – 50 GHz
- Equivalent circuit based
- Substrate scalable: (0.9 ≤ H/Er ≤ 8.6 mil)
- Part value scalable: (0.5 to 27 pF)
- Land Pattern (Pad) scalable
- Orientation Selectable (H/V)
- Validation: Equivalent series resistance
- Developed for microstrip interconnects

** See Technical Notes for more details*



CAP-AMH-0402-001
(0.5 to 27 pF)
0402 Body Style

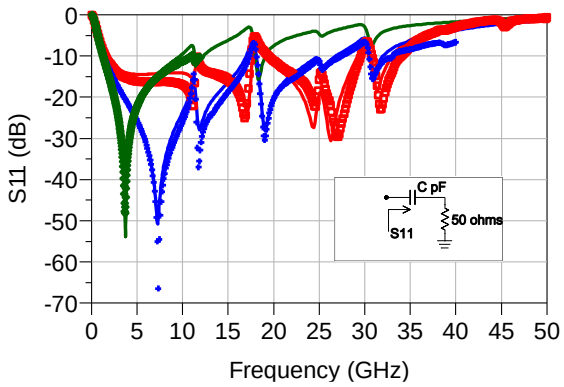
Model Description

The CAP-AMH-0402-001 is a substrate scalable Microwave Global Model™ for the P/N A60L surface mount chip capacitor family (additional information is available at http://global.amotech.co.kr/wp/). 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, component value, pad width, pad length, and pad gap, and orientation are model input parameters. Models account for up to two higher-order resonant frequency pairs beyond the fundamental series resonant frequency. The model is validated with measured equivalent series resistance (ESR). A single, substrate scalable, pad scalable, and orientation selectable Microwave Global Model™ is available that accurately emulates all capacitor values within the valid capacitance range. A Sim_mode switch allows pad stack effects to be disabled.

Model simulation may vary slightly based on simulator used.

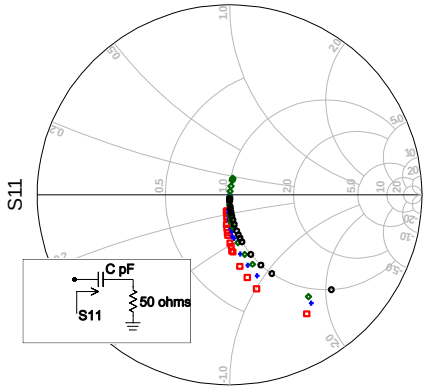
The pad dimensions used to develop datasheet plots for the model are: length = 17.0 (0.432), width = 20.0 (0.507), gap = 20.1 (0.510).

Frequency Sweep



Legend: □ 4 mil Rogers 4350B, + 10 mil Rogers 4350B, ◊ 30 mil Rogers 4350B.Lines - Model, Symbols - Measured data. Measured data stops at highest valid frequency for each substrate.
S11 for a 3.3 pF capacitor mounted on various substrates from 0.05 to 50.0 GHz.

Part Value Sweep



Legend: □ 4 mil Rogers 4350B, + 10 mil Rogers 4350B, ◊ 30 mil Rogers 4350B O Ideal
Model S11 at 3.0 GHz for capacitor values from 0.5 to 27 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 2-port series configuration using a 50-ohm microstrip test fixture. Models for alternative interconnect configurations (e.g. coplanar waveguide) are available upon request.
- Nominal part value range (0.5 to 27 pF)
  - Tolerance on low value: 50%
  - Tolerance on high value: 5%
  - Actual part value range (0.2 to 28.4 pF).
- Pad scalable models are validated with S-parameter measurements within the recommended pad range.
- Substrates used to extract the models: 4 mil Rogers 4350B, 10 mil Rogers 4350B, and 30 mil Rogers 4350B.
- Measurement validated substrate range of substrate height and dielectric constant ratios based on substrates used to develop model:

  0.9 ≤ H/Er ≤ 8.6 (mil)

  0.02 ≤ H/Er ≤ 0.22 (mm)
- Equivalent series resistance (ESR) was measured using a Boonton model 34A coaxial resonator line.
- Highest frequency for measurement validation: 50 GHz (4 mil Rogers 4350B), 40 GHz (10 mil Rogers 4350B), and 12 GHz (30 mil Rogers 4350B)
- Multiple simulation modes (Sim_mode) are available - full mode, ideal mode and no pad stack.

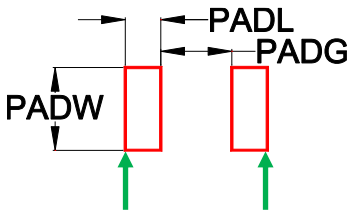
Device Image

Capacitor Values (pF)

0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2
1.3	1.5	1.6	1.8	2.0	2.2	2.4	2.7
3.0	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
15	18	20	22	24	27		

Highlighted capacitor values are measurement-based models. Other models found via interpolation. Table shows 38 part values in the model range based on manufacturer's datasheet.

PC Board Footprint



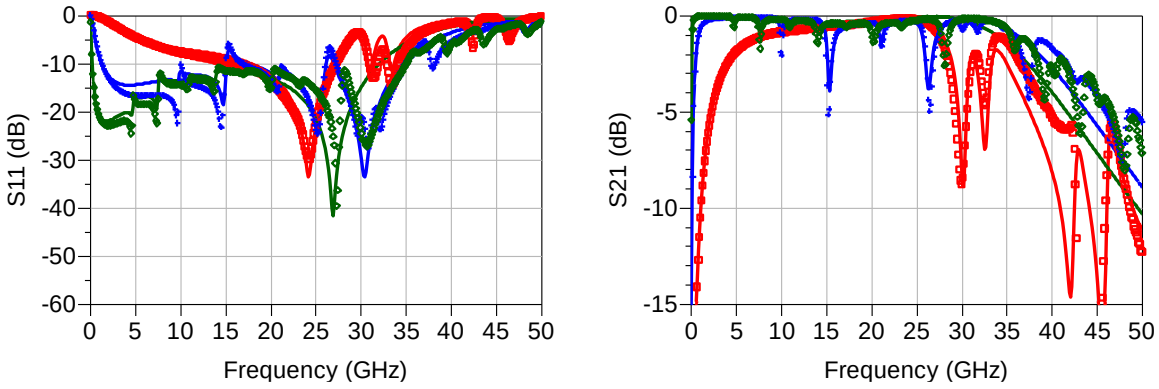
17.0 (0.43) ≤ PADL ≤ 28.3 (0.72)
20.0 (0.52) ≤ PADW ≤ 28.3 (0.72)
11.0 (0.28) ≤ PADG ≤ 20.1 (0.51)
Units in mil (mm)

Model Input Parameters

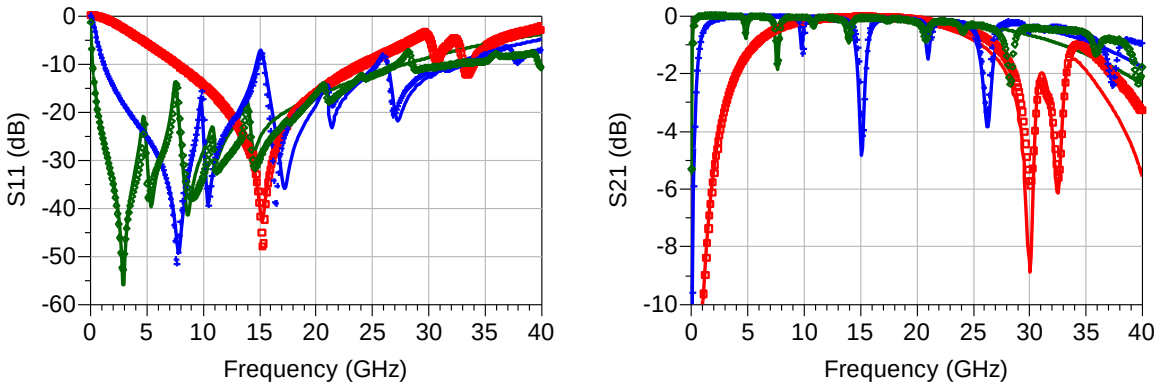
- C - Nominal component value in pF. The full parasitic model is invoked if the part value is within the valid limits of the model, otherwise an ideal element model is used.
- Subst - Microstrip substrate instance name. The model will reference the named substrate instance to obtain values for H, Er, T and TanD.
- Sim_mode - 0 for full parasitic model, 1 for ideal element, 2 for removing pad effects, 3 for simplified parasitic model
- 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 pattern footprint
- Pad_Length - Length of land pattern footprint
- Pad_Gap - Pad - to - pad spacing (inside pad edge - to - inside pad edge)
- Orient – 0 for Horizontal, 1 for Vertical
- C_Discrete - Discrete input parameter based on manufacturer available part values can be used for tuning and optimization. Overrides C input parameter.

Model vs. Measured Series 2-port S-parameter Data

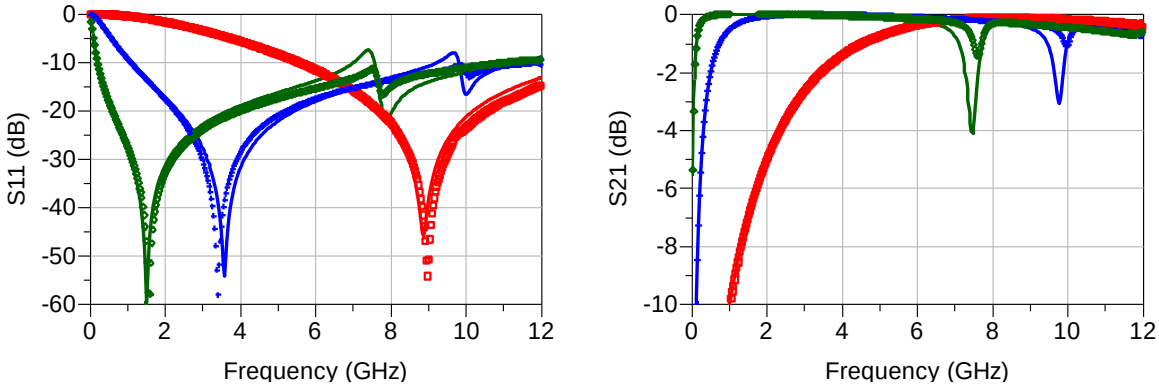
4 mil Rogers 4350B (H/Er = 0.9 mil):



10 mil Rogers 4350B (H/Er = 2.6 mil):

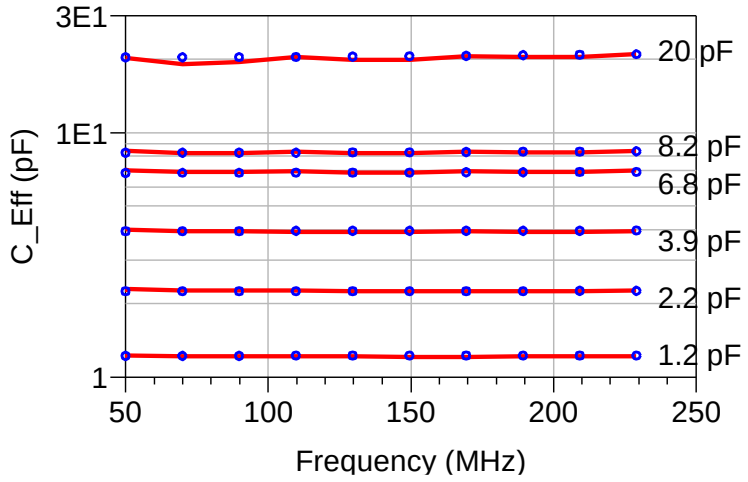


30 mil Rogers 4350B (H/Er = 8.6 mil):



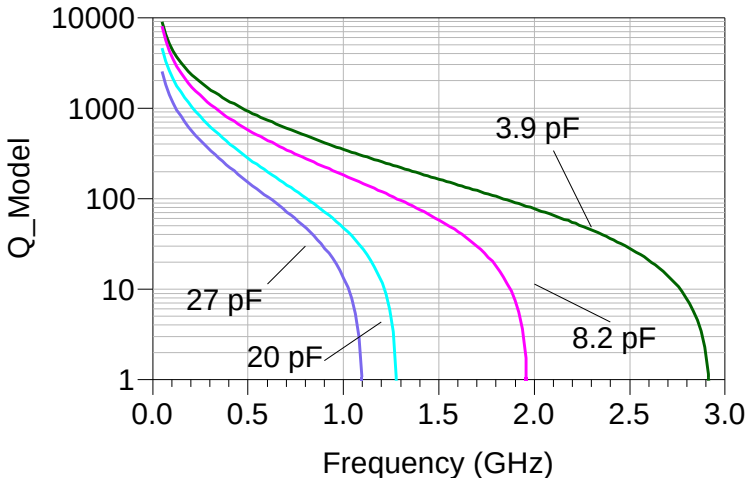
Legend: □ 0.5 pF, + 3.9 pF, ◊ 22 pF, Solid lines - Model data, Symbols - Measured data

Effective Capacitance



Legend: Red solid lines - Model response on 30 mil Rogers 4350B
Blue symbols - Measurement on 30 mil Rogers 4350B
Note: Plot shows selected values within the model range.

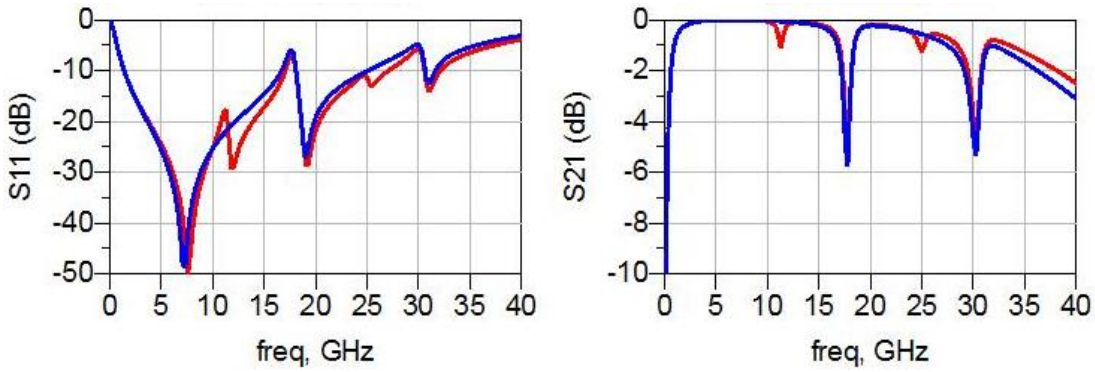
Simulated Q-Factor



Legend: solid lines - Model response on 30 mil Rogers 4350B
Note: Plot shows selected values within the model range.

Horizontal vs. Vertical Model Comparison

10 mil Rogers 4350B (H/Er = 2.6 mil):



Legend: 3.3 pF Capacitor. Blue line - Vertical Model performance, Red Line - Horizontal Model performance

Model and Datasheet Revision Notes

09/15/2021 Original model and datasheet development