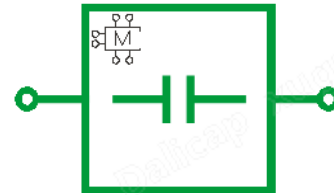


surface mount chip capacitor model

Model Features*

- Broadband validation: DC – 30 GHz
- Equivalent circuit based
- Substrate scalable: ($0.9 \leq H/Er \leq 17$ mil)
- Part value scalable: (0.3 to 5100 pF)
- Land Pattern (Pad) scalable
- Orientation Selectable (H/V)
- Validation: Equivalent series resistance
- Developed for microstrip interconnects

* See Technical Notes for more details



CAP-DLP-1111-001
(0.3 to 5100 pF)
1111 Body Style

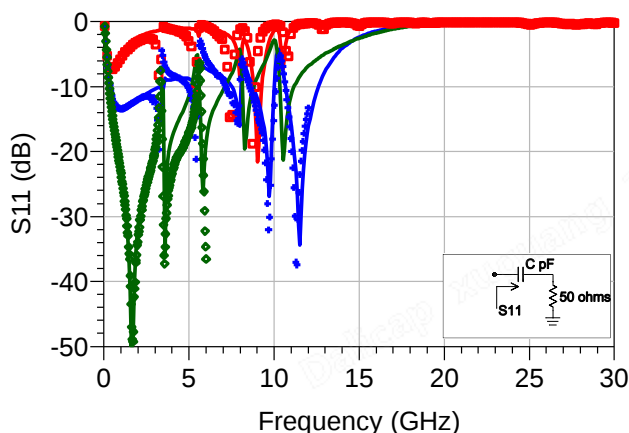
Model Description

The CAP-DLP-1111-001 is a substrate scalable Microwave Global Model™ for the Dalicap P/N DLP70B surface mount chip capacitor family (additional information is available at www.dalicap.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, 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.

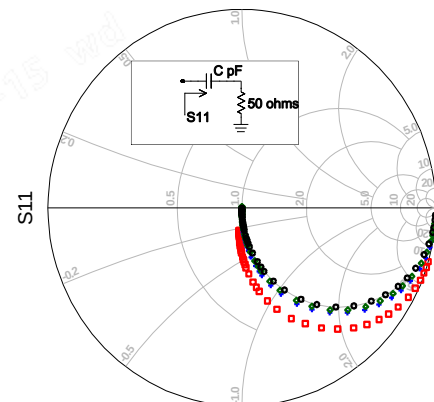
The pad dimensions used to develop datasheet plots for the model are: length = 59.1 (1.500), width = 110.2 (2.800), gap = 78.7 (2.000). Units in mil (mm).

Frequency Sweep



Legend: ■ 4 mil Rogers 4350B, + 20 mil Rogers 4350B, ◇ 60 mil Rogers 4003C. Lines - Model, Symbols - Measured data. Measured data stops at highest valid frequency for each substrate. S11 for a 15 pF capacitor mounted on various substrates from 0.045 to 30.0 GHz.

Part Value Sweep



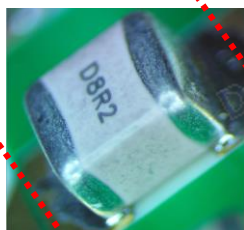
Legend: ■ 4 mil Rogers 4350B, + 20 mil Rogers 4350B, ◇ 60 mil Rogers 4003C O Ideal. Model S11 at 0.2 GHz for capacitor values from 0.3 to 5100 pF on various substrates compared to an ideal capacitor response.



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 (0.3 to 5100 pF)
 - Tolerance low value: $\pm 0.1\text{pF}$
 - Tolerance on high value: 5%
- Pad scalable models are validated with S-parameter measurements within the recommended pad range.
- Substrates used to extract the models: 4 mil Rogers 4350B, 20 mil Rogers 4350B, and 60 mil Rogers 4003C.
- Measurement validated substrate range of substrate height and dielectric constant ratios based on substrates used to develop model:
 $1 \leq H/Er \leq 16.4$ (mil)
 $0.02 \leq H/Er \leq 0.42$ (mm)
- Equivalent series resistance (ESR) was measured using a Boonton 34A resonant line.
- Highest frequency for measurement validation: 30 GHz (4 mil Rogers 4350B), 12 GHz (20 mil Rogers 4350B), and 6 GHz (60 mil Rogers 4003C)
- Multiple simulation modes (Sim_mode) are available - full mode, ideal mode and no pad stack.

Device Image



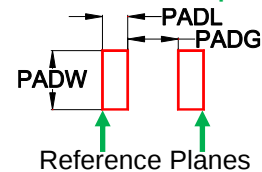
Reference Planes at pad edge

Capacitor Values (pF)

0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.2
1.5	1.6	1.8	2	2.2	2.4	2.7	3	3.3	3.9	4.7
5.6	6.8	8.2	10	12	15	18	20	22	24	27
30	33	39	43	47	51	56	68	75	82	91
100	120	150	180	200	220	270	330	390	430	470
510	560	1000	1500	1800	2200	2700	4700	5100	5600	10000

Highlighted capacitor values are measurement-based models. Other models found via interpolation. Table shows 66-part values in the model range based on manufacturer's datasheet.

PC Board Footprint



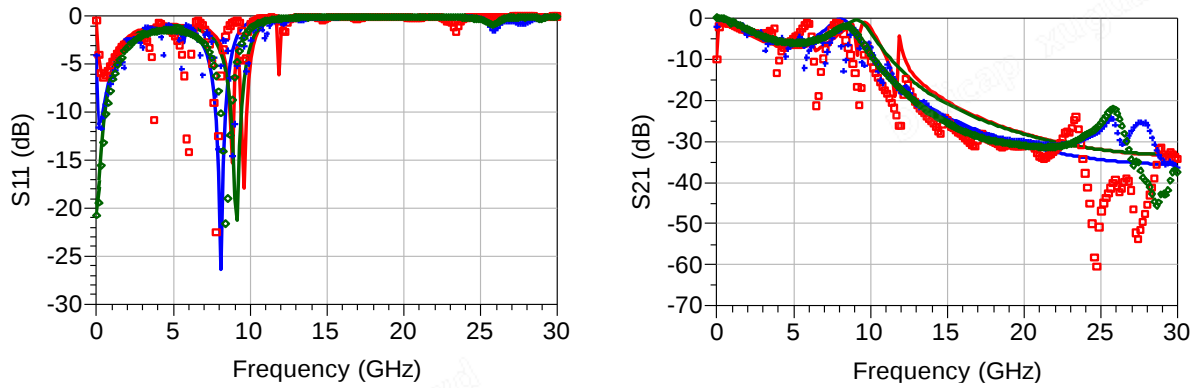
$$\begin{aligned} 37.4 (0.950) &\leq \text{PADL} \leq 59.1 (1.500) \\ 102.36 (2.600) &\text{PADW} = 110.2 (2.800) \\ 72.8 (1.850) &\leq \text{PADG} \leq 78.7 (2.000) \\ \text{Units in mil (mm)} \end{aligned}$$

Model Input Parameters

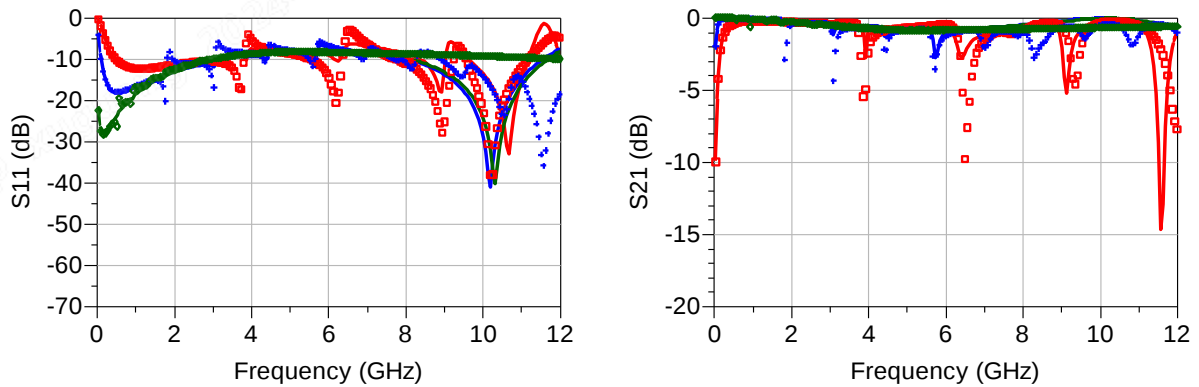
- C - Nominal component value in pF. The full parasitic model is invoked if the part value is within the valid limits of the model, otherwise an ideal element model is used.
- Subst - Microstrip substrate instance name. The model will reference the named substrate instance to obtain values for H, Er, 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

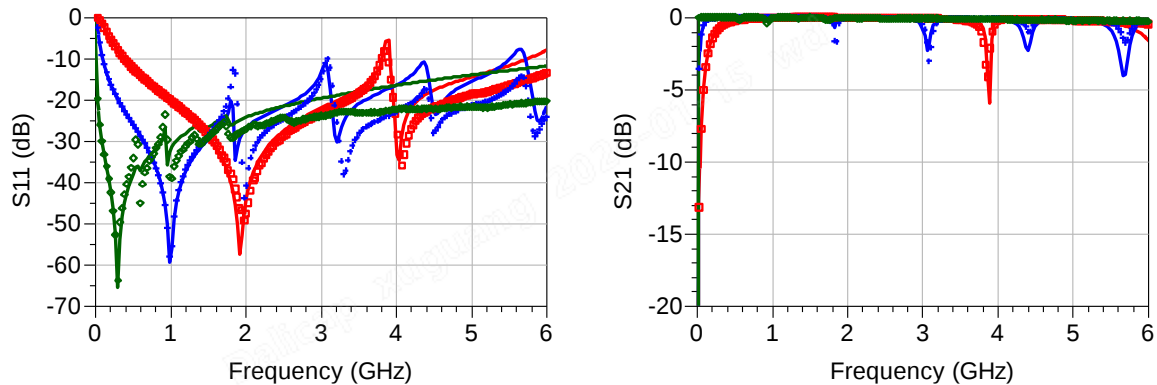
4 mil Rogers 4350B Substrate (H/Er = 1.0 mil):



20 mil Rogers 4350B Substrate (H/Er = 5.33 mil):

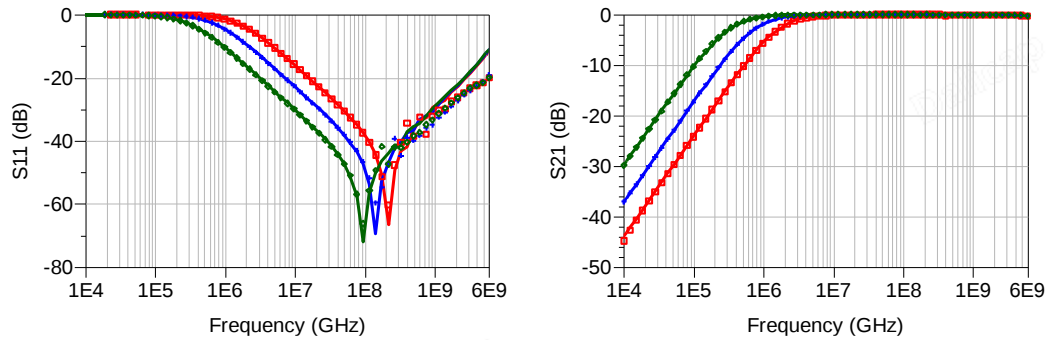


60 mil Rogers 4003C Substrate (H/Er = 16.4 mil):

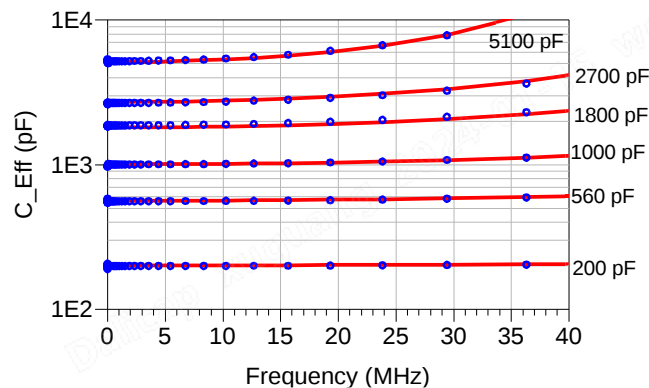
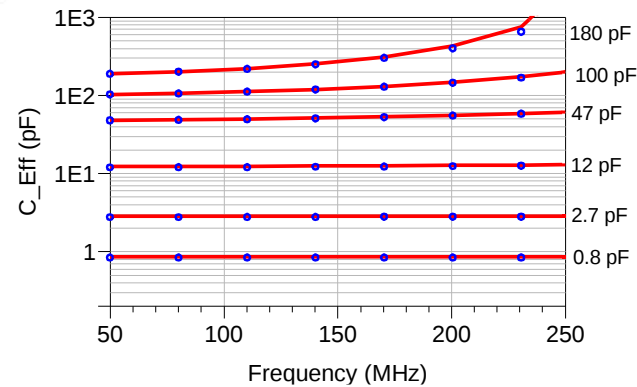


Legend: $\square$ 12 pF, $+$ 47 pF, $\diamond$ 510 pF, Solid lines - Model data, Symbols - Measured data

60 mil Rogers 4003C Substrate (H/Er = 16.4 mil):

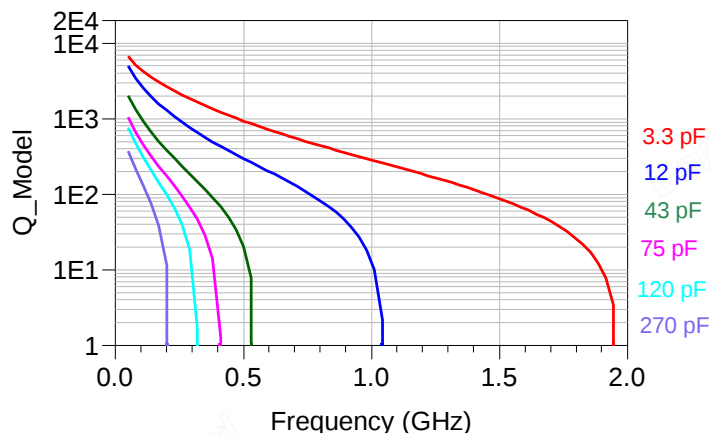


Effective Capacitance



Legend: Red solid lines - Model response on 60 mil Rogers 4003C
Blue symbols - Measurement on 60 mil Rogers 4003C
Note: Plot shows selected values within the model range.

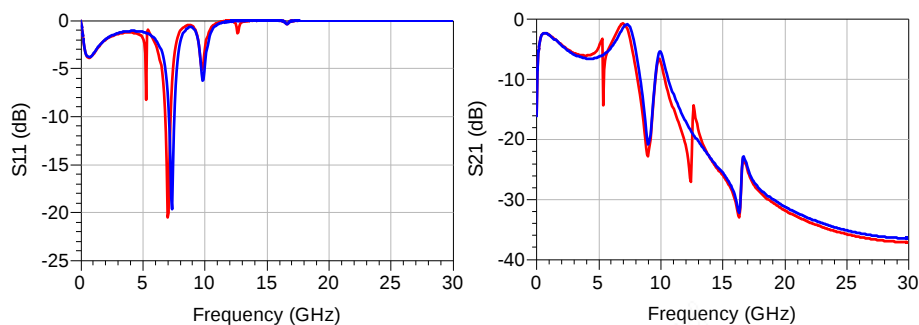
Simulated Q-Factor



Legend: solid lines - Model response on 60 mil Rogers 4003C
Note: Plot shows selected values within the model range.

Horizontal vs. Vertical Model Comparison

4 mil Rogers 4350B Substrate (H/Er = 1.0 mil):

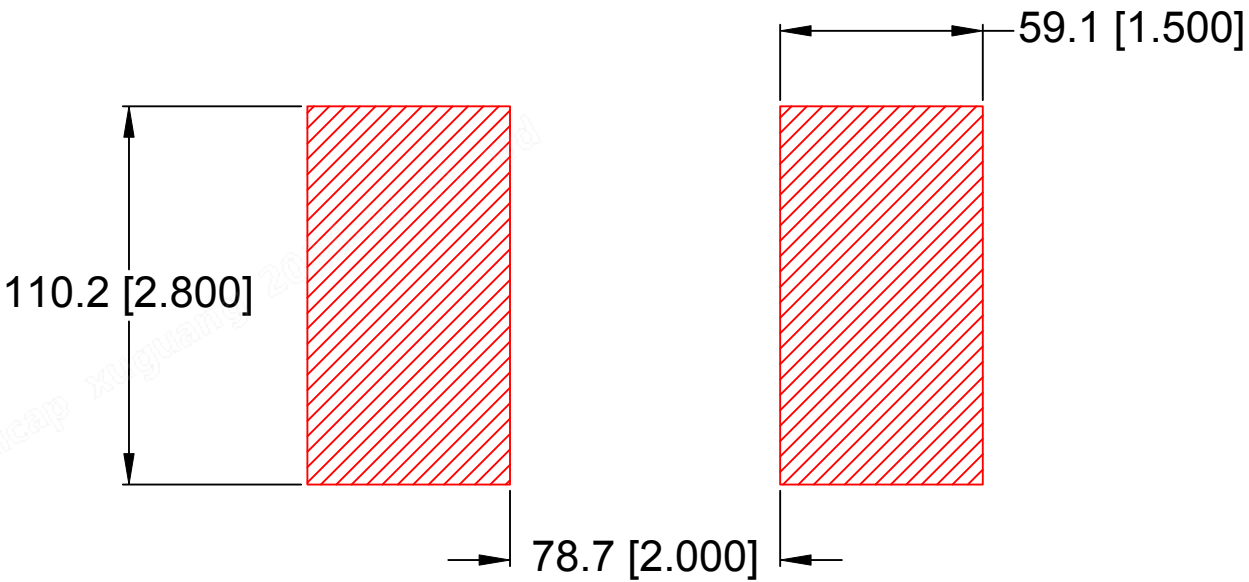


Legend: 5.6 pF Capacitor. Red Line - Horizontal Model performance and Blue line - Vertical Model performance

Model and Datasheet Revision Notes

12/22/2023 Original model and datasheet development

NOMINAL FOOTPRINT



Denotes plated copper land pattern
free of solder mask.



Title Modelithics, INC.

CONTROLLING DIMENSIONS - MILS (0.001")
[METRIC DIM - mm] FOR REFERENCE ONLY

Scale
NOT TO
SCALE

Drawn by
MDLX

File Name CAP-DLP-1111-001_datasheet.dwg

Date 12-19-2023

Sheet 1

Rev
1