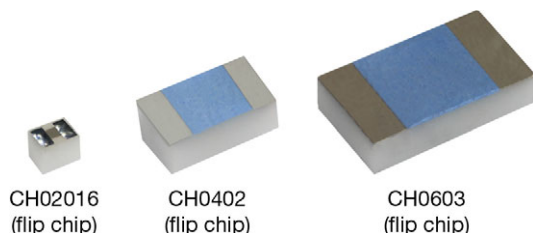


# High Frequency 70 GHz Thin Film Chip Resistor


CH02016  
(flip chip)

CH0402  
(flip chip)

CH0603  
(flip chip)

## LINKS TO ADDITIONAL RESOURCES



3D Models



S-Parameters


Simulation  
Tools

Application  
Notes

Capabilities and  
Custom Options

Did You  
Know?


Infographics


Why It  
Matters

## FEATURES

- Operating frequency 70 GHz
- Thin film microwave resistors
- Flip chip, wraparound or one face termination
- Ohmic range: 10  $\Omega$  to 500  $\Omega$
- Design kits available
- Modelithics® library available
- Small internal reactance (LC down to  $1 \times 10^{-24}$ )
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**  
**GREEN**  
(5-2008)

Those miniaturized components are designed in such a way that their internal reactance is very small. When correctly mounted and utilized, they function as almost pure resistors on a very large range of frequency, up to 50 GHz for CH0402 and CH0603, and 70 GHz for CH02016 from 10  $\Omega$  to 500  $\Omega$ .

## STANDARD ELECTRICAL SPECIFICATIONS

| MODEL   | SIZE  | RESISTANCE RANGE $\Omega$ | RATED POWER $P_n$ W | LIMITING ELEMENT VOLTAGE V | TOLERANCE $\pm$ % | TEMPERATURE COEFFICIENT $\pm$ ppm/ $^{\circ}$ C |
|---------|-------|---------------------------|---------------------|----------------------------|-------------------|-------------------------------------------------|
| CH02016 | 02016 | 10 to < 50                | 0.030               | 30                         | 5                 | 100 (50 upon request)                           |
| CH02016 | 02016 | 50 to $\leq$ 500          | 0.030               | 30                         | 2, 5              | 100 (50 upon request)                           |
| CH02016 | 02016 | 50 and 100                | 0.030               | 30                         | 1, 2, 5           | 100 (50 upon request)                           |
| CH0402  | 0402  | 10 to < 50                | 0.300               | 37                         | 2, 5              | 100 (50 upon request)                           |
| CH0402  | 0402  | 50 to $\leq$ 500          | 0.300               | 37                         | 1, 2, 5           | 100 (50 upon request)                           |
| CH0603  | 0603  | 10 to < 50                | 0.400               | 50                         | 2, 5              | 100 (50 upon request)                           |
| CH0603  | 0603  | 50 to $\leq$ 500          | 0.400               | 50                         | 1, 2, 5           | 100 (50 upon request)                           |

### Note

(1) PCB mounting with +70  $^{\circ}$ C ambient temperature

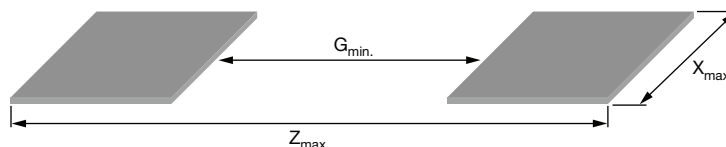
## DIMENSIONS in millimeters (inches)

|                                                        |                                |                                                      |
|--------------------------------------------------------|--------------------------------|------------------------------------------------------|
| <b>CH02016 F / CH02016 P / CH0402 P / CH0603 P</b><br> | <b>CH0402 F / CH0603 F</b><br> | <b>CH0402 N / CH0402 G / CH0603 N / CH0603 G</b><br> |
|--------------------------------------------------------|--------------------------------|------------------------------------------------------|

| CASE SIZE<br>MODEL /<br>TERMINATION | DIMENSIONS                |                           |                            |                                     |                  |                            |                            |
|-------------------------------------|---------------------------|---------------------------|----------------------------|-------------------------------------|------------------|----------------------------|----------------------------|
|                                     | $\pm$ 0.10 ( $\pm$ 0.004) | $\pm$ 0.10 ( $\pm$ 0.004) | $\pm$ 0.127 ( $\pm$ 0.005) | D<br>E when applicable<br>MIN. MAX. |                  | $\pm$ 0.050 ( $\pm$ 0.002) | $\pm$ 0.050 ( $\pm$ 0.002) |
| CH02016 F<br>CH02016 P              | 0.480 (0.020)             | 0.390 (0.016)             | 0.420 (0.016) (1)          | 0.110<br>(0.004)                    | 0.150<br>(0.006) | 0.260 (0.010)              | 0.300 (0.012)              |
| CH0402 F<br>CH0402 N<br>CH0402 G    | 1.000 (0.040)             | 0.600 (0.023)             | 0.500 (0.020)              | 0.150<br>(0.006)                    | 0.350<br>(0.014) | n/a                        | n/a                        |
| CH0402 P                            | 1.200 (0.047)             | 0.600 (0.023)             | 0.500 (0.020)              | 0.110<br>(0.004)                    | 0.150<br>(0.006) | 0.320 (0.013)              | 0.880 (0.035)              |
| CH0603 F<br>CH0603 N<br>CH0603 G    | 1.520 (0.060)             | 0.850 (0.033)             | 0.500 (0.020)              | 0.250<br>(0.010)                    | 0.510<br>(0.020) | n/a                        | n/a                        |
| CH0603 P                            | 1.720 (0.068)             | 0.850 (0.033)             | 0.500 (0.020)              | 0.235<br>(0.009)                    | 0.275<br>(0.011) | 0.660 (0.026)              | 1.355 (0.053)              |

### Note

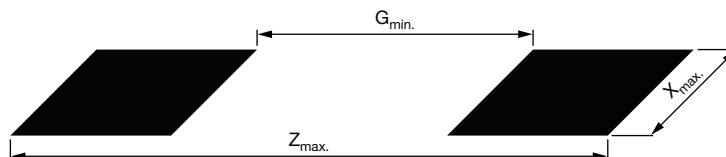
(1)  $\pm$  0.070 ( $\pm$  0.003)

**LAND PATTERN FOR F “FLIP CHIP” TERMINATIONS** in millimeters (inches)


| CHIP SIZE | $Z_{max.}$   | $X_{max.}$   | $G_{min.}$   |
|-----------|--------------|--------------|--------------|
| 02016     | 0.53 (0.021) | 0.44 (0.017) | 0.15 (0.006) |
| 0402      | 1.40 (0.055) | 0.65 (0.026) | 0.40 (0.016) |
| 0603      | 1.71 (0.067) | 0.90 (0.035) | 0.76 (0.030) |

**Note**

- Suggested land pattern: according to IPC-7351

**LAND PATTERN FOR N AND G WRAPAROUND TERMINATIONS** in millimeters (inches)


| CHIP SIZE | $Z_{max.}$   | $X_{max.}$   | $G_{min.}$   |
|-----------|--------------|--------------|--------------|
| 0402      | 1.55 (0.061) | 0.73 (0.029) | 0.15 (0.006) |
| 0603      | 2.37 (0.093) | 0.98 (0.039) | 0.35 (0.014) |

Dimension and tolerance of land pattern shall be defined by PCB designer; PCB can be designed according to IPC-7351A “Generic Requirements for Surface Mount Design and Land Pattern Standard”

**PERFORMANCE (CH02016 F TERMINATION)**

| TEST PROCEDURES AND REQUIREMENTS |                              |                                                                                                                                                                           |                                     |                                      |
|----------------------------------|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|--------------------------------------|
| AEC-Q200 CLAUSE                  | TEST                         | PROCEDURE                                                                                                                                                                 | GLOBAL PERFORMANCES                 | TYPICAL PERFORMANCES (25 Ω TO 250 Ω) |
| 3                                | High temperature exposure    | MIL-STD-202 method 108<br>1000 h at $T = 125\text{ }^{\circ}\text{C}$ ,<br>unpowered                                                                                      | $\pm 2\% \pm 0.05\text{ }\Omega$    | $\pm 0.2\% \pm 0.05\text{ }\Omega$   |
| 4                                | Temperature cycling          | JESD22 method JA-104<br>1000 cycles ( $-55\text{ }^{\circ}\text{C}$ to $+155\text{ }^{\circ}\text{C}$ )                                                                   | $\pm 1.8\% \pm 0.05\text{ }\Omega$  | $\pm 1.5\% \pm 0.05\text{ }\Omega$   |
| 7                                | Biased humidity              | MIL-STD-202 method 103<br>1000 h $85\text{ }^{\circ}\text{C} / 85\text{ }\%$ RH<br>10 % of operating power                                                                | $\pm 2\% \pm 0.05\text{ }\Omega$    | $\pm 0.75\% \pm 0.05\text{ }\Omega$  |
| 8                                | Operational life             | MIL-STD-202 method 108<br>condition D steady state<br>$T = 125\text{ }^{\circ}\text{C}$ at rated power<br>90' on / 30' off / 1000 h                                       | $\pm 2.5\% \pm 0.05\text{ }\Omega$  | $\pm 1\% \pm 0.05\text{ }\Omega$     |
| 13                               | Mechanical shock             | MIL-STD-202 method 213<br>condition C<br>100 g/6 ms 3.75 m/s<br>3 shock/direction,<br>2 directions along 3 axes (18 shocks)                                               | $\pm 0.05\% \pm 0.05\text{ }\Omega$ | $\pm 0.015\% \pm 0.05\text{ }\Omega$ |
| 14                               | Vibration                    | MIL-STD-202 method 204<br>5 g for 20 min,<br>12 cycles each of 3 orientations<br>Test from 10 Hz to 2000 Hz                                                               | $\pm 0.1\% \pm 0.05\text{ }\Omega$  | $\pm 0.05\% \pm 0.05\text{ }\Omega$  |
| 15                               | Resistance to soldering heat | MIL-STD-202 method 210<br>condition D<br>Flux used: alpha 611<br>Solder temp.: $260\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$<br>Total immersion during 10 s | $\pm 2.5\% \pm 0.05\text{ }\Omega$  | $\pm 0.5\% \pm 0.05\text{ }\Omega$   |

| TEST PROCEDURES AND REQUIREMENTS |                  |                                                                                                                       |                                                                   |                                            |
|----------------------------------|------------------|-----------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|--------------------------------------------|
| AEC-Q200<br>CLAUSE               | TEST             | PROCEDURE                                                                                                             | GLOBAL<br>PERFORMANCES                                            | TYPICAL<br>PERFORMANCES<br>(25 Ω TO 250 Ω) |
| 17                               | ESD              | AEC-Q200-002                                                                                                          | Classification 1C<br>1000 V <sub>DC</sub> to 2000 V <sub>DC</sub> |                                            |
| 18                               | Solderability    | J-STD-002<br>- Preconditioning 4 h dry heat<br>aging and 235 °C SnPb 5 s<br>- 215 °C SnPb 5 s<br>- 260 °C SnAgCu 10 s | Good tinning (≥ 95 % covered)<br>No visible damage                |                                            |
| 20                               | Flammability     | UL 94                                                                                                                 | Class V-0<br>No burning                                           |                                            |
| 21                               | Board flex       | AEC-Q200-005                                                                                                          | ± 0.1 % ± 0.05 Ω                                                  | ± 0.05 % ± 0.05 Ω                          |
| 24                               | Flame retardance | AEC-Q200-001                                                                                                          | No flame, no explosion,<br>no temperature higher than 350 °C      |                                            |

## PREFERRED MODELS AND VALUES

Vishay Sfernice highly recommend to use the smallest sizes and flip chip version to get the best performances.

### Recommended Values:

10 Ω / 18 Ω / 25 Ω / 50 Ω / 75 Ω / 100 Ω / 150 Ω / 180 Ω /  
200 Ω / 250 Ω / 330 Ω / 500 Ω

Those values are available with a **MOQ of 100 pieces**.

**Other values can be ordered upon request, but higher  
MOQ will apply: 1000 pieces for CH02016, 500 pieces for  
CH0402, 250 pieces for CH0603.**

### Recommended termination:

F

### Recommended tolerance:

2 %

## DESIGN KITS

Design kits are available ex stock in CH02016 and CH0402 sizes. There are 20 pieces per recommended value. F termination.  
5 % tolerance.

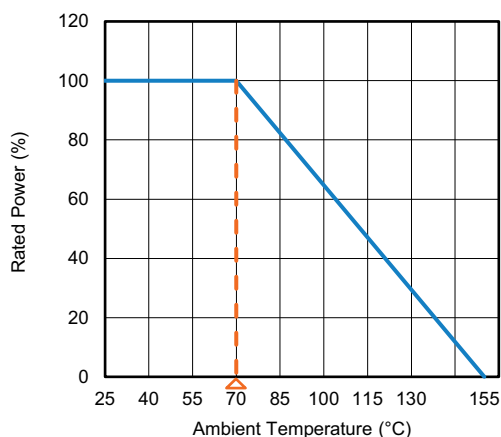
Those kits are packaged in pieces of tape and delivered in ESD bags.

## TEST BOARDS

TRL (Thru Reflect Line) and DUT (Device Under Test) evaluation boards (50 Ω or 100 Ω) are available on request.

## THERMAL SPECIFICATIONS (CH0402 AND CH0603)

### POWER DERATING CURVE



| PCB MOUNTING |                                |
|--------------|--------------------------------|
| CHIP SIZE    | RATED POWER <sup>(1)</sup> (W) |
| 0402         | 0.300                          |
| 0603         | 0.400                          |

### Note

<sup>(1)</sup> PCB mounting with +70 °C ambient temperature.

PCB is FR4 base material 100 mm x 150 mm x 1.5 mm, 35 μm  
Cu-layer

## SUGGESTIONS TO INCREASE POWER

| PCB MOUNTING AMBIENT +25 °C |                    |                        |                    |
|-----------------------------|--------------------|------------------------|--------------------|
| CHIP SIZE                   | POWER (W)          |                        |                    |
|                             | FR4 <sup>(1)</sup> | ALUMINA <sup>(2)</sup> | AIN <sup>(2)</sup> |
| 0402                        | 0.450              | 1.000                  | 1.200              |
| 0603                        | 0.580              | 1.820                  | 2.220              |

### Notes

- <sup>(1)</sup> Thermal measurement with Optris Xi 400 camera. Test performed with standard FR4 (PCB thickness 1.6 mm, copper thickness 35 µm)
- <sup>(2)</sup> Estimations with PCB thermal resistance knowledge

| BACKSIDE CHIP TEMPERATURE +25 °C |                          |
|----------------------------------|--------------------------|
| CHIP SIZE                        | POWER <sup>(1)</sup> (W) |
| 0402                             | 2.000                    |
| 0603                             | 5.000                    |

### Note

- <sup>(1)</sup> Estimations with components thermal resistance knowledge

## PACKAGING

Standard packaging is plastic tape and reel for all sizes.

Paper tape and reel is available for sizes 0402 and 0603 with F, N, and G terminations.

Waffle pack is available for all sizes.

Depending on the type of terminations, parts will be packed differently:

### One face:

- Gold terminations: (P termination option): Active face up.  
Please use M termination code for active face down in tape and reel.
- Tin / silver terminations: (F termination option): Active face down in tape and reel.  
Active face up in waffle pack.

### Notes

- CH02016 with active face down in tape and reel have back-side blue marked to indicate right orientation
- Please refer to Vishay Sfernice Application Note [“Guidelines for Vishay Sfernice Resistive and Inductive Components”](#) for soldering recommendation (document number 52029, section “3. Guidelines for Surface Mounting Components (SMD)”, profile number 3 applies

| SIZE  | MOQ                                              | NUMBER OF PIECES PER PACKAGE |               |      | TAPE WIDTH |
|-------|--------------------------------------------------|------------------------------|---------------|------|------------|
|       |                                                  | WAFFLE PACK<br>2" x 2"       | TAPE AND REEL |      |            |
|       |                                                  |                              | MIN.          | MAX. |            |
| 02016 | See MOQ mentioned on preferred models and values | 484                          | 100           | 5000 | 8 mm       |
| 0402  |                                                  | 100                          |               |      |            |
| 0603  |                                                  | 100                          |               |      |            |

## PACKAGING RULES

### Waffle Pack

Can be filled up to maximum quantity indicated in the table here above, taking into account the minimum order quantity. When quantity ordered exceeds maximum quantity of a single waffle pack, the waffle packs are stacked up on the top of each other and closed by one single cover. To get “not stacked up” waffle pack in case of ordered quantity > maximum number of pieces per package: please consult Vishay Sfernice for specific ordering code.

### Tape and Reel

See Part Numbering information to get the quantity desired by tape.

In regard to the CH02016 size only, up to 5 empty cavities can be found every 1000 parts in the reel. Nevertheless, the number of requested parts will be respected.

**GLOBAL PART NUMBER INFORMATION**

New Global Part Numbering: CH0402-50RJF (preferred part number format)

|              |   |                       |   |             |   |                               |   |                                                                                                                                                                                                                                                                                                                                           |   |   |   |                                                                   |  |                                                        |   |   |
|--------------|---|-----------------------|---|-------------|---|-------------------------------|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|-------------------------------------------------------------------|--|--------------------------------------------------------|---|---|
| C            | H | 0                     | 4 | 0           | 2 | -                             | 5 | 0                                                                                                                                                                                                                                                                                                                                         | R | J | F | T                                                                 |  | 9                                                      | 9 | 9 |
| GLOBAL MODEL |   | SIZE                  |   | OHMIC VALUE |   | TOLERANCE                     |   | TERMINATION                                                                                                                                                                                                                                                                                                                               |   |   |   | PACKAGING                                                         |  | OPTION                                                 |   |   |
| CH           |   | 02016<br>0402<br>0603 |   | 10R to 500R |   | F = 1 %<br>G = 2 %<br>J = 5 % |   | <b>F</b> (flip chip):<br>SnAg over nickel barrier<br><b>N</b> (W/A):<br>SnAg over nickel barrier<br>(except 02016)<br><b>P</b> (one face): <sup>(1)</sup><br>gold bonding pads<br><b>M</b> (one face):<br>gold bonding pads<br>with active face down<br>in tape and reel<br><b>G</b> (W/A): gold over nickel<br>barrier<br>(except 02016) |   |   |   | For more<br>information see<br>Codification of<br>Packaging table |  | From<br>1 to 3 digits.<br>Leave blank<br>if no option. |   |   |

Historical Part Number Example: CH02016-100RGFPT1K (tapes of 1000 pieces)  
 CH0402-50RJF (waffle pack)

CHKIT Part Numbers <sup>(2)</sup>: CHKIT-02016  
 CHKIT-0402

**Notes**

- Historical part numbers are not recommended but can still be used for ordering
- (1) Gold termination for application in hermetic package. Can also be mounted on PCB with SnAg solder paste. Please use M termination code for active face down in tape and reel
- (2) CHKIT for 0603 size is not available

**CODIFICATION OF PACKAGING****WAFFLE PACK (available for all sizes)**

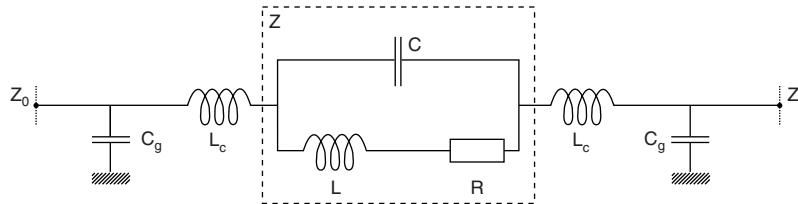
|   |                                 |
|---|---------------------------------|
| W | 100 min., 1 mult.; 100 pcs max. |
|---|---------------------------------|

**PLASTIC TAPE (standard packaging for all sizes) - TA, TB, TC, TD NOT RECOMMENDED FOR NEW DESIGNS**

|    |                                                          |
|----|----------------------------------------------------------|
| T  | 100 min., 100 mult.; delivered in reels of 1000 pcs max. |
| TA | 100 min., 100 mult.; delivered in reels of 100 pcs       |
| TB | 250 min., 250 mult.; delivered in reels of 250 pcs       |
| TC | 500 min., 500 mult.; delivered in reels of 500 pcs       |
| TD | 1000 min., 1000 mult.; delivered in reels of 1000 pcs    |
| TF | 5000 min., 5000 mult.; delivered in reels of 5000 pcs    |

**PAPER TAPE (available for 0402 and 0603 with F, N, and G terminations) - NOT RECOMMENDED FOR NEW DESIGNS**

|    |                                                          |
|----|----------------------------------------------------------|
| PT | 100 min., 100 mult.; delivered in reels of 1000 pcs max. |
| PA | 100 min., 100 mult.; delivered in reels of 100 pcs       |
| PB | 250 min., 250 mult.; delivered in reels of 250 pcs       |
| PC | 500 min., 500 mult.; delivered in reels of 500 pcs       |

**TYPICAL HIGH FREQUENCY PERFORMANCE ELECTRICAL MODEL**


|                |                                |
|----------------|--------------------------------|
| C              | Internal shunt capacitance     |
| L              | Internal inductance            |
| R              | Resistance                     |
| Z              | Internal impedance (R, L, C)   |
| L <sub>c</sub> | External connection inductance |
| C <sub>g</sub> | External capacitance to ground |

The complex impedance of the chip resistor is given by the following equations:

$$Z = \frac{R + j\omega(L - R^2C - L^2C\omega^2)}{1 + C[(R^2C - 2L)\omega^2 + L^2C\omega^4]}$$

$$\frac{|Z|}{R} = \frac{1}{1 + C[(R^2C - 2L)\omega^2 + L^2C\omega^4]} \times \sqrt{1 + \left[ \frac{\omega(L - R^2C - L^2C\omega^2)}{R} \right]^2}$$

$$\theta = \tan^{-1} \frac{\omega(L - R^2C - L^2C\omega^2)}{R}$$

**Notes**

- $\omega = 2 \times \pi \times f$
- $f$ : frequency

R, L and C are relevant to the chip resistor itself.

L<sub>c</sub> and C<sub>g</sub> also depend on the way the chip resistor is mounted.

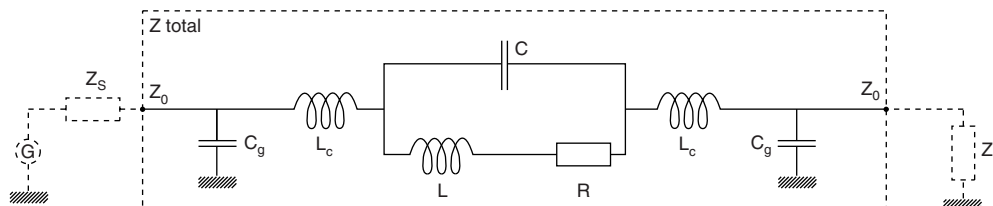
It is important to notice that after assembly the external reactance of L<sub>c</sub> and C<sub>g</sub> will be combined to internal reactance of L and C. This combination can upgrade or downgrade the HF behavior of the component.

This is why we are displaying three sets of data:

- $\frac{|Z|}{R}$  versus frequency curves which aim to show at a glance the intrinsic HF performance of a given chip resistor
- $\frac{|Z_{total}|}{R}$  versus frequency curves which aim to show the behavior of the chip resistor when mounted

These lines are terminated with adapted source and load impedance respectively Z<sub>s</sub> and Z<sub>l</sub> with Z<sub>0</sub> = Z<sub>L</sub> = Z<sub>s</sub> (for others configurations please consult us).

Equivalent circuit for S-parameters:

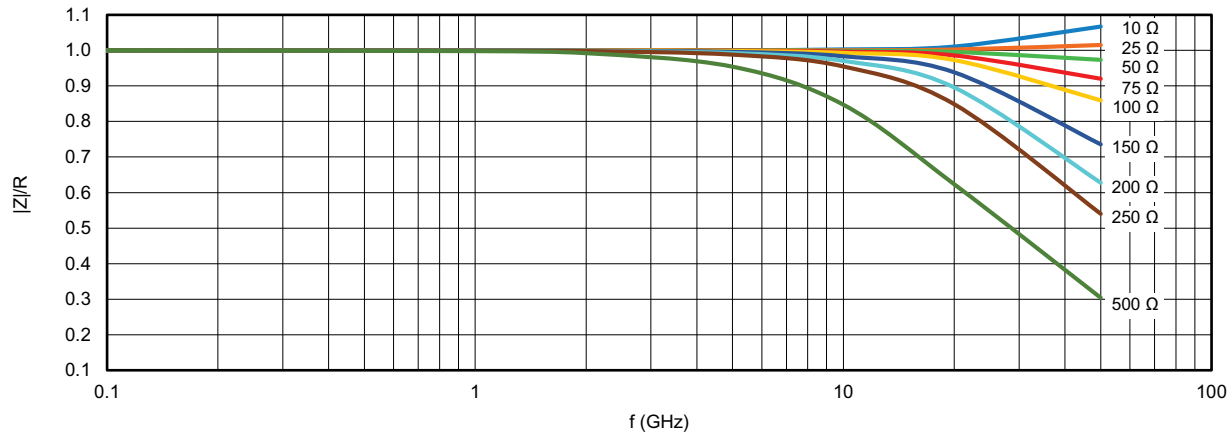


S-parameters are computed taking into account all the resistive, inductive and capacitive elements (Z total) and Z<sub>0</sub> = Z<sub>L</sub> = Z<sub>s</sub> = R.

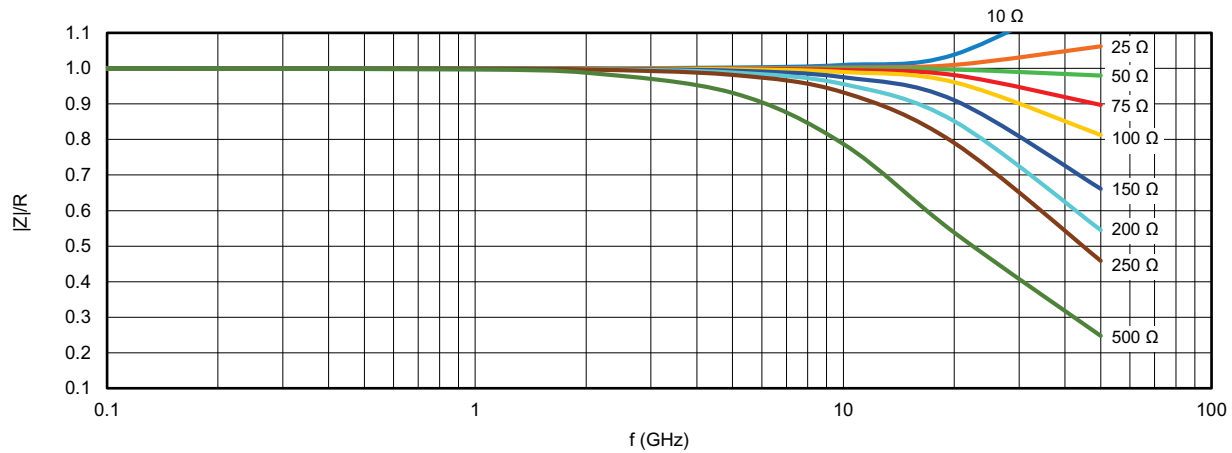
For simulation purposes, those S-parameter data are available for download here: [www.vishay.com/doc?53061](http://www.vishay.com/doc?53061)



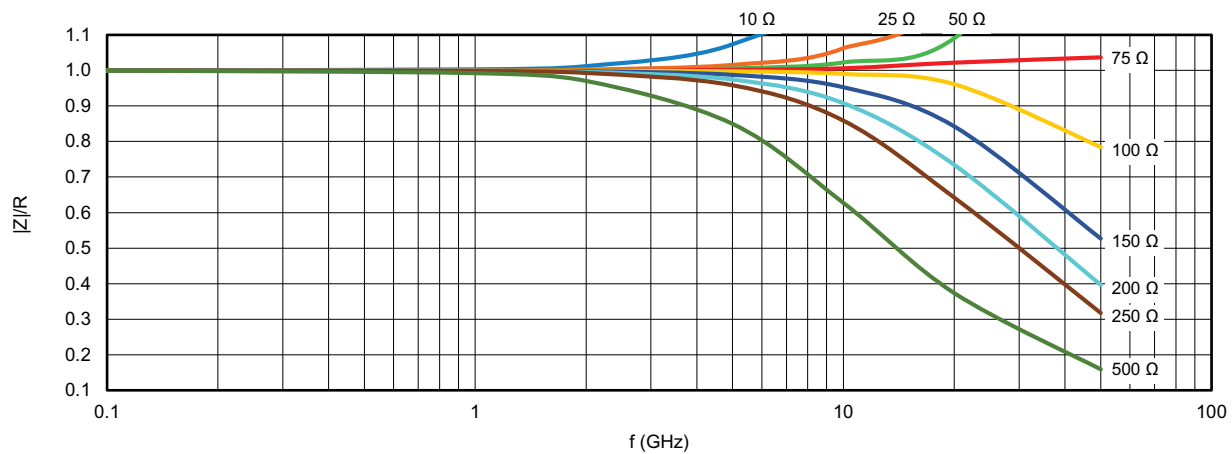
## INTERNAL IMPEDANCE CURVES



Internal impedance curve for 02016 size (F and P terminations)



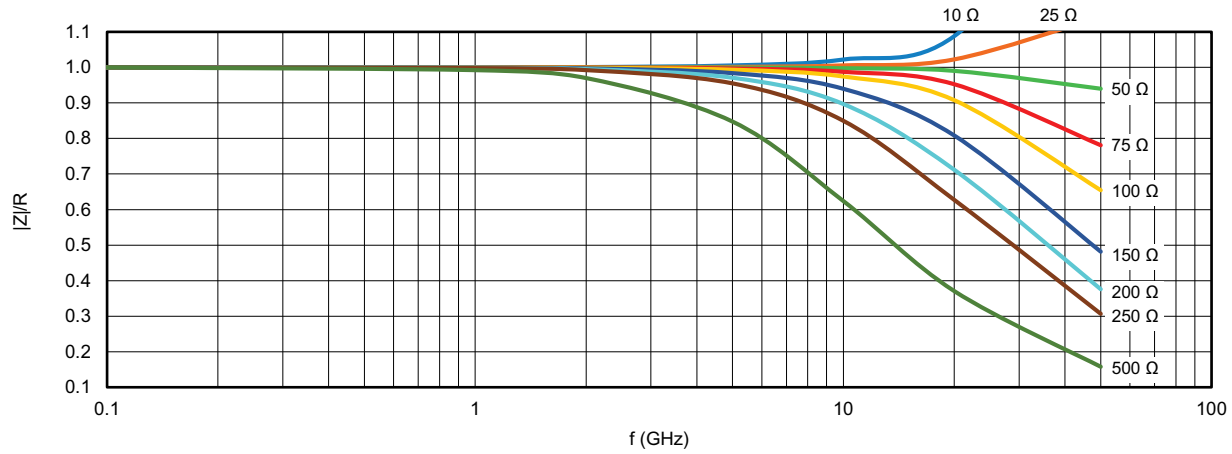
Internal impedance curve for 0402 size (F and P terminations)



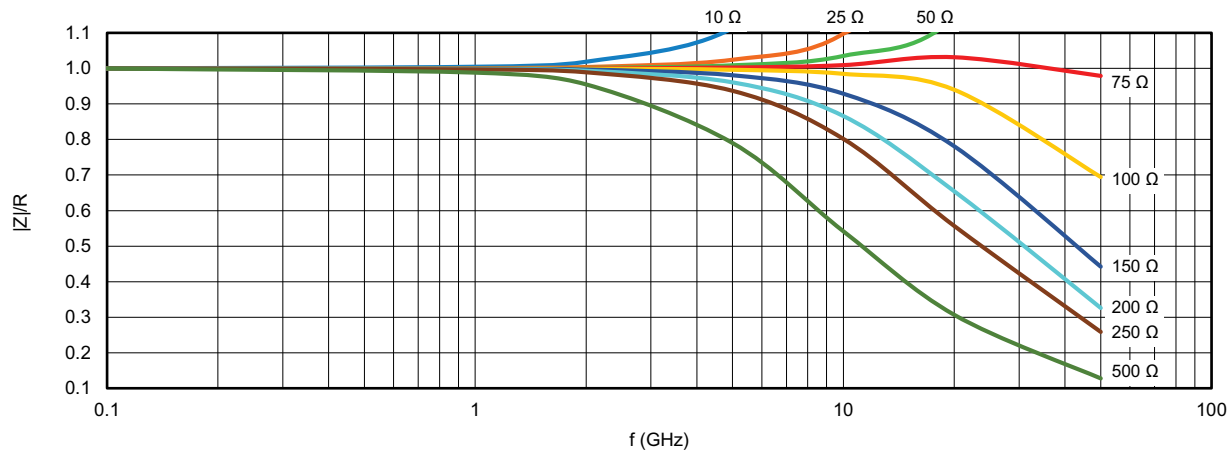
Internal impedance curve for 0402 size (N and G terminations)



## INTERNAL IMPEDANCE CURVES



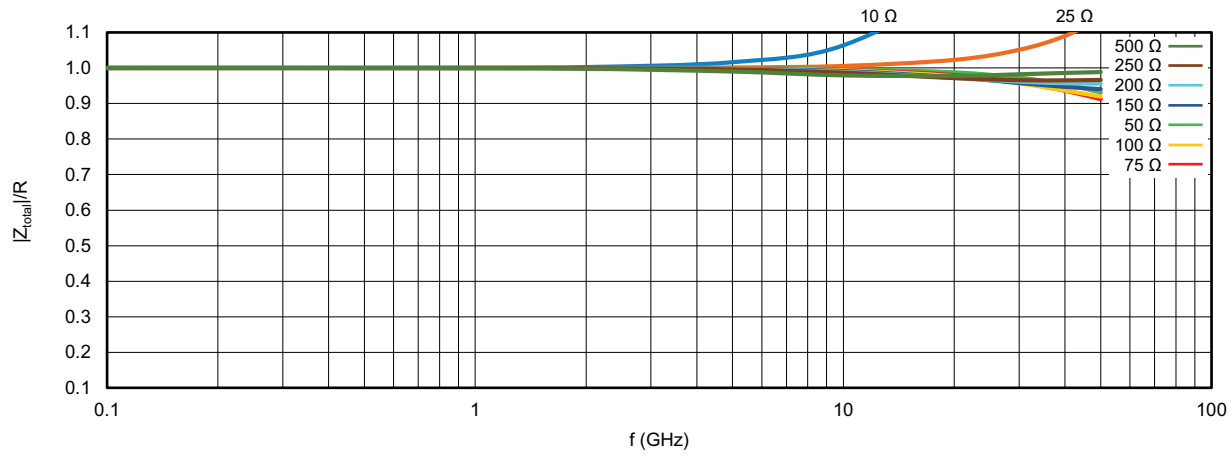
Internal impedance curve for 0603 size (F and P terminations)



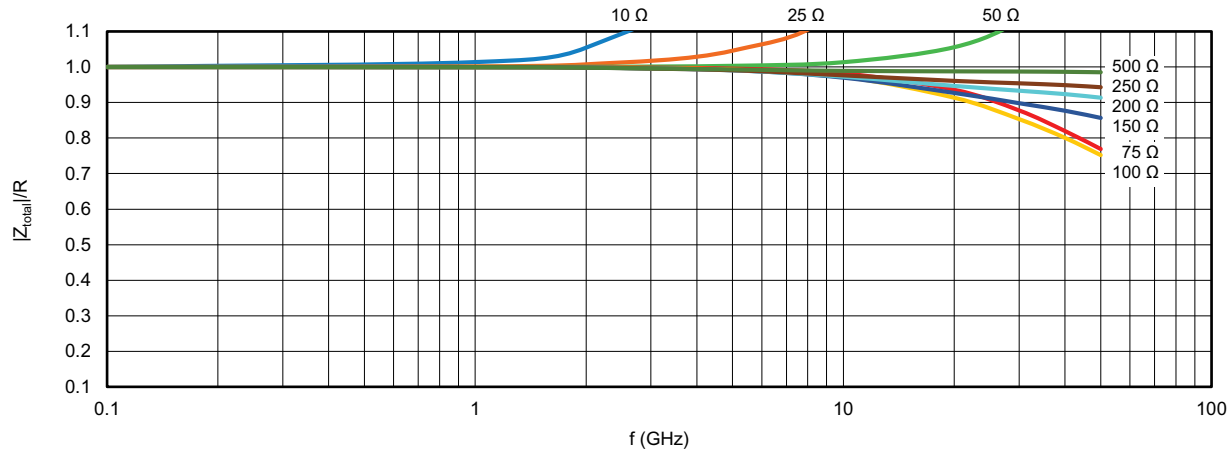
Internal impedance curve for 0603 size (N and G terminations)



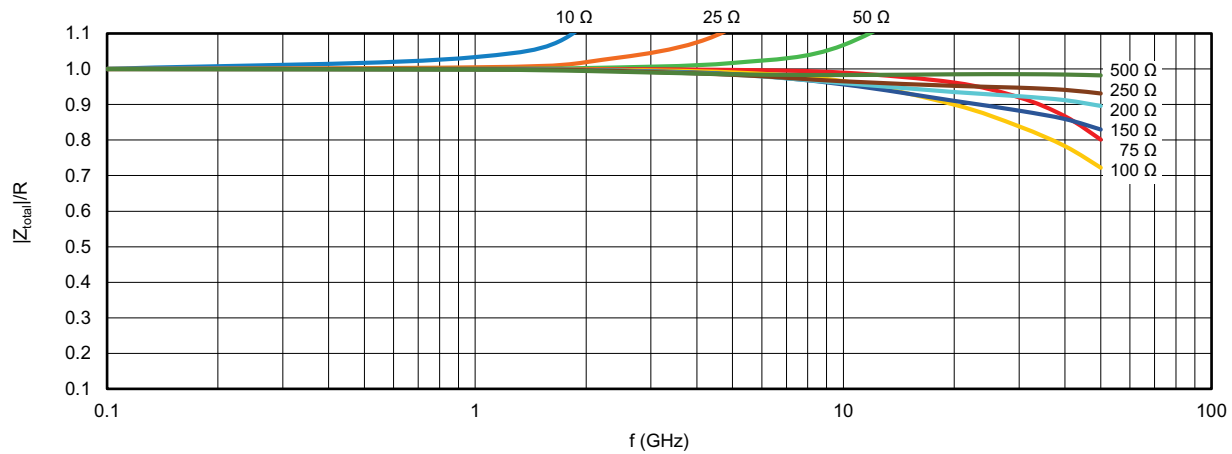
## INTERNAL IMPEDANCE CURVES ( $|Z_{TOTAL}| / R$ )



Internal impedance curve for 02016 size (F and P terminations)



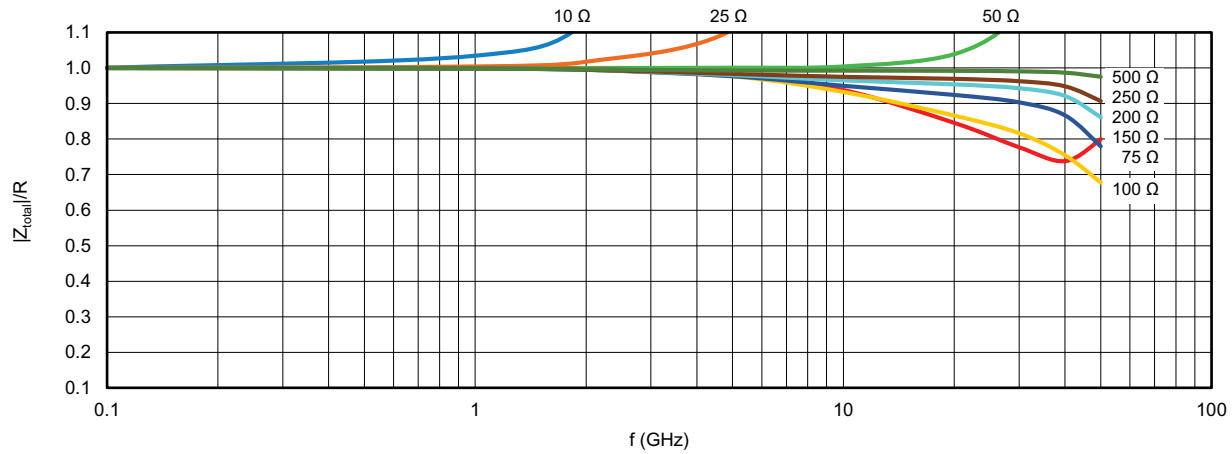
Internal impedance curve for 0402 size (F and P terminations)



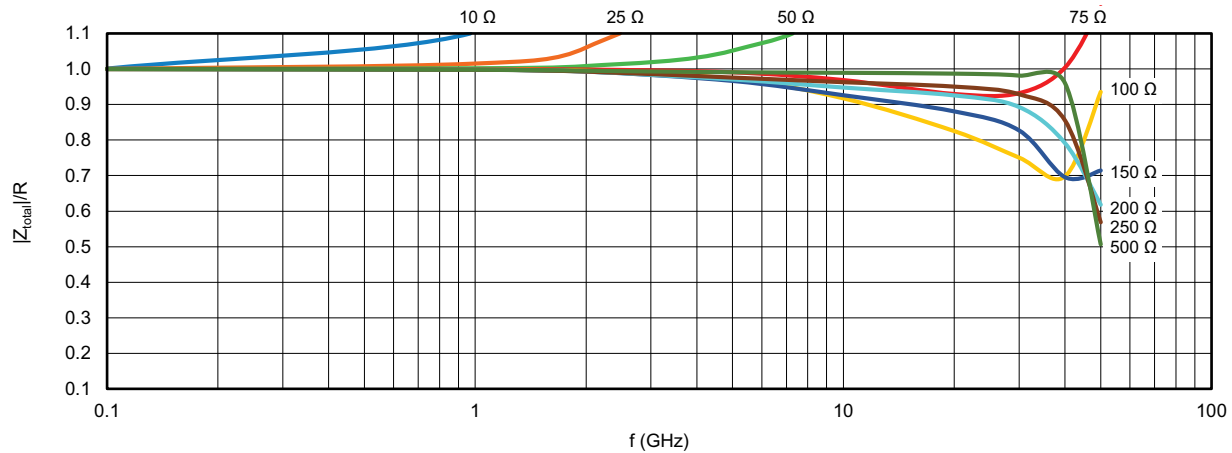
Internal impedance curve for 0402 size (N and G terminations)



## INTERNAL IMPEDANCE CURVES ( $|Z_{\text{TOTAL}}| / R$ )



Internal impedance curve for 0603 size (F and P terminations)

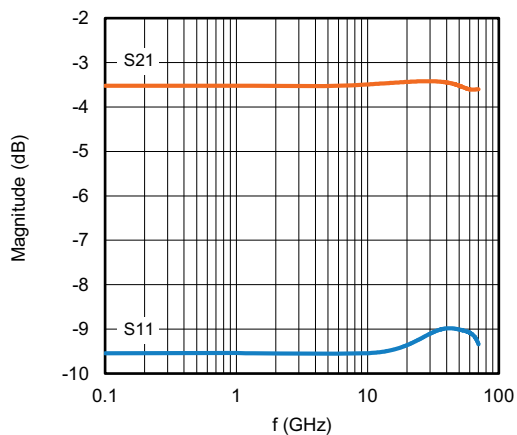


Internal impedance curve for 0603 size (N and G terminations)

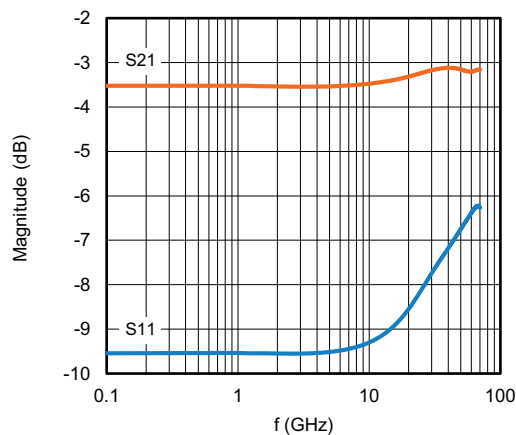


## S-PARAMETER

### CH02016 (F and P Terminations)

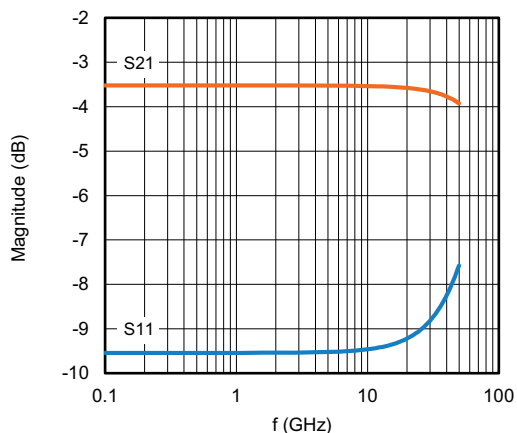


CH02016 flip chip ( $Z_0 = Z_l = Z_s = R = 50 \Omega$ )

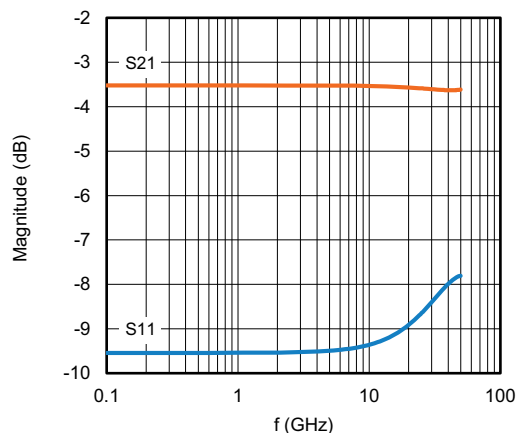


CH02016 flip chip ( $Z_0 = Z_l = Z_s = R = 100 \Omega$ )

### CH0402 (F and P Terminations)

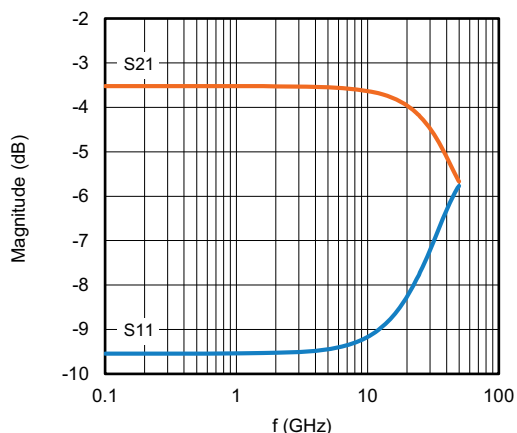


CH0402 flip chip ( $Z_0 = Z_l = Z_s = R = 50 \Omega$ )

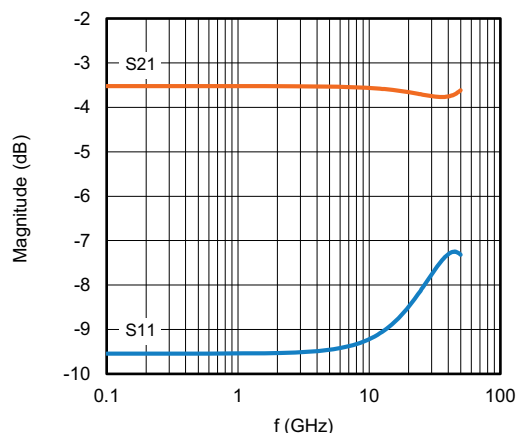


CH0402 flip chip ( $Z_0 = Z_l = Z_s = R = 100 \Omega$ )

### CH0402 (N and G Terminations)



CH0402 wraparound ( $Z_0 = Z_l = Z_s = R = 50 \Omega$ )

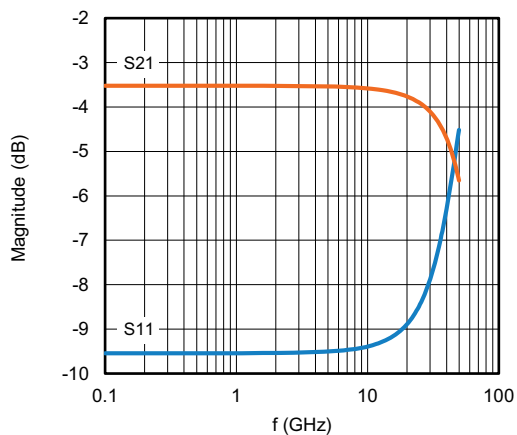


CH0402 wraparound ( $Z_0 = Z_l = Z_s = R = 100 \Omega$ )

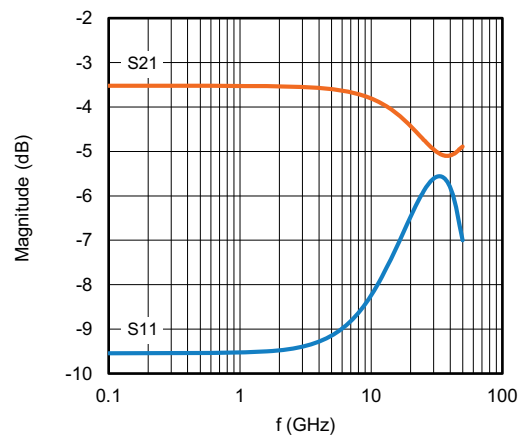


## S-PARAMETER

### CH0603 (F and P Terminations)

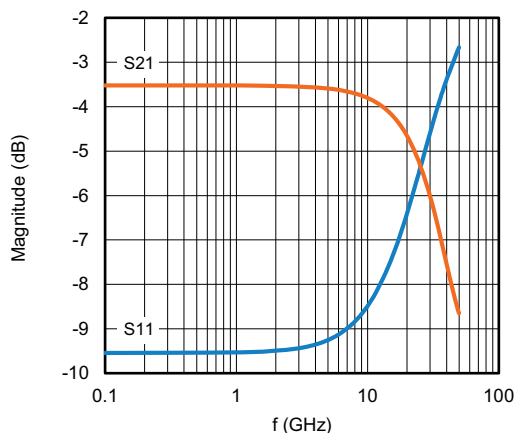


CH0603 flip chip ( $Z_0 = Z_1 = Z_s = R = 50 \Omega$ )

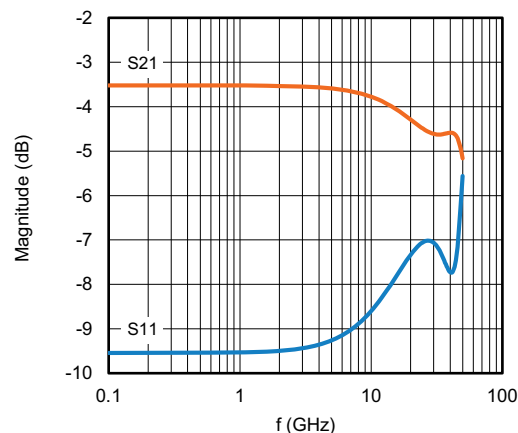


CH0603 flip chip ( $Z_0 = Z_1 = Z_s = R = 100 \Omega$ )

### CH0603 (N and G Terminations)



CH0603 wraparound ( $Z_0 = Z_1 = Z_s = R = 50 \Omega$ )



CH0603 wraparound ( $Z_0 = Z_1 = Z_s = R = 100 \Omega$ )



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