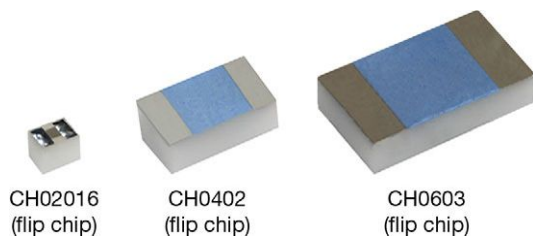


# AEC-Q200 Qualified High Frequency 70 GHz Thin Film Chip Resistor


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

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, and 70 GHz for CH02016 from 50  $\Omega$  to 100  $\Omega$ .

## FEATURES

- Operating frequency 70 GHz
- AEC-Q200 qualified (CHA02016 flip chip only)
- Thin film microwave resistors
- Flip chip, wraparound or one face termination
- Small size, down to 20 mils by 16 mils
- Edged trimmed block resistors
- Pure alumina substrate (99.5 %)
- Ohmic range: 10R to 500R
- Design kits available
- Modelithics® library available
- Small internal reactance (LC down to  $1 \times 10^{-24}$ )
- Tolerance 1 %, 2 %, 5 %
- TCR: 100 ppm/°C in (-55 °C, +155 °C) temperature range
- TCR: 50 ppm/°C available upon request for 10  $\Omega$  to 150  $\Omega$  ohmic range
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



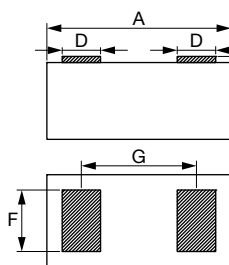
**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**  
**GREEN**  
(5-2008)

## STANDARD ELECTRICAL SPECIFICATIONS

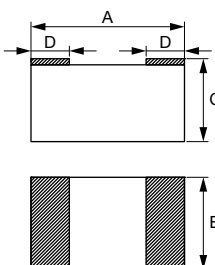
| MODEL   | SIZE  | RESISTANCE RANGE<br>$\Omega$ | RATED POWER<br>Pn<br>W | LIMITING ELEMENT VOLTAGE<br>V | TOLERANCE<br>$\pm$ % | TEMPERATURE COEFFICIENT<br>$\pm$ ppm/°C |
|---------|-------|------------------------------|------------------------|-------------------------------|----------------------|-----------------------------------------|
| CH02016 | 02016 | 10 to 500                    | 0.030                  | 30                            | 1, 2, 5              | 100 (50 upon request)                   |
| CH0402  | 0402  | 10 to 500                    | 0.050                  | 37                            | 1, 2, 5              | 100 (50 upon request)                   |
| CH0603  | 0603  | 10 to 500                    | 0.125                  | 50                            | 1, 2, 5              | 100 (50 upon request)                   |

## DIMENSIONS in millimeters (inches)

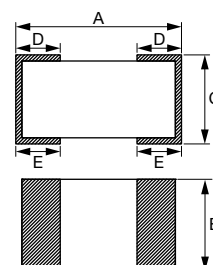
CH02016 F / CH02016 P / CH0402 P / CH0603 P



CH0402 F / CH0603 F



CH0402 N / CH0402 G / CH0603 N / CH0603 G



### CASE SIZE

### DIMENSIONS

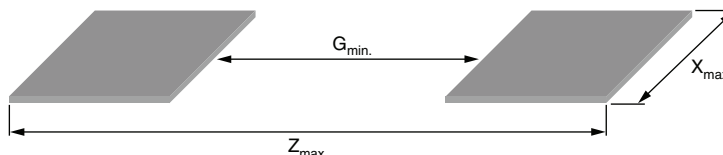
| MODEL /<br>TERMINATION           | $\pm 0.10$ (± 0.004) | $\pm 0.10$ (± 0.004) | $\pm 0.127$ (± 0.005)        | D<br>E when applicable |                  | $\pm 0.050$ (± 0.002) | $\pm 0.050$ (± 0.002) |
|----------------------------------|----------------------|----------------------|------------------------------|------------------------|------------------|-----------------------|-----------------------|
|                                  |                      |                      |                              | MIN.                   | MAX.             |                       |                       |
| CH02016 F<br>CH02016 P           | 0.480 (0.020)        | 0.390 (0.016)        | 0.420 (0.016) <sup>(1)</sup> | 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)        | 0.750 (0.030)        | 0.500 (0.020)                | 0.250<br>(0.010)       | 0.510<br>(0.020) | n/a                   | n/a                   |
| CH0603 P                         | 1.720 (0.068)        | 0.750 (0.030)        | 0.500 (0.020)                | 0.235<br>(0.009)       | 0.275<br>(0.011) | 0.660 (0.026)         | 1.355 (0.053)         |

### Note

<sup>(1)</sup>  $\pm 0.070$  (± 0.003)

**TOLERANCE VS. OHMIC VALUES**

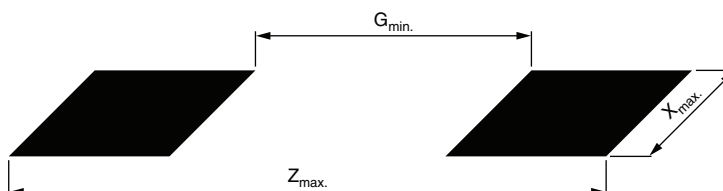
| Ohmic range                 | $10\ \Omega \leq R < 50\ \Omega$ | $50\ \Omega \leq R \leq 500\ \Omega$            |
|-----------------------------|----------------------------------|-------------------------------------------------|
| Tolerance CH02016           | 5 %                              | 1 % for 50 $\Omega$ and 100 $\Omega$ , 2 %, 5 % |
| Tolerance CH0402 and CH0603 | 2 %, 5 %                         | 1 %, 2 %, 5 %                                   |

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

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<br>CLAUSE | TEST                      | PROCEDURE                                                                                           | GLOBAL<br>PERFORMANCES         | TYPICAL<br>PERFORMANCES<br>(25 $\Omega$ TO 250 $\Omega$ ) |
|--------------------|---------------------------|-----------------------------------------------------------------------------------------------------|--------------------------------|-----------------------------------------------------------|
| 3                  | High temperature exposure | MIL-STD-202 method 108<br>1000 h at $T = 125\ ^\circ\text{C}$ ,<br>unpowered                        | $\pm 2\ \% \pm 0.05\ \Omega$   | $\pm 0.2\ \% \pm 0.05\ \Omega$                            |
| 4                  | Temperature cycling       | JESD22 method JA-104<br>1000 cycles ( $-55\ ^\circ\text{C}$ to $+155\ ^\circ\text{C}$ )             | $\pm 1.8\ \% \pm 0.05\ \Omega$ | $\pm 1.5\ \% \pm 0.05\ \Omega$                            |
| 7                  | Biased humidity           | MIL-STD-202 method 103<br>1000 h $85\ ^\circ\text{C} / 85\ \% \text{RH}$<br>10 % of operating power | $\pm 2\ \% \pm 0.05\ \Omega$   | $\pm 0.75\ \% \pm 0.05\ \Omega$                           |

| <b>TEST PROCEDURES AND REQUIREMENTS</b> |                              |                                                                                                                                 |                                                                   |                                                     |
|-----------------------------------------|------------------------------|---------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|-----------------------------------------------------|
| <b>AEC-Q200<br/>CLAUSE</b>              | <b>TEST</b>                  | <b>PROCEDURE</b>                                                                                                                | <b>GLOBAL<br/>PERFORMANCES</b>                                    | <b>TYPICAL<br/>PERFORMANCES<br/>(25 Ω TO 250 Ω)</b> |
| 8                                       | Operational life             | MIL-STD-202 method 108<br>Condition D steady state<br>T = 125 °C at rated power<br>90' on / 30' off / 1000 h                    | $\pm 2.5 \% \pm 0.05 \Omega$                                      | $\pm 1 \% \pm 0.05 \Omega$                          |
| 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)     | $\pm 0.05 \% \pm 0.05 \Omega$                                     | $\pm 0.015 \% \pm 0.05 \Omega$                      |
| 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                     | $\pm 0.1 \% \pm 0.05 \Omega$                                      | $\pm 0.05 \% \pm 0.05 \Omega$                       |
| 15                                      | Resistance to soldering heat | MIL-STD-202 method 210<br>condition D<br>Flux used: alpha 611<br>Solder temp.: 260 °C $\pm 5$ °C<br>Total immersion during 10 s | $\pm 2.5 \% \pm 0.05 \Omega$                                      | $\pm 0.5 \% \pm 0.05 \Omega$                        |
| 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 ( $\geq 95$ % covered)<br>No visible damage          |                                                     |
| 20                                      | Flammability                 | UL 94                                                                                                                           | Class V-0<br>No burning                                           |                                                     |
| 21                                      | Board flex                   | AEC-Q200-005                                                                                                                    | $\pm 0.1 \% \pm 0.05 \Omega$                                      | $\pm 0.05 \% \pm 0.05 \Omega$                       |
| 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:

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

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

### Recommended termination:

F

### Recommended tolerance:

2 %

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

## 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.

**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.

**Note**

- Please refer to Vishay Sfernice Application Note "Guidelines for Vishay Sfernice Resistive and Inductive Products" for soldering recommendation (document number 52029, 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<br>on preferred models<br>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)

AEC-Q200 Version Part Numbering: CHA02016-xxxx

|              |   |                       |   |             |   |                               |   |                                                                                                                                                                                                                     |   |   |   |                                                                   |  |                                                        |   |   |
|--------------|---|-----------------------|---|-------------|---|-------------------------------|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|-------------------------------------------------------------------|--|--------------------------------------------------------|---|---|
| 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, CHA      |   | 02016<br>0402<br>0603 |   | 10R to 500R |   | F = 1 %<br>G = 2 %<br>J = 5 % |   | F (flip chip):<br>SnAg over nickel barrier<br>N (W/A):<br>SnAg over nickel barrier<br>(except 02016)<br>P (one face): <sup>(1)</sup><br>gold bonding pads<br>G (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. |   |   |

AEC-Q200 Part Number Example: CHA02016-100RJFTF (AEC-Q200 qualified CH series, 100 Ω, 5 % tolerance, 5000 pieces reels)

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

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

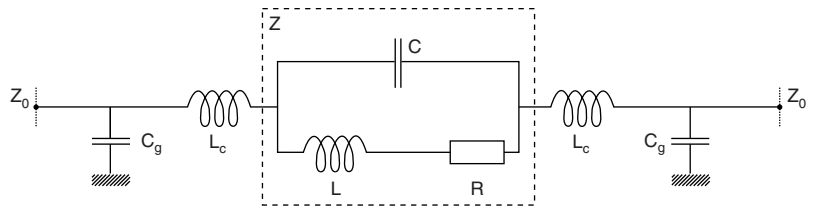
**Notes**

- Historical part numbers are not recommended but can still be used for ordering
- <sup>(1)</sup> 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
- <sup>(2)</sup> CHKIT for 0603 size is not available

**CODIFICATION OF PACKAGING**

|                                                                               |                                                 |
|-------------------------------------------------------------------------------|-------------------------------------------------|
| <b>WAFFLE PACK (available for all sizes)</b>                                  |                                                 |
| W                                                                             | 100 min., 1 mult.                               |
| <b>PLASTIC TAPE (standard packaging for all sizes)</b>                        |                                                 |
| T                                                                             | 100 min., 1 mult.                               |
| TA                                                                            | 100 min., 100 mult.                             |
| TB                                                                            | 250 min., 250 mult.                             |
| TC                                                                            | 500 min., 500 mult.                             |
| TD                                                                            | 1000 min., 1000 mult.                           |
| TF                                                                            | Full tape (quantity depending on size of chips) |
| <b>PAPER TAPE (available for 0402 and 0603 with F, N, and G terminations)</b> |                                                 |
| PT                                                                            | 100 min., 1 mult.                               |
| PA                                                                            | 100 min., 100 mult.                             |
| PB                                                                            | 250 min., 250 mult.                             |
| PC                                                                            | 500 min., 500 mult.                             |

**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.

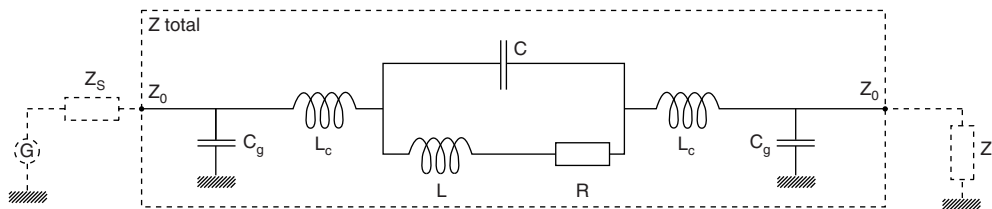
It is important to notice that after assembly the external reactance of L<sub>c</sub> and C<sub>g</sub> will be combined to internal reactance of L and C. This combination can upgrade or downgrade the HF behavior of the component.

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  $Z_s$  and  $Z_L$  with  $Z_0 = Z_L = Z_s$  (for others configurations please consult us).

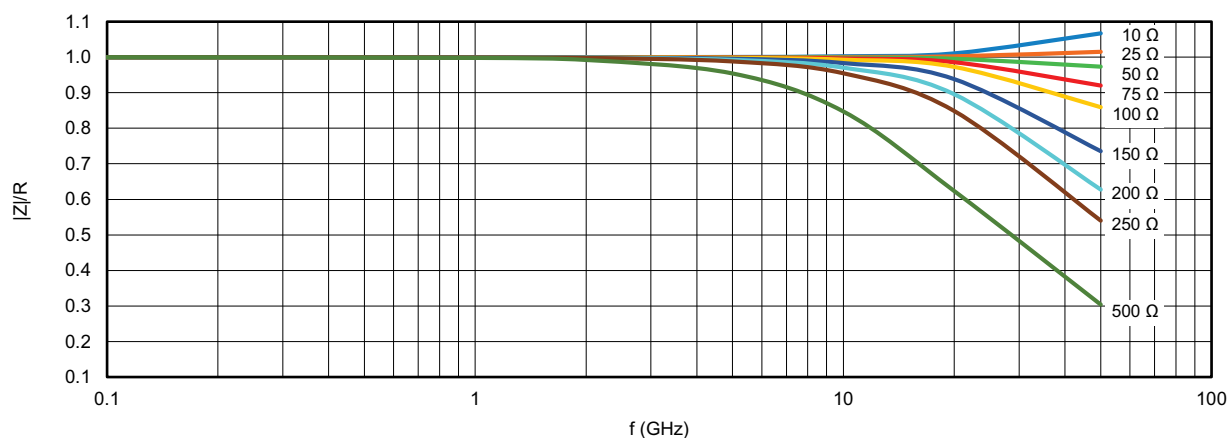
Equivalent circuit for S-parameters:



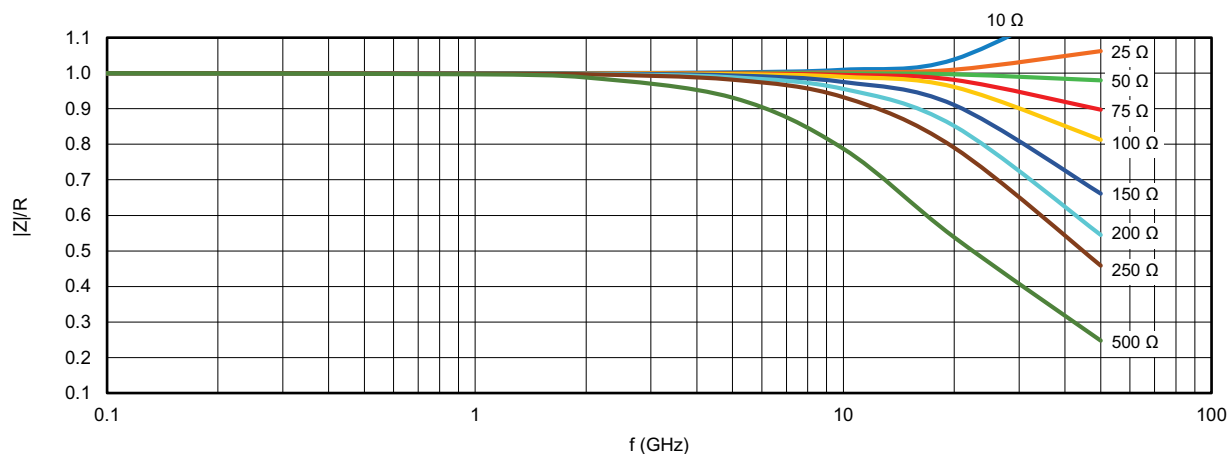
S-parameters are computed taking into account all the resistive, inductive and capacitive elements ( $Z_{total}$ ) and  $Z_0 = Z_L = Z_s = R$ .

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



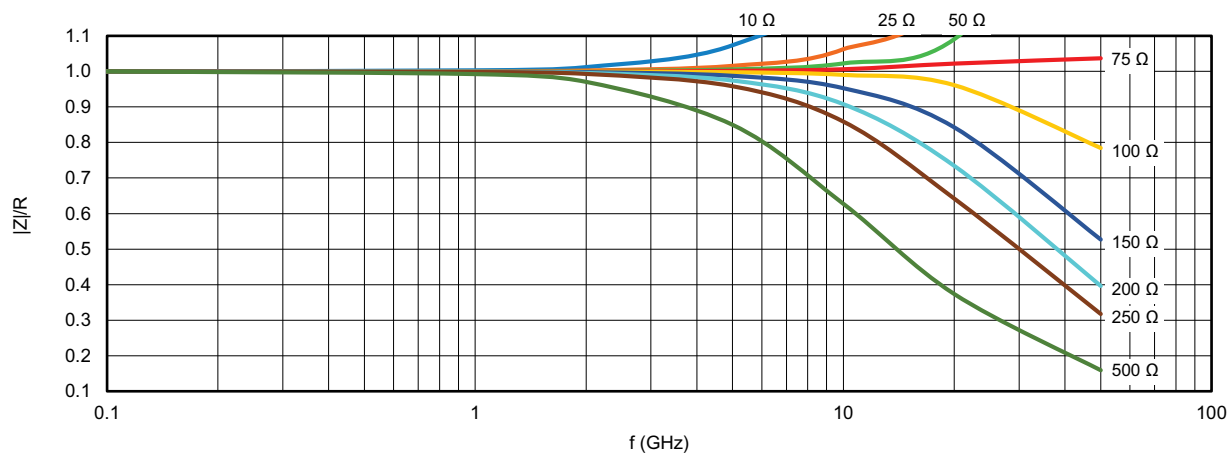
Internal impedance curve for 02016 size (F and P terminations)



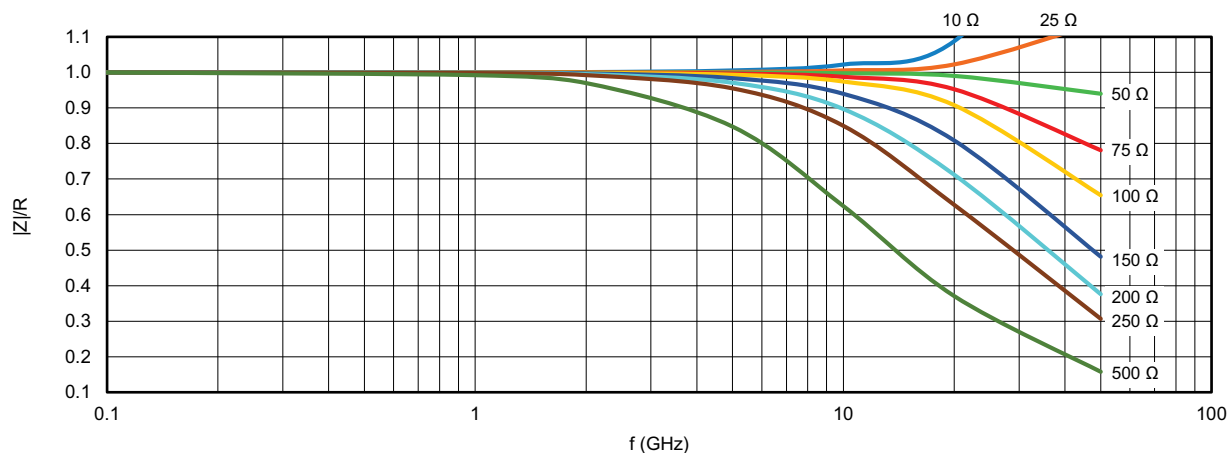
Internal impedance curve for 0402 size (F and P terminations)



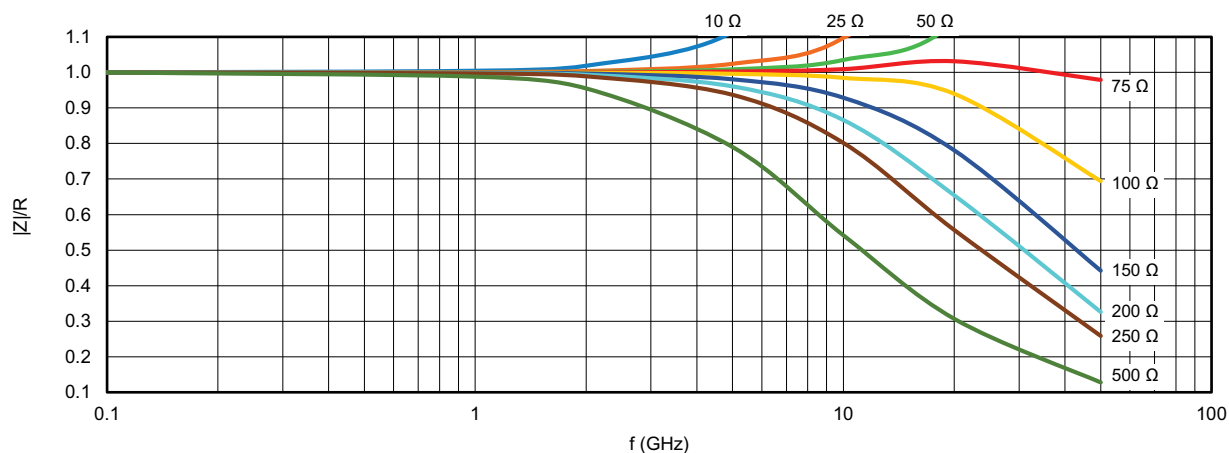
## INTERNAL IMPEDANCE CURVES



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



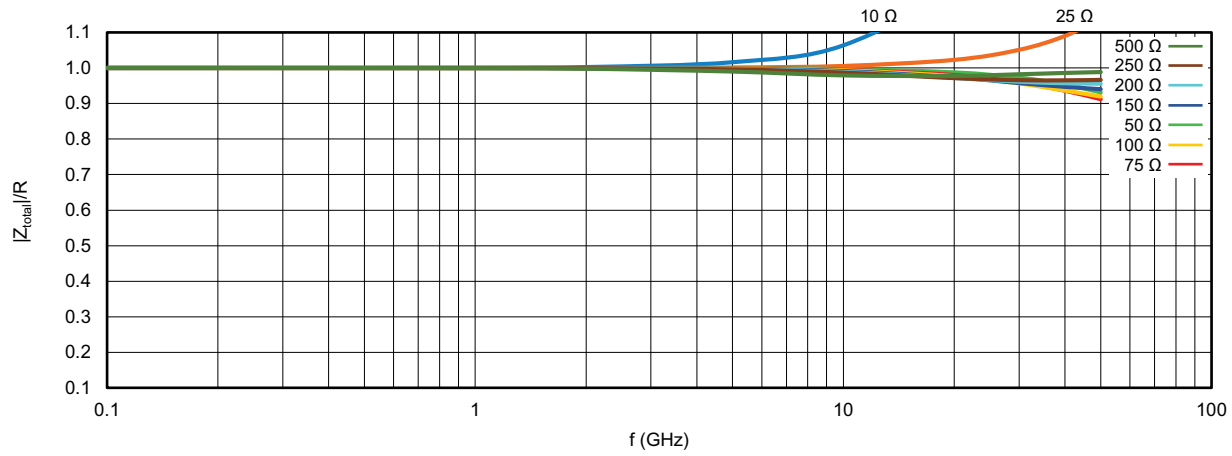
Internal impedance curve for 0603 size (F and P terminations)



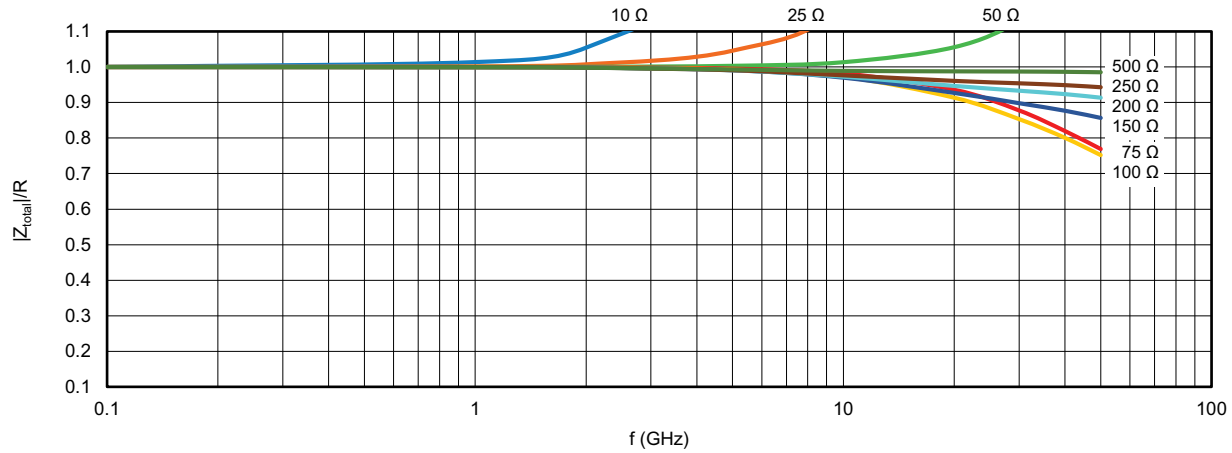
Internal impedance curve for 0603 size (N and G terminations)



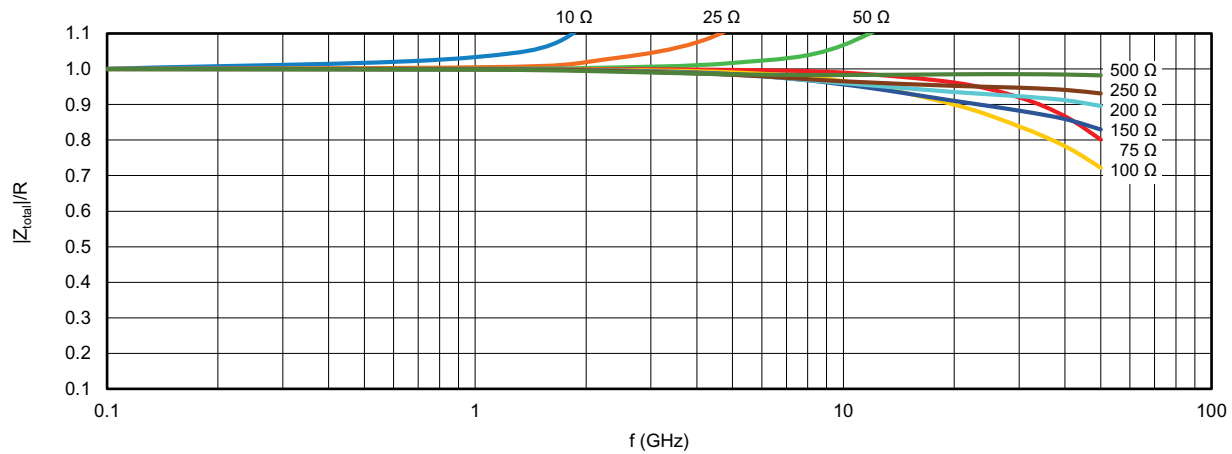
# INTERNAL IMPEDANCE CURVES ( $|Z_{TOTAL}| / R$ )



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



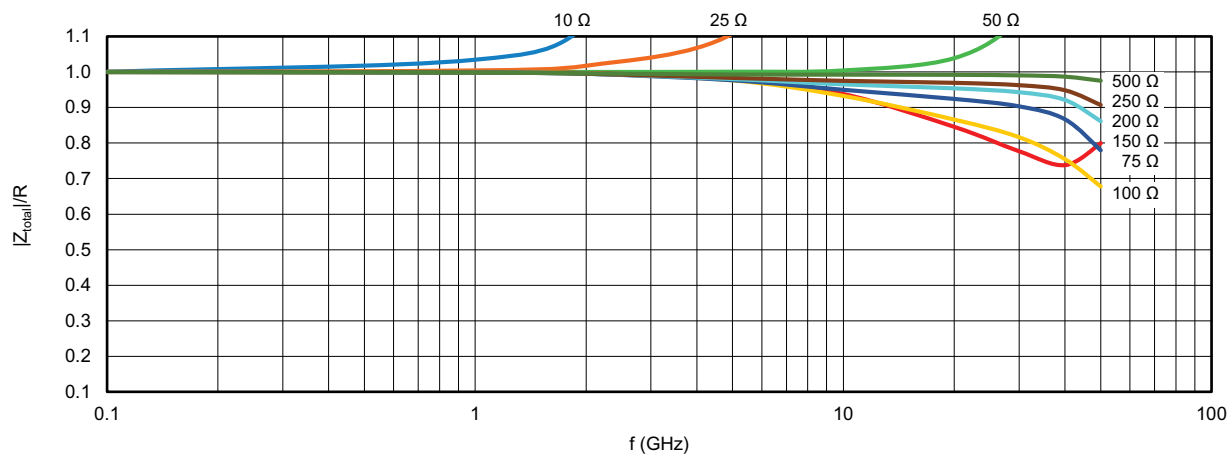
Internal impedance curve for 0402 size (F and P terminations)



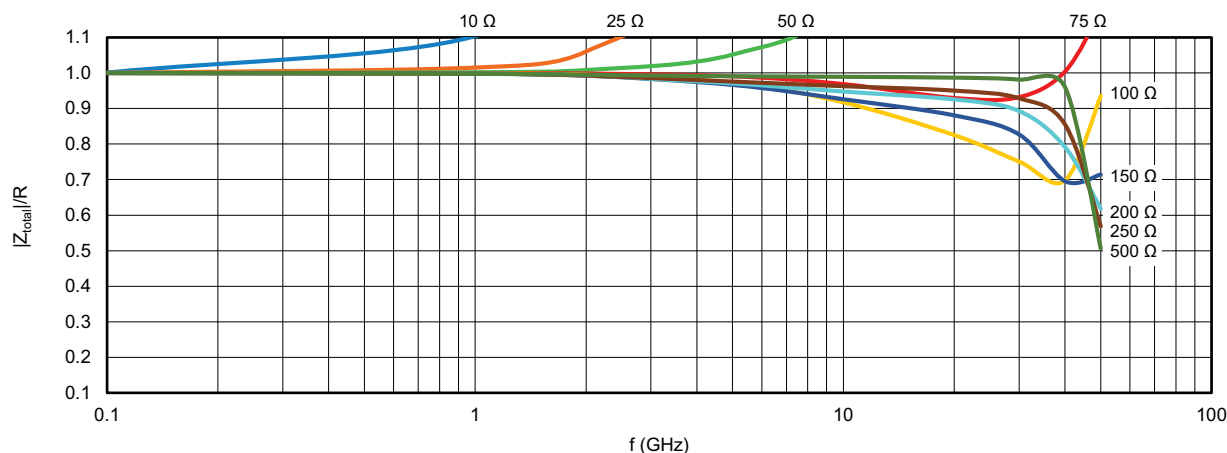
Internal impedance curve for 0402 size (N and G terminations)



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



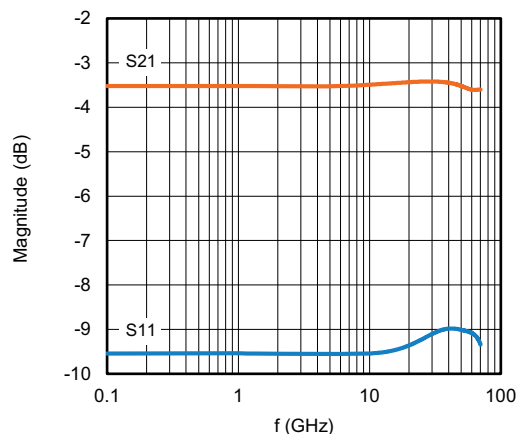
Internal impedance curve for 0603 size (F and P terminations)



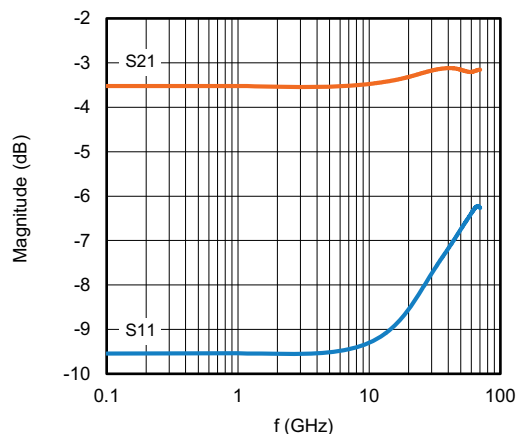
Internal impedance curve for 0603 size (N and G terminations)

## S-PARAMETER

### CH02016 (F and P Terminations)



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

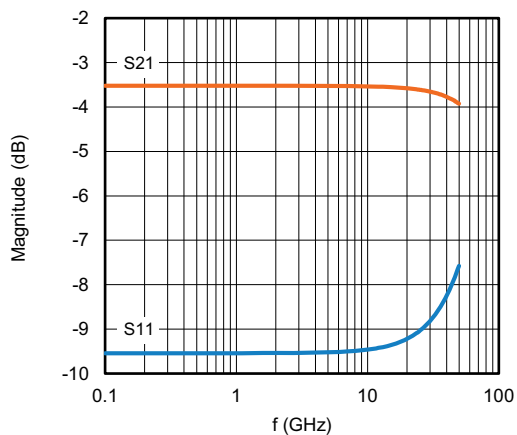


CH02016 flip chip ( $Z_0 = Z_l = Z_s = R = 100 \Omega$ )

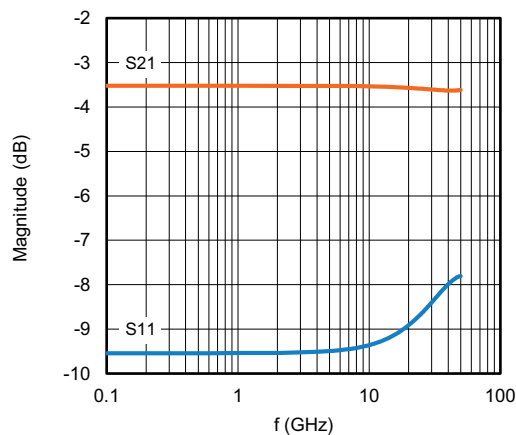


## S-PARAMETER

### CH0402 (F and P Terminations)

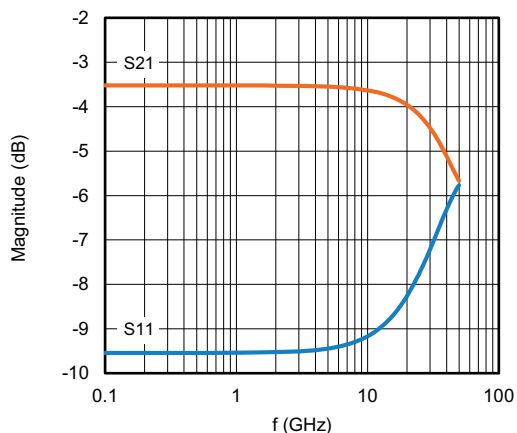


CH0402 flip chip ( $Z_0 = Z_1 = Z_s = R = 50 \Omega$ )

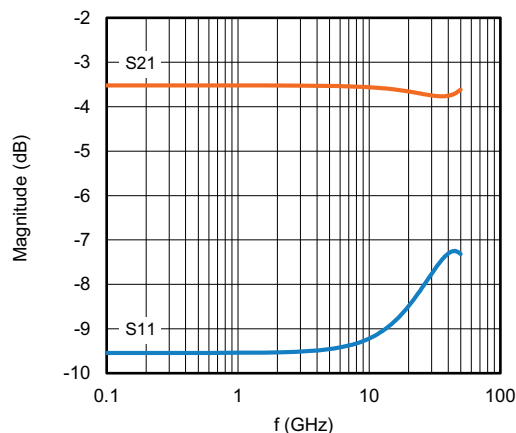


CH0402 flip chip ( $Z_0 = Z_1 = Z_s = R = 100 \Omega$ )

### CH0402 (N and G Terminations)

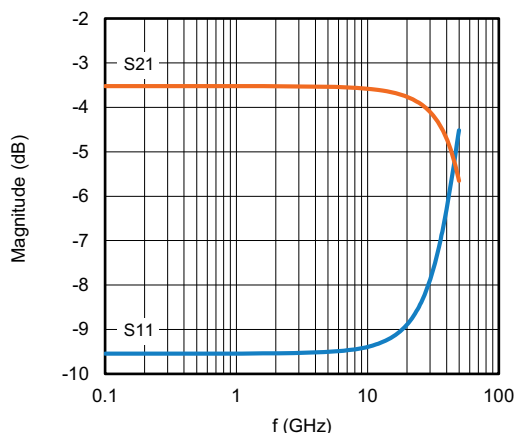


CH0402 wraparound ( $Z_0 = Z_1 = Z_s = R = 50 \Omega$ )

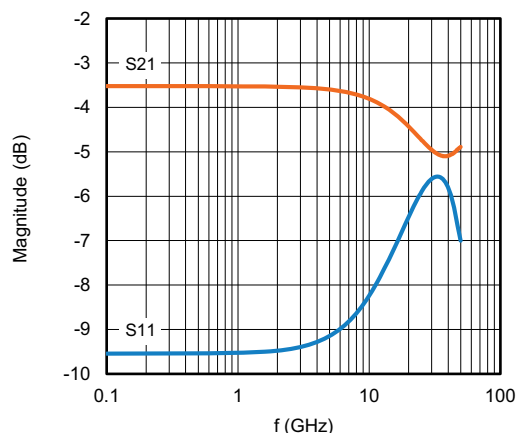


CH0402 wraparound ( $Z_0 = Z_1 = Z_s = R = 100 \Omega$ )

### CH0603 (F and P Terminations)



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

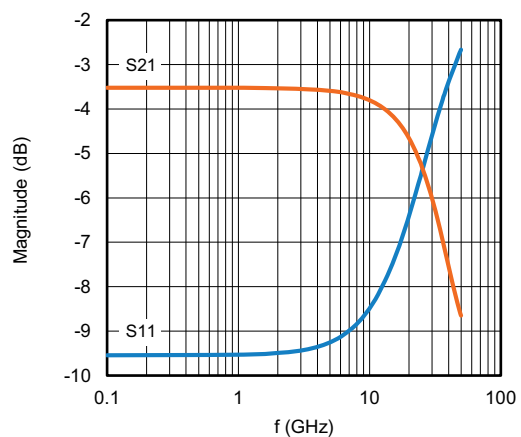


CH0603 flip chip ( $Z_0 = Z_1 = Z_s = R = 100 \Omega$ )

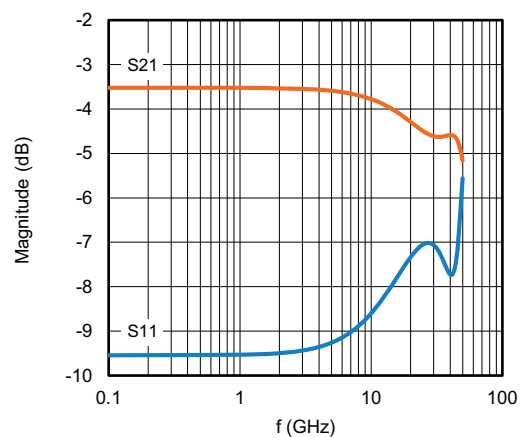


## S-PARAMETER

### CH0603 (N and G Terminations)



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



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



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