

**AVX**  
A KYOCERA GROUP COMPANY



**AVX**  
**RF Microwave/Thin-Film**  
**Products**

*AVX Microwave  
Ask The World Of Us*

As one of the world's broadest line multilayer ceramic chip capacitor suppliers, and a major Thin Film RF/Microwave capacitor, inductor, directional coupler and low pass filter and microwave ceramic capacitor manufacturer, it is our mission to provide **First In Class** Technology, Quality and Service, by establishing progressive design, manufacturing and continuous improvement programs driving toward a single goal:

**TOTAL CUSTOMER SATISFACTION**

QV2000

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| • AQ06 (0.063" x 0.032") - Cap. Range: 0.1 to 120pF                                              |               |
| • AQ11; AQ12 (0.055" x 0.055") - Cap. Range: 0.1 to 1000pF                                       |               |
| • AQ13; AQ14 (0.110" x 0.110") - Cap. Range: 0.1 to 5100pF                                       |               |
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AVX Corporation is a leading manufacturer of multilayer ceramic, thin film, tantalum, and glass capacitors, as well as other passive electronic components. These products are used in virtually every variety of electronic system today, including data processing, telecommunications, consumer/automotive electronics, military and aerospace systems, and instrumentation and process controls.

We continually strive to be the leader in all component segments we supply. RF/Microwave capacitors is a thrust business for us. AVX offers a broad line of RF/Microwave Chip Capacitors in a wide range of sizes, styles, and ratings.

The Thin-Film Products range illustrated in this catalog represents the state-of-the-art in RF Capacitors, Inductors, Directional Couplers and Low Pass Filters. The thin-film technology provides components that exhibit excellent batch-to-batch repeatability of electrical parameters at RF frequencies.

The Accu-F® and Accu-P® series of capacitors are available in ultra-tight tolerances ( $\pm 0.02\text{pF}$ ) as well as non-standard capacitance values.

The Accu-L® series of inductors are ideally suited for applications requiring an extremely high Q and high current capability.

The CP0402/CP0603/CP0805 series of Directional Couplers cover the frequency range of 800 MHz to 6 GHz. They feature low insertion loss, high directivity and highly accurate coupling factors.

The LP0805 series of Low Pass Filters provide a rugged component in a small 0805 size package with excellent high frequency performance.

Another major series of microwave capacitors consists of both multilayer porcelain and ceramic capacitors for frequencies from 10 MHz to 4.2 GHz (AQ11 - 14 Series). Three sizes of specially designed ultra-low ESR COG (NP0) capacitors are covered for RF applications ("U" Series).

**Ask the world of us. Call (843) 448-9411.**

**Or visit our website <http://www.avx.com>**



# Thin-Film Technology

Accu-F<sup>®</sup> / Accu-P<sup>®</sup>

Thin-Film RF/Microwave Capacitors

### THE IDEAL CAPACITOR

The non-ideal characteristics of a real capacitor can be ignored at low frequencies. Physical size imparts inductance to the capacitor and dielectric and metal electrodes result in resistive losses, but these often are of negligible effect on the circuit. At the very high frequencies of radio communication (>100MHz) and satellite systems (>1GHz), these effects become important. Recognizing that a real capacitor will exhibit inductive and resistive impedances in addition to capacitance, the ideal capacitor for these high frequencies is an ultra low loss component which can be fully characterized in all parameters with total repeatability from unit to unit.

Until recently, most high frequency/microwave capacitors were based on fired-ceramic (porcelain) technology. Layers of ceramic dielectric material and metal alloy electrode paste are interleaved and then sintered in a high temperature oven. This technology exhibits component variability in dielectric quality (losses, dielectric constant and insulation resistance), variability in electrode conductivity and variability in physical size (affecting inductance). An alternate thin-film technology has been developed which virtually eliminates these variances. It is this technology which has been fully incorporated into Accu-F® and Accu-P® to provide high frequency capacitors exhibiting truly ideal characteristics.

The main features of Accu-F® and Accu-P® may be summarized as follows:

- High purity of electrodes for very low and repeatable ESR.
- Highly pure, low-K dielectric for high breakdown field, high insulation resistance and low losses to frequencies above 40GHz.
- Very tight dimensional control for uniform inductance, unit to unit.
- Very tight capacitance tolerances for high frequency signal applications.

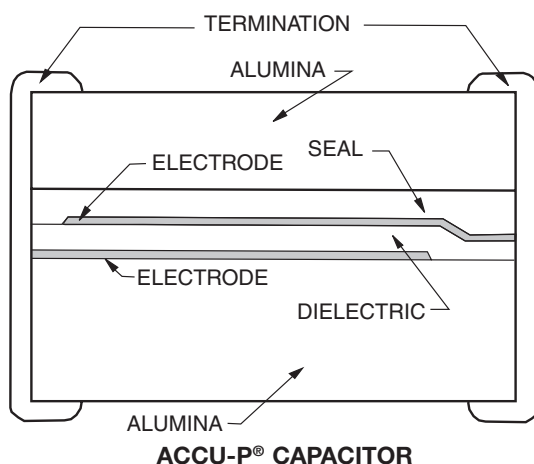
This accuracy sets apart these Thin-Film capacitors from ceramic capacitors so that the term Accu has been employed as the designation for this series of devices, an abbreviation for “accurate.”

### THIN-FILM TECHNOLOGY

Thin-film technology is commonly used in producing semiconductor devices. In the last two decades, this technology has developed tremendously, both in performance and in process control. Today's techniques enable line definitions of below 1µm, and the controlling of thickness of layers at 100Å (10<sup>-2</sup>µm). Applying this technology to the manufacture of capacitors has enabled the development of components where both electrical and physical properties can be tightly controlled.

The thin-film production facilities at AVX consist of:

- Class 1000 clean rooms, with working areas under laminar-flow hoods of class 100, (below 100 particles per cubic foot larger than 0.5µm).
- High vacuum metal deposition systems for high-purity electrode construction.
- Photolithography equipment for line definition down to 2.0µm accuracy.
- Plasma-enhanced CVD for various dielectric depositions (CVD=Chemical Vapor Deposition).
- High accuracy, microprocessor-controlled dicing saws for chip separation.
- High speed, high accuracy sorting to ensure strict tolerance adherence.



## Thin-Film Chip Capacitors

### ACCU-F® TECHNOLOGY

The use of very low-loss dielectric materials, silicon dioxide and silicon oxynitride, in conjunction with highly conductive electrode metals results in low ESR and high Q. These high-frequency characteristics change at a slower rate with increasing frequency than for ceramic microwave capacitors.

Because of the thin-film technology, the above-mentioned frequency characteristics are obtained without significant compromise of properties required for surface mounting.

The main Accu-F® properties are:

- Internationally agreed sizes with excellent dimensional control.
- Small size chip capacitors (0603) are available.
- Tight capacitance tolerances.
- Low ESR at VHF, UHF and microwave frequencies.
- High stability with respect to time, temperature, frequency and voltage variation.
- Nickel/solder-coated terminations to provide excellent solderability and leach resistance.

### ACCU-F® FEATURES

Accu-F® meets the fast-growing demand for low-loss (high-Q) capacitors for use in surface mount technology especially for the mobile communications market, such as cellular radio of 450 and 900 MHz, UHF walkie-talkies, UHF cordless telephones to 2.3 GHz, low noise blocks at 11-12.5 GHz and for other VHF, UHF and microwave applications.

Accu-F® is currently unique in its ability to offer very low capacitance values (0.1pF) and very tight capacitance tolerances ( $\pm 0.05\text{pF}$ ). Typically Accu-F® will be used in small signal applications in VCO's, matching networks, filters, etc.

Inspection test and quality control procedures in accordance with ISO 9001, CECC, IECQ and USA MIL Standards yield products of the highest quality.

### APPLICATIONS

|                                                      |                     |
|------------------------------------------------------|---------------------|
| Cellular Communications                              | Radar Systems       |
| CT2/PCN (Cordless Telephone/Personal Comm. Networks) | Video Switching     |
| Satellite TV                                         | Test & Measurements |
| Cable TV                                             | Filters             |
| GPS (Global Positioning Systems)                     | VCO's               |
| Vehicle Location Systems                             | Matching Networks   |
| Vehicle Alarm Systems                                |                     |
| Paging                                               |                     |
| Military Communications                              |                     |

### APPROVALS

ISO 9001

### ACCU-P® TECHNOLOGY

As in the Accu-F® series the use of very low-loss dielectric materials (silicon dioxide and silicon oxynitride) in conjunction with highly conductive electrode metals results in low ESR and high Q. At high frequency these characteristics change at a slower rate with increasing frequency than conventional ceramic microwave capacitors. Using thin-film technology, the above-mentioned frequency characteristics are obtained without significant compromise of properties required for surface mounting. The use of high thermal conductivity materials results in excellent RF power handling capabilities.

The main Accu-P® properties are:

- Enhanced RF power handling capability.
- Improved mechanical characteristics.
- Internationally agreed sizes with excellent dimensional control.
- Ultra Small size chip capacitors (0201) are available.
- Tight capacitance tolerances.
- Low ESR at UHF, VHF, and microwave frequencies.
- High-stability with respect to time, temperature, frequency and voltage variation.
- High temperature nickel/solder-coated terminations as standard to provide excellent solderability and leach resistance.

### ACCU-P® FEATURES

- Minimal batch to batch variability of parameters at high frequency.
- The Accu-P® has the same unique features as the Accu-F® capacitor such as low ESR, high Q, availability of very low capacitance values and very tight capacitance tolerances.
- The RF power handling capability of the Accu-P® allows for its usage in both small signal and RF power applications.
- Inspection, test and quality control procedures in accordance with ISO 9001, CECC, IECQ and USA MIL Standards guarantee product of the highest quality.
- Hand soldering Accu-P®: Due to their construction utilizing relatively high thermal conductivity materials, Accu-P's have become the preferred device in R & D labs and production environments where hand soldering is used. Accu-P's are available in all sizes and are electrically identical to their Accu-F counterparts.

### APPLICATIONS

|                                                      |                     |
|------------------------------------------------------|---------------------|
| Cellular Communications                              | Radar Systems       |
| CT2/PCN (Cordless Telephone/Personal Comm. Networks) | Video Switching     |
| Satellite TV                                         | Test & Measurements |
| Cable TV                                             | Filters             |
| GPS (Global Positioning Systems)                     | VCO's               |
| Vehicle Location Systems                             | Matching Networks   |
| Vehicle Alarm Systems                                | RF Amplifiers       |
| Paging                                               |                     |
| Military Communications                              |                     |

### APPROVALS

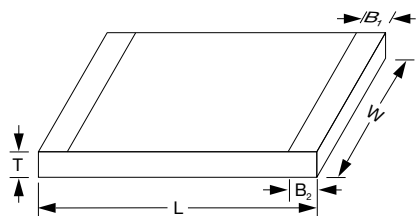
ISO 9001

# Accu-F® \*/ Accu-P®

## Thin-Film Chip Capacitors for RF Signal and Power Applications



1



### ACCU-F® \*(Signal Type Capacitors)

|          | 0603                      | 0805                      |
|----------|---------------------------|---------------------------|
| <b>L</b> | 1.60±0.1<br>(0.063±0.004) | 2.01±0.1<br>(0.079±0.004) |
| <b>W</b> | 0.81±0.1<br>(0.032±0.004) | 1.27±0.1<br>(0.050±0.004) |
| <b>T</b> | 0.63±0.1<br>(0.025±0.004) | 0.63±0.1<br>(0.025±0.004) |
| <b>B</b> | 0.30±0.1<br>(0.012±0.004) | 0.30±0.1<br>(0.012±0.004) |

\*Not recommended for new designs.  
Accu-P's are recommended.

**DIMENSIONS:**  
millimeters (inches)

### ACCU-P® (Signal and Power Type Capacitors)

|                      | 0201                          | 0402*                           | 0603*                      | 0805*                     | 1210                      |
|----------------------|-------------------------------|---------------------------------|----------------------------|---------------------------|---------------------------|
| <b>L</b>             | 0.60±0.05<br>(0.023±0.002)    | 1.00±0.1<br>(0.039±0.004)       | 1.60±0.1<br>(0.063±0.004)  | 2.01±0.1<br>(0.079±0.004) | 3.02±0.1<br>(0.119±0.004) |
| <b>W</b>             | 0.325±0.050<br>(0.0128±0.002) | 0.55±0.07<br>(0.022±0.003)      | 0.81±0.1<br>(0.032±0.004)  | 1.27±0.1<br>(0.050±0.004) | 2.5±0.1<br>(0.100±0.004)  |
| <b>T</b>             | 0.225±0.050<br>(0.009±0.002)  | 0.40±0.1<br>(0.016±0.004)       | 0.63±0.1<br>(0.025±0.004)  | 0.93±0.2<br>(0.036±0.008) | 0.93±0.2<br>(0.036±0.008) |
| <b>B<sub>1</sub></b> | 0.10±0.10<br>(0.004±0.004)    | 0.00±0.1/-0<br>(0.000±0.004/-0) | 0.35±0.15<br>(0.014±0.006) | 0.30±0.1<br>(0.012±0.004) | 0.43±0.1<br>(0.017±0.004) |
| <b>B<sub>2</sub></b> | 0.15±0.05<br>(0.006±0.002)    | 0.20±0.1<br>(0.008±0.004)       | 0.35±0.15<br>(0.014±0.006) | 0.30±0.1<br>(0.012±0.004) | 0.43±0.1<br>(0.017±0.004) |

\*Mount Black Side Up

**DIMENSIONS:** millimeters (inches)

### HOW TO ORDER

| 0805        | 5              | J                                  | 120                                                                                                                                                                | G                                                                             | A                                                | W                                                                                                      | TR                    |
|-------------|----------------|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------------------------------------------------------------|-----------------------|
| <b>Size</b> | <b>Voltage</b> | <b>Temperature Coefficient (1)</b> | <b>Capacitance</b>                                                                                                                                                 | <b>Tolerance for C≤2.0pF*</b>                                                 | <b>Specification Code</b>                        | <b>Termination Code</b>                                                                                | <b>Packaging Code</b> |
| 0201*       | 1 = 100V       | J = 0±30ppm/°C (-55°C to +125°C)   | Capacitance expressed in pF. (2 significant digits + number of zeros) <b>for values &lt;10pF</b> , letter R denotes decimal point. Example: 68pF = 680 8.2pF = 8R2 | P = ±0.02pF<br>Q = ±0.03pF<br>A = ±0.05pF<br>B = ±0.1pF<br>C = ±0.25pF        | A = Accu-F® technology<br>B = Accu-P® technology | W = Nickel/<br>Solder Coated<br><b>Accu-F®</b> Sn63, Pb37<br><b>Accu-P® 0201 &amp; 0402</b> Sn90, Pb10 | TR = Tape and Reel    |
| 0402*       | 5 = 50V        | K = 0±60ppm/°C (-55°C to +125°C)   |                                                                                                                                                                    | <b>for C≤3.0pF</b><br>Q = ±0.03pF<br>A = ±0.05pF<br>B = ±0.1pF<br>C = ±0.25pF |                                                  | T = Nickel/High Temperature<br>Solder Coated<br><b>Accu-P® 0603, 0805, 1210</b> Sn96, Ag4              |                       |
| 0603        | 3 = 25V        |                                    |                                                                                                                                                                    | <b>for C≤5.6pF</b><br>A = ±0.05pF<br>B = ±0.1pF<br>C = ±0.25pF                |                                                  | S = Nickel/Lead Free<br>Solder Coated<br><b>Accu-P® 0402</b> Sn100                                     |                       |
| 0805        | Y = 16V        |                                    |                                                                                                                                                                    | <b>for 5.6pF&lt;C&lt;10pF</b><br>B = ±0.1pF<br>C = ±0.25pF<br>D = ±0.5pF      |                                                  |                                                                                                        |                       |
| 1210*       | Z = 10V        |                                    |                                                                                                                                                                    | <b>for C≥10pF</b><br>F = ±1%<br>G = ±2%<br>J = ±5%                            |                                                  |                                                                                                        |                       |

(1) TC's shown are per EIA/IEC Specifications.

\* Tolerances as tight as ±0.01pF are available.  
Please consult the factory.

### ELECTRICAL SPECIFICATIONS

|                                         |                                                                        |
|-----------------------------------------|------------------------------------------------------------------------|
| Operating and Storage Temperature Range | -55°C to +125°C                                                        |
| Temperature Coefficients (1)            | 0 ± 30ppm/°C dielectric code "J" / 0 ± 60ppm/°C dielectric code "K"    |
| Capacitance Measurement                 | 1 MHz, 1 Vrms                                                          |
| Insulation Resistance (IR)              | ≥10 <sup>11</sup> Ohms (≥10 <sup>10</sup> Ohms for 0201 and 0402 size) |
| Proof Voltage                           | 2.5 U <sub>R</sub> for 5 secs.                                         |
| Aging Characteristic                    | Zero                                                                   |
| Dielectric Absorption                   | 0.01%                                                                  |

(1) TC's shown are per EIA/IEC Specifications.

## Signal Type Capacitors

### Accu-F® Capacitance Ranges (pF)

#### TEMP. COEFFICIENT CODE

“J” =  $0 \pm 30 \text{ ppm}/^\circ\text{C}$   
 (-55°C to +125°C)<sup>(2)</sup>

| Size                     |          | 0603 |    |    | 0805 |    |    |
|--------------------------|----------|------|----|----|------|----|----|
| Size Code                |          | 0603 |    |    | 0805 |    |    |
| Voltage                  |          | 100  | 50 | 25 | 100  | 50 | 25 |
| Cap in pF <sup>(1)</sup> | Cap code |      |    |    |      |    |    |
| 0.1 —                    | 0R1      |      |    |    |      |    |    |
| 0.2 —                    | 0R2      |      |    |    |      |    |    |
| 0.3 —                    | 0R3      |      |    |    |      |    |    |
| 0.4 —                    | 0R4      |      |    |    |      |    |    |
| 0.5 —                    | 0R5      |      |    |    |      |    |    |
| 0.6 —                    | 0R6      |      |    |    |      |    |    |
| 0.7 —                    | 0R7      |      |    |    |      |    |    |
| 0.8 —                    | 0R8      |      |    |    |      |    |    |
| 0.9 —                    | 0R9      |      |    |    |      |    |    |
| 1.0 —                    | 1R0      |      |    |    |      |    |    |
| 1.2 —                    | 1R2      |      |    |    |      |    |    |
| 1.5 —                    | 1R5      |      |    |    |      |    |    |
| 1.8 —                    | 1R8      |      |    |    |      |    |    |
| 2.2 —                    | 2R2      |      |    |    |      |    |    |
| 2.7 —                    | 2R7      |      |    |    |      |    |    |
| 3.3 —                    | 3R3      |      |    |    |      |    |    |
| 3.9 —                    | 3R9      |      |    |    |      |    |    |
| 4.7 —                    | 4R7      |      |    |    |      |    |    |
| 5.6 —                    | 5R6      |      |    |    |      |    |    |
| 6.8 —                    | 6R8      |      |    |    |      |    |    |
| 8.2 —                    | 8R2      |      |    |    |      |    |    |
| 10 —                     | 100      |      |    |    |      |    |    |
| 12 —                     | 120      |      |    |    |      |    |    |
| 15 —                     | 150      |      |    |    |      |    |    |
| 18 —                     | 180      |      |    |    |      |    |    |
| 22 —                     | 220      |      |    |    |      |    |    |
| 27 —                     | 270      |      |    |    |      |    |    |
| 33 —                     | 330      |      |    |    |      |    |    |
| 39 —                     | 390      |      |    |    |      |    |    |
| 47 —                     | 470      |      |    |    |      |    |    |
| 56 —                     | 560      |      |    |    |      |    |    |
| 68 —                     | 680      |      |    |    |      |    |    |
| 82 —                     | 820      |      |    |    |      |    |    |
| 100 —                    | 101      |      |    |    |      |    |    |
| 120 —                    | 121      |      |    |    |      |    |    |
| 150 —                    | 151      |      |    |    |      |    |    |

<sup>(1)</sup> For capacitance values higher than listed in table, please consult factory.

<sup>(2)</sup> TC shown is per EIA/IEC Specifications.

#### TEMP. COEFFICIENT CODE

“K” =  $0 \pm 60 \text{ ppm}/^\circ\text{C}$   
 (-55°C to +125°C)<sup>(2)</sup>

| Size                     |          | 0603 |    |    | 0805 |    |    |
|--------------------------|----------|------|----|----|------|----|----|
| Size Code                |          | 0603 |    |    | 0805 |    |    |
| Voltage                  |          | 100  | 50 | 25 | 100  | 50 | 25 |
| Cap in pF <sup>(1)</sup> | Cap code |      |    |    |      |    |    |
| 0.1 —                    | 0R1      |      |    |    |      |    |    |
| 0.2 —                    | 0R2      |      |    |    |      |    |    |
| 0.3 —                    | 0R3      |      |    |    |      |    |    |
| 0.4 —                    | 0R4      |      |    |    |      |    |    |
| 0.5 —                    | 0R5      |      |    |    |      |    |    |
| 0.6 —                    | 0R6      |      |    |    |      |    |    |
| 0.7 —                    | 0R7      |      |    |    |      |    |    |
| 0.8 —                    | 0R8      |      |    |    |      |    |    |
| 0.9 —                    | 0R9      |      |    |    |      |    |    |
| 1.0 —                    | 1R0      |      |    |    |      |    |    |
| 1.2 —                    | 1R2      |      |    |    |      |    |    |
| 1.5 —                    | 1R5      |      |    |    |      |    |    |
| 1.8 —                    | 1R8      |      |    |    |      |    |    |
| 2.2 —                    | 2R2      |      |    |    |      |    |    |
| 2.7 —                    | 2R7      |      |    |    |      |    |    |
| 3.3 —                    | 3R3      |      |    |    |      |    |    |
| 3.9 —                    | 3R9      |      |    |    |      |    |    |
| 4.7 —                    | 4R7      |      |    |    |      |    |    |
| 5.6 —                    | 5R6      |      |    |    |      |    |    |
| 6.8 —                    | 6R8      |      |    |    |      |    |    |
| 8.2 —                    | 8R2      |      |    |    |      |    |    |
| 10 —                     | 100      |      |    |    |      |    |    |
| 12 —                     | 120      |      |    |    |      |    |    |
| 15 —                     | 150      |      |    |    |      |    |    |
| 18 —                     | 180      |      |    |    |      |    |    |
| 22 —                     | 220      |      |    |    |      |    |    |
| 27 —                     | 270      |      |    |    |      |    |    |
| 33 —                     | 330      |      |    |    |      |    |    |
| 39 —                     | 390      |      |    |    |      |    |    |
| 47 —                     | 470      |      |    |    |      |    |    |
| 56 —                     | 560      |      |    |    |      |    |    |
| 68 —                     | 680      |      |    |    |      |    |    |
| 82 —                     | 820      |      |    |    |      |    |    |
| 100 —                    | 101      |      |    |    |      |    |    |
| 120 —                    | 121      |      |    |    |      |    |    |
| 150 —                    | 151      |      |    |    |      |    |    |

<sup>(1)</sup> For capacitance values higher than listed in table, please consult factory.

<sup>(2)</sup> TC shown is per EIA/IEC Specifications.

Intermediate values are available within the indicated range.

\*Not recommended for new designs.  
 Accu-P's are recommended.

## Signal and Power Type Capacitors

### Accu-P® Capacitance Ranges (pF)

#### TEMP. COEFFICIENT CODE

“J” =  $0 \pm 30 \text{ ppm}/^\circ\text{C}$  ( $-55^\circ\text{C}$  to  $+125^\circ\text{C}$ )<sup>(2)</sup>

| Size                     |          | 0201 |    |    | 0402 |    |    | 0603 |    | 0805 |    |    | 1210 |    |
|--------------------------|----------|------|----|----|------|----|----|------|----|------|----|----|------|----|
| Size Code                |          | 0201 |    |    | 0402 |    |    | 0603 |    | 0805 |    |    | 1210 |    |
| Voltage                  |          | 25   | 16 | 10 | 25   | 16 | 10 | 50   | 25 | 100  | 50 | 25 | 100  | 50 |
| Cap in pF <sup>(1)</sup> | Cap code |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 0.1 —                    | 0R1      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 0.2 —                    | 0R2      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 0.3 —                    | 0R3      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 0.4 —                    | 0R4      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 0.5 —                    | 0R5      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 0.6 —                    | 0R6      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 0.7 —                    | 0R7      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 0.8 —                    | 0R8      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 0.9 —                    | 0R9      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 1.0 —                    | 1R0      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 1.1 —                    | 1R1      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 1.2 —                    | 1R2      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 1.3 —                    | 1R3      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 1.4 —                    | 1R4      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 1.5 —                    | 1R5      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 1.6 —                    | 1R6      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 1.7 —                    | 1R7      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 1.8 —                    | 1R8      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 1.9 —                    | 1R9      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 2.0 —                    | 2R0      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 2.1 —                    | 2R1      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 2.2 —                    | 2R2      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 2.3 —                    | 2R3      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 2.4 —                    | 2R4      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 2.5 —                    | 2R5      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 2.6 —                    | 2R6      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 2.7 —                    | 2R7      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 2.8 —                    | 2R8      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 2.9 —                    | 2R9      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 3.0 —                    | 3R0      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 3.1 —                    | 3R1      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 3.2 —                    | 3R2      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 3.3 —                    | 3R3      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 3.4 —                    | 3R4      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 3.5 —                    | 3R5      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 3.6 —                    | 3R6      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 3.7 —                    | 3R7      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 3.8 —                    | 3R8      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 3.9 —                    | 3R9      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 4.0 —                    | 4R0      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 4.1 —                    | 4R1      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 4.2 —                    | 4R2      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 4.3 —                    | 4R3      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 4.4 —                    | 4R4      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 4.5 —                    | 4R5      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 4.6 —                    | 4R6      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 4.7 —                    | 4R7      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 5.1 —                    | 5R1      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 5.6 —                    | 5R6      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 6.2 —                    | 6R2      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 6.8 —                    | 6R8      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 7.5 —                    | 7R5      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 8.2 —                    | 8R2      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 9.1 —                    | 9R1      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 10.0 —                   | 100      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 11.0 —                   | 110      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 12.0 —                   | 120      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 13.0 —                   | 130      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 14.0 —                   | 140      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 15.0 —                   | 150      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 16.0 —                   | 160      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 17.0 —                   | 170      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 18.0 —                   | 180      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 22.0 —                   | 220      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 24.0 —                   | 240      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 27.0 —                   | 270      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 30.0 —                   | 300      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 33.0 —                   | 330      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 39.0 —                   | 390      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 47.0 —                   | 470      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 56.0 —                   | 560      |      |    |    |      |    |    |      |    |      |    |    |      |    |
| 68.0 —                   | 680      |      |    |    |      |    |    |      |    |      |    |    |      |    |

<sup>(1)</sup> For capacitance values higher than listed in table, please consult factory.

<sup>(2)</sup> TC shown is per EIA/IEC Specifications.

These values are produced with “K” temperature coefficient code only.

#### TEMP. COEFFICIENT CODE

“K” =  $0 \pm 60 \text{ ppm}/^\circ\text{C}$  ( $-55^\circ\text{C}$  to  $+125^\circ\text{C}$ )<sup>(2)</sup>

| Size                     |          | 0805 |    |    | 1210 |                   |
|--------------------------|----------|------|----|----|------|-------------------|
| Size Code                |          | 0805 |    |    | 1210 |                   |
| Voltage                  |          | 100  | 50 | 25 | 100  | 50 <sup>(3)</sup> |
| Cap in pF <sup>(1)</sup> | Cap code |      |    |    |      |                   |
| 0.1 —                    | 0R1      |      |    |    |      |                   |
| 0.2 —                    | 0R2      |      |    |    |      |                   |
| 0.3 —                    | 0R3      |      |    |    |      |                   |
| 0.4 —                    | 0R4      |      |    |    |      |                   |
| 0.5 —                    | 0R5      |      |    |    |      |                   |
| 0.6 —                    | 0R6      |      |    |    |      |                   |
| 0.7 —                    | 0R7      |      |    |    |      |                   |
| 0.8 —                    | 0R8      |      |    |    |      |                   |
| 0.9 —                    | 0R9      |      |    |    |      |                   |
| 1.0 —                    | 1R0      |      |    |    |      |                   |
| 1.1 —                    | 1R1      |      |    |    |      |                   |
| 1.2 —                    | 1R2      |      |    |    |      |                   |
| 1.3 —                    | 1R3      |      |    |    |      |                   |
| 1.4 —                    | 1R4      |      |    |    |      |                   |
| 1.5 —                    | 1R5      |      |    |    |      |                   |
| 1.6 —                    | 1R6      |      |    |    |      |                   |
| 1.7 —                    | 1R7      |      |    |    |      |                   |
| 1.8 —                    | 1R8      |      |    |    |      |                   |
| 1.9 —                    | 1R9      |      |    |    |      |                   |
| 2.0 —                    | 2R0      |      |    |    |      |                   |
| 2.1 —                    | 2R1      |      |    |    |      |                   |
| 2.2 —                    | 2R2      |      |    |    |      |                   |
| 2.3 —                    | 2R3      |      |    |    |      |                   |
| 2.4 —                    | 2R4      |      |    |    |      |                   |
| 2.5 —                    | 2R5      |      |    |    |      |                   |
| 2.6 —                    | 2R6      |      |    |    |      |                   |
| 2.7 —                    | 2R7      |      |    |    |      |                   |
| 2.8 —                    | 2R8      |      |    |    |      |                   |
| 2.9 —                    | 2R9      |      |    |    |      |                   |
| 3.0 —                    | 3R0      |      |    |    |      |                   |
| 3.1 —                    | 3R1      |      |    |    |      |                   |
| 3.2 —                    | 3R2      |      |    |    |      |                   |
| 3.3 —                    | 3R3      |      |    |    |      |                   |
| 3.4 —                    | 3R4      |      |    |    |      |                   |
| 3.5 —                    | 3R5      |      |    |    |      |                   |
| 3.6 —                    | 3R6      |      |    |    |      |                   |
| 3.7 —                    | 3R7      |      |    |    |      |                   |
| 3.8 —                    | 3R8      |      |    |    |      |                   |
| 3.9 —                    | 3R9      |      |    |    |      |                   |
| 4.0 —                    | 4R0      |      |    |    |      |                   |
| 4.1 —                    | 4R1      |      |    |    |      |                   |
| 4.2 —                    | 4R2      |      |    |    |      |                   |
| 4.3 —                    | 4R3      |      |    |    |      |                   |
| 4.4 —                    | 4R4      |      |    |    |      |                   |
| 4.5 —                    | 4R5      |      |    |    |      |                   |
| 4.6 —                    | 4R6      |      |    |    |      |                   |
| 4.7 —                    | 4R7      |      |    |    |      |                   |
| 5.1 —                    | 5R1      |      |    |    |      |                   |
| 5.6 —                    | 5R6      |      |    |    |      |                   |
| 6.2 —                    | 6R2      |      |    |    |      |                   |
| 6.8 —                    | 6R8      |      |    |    |      |                   |
| 7.5 —                    | 7R5      |      |    |    |      |                   |
| 8.2 —                    | 8R2      |      |    |    |      |                   |
| 9.1 —                    | 9R1      |      |    |    |      |                   |
| 10.0 —                   | 100      |      |    |    |      |                   |
| 11.0 —                   | 110      |      |    |    |      |                   |
| 12.0 —                   | 120      |      |    |    |      |                   |
| 13.0 —                   | 130      |      |    |    |      |                   |
| 14.0 —                   | 140      |      |    |    |      |                   |
| 15.0 —                   | 150      |      |    |    |      |                   |
| 16.0 —                   | 160      |      |    |    |      |                   |
| 17.0 —                   | 170      |      |    |    |      |                   |
| 18.0 —                   | 180      |      |    |    |      |                   |
| 22.0 —                   | 220      |      |    |    |      |                   |
| 24.0 —                   | 240      |      |    |    |      |                   |
| 27.0 —                   | 270      |      |    |    |      |                   |
| 30.0 —                   | 300      |      |    |    |      |                   |
| 33.0 —                   | 330      |      |    |    |      |                   |
| 39.0 —                   | 390      |      |    |    |      |                   |
| 47.0 —                   | 470      |      |    |    |      |                   |
| 56.0 —                   | 560      |      |    |    |      |                   |
| 68.0 —                   | 680      |      |    |    |      |                   |

<sup>(1)</sup> For capacitance values higher than listed in table, please consult factory.

<sup>(2)</sup> TC shown is per EIA/IEC Specifications.

<sup>(3)</sup> For 50 volt range, please consult factory.

Intermediate values are available within the indicated range.

## 0201 Typical Electrical Tables

| Capacitance<br>@ 1 MHz<br>(pF) | Self<br>Resonance<br>Frequency<br>(GHz)<br>Typical | 250MHz                 |           |                     | 500MHz                 |           |                     | 750MHz                 |           |                     | 1000MHz                |           |                     | 1250MHz                |           |                     |
|--------------------------------|----------------------------------------------------|------------------------|-----------|---------------------|------------------------|-----------|---------------------|------------------------|-----------|---------------------|------------------------|-----------|---------------------|------------------------|-----------|---------------------|
|                                |                                                    | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(mΩ) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(mΩ) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(mΩ) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(mΩ) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(mΩ) |
| 0.8                            | 9.1                                                | 0.84                   | 2154      | 360                 | 0.84                   | 630       | 603                 | 0.85                   | 424       | 594                 | 0.85                   | 327       | 577                 | 0.86                   | 255       | 588                 |
| 1.2                            | 7.6                                                | 1.21                   | 1375      | 405                 | 1.21                   | 525       | 517                 | 1.22                   | 341       | 527                 | 1.23                   | 267       | 503                 | 1.23                   | 208       | 515                 |
| 1.8                            | 6.3                                                | 1.84                   | 1298      | 271                 | 1.85                   | 520       | 341                 | 1.86                   | 337       | 347                 | 1.87                   | 270       | 326                 | 1.88                   | 201       | 347                 |
| 2.2                            | 5.7                                                | 2.23                   | 1355      | 214                 | 2.24                   | 512       | 281                 | 2.25                   | 335       | 284                 | 2.27                   | 264       | 270                 | 2.29                   | 199       | 284                 |
| 3.3                            | 4.6                                                | 3.29                   | 1295      | 156                 | 3.31                   | 430       | 230                 | 3.33                   | 285       | 230                 | 3.36                   | 220       | 223                 | 3.40                   | 159       | 242                 |
| 3.9                            | 4.3                                                | 3.91                   | 1902      | 93                  | 3.93                   | 460       | 181                 | 3.97                   | 298       | 185                 | 4.02                   | 227       | 181                 | 4.08                   | 163       | 198                 |
| 4.7                            | 3.9                                                | 4.71                   | 1677      | 84                  | 4.74                   | 391       | 174                 | 4.80                   | 252       | 178                 | 4.87                   | 181       | 183                 | 4.97                   | 130       | 200                 |
| 5.6                            | 3.6                                                | 5.62                   | 1391      | 84                  | 5.67                   | 370       | 154                 | 5.74                   | 257       | 148                 | 5.83                   | 195       | 144                 | 5.95                   | 140       | 157                 |
| 6.8                            | 3.3                                                | 6.77                   | 1135      | 84                  | 6.83                   | 314       | 149                 | 6.91                   | 217       | 142                 | 7.03                   | 164       | 139                 | 7.18                   | 118       | 151                 |

| Capacitance<br>@ 1 MHz<br>(pF) | Self<br>Resonance<br>Frequency<br>(GHz)<br>Typical | 1500MHz                |           |                     | 1750MHz                |           |                     | 2250MHz                |           |                     | 2500MHz                |                |                     | 2750MHz                |           |                     |
|--------------------------------|----------------------------------------------------|------------------------|-----------|---------------------|------------------------|-----------|---------------------|------------------------|-----------|---------------------|------------------------|----------------|---------------------|------------------------|-----------|---------------------|
|                                |                                                    | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(mΩ) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(mΩ) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(mΩ) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q<br>M | Typ.<br>ESR<br>(mΩ) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(mΩ) |
| 0.8                            | 9.1                                                | 0.86                   | 204       | 611                 | 0.87                   | 168       | 631                 | 0.88                   | 141       | 587                 | 0.89                   | 126            | 571                 | 0.90                   | 122       | 532                 |
| 1.2                            | 7.6                                                | 1.24                   | 155       | 565                 | 1.26                   | 129       | 577                 | 1.28                   | 92        | 570                 | 1.30                   | 89             | 566                 | 1.31                   | 81        | 558                 |
| 1.8                            | 6.3                                                | 1.90                   | 148       | 388                 | 1.92                   | 123       | 395                 | 1.96                   | 96        | 395                 | 1.99                   | 83             | 396                 | 2.02                   | 74        | 397                 |
| 2.2                            | 5.7                                                | 2.32                   | 145       | 320                 | 2.34                   | 123       | 322                 | 2.41                   | 93        | 329                 | 2.46                   | 81             | 328                 | 2.50                   | 72        | 330                 |
| 3.3                            | 4.6                                                | 3.45                   | 119       | 266                 | 3.50                   | 101       | 263                 | 3.63                   | 74        | 277                 | 3.73                   | 64             | 276                 | 3.84                   | 55        | 281                 |
| 3.9                            | 4.3                                                | 4.16                   | 122       | 216                 | 4.25                   | 103       | 214                 | 4.46                   | 75        | 224                 | 4.63                   | 64             | 223                 | 4.79                   | 56        | 225                 |
| 4.7                            | 3.9                                                | 5.08                   | 99        | 213                 | 5.23                   | 83        | 212                 | 5.55                   | 60        | 221                 | 5.83                   | 50             | 222                 | 6.10                   | 43        | 224                 |
| 5.6                            | 3.6                                                | 6.11                   | 108       | 166                 | 6.31                   | 91        | 164                 | 6.76                   | 64        | 174                 | 7.16                   | 53             | 175                 | 7.56                   | 45        | 141                 |
| 6.8                            | 3.3                                                | 7.38                   | 93        | 155                 | 7.63                   | 76        | 158                 | 8.22                   | 54        | 166                 | 8.74                   | 44             | 169                 | 9.29                   | 37        | 173                 |

## 0402 Typical Electrical Tables

| Capacitance<br>& Tolerance*<br>@ 1 MHz<br>(pF) | Self<br>Resonance<br>Frequency<br>(GHz)<br>Typical | Ref<br>Freq<br>(MHz) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(Ω) | Ref<br>Freq<br>(MHz) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(Ω) | Ref<br>Freq<br>(MHz) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(Ω) | Ref<br>Freq<br>(MHz) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(Ω) | Ref<br>Freq<br>(MHz) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(Ω) |
|------------------------------------------------|----------------------------------------------------|----------------------|------------------------|-----------|--------------------|----------------------|------------------------|-----------|--------------------|----------------------|------------------------|-----------|--------------------|----------------------|------------------------|-----------|--------------------|----------------------|------------------------|-----------|--------------------|
| 0.1±0.05                                       | 19.4                                               | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 0.2±0.05                                       | 16.4                                               | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 0.3±0.05                                       | 14.6                                               | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 0.4±0.05                                       | 12.5                                               | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 0.5±0.05                                       | 11.3                                               | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 0.6±0.05                                       | 10.4                                               | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 0.7±0.05                                       | 9.5                                                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 0.8±0.05                                       | 9.1                                                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 0.9±0.05                                       | 8.8                                                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 1.00±0.05                                      | 8                                                  | 247                  | 1.16                   | 1635      | 0.34               | 494                  | 1.15                   | 1283      | 0.22               | 742                  | 1.13                   | 870       | 0.22               | 991                  | 1.12                   | 620       | 0.23               | 1240                 | 1.14                   | 474       | 0.25               |
| 1.10±0.05                                      | 7.8                                                | 246                  | 1.25                   | 1581      | 0.32               | 492                  | 1.22                   | 1219      | 0.21               | 740                  | 1.21                   | 791       | 0.22               | 989                  | 1.19                   | 561       | 0.24               | 1238                 | 1.21                   | 425       | 0.25               |
| 1.20±0.05                                      | 7.4                                                | 245                  | 1.34                   | 1538      | 0.30               | 491                  | 1.33                   | 1153      | 0.21               | 738                  | 1.31                   | 727       | 0.22               | 986                  | 1.3                    | 503       | 0.25               | 1234                 | 1.33                   | 372       | 0.25               |
| 1.30±0.05                                      | 7                                                  | 244                  | 1.42                   | 1502      | 0.29               | 490                  | 1.42                   | 1109      | 0.21               | 736                  | 1.4                    | 701       | 0.21               | 983                  | 1.35                   | 480       | 0.24               | 1230                 | 1.41                   | 350       | 0.25               |
| 1.40±0.05                                      | 6.8                                                | 243                  | 1.53                   | 1476      | 0.28               | 488                  | 1.54                   | 1061      | 0.20               | 733                  | 1.52                   | 680       | 0.21               | 980                  | 1.49                   | 461       | 0.23               | 1229                 | 1.53                   | 333       | 0.25               |
| 1.50±0.05                                      | 6.5                                                | 242                  | 1.63                   | 1454      | 0.28               | 486                  | 1.63                   | 1002      | 0.20               | 731                  | 1.58                   | 638       | 0.21               | 978                  | 1.6                    | 438       | 0.23               | 1226                 | 1.65                   | 316       | 0.25               |
| 1.60±0.05                                      | 6.5                                                | 242                  | 1.71                   | 1448      | 0.27               | 485                  | 1.76                   | 986       | 0.20               | 729                  | 1.69                   | 622       | 0.21               | 986                  | 1.71                   | 429       | 0.23               | 1224                 | 1.77                   | 309       | 0.24               |
| 1.70±0.05                                      | 6.4                                                | 241                  | 1.85                   | 1444      | 0.27               | 483                  | 1.81                   | 970       | 0.19               | 728                  | 1.75                   | 612       | 0.20               | 985                  | 1.75                   | 422       | 0.22               | 1223                 | 1.86                   | 305       | 0.23               |
| 1.80±0.05                                      | 6.2                                                | 240                  | 1.93                   | 1430      | 0.26               | 482                  | 1.86                   | 931       | 0.19               | 727                  | 1.83                   | 597       | 0.20               | 983                  | 1.8                    | 413       | 0.22               | 1220                 | 1.91                   | 299       | 0.23               |
| 1.90±0.05                                      | 6                                                  | 239                  | 2.01                   | 1421      | 0.25               | 481                  | 1.93                   | 897       | 0.19               | 726                  | 1.91                   | 583       | 0.20               | 972                  | 1.91                   | 401       | 0.21               | 1219                 | 1.97                   | 294       | 0.22               |
| 2.00±0.05                                      | 5.7                                                | 239                  | 2.11                   | 1410      | 0.24               | 480                  | 2.06                   | 896       | 0.18               | 722                  | 2.11                   | 582       | 0.19               | 969                  | 2.01                   | 400       | 0.20               | 1215                 | 2.11                   | 293       | 0.21               |
| 2.10±0.05                                      | 5.4                                                | 238                  | 2.21                   | 1406      | 0.23               | 478                  | 2.14                   | 893       | 0.17               | 720                  | 2.21                   | 581       | 0.18               | 966                  | 2.1                    | 398       | 0.19               | 1213                 | 2.22                   | 291       | 0.20               |
| 2.20±0.05                                      | 5.1                                                | 237                  | 2.28                   | 1406      | 0.22               | 476                  | 2.27                   | 893       | 0.16               | 718                  | 2.26                   | 581       | 0.17               | 964                  | 2.27                   | 396       | 0.18               | 1212                 | 2.35                   | 289       | 0.19               |
| 2.30±0.05                                      | 5                                                  | 237                  | 2.32                   | 1405      | 0.20               | 475                  | 2.36                   | 870       | 0.16               | 716                  | 2.4                    | 549       | 0.17               | 962                  | 2.3                    | 379       | 0.18               | 1209                 | 2.4                    | 262       | 0.20               |
| 2.40±0.05                                      | 4.9                                                | 236                  | 2.45                   | 1404      | 0.19               | 473                  | 2.48                   | 845       | 0.16               | 715                  | 2.51                   | 501       | 0.17               | 960                  | 2.41                   | 358       | 0.19               | 1208                 | 2.53                   | 253       | 0.20               |
| 2.50±0.05                                      | 4.7                                                | 235                  | 2.49                   | 1404      | 0.18               | 472                  | 2.6                    | 821       | 0.16               | 714                  | 2.62                   | 486       | 0.17               | 959                  | 2.52                   | 349       | 0.19               | 1205                 | 2.7                    | 240       | 0.20               |
| 2.60±0.05                                      | 4.6                                                | 234                  | 2.6                    | 1402      | 0.16               | 470                  | 2.71                   | 799       | 0.15               | 712                  | 2.73                   | 477       | 0.17               | 958                  | 2.65                   | 331       | 0.19               | 1204                 | 2.85                   | 231       | 0.20               |
| 2.70±0.05                                      | 4.5                                                | 233                  | 2.84                   | 1399      | 0.15               | 469                  | 2.83                   | 778       | 0.15               | 711                  | 2.82                   | 464       | 0.17               | 956                  | 2.86                   | 313       | 0.19               | 1203                 | 3                      | 224       | 0.20               |
| 2.80±0.05                                      | 4.5                                                | 233                  | 2.85                   | 1395      | 0.15               | 468                  | 2.94                   | 769       | 0.15               | 710                  | 2.9                    | 458       | 0.16               | 954                  | 2.91                   | 308       | 0.18               | 1202                 | 3.12                   | 220       | 0.20               |
| 2.90±0.05                                      | 4.4                                                | 232                  | 2.87                   | 1395      | 0.15               | 467                  | 3.11                   | 751       | 0.15               | 710                  | 2.99                   | 450       | 0.16               | 953                  | 3.15                   | 303       | 0.18               | 1201                 | 3.24                   | 218       | 0.19               |
| 3.00±0.05                                      | 4.4                                                | 231                  | 2.88                   | 1392      | 0.14               | 466                  | 3.39                   | 746       | 0.15               | 709                  | 3.11                   | 440       | 0.16               | 952                  | 3.41                   | 299       | 0.18               | 1201                 | 3.33                   | 212       | 0.19               |
| 3.10±0.05                                      | 4.4                                                | 230                  | 2.9                    | 1392      | 0.14               | 465                  | 3.45                   | 733       | 0.15               | 708                  | 3.22                   | 429       | 0.16               | 951                  | 3.48                   | 291       | 0.18               | 1199                 | 3.45                   | 207       | 0.19               |
| 3.20±0.05                                      | 4.3                                                | 230                  | 2.91                   | 1391      | 0.14               | 464                  | 3.61                   | 725       | 0.15               | 707                  | 3.3                    | 421       | 0.16               | 950                  | 3.68                   | 285       | 0.17               | 1198                 | 3.58                   | 203       | 0.19               |
| 3.30±0.05                                      | 4.3                                                | 229                  | 2.92                   | 1391      | 0.14               | 462                  | 3.72                   | 711       | 0.14               | 707                  | 3.42                   | 415       | 0.16               | 949                  | 3.8                    | 282       | 0.17               | 1197                 | 3.61                   | 198       | 0.19               |
| 3.40±0.05                                      | 4.3                                                | 228                  | 2.93                   | 1390      | 0.14               | 461                  | 3.78                   | 705       | 0.14               | 706                  | 3.53                   | 407       | 0.15               | 948                  | 3.79                   | 276       | 0.17               | 1196                 | 3.78                   | 195       | 0.19               |
| 3.50±0.05                                      | 4.2                                                | 227                  | 2.95                   | 1389      | 0.13               | 460                  | 3.82                   | 693       | 0.14               | 705                  | 3.6                    | 402       | 0.15               | 947                  | 3.85                   | 273       | 0.16               | 1195                 | 3.91                   | 191       | 0.18               |
| 3.60±0.05                                      | 4.2                                                | 226                  | 2.97                   | 1382      | 0.13               | 459                  | 3.87                   | 688       | 0.14               | 704                  | 3.7                    | 395       | 0.15               | 946                  | 3.89                   | 270       | 0.16               | 1194                 | 4                      | 186       | 0.18               |
| 3.70±0.05                                      | 4.1                                                | 226                  | 2.99                   | 1381      | 0.13               | 458                  | 3.93                   | 667       | 0.14               | 702                  | 3.81                   | 389       | 0.15               | 945                  | 3.95                   | 262       | 0.16               | 1193                 | 4.1                    | 181       | 0.18               |
| 3.80±0.05                                      | 4                                                  | 225                  | 4                      | 1380      | 0.13               | 458                  | 4                      | 658       | 0.13               | 699                  | 3.9                    | 386       | 0.15               | 944                  | 4.02                   | 256       | 0.16               | 1192                 | 4.23                   | 177       | 0.18               |
| 3.90±0.05                                      | 3.9                                                | 224                  | 4.01                   | 1379      | 0.13               | 457                  | 4.01                   | 649       | 0.13               | 697                  | 4.02                   | 384       | 0.15               | 943                  | 4.11                   | 251       | 0.16               | 1191                 | 4.37                   | 172       | 0.18               |
| 4.00±0.05                                      | 3.9                                                | 224                  | 4.09                   | 1372      | 0.12               | 457                  | 4.07                   | 650       | 0.13               | 696                  | 4.11                   | 381       | 0.14               | 942                  | 4.18                   | 250       | 0.16               | 1190                 | 4.46                   | 170       | 0.18               |
| 4.10±0.05                                      | 3.8                                                | 223                  | 4.18                   | 1370      | 0.12               | 456                  | 4.18                   | 655       | 0.13               | 696                  | 4.2                    | 380       | 0.14               | 941                  | 4.23                   | 248       | 0.15               | 1190                 | 4.52                   | 169       | 0.17               |
| 4.20±0.05                                      | 3.8                                                | 223                  | 4.27                   | 1356      | 0.12               | 455                  | 4.27                   | 658       | 0.12               | 695                  | 4.29                   | 379       | 0.14               | 940                  | 4.37                   | 247       | 0.15               | 1199                 | 4.66                   | 167       | 0.17               |
| 4.30±0.05                                      | 3.7                                                | 222                  | 4.36                   | 1355      | 0.12               | 454                  | 4.34                   | 657       | 0.12               | 694                  | 4.43                   | 373       | 0.14               | 939                  | 4.58                   | 246       | 0.15               | 1195                 | 4.75                   | 168       | 0.17               |
| 4.40±0.05                                      | 3.7                                                | 222                  | 4.44                   | 1351      | 0.11               | 453                  | 4.45                   | 660       | 0.12               | 693                  | 4.5                    | 369       | 0.14               | 939                  | 4.62                   | 246       | 0.14               | 1192                 | 4.82                   | 162       | 0.16               |
| 4.50±0.05                                      | 3.6                                                | 221                  | 4.53                   | 1350      | 0.11               | 452                  | 4.52                   | 665       | 0.12               | 692                  | 4.6                    | 364       | 0.13               | 938                  | 4.7                    | 245       | 0.14               | 1190                 | 4.96                   | 161       | 0.16               |
| 4.60±0.05                                      | 3.6                                                | 221                  | 4.62                   | 1347      | 0.11               | 451                  | 4.62                   | 670       | 0.11               | 691                  | 4.72                   | 359       | 0.13               | 938                  | 4.79                   | 244       | 0.14               | 1188                 | 5.07                   | 161       | 0.16               |
| 4.70±0.05                                      | 3.5                                                | 220                  | 4.75                   | 1343      | 0.11               | 450                  | 4.74                   | 673       | 0.11               | 690                  | 4.74                   | 351       | 0.13               | 937                  | 4.86                   | 244       | 0.14               | 1186                 | 5.18                   | 159       | 0.16               |
| 5.10±0.05                                      | 3.4                                                | 217                  | 5.19                   | 1310      | 0.11               | 447                  | 5.16                   | 589       | 0.11               | 687                  | 5.23                   | 348       | 0.13               | 934                  | 5.53                   | 230       | 0.14               | 1184                 | 5.82                   | 131       | 0.16               |
| 5.60±0.05                                      | 3.3                                                | 214                  | 5.74                   | 1297      | 0.11               | 443                  | 5.75                   | 576       | 0.11               | 684                  | 5.81                   | 342       | 0.12               | 932                  | 6.01                   | 201       | 0.14               | 1182                 | 6.62                   | 129       | 0.16               |
| 6.2±0.1                                        | 3                                                  | 211                  | 6.31                   | 1244      | 0.10               | 440                  | 6.09                   | 585       | 0.10               | 681                  | 6.33                   | 339       | 0.11               | 928                  | 6.68                   | 202       | 0.12               | 1180                 | 7.34                   | 128       | 0.15               |
| 6.8±0.1                                        | 2.8                                                | 208                  | 6.92                   | 1202      | 0.09               | 436                  | 6.94                   | 591       | 0.09               | 678                  | 7.04                   | 334       | 0.10               | 926                  | 7.39                   | 203       | 0.11               | 1177                 | 8.22                   | 127       | 0.14               |
| 7.5±0.1                                        | 2.7                                                | 205                  | 7.57                   | 1155      | 0.08               | 433                  | 7.51                   | 567       | 0.09               | 675                  | 7.85                   | 320       | 0.10               | 924                  | 8.17                   | 191       | 0.10               | 1176                 | 9.01                   | 120       | 0.13               |
| 8.2±0.1                                        | 2.6                                                | 202                  | 8.35                   | 1116      | 0.08               | 430                  | 8.36                   | 542       | 0.08               | 673                  | 8.48                   | 306       | 0.09               | 922                  | 8.93                   | 186       | 0.10               | 1174                 | 10.04                  | 118       | 0.13               |
| 9.1±0.1                                        | 2.5                                                | 199                  | 9.23                   | 1059      | 0.09               | 428                  | 9.28                   | 458       | 0.09               | 670                  | 9.87                   | 249       | 0.10               | 920                  | 10.2                   | 152       | 0.11               | 1172                 | 11.98                  | 88        | 0.13               |
| 10.0±1%                                        | 2.4                                                | 196                  | 10.14                  | 936       | 0.09               | 424                  | 10.24                  | 385       | 0.10               | 668                  | 10.55                  | 202       | 0.11               | 919                  | 11.49                  | 118       | 0.13               | 1171                 | 13.75                  | 70        | 0.12               |
| 11.0±1%                                        | 2.3                                                | 193                  | 11.19                  | 912       | 0.08               | 421                  | 11.17                  | 363       | 0.09               | 666                  | 11.81                  | 185       | 0.11               | 917                  | 12.87                  | 103       | 0.12               | 1170                 | 15.3                   | 61        | 0.12               |
| 12.0±1%                                        | 2.2                                                | 189                  | 12.16                  | 889       | 0.08               | 418                  | 12.3                   | 348       | 0.09               | 664                  | 12.77                  | 173       | 0.11               | 915                  | 14.16                  | 95        | 0.13               | 1168                 | 17.63                  | 52        | 0.12               |
| 13.0±1%                                        | 2.2                                                | 186                  | 13.3                   | 984       | 0.07               | 416                  | 13.32                  | 363       | 0.08               | 661                  | 14.1                   | 183       | 0.09               | 912                  | 15.8                   | 101       | 0.11               | 1164                 | 23.9                   | 47        | 0.12               |
| 14.0±1%                                        | 2.1                                                | 184                  | 14.26                  | 802       | 0.08               | 414                  | 14.44                  | 298       | 0.09               | 660                  | 15.03                  | 149       | 0.12               | 913                  | 16.72                  | 76.7      | 0.14               | 1167                 | 23.1                   | 40        | 0.15               |
| 15.0±1%                                        | 2.1                                                | 182                  | 15.34                  | 791       | 0.07               | 413                  | 15.46                  | 283       | 0.08               | 660                  | 16.16                  | 138       | 0.10               | 912                  | 18.51                  | 82        | 0.16               | 1166                 | 23.6                   | 44        | 0.13               |
| 16.0±1%                                        | 2                                                  | 179                  | 16.3                   | 780       | 0.07               | 410                  | 16.4                   | 270       | 0.08               | 657                  | 17.6                   | 129       | 0.11               | 909                  | 20.2                   | 68        | 0.13               | 1161                 | 34.7                   | 28        | 0.14               |
| 17.0±1%                                        | 1.9                                                | 178                  | 17.6                   | 765       | 0.07               | 410                  | 17.7                   | 263       | 0.08               | 657                  | 18.2                   | 130       | 0.11               | 909                  | 21.3                   | 70        | 0.12               | 1163                 | 34.9                   | 28        | 0.14               |
| 18.0±1%                                        | 1.8                                                | 176.5                | 18.13                  | 754       | 0.07               | 409                  | 18.42                  | 258       | 0.07               | 65                   |                        |           |                    |                      |                        |           |                    |                      |                        |           |                    |

## 0402 Typical Electrical Tables

| Capacitance<br>& Tolerance*<br>@ 1 MHz<br>(pF) | Self<br>Resonance<br>Frequency<br>(GHz)<br>Typical | Ref<br>Freq<br>(MHz) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(Ω) | Ref<br>Freq<br>(MHz) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(Ω) | Ref<br>Freq<br>(MHz) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(Ω) | Ref<br>Freq<br>(MHz) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(Ω) | Ref<br>Freq<br>(MHz) | Typ.<br>C(eff)<br>(pF) | Typ.<br>Q | Typ.<br>ESR<br>(Ω) |
|------------------------------------------------|----------------------------------------------------|----------------------|------------------------|-----------|--------------------|----------------------|------------------------|-----------|--------------------|----------------------|------------------------|-----------|--------------------|----------------------|------------------------|-----------|--------------------|----------------------|------------------------|-----------|--------------------|
| 0.1±0.05                                       | 19.4                                               | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 0.2±0.05                                       | 16.4                                               | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 0.3±0.05                                       | 14.6                                               | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 0.4±0.05                                       | 12.5                                               | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 0.5±0.05                                       | 11.3                                               | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 0.6±0.05                                       | 10.4                                               | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 0.7±0.05                                       | 9.5                                                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 0.8±0.05                                       | 9.1                                                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 0.9±0.05                                       | 8.8                                                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                | n/a                  | n/a                    | n/a       | n/a                |
| 1.00±0.05                                      | 8                                                  | 1489                 | 1.18                   | 380       | 0.25               | 1739                 | 1.25                   | 314       | 0.25               | 1988                 | 1.32                   | 265       | 0.24               | 2240                 | 1.38                   | 229       | 0.23               | 2493                 | 1.41                   | 200       | 0.23               |
| 1.10±0.05                                      | 7.8                                                | 1485                 | 1.29                   | 342       | 0.25               | 1735                 | 1.33                   | 275       | 0.25               | 1986                 | 1.41                   | 232       | 0.24               | 2238                 | 1.49                   | 201       | 0.24               | 2490                 | 1.55                   | 177       | 0.25               |
| 1.20±0.05                                      | 7.4                                                | 1483                 | 1.37                   | 307       | 0.25               | 1732                 | 1.45                   | 251       | 0.25               | 1982                 | 1.54                   | 208       | 0.24               | 2234                 | 1.59                   | 173       | 0.25               | 2488                 | 1.62                   | 149       | 0.27               |
| 1.30±0.05                                      | 7                                                  | 1479                 | 1.45                   | 289       | 0.25               | 1729                 | 1.58                   | 240       | 0.25               | 1980                 | 1.66                   | 196       | 0.24               | 2230                 | 1.73                   | 166       | 0.25               | 2485                 | 1.76                   | 137       | 0.27               |
| 1.40±0.05                                      | 6.8                                                | 1477                 | 1.6                    | 265       | 0.25               | 1726                 | 1.71                   | 221       | 0.25               | 1977                 | 1.78                   | 179       | 0.24               | 2229                 | 1.88                   | 154       | 0.25               | 2483                 | 1.89                   | 125       | 0.26               |
| 1.50±0.05                                      | 6.5                                                | 1474                 | 1.72                   | 252       | 0.25               | 1724                 | 1.82                   | 203       | 0.25               | 1974                 | 1.94                   | 169       | 0.24               | 2227                 | 2.01                   | 143       | 0.25               | 2481                 | 2.03                   | 115       | 0.27               |
| 1.60±0.05                                      | 6.5                                                | 1472                 | 1.81                   | 246       | 0.24               | 1722                 | 1.91                   | 201       | 0.24               | 1971                 | 2.01                   | 168       | 0.23               | 2226                 | 2.1                    | 142       | 0.24               | 2479                 | 2.1                    | 119       | 0.25               |
| 1.70±0.05                                      | 6.4                                                | 1470                 | 1.92                   | 241       | 0.23               | 1719                 | 1.99                   | 199       | 0.23               | 1970                 | 2.1                    | 167       | 0.22               | 2225                 | 2.23                   | 141       | 0.23               | 2478                 | 2.23                   | 120       | 0.24               |
| 1.80±0.05                                      | 6.2                                                | 1469                 | 1.98                   | 240       | 0.22               | 1718                 | 2.06                   | 198       | 0.22               | 1969                 | 2.24                   | 166       | 0.21               | 2223                 | 2.34                   | 141       | 0.22               | 2477                 | 2.35                   | 122       | 0.22               |
| 1.90±0.05                                      | 6                                                  | 1468                 | 2.06                   | 239       | 0.22               | 1717                 | 2.19                   | 197       | 0.21               | 1968                 | 2.33                   | 165       | 0.21               | 2222                 | 2.41                   | 140       | 0.21               | 2476                 | 2.42                   | 123       | 0.21               |
| 2.00±0.05                                      | 5.7                                                | 1466                 | 2.12                   | 233       | 0.21               | 1716                 | 2.22                   | 190       | 0.21               | 1968                 | 2.51                   | 160       | 0.20               | 2220                 | 2.62                   | 138       | 0.21               | 2475                 | 2.65                   | 118       | 0.21               |
| 2.10±0.05                                      | 5.4                                                | 1463                 | 2.31                   | 230       | 0.20               | 1714                 | 2.43                   | 185       | 0.21               | 1966                 | 2.62                   | 155       | 0.20               | 2219                 | 2.76                   | 132       | 0.2                | 2474                 | 2.81                   | 115       | 0.20               |
| 2.20±0.05                                      | 5.1                                                | 1461                 | 2.47                   | 228       | 0.20               | 1711                 | 2.65                   | 183       | 0.20               | 1964                 | 2.83                   | 149       | 0.20               | 2217                 | 2.91                   | 126       | 0.19               | 2473                 | 2.91                   | 108       | 0.20               |
| 2.30±0.05                                      | 5                                                  | 1460                 | 2.51                   | 214       | 0.20               | 1709                 | 2.81                   | 168       | 0.20               | 1963                 | 2.98                   | 132       | 0.19               | 2216                 | 3.15                   | 121       | 0.19               | 2471                 | 3.16                   | 99        | 0.22               |
| 2.40±0.05                                      | 4.9                                                | 1459                 | 2.6                    | 196       | 0.20               | 1708                 | 3                      | 151       | 0.20               | 1962                 | 3.16                   | 120       | 0.19               | 2215                 | 3.42                   | 109       | 0.2                | 2469                 | 3.42                   | 91        | 0.23               |
| 2.50±0.05                                      | 4.7                                                | 1458                 | 2.77                   | 182       | 0.20               | 1706                 | 3.12                   | 144       | 0.20               | 1960                 | 3.32                   | 112       | 0.19               | 2214                 | 3.58                   | 92        | 0.21               | 2468                 | 3.66                   | 81        | 0.23               |
| 2.60±0.05                                      | 4.6                                                | 1455                 | 2.85                   | 173       | 0.20               | 1705                 | 3.25                   | 132       | 0.20               | 1957                 | 3.51                   | 97        | 0.19               | 2212                 | 3.73                   | 85        | 0.22               | 2467                 | 3.73                   | 72        | 0.24               |
| 2.70±0.05                                      | 4.5                                                | 1453                 | 3.18                   | 164       | 0.20               | 1703                 | 3.47                   | 122       | 0.20               | 1956                 | 3.75                   | 94        | 0.20               | 2211                 | 3.89                   | 78        | 0.24               | 2466                 | 3.89                   | 66        | 0.25               |
| 2.80±0.05                                      | 4.5                                                | 1451                 | 3.25                   | 159       | 0.20               | 1702                 | 3.62                   | 120       | 0.20               | 1956                 | 3.93                   | 88        | 0.20               | 2210                 | 3.97                   | 75        | 0.24               | 2466                 | 4.03                   | 65        | 0.25               |
| 2.90±0.05                                      | 4.4                                                | 1450                 | 3.33                   | 156       | 0.19               | 1702                 | 3.77                   | 117       | 0.20               | 1956                 | 4.02                   | 84        | 0.20               | 2210                 | 4.12                   | 73        | 0.24               | 2466                 | 4.17                   | 63        | 0.25               |
| 3.00±0.05                                      | 4.4                                                | 1449                 | 3.49                   | 150       | 0.19               | 1701                 | 3.99                   | 114       | 0.20               | 1955                 | 4.21                   | 81        | 0.20               | 2209                 | 4.26                   | 72        | 0.24               | 2465                 | 4.21                   | 61        | 0.25               |
| 3.10±0.05                                      | 4.4                                                | 1448                 | 3.61                   | 148       | 0.19               | 1700                 | 4.16                   | 109       | 0.20               | 1952                 | 4.4                    | 79        | 0.20               | 2209                 | 4.45                   | 70        | 0.24               | 2465                 | 4.33                   | 59        | 0.25               |
| 3.20±0.05                                      | 4.3                                                | 1447                 | 3.7                    | 145       | 0.19               | 1700                 | 4.31                   | 105       | 0.20               | 1952                 | 4.62                   | 77        | 0.19               | 2208                 | 4.62                   | 69        | 0.23               | 2464                 | 4.49                   | 58        | 0.25               |
| 3.30±0.05                                      | 4.3                                                | 1446                 | 3.79                   | 143       | 0.19               | 1699                 | 4.47                   | 101       | 0.20               | 1951                 | 4.76                   | 76        | 0.20               | 2207                 | 4.81                   | 68        | 0.23               | 2464                 | 4.66                   | 55        | 0.25               |
| 3.40±0.05                                      | 4.3                                                | 1446                 | 4.01                   | 138       | 0.19               | 1698                 | 4.62                   | 101       | 0.20               | 1950                 | 4.92                   | 75        | 0.20               | 2206                 | 4.93                   | 66        | 0.22               | 2464                 | 4.92                   | 52        | 0.24               |
| 3.50±0.05                                      | 4.2                                                | 1445                 | 4.11                   | 133       | 0.19               | 1697                 | 4.78                   | 95        | 0.20               | 1950                 | 5.18                   | 73        | 0.19               | 2206                 | 5.21                   | 65        | 0.23               | 2463                 | 5.15                   | 51        | 0.24               |
| 3.60±0.05                                      | 4.2                                                | 1445                 | 4.2                    | 130       | 0.19               | 1697                 | 4.91                   | 94        | 0.20               | 1949                 | 5.34                   | 71        | 0.20               | 2205                 | 5.4                    | 63        | 0.22               | 2463                 | 5.25                   | 51        | 0.24               |
| 3.70±0.05                                      | 4.1                                                | 1444                 | 4.28                   | 126       | 0.19               | 1696                 | 5.05                   | 92        | 0.19               | 1949                 | 5.5                    | 69        | 0.20               | 2205                 | 5.62                   | 62        | 0.22               | 2462                 | 5.41                   | 49        | 0.24               |
| 3.80±0.05                                      | 4                                                  | 1443                 | 4.44                   | 125       | 0.19               | 1696                 | 5.11                   | 90        | 0.19               | 1948                 | 5.61                   | 67        | 0.20               | 2204                 | 5.78                   | 61        | 0.22               | 2462                 | 5.66                   | 48        | 0.24               |
| 3.90±0.05                                      | 3.9                                                | 1442                 | 4.72                   | 121       | 0.19               | 1695                 | 5.26                   | 89        | 0.19               | 1948                 | 5.77                   | 66        | 0.21               | 2204                 | 5.94                   | 60        | 0.22               | 2461                 | 5.82                   | 47        | 0.24               |
| 4.00±0.05                                      | 3.9                                                | 1441                 | 4.8                    | 121       | 0.18               | 1694                 | 5.38                   | 88        | 0.19               | 1947                 | 5.81                   | 66        | 0.20               | 2203                 | 6.03                   | 60        | 0.21               | 2461                 | 5.86                   | 48        | 0.23               |
| 4.10±0.05                                      | 3.8                                                | 1440                 | 4.92                   | 121       | 0.18               | 1693                 | 5.5                    | 87        | 0.19               | 1947                 | 5.93                   | 65        | 0.19               | 2203                 | 6.11                   | 60        | 0.21               | 2460                 | 5.9                    | 49        | 0.23               |
| 4.20±0.05                                      | 3.8                                                | 1440                 | 5.01                   | 120       | 0.18               | 1692                 | 5.63                   | 87        | 0.18               | 1946                 | 6.05                   | 65        | 0.18               | 2203                 | 6.24                   | 59        | 0.21               | 2460                 | 5.95                   | 49        | 0.21               |
| 4.30±0.05                                      | 3.7                                                | 1439                 | 5.17                   | 120       | 0.18               | 1692                 | 5.78                   | 85        | 0.18               | 1946                 | 6.11                   | 64        | 0.18               | 2202                 | 6.35                   | 58        | 0.2                | 2459                 | 6.01                   | 50        | 0.20               |
| 4.40±0.05                                      | 3.7                                                | 1439                 | 5.28                   | 119       | 0.18               | 1691                 | 5.91                   | 85        | 0.18               | 1945                 | 6.23                   | 64        | 0.18               | 2202                 | 6.4                    | 57        | 0.2                | 2459                 | 6.12                   | 52        | 0.20               |
| 4.50±0.05                                      | 3.6                                                | 1438                 | 5.41                   | 119       | 0.18               | 1691                 | 6.04                   | 81        | 0.18               | 1945                 | 6.45                   | 64        | 0.19               | 2201                 | 6.52                   | 56        | 0.19               | 2458                 | 6.23                   | 52        | 0.19               |
| 4.60±0.05                                      | 3.6                                                | 1438                 | 5.49                   | 118       | 0.17               | 1691                 | 6.11                   | 80        | 0.18               | 1944                 | 6.66                   | 63        | 0.17               | 2201                 | 6.67                   | 55        | 0.18               | 2458                 | 6.29                   | 54        | 0.19               |
| 4.70±0.05                                      | 3.5                                                | 1437                 | 5.6                    | 118       | 0.17               | 1690                 | 6.23                   | 80        | 0.18               | 1944                 | 6.72                   | 63        | 0.17               | 2200                 | 6.71                   | 56        | 0.18               | 2457                 | 6.35                   | 54        | 0.19               |
| 5.10±0.05                                      | 3.4                                                | 1435                 | 6.59                   | 105       | 0.17               | 1689                 | 7.48                   | 75        | 0.18               | 1943                 | 7.97                   | 60        | 0.19               | 2200                 | 8.11                   | 45        | 0.2                | 2456                 | 8.1                    | 39        | 0.21               |
| 5.60±0.05                                      | 3.3                                                | 1434                 | 7.43                   | 90        | 0.17               | 1687                 | 8.75                   | 61        | 0.17               | 1942                 | 10.03                  | 51        | 0.21               | 2199                 | 10.42                  | 37        | 0.22               | 2456                 | 10.07                  | 28        | 0.23               |
| 6.2±0.1                                        | 3                                                  | 1432                 | 8.27                   | 91        | 0.15               | 1686                 | 10.21                  | 60        | 0.15               | 1941                 | 11.52                  | 48        | 0.18               | 2198                 | 11.88                  | 36        | 0.18               | 2455                 | 11.02                  | 33        | 0.19               |
| 6.8±0.1                                        | 2.8                                                | 1430                 | 9.41                   | 88        | 0.13               | 1684                 | 11.43                  | 58        | 0.13               | 1940                 | 13.36                  | 45        | 0.14               | 2196                 | 13.72                  | 37        | 0.14               | 2454                 | 12.85                  | 36        | 0.14               |
| 7.5±0.1                                        | 2.7                                                | 1429                 | 10.05                  | 85        | 0.13               | 1683                 | 12.25                  | 56        | 0.14               | 1939                 | 15.06                  | 40        | 0.13               | 2195                 | 15.24                  | 35        | 0.15               | 2454                 | 13.66                  | 33        | 0.14               |
| 8.2±0.1                                        | 2.6                                                | 1428                 | 11.64                  | 79        | 0.13               | 1682                 | 14.43                  | 52        | 0.13               | 1938                 | 16.85                  | 38        | 0.13               | 2195                 | 16.65                  | 32        | 0.14               | 2453                 | 15.32                  | 31        | 0.14               |
| 9.1±0.1                                        | 2.5                                                | 1427                 | 13.39                  | 60        | 0.13               | 1681                 | 19.07                  | 33        | 0.14               | 1937                 | 28.35                  | 25        | 0.15               | 2194                 | 31.08                  | 15        | 0.16               | 2452                 | 29.91                  | 15        | 0.16               |
| 10.0±1%                                        | 2.4                                                | 1425                 | 17.6                   | 41        | 0.14               | 1680                 | 26.51                  | 21        | 0.16               | 1936                 | 40.16                  | 11        | 0.17               | 2194                 | 45.46                  | 8         | 0.18               | 2452                 | 39.54                  | 8         | 0.18               |
| 11.0±1%                                        | 2.3                                                | 1424                 | 20.09                  | 36        | 0.15               | 1679                 | 32.66                  | 19        | 0.15               | 1935                 | 66.25                  | 8         | 0.17               | 2192                 | 81.07                  | 5         | 0.2                | 2451                 | 61.28                  | 6         | 0.18               |
| 12.0±1%                                        | 2.2                                                | 1423                 | 24.14                  | 29        | 0.15               | 1678                 | 43.51                  | 13        | 0.14               | 1934                 | 92.97                  | 5         | 0.18               | 2192                 | 123.19                 | 3         | 0.2                | 2450                 | 82.44                  | 4         | 0.19               |
| 13.0±1%                                        | 2.2                                                | 1417                 | 48.3                   | 18        | 0.13               | 1671                 | 63.2                   | 5         | 0.17               | 1934                 | 125                    | 3         | 0.18               | 2191                 |                        |           | 0.2                |                      |                        |           |                    |
| 14.0±1%                                        | 2.1                                                | 1422                 | 39.55                  | 17        | 0.15               | 1677                 | 122                    | 2         | 0.21               | 1934                 | 180.3                  | 1         | 0.19               | 2191                 |                        |           | 0.18               |                      |                        |           |                    |
| 15.0±1%                                        | 2.1                                                | 1421                 | 38.93                  | 20        | 0.14               | 1676                 | 154                    | 2         | 0.17               | 1933                 | 244.5                  |           | 0.16               | 2191                 |                        |           | 0.161              |                      |                        |           |                    |
| 16.0±1%                                        | 2                                                  | 1416                 | 79.3                   | 12        | 0.14               | 1670                 |                        |           | 0.17               | 1932                 |                        |           | 0.16               | 2191                 |                        |           | 0.16               |                      |                        |           |                    |
| 17.0±1%                                        | 1.9                                                | 1415                 | 77.6                   | 11        | 0.14               | 1670                 |                        |           | 0.17               | 1932                 |                        |           | 0.16               | 2191                 |                        |           | 0.16               |                      |                        |           |                    |
| 18.0±1%                                        | 1.8                                                | 1411                 | 83.13                  | 9         | 0.15               | 1675                 |                        |           | 0.17               | 1932                 |                        |           | 0.16               | 2182                 |                        |           | 0.16               |                      |                        |           |                    |
| 19.0±1%                                        | 1.8                                                | 1415                 | 79.6                   | 7         | 0.15               | 1673                 |                        |           | 0.16               |                      |                        |           |                    |                      |                        |           |                    |                      |                        |           |                    |

## 0603 Typical Electrical Tables

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| Capacitance & Tolerance*<br>@ 1 MHz<br>(pF) | Self<br>Resonance<br>Frequency<br>(GHz) | Ref<br>Freq.<br>MHz | Effective<br>Capacitance<br>Max/Min<br>(pF) | Max<br>ESR<br>(Ω) | Ref<br>Freq.<br>MHz | Effective<br>Capacitance<br>Max/Min<br>(pF) | Max<br>ESR<br>(Ω) | Ref<br>Freq.<br>MHz | Effective<br>Capacitance<br>Max/Min<br>(pF) | Max<br>ESR<br>(Ω) | Ref<br>Freq.<br>MHz | Effective<br>Capacitance<br>Max/Min<br>(pF) | Max<br>ESR<br>(Ω) |
|---------------------------------------------|-----------------------------------------|---------------------|---------------------------------------------|-------------------|---------------------|---------------------------------------------|-------------------|---------------------|---------------------------------------------|-------------------|---------------------|---------------------------------------------|-------------------|
| 0.1±0.05                                    | 18.0                                    |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 0.2±0.05                                    | 12.7                                    |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 0.3±0.05                                    | 10.4                                    |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 0.4±0.05                                    | 9.0                                     |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 0.5±0.05                                    | 8.1                                     |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 0.6±0.10                                    | 7.4                                     |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 0.7±0.10                                    | 6.8                                     |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 0.8±0.10                                    | 6.4                                     |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 0.9±0.10                                    | 6.0                                     |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 1.0±0.10                                    | 5.7                                     | 245                 | 1.15/0.90                                   | .280              | 491                 | 1.10/0.90                                   | .220              | 738                 | 1.10/0.90                                   | .220              | 987                 | 1.15/0.90                                   | .300              |
| 1.1±0.10                                    | 5.4                                     | 244                 | 1.25/1.00                                   | .270              | 490                 | 1.25/1.00                                   | .210              | 736                 | 1.11/1.00                                   | .210              | 985                 | 1.25/1.00                                   | .290              |
| 1.2±0.10                                    | 5.2                                     | 243                 | 1.35/1.10                                   | .260              | 487                 | 1.35/1.05                                   | .200              | 734                 | 1.40/1.05                                   | .210              | 981                 | 1.35/1.05                                   | .280              |
| 1.3±0.10                                    | 5.0                                     | 242                 | 1.45/1.15                                   | .260              | 486                 | 1.45/1.15                                   | .200              | 732                 | 1.45/1.15                                   | .200              | 974                 | 1.45/1.15                                   | .270              |
| 1.4±0.10                                    | 4.8                                     | 241                 | 1.55/1.25                                   | .250              | 485                 | 1.55/1.25                                   | .190              | 731                 | 1.45/1.25                                   | .200              | 977                 | 1.55/1.25                                   | .260              |
| 1.5±0.10                                    | 4.7                                     | 241                 | 1.65/1.35                                   | .250              | 484                 | 1.65/1.35                                   | .180              | 729                 | 1.65/1.35                                   | .190              | 976                 | 1.70/1.35                                   | .250              |
| 1.6±0.10                                    | 4.5                                     | 240                 | 1.75/1.45                                   | .240              | 483                 | 1.75/1.45                                   | .180              | 727                 | 1.75/1.45                                   | .190              | 973                 | 1.80/1.50                                   | .250              |
| 1.7±0.10                                    | 4.4                                     | 240                 | 1.85/1.55                                   | .230              | 482                 | 1.85/1.60                                   | .170              | 725                 | 1.85/1.60                                   | .180              | 971                 | 1.90/1.60                                   | .250              |
| 1.8±0.10                                    | 4.2                                     | 239                 | 2.10/1.70                                   | .220              | 479                 | 2.10/1.70                                   | .160              | 723                 | 2.10/1.70                                   | .170              | 969                 | 2.15/1.70                                   | .250              |
| 1.9±0.10                                    | 4.1                                     | 239                 | 2.15/1.78                                   | .210              | 478                 | 2.15/1.80                                   | .160              | 721                 | 2.15/1.80                                   | .167              | 967                 | 2.20/1.80                                   | .240              |
| 2.0±0.10                                    | 4.0                                     | 238                 | 2.11/1.80                                   | .205              | 477                 | 2.11/1.80                                   | .155              | 720                 | 2.11/1.80                                   | .165              | 966                 | 2.25/1.90                                   | .230              |
| 2.1±0.10                                    | 3.9                                     | 237                 | 2.25/1.95                                   | .200              | 475                 | 2.25/1.98                                   | .150              | 718                 | 2.35/1.98                                   | .162              | 964                 | 2.35/2.00                                   | .220              |
| 2.2±0.10                                    | 3.8                                     | 236                 | 2.40/2.05                                   | .190              | 474                 | 2.45/2.05                                   | .145              | 717                 | 2.42/2.05                                   | .160              | 962                 | 2.45/2.10                                   | .210              |
| 2.4±0.25                                    | 3.7                                     | 234                 | 2.70/2.15                                   | .175              | 471                 | 2.75/2.15                                   | .140              | 713                 | 2.80/2.15                                   | .150              | 958                 | 2.80/2.15                                   | .200              |
| 2.7±0.25                                    | 3.5                                     | 232                 | 3.00/2.45                                   | .160              | 468                 | 3.10/2.45                                   | .125              | 709                 | 3.10/2.45                                   | .145              | 954                 | 3.15/2.48                                   | .190              |
| 3.0±0.25                                    | 3.3                                     | 230                 | 3.40/2.75                                   | .150              | 465                 | 3.40/2.75                                   | .120              | 706                 | 3.40/2.75                                   | .140              | 951                 | 3.60/2.80                                   | .170              |
| 3.3±0.25                                    | 3.1                                     | 226                 | 3.60/3.05                                   | .130              | 459                 | 3.70/3.05                                   | .120              | 699                 | 3.70/3.05                                   | .130              | 945                 | 3.80/3.10                                   | .165              |
| 3.6±0.25                                    | 3.0                                     | 224                 | 3.90/3.30                                   | .128              | 456                 | 4.25/3.35                                   | .119              | 697                 | 3.90/3.35                                   | .125              | 942                 | 4.10/3.40                                   | .160              |
| 3.9±0.25                                    | 2.9                                     | 223                 | 4.20/3.65                                   | .125              | 455                 | 4.35/3.70                                   | .115              | 695                 | 4.90/3.75                                   | .120              | 940                 | 5.15/3.75                                   | .150              |
| 4.3±0.25                                    | 2.7                                     | 220                 | 4.60/4.00                                   | .122              | 451                 | 4.80/4.05                                   | .117              | 692                 | 5.10/4.05                                   | .115              | 937                 | 5.30/4.05                                   | .150              |
| 4.7±0.25                                    | 2.6                                     | 218                 | 5.00/4.45                                   | .120              | 448                 | 5.20/4.45                                   | .110              | 689                 | 5.30/4.50                                   | .115              | 935                 | 5.50/4.55                                   | .145              |
| 5.1±0.25                                    | 2.5                                     | 216                 | 5.40/4.85                                   | .115              | 445                 | 5.70/4.89                                   | .105              | 686                 | 6.00/4.90                                   | .115              | 931                 | 6.20/5.00                                   | .140              |
| 5.6±0.25                                    | 2.4                                     | 214                 | 5.90/5.35                                   | .110              | 443                 | 6.10/5.35                                   | .100              | 684                 | 6.15/5.40                                   | .110              | 929                 | 6.50/5.50                                   | .135              |
| 6.2±0.25                                    | 2.3                                     | 211                 | 6.50/5.95                                   | .105              | 439                 | 6.90/5.95                                   | .099              | 680                 | 7.10/6.00                                   | .110              | 927                 | 8.00/6.10                                   | .130              |
| 6.8±0.25                                    | 2.2                                     | 208                 | 7.20/6.55                                   | .100              | 435                 | 7.25/6.55                                   | .099              | 677                 | 7.50/6.60                                   | .110              | 925                 | 9.00/6.65                                   | .130              |
| 7.5±0.50                                    | 2.1                                     | 205                 | 8.10/7.00                                   | .095              | 432                 | 8.10/7.00                                   | .099              | 675                 | 8.20/7.00                                   | .110              | 925                 | 9.50/7.05                                   | .125              |
| 8.2±0.50                                    | 2.0                                     | 202                 | 8.80/7.70                                   | .090              | 429                 | 8.80/7.70                                   | .098              | 672                 | 9.00/7.70                                   | .110              | 921                 | 10.00/7.80                                  | .125              |
| 9.1±0.50                                    | 1.9                                     | 200                 | 9.80/8.60                                   | .090              | 425                 | 10.95/8.65                                  | .098              | 670                 | 12.00/9.00                                  | .110              | 919                 | 13.00/9.10                                  | .120              |
| 10±5%                                       | 1.8                                     | 195                 | 10.70/9.50                                  | .085              | 422                 | 11.60/9.50                                  | .097              | 667                 | 12.50/9.60                                  | .110              | 917                 | 16.00/9.90                                  | .120              |
| 11±5%                                       | 1.7                                     | 191                 | 11.60/10.90                                 | .085              | 420                 | 12.20/10.60                                 | .095              | 665                 | 13.20/10.50                                 | .110              | 916                 | 17.00/10.00                                 | .120              |
| 12±5%                                       | 1.6                                     | 189                 | 12.90/11.40                                 | .085              | 418                 | 13.40/11.50                                 | .095              | 663                 | 14.60/11.90                                 | .110              | 914                 | 18.00/12.00                                 | .120              |
| 13±5%                                       | 1.6                                     | 187                 | 13.10/12.90                                 | .080              | 416                 | 14.00/13.00                                 | .095              | 661                 | 16.00/13.50                                 | .110              | 913                 | 21.00/14.00                                 | .120              |
| 14±5%                                       | 1.5                                     | 185                 | 14.90/13.25                                 | .080              | 414                 | 16.90/14.00                                 | .090              | 660                 | 19.00/15.00                                 | .110              | 912                 | 26.00/15.00                                 | .120              |
| 15±5%                                       | 1.5                                     | 182                 | 15.90/14.25                                 | .080              | 412                 | 17.50/15.30                                 | .090              | 659                 | 21.00/16.50                                 | .100              | 911                 | 29.00/17.00                                 | .120              |
| 16±5%                                       | 1.4                                     | 179                 | 17.00/15.15                                 | .070              | 410                 | 18.00/15.90                                 | .085              | 657                 | 22.00/17.00                                 | .100              | 910                 | 30.00/18.00                                 | .120              |
| 18±5%                                       | 1.3                                     | 176                 | 19.50/17.00                                 | .070              | 408                 | 20.20/17.10                                 | .085              | 656                 | 23.70/19.00                                 | .100              | 908                 | 33.00/21.00                                 | .120              |
| 22±5%                                       | 1.2                                     | 170                 | 24.00/20.90                                 | .066              | 404                 | 25.00/20.90                                 | .080              | 654                 | 28.00/21.00                                 | .10               | 906                 | 39.00/21.50                                 | .120              |
| 24±5%                                       | 1.2                                     | 168                 | 26.00/22.80                                 | .066              | 403                 | 30.00/23.00                                 | .080              | 653                 | N/A                                         | .10               | 905                 | N/A                                         | .120              |
| 27±5%                                       | 1.1                                     | 165                 | 29.00/25.60                                 | .065              | 402                 | 36.00/27.00                                 | .080              | 652                 | N/A                                         | .10               | 905                 | N/A                                         | .120              |
| 30±5%                                       | 1.0                                     | 163                 | 32.00/28.50                                 | .064              | 401                 | 40.00/30.00                                 | .080              | 651                 | N/A                                         | .10               | 904                 | N/A                                         | .120              |
| 33±5%                                       | 1.0                                     | 160                 | 37.65/31.35                                 | .064              | 400                 | 45.00/33.00                                 | .080              | 650                 | N/A                                         | .10               | 904                 | N/A                                         | .120              |

\* Other tolerances are available, see page 8

## 0805 Typical Electrical Tables

| Capacitance & Tolerance*<br>@ 1 MHz<br>(pF) | Self<br>Resonance<br>Frequency<br>(GHz) | Ref<br>Freq.<br>MHz | Effective<br>Capacitance<br>Max/Min<br>(pF) | Max<br>ESR<br>(Ω) | Ref<br>Freq.<br>MHz | Effective<br>Capacitance<br>Max/Min<br>(pF) | Max<br>ESR<br>(Ω) | Ref<br>Freq.<br>MHz | Effective<br>Capacitance<br>Max/Min<br>(pF) | Max<br>ESR<br>(Ω) | Ref<br>Freq.<br>MHz | Effective<br>Capacitance<br>Max/Min<br>(pF) | Max<br>ESR<br>(Ω) |
|---------------------------------------------|-----------------------------------------|---------------------|---------------------------------------------|-------------------|---------------------|---------------------------------------------|-------------------|---------------------|---------------------------------------------|-------------------|---------------------|---------------------------------------------|-------------------|
| 0.1±0.05                                    |                                         |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 0.2±0.05                                    |                                         |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 0.3±0.05                                    |                                         |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 0.4±0.05                                    |                                         |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 0.5±0.05                                    |                                         |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 0.6±0.10                                    |                                         |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 0.7±0.10                                    |                                         |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 0.8±0.10                                    |                                         |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 0.9±0.10                                    |                                         |                     | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               | N/A                 | N/A                                         | N/A               |
| 1.0±0.10                                    | 5.6                                     | 250                 | 1.20/0.90                                   | .320              | 500                 | 1.20/0.90                                   | .300              | 750                 | 1.20/0.90                                   | .270              | 999                 | 1.20/0.90                                   | .300              |
| 1.1±0.10                                    | 5.4                                     | 248                 | 1.30/1.00                                   | .290              | 496                 | 1.30/1.00                                   | .270              | 754                 | 1.30/1.00                                   | .250              | 993                 | 1.30/1.00                                   | .290              |
| 1.2±0.10                                    | 5.1                                     | 245                 | 1.40/1.10                                   | .270              | 492                 | 1.40/1.10                                   | .250              | 739                 | 1.40/1.10                                   | .240              | 987                 | 1.40/1.10                                   | .280              |
| 1.3±0.10                                    | 4.9                                     | 243                 | 1.50/1.20                                   | .260              | 488                 | 1.50/1.20                                   | .230              | 734                 | 1.50/1.10                                   | .230              | 980                 | 1.50/1.20                                   | .270              |
| 1.4±0.10                                    | 4.8                                     | 242                 | 1.60/1.30                                   | .240              | 487                 | 1.60/1.20                                   | .220              | 733                 | 1.60/1.20                                   | .220              | 979                 | 1.60/1.30                                   | .260              |
| 1.5±0.10                                    | 4.6                                     | 242                 | 1.70/1.40                                   | .230              | 486                 | 1.70/1.40                                   | .210              | 731                 | 1.70/1.40                                   | .220              | 977                 | 1.70/1.40                                   | .260              |
| 1.6±0.10                                    | 4.5                                     | 241                 | 1.80/1.50                                   | .220              | 484                 | 1.85/1.50                                   | .210              | 729                 | 2.00/1.50                                   | .220              | 975                 | 2.00/1.50                                   | .250              |
| 1.7±0.10                                    | 4.3                                     | 240                 | 1.90/1.60                                   | .210              | 483                 | 1.95/1.60                                   | .200              | 728                 | 2.05/1.60                                   | .210              | 974                 | 2.20/1.60                                   | .240              |
| 1.8±0.10                                    | 4.2                                     | 239                 | 2.00/1.70                                   | .200              | 482                 | 2.05/1.70                                   | .190              | 726                 | 2.10/1.70                                   | .210              | 972                 | 2.30/1.70                                   | .230              |
| 1.9±0.10                                    | 4.1                                     | 239                 | 2.10/1.80                                   | .200              | 481                 | 2.15/1.80                                   | .190              | 724                 | 2.25/1.80                                   | .200              | 970                 | 2.40/1.80                                   | .230              |
| 2.0±0.10                                    | 4.0                                     | 238                 | 2.20/1.90                                   | .190              | 479                 | 2.30/1.90                                   | .180              | 722                 | 2.40/1.90                                   | .200              | 967                 | 2.60/1.95                                   | .220              |
| 2.1±0.10                                    | 3.9                                     | 237                 | 2.30/2.00                                   | .190              | 477                 | 2.40/2.00                                   | .170              | 720                 | 2.60/2.00                                   | .190              | 964                 | 2.80/2.06                                   | .210              |
| 2.2±0.10                                    | 3.8                                     | 236                 | 2.40/2.10                                   | .180              | 475                 | 2.60/2.10                                   | .170              | 716                 | 2.80/2.14                                   | .190              | 962                 | 3.06/2.17                                   | .210              |
| 2.4±0.25                                    | 3.6                                     | 235                 | 2.85/2.15                                   | .170              | 473                 | 3.13/2.29                                   | .170              | 714                 | 3.17/2.30                                   | .190              | 960                 | 3.31/2.31                                   | .210              |
| 2.7±0.25                                    | 3.4                                     | 233                 | 3.19/2.45                                   | .160              | 470                 | 3.47/2.55                                   | .150              | 711                 | 3.52/2.60                                   | .170              | 957                 | 3.67/2.60                                   | .200              |
| 3.0±0.25                                    | 3.3                                     | 231                 | 3.51/2.75                                   | .150              | 465                 | 3.76/2.86                                   | .140              | 707                 | 3.84/2.93                                   | .160              | 952                 | 4.00/3.00                                   | .190              |
| 3.3±0.25                                    | 3.1                                     | 229                 | 3.83/3.05                                   | .140              | 463                 | 4.04/3.10                                   | .140              | 704                 | 4.15/3.19                                   | .160              | 948                 | 4.38/3.30                                   | .190              |
| 3.6±0.25                                    | 3.0                                     | 228                 | 4.16/3.35                                   | .140              | 462                 | 4.35/3.42                                   | .130              | 704                 | 4.50/3.53                                   | .150              | 947                 | 4.80/3.60                                   | .190              |
| 3.9±0.25                                    | 2.9                                     | 227                 | 4.48/3.65                                   | .130              | 459                 | 4.67/3.72                                   | .120              | 701                 | 4.85/3.86                                   | .150              | 944                 | 5.23/3.90                                   | .180              |
| 4.3±0.25                                    | 2.7                                     | 223                 | 4.91/4.05                                   | .130              | 456                 | 5.11/4.13                                   | .120              | 697                 | 5.32/4.25                                   | .150              | 940                 | 5.79/4.50                                   | .180              |
| 4.7±0.25                                    | 2.6                                     | 220                 | 5.35/4.45                                   | .120              | 451                 | 5.52/4.53                                   | .110              | 691                 | 5.79/4.60                                   | .140              | 936                 | 6.36/4.80                                   | .170              |
| 5.1±0.25                                    | 2.5                                     | 218                 | 5.78/4.85                                   | .120              | 447                 | 5.94/4.94                                   | .110              | 688                 | 6.25/5.20                                   | .140              | 934                 | 7.16/5.74                                   | .160              |
| 5.6±0.25                                    | 2.4                                     | 215                 | 6.00/5.35                                   | .100              | 444                 | 6.82/5.40                                   | .100              | 684                 | 7.27/5.60                                   | .120              | 930                 | 8.25/5.90                                   | .150              |
| 6.2±0.25                                    | 2.3                                     | 212                 | 7.00/5.95                                   | .100              | 442                 | 7.52/6.00                                   | .100              | 683                 | 8.08/6.10                                   | .120              | 927                 | 9.35/6.80                                   | .150              |
| 6.8±0.25                                    | 2.2                                     | 208                 | 7.20/6.55                                   | .100              | 435                 | 8.21/6.88                                   | .100              | 677                 | 8.90/6.96                                   | .120              | 925                 | 10.46/7.32                                  | .150              |
| 7.5±0.05                                    | 2.1                                     | 206                 | 8.64/7.00                                   | .100              | 434                 | 9.02/7.10                                   | .100              | 675                 | 9.85/7.50                                   | .120              | 924                 | 11.75/8.42                                  | .150              |
| 8.2±0.05                                    | 2.0                                     | 203                 | 9.40/7.70                                   | .090              | 432                 | 9.83/7.90                                   | .080              | 673                 | 10.80/8.25                                  | .110              | 922                 | 13.04/9.53                                  | .150              |
| 9.1±0.05                                    | 1.9                                     | 199                 | 10.37/8.60                                  | .080              | 429                 | 10.88/8.76                                  | .080              | 670                 | 12.02/9.10                                  | .110              | 920                 | 14.70/10.70                                 | .150              |
| 10±5%                                       | 1.8                                     | 196                 | 11.00/9.50                                  | .080              | 423                 | 11.92/9.76                                  | .080              | 668                 | 13.24/10.00                                 | .110              | 918                 | 15.37/11.80                                 | .140              |
| 11±5%                                       | 1.8                                     | 193                 | 12.50/10.45                                 | .080              | 420                 | 13.23/10.50                                 | .080              | 665                 | 15.07/11.00                                 | .110              | 916                 | 16.00/12.20                                 | .140              |
| 12±5%                                       | 1.6                                     | 190                 | 13.61/11.40                                 | .070              | 418                 | 14.50/11.90                                 | .080              | 663                 | 16.90/12.82                                 | .110              | 915                 | N/A                                         | .140              |
| 13±5%                                       | 1.6                                     | 187                 | 14.75/12.35                                 | .070              | 416                 | 15.80/13.00                                 | .080              | 662                 | 18.87/14.00                                 | .110              | 914                 | N/A                                         | .140              |
| 14±5%                                       | 1.5                                     | 184                 | 15.88/13.30                                 | .070              | 414                 | 17.22/14.00                                 | .080              | 661                 | 20.84/16.00                                 | .110              | 913                 | N/A                                         | .140              |
| 15±5%                                       | 1.5                                     | 182                 | 17.02/14.25                                 | .070              | 414                 | 18.56/15.19                                 | .080              | 660                 | 22.62/19.13                                 | .110              | 912                 | N/A                                         | .130              |
| 16±5%                                       | 1.4                                     | 179                 | 18.16/15.20                                 | .070              | 411                 | 19.90/16.28                                 | .080              | 659                 | 27.00/20.89                                 | .100              | 911                 | N/A                                         | .130              |
| 18±5%                                       | 1.3                                     | 176                 | 20.42/17.10                                 | .070              | 408                 | 22.69/18.57                                 | .070              | 657                 | 33.00/22.10                                 | .100              | 910                 | N/A                                         | .130              |
| 20±5%                                       | 1.3                                     | 173                 | 22.70/19.00                                 | .060              | 406                 | 25.38/20.78                                 | .070              | 656                 | 38.00/23.15                                 | .100              | 908                 | N/A                                         | .130              |
| 22±5%                                       | 1.2                                     | 171                 | 24.95/20.90                                 | .060              | 405                 | 28.08/21.00                                 | .070              | 655                 | 42.00/24.00                                 | .100              | 907                 | N/A                                         | .130              |
| 24±5%                                       | 1.2                                     | 168                 | 27.20/22.80                                 | .060              | 403                 | 31.31/25.61                                 | .070              | 654                 | N/A                                         | .090              | 907                 | N/A                                         | .130              |
| 27±5%                                       | 1.1                                     | 165                 | 30.78/25.69                                 | .060              | 401                 | 36.10/32.20                                 | .070              | 652                 | N/A                                         | .090              | 906                 | N/A                                         | .130              |
| 30±5%                                       | 1.0                                     | 163                 | 34.23/28.50                                 | .050              | 400                 | 40.58/33.20                                 | .070              | 651                 | N/A                                         | .090              | 905                 | N/A                                         | .130              |
| 33±5%                                       | 1.0                                     | 159                 | 37.85/31.35                                 | .050              | 399                 | 46.65/35.00                                 | .070              | 650                 | N/A                                         | .090              | 904                 | N/A                                         | .120              |
| 36±5%                                       | 0.9                                     | 157                 | 41.19/34.20                                 | .050              | 397                 | 52.22/38.00                                 | .070              | 649                 | N/A                                         | .090              | 903                 | N/A                                         | .120              |
| 39±5%                                       | 0.9                                     | 155                 | 44.79/37.05                                 | .050              | 396                 | 59.08/47.08                                 | .070              | 648                 | N/A                                         | .090              | 902                 | N/A                                         | .120              |
| 43±5%                                       | 0.9                                     | 153                 | 49.99/40.85                                 | .050              | 395                 | 70.50/53.04                                 | .060              | 647                 | N/A                                         | .090              | 901                 | N/A                                         | .120              |
| 47±5%                                       | 0.8                                     | 152                 | 55.19/44.65                                 | .050              | 394                 | 81.99/59.00                                 | .060              | 646                 | N/A                                         | .090              | 900                 | N/A                                         | .110              |

\* Other tolerances are available, see page 8

## 1210 Typical Electrical Tables

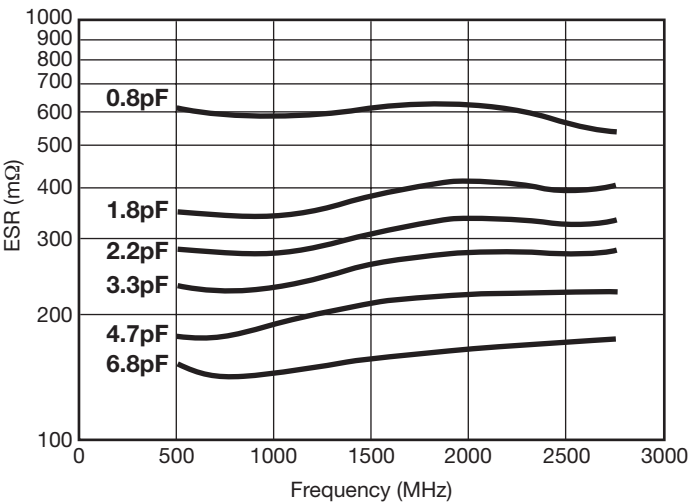
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| Capacitance & Tolerance*<br>@ 1 MHz<br>(pF) | Self<br>Resonance<br>Frequency<br>(GHz) | Ref<br>Freq.<br>(MHz) | Effective<br>Capacitance<br>Max/Min<br>(pF) | Max<br>ESR<br>(Ω) | Ref<br>Freq.<br>(MHz) | Effective<br>Capacitance<br>Max/Min<br>(pF) | Max<br>ESR<br>(Ω) | Ref<br>Freq.<br>(MHz) | Effective<br>Capacitance<br>Max/Min<br>(pF) | Max<br>ESR<br>(Ω) | Ref<br>Freq.<br>(MHz) | Effective<br>Capacitance<br>Max/Min<br>(pF) | Max<br>ESR<br>(Ω) |
|---------------------------------------------|-----------------------------------------|-----------------------|---------------------------------------------|-------------------|-----------------------|---------------------------------------------|-------------------|-----------------------|---------------------------------------------|-------------------|-----------------------|---------------------------------------------|-------------------|
| 1.0±0.25                                    | 4.98                                    | 247                   | 1.23/0.75                                   | .350              | 495                   | 1.34/0.86                                   | .260              | 745                   | 1.46/0.94                                   | .280              | 995                   | 1.6/0.99                                    | .350              |
| 1.2±0.25                                    | 4.55                                    | 245                   | 1.32/0.95                                   | .310              | 491                   | 1.45/1.00                                   | .240              | 739                   | 1.64/1.1                                    | .260              | 987                   | 2.00/1.2                                    | .320              |
| 1.5±0.25                                    | 4.07                                    | 242                   | 1.6/1.23                                    | .250              | 486                   | 1.75/1.3                                    | .230              | 731                   | 1.82/1.95                                   | .250              | 978                   | 2.1/1.4                                     | .270              |
| 1.8±0.25                                    | 9.71                                    | 240                   | 2.1/1.55                                    | .200              | 482                   | 2.21/1.56                                   | .200              | 731                   | 2.4/1.6                                     | .200              | 978                   | 2.54/1.7                                    | .210              |
| 2.2±0.25                                    | 9.96                                    | 237                   | 2.48/1.95                                   | .170              | 476                   | 2.68/2.00                                   | .170              | 727                   | 2.85/2.1                                    | .180              | 969                   | 3.02/2.2                                    | .200              |
| 2.7±0.25                                    | 2.70                                    | 233                   | 3.42/2.45                                   | .140              | 466                   | 3.49/2.55                                   | .140              | 708                   | 3.73/2.63                                   | .150              | 952                   | 3.89/2.70                                   | .170              |
| 3.3±0.25                                    | 2.60                                    | 229                   | 4.02/3.05                                   | .140              | 463                   | 4.09/3.15                                   | .130              | 704                   | 4.33/3.23                                   | .140              | 948                   | 4.49/3.30                                   | .160              |
| 3.6±0.25                                    | 2.50                                    | 228                   | 4.18/3.35                                   | .130              | 462                   | 4.32/3.43                                   | .130              | 704                   | 4.50/3.32                                   | .140              | 947                   | 4.78/3.45                                   | .160              |
| 3.9±0.25                                    | 2.40                                    | 227                   | 4.53/3.65                                   | .130              | 458                   | 4.66/3.73                                   | .120              | 701                   | 4.85/3.75                                   | .140              | 944                   | 5.18/3.90                                   | .150              |
| 4.3±0.25                                    | 2.30                                    | 223                   | 5.01/4.05                                   | .120              | 456                   | 5.11/4.14                                   | .110              | 697                   | 5.32/4.29                                   | .130              | 940                   | 5.72/4.30                                   | .140              |
| 4.7±0.25                                    | 2.20                                    | 220                   | 5.48/4.45                                   | .120              | 451                   | 5.62/4.50                                   | .110              | 691                   | 5.94/4.60                                   | .130              | 936                   | 6.56/4.70                                   | .140              |
| 5.1±0.25                                    | 2.10                                    | 218                   | 5.88/4.85                                   | .110              | 447                   | 6.04/4.90                                   | .110              | 683                   | 6.36/5.10                                   | .130              | 933                   | 7.20/5.40                                   | .140              |
| 5.6±0.25                                    | 2.00                                    | 215                   | 6.49/5.35                                   | .110              | 441                   | 6.72/5.56                                   | .100              | 681                   | 7.17/5.67                                   | .120              | 928                   | 8.15/6.00                                   | .140              |
| 6.2±0.25                                    | 1.90                                    | 212                   | 7.19/5.95                                   | .100              | 442                   | 7.26/6.07                                   | .100              | 679                   | 7.99/6.10                                   | .110              | 927                   | 9.18/7.00                                   | .130              |
| 6.8±0.25                                    | 1.80                                    | 208                   | 7.38/6.55                                   | .100              | 435                   | 8.16/6.42                                   | .100              | 677                   | 8.81/6.93                                   | .110              | 925                   | 10.20/7.42                                  | .130              |
| 7.5±0.25                                    | 1.70                                    | 206                   | 8.60/7.90                                   | .100              | 434                   | 8.90/7.25                                   | .100              | 675                   | 9.58/7.60                                   | .100              | 924                   | 11.36/8.00                                  | .130              |
| 8.2±0.25                                    | 1.70                                    | 203                   | 9.36/7.70                                   | .100              | 432                   | 9.76/7.96                                   | .090              | 673                   | 10.68/8.31                                  | .100              | 922                   | 13.00/9.10                                  | .130              |
| 9.1±0.25                                    | 1.60                                    | 199                   | 10.34/8.60                                  | .090              | 429                   | 10.87/8.88                                  | .090              | 670                   | 12.10/9.66                                  | .090              | 920                   | 15.11/10.25                                 | .130              |
| 10±5%                                       | 1.50                                    | 196                   | 11.33/9.50                                  | .090              | 423                   | 11.97/9.79                                  | .090              | 668                   | 13.51/10.05                                 | .090              | 918                   | 17.22/11.06                                 | .130              |
| 11±5%                                       | 1.50                                    | 193                   | 12.50/10.45                                 | .090              | 420                   | 13.23/10.83                                 | .090              | 665                   | 15.07/11.33                                 | .090              | 916                   | N/A                                         | .130              |
| 12±5%                                       | 1.40                                    | 190                   | 13.61/11.40                                 | .080              | 418                   | 14.59/11.90                                 | .080              | 663                   | 16.90/12.82                                 | .090              | 915                   | N/A                                         | .120              |
| 13±5%                                       | 1.30                                    | 185                   | 14.75/12.35                                 | .080              | 416                   | 15.64/13.00                                 | .080              | 662                   | 18.80/13.60                                 | .090              | 914                   | N/A                                         | .120              |
| 14±5%                                       | 1.30                                    | 183                   | 15.89/13.30                                 | .080              | 415                   | 17.22/14.00                                 | .080              | 661                   | 20.85/16.00                                 | .090              | 913                   | N/A                                         | .120              |
| 15±5%                                       | 1.20                                    | 182                   | 17.02/14.25                                 | .080              | 414                   | 18.56/15.19                                 | .080              | 660                   | 22.62/17.00                                 | .090              | 912                   | N/A                                         | .110              |
| 16±5%                                       | 1.20                                    | 180                   | 18.16/15.20                                 | .080              | 411                   | 19.90/16.28                                 | .080              | 659                   | 25.12/18.00                                 | .090              | 911                   | N/A                                         | .110              |
| 18±5%                                       | 1.10                                    | 176                   | 20.42/17.10                                 | .070              | 408                   | 22.69/18.57                                 | .080              | 657                   | 30.00/24.00                                 | .080              | 909                   | N/A                                         | .110              |
| 20±5%                                       | 1.10                                    | 173                   | 22.70/19.00                                 | .070              | 406                   | 25.36/20.78                                 | .080              | 656                   | 35.00/26.00                                 | .080              | 908                   | N/A                                         | .110              |
| 22±5%                                       | 1.00                                    | 171                   | 24.95/20.90                                 | .070              | 405                   | 28.06/22.96                                 | .080              | 655                   | 42.00/27.00                                 | .080              | 908                   | N/A                                         | .110              |
| 24±5%                                       | 0.98                                    | 168                   | 27.20/22.60                                 | .070              | 403                   | 31.31/25.60                                 | .080              | 654                   | N/A                                         | .080              | 907                   | N/A                                         | .110              |
| 25±5%                                       | 0.96                                    | 166                   | 26.39/23.75                                 | .070              | 402                   | 32.91/26.00                                 | .080              | 653                   | N/A                                         | .080              | 907                   | N/A                                         | .110              |
| 27±5%                                       | 0.92                                    | 164                   | 30.78/25.65                                 | .070              | 401                   | 36.10/28.00                                 | .070              | 652                   | N/A                                         | .080              | 906                   | N/A                                         | .110              |
| 28±5%                                       | 0.91                                    | 163                   | 31.93/26.50                                 | .070              | 401                   | 37.60/30.76                                 | .070              | 651                   | N/A                                         | .080              | 906                   | N/A                                         | .110              |
| 30±5%                                       | 0.88                                    | 162                   | 34.23/28.50                                 | .070              | 400                   | 40.50/33.20                                 | .070              | 651                   | N/A                                         | .080              | 905                   | N/A                                         | .110              |
| 32±5%                                       | 0.85                                    | 161                   | 36.51/30.40                                 | .070              | 399                   | 44.63/34.50                                 | .070              | 650                   | N/A                                         | .080              | 905                   | N/A                                         | .110              |
| 33±5%                                       | 0.84                                    | 159                   | 37.65/31.35                                 | .060              | 399                   | 46.65/35.00                                 | .070              | 650                   | N/A                                         | .080              | 905                   | N/A                                         | .110              |
| 34±5%                                       | 0.82                                    | 158                   | 38.83/32.30                                 | .060              | 398                   | 48.51/37.00                                 | .070              | 649                   | N/A                                         | .080              | 904                   | N/A                                         | .110              |
| 36±5%                                       | 0.80                                    | 157                   | 41.20/34.20                                 | .060              | 397                   | 52.22/41.00                                 | .070              | 649                   | N/A                                         | .070              | 904                   | N/A                                         | .110              |
| 39±5%                                       | 0.77                                    | 155                   | 44.79/37.05                                 | .060              | 396                   | 59.00/43.00                                 | .070              | 649                   | N/A                                         | .070              | 904                   | N/A                                         | .110              |
| 43±5%                                       | 0.73                                    | 153                   | 49.99/40.85                                 | .060              | 396                   | 70.00/46.00                                 | .070              | 648                   | N/A                                         | .070              | 904                   | N/A                                         | .110              |
| 47±5%                                       | 0.70                                    | 152                   | 55.69/44.65                                 | .060              | 395                   | 81.00/53.00                                 | .070              | 648                   | N/A                                         | .070              | 903                   | N/A                                         | .110              |

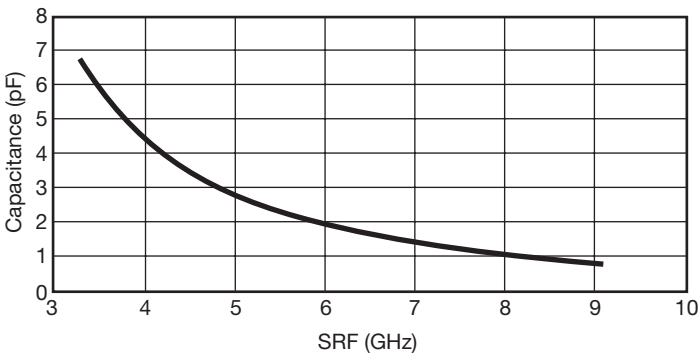
\* Other tolerances are available, see page 8

## High Frequency Characteristics

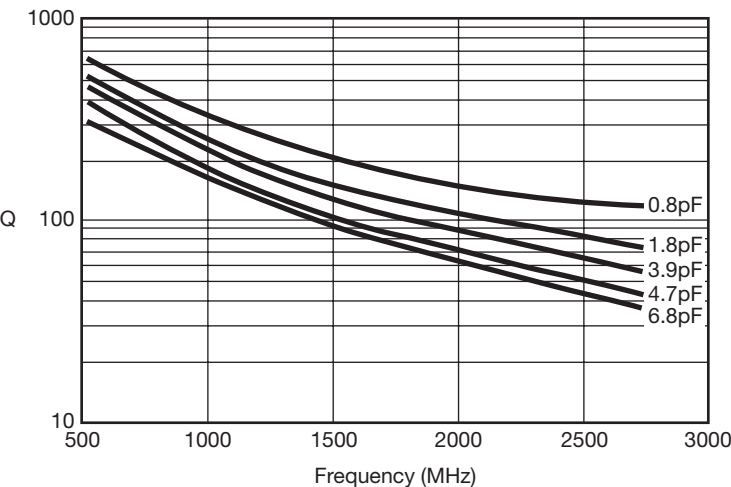
Typical ESR vs. Frequency  
Accu-P® 0201



Typical SRF vs. Capacitance  
Accu-P® 0201



Typical Q vs. Frequency  
Accu-P® 0201

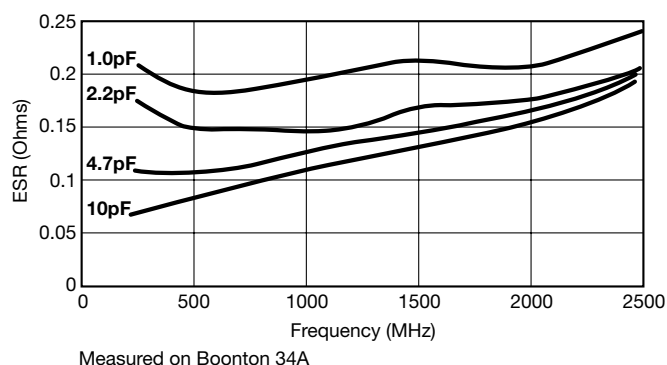


# Accu-F® / Accu-P®

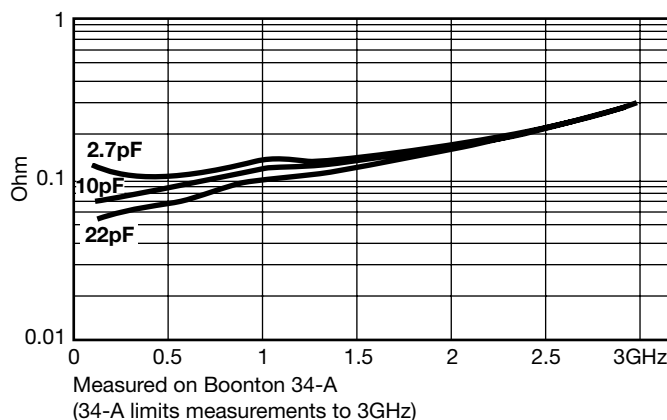
## High Frequency Characteristics



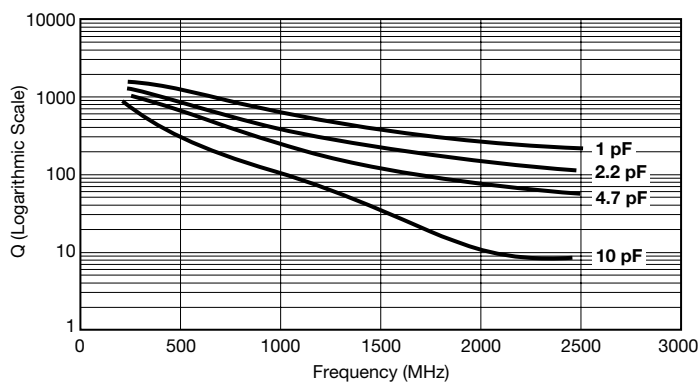
Typical ESR vs. Frequency  
Accu-P® 0402



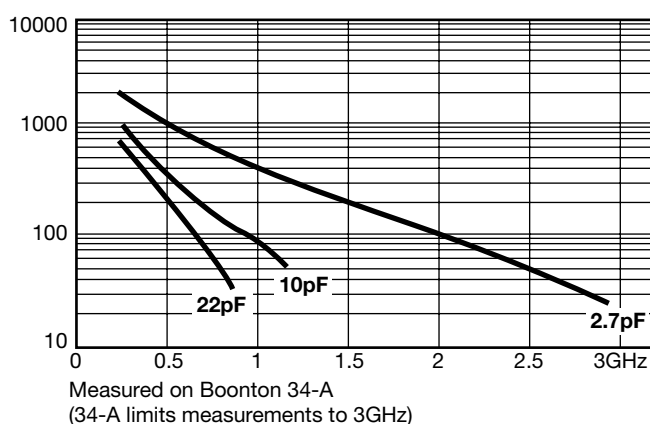
Typical ESR vs. Frequency  
Accu-F®/Accu-P® 0603



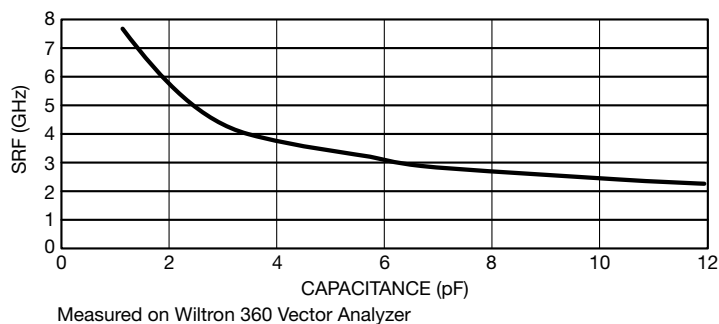
Typical Q vs. Frequency  
Accu-P® 0402



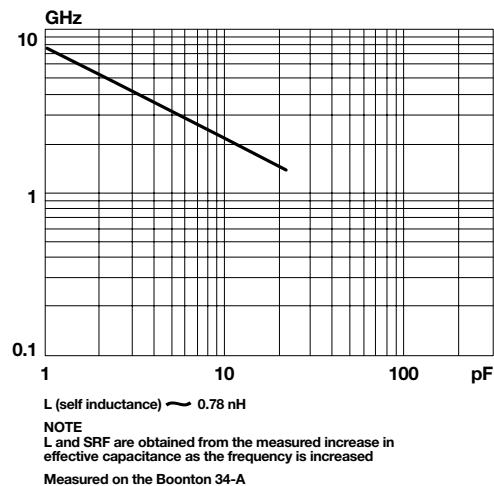
Typical Q vs. Frequency  
Accu-F®/Accu-P® 0603



Typical Self Resonant Frequency vs. Capacitance  
Accu-P® 0402



Typical Self Resonant Frequency vs. Capacitance  
Accu-F®/Accu-P® 0603

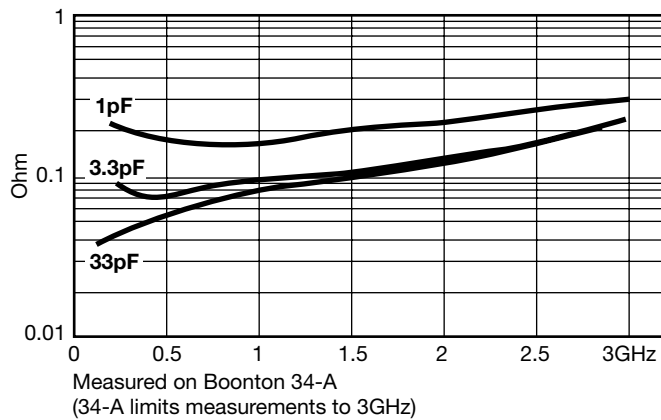


# Accu-F® / Accu-P®

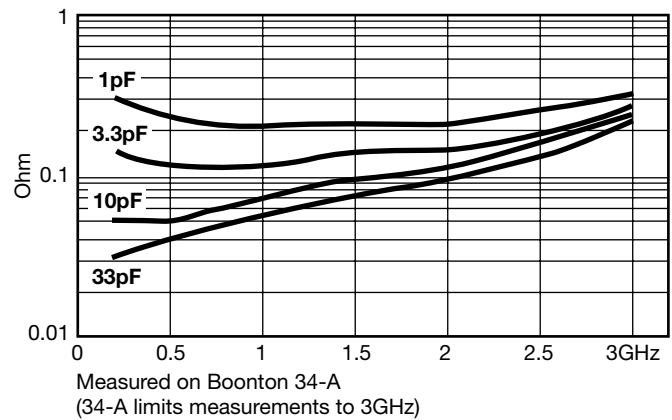
## High Frequency Characteristics



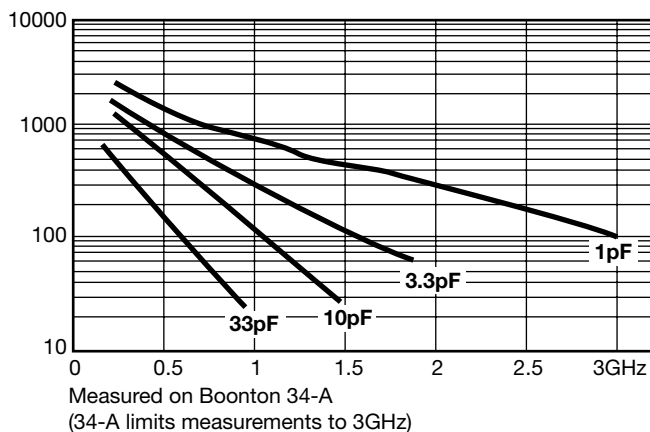
Typical ESR vs. Frequency  
Accu-F®/Accu-P® 0805



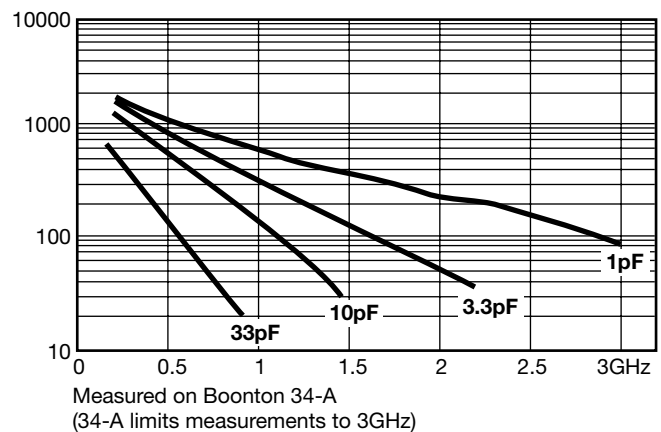
Typical ESR vs. Frequency  
Accu-P® 1210



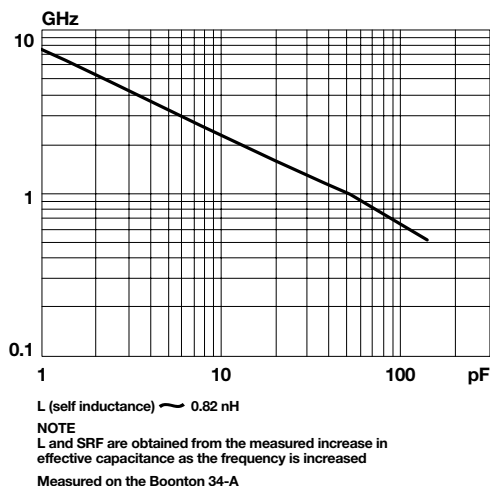
Typical Q vs. Frequency  
Accu-F®/Accu-P® 0805



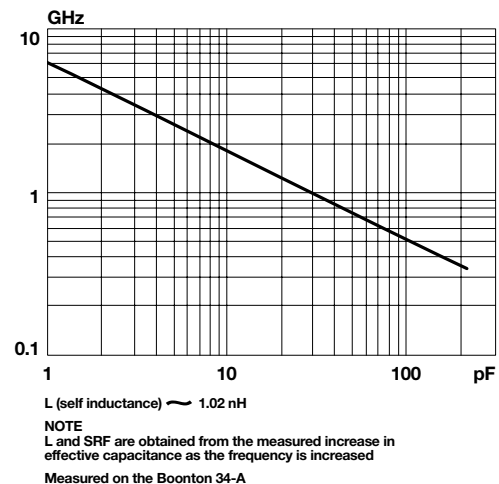
Typical Q vs. Frequency  
Accu-P® 1210



Typical Self Resonant Frequency vs. Capacitance  
Accu-F®/Accu-P® 0805



Typical Self Resonant Frequency vs. Capacitance  
Accu-P® 1210



## Environmental / Mechanical Characteristics

### ENVIRONMENTAL CHARACTERISTICS

| TEST                                                                                 | CONDITIONS                                                                  | REQUIREMENT                                                                                                              |
|--------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| <b>Life (Endurance)</b><br>MIL-STD-202F Method 108A                                  | 125°C, 2U <sub>R</sub> , 1000 hours                                         | No visible damage<br>$\Delta C/C \leq 2\%$ for $C \geq 5\text{pF}$<br>$\Delta C \leq 0.25\text{pF}$ for $C < 5\text{pF}$ |
| <b>Accelerated Damp Heat Steady State</b><br>MIL-STD-202F Method 103B                | 85°C, 85% RH, U <sub>R</sub> , 1000 hours                                   | No visible damage<br>$\Delta C/C \leq 2\%$ for $C \geq 5\text{pF}$<br>$\Delta C \leq 0.25\text{pF}$ for $C < 5\text{pF}$ |
| <b>Temperature Cycling</b><br>MIL-STD-202F Method 107E<br>MIL-STD-883D Method 1010.7 | -55°C to +125°C, 15 cycles – Accu-P®<br>-55°C to +125°C, 5 cycles – Accu-F® | No visible damage<br>$\Delta C/C \leq 2\%$ for $C \geq 5\text{pF}$<br>$\Delta C \leq 0.25\text{pF}$ for $C < 5\text{pF}$ |
| <b>Resistance to Solder Heat</b><br>IEC-68-2-58                                      | 260°C $\pm$ 5°C for 10 secs                                                 | C remains within initial limits                                                                                          |

### MECHANICAL CHARACTERISTICS

| TEST                                                                             | CONDITIONS                                                                                                       | REQUIREMENT                                                                                                              |
|----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| <b>Solderability</b><br>IEC-68-2-58                                              | Components completely immersed in a solder bath at 235°C for 2 secs.                                             | Terminations to be well tinned, minimum 95% coverage                                                                     |
| <b>Leach Resistance</b><br>IEC-68-2-58                                           | Components completely immersed in a solder bath at 260 $\pm$ 5°C for 60 secs.                                    | Dissolution of termination faces $\leq 15\%$ of area<br>Dissolution of termination edges $\leq 25\%$ of length           |
| <b>Adhesion</b><br>MIL-STD-202F Method 211A                                      | A force of 5N applied for 10 secs.                                                                               | No visible damage                                                                                                        |
| <b>Termination Bond Strength</b><br>IEC-68-2-21 Amend. 2                         | Tested as shown in diagram<br> | No visible damage<br>$\Delta C/C \leq 2\%$ for $C \geq 5\text{pF}$<br>$\Delta C \leq 0.25\text{pF}$ for $C < 5\text{pF}$ |
| <b>Robustness of Termination</b><br>IEC-68-2-21 Amend. 2                         | A force of 5N applied for 10 secs.                                                                               | No visible damage                                                                                                        |
| <b>High Frequency Vibration</b><br>MIL-STD-202F Method 201A, 204D (Accu-P® only) | 55Hz to 2000Hz, 20G                                                                                              | No visible damage                                                                                                        |
| <b>Storage</b>                                                                   | 12 months minimum with components stored in "as received" packaging                                              | Good solderability                                                                                                       |

### QUALITY & RELIABILITY

Accu-P® is based on well established thin-film technology and materials.

#### • ON-LINE PROCESS CONTROL

This program forms an integral part of the production cycle and acts as a feedback system to regulate and control production processes. The test procedures, which are integrated into the production process, were developed after long research work and are based on the highly developed semiconductor industry test procedures and equipment. These measures help AVX to produce a consistent and high yield line of products.

#### • FINAL QUALITY INSPECTION

Finished parts are tested for standard electrical parameters and visual/mechanical characteristics. Each production lot is 100% evaluated for: capacitance and proof voltage at 2.5 U<sub>R</sub>. In addition, production is periodically evaluated for:

Average capacitance with histogram printout for capacitance distribution;  
IR and Breakdown Voltage distribution;  
Temperature Coefficient;  
Solderability;  
Dimensional, mechanical and temperature stability.

### QUALITY ASSURANCE

The reliability of these thin-film chip capacitors has been studied intensively for several years. Various measures have been taken to obtain the high reliability required today by the industry. Quality assurance policy is based on well established international industry standards. The reliability of the capacitors is determined by accelerated testing under the following conditions:

|                                    |                                            |
|------------------------------------|--------------------------------------------|
| Life (Endurance)                   | 125°C, 2U <sub>R</sub> , 1000 hours        |
| Accelerated Damp Heat Steady State | 85°C, 85% RH, U <sub>R</sub> , 1000 hours. |

## Performance Characteristics RF Power Applications

### RF POWER APPLICATIONS

In RF power applications capacitor losses generate heat. Two factors of particular importance to designers are:

- Minimizing the generation of heat.
- Dissipating heat as efficiently as possible.

### CAPACITOR HEATING

- The major source of heat generation in a capacitor in RF power applications is a function of RF current (I) and ESR, from the relationship:

$$\text{Power dissipation} = I_{\text{RMS}}^2 \times \text{ESR}$$

- Accu-P® capacitors are specially designed to minimize

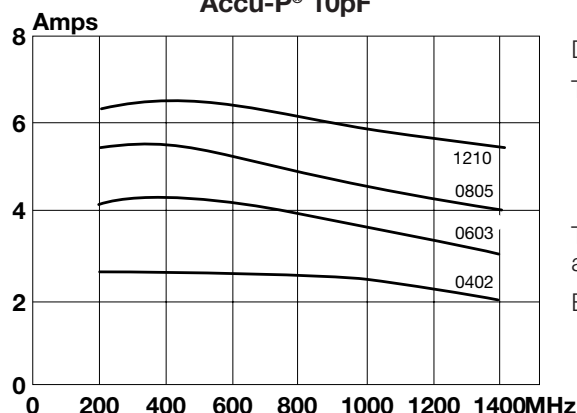
ESR and therefore RF heating. Values of ESR for Accu-P® capacitors are significantly less than those of ceramic MLC components currently available.

### HEAT DISSIPATION

- Heat is dissipated from a capacitor through a variety of paths, but the key factor in the removal of heat is the thermal conductivity of the capacitor material.
- The higher the thermal conductivity of the capacitor, the more rapidly heat will be dissipated.
- The table below illustrates the importance of thermal conductivity to the performance of Accu-P® in power applications.

| PRODUCT       | MATERIAL           | THERMAL CONDUCTIVITY W/mK |
|---------------|--------------------|---------------------------|
| Accu-P®       | Alumina            | 18.9                      |
| Microwave MLC | Magnesium Titanate | 6.0                       |

**Power Handling  
Accu-P® 10pF**



Data used in calculating the graph:

Thermal impedance of capacitors:

|      |         |
|------|---------|
| 0402 | 17°C/W  |
| 0603 | 12°C/W  |
| 0805 | 6.5°C/W |
| 1210 | 5°C/W   |

Thermal impedance measured using RF generator, amplifier and strip-line transformer.

ESR of capacitors measured on Boonton 34A

### THERMAL IMPEDANCE

Thermal impedance of Accu-P® chips is shown below compared with the thermal impedance of Microwave MLC's.

| CAPACITOR TYPE | CHIP SIZE | THERMAL IMPEDANCE (°C/W) |
|----------------|-----------|--------------------------|
| Accu-P®        | 0805      | 6.5                      |
|                | 1210      | 5                        |
| Microwave MLC  | 0505      | 12                       |
|                | 1210      | 7.5                      |

The thermal impedance expresses the temperature difference in °C between chip center and termination caused by a power dissipation of 1 watt in the chip. It is expressed in °C/W.

### ADVANTAGES OF ACCU-P® IN RF POWER CIRCUITS

The optimized design of Accu-P® offers the designer of RF power circuits the following advantages:

- Reduced power losses due to the inherently low ESR of Accu-P®.
- Increased power dissipation due to the high thermal conductivity of Accu-P®.

• THE ONLY TRUE TEST OF A CAPACITOR IN ANY PARTICULAR APPLICATION IS ITS PERFORMANCE UNDER OPERATING CONDITIONS IN THE ACTUAL CIRCUIT.

### PRACTICAL APPLICATION IN RF POWER CIRCUITS

- There is a wide variety of different experimental methods for measuring the power handling performance of a capacitor in RF power circuits. Each method has its own problems and few of them exactly reproduce the conditions present in "real" circuit applications.
- Similarly, there is a very wide range of different circuit applications, all with their unique characteristics and operating conditions which cannot possibly be covered by such "theoretical" testing.

## Application Notes

### GENERAL

Accu-F® and Accu-P® SMD capacitors are designed for soldering to printed circuit boards or other substrates. The construction of the components is such that they will withstand the time/temperature profiles used in both wave and reflow soldering methods.

### HANDLING

SMD capacitors should be handled with care to avoid damage or contamination from perspiration and skin oils. The use of plastic tipped tweezers or vacuum pick-ups is strongly recommended for individual components. Bulk handling should ensure that abrasion and mechanical shock are minimized. For automatic equipment, taped and reeled product gives the ideal medium for direct presentation to the placement machine.

### CIRCUIT BOARD TYPE

The circuit board types which may be used with Accu-F® and Accu-P® are as follows:

Accu-F®: All flexible types of circuit boards (eg. FR-4, G-10).

Accu-P®: All flexible types of circuit boards (eg. FR-4, G-10) and also alumina.

For other circuit board materials, please consult factory.

### COMPONENT PAD DESIGN

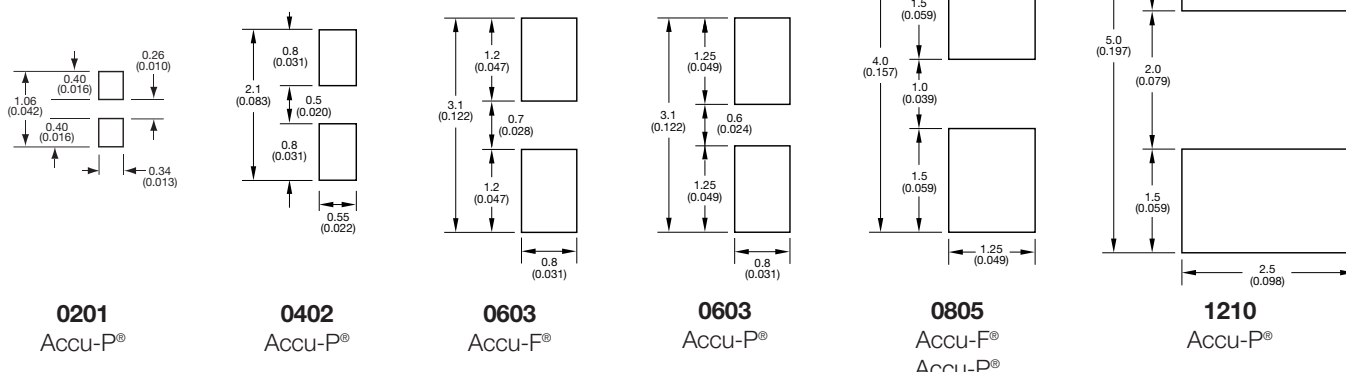
Component pads must be designed to achieve good joints and minimize component movement during reflow soldering. Pad designs are given below for both wave and reflow soldering.

The basis of these designs is:

- Pad width equal to component width. It is permissible to decrease this to as low as 85% of component width but it is not advisable to go below this.
- Pad overlap 0.5mm beneath large components. Pad overlap about 0.3mm beneath small components.
- Pad extension of 0.5mm for reflow of large components and pad extension about 0.3mm for reflow of small components. Pad extension about 1.0mm for wave soldering.

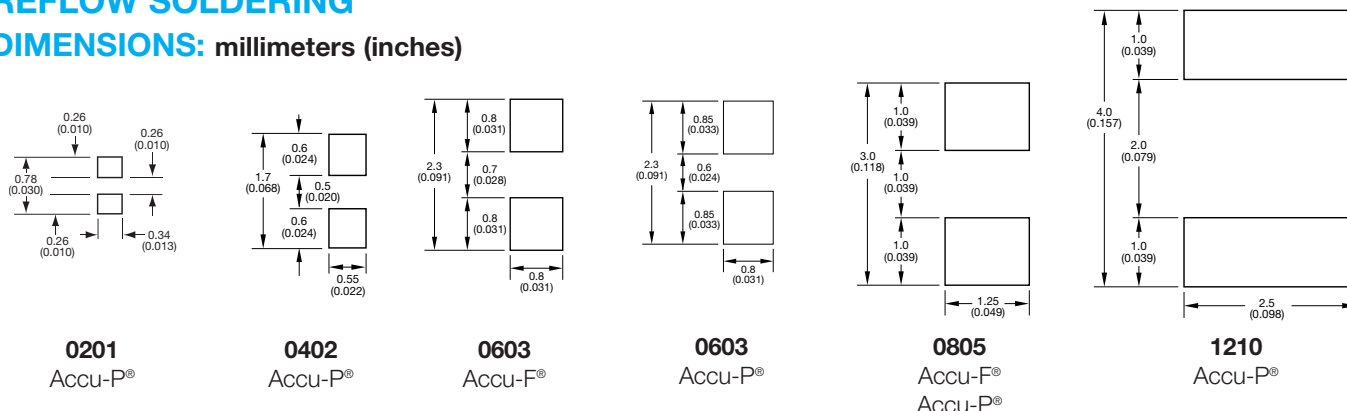
### WAVE SOLDERING

**DIMENSIONS:** millimeters (inches)



### REFLOW SOLDERING

**DIMENSIONS:** millimeters (inches)



## Application Notes

### PREHEAT & SOLDERING

The rate of preheat in production should not exceed 4°C/second and a recommended maximum is about 2°C/second. Temperature differential from preheat to soldering should not exceed 100°C.

For further specific application or process advice, please consult AVX.

### COOLING

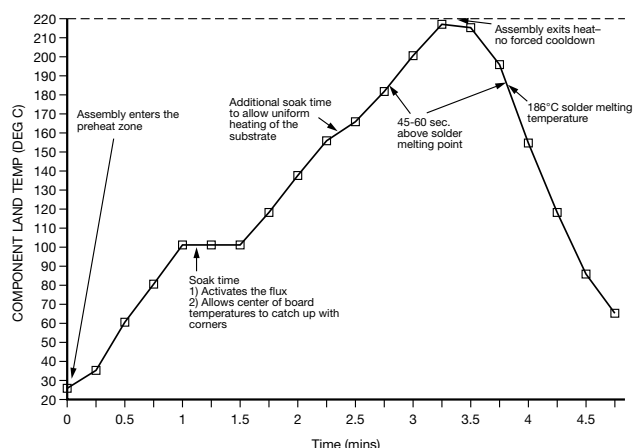
After soldering, the assembly should preferably be allowed to cool naturally. In the event of assisted cooling, similar conditions to those recommended for preheating should be used.

### HAND SOLDERING & REWORK

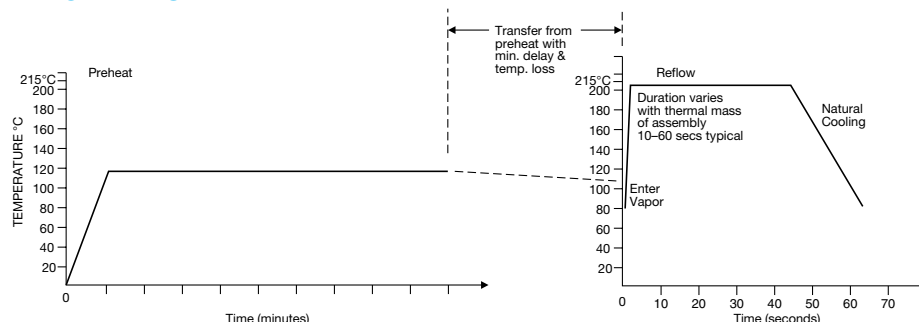
Hand soldering is permissible. Preheat of the PCB to 150°C is required. The most preferable technique is to use hot air soldering tools. Where a soldering iron is used, a temperature controlled model not exceeding 30 watts should be used and set to not more than 260°C.

## RECOMMENDED SOLDERING PROFILE

### IR REFLOW



### VAPOR PHASE



### CLEANING RECOMMENDATIONS

Care should be taken to ensure that the devices are thoroughly cleaned of flux residues, especially the space beneath the device. Such residues may otherwise become conductive and effectively offer a lossy bypass to the device. Various recommended cleaning conditions (which must be optimized for the flux system being used) are as follows:

Cleaning liquids. . . . . i-propanol, ethanol, acetylacetone, water and other standard PCB cleaning liquids.

Ultrasonic conditions . . power-20w/liter max.  
frequency-20kHz to 45kHz.

Temperature . . . . . 80°C maximum (if not otherwise limited by chosen solvent system).

Time . . . . . 5 minutes max.

### STORAGE CONDITIONS

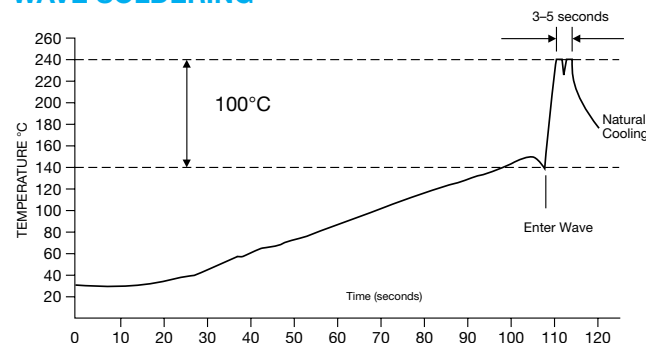
Recommended storage conditions for Accu-F® and Accu-P® prior to use are as follows:

Temperature . . . . . 15°C to 35°C

Humidity . . . . . ≤65%

Air Pressure . . . . . 860mbar to 1060mbar

### WAVE SOLDERING



## Automatic Insertion Packaging

### TAPE & REEL

All tape and reel specifications are in compliance with EIA 481-1-A.  
(equivalent to IEC 286 part 3).

- 8mm carrier
- Reeled quantities: Reels of 3,000 per 7" reel or 10,000 pieces per 13" reel  
0201 and 0402 = 5,000 pieces per 7" reel and 20,000 pieces per 13" reel

### REEL

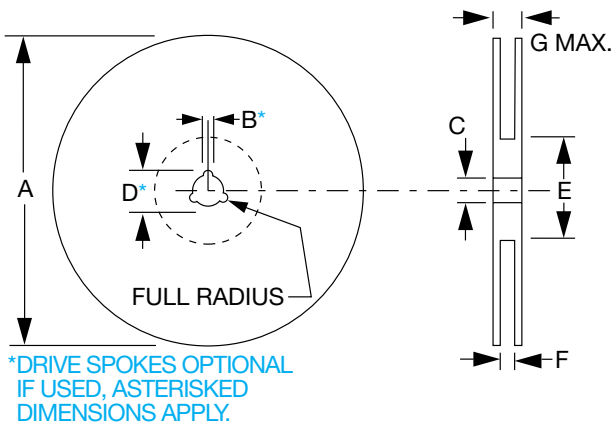
#### DIMENSIONS: millimeters (inches)

| A <sup>(1)</sup>         | B                        | C                         | D                         | E                       | F                          | G                         |
|--------------------------|--------------------------|---------------------------|---------------------------|-------------------------|----------------------------|---------------------------|
| 180±1.0<br>(7.087±0.039) | 1.5 min.<br>(0.059 min.) | 13±0.2<br>(0.512 ± 0.008) | 20.2 min.<br>(0.795 min.) | 50 min.<br>(1.969 min.) | 9.6±1.5<br>(0.370 ± 0.050) | 14.4 max.<br>(0.567 max.) |

Metric dimensions will govern.

Inch measurements rounded and for reference only.

(1) 330mm (13 inch) reels are available.

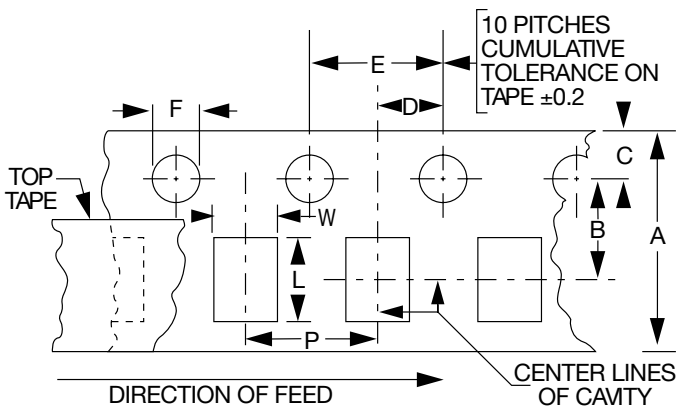


### CARRIER

#### DIMENSIONS: millimeters (inches)

| A                            | B                             | C                           | D                             | E                            | F                                                                                   |
|------------------------------|-------------------------------|-----------------------------|-------------------------------|------------------------------|-------------------------------------------------------------------------------------|
| 8.0 ± 0.3<br>(0.315 ± 0.012) | 3.5 ± 0.05<br>(0.138 ± 0.002) | 1.75±0.1<br>(0.069 ± 0.004) | 2.0 ± 0.05<br>(0.079 ± 0.002) | 4.0 ± 0.1<br>(0.157 ± 0.004) | 1.5 <sup>+0.1</sup> <sub>-0.0</sub><br>(0.059 <sup>+0.004</sup> <sub>-0.000</sub> ) |

NOTE: The nominal dimensions of the component compartment (W,L) are derived from the component size.



P = 4mm except 0201 and 0402 where P = 2mm

NOTE: AVX reserves the right to change the information published herein without notice.

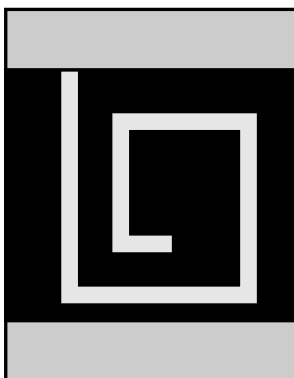


# Thin-Film Technology

2

Accu-L<sup>®</sup> L0603/L0805

Thin-Film RF/Microwave Inductors



10 nH Inductor (Top View)

### ACCU-L<sup>®</sup> TECHNOLOGY

The Accu-L<sup>®</sup> SMD Inductor is based on thin-film multilayer technology. This technology provides a level of control on the electrical and physical characteristics of the component which gives consistent characteristics within a lot and lot-to-lot.

The original design provides small size, excellent high-frequency performance and rugged construction for reliable automatic assembly.

The Accu-L<sup>®</sup> inductor is particularly suited for the telecommunications industry where there is a continuing trend towards miniaturization and increasing frequencies. The Accu-L<sup>®</sup> inductor meets both the performance and tolerance requirements of present cellular frequencies 450MHz and 900MHz and of future frequencies, such as 1700MHz, 1900MHz and 2400MHz.

### FEATURES

- High Q
- RF Power Capability
- High SRF
- Low DC Resistance
- Ultra-Tight Tolerance on Inductance
- Standard 0603 and 0805 Chip Size
- Low Profile
- Rugged Construction
- Taped and Reeled

### APPLICATIONS

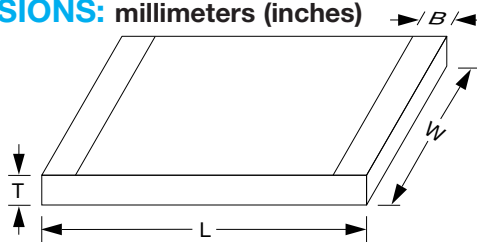
- Mobile Communications
- Satellite TV Receivers
- GPS
- Vehicle Locations Systems
- Filters
- Matching Networks

# Accu-L® 0603 and 0805



## SMD High-Q RF Inductor

### DIMENSIONS: millimeters (inches)



|   | 0603                                                                    | 0805                       |
|---|-------------------------------------------------------------------------|----------------------------|
| L | 1.6±0.10<br>(0.063±0.004)                                               | 2.11±0.10<br>(0.083±0.004) |
| W | 0.81±0.10<br>(0.032±0.004)                                              | 1.5±0.10<br>(0.059±0.004)  |
| T | 0.61±0.10<br>(0.024±0.004)                                              | 0.91±0.13<br>(0.036±0.005) |
| B | top: 0.0 +0.3/-0.0<br>(0.0+0.012)<br>bottom: 0.35±0.20<br>(0.014±0.008) | 0.25±0.15<br>(0.010±0.006) |

Operating/Storage  
Temp. Range:  
-55°C to +125°C

### HOW TO ORDER

|                                 |                                     |                                                                                                                                                                                                   |                                                                                                                                                                                                                             |                                                                                                       |                                                                                   |                                                                      |
|---------------------------------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------------------------------------|
| <b>L</b><br>Product<br>Inductor | <b>0805</b><br>Size<br>0603<br>0805 | <b>4R7</b><br>Inductance<br>Expressed in nH<br>(2 significant digits +<br>number of zeros)<br>for<br>values <10nH,<br>letter R denotes<br>decimal point.<br>Example:<br>22nH = 220<br>4.7nH = 4R7 | <b>D</b><br>Tolerance<br>for<br>$L \leq 4.7\text{nH}$ ,<br>B = ±0.1nH<br>C = ±0.2nH<br>D = ±0.5nH<br><br>$4.7\text{nH} < L < 10\text{nH}$ ,<br>C = ±0.2nH<br>D = ±0.5nH<br><br>$L \geq 10\text{nH}$ ,<br>G = ±2%<br>J = ±5% | <b>E</b><br>Specification<br>Code<br>E = Accu-L® 0805<br>technology<br>G = Accu-L® 0603<br>technology | <b>W</b><br>Termination<br>Code<br>W = Nickel/<br>solder coated<br>(Sn 63, Pb 37) | <b>TR</b><br>Packaging<br>Code<br>TR = Tape and Reel<br>(3,000/reel) |
|---------------------------------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------------------------------------------------|

2

### ELECTRICAL SPECIFICATIONS TABLE FOR ACCU-L® 0603

| 450 MHz<br>Test Frequency |                                   |              | 900 MHz<br>Test Frequency |              | 1900 MHz<br>Test Frequency |              | 2400 MHz<br>Test Frequency |              | SRF min<br>(MHz) | R <sub>DC</sub> max<br>(Ω) | I <sub>DC</sub> max<br>(mA)<br>(1) |
|---------------------------|-----------------------------------|--------------|---------------------------|--------------|----------------------------|--------------|----------------------------|--------------|------------------|----------------------------|------------------------------------|
| Inductance<br>L (nH)      | Available<br>Inductance Tolerance | Q<br>Typical | L (nH)                    | Q<br>Typical | L (nH)                     | Q<br>Typical | L (nH)                     | Q<br>Typical |                  |                            |                                    |
| 1.2                       | ±0.1, ±0.2nH                      | 49           | 1.2                       | 70           | 1.2                        | 134          | 1.2                        | 170          | 10000            | 0.04                       | 1000                               |
| 1.5                       | ±0.1, ±0.2nH                      | 26           | 1.54                      | 39           | 1.52                       | 63           | 1.52                       | 76           | 10000            | 0.06                       | 1000                               |
| 1.8                       | ±0.1, ±0.2nH                      | 20           | 1.74                      | 30           | 1.73                       | 50           | 1.72                       | 59           | 10000            | 0.07                       | 1000                               |
| 2.2                       | ±0.1, ±0.2nH                      | 20           | 2.2                       | 30           | 2.24                       | 49           | 2.24                       | 56           | 10000            | 0.08                       | 1000                               |
| 2.7                       | ±0.1, ±0.2nH                      | 21           | 2.7                       | 30           | 2.75                       | 48           | 2.79                       | 54           | 9000             | 0.08                       | 750                                |
| 3.3                       | ±0.1, ±0.2, ±0.5nH                | 24           | 3.33                      | 35           | 3.39                       | 56           | 3.47                       | 64           | 8400             | 0.08                       | 750                                |
| 3.9                       | ±0.1, ±0.2, ±0.5nH                | 25           | 3.9                       | 57           | 4.06                       | 60           | 4.21                       | 69           | 6500             | 0.12                       | 500                                |
| 4.7                       | ±0.1, ±0.2, ±0.5nH                | 23           | 4.68                      | 32           | 4.92                       | 46           | 5.2                        | 49           | 5500             | 0.15                       | 500                                |
| 5.6                       | ±0.2, ±0.5nH                      | 26           | 5.65                      | 36           | 5.94                       | 54           | 6.23                       | 60           | 5000             | 0.25                       | 300                                |
| 6.8                       | ±0.2, ±0.5nH                      | 23           | 6.9                       | 33           | 7.3                        | 47           | 8.1                        | 39           | 4500             | 0.30                       | 300                                |
| 8.2                       | ±0.2, ±0.5nH                      | 23           | 8.4                       | 31           | 10                         | 35           | 12.1                       | 31           | 3800             | 0.35                       | 300                                |
| 10.0                      | ±2%, ±5%                          | 28           | 10                        | 39           | 11.8                       | 47           | 14.1                       | 41           | 3500             | 0.45                       | 300                                |
| 12.0                      | ±2%, ±5%                          | 28           | 13.2                      | 38           | 14.1                       | 30           | 17.2                       | 20           | 3000             | 0.50                       | 300                                |
| 15.0                      | ±2%, ±5%                          | 28           | 16.2                      | 38           | 25.9                       | 30           | 49.8                       | 15           | 2500             | 0.60                       | 300                                |

(1) I<sub>DC</sub> measured for 15°C rise at 25°C ambient temperature when soldered to FR-4 board.

Inductance and Q measured on Agilent 4291B / 4287 using the 16196A test fixture.

### ELECTRICAL SPECIFICATIONS TABLE FOR ACCU-L® 0805

| 450 MHz<br>Test Frequency |                                   |              | 900 MHz<br>Test Frequency |              | 1700 MHz<br>Test Frequency |              | 2400 MHz<br>Test Frequency |              | SRF min<br>(MHz) | R <sub>DC</sub> max<br>(Ω) | I <sub>DC</sub> max<br>(mA) |                  |
|---------------------------|-----------------------------------|--------------|---------------------------|--------------|----------------------------|--------------|----------------------------|--------------|------------------|----------------------------|-----------------------------|------------------|
| Inductance<br>L (nH)      | Available<br>Inductance Tolerance | Q<br>Typical | L (nH)                    | Q<br>Typical | L (nH)                     | Q<br>Typical | L (nH)                     | Q<br>Typical |                  |                            | ΔT = 15°C<br>(1)            | ΔT = 70°C<br>(2) |
| 1.2                       | ±0.1nH, ±0.2nH, ±0.5nH            | 60           | 1.2                       | 92           | 1.2                        | 122          | 1.2                        | 92           | 10000            | 0.05                       | 1000                        | 2000             |
| 1.5                       | ±0.1nH, ±0.2nH, ±0.5nH            | 50           | 1.5                       | 74           | 1.5                        | 102          | 1.5                        | 84           | 10000            | 0.05                       | 1000                        | 2000             |
| 1.8                       | ±0.1nH, ±0.2nH, ±0.5nH            | 50           | 1.8                       | 72           | 1.8                        | 88           | 1.9                        | 73           | 10000            | 0.06                       | 1000                        | 2000             |
| 2.2                       | ±0.1nH, ±0.2nH, ±0.5nH            | 42           | 2.2                       | 62           | 2.2                        | 82           | 2.3                        | 72           | 10000            | 0.07                       | 1000                        | 2000             |
| 2.7                       | ±0.1nH, ±0.2nH, ±0.5nH            | 42           | 2.7                       | 62           | 2.8                        | 80           | 2.9                        | 70           | 10000            | 0.08                       | 1000                        | 2000             |
| 3.3                       | ±0.1nH, ±0.2nH, ±0.5nH            | 38           | 3.3                       | 46           | 3.4                        | 48           | 3.5                        | 57           | 10000            | 0.11                       | 750                         | 1500             |
| 3.9                       | ±0.1nH, ±0.2nH, ±0.5nH            | 27           | 3.9                       | 36           | 4.0                        | 38           | 4.1                        | 42           | 10000            | 0.20                       | 750                         | 1500             |
| 4.7                       | ±0.1nH, ±0.2nH, ±0.5nH            | 43           | 4.8                       | 62           | 5.3                        | 76           | 5.8                        | 60           | 5500             | 0.10                       | 750                         | 1500             |
| 5.6                       | ±0.5nH                            | 50           | 5.7                       | 68           | 6.3                        | 73           | 7.6                        | 62           | 4600             | 0.10                       | 750                         | 1500             |
| 6.8                       | ±0.5nH                            | 43           | 7.0                       | 62           | 7.7                        | 71           | 9.4                        | 50           | 4500             | 0.11                       | 750                         | 1500             |
| 8.2                       | ±0.5nH                            | 43           | 8.5                       | 56           | 10.0                       | 55           | 15.2                       | 32           | 3500             | 0.12                       | 750                         | 1500             |
| 10                        | ±2%, ±5%                          | 46           | 10.6                      | 60           | 13.4                       | 52           | —                          | —            | 2500             | 0.13                       | 750                         | 1500             |
| 12                        | ±2%, ±5%                          | 40           | 12.9                      | 50           | 17.3                       | 40           | —                          | —            | 2400             | 0.20                       | 750                         | 1500             |
| 15                        | ±2%, ±5%                          | 36           | 16.7                      | 46           | 27                         | 23           | —                          | —            | 2200             | 0.20                       | 750                         | 1000             |
| 18                        | ±2%, ±5%                          | 30           | 21.9                      | 27           | —                          | —            | —                          | —            | 1700             | 0.35                       | 500                         | 1000             |
| 22                        | ±2%, ±5%                          | 36           | 27.5                      | 33           | —                          | —            | —                          | —            | 1400             | 0.40                       | 500                         | 1000             |

(1) I<sub>DC</sub> measured for 15°C rise at 25°C ambient temperature

(2) I<sub>DC</sub> measured for 70°C rise at 25°C ambient temperature

L, Q, SRF measured on HP 4291A, Boonton 34A and Wiltron 360  
Vector Analyzer, R<sub>DC</sub> measured on Keithley 580 micro-ohmmeter.



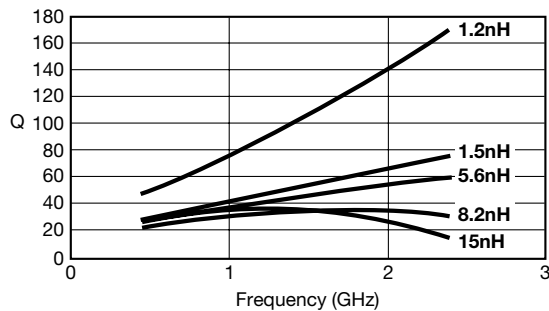
# Accu-L<sup>®</sup> 0603 and 0805



## SMD High-Q RF Inductor

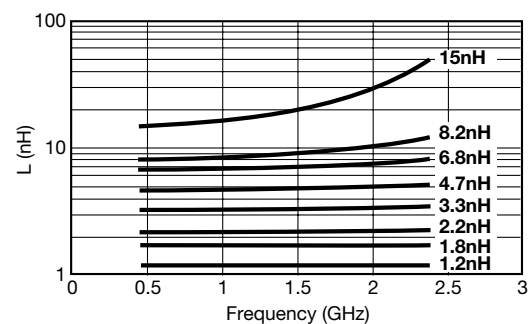
### L0603

Typical Q vs. Frequency  
L0603



Measured on AGILENT 4291B/4287  
using the 16196A test fixture

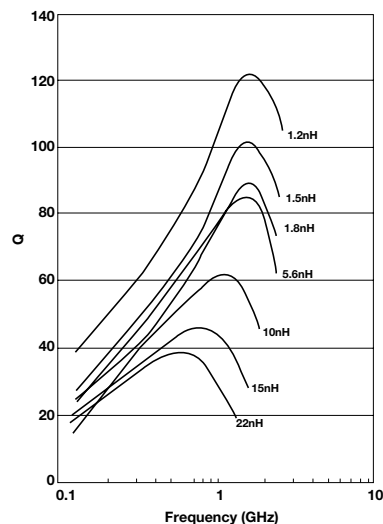
Typical Inductance vs. Frequency  
L0603



Measured on AGILENT 4291B/4287  
using the 16196A test fixture

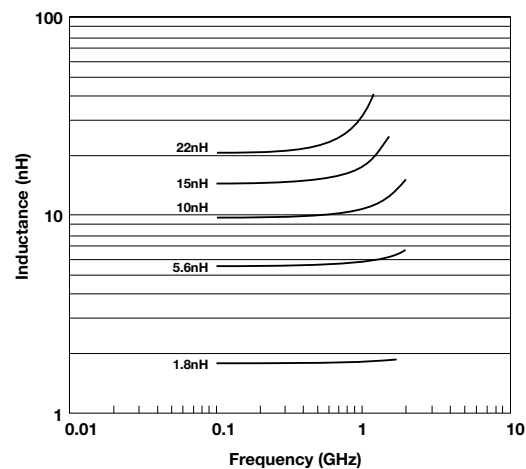
### L0805

Typical Q vs. Frequency  
L0805



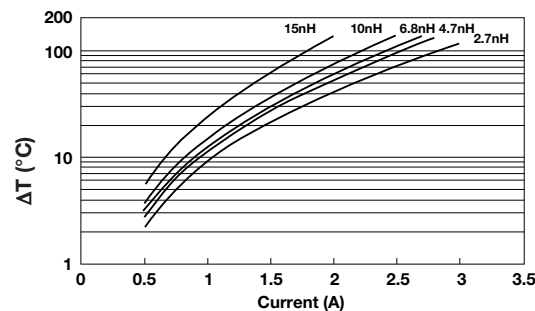
Measured on HP4291A and  
Boonton 34A Coaxial Line

Typical Inductance vs. Frequency  
L0805



Measured on HP4291A and  
Wiltron 360 Vector Analyzer

Maximum Temperature Rise  
at 25°C ambient temperature (on FR-4)  
L0805



Temperature rise will typically be no higher than shown by the graph



# Accu-L<sup>®</sup> 0603 and 0805



## SMD High-Q RF Inductor

### FINAL QUALITY INSPECTION

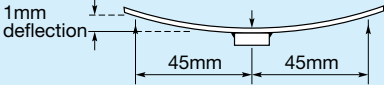
Finished parts are tested for electrical parameters and visual/mechanical characteristics.

Parts are 100% tested for inductance at 450MHz. Parts are 100% tested for  $R_{DC}$ . Each production lot is evaluated on a sample basis for:

- Q at test frequency
- Static Humidity Resistance: 85°C, 85% RH, 160 hours
- Endurance: 125°C,  $I_R$ , 4 hours

2

### ENVIRONMENTAL CHARACTERISTICS

| TEST                                               | CONDITIONS                                                                                                                                    | REQUIREMENT                                                                                                                          |
|----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| <b>Solderability</b>                               | Components completely immersed in a solder bath at $235 \pm 5^\circ\text{C}$ for 2 secs.                                                      | Terminations to be well tinned. No visible damage.                                                                                   |
| <b>Leach Resistance</b>                            | Components completely immersed in a solder bath at $260 \pm 5^\circ\text{C}$ for 60 secs.                                                     | Dissolution of termination faces $\leq 15\%$ of area.<br>Dissolution of termination edges $\leq 25\%$ of length.                     |
| <b>Storage</b>                                     | 12 months minimum with components stored in "as received" packaging.                                                                          | Good solderability                                                                                                                   |
| <b>Shear</b>                                       | Components mounted to a substrate. A force of 5N applied normal to the line joining the terminations and in a line parallel to the substrate. | No visible damage                                                                                                                    |
| <b>Rapid Change of Temperature</b>                 | Components mounted to a substrate. 5 cycles $-55^\circ\text{C}$ to $+125^\circ\text{C}$ .                                                     | No visible damage                                                                                                                    |
| <b>Bend Strength</b>                               | Tested as shown in diagram<br>                             | No visible damage                                                                                                                    |
| <b>Temperature Coefficient of Inductance (TCL)</b> | Component placed in environmental chamber $-55^\circ\text{C}$ to $+125^\circ\text{C}$ .                                                       | $+0$ to $+125 \text{ ppm}/^\circ\text{C}$ (typical)<br>$TCL = \frac{L_2 - L_1}{L_1 (T_2 - T_1)} \cdot 10^6$ $T_1 = 25^\circ\text{C}$ |

## Application Notes

### HANDLING

SMD chips should be handled with care to avoid damage or contamination from perspiration and skin oils. The use of plastic tipped tweezers or vacuum pick-ups is strongly recommended for individual components. Bulk handling should ensure that abrasion and mechanical shock are minimized. For automatic equipment, taped and reeled product is the ideal medium for direct presentation to the placement machine.

### CIRCUIT BOARD TYPE

All flexible types of circuit boards may be used (e.g. FR-4, G-10) and also alumina.

For other circuit board materials, please consult factory.

### COMPONENT PAD DESIGN

Component pads must be designed to achieve good joints and minimize component movement during soldering.

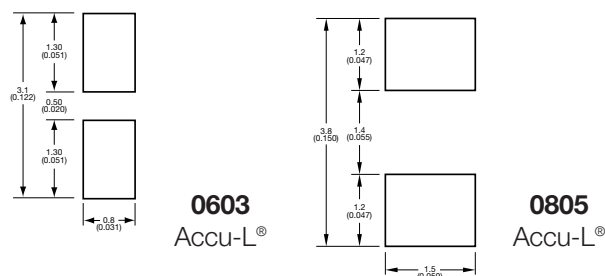
Pad designs are given below for both wave and reflow soldering.

The basis of these designs is:

- Pad width equal to component width. It is permissible to decrease this to as low as 85% of component width but it is not advisable to go below this.
- Pad overlap about 0.3mm.
- Pad extension about 0.3mm for reflow.  
Pad extension about 0.8mm for wave soldering.

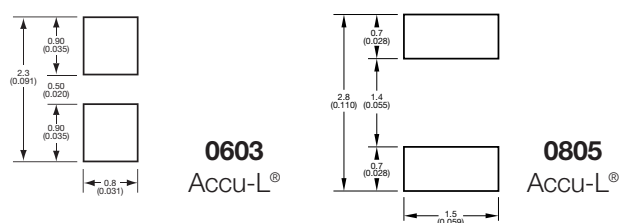
### WAVE SOLDERING

#### DIMENSIONS: millimeters (inches)



### REFLOW SOLDERING

#### DIMENSIONS: millimeters (inches)



### PREHEAT & SOLDERING

The rate of preheat in production should not exceed 4°C/second. It is recommended not to exceed 2°C/second.

Temperature differential from preheat to soldering should not exceed 150°C.

For further specific application or process advice, please consult AVX.

### HAND SOLDERING & REWORK

Hand soldering is permissible. Preheat of the PCB to 100°C is required. The most preferable technique is to use hot air soldering tools. Where a soldering iron is used, a temperature controlled model not exceeding 30 watts should be used and set to not more than 260°C. Maximum allowed time at temperature is 1 minute. When hand soldering, the base side (white side) must be soldered to the board.

### COOLING

After soldering, the assembly should preferably be allowed to cool naturally. In the event of assisted cooling, similar conditions to those recommended for preheating should be used.

### CLEANING RECOMMENDATIONS

Care should be taken to ensure that the devices are thoroughly cleaned of flux residues, especially the space beneath the device. Such residues may otherwise become conductive and effectively offer a lossy bypass to the device. Various recommended cleaning conditions (which must be optimized for the flux system being used) are as follows:

Cleaning liquids . . . . . i-propanol, ethanol, acetone, water, and other standard PCB cleaning liquids.

Ultrasonic conditions . . power – 20w/liter max.  
frequency – 20kHz to 45kHz.

Temperature . . . . . 80°C maximum (if not otherwise limited by chosen solvent system).

Time . . . . . 5 minutes max.

### STORAGE CONDITIONS

Recommended storage conditions for Accu-L® prior to use are as follows:

Temperature . . . . . 15°C to 35°C

Humidity . . . . . ≤65%

Air Pressure . . . . . 860mbar to 1060mbar

### RECOMMENDED SOLDERING PROFILE

For recommended soldering profile see page 23



# Thin-Film Technology

CP0402/CP0603/CP0805  
and DB0805 3dB 90°  
Thin-Film RF/Microwave  
Directional Couplers

3

# Thin-Film Directional Couplers



## CP0402 High Directivity LGA Termination

### GENERAL DESCRIPTION

#### ITF (Integrated Thin-Film) TECHNOLOGY

The ITF High Directivity LGA Coupler is based on thin-film multilayer technology. The technology provides a miniature part with excellent high frequency performance and rugged construction for reliable automatic assembly.

The ITF Coupler is offered in a variety of frequency bands compatible with various types of high frequency wireless systems.

### APPLICATIONS

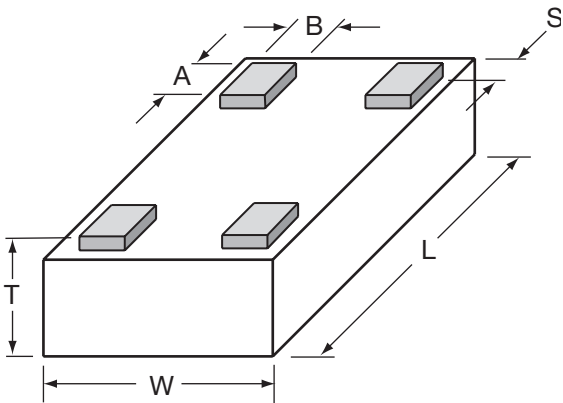
- Mobile Communications
- Satellite TV Receivers
- GPS
- Vehicle Location Systems
- Wireless LAN's

### FEATURES

- Inherent Low Profile
- Self Alignment during Reflow
- Excellent Solderability
- Low Parasitics
- Better Heat Dissipation
- Operating/Storage Temp -40°C to +85°C
- Power Rating 3W RF Cont

### DIMENSIONS: (Bottom View)

millimeters (inches)



|   |                            |   |                            |
|---|----------------------------|---|----------------------------|
| L | 1.00±0.05<br>(0.040±0.002) | A | 0.20±0.05<br>(0.008±0.002) |
| W | 0.58±0.04<br>(0.023±0.002) | B | 0.18±0.05<br>(0.007±0.002) |
| T | 0.35±0.05<br>(0.014±0.002) | S | 0.05±0.05<br>(0.002±0.002) |

### HOW TO ORDER

|                                           |                             |                  |                                   |                      |                                                                    |                                                   |
|-------------------------------------------|-----------------------------|------------------|-----------------------------------|----------------------|--------------------------------------------------------------------|---------------------------------------------------|
| <b>CP</b><br>Style<br>Directional Coupler | <b>0402</b><br>Size<br>0402 | <b>X</b><br>Type | <b>****</b><br>Frequency<br>(MHz) | <b>X</b><br>Sub Type | <b>L</b><br>LGA Termination<br>L = LGA Sn90, Pb10<br>N = LGA Sn100 | <b>TR</b><br>Packaging Code<br>TR = Tape and Reel |
|-------------------------------------------|-----------------------------|------------------|-----------------------------------|----------------------|--------------------------------------------------------------------|---------------------------------------------------|

### QUALITY INSPECTION

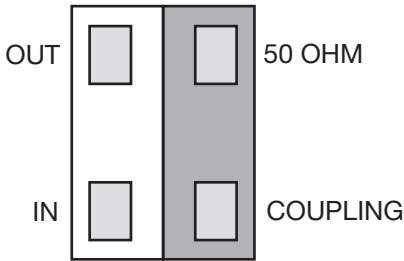
Finished parts are 100% tested for electrical parameters and visual characteristics. Each production lot is evaluated on a sample basis for:

- Static Humidity: 85°C, 85% RH, 160 hours
- Endurance: 125°C,  $I_R$ , 4 hours

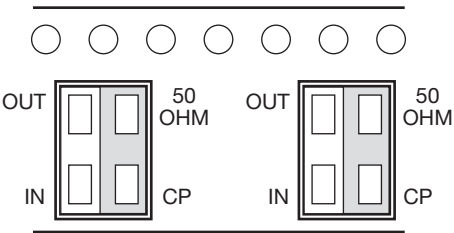
### TERMINATION

Sn90Pb10 or Lead-Free Sn100 Nickel/Solder coating compatible with automatic soldering technologies: reflow, wave soldering, vapor phase and manual.

### TERMINALS (Top View)

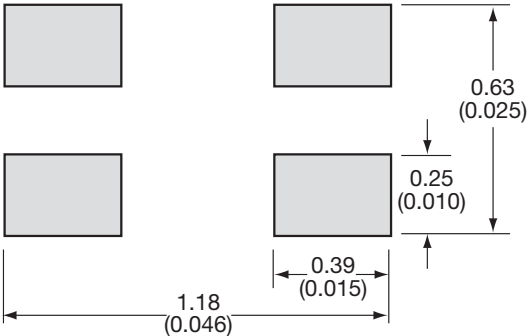


### ORIENTATION IN TAPE



### Recommended Pad Layout Dimensions

mm (inches)



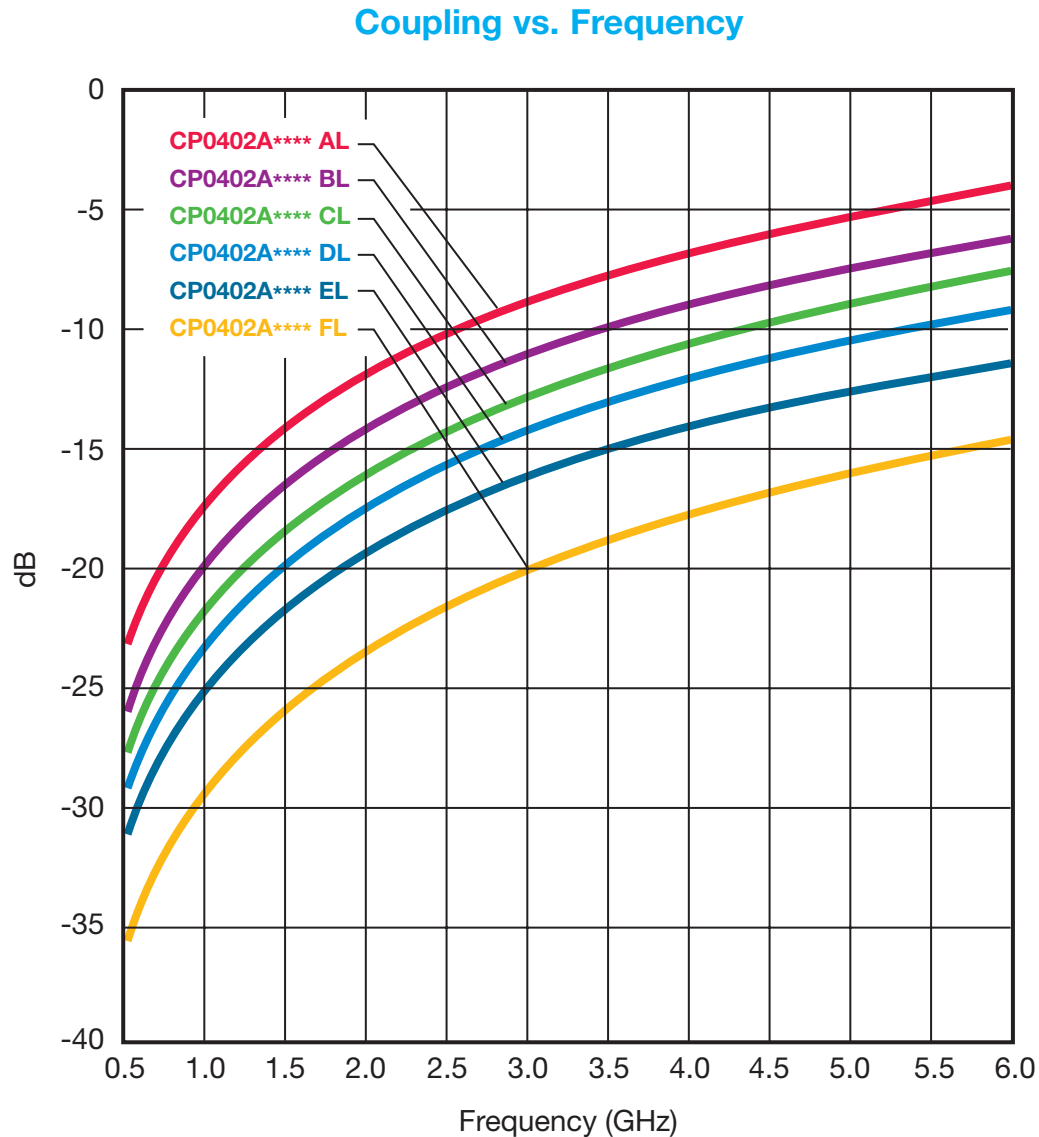
\*The recommended distance to the PCB Ground Plane is 0.254mm (0.010")

# Thin-Film Directional Couplers



## CP0402 High Directivity LGA Termination

### COUPLER TYPE SELECTION GRAPH



3

Intermediate coupling factors are readily available.  
Please contact factory.

# Thin-Film Directional Couplers

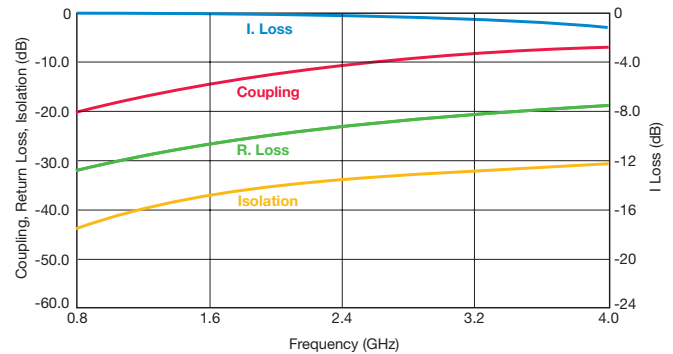


## CP0402 High Directivity LGA Termination

Coupler P/N CP0402AxxxxAL

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max. [dB] | Return Loss [dB] | Directivity [dB] |      |       |      |    |
|--------------|---------------|----------------------|---------------|-------------------|------------------|------------------|------|-------|------|----|
| AMPS         | CP0402A0836AL | 824 - 849            | 19.10         | 0.25              | 32               | 21               |      |       |      |    |
|              | CP0402A0881AL | 869 - 894            | 18.60         |                   | 31               |                  |      |       |      |    |
| GSM          | CP0402A0902AL | 890 - 915            | 18.50         |                   |                  |                  | 0.40 | 28    |      |    |
|              | CP0402A0947AL | 935 - 960            | 18.00         |                   |                  |                  |      |       |      |    |
| E-GSM        | CP0402A0897AL | 880 - 915            | 18.50         |                   |                  |                  |      |       | 0.50 | 26 |
|              | CP0402A0942AL | 925 - 960            | 18.00         |                   |                  |                  |      |       |      |    |
| PDC          | CP0402A1441AL | 1429 - 1453          | 14.50         | 25                |                  |                  |      |       |      |    |
| PCN          | CP0402A1747AL | 1710 - 1785          | 13.00         |                   | 0.70             |                  | 23   |       |      |    |
|              | CP0402A1842AL | 1805 - 1880          | 12.50         |                   |                  |                  |      |       |      |    |
| PCS          | CP0402A1880AL | 1850 - 1910          | 12.30         |                   |                  |                  |      | 10.30 |      |    |
|              | CP0402A1960AL | 1930 - 1990          | 12.00         |                   |                  |                  |      |       |      |    |
| PHP          | CP0402A1907AL | 1895 - 1920          | 12.30         |                   |                  |                  |      |       |      |    |
| DECT         | CP0402A1890AL | 1880 - 1900          |               |                   |                  |                  |      |       |      |    |
| Wireless LAN | CP0402A2442AL | 2400 - 2484          | 10.30         | 0.70              | 23               |                  |      |       |      |    |

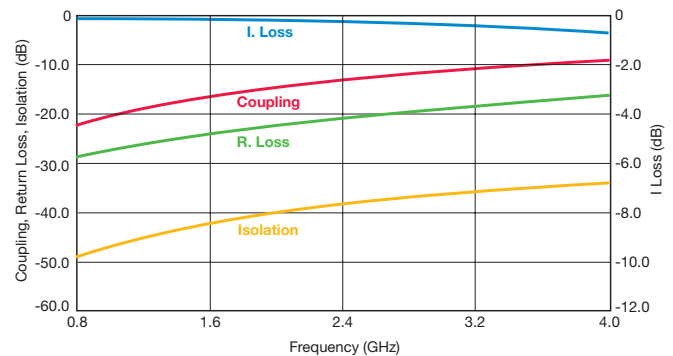
CP0402AxxxxALTR



Coupler P/N CP0402AxxxxBL

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max. [dB] | Return Loss [dB] | Directivity [dB] |
|--------------|---------------|----------------------|---------------|-------------------|------------------|------------------|
| AMPS         | CP0402A0836BL | 824 - 849            | 22.00         | 0.20              | 28               | 27               |
|              | CP0402A0881BL | 869 - 894            | 21.70         |                   |                  |                  |
| GSM          | CP0402A0902BL | 890 - 915            | 21.50         | 0.25              | 27               |                  |
|              | CP0402A0947BL | 935 - 960            | 21.00         |                   |                  |                  |
| E-GSM        | CP0402A0897BL | 880 - 915            | 21.50         | 0.20              | 28               |                  |
|              | CP0402A0942BL | 925 - 960            | 21.00         |                   |                  |                  |
| PDC          | CP0402A1441BL | 1429 - 1453          | 17.50         | 0.25              | 24               |                  |
|              | CP0402A1747BL | 1710 - 1785          | 16.00         |                   |                  |                  |
| PCN          | CP0402A1842BL | 1805 - 1880          | 15.50         | 0.30              | 23               |                  |
|              | CP0402A1880BL | 1850 - 1910          | 15.00         |                   |                  |                  |
| PCS          | CP0402A1960BL | 1930 - 1990          | 15.00         | 0.35              | 22               |                  |
|              | CP0402A1907BL | 1895 - 1920          | 15.50         |                   |                  |                  |
| PHP          | CP0402A1890BL | 1880 - 1900          | 15.50         | 0.40              | 23               |                  |
| DECT         | CP0402A1890BL | 1880 - 1900          | 15.50         |                   |                  |                  |
| Wireless LAN | CP0402A2442BL | 2400 - 2484          | 13.30         | 0.40              | 21               |                  |

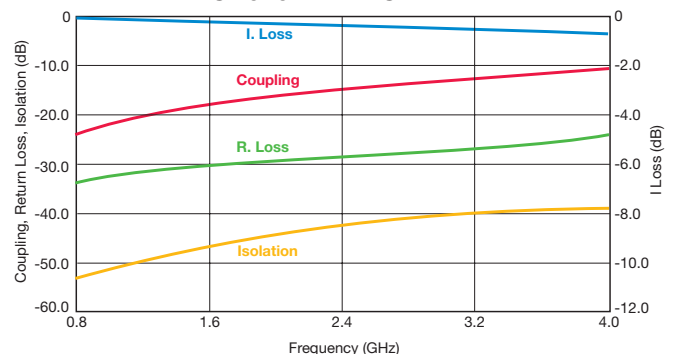
CP0402AxxxxBLTR



Coupler P/N CP0402AxxxxCL

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max. [dB] | Return Loss [dB] | Directivity [dB] |    |
|--------------|---------------|----------------------|---------------|-------------------|------------------|------------------|----|
| AMPS         | CP0402A0836CL | 824 - 849            | 23.60         | 0.20              | 33               | 22               |    |
|              | CP0402A0881CL | 869 - 894            | 23.00         |                   | 26               |                  |    |
| GSM          | CP0402A0902CL | 890 - 915            | 22.50         |                   | 33               |                  |    |
|              | CP0402A0947CL | 935 - 960            | 22.50         |                   | 25               |                  |    |
| E-GSM        | CP0402A0897CL | 880 - 915            | 23.00         |                   | 32               |                  |    |
|              | CP0402A0942CL | 925 - 960            | 22.50         | 0.25              | 31               | 30               |    |
| PDC          | CP0402A1441CL | 1429 - 1453          | 19.00         |                   | 0.25             |                  | 30 |
|              | CP0402A1747CL | 1710 - 1785          | 17.20         |                   |                  |                  |    |
| PCN          | CP0402A1842CL | 1805 - 1880          | 17.00         |                   |                  |                  |    |
|              | CP0402A1880CL | 1850 - 1910          | 16.80         |                   |                  |                  |    |
| PCS          | CP0402A1960CL | 1930 - 1990          | 16.50         |                   |                  |                  |    |
|              | CP0402A1907CL | 1895 - 1920          | 16.80         | 0.45              | 29               | 30               |    |
|              | CP0402A1890CL | 1880 - 1900          | 16.80         |                   | 30               |                  |    |
| DECT         | CP0402A2442CL | 2400 - 2484          | 14.70         |                   | 28               |                  |    |
| Wireless LAN |               |                      |               |                   |                  |                  |    |

CP0402AxxxxCLTR



Important: Couplers can be used at any frequency within the indicated range.

# Thin-Film Directional Couplers

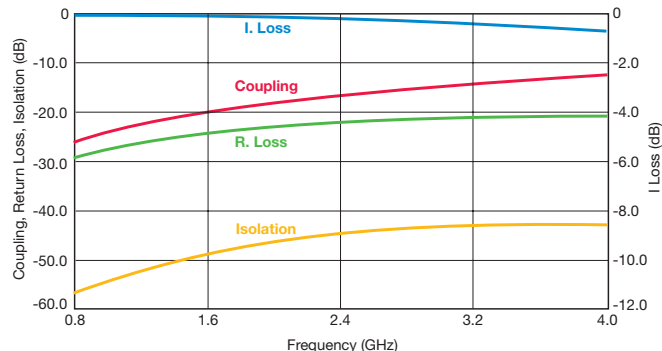


## CP0402 High Directivity LGA Termination

Coupler P/N CP0402AxxxxDL

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max. [dB] | Return Loss [dB] | Directivity [dB] |
|--------------|---------------|----------------------|---------------|-------------------|------------------|------------------|
| AMPS         | CP0402A0836DL | 824 - 849            | 25.20         | 0.20              | 29               | 20               |
|              | CP0402A0881DL | 869 - 894            | 24.80         |                   |                  |                  |
| GSM          | CP0402A0902DL | 890 - 915            | 24.70         |                   | 28               |                  |
|              | CP0402A0947DL | 935 - 960            | 24.10         |                   |                  |                  |
| E-GSM        | CP0402A0897DL | 880 - 915            | 24.70         | 0.25              | 25               | 23               |
|              | CP0402A0942DL | 925 - 960            | 24.10         |                   | 24               |                  |
| PDC          | CP0402A1441DL | 1429 - 1453          | 20.50         |                   |                  |                  |
|              | CP0402A1747DL | 1710 - 1785          | 19.00         |                   |                  |                  |
| PCN          | CP0402A1842DL | 1805 - 1880          | 18.50         | 0.35              | 23               | 23               |
|              | CP0402A1880DL | 1850 - 1910          | 18.20         |                   |                  |                  |
|              | CP0402A1960DL | 1930 - 1990          | 18.00         |                   |                  |                  |
|              | CP0402A1907DL | 1895 - 1920          | 18.10         |                   |                  |                  |
| DECT         | CP0402A1890DL | 1880 - 1900          | 18.20         | 0.35              | 22               | 23               |
| Wireless LAN | CP0402A2442DL | 2400 - 2484          | 16.00         |                   |                  |                  |

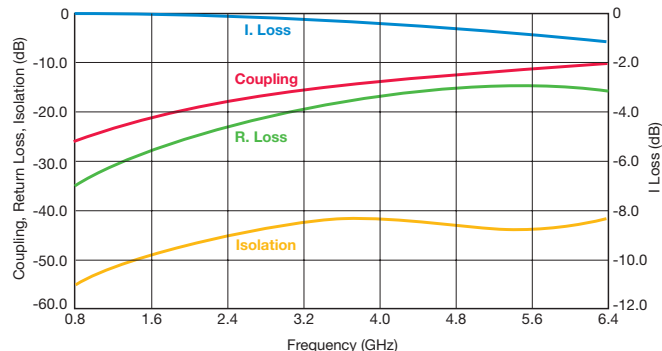
CP0402AxxxxDLTR



Coupler P/N CP0402AxxxxEL

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max. [dB] | Return Loss [dB] | Directivity [dB] |
|--------------|---------------|----------------------|---------------|-------------------|------------------|------------------|
| AMPS         | CP0402A0836EL | 824 - 849            | 27.20         | 0.20              | 35               | 25               |
|              | CP0402A0881EL | 869 - 894            | 26.80         |                   |                  |                  |
| GSM          | CP0402A0902EL | 890 - 915            | 26.50         |                   | 34               |                  |
|              | CP0402A0947EL | 935 - 960            | 26.00         |                   |                  |                  |
| E-GSM        | CP0402A0897EL | 880 - 915            | 26.50         | 0.25              | 29               | 23               |
|              | CP0402A0942EL | 925 - 960            | 26.00         |                   | 27               |                  |
| PDC          | CP0402A1441EL | 1429 - 1453          | 22.30         |                   |                  |                  |
|              | CP0402A1747EL | 1710 - 1785          | 20.50         |                   |                  |                  |
| PCN          | CP0402A1842EL | 1805 - 1880          | 20.30         | 0.35              | 26               | 23               |
|              | CP0402A1880EL | 1850 - 1910          | 20.00         |                   |                  |                  |
|              | CP0402A1960EL | 1930 - 1990          | 18.00         |                   |                  |                  |
|              | CP0402A1907EL | 1895 - 1920          | 18.00         |                   |                  |                  |
| DECT         | CP0402A1890EL | 1880 - 1900          | 18.00         | 0.35              | 23               | 23               |
| Wireless LAN | CP0402A2442EL | 2400 - 2484          | 18.00         |                   |                  |                  |

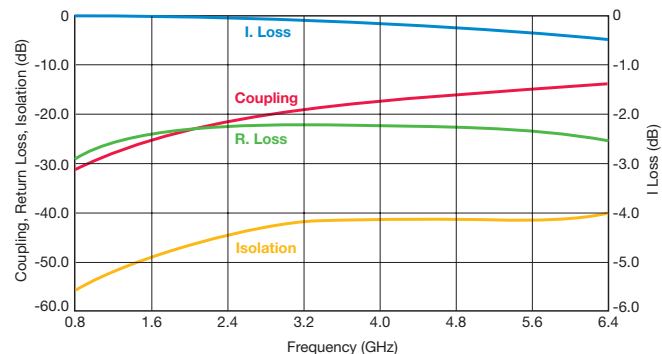
CP0402AxxxxELTR



Coupler P/N CP0402AxxxxFL

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max. [dB] | Return Loss [dB] | Directivity [dB] |
|--------------|---------------|----------------------|---------------|-------------------|------------------|------------------|
| AMPS         | CP0402A0836FL | 824 - 849            | 31.00         | 0.20              | 29.10            | 11               |
|              | CP0402A0881FL | 869 - 894            | 30.70         |                   | 28.60            |                  |
| GSM          | CP0402A0902FL | 890 - 915            | 30.60         |                   | 28.50            |                  |
|              | CP0402A0947FL | 935 - 960            | 30.00         |                   | 28.10            |                  |
| E-GSM        | CP0402A0897FL | 880 - 915            | 30.60         | 0.25              | 28.50            | 11               |
|              | CP0402A0942FL | 925 - 960            | 30.00         |                   | 28.10            |                  |
| PDC          | CP0402A1441FL | 1429 - 1453          | 26.50         |                   | 25.00            |                  |
|              | CP0402A1747FL | 1710 - 1785          | 25.00         |                   | 23.80            |                  |
| PCN          | CP0402A1842FL | 1805 - 1880          | 24.50         | 0.35              | 23.60            | 11               |
|              | CP0402A1880FL | 1850 - 1910          | 24.20         |                   | 23.50            |                  |
|              | CP0402A1960FL | 1930 - 1990          | 24.00         |                   | 23.30            |                  |
|              | CP0402A1907FL | 1895 - 1920          | 24.20         |                   | 23.40            |                  |
| DECT         | CP0402A1890FL | 1880 - 1900          | 22.00         | 0.25              | 23.50            | 11               |
| Wireless LAN | CP0402A2442FL | 2400 - 2484          | 22.00         |                   | 22.60            |                  |

CP0402AxxxxFLTR



Important: Couplers can be used at any frequency within the indicated range.



# Thin-Film Directional Couplers



## CP0603 High Directivity LGA Termination

### GENERAL DESCRIPTION

#### ITF (Integrated Thin-Film) TECHNOLOGY

The ITF LGA Coupler is based on thin-film multilayer technology. The technology provides a miniature part with excellent high frequency performance and rugged construction for reliable automatic assembly. The ITF Coupler is offered in a variety of frequency bands compatible with various types of high frequency wireless systems.

### APPLICATIONS

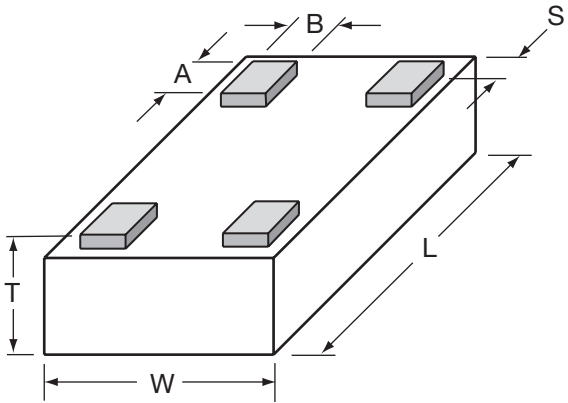
- Mobile Communications
- Satellite TV Receivers
- GPS
- Vehicle Location Systems
- Wireless LAN's

### FEATURES

- Inherent Low Profile
- Self Alignment during Reflow
- Excellent Solderability
- Low Parasitics
- Better Heat Dissipation
- Operating/Storage Temp -40°C to +85°C
- Power Rating 3W RF Cont

### DIMENSIONS: (Bottom View)

millimeters (inches)



|   |                            |
|---|----------------------------|
| L | 1.60±0.10<br>(0.063±0.004) |
| W | 0.84±0.10<br>(0.033±0.004) |
| T | 0.60±0.10<br>(0.024±0.004) |

|   |                            |
|---|----------------------------|
| A | 0.25±0.05<br>(0.010±0.002) |
| B | 0.20±0.05<br>(0.008±0.002) |
| S | 0.05±0.05<br>(0.002±0.002) |

### HOW TO ORDER

|                                           |                             |                  |                                   |                      |                                                                        |                                                   |
|-------------------------------------------|-----------------------------|------------------|-----------------------------------|----------------------|------------------------------------------------------------------------|---------------------------------------------------|
| <b>CP</b><br>Style<br>Directional Coupler | <b>0603</b><br>Size<br>0603 | <b>X</b><br>Type | <b>****</b><br>Frequency<br>(MHz) | <b>X</b><br>Sub Type | <b>L</b><br>Termination<br>Code<br>L = LGA Sn90, Pb10<br>N = LGA Sn100 | <b>TR</b><br>Packaging Code<br>TR = Tape and Reel |
|-------------------------------------------|-----------------------------|------------------|-----------------------------------|----------------------|------------------------------------------------------------------------|---------------------------------------------------|

### QUALITY INSPECTION

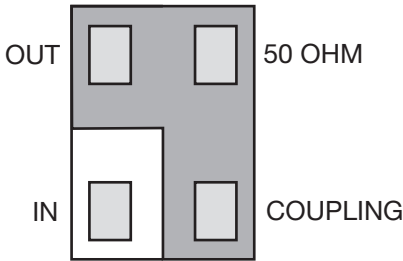
Finished parts are 100% tested for electrical parameters and visual characteristics. Each production lot is evaluated on a sample basis for:

- Static Humidity: 85°C, 85% RH, 160 hours
- Endurance: 125°C, I<sub>R</sub>, 4 hours

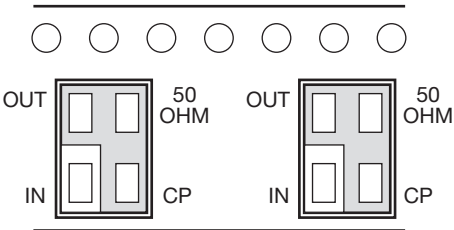
### TERMINATION

Sn90Pb10 or Lead-Free Sn100 Nickel/Solder coating compatible with automatic soldering technologies: reflow, wave soldering, vapor phase and manual.

### TERMINALS (Top View)

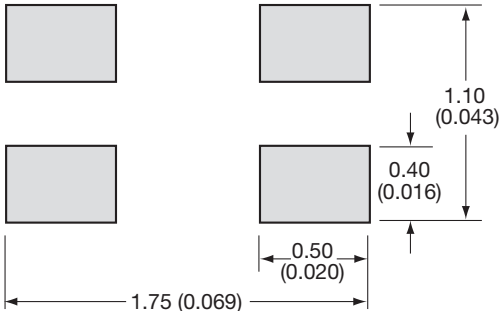


### ORIENTATION IN TAPE



### Recommended Pad Layout Dimensions

mm (inches)



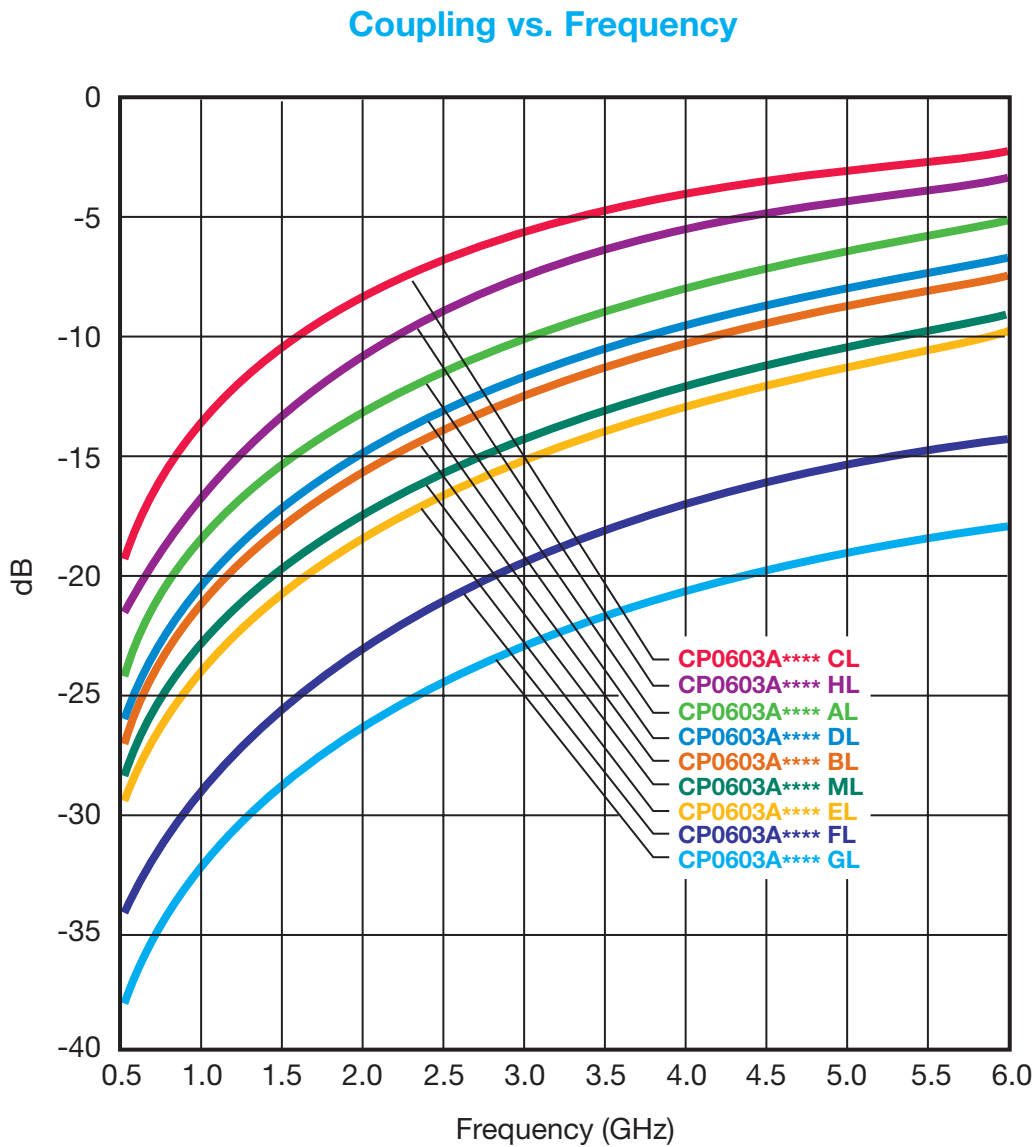
\*The recommended distance to the PCB Ground Plane is 0.254mm (0.010")

# Thin-Film Directional Couplers



## CP0603 High Directivity LGA Termination

### COUPLER TYPE SELECTION GRAPH



Intermediate coupling factors are readily available.  
Please contact factory.

# Thin-Film Directional Couplers

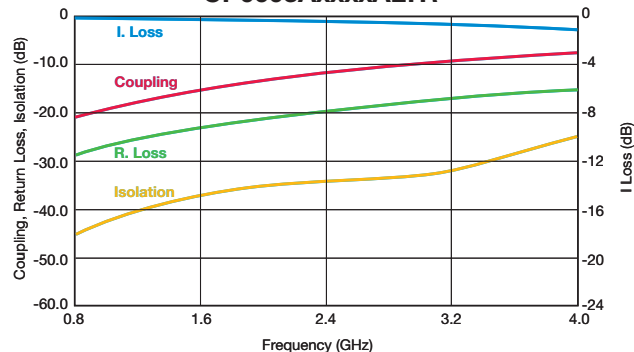


## CP0603 High Directivity LGA Type

Coupler P/N CP0603AxxxxAL

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max. [dB] | Return Loss [dB] | Directivity [dB] |
|--------------|---------------|----------------------|---------------|-------------------|------------------|------------------|
| AMPS         | CP0603A0836AL | 824 - 849            | 20.0          | 0.25              | 28               | 22               |
|              | CP0603A0881AL | 869 - 894            | 19.7          |                   |                  |                  |
| GSM          | CP0603A0902AL | 890 - 915            | 19.4          |                   | 27               |                  |
|              | CP0603A0947AL | 935 - 960            | 19.0          |                   |                  |                  |
| E-GSM        | CP0603A0897AL | 880 - 915            | 19.4          | 0.40              | 28               |                  |
|              | CP0603A0942AL | 925 - 960            | 19.0          |                   | 27               |                  |
| PDC          | CP0603A1441AL | 1429 - 1453          | 15.5          |                   | 24               |                  |
| PCN          | CP0603A1747AL | 1710 - 1785          | 14.0          |                   |                  |                  |
|              | CP0603A1842AL | 1805 - 1880          | 13.5          | 0.50              | 22               |                  |
| PCS          | CP0603A1880AL | 1850 - 1910          | 13.2          | 0.55              | 21               |                  |
|              | CP0603A1960AL | 1930 - 1990          | 13.0          |                   |                  |                  |
| PHP          | CP0603A1907AL | 1895 - 1920          | 13.2          |                   | 22               |                  |
| DECT         | CP0603A1890AL | 1880 - 1900          | 13.2          |                   |                  |                  |
| Wireless LAN | CP0603A2442AL | 2400 - 2484          | 11.5          | 0.75              | 20               |                  |

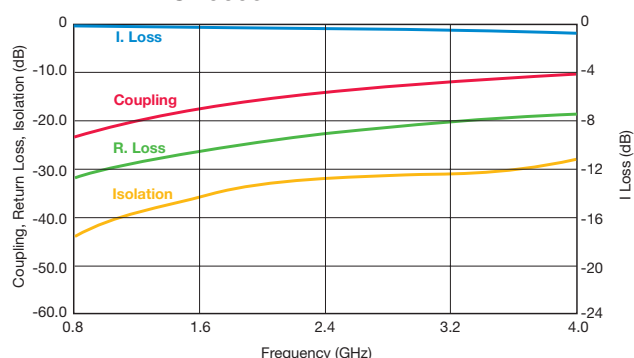
CP0603AxxxxALTR



Coupler P/N CP0603AxxxxBL

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max. [dB] | Return Loss [dB] | Directivity [dB] |
|--------------|---------------|----------------------|---------------|-------------------|------------------|------------------|
| AMPS         | CP0603A0836BL | 824 - 849            | 23.0          | 0.20              | 31               | 29               |
|              | CP0603A0881BL | 869 - 894            | 22.7          |                   |                  |                  |
| GSM          | CP0603A0902BL | 890 - 915            | 22.5          |                   | 30               |                  |
|              | CP0603A0947BL | 935 - 960            | 22.0          |                   |                  |                  |
| E-GSM        | CP0603A0897BL | 880 - 915            | 22.5          | 0.25              | 31               | 24               |
|              | CP0603A0942BL | 925 - 960            | 22.0          |                   | 30               |                  |
| PDC          | CP0603A1441BL | 1429 - 1453          | 18.5          |                   | 27               |                  |
| PCN          | CP0603A1747BL | 1710 - 1785          | 17.0          |                   |                  |                  |
|              | CP0603A1842BL | 1805 - 1880          | 16.4          | 0.35              | 25               |                  |
| PCS          | CP0603A1880BL | 1850 - 1910          | 16.2          |                   |                  |                  |
|              | CP0603A1960BL | 1930 - 1990          | 16.0          |                   | 24               |                  |
| PHP          | CP0603A1907BL | 1895 - 1920          | 16.1          |                   | 25               |                  |
| DECT         | CP0603A1890BL | 1880 - 1900          | 16.2          | 0.35              |                  |                  |
| Wireless LAN | CP0603A2442BL | 2400 - 2484          | 14.2          |                   | 23               |                  |

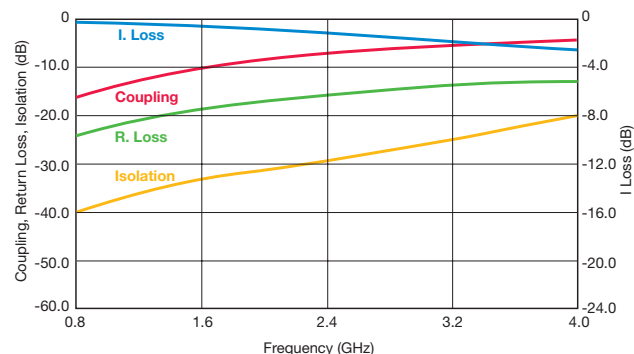
CP0603AxxxxBLTR



Coupler P/N CP0603AxxxxCL

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max. [dB] | Return Loss [dB] | Directivity [dB] |
|--------------|---------------|----------------------|---------------|-------------------|------------------|------------------|
| AMPS         | CP0603A0836CL | 824 - 849            | 15.2          | 0.35              | 23               | 23               |
|              | CP0603A0881CL | 869 - 894            | 15.0          |                   |                  |                  |
| GSM          | CP0603A0902CL | 890 - 915            | 14.7          |                   |                  |                  |
|              | CP0603A0947CL | 935 - 960            | 14.3          | 0.40              | 22               |                  |
| E-GSM        | CP0603A0897CL | 880 - 915            | 14.7          | 0.35              | 23               | 21               |
|              | CP0603A0942CL | 925 - 960            | 14.3          | 0.40              | 22               |                  |
| PDC          | CP0603A1441CL | 1429 - 1453          | 11.0          | 0.70              | 19               |                  |
| PCN          | CP0603A1747CL | 1710 - 1785          | 9.5           | 0.80              | 18               |                  |
|              | CP0603A1842CL | 1805 - 1880          | 9.0           | 0.90              |                  |                  |
| PCS          | CP0603A1880CL | 1850 - 1910          | 8.8           |                   |                  |                  |
|              | CP0603A1960CL | 1930 - 1990          | 8.5           |                   | 17               |                  |
| PHP          | CP0603A1907CL | 1895 - 1920          | 8.8           |                   |                  |                  |
| DECT         | CP0603A1890CL | 1880 - 1900          | 8.8           | 0.90              |                  |                  |
| Wireless LAN | CP0603A2442CL | 2400 - 2484          | 7.0           | 1.40              | 15               |                  |

CP0603AxxxxCLTR



Important: Couplers can be used at any frequency within the indicated range.

# Thin-Film Directional Couplers

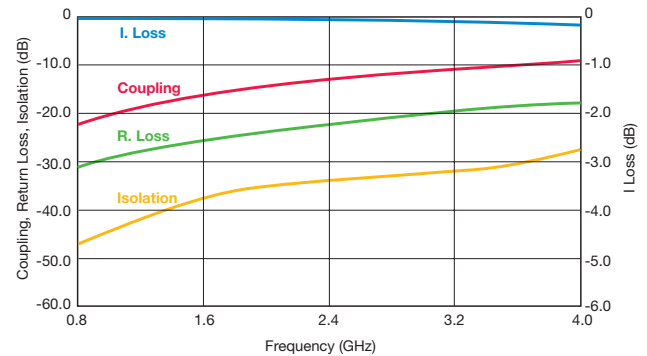


## CP0603 High Directivity LGA Type

Coupler P/N CP0603AxxxxDL

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max. [dB] | Return Loss [dB] | Directivity [dB] |
|--------------|---------------|----------------------|---------------|-------------------|------------------|------------------|
| AMPS         | CP0603A0836DL | 824 - 849            | 22.0          | 0.25              | 31               | 30               |
|              | CP0603A0881DL | 869 - 894            | 21.8          |                   |                  |                  |
| GSM          | CP0603A0902DL | 890 - 915            | 21.3          |                   |                  |                  |
|              | CP0603A0947DL | 935 - 960            | 21.0          | 0.30              | 30               |                  |
| E-GSM        | CP0603A0897DL | 880 - 915            | 21.3          | 0.25              |                  | 25               |
|              | CP0603A0942DL | 925 - 960            | 21.0          | 0.30              |                  |                  |
| PDC          | CP0603A1441DL | 1429 - 1453          | 17.7          | 0.40              | 27               |                  |
| PCN          | CP0603A1747DL | 1710 - 1785          | 16.0          |                   | 25               |                  |
|              | CP0603A1842DL | 1805 - 1880          | 15.4          |                   |                  |                  |
| PCS          | CP0603A1880DL | 1850 - 1910          | 15.2          |                   |                  |                  |
|              | CP0603A1960DL | 1930 - 1990          | 15.0          |                   | 24               |                  |
| PHP          | CP0603A1907DL | 1895 - 1920          | 15.2          |                   |                  |                  |
| DECT         | CP0603A1890DL | 1880 - 1900          |               |                   |                  |                  |
| Wireless LAN | CP0603A2442DL | 2400 - 2484          | 13.3          | 0.55              | 22               |                  |

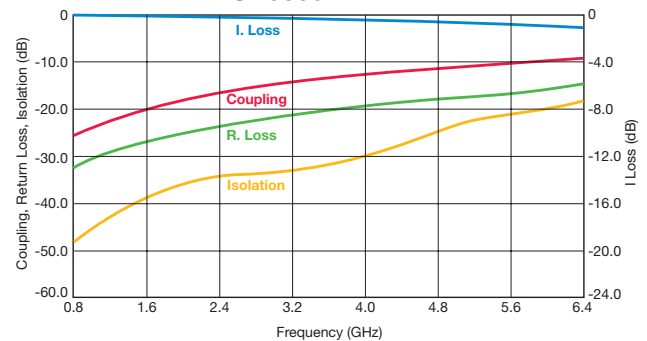
CP0603AxxxxDLTR



Coupler P/N CP0603AxxxxEL

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max. [dB] | Return Loss [dB] | Directivity [dB] |
|--------------|---------------|----------------------|---------------|-------------------|------------------|------------------|
| AMPS         | CP0603A0836EL | 824 - 849            | 25.8          | 0.20              | 32               | 21               |
|              | CP0603A0881EL | 869 - 894            | 25.3          |                   |                  |                  |
| GSM          | CP0603A0902EL | 890 - 915            | 25.0          |                   |                  |                  |
|              | CP0603A0947EL | 935 - 960            | 24.7          |                   | 31               |                  |
| E-GSM        | CP0603A0897EL | 880 - 915            | 26.0          |                   | 32               | 26               |
|              | CP0603A0942EL | 925 - 960            | 24.7          |                   | 31               |                  |
| PDC          | CP0603A1441EL | 1429 - 1453          | 22.0          | 0.25              | 28               |                  |
| PCN          | CP0603A1747EL | 1710 - 1785          | 19.5          | 0.30              |                  |                  |
|              | CP0603A1842EL | 1805 - 1880          | 19.0          |                   |                  |                  |
| PCS          | CP0603A1880EL | 1850 - 1910          | 18.8          |                   |                  |                  |
|              | CP0603A1960EL | 1930 - 1990          | 18.5          |                   |                  |                  |
| PHP          | CP0603A1907EL | 1895 - 1920          | 18.7          |                   |                  |                  |
| DECT         | CP0603A1890EL | 1880 - 1900          | 18.8          |                   |                  |                  |
| Wireless LAN | CP0603A2442EL | 2400 - 2484          | 17.0          | 0.40              | 24               |                  |

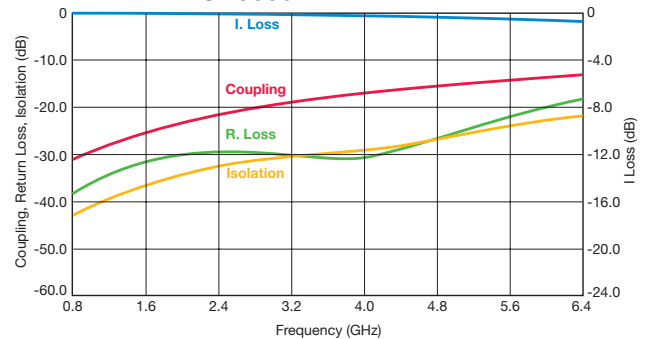
CP0603AxxxxELTR



Coupler P/N CP0603AxxxxFL

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max. [dB] | Return Loss [dB] | Directivity [dB] |
|--------------|---------------|----------------------|---------------|-------------------|------------------|------------------|
| AMPS         | CP0603A0836FL | 824 - 849            | 31.2          | 0.20              | 38               | 12               |
|              | CP0603A0881FL | 869 - 894            | 30.8          |                   |                  |                  |
| GSM          | CP0603A0902FL | 890 - 915            | 30.5          |                   |                  |                  |
|              | CP0603A0947FL | 935 - 960            | 30.2          |                   | 37               |                  |
| E-GSM        | CP0603A0897FL | 880 - 915            | 30.5          |                   |                  | 30               |
|              | CP0603A0942FL | 925 - 960            | 30.2          |                   |                  |                  |
| PDC          | CP0603A1441FL | 1429 - 1453          | 27.0          | 0.25              | 33               |                  |
| PCN          | CP0603A1747FL | 1710 - 1785          | 25.0          |                   | 31               |                  |
|              | CP0603A1842FL | 1805 - 1880          | 26.5          |                   |                  |                  |
| PCS          | CP0603A1880FL | 1850 - 1910          | 24.3          |                   |                  |                  |
|              | CP0603A1960FL | 1930 - 1990          | 24.0          |                   | 30               |                  |
| PHP          | CP0603A1907FL | 1895 - 1920          | 24.2          |                   |                  |                  |
| DECT         | CP0603A1890FL | 1880 - 1900          |               |                   |                  |                  |
| Wireless LAN | CP0603A2442FL | 2400 - 2484          | 21.5          |                   | 30               |                  |

CP0603AxxxxFLTR



Important: Couplers can be used at any frequency within the indicated range.



# Thin-Film Directional Couplers

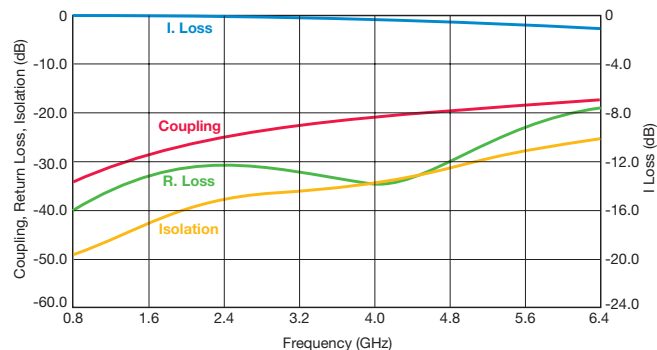


## CP0603 High Directivity LGA Type

Coupler P/N CP0603AxxxxGL

| Application  | P/N Examples                   | Frequency Band [MHz]       | Coupling [dB] | I. Loss max. [dB] | Return Loss [dB] | Directivity [dB] |
|--------------|--------------------------------|----------------------------|---------------|-------------------|------------------|------------------|
| AMPS         | CP0603A0836GL<br>CP0603A0881GL | 824 - 849<br>869 - 894     | 34.2<br>33.8  | 0.20              | 39               | 13               |
| GSM          | CP0603A0902GL<br>CP0603A0947GL | 890 - 915<br>935 - 960     | 33.6<br>33.2  |                   | 38<br>39         |                  |
| E-GSM        | CP0603A0897GL<br>CP0603A0942GL | 880 - 915<br>925 - 960     | 33.6<br>33.2  |                   | 39<br>38         |                  |
| PDC          | CP0603A1441GL                  | 1429 - 1453                | 30.0          | 0.25              | 34               |                  |
| PCN          | CP0603A1747GL<br>CP0603A1842GL | 1710 - 1785<br>1805 - 1880 | 28.5<br>28.0  |                   | 32               |                  |
| PCS          | CP0603A1880GL<br>CP0603A1960GL | 1850 - 1910<br>1930 - 1990 | 27.7<br>27.5  |                   | 31               |                  |
| PHP          | CP0603A1907GL                  | 1895 - 1920                | 27.6          |                   | 32               |                  |
| DECT         | CP0603A1890GL                  | 1880 - 1900                | 27.7          |                   | 31               |                  |
| Wireless LAN | CP0603A2442GL                  | 2400 - 2484                | 25.5          |                   | 31               |                  |

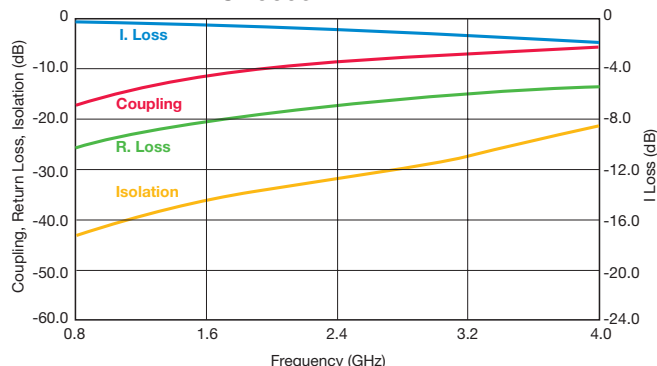
CP0603AxxxxGLTR



Coupler P/N CP0603AxxxxHL

| Application  | P/N Examples                   | Frequency Band [MHz]       | Coupling [dB] | I. Loss max. [dB] | Return Loss [dB] | Directivity [dB] |
|--------------|--------------------------------|----------------------------|---------------|-------------------|------------------|------------------|
| AMPS         | CP0603A0836HL<br>CP0603A0881HL | 824 - 849<br>869 - 894     | 17.3<br>17.0  | 0.30              | 26               | 26               |
| GSM          | CP0603A0902HL<br>CP0603A0947HL | 890 - 915<br>935 - 960     | 16.7<br>16.3  | 0.35              | 25               |                  |
| E-GSM        | CP0603A0897HL<br>CP0603A0942HL | 880 - 915<br>925 - 960     | 17.0<br>16.3  |                   | 25               |                  |
| PDC          | CP0603A1441HL                  | 1429 - 1453                | 13.0          | 0.55              | 22               | 24               |
| PCN          | CP0603A1747HL<br>CP0603A1842HL | 1710 - 1785<br>1805 - 1880 | 11.4<br>11.0  | 0.75              | 20               |                  |
| PCS          | CP0603A1880HL<br>CP0603A1960HL | 1850 - 1910<br>1930 - 1990 | 10.8<br>10.5  |                   | 19               |                  |
| PHP          | CP0603A1907HL                  | 1895 - 1920                | 10.7          |                   | 19               |                  |
| DECT         | CP0603A1890HL                  | 1880 - 1900                | 10.8          |                   | 19               |                  |
| Wireless LAN | CP0603A2442HL                  | 2400 - 2484                | 8.8           | 1.00              | 17               |                  |

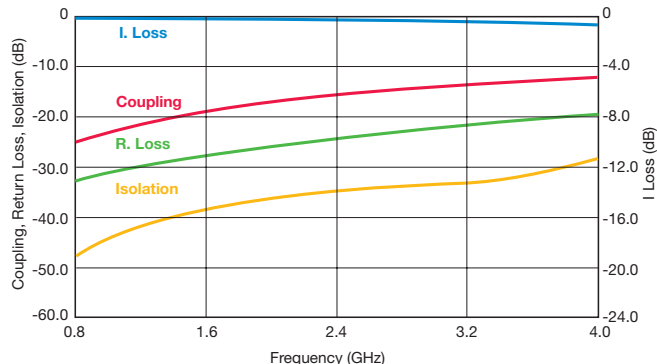
CP0603AxxxxHLTR



Coupler P/N CP0603AxxxxML

| Application  | P/N Examples                   | Frequency Band [MHz]       | Coupling [dB] | I. Loss max. [dB] | Return Loss [dB] | Directivity [dB] |
|--------------|--------------------------------|----------------------------|---------------|-------------------|------------------|------------------|
| AMPS         | CP0603A0836ML<br>CP0603A0881ML | 824 - 849<br>869 - 894     | 24.2<br>23.8  | 0.20              | 33               | 23               |
| GSM          | CP0603A0902ML<br>CP0603A0947ML | 890 - 915<br>935 - 960     | 23.4<br>23.2  |                   | 32               |                  |
| E-GSM        | CP0603A0897ML<br>CP0603A0942ML | 880 - 915<br>925 - 960     | 23.4<br>23.2  |                   | 32               |                  |
| PDC          | CP0603A1441ML                  | 1429 - 1453                | 20.0          | 0.25              | 28               | 20               |
| PCN          | CP0603A1747ML<br>CP0603A1842ML | 1710 - 1785<br>1805 - 1880 | 18.4<br>18.0  |                   | 27               |                  |
| PCS          | CP0603A1880ML<br>CP0603A1960ML | 1850 - 1910<br>1930 - 1990 | 17.8<br>17.5  |                   | 26               |                  |
| PHP          | CP0603A1907ML                  | 1895 - 1920                | 17.7          |                   | 26               |                  |
| DECT         | CP0603A1890ML                  | 1880 - 1900                | 17.8          |                   | 26               |                  |
| Wireless LAN | CP0603A2442ML                  | 2400 - 2484                | 15.6          | 0.35              | 24               |                  |

CP0603AxxxxMLTR



Important: Couplers can be used at any frequency within the indicated range.

# Thin-Film Directional Couplers



## CP0402 / CP0603 High Directivity Couplers Test Jigs

### GENERAL DESCRIPTION

These jigs are designed for testing the CP0402 and CP0603 High Directivity Couplers using a Vector Network Analyzer.

They consist of a dielectric substrate, having 50Ω microstrips as conducting lines and a bottom ground plane located at a distance of 0.254mm (0.010") from the microstrips.

The substrate used is Neltec's NH9338ST0254C1BC.

The connectors are SMA type (female), 'Johnson Components Inc.' Product P/N: 142-0701-841.

Both a measurement jig and a calibration jig are provided.

The calibration jig is designed for a full 2-port calibration, and consists of an open line, short line and through line. LOAD calibration can be done by a 50Ω SMA termination.

### MEASUREMENT PROCEDURE

When measuring a component, it can be either soldered or pressed using a non-metallic stick until all four ports touch the appropriate pads. Set the VNA to the relevant frequency band. Connect the VNA using a 10dB attenuator on the jig

terminal connected to port 2. Follow the VNA's instruction manual and use the [calibration jig](#) to perform a full 2-Port calibration in the required bandwidths.

3

#### Place the coupler on the [measurement jig](#) as follows:

Input (Coupler) → Connector 1 (Jig)      Termination (Coupler) → Connector 3 (Jig)  
Output (Coupler) → Connector 2 (Jig)      Coupling (Coupler) → Connector 4 (Jig)

#### To measure I. Loss connect:

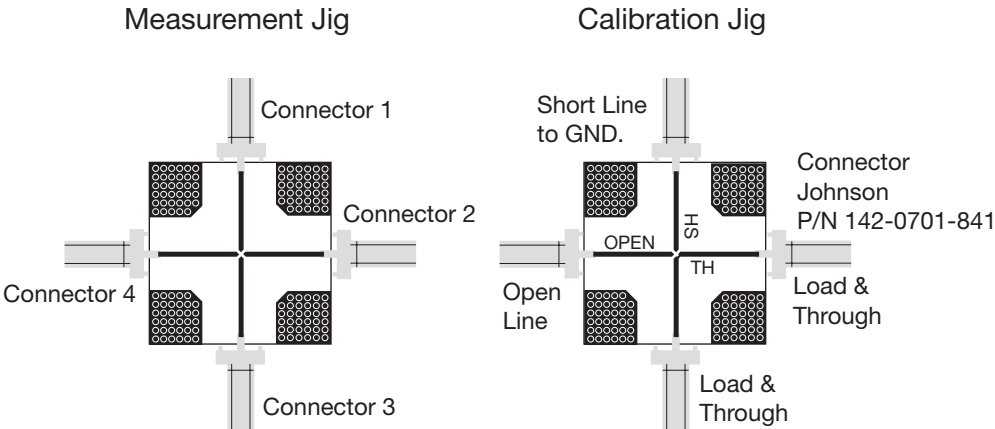
Connector 1 (Jig) → Port 1 (VNA)      Connector 3 (Jig) → 50Ω  
Connector 2 (Jig) → Port 2 (VNA)      Connector 4 (Jig) → 50Ω

#### To measure R. Loss and Coupling connect:

Connector 1 (Jig) → Port 1 (VNA)      Connector 3 (Jig) → 50Ω  
Connector 2 (Jig) → 50Ω      Connector 4 (Jig) → Port 2 (VNA)

#### To measure Isolation connect:

Connector 1 (Jig) → 50Ω      Connector 3 (Jig) → 50Ω  
Connector 2 (Jig) → Port 1 (VNA)      Connector 4 (Jig) → Port 2 (VNA)



# Thin-Film Directional Couplers



## CP0603 SMD Type

### GENERAL DESCRIPTION ITF (Integrated Thin-Film) TECHNOLOGY

The ITF SMD Coupler is based on thin-film multilayer technology. The technology provides a miniature part with excellent high frequency performance and rugged construction for reliable automatic assembly. The ITF Coupler is offered in a variety of frequency bands compatible with various types of high frequency wireless systems.

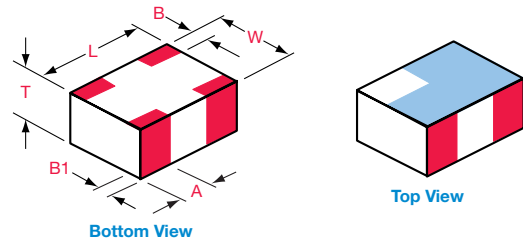
### APPLICATIONS

- Mobile Communications
- Satellite TV Receivers
- GPS
- Vehicle Location Systems
- Wireless LAN's
- Miniature Size: 0603
- Frequency Range: 800MHz - 3GHz
- Characteristic Impedance: 50Ω
- Operating / Storage Temp.: -40°C to +85°C
- Power Rating: 3W Continuous
- Low Profile
- Rugged Construction
- Taped and Reeled

### FEATURES

### DIMENSIONS:

millimeters (inches)



|    | 0603                                |
|----|-------------------------------------|
| L  | 1.6±0.1<br>(0.063±0.004)            |
| W  | 0.84±0.1<br>(0.033±0.004)           |
| T  | 0.60±0.1<br>(0.028±0.004)           |
| A  | 0.35±0.15<br>(0.014±0.006)          |
| B  | 0.175±0.1<br>(0.007±0.004)          |
| B1 | 0.00±0.1/0-0.0<br>(0.00±0.004/-0.0) |

### HOW TO ORDER

|                                           |                             |                  |                                 |                      |                                                                |                                                   |
|-------------------------------------------|-----------------------------|------------------|---------------------------------|----------------------|----------------------------------------------------------------|---------------------------------------------------|
| <b>CP</b><br>Style<br>Directional Coupler | <b>0603</b><br>Size<br>0603 | <b>X</b><br>Type | <b>****</b><br>Frequency<br>MHz | <b>X</b><br>Sub Type | <b>W</b><br>Termination<br>Code<br>W = Sn90, Pb10<br>S = Sn100 | <b>TR</b><br>Packaging Code<br>TR = Tape and Reel |
|-------------------------------------------|-----------------------------|------------------|---------------------------------|----------------------|----------------------------------------------------------------|---------------------------------------------------|

### QUALITY INSPECTION

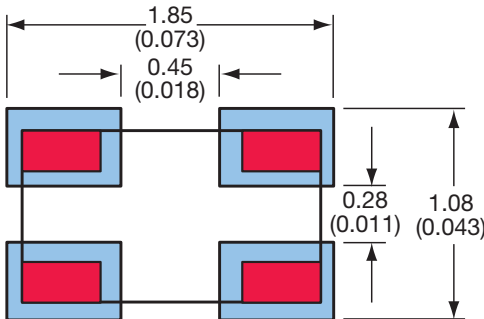
Finished parts are 100% tested for electrical parameters and visual characteristics. Each production lot is evaluated on a sample basis for:

- Static Humidity: 85°C, 85% RH, 160 hours
- Endurance: 125°C, I<sub>B</sub>, 4 hours

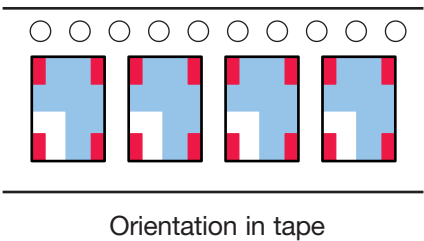
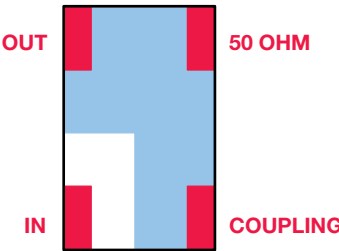
### TERMINATION

Nickel/Solder coating compatible with automatic soldering technologies: reflow, wave soldering, vapor phase and manual.

### Recommended Pad Layout Dimensions mm (inches)



### TERMINALS (Top View)



# Thin-Film Directional Couplers

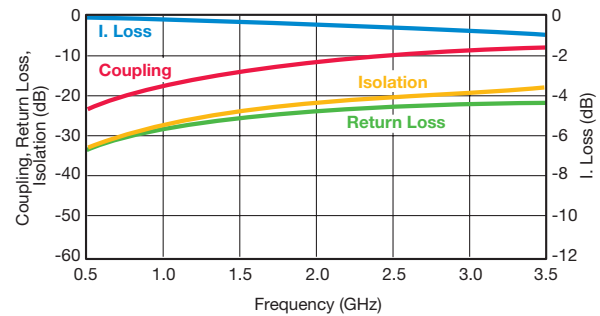


## CP0603 SMD Type

Coupler P/N CP0603A\*\*\*\*AW

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max | VSWR max |
|--------------|---------------|----------------------|---------------|-------------|----------|
| AMPS         | CP0603A0836AW | 824 - 849            | 18.5±1        | 0.25        | 1.2      |
|              | CP0603A0881AW | 869 - 894            | 18.5±1        |             |          |
| GSM          | CP0603A0902AW | 890 - 915            | 18±1          |             |          |
|              | CP0603A0947AW | 935 - 960            | 17.5±1        |             |          |
| E-GSM        | CP0603A0897AW | 880 - 915            | 18±1          |             |          |
|              | CP0603A0942AW | 925 - 960            | 17.5±1        |             |          |
| PDC          | CP0603A1441AW | 1429 - 1453          | 14±1          | 0.4         |          |
| PCN          | CP0603A1747AW | 1710 - 1785          | 12.5±1        | 0.6         |          |
|              | CP0603A1842AW | 1805 - 1880          | 12±1          |             |          |
| PCS          | CP0603A1880AW | 1850 - 1910          | 12±1          |             |          |
|              | CP0603A1960AW | 1930 - 1990          | 11.5±1        |             |          |
| PHP          | CP0603A1907AW | 1895 - 1920          | 12±1          | 0.6         |          |
| DECT         | CP0603A1890AW | 1880 - 1900          | 12±1          | 0.85        |          |
| Wireless LAN | CP0603A2442AW | 2400 - 2484          | 10±1          |             |          |

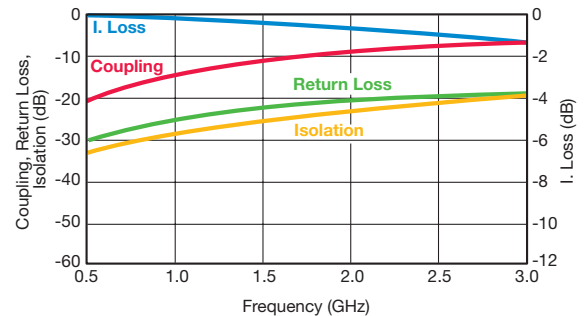
P/N CP0603A\*\*\*\*AW



Coupler P/N CP0603A\*\*\*\*BW

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max | VSWR max |     |  |
|--------------|---------------|----------------------|---------------|-------------|----------|-----|--|
| AMPS         | CP0603A0836BW | 824 - 849            | 16±1          | 0.25        | 1.2      |     |  |
|              | CP0603A0881BW | 869 - 894            | 15.5±1        |             |          |     |  |
| GSM          | CP0603A0902BW | 890 - 915            | 15.5±1        |             |          |     |  |
|              | CP0603A0947BW | 935 - 960            | 15±1          |             |          |     |  |
| E-GSM        | CP0603A0897BW | 880 - 915            | 15.5±1        |             |          |     |  |
|              | CP0603A0942BW | 925 - 960            | 15±1          |             |          |     |  |
| PDC          | CP0603A1441BW | 1429 - 1453          | 11.5±1        | 0.55        |          |     |  |
| PCN          | CP0603A1747BW | 1710 - 1785          | 10±1          | 0.8         | 1.3      |     |  |
|              | CP0603A1842BW | 1805 - 1880          | 9.5±1         |             |          |     |  |
| PCS          | CP0603A1880BW | 1850 - 1910          | 9±1           |             |          | 1.4 |  |
|              | CP0603A1960BW | 1930 - 1990          | 9±1           |             |          |     |  |
| PHP          | CP0603A1907BW | 1895 - 1920          | 9±1           |             |          |     |  |
| DECT         | CP0603A1890BW | 1880 - 1900          | 9±1           |             |          |     |  |
| Wireless LAN | CP0603A2442BW | 2400 - 2484          | 7.5±1         | 1.1         |          |     |  |

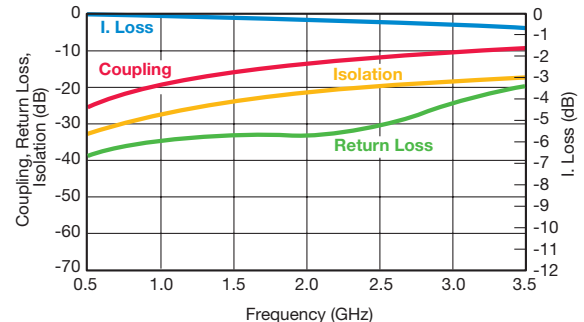
CP0603A\*\*\*\*BW



Coupler P/N CP0603A\*\*\*\*CW

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max | VSWR max |
|--------------|---------------|----------------------|---------------|-------------|----------|
| AMPS         | CP0603A0836CW | 824 - 849            | 21±1          | 0.25        | 1.2      |
|              | CP0603A0881CW | 869 - 894            | 20.5±1        |             |          |
| GSM          | CP0603A0902CW | 890 - 915            | 20.5±1        |             |          |
|              | CP0603A0947CW | 935 - 960            | 20±1          |             |          |
| E-GSM        | CP0603A0897CW | 880 - 915            | 20.5±1        | 0.40        |          |
|              | CP0603A0942CW | 925 - 960            | 20±1          |             |          |
| PDC          | CP0603A1441CW | 1429 - 1453          | 16.5±1        |             |          |
| PCN          | CP0603A1747CW | 1710 - 1785          | 15±1          |             |          |
|              | CP0603A1842CW | 1805 - 1880          | 14.5±1        |             |          |
| PCS          | CP0603A1880CW | 1850 - 1910          | 14.5±1        | 0.5         |          |
|              | CP0603A1960CW | 1930 - 1990          | 14±1          |             |          |
| PHP          | CP0603A1907CW | 1895 - 1920          | 14.5±1        |             | 0.65     |
| DECT         | CP0603A1890CW | 1880 - 1900          | 14.5±1        |             |          |
| Wireless LAN | CP0603A2442CW | 2400 - 2484          | 12.5±1        |             |          |

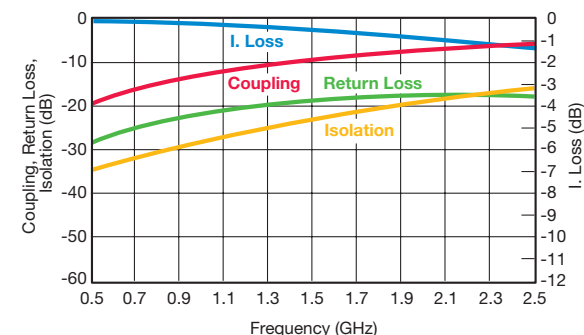
CP0603A\*\*\*\*CW



Coupler P/N CP0603A\*\*\*\*DW

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max | VSWR max |
|--------------|---------------|----------------------|---------------|-------------|----------|
| AMPS         | CP0603A0836DW | 824 - 849            | 15.0±1        | 0.40        | 1.2      |
|              | CP0603A0881DW | 869 - 894            | 14.5±1        |             |          |
| GSM          | CP0603A0902DW | 890 - 915            | 14.5±1        |             |          |
|              | CP0603A0947DW | 935 - 960            | 14±1          |             |          |
| E-GSM        | CP0603A0897DW | 880 - 915            | 14.5±1        |             |          |
|              | CP0603A0942DW | 925 - 960            | 14±1          |             |          |
| PDC          | CP0603A1441DW | 1429 - 1453          | 10.5±1        | 0.7         | 1.3      |
| PCN          | CP0603A1747DW | 1710 - 1785          | 9±1           | 0.9         |          |
|              | CP0603A1842DW | 1805 - 1880          | 8.5±1         |             |          |
| PCS          | CP0603A1880DW | 1850 - 1910          | 8.5±1         |             |          |
|              | CP0603A1960DW | 1930 - 1990          | 8±1           |             |          |
| PHP          | CP0603A1907DW | 1895 - 1920          | 8.5±1         |             |          |
| DECT         | CP0603A1890DW | 1880 - 1900          | 8.5±1         |             |          |
| Wireless LAN | CP0603A2442DW | 2400 - 2484          | 6.5±1         | 1.5         |          |

CP0603A\*\*\*\*DW



Important: Couplers can be used at any frequency within the indicated range.



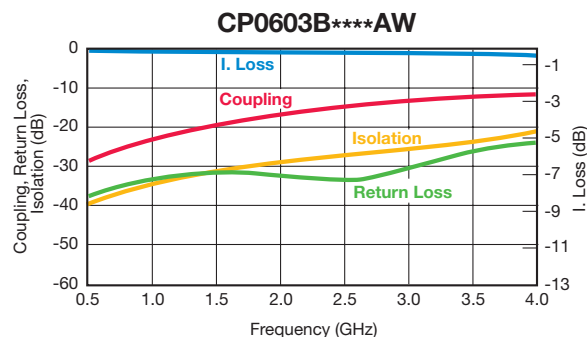
# Thin-Film Directional Couplers



## CP0603 SMD Type

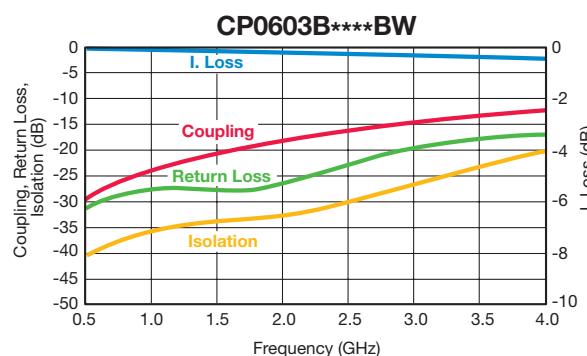
Coupler P/N CP0603B\*\*\*\*AW

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max | VSWR max |
|--------------|---------------|----------------------|---------------|-------------|----------|
| AMPS         | CP0603B0836AW | 824 - 849            | 24.5±1        | 0.2         | 1.2      |
|              | CP0603B0881AW | 869 - 894            | 24±1          |             |          |
| GSM          | CP0603B0902AW | 890 - 915            | 24±1          |             |          |
|              | CP0603B0947AW | 935 - 960            | 23.5±1        |             |          |
| E-GSM        | CP0603B0897AW | 880 - 915            | 24±1          | 0.25        |          |
|              | CP0603B0942AW | 925 - 960            | 23.5±1        |             |          |
| PDC          | CP0603B1441AW | 1429 - 1453          | 20±1          | 0.3         |          |
| PCN          | CP0603B1747AW | 1710 - 1785          | 18±1          |             |          |
|              | CP0603B1842AW | 1805 - 1880          | 17.5±1        |             |          |
| PCS          | CP0603B1880AW | 1850 - 1910          | 17.5±1        |             |          |
|              | CP0603B1960AW | 1930 - 1990          | 17.5±1        |             |          |
| PHP          | CP0603B1907AW | 1895 - 1920          | 17.5±1        |             |          |
| DECT         | CP0603B1890AW | 1880 - 1900          | 17.5±1        |             |          |
| Wireless LAN | CP0603B2442AW | 2400 - 2484          | 15.5±1        |             |          |



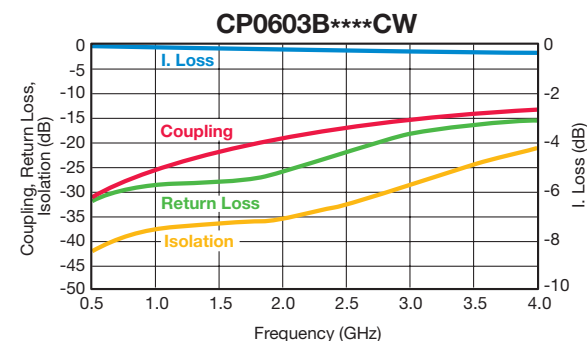
Coupler P/N CP0603B\*\*\*\*BW

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max | VSWR max |
|--------------|---------------|----------------------|---------------|-------------|----------|
| AMPS         | CP0603B0836BW | 824 - 849            | 25.5±1        | 0.2         | 1.2      |
|              | CP0603B0881BW | 869 - 894            | 25±1          |             |          |
| GSM          | CP0603B0902BW | 890 - 915            | 25±1          |             |          |
|              | CP0603B0947BW | 935 - 960            | 24.5±1        |             |          |
| E-GSM        | CP0603B0897BW | 880 - 915            | 25±1          | 0.25        |          |
|              | CP0603B0942BW | 925 - 960            | 24.5±1        |             |          |
| PDC          | CP0603B1441BW | 1429 - 1453          | 21±1          |             |          |
| PCN          | CP0603B1747BW | 1710 - 1785          | 19±1          |             |          |
|              | CP0603B1842BW | 1805 - 1880          | 19±1          |             |          |
| PCS          | CP0603B1880BW | 1850 - 1910          | 18.5±1        |             |          |
|              | CP0603B1960BW | 1930 - 1990          | 18.5±1        |             |          |
| PHP          | CP0603B1907BW | 1895 - 1920          | 18.5±1        |             |          |
| DECT         | CP0603B1890BW | 1880 - 1900          | 18.5±1        |             |          |
| Wireless LAN | CP0603B2442BW | 2400 - 2484          | 16.5±1        | 0.35        |          |



Coupler P/N CP0603B\*\*\*\*CW

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max | VSWR max |      |
|--------------|---------------|----------------------|---------------|-------------|----------|------|
| AMPS         | CP0603B0836CW | 824 - 849            | 26.5±1        | 0.2         | 1.2      |      |
|              | CP0603B0881CW | 869 - 894            | 26±1          |             |          |      |
| GSM          | CP0603B0902CW | 890 - 915            | 26±1          |             |          |      |
|              | CP0603B0947CW | 935 - 960            | 25.5±1        |             |          |      |
| E-GSM        | CP0603B0897CW | 880 - 915            | 26±1          | 0.25        |          |      |
|              | CP0603B0942CW | 925 - 960            | 25.5±1        |             |          |      |
| PDC          | CP0603B1441CW | 1429 - 1453          | 22±1          |             |          |      |
| PCN          | CP0603B1747CW | 1710 - 1785          | 20.5±1        |             |          | 0.25 |
|              | CP0603B1842CW | 1805 - 1880          | 20±1          |             |          |      |
| PCS          | CP0603B1880CW | 1850 - 1910          | 20±1          | 0.35        |          |      |
|              | CP0603B1960CW | 1930 - 1990          | 19.5±1        |             |          |      |
| PHP          | CP0603B1907CW | 1895 - 1920          | 20±1          |             |          | 1.3  |
| DECT         | CP0603B1890CW | 1880 - 1900          | 20±1          |             |          |      |
| Wireless LAN | CP0603B2442CW | 2400 - 2484          | 18±1          | 0.35        |          |      |



Important: Couplers can be used at any frequency within the indicated range.

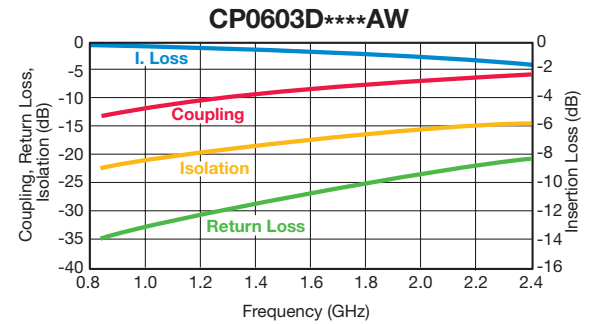
# Thin-Film Directional Couplers



## CP0603 SMD Type – High Directivity

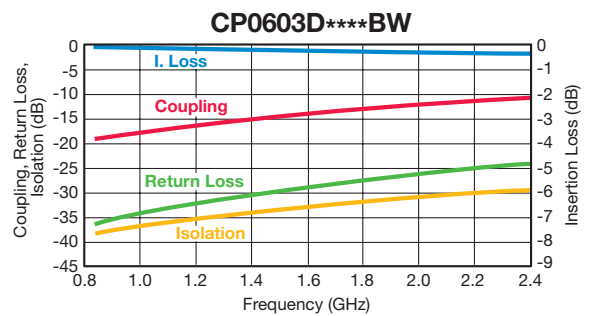
Coupler P/N CP0603D\*\*\*\*AW

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max. [dB] | Return Loss [dB] | Directivity [dB] |      |
|--------------|---------------|----------------------|---------------|-------------------|------------------|------------------|------|
| AMPS         | CP0603D0836AW | 824 - 849            | 13.50         | 0.50              | 23               | 21               |      |
|              | CP0603D0881AW | 869 - 894            | 13.00         |                   | 22               |                  |      |
| GSM          | CP0603D0902AW | 890 - 915            | 12.50         |                   |                  |                  | 18   |
|              | CP0603D0947AW | 935 - 960            | 12.50         |                   | 17               |                  |      |
| E-GSM        | CP0603D0897AW | 880 - 915            | 13.00         | 1.40              |                  | 16               | 17   |
|              | CP0603D0942AW | 925 - 960            | 12.50         |                   | 1.40             |                  |      |
| PDC          | CP0603D1441AW | 1429 - 1453          | 9.00          | 1.00              |                  | 18               | 19   |
| PCN          | CP0603D1747AW | 1710 - 1785          | 8.00          | 1.40              | 17               | 18               |      |
|              | CP0603D1842AW | 1805 - 1880          | 7.50          |                   |                  |                  | 16   |
| PCS          | CP0603D1880AW | 1850 - 1910          | 7.00          |                   | 1.40             | 16               |      |
|              | CP0603D1960AW | 1930 - 1990          | 7.00          |                   |                  |                  | 1.40 |
| PHP          | CP0603D1907AW | 1895 - 1920          | 7.00          | 1.40              | 16               | 17               |      |
| DECT         | CP0603D1890AW | 1880 - 1900          | 7.00          |                   |                  |                  | 1.40 |
| Wireless LAN | CP0603D2442AW | 2400 - 2484          | 5.50          | 2.00              | 15               | 15               |      |



Coupler P/N CP0603D\*\*\*\*BW

| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max. [dB] | Return Loss [dB] | Directivity [dB] |
|--------------|---------------|----------------------|---------------|-------------------|------------------|------------------|
| AMPS         | CP0603D0836BW | 824 - 849            | 20.00         | 0.25              | 36               | 19               |
|              | CP0603D0881BW | 869 - 894            | 19.50         |                   |                  |                  |
| GSM          | CP0603D0902BW | 890 - 915            |               |                   | 35               |                  |
|              | CP0603D0947BW | 935 - 960            | 19.00         |                   |                  |                  |
| E-GSM        | CP0603D0897BW | 880 - 915            | 19.50         |                   | 36               |                  |
|              | CP0603D0942BW | 925 - 960            | 19.00         |                   | 35               |                  |
| PDC          | CP0603D1441BW | 1429 - 1453          | 15.50         | 0.40              | 30               |                  |
| PCN          | CP0603D1747BW | 1710 - 1785          | 14.00         | 0.50              | 28               |                  |
|              | CP0603D1842BW | 1805 - 1880          |               |                   |                  |                  |
| PCS          | CP0603D1880BW | 1850 - 1910          | 13.50         | 0.55              | 27               |                  |
|              | CP0603D1960BW | 1930 - 1990          |               |                   |                  |                  |
| PHP          | CP0603D1907BW | 1895 - 1920          |               |                   |                  |                  |
| DECT         | CP0603D1890BW | 1880 - 1900          | 13.00         |                   |                  |                  |
| Wireless LAN | CP0603D2442BW | 2400 - 2484          | 11.00         | 0.70              | 24               |                  |



Important: Couplers can be used at any frequency within the indicated range.

# Thin-Film Directional Couplers



## CP0805 Type

### GENERAL DESCRIPTION ITF (Integrated Thin-Film) TECHNOLOGY

The ITF SMD Coupler is based on thin-film multilayer technology. The technology provides a miniature part with excellent high frequency performance and rugged construction for reliable automatic assembly. The ITF Coupler is offered in a variety of frequency bands compatible with various types of high frequency wireless systems.

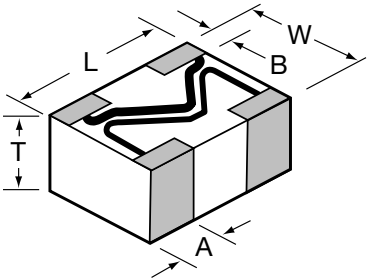
### FEATURES

- Small Size: 0805
- Frequency Range: 800MHz - 3GHz
- Characteristic Impedance: 50Ω
- Operating / Storage Temp.: -40°C to +85°C
- Power Rating: 3W Continuous
- Low Profile
- Rugged Construction
- Taped and Reeled

### APPLICATIONS

- Mobile Communications
- Satellite TV Receivers
- GPS
- Vehicle Location Systems
- Wireless LAN's

### DIMENSIONS: (Top View)



|          | 0805                    |
|----------|-------------------------|
| <b>L</b> | 2.03±0.1 (0.080±0.004)  |
| <b>W</b> | 1.55±0.1 (0.061±0.004)  |
| <b>T</b> | 0.98±0.1 (0.039±0.004)  |
| <b>A</b> | 0.56±0.25 (0.022±0.010) |
| <b>B</b> | 0.35±0.15 (0.014±0.006) |

### HOW TO ORDER

|                                                       |                                         |                                                           |                                             |                                                            |                                                                       |                                                               |
|-------------------------------------------------------|-----------------------------------------|-----------------------------------------------------------|---------------------------------------------|------------------------------------------------------------|-----------------------------------------------------------------------|---------------------------------------------------------------|
| <b>CP</b><br>T<br><b>Style</b><br>Directional Coupler | <b>0805</b><br>T<br><b>Size</b><br>0805 | <b>A</b><br>T<br><b>Layout Type</b><br>(see layout types) | <b>0902</b><br>T<br><b>Frequency</b><br>MHz | <b>A</b><br>T<br><b>Sub Type</b><br>(see layout sub-types) | <b>W</b><br>T<br><b>Termination Code</b><br>W = Nickel/Solder (Sn/Pb) | <b>TR</b><br>T<br><b>Packaging Code</b><br>TR = Tape and Reel |
|-------------------------------------------------------|-----------------------------------------|-----------------------------------------------------------|---------------------------------------------|------------------------------------------------------------|-----------------------------------------------------------------------|---------------------------------------------------------------|

### QUALITY INSPECTION

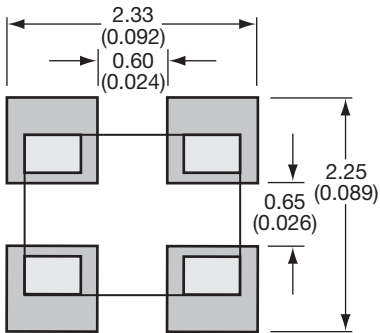
Finished parts are 100% tested for electrical parameters and visual characteristics. Each production lot is evaluated on a sample basis for:

- Static Humidity: 85°C, 85% RH, 160 hours
- Endurance: 125°C, I<sub>R</sub>, 4 hours

### TERMINATION

Nickel/Solder coating (Sn, Pb) compatible with automatic soldering technologies: reflow, wave soldering, vapor phase and manual.

### Recommended Pad Layout Dimensions mm (inches)



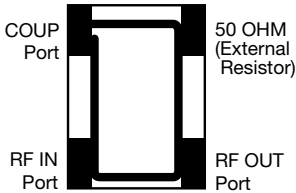
**NOTE:** Components must be mounted on the board with the white (Alumina) side DOWN.

# Thin-Film Directional Couplers

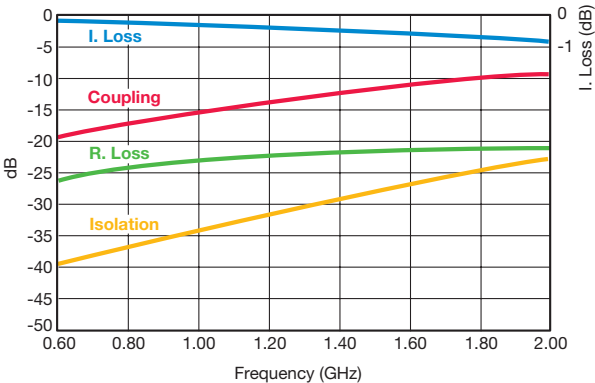


## CP0805 Layout Types

### LAYOUT

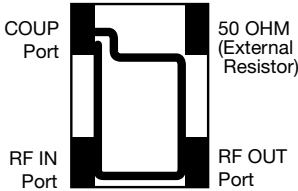


Type: A  
Sub-Type: A

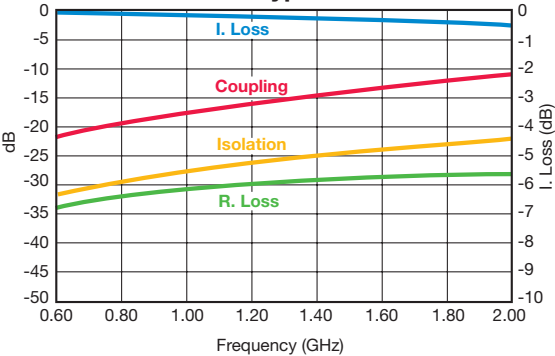


| Application | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max | VSWR max |  |
|-------------|---------------|----------------------|---------------|-------------|----------|--|
| AMPS        | CP0805A0836AW | 824 - 849            | 16.5±1        | 0.25        | 1.2      |  |
|             | CP0805A0881AW | 869 - 894            | 16±1          |             |          |  |
| GSM         | CP0805A0902AW | 890 - 915            | 16±1          | 0.25        |          |  |
|             | CP0805A0947AW | 935 - 960            | 15.5±1        |             |          |  |
| E-GSM       | CP0805A0897AW | 880 - 915            | 16±1          | 0.25        |          |  |
|             | CP0805A0942AW | 925 - 960            | 15.5±1        |             |          |  |
| PDC         | CP0805A1441AW | 1429 - 1453          | 12±1          | 0.5         | 1.3      |  |
| PCN         | CP0805A1747AW | 1710 - 1785          | 10.5±1        | 0.7         | 1.4      |  |
|             | CP0805A1842AW | 1805 - 1880          | 10±1          | 0.8         |          |  |
| PCS         | CP0805A1880AW | 1850 - 1910          | 9.5±1         | 0.8         |          |  |
|             | CP0805A1960AW | 1930 - 1990          | 9.5±1         |             |          |  |
| PHP         | CP0805A1907AW | 1895 - 1920          | 9.5±1         | 0.8         |          |  |
| DECT        | CP0805A1890AW | 1880 - 1900          | 9.5±1         | 0.8         |          |  |

### LAYOUT

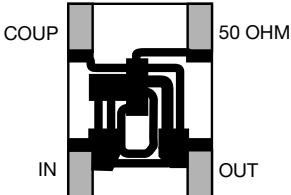


Type: A  
Sub-Type: B

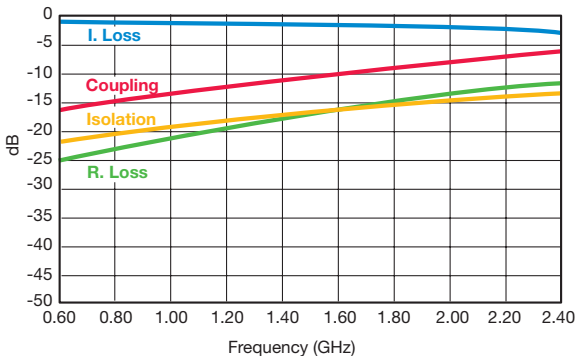


| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max | VSWR max |
|--------------|---------------|----------------------|---------------|-------------|----------|
| AMPS         | CP0805A0836BW | 824 - 849            | 19±1          | 0.25        | 1.2      |
|              | CP0805A0881BW | 869 - 894            | 18.5±1        |             |          |
| GSM          | CP0805A0902BW | 890 - 915            | 18±1          | 0.25        | 1.2      |
|              | CP0805A0947BW | 935 - 960            | 18±1          |             |          |
| E-GSM        | CP0805A0897BW | 880 - 915            | 18.5±1        | 0.25        | 1.2      |
|              | CP0805A0942BW | 925 - 960            | 18±1          |             |          |
| PDC          | CP0805A1441BW | 1429 - 1453          | 14.5±1        | 0.35        | 1.4      |
| PCN          | CP0805A1747BW | 1710 - 1785          | 12.5±1        | 0.5         |          |
|              | CP0805A1842BW | 1805 - 1880          | 12.5±1        | 0.5         |          |
| PCS          | CP0805A1880BW | 1850 - 1910          | 12±1          | 0.6         |          |
|              | CP0805A1960BW | 1930 - 1990          | 11.5±1        | 0.7         |          |
| PHP          | CP0805A1907BW | 1895 - 1920          | 12±1          | 0.6         |          |
| DECT         | CP0805A1890BW | 1880 - 1900          | 12±1          | 0.6         |          |
| Wireless LAN | CP0805A2442BW | 2400 - 2484          | 10±1          | 0.9         |          |

### LAYOUT



Type: A  
Sub-Type: C



| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max | VSWR max |  |
|--------------|---------------|----------------------|---------------|-------------|----------|--|
| AMPS         | CP0805A0836CW | 824 - 849            | 14±1          | 0.5         | 1.4      |  |
|              | CP0805A0881CW | 869 - 894            | 13.5±1        |             |          |  |
| GSM          | CP0805A0902CW | 890 - 915            | 13.5±1        | 0.5         |          |  |
|              | CP0805A0947CW | 935 - 960            | 13±1          |             |          |  |
| E-GSM        | CP0805A0897CW | 880 - 915            | 13.5±1        | 0.5         |          |  |
|              | CP0805A0942CW | 925 - 960            | 13±1          |             |          |  |
| PDC          | CP0805A1441CW | 1429 - 1453          | 9.5±1         | 1.15        | 1.8      |  |
| PCN          | CP0805A1747CW | 1710 - 1785          | 8±1           | 1.6         | 2.2      |  |
|              | CP0805A1842CW | 1805 - 1880          | 8±1           |             |          |  |
| PCS          | CP0805A1880CW | 1850 - 1910          | 7.5±1         | 1.75        |          |  |
|              | CP0805A1960CW | 1930 - 1990          | 7.5±1         |             |          |  |
| PHP          | CP0805A1907CW | 1895 - 1920          | 7.5±1         | 1.75        |          |  |
| DECT         | CP0805A1890CW | 1880 - 1900          | 7.5±1         | 1.75        |          |  |
| Wireless LAN | CP0805A2442CW | 2400 - 2484          | 6±1           | 2.5         |          |  |

Important: Couplers can be used at any frequency within the indicated range.

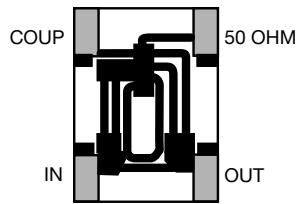


# Thin-Film Directional Couplers

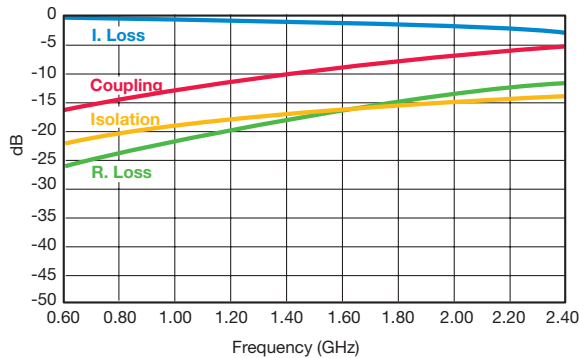


## CP0805 Layout Types

### LAYOUT

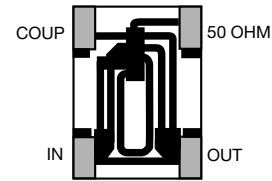


Type: A  
Sub-Type: D

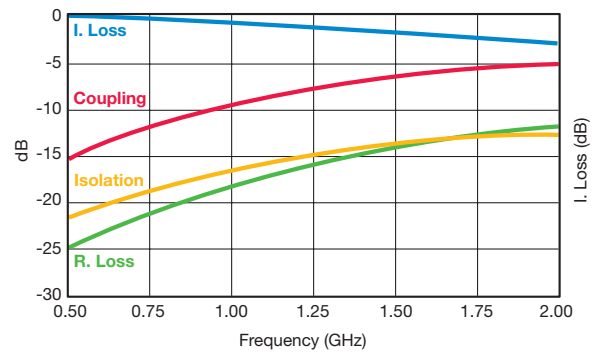


| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max | VSWR max |
|--------------|---------------|----------------------|---------------|-------------|----------|
| AMPS         | CP0805A0836DW | 824 - 849            | 13.0±1        | 0.5         | 1.4      |
|              | CP0805A0881DW | 869 - 894            | 12.5±1        |             |          |
|              | CP0805A0902DW | 890 - 915            | 12.5±1        |             |          |
| GSM          | CP0805A0947DW | 935 - 960            | 12±1          | 1.25        | 1.8      |
| E-GSM        | CP0805A0897DW | 880 - 915            | 12.5±1        |             |          |
|              | CP0805A0942DW | 925 - 960            | 12±1          |             |          |
| PDC          | CP0805A1441DW | 1429 - 1453          | 8.5±1         | 1.85        | 2.1      |
| PCN          | CP0805A1747DW | 1710 - 1785          | 7±1           |             |          |
|              | CP0805A1842DW | 1805 - 1880          | 7±1           |             |          |
| PCS          | CP0805A1880DW | 1850 - 1910          | 7±1           | 2.4         | 2.1      |
|              | Cp0805A1960DW | 1930 - 1990          | 6.5±1         |             |          |
|              | CP0805A1907DW | 1895 - 1920          | 6.5±1         |             |          |
| PHP          | CP0805A1890DW | 1880 - 1900          | 7±1           | 2.4         | 2.1      |
| DECT         | CP0805A1890DW | 1880 - 1900          | 7±1           |             |          |
| Wireless LAN | CP0805A2442DW | 2400 - 2484          | 5.5±1         | 2.4         | 2.1      |

### LAYOUT

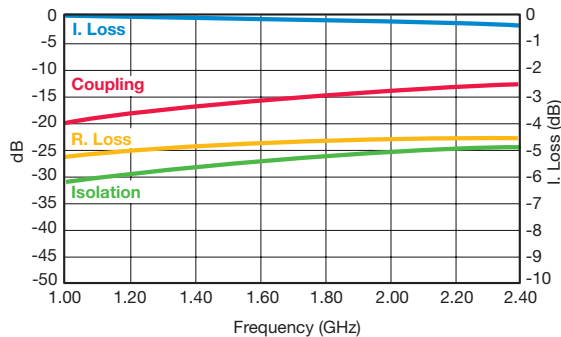


Type: A  
Sub-Type: E

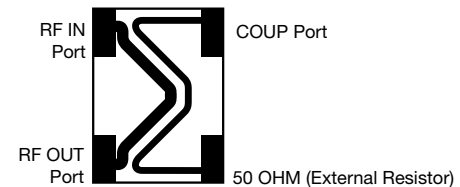


| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max | VSWR max |
|--------------|---------------|----------------------|---------------|-------------|----------|
| AMPS         | CP0805A0836EW | 824 - 849            | 11±1          | 0.85        | 1.4      |
|              | CP0805A0881EW | 869 - 894            | 10.5±1        |             |          |
|              | CP0805A0902EW | 890 - 915            | 10.5±1        |             |          |
| GSM          | CP0805A0947EW | 935 - 960            | 10±1          | 1.8         | 1.8      |
| E-GSM        | CP0805A0897EW | 880 - 915            | 10.5±1        |             |          |
|              | CP0805A0942EW | 925 - 960            | 10±1          |             |          |
| PDC          | CP0805A1441EW | 1429 - 1453          | 7±1           | 2.7         | 2.2      |
| PCN          | CP0805A1747EW | 1710 - 1785          | 5.5±1         |             |          |
|              | CP0805A1842EW | 1805 - 1880          | 5.5±1         |             |          |
| PCS          | CP0805A1880EW | 1850 - 1910          | 5±1           | 3.15        | 2.4      |
|              | Cp0805A1960EW | 1930 - 1990          | 5±1           |             |          |
|              | CP0805A1907EW | 1895 - 1920          | 5±1           |             |          |
| PHP          | CP0805A1890EW | 1880 - 1900          | 5±1           | 4.2         |          |
| DECT         | CP0805A1890EW | 1880 - 1900          | 5±1           |             |          |
| Wireless LAN | CP0805A2442EW | 2400 - 2484          | 4±1           | 4.2         |          |

Type: B  
Sub-Type: A



### LAYOUT



| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max | VSWR max |
|--------------|---------------|----------------------|---------------|-------------|----------|
| AMPS         | CP0805B0836AW | 824 - 849            | 21.5±1        | 0.25        | 1.2      |
|              | CP0805B0881AW | 869 - 894            | 21±1          |             |          |
|              | CP0805B0902AW | 890 - 915            | 21±1          |             |          |
| GSM          | CP0805B0947AW | 935 - 960            | 20.5±1        | 0.3         | 0.3      |
| E-GSM        | CP0805B0897AW | 880 - 915            | 21±1          |             |          |
|              | CP0805B0942AW | 925 - 960            | 20.5±1        |             |          |
| PDC          | CP0805B1441AW | 1429 - 1453          | 17±1          | 0.4         | 0.4      |
| PCN          | CP0805B1747AW | 1710 - 1785          | 15.5±1        |             |          |
|              | Cp0805B1842AW | 1805 - 1880          | 15.5±1        |             |          |
| PCS          | CP0805B1880AW | 1850 - 1910          | 15±1          | 0.3         | 0.3      |
|              | CP0805B1960AW | 1930 - 1990          | 14.5±1        |             |          |
|              | CP0805B1907AW | 1895 - 1920          | 15±1          |             |          |
| PHP          | CP0805B1890AW | 1880 - 1900          | 15±1          | 0.4         |          |
| DECT         | CP0805B1890AW | 1880 - 1900          | 15±1          |             |          |
| Wireless LAN | CP0805B2442AW | 2400 - 2484          | 13±1          | 0.4         |          |

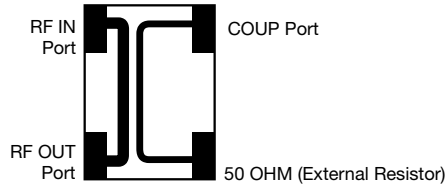
Important: Couplers can be used at any frequency within the indicated range.

# Thin-Film Directional Couplers

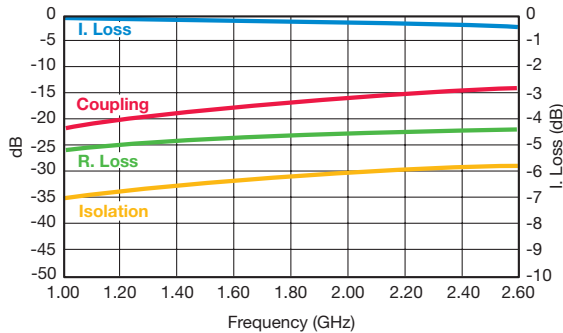


## CP0805 Layout Types

### LAYOUT

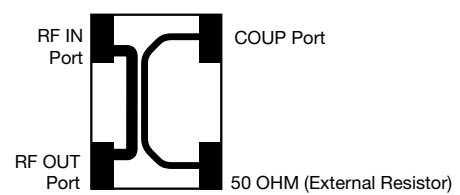


Type: B  
Sub-Type: B

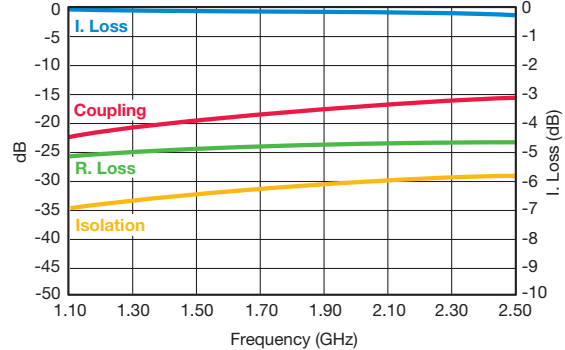


| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max | VSWR max |
|--------------|---------------|----------------------|---------------|-------------|----------|
| AMPS         | CP0805B0836BW | 824 - 849            | 23.5±1        | 0.25        | 1.2      |
|              | CP0805B0881BW | 869 - 894            | 23±1          |             |          |
| GSM          | CP0805B0902BW | 890 - 915            | 22.5±1        |             |          |
|              | CP0805B0947BW | 935 - 960            | 22±1          |             |          |
| E-GSM        | CP0805B0897BW | 880 - 915            | 23±1          |             |          |
|              | CP0805B0942BW | 925 - 960            | 22±1          |             |          |
| PDC          | CP0805B1441BW | 1429 - 1453          | 18.5±1        |             |          |
| PCN          | CP0805B1747BW | 1710 - 1785          | 17±1          |             |          |
|              | CP0805B1842BW | 1805 - 1880          | 16.5±1        |             |          |
| PCS          | CP0805B1880BW | 1850 - 1910          | 16.5±1        |             |          |
|              | CP0805B1960BW | 1930 - 1990          | 16±1          |             |          |
| PHP          | CP0805B1907BW | 1895 - 1920          | 16±1          | 0.4         |          |
| DECT         | CP0805B1890BW | 1880 - 1900          | 16±1          |             |          |
| Wireless LAN | CP0805B2442BW | 2400 - 2484          | 14±1          | 0.4         |          |

### LAYOUT



Type: B  
Sub-Type: C



| Application  | P/N Examples  | Frequency Band [MHz] | Coupling [dB] | I. Loss max | VSWR max |
|--------------|---------------|----------------------|---------------|-------------|----------|
| AMPS         | CP0805B0836CW | 824 - 849            | 25±1          | 0.25        | 1.2      |
|              | CP0805B0881CW | 869 - 894            | 24.5±1        |             |          |
| GSM          | CP0805B0902CW | 890 - 915            | 24±1          |             |          |
|              | CP0805B0947CW | 935 - 960            | 24±1          |             |          |
| E-GSM        | CP0805B0897CW | 880 - 915            | 24.5±1        |             |          |
|              | CP0805B0942CW | 925 - 960            | 24±1          |             |          |
| PDC          | CP0805B1441CW | 1429 - 1453          | 20±1          |             |          |
| PCN          | CP0805B1747CW | 1710 - 1785          | 18.5±1        |             |          |
|              | CP0805B1842CW | 1805 - 1880          | 18.5±1        |             |          |
| PCS          | CP0805B1880CW | 1850 - 1910          | 18±1          |             |          |
|              | CP0805B1960CW | 1930 - 1990          | 17.5±1        | 0.4         |          |
| PHP          | CP0805B1907CW | 1895 - 1920          | 18±1          |             |          |
| DECT         | CP0805B1890CW | 1880 - 1900          | 18±1          | 0.4         |          |
| Wireless LAN | CP0805B2442CW | 2400 - 2484          | 16±1          |             |          |

Important: Couplers can be used at any frequency within the indicated range.



# Thin-Film Directional Couplers

## CP0805 and CP0603 Test Jig

### ITF TEST JIG FOR COUPLER TYPES 0805 AND 0603 SMD

#### GENERAL DESCRIPTION

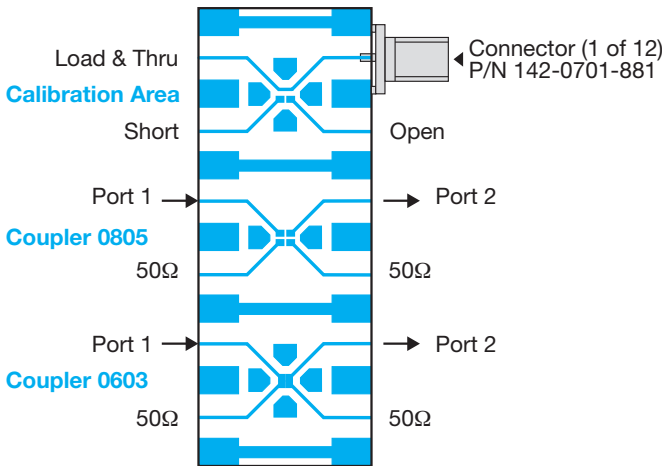
This jig is designed for the testing of CP0805 and CP0603 series Directional Couplers using a vector network analyzer. It consists of a FR4 multi-layer substrate, having 50Ω microstrips as conducting lines and a ground plane in the middle layer, located at a distance of 0.2mm from the microstrips.

The connectors are SMA type (female), 'Johnson Components Inc.' Product P/N: 142-0701-881.

The jig is designed for a full 2-port calibration. LOAD calibration can be done either by a 50Ω SMA termination, or by soldering a 50Ω chip resistor at the 50Ω ports.

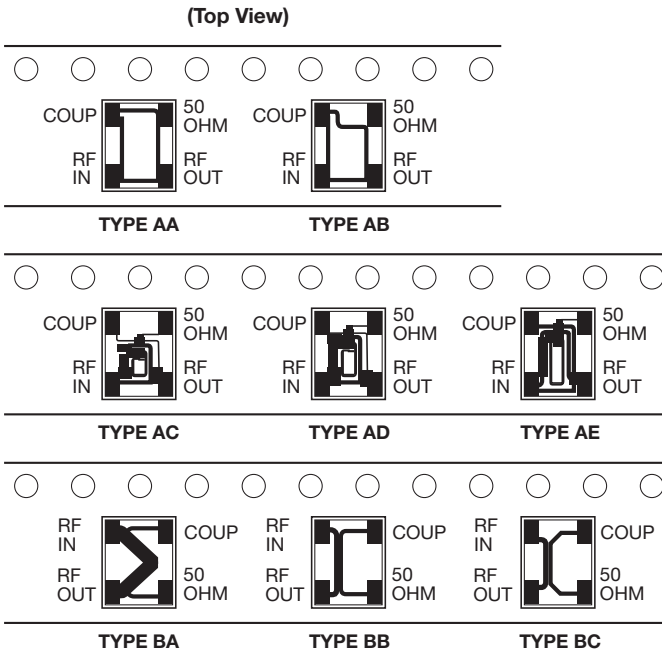
#### MEASUREMENT PROCEDURE

When measuring a component, it can be either soldered or pressed by a non-metallic stick until all four ports touch the appropriate pads. To measure the coupling (and the R. Loss) place the component on the Port 1 & Port 2 pads. Use two SMA 50Ω terminations (male) to terminate the ports, which are not connected to the network analyzer, and connect the network analyzer to the two ports. A 90° rotation of the component on its pads allows measuring a second parameter (I. Loss).



### CP0805 SERIES DIRECTIONAL COUPLERS

#### Orientation and Tape and Reel Packaging Specification



The parts should be mounted on the PCB with White (Alumina) side down and the "dark" side up.

# Thin-Film Directional Couplers

## DB0805 3dB 90° Couplers

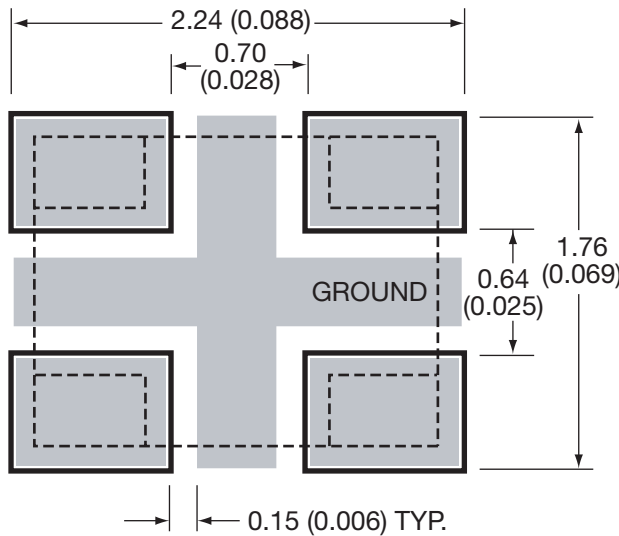


### GENERAL DESCRIPTION ITF TECHNOLOGY

The ITF SMD 3dB 90° Coupler is based on thin-film multilayer technology. The technology provides a miniature part with excellent high frequency performance and rugged construction for reliable automatic assembly.

The ITF 3dB 90° Coupler is offered in a variety of frequency bands compatible with various types of high frequency wireless systems.

### Recommended Pad Layout Dimensions mm (inches)



### APPLICATIONS

- Balanced Amplifiers and Signal Distribution in Mobile Communications

### FEATURES

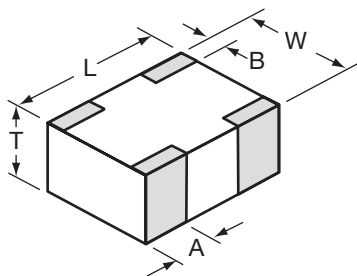
- Miniature 0805 size
- Low I. Loss
- High Isolation
- Power Handling: 10W RF CW
- Surface Mountable
- Supplied on Tape and Reel
- Operating Temperature -40°C to +85°C

### DIMENSIONS:

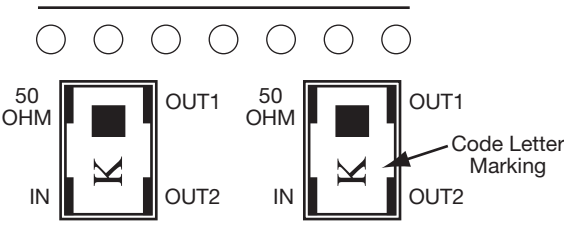
millimeters (inches)

|   |                            |
|---|----------------------------|
| L | 2.03±0.10<br>(0.080±0.004) |
| W | 1.55±0.10<br>(0.061±0.004) |
| T | 0.98±0.15<br>(0.037±0.006) |
| A | 0.56±0.25<br>(0.022±0.010) |
| B | 0.35±0.15<br>(0.014±0.006) |

### Bottom View



### TERMINALS (Top View) Orientation in Tape



### ELECTRICAL PARAMETERS\*

| Part Number     | Frequency F <sub>0</sub><br>[MHz] | I. Loss @ F <sub>0</sub><br>[dB] | Phase Balance<br>[deg] max. | Code Letter<br>Marking |
|-----------------|-----------------------------------|----------------------------------|-----------------------------|------------------------|
| DB0805A0880AWTR | 880±30                            | 0.35                             | 3                           | Y                      |
| DB0805A0915AWTR | 915±30                            | 0.35                             | 3                           | V                      |
| DB0805A0967AWTR | 967±30                            | 0.35                             | 3                           | V                      |
| DB0805A1350AWTR | 1350±50                           | 0.35                             | 3                           | C                      |
| DB0805A1650AWTR | 1650±50                           | 0.35                             | 3                           | F                      |
| DB0805A1800AWTR | 1800±50                           | 0.30                             | 3                           | F                      |
| DB0805A1850AWTR | 1850±50                           | 0.30                             | 3                           | K                      |
| DB0805A1900AWTR | 1900±50                           | 0.30                             | 3                           | K                      |
| DB0805A1950AWTR | 1950±50                           | 0.25                             | 3                           | K                      |
| DB0805A2140AWTR | 2140±50                           | 0.25                             | 3                           | L                      |
| DB0805A2325AWTR | 2325±50                           | 0.25                             | 3                           | T                      |

\*With Recommended Pad Layout

**Important:** All intermediate frequencies within the indicated range are readily available.



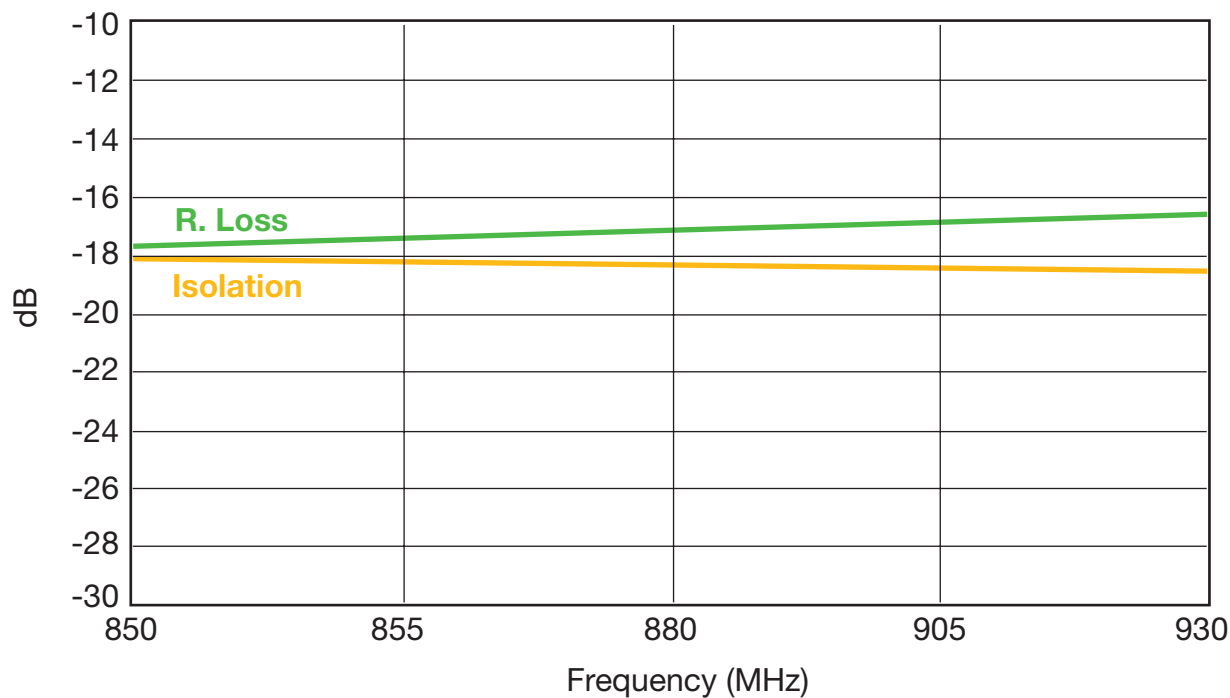
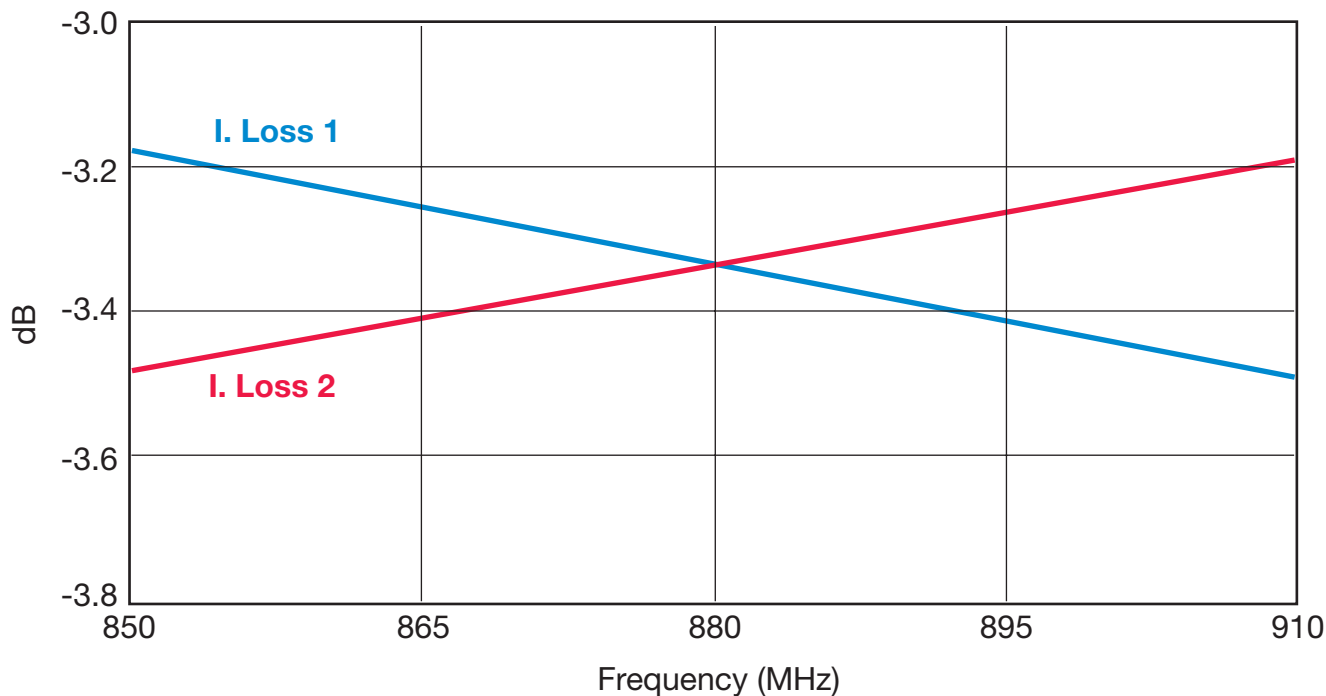
# Thin-Film Directional Couplers



## DB0805 3dB 90° Couplers

880 ± 30MHz DB0805A0880AWTR

3

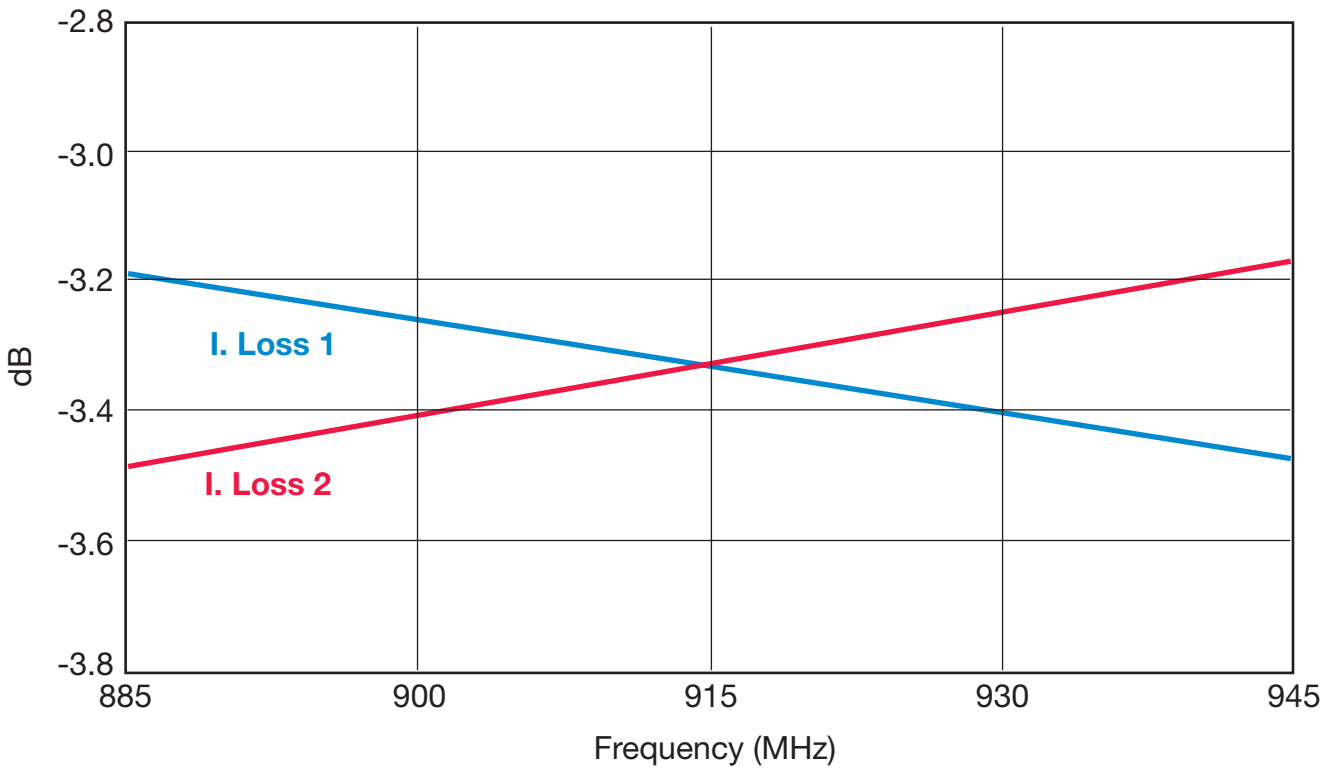


# Thin-Film Directional Couplers

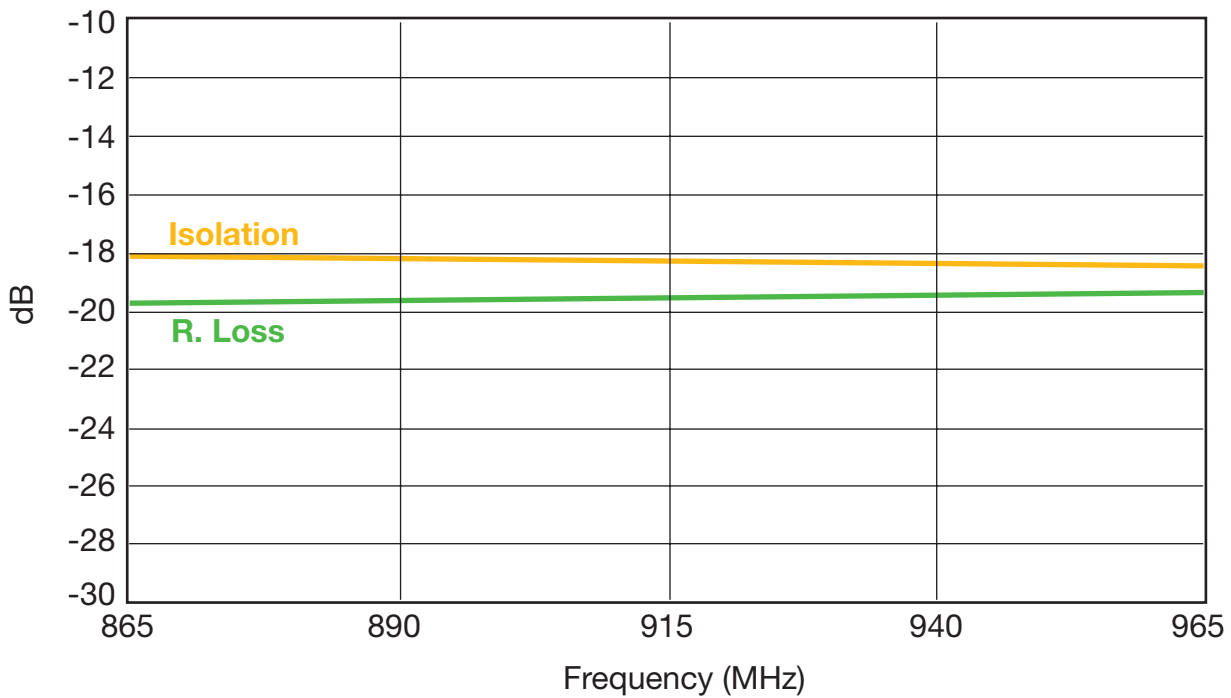


## DB0805 3dB 90° Couplers

915 ± 30MHz DB0805A0915AWTR



3



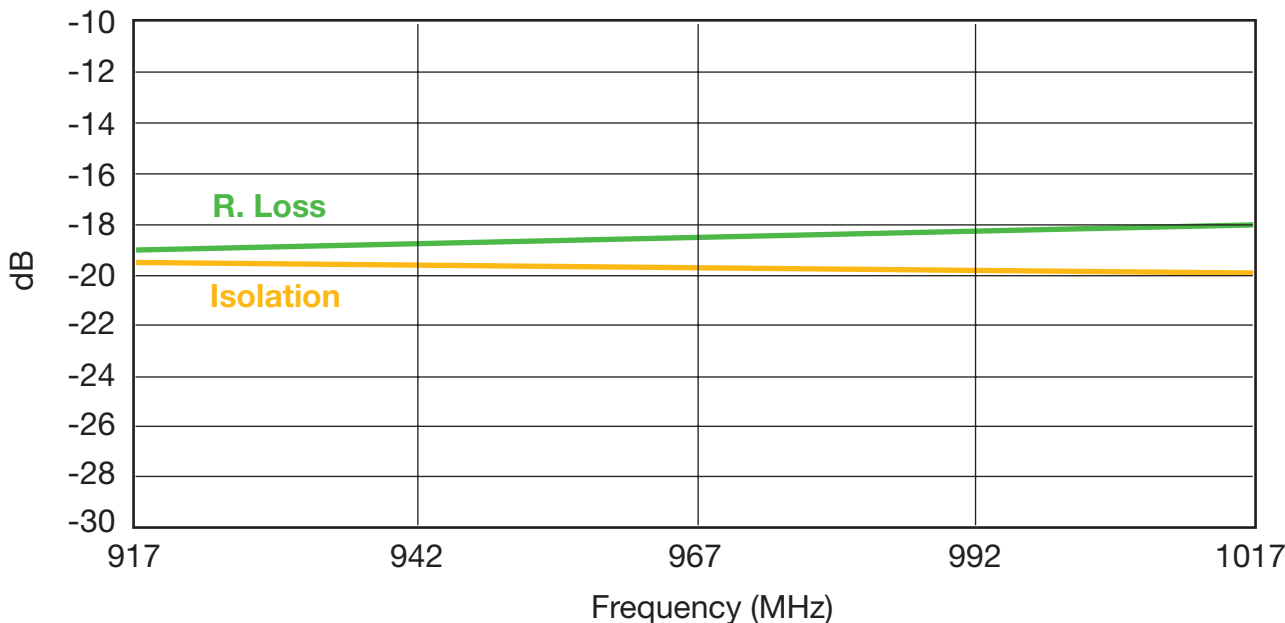
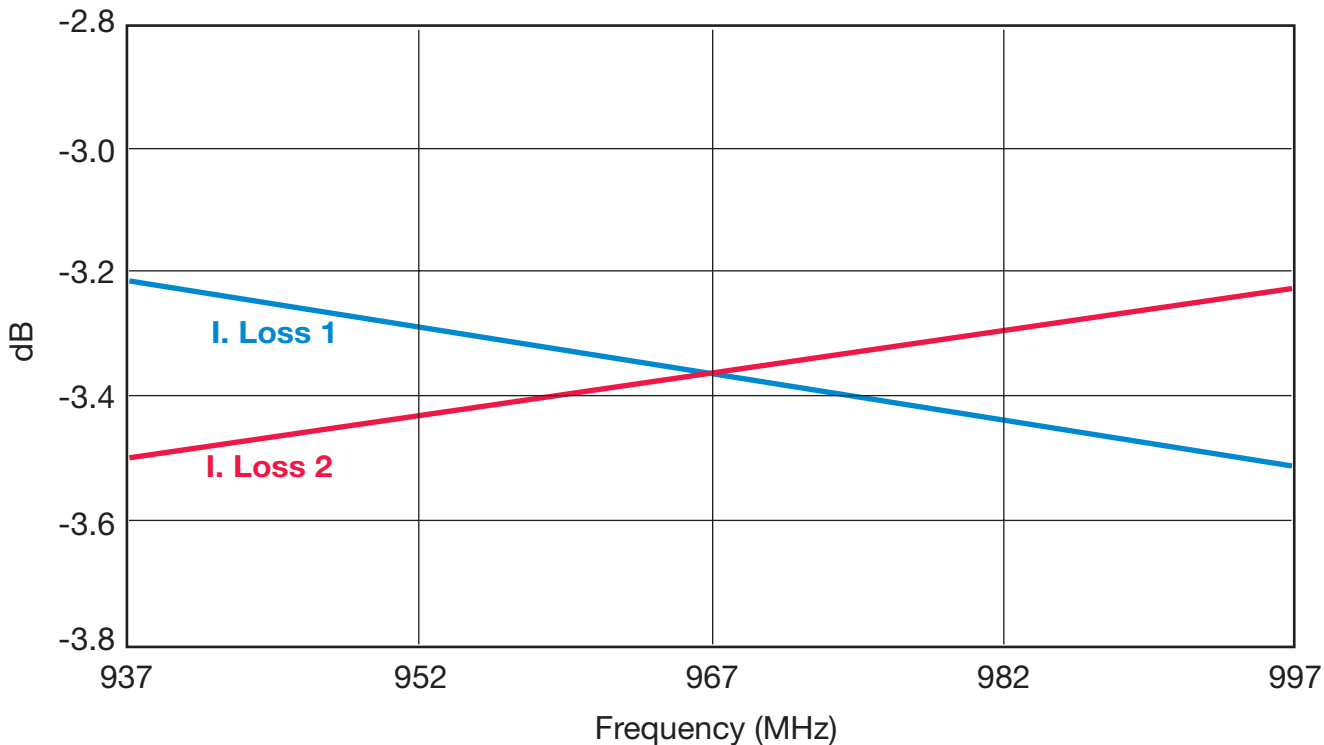
# Thin-Film Directional Couplers



## DB0805 3dB 90° Couplers

967± 30MHz DB0805A0967AWTR

3

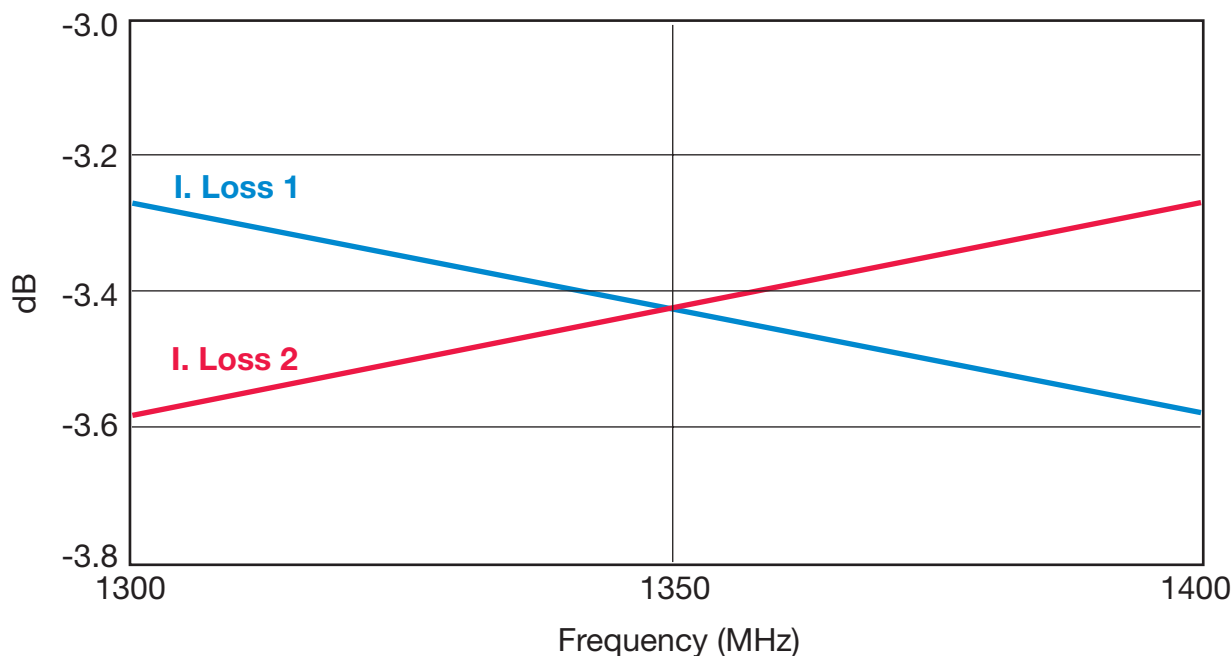


# Thin-Film Directional Couplers

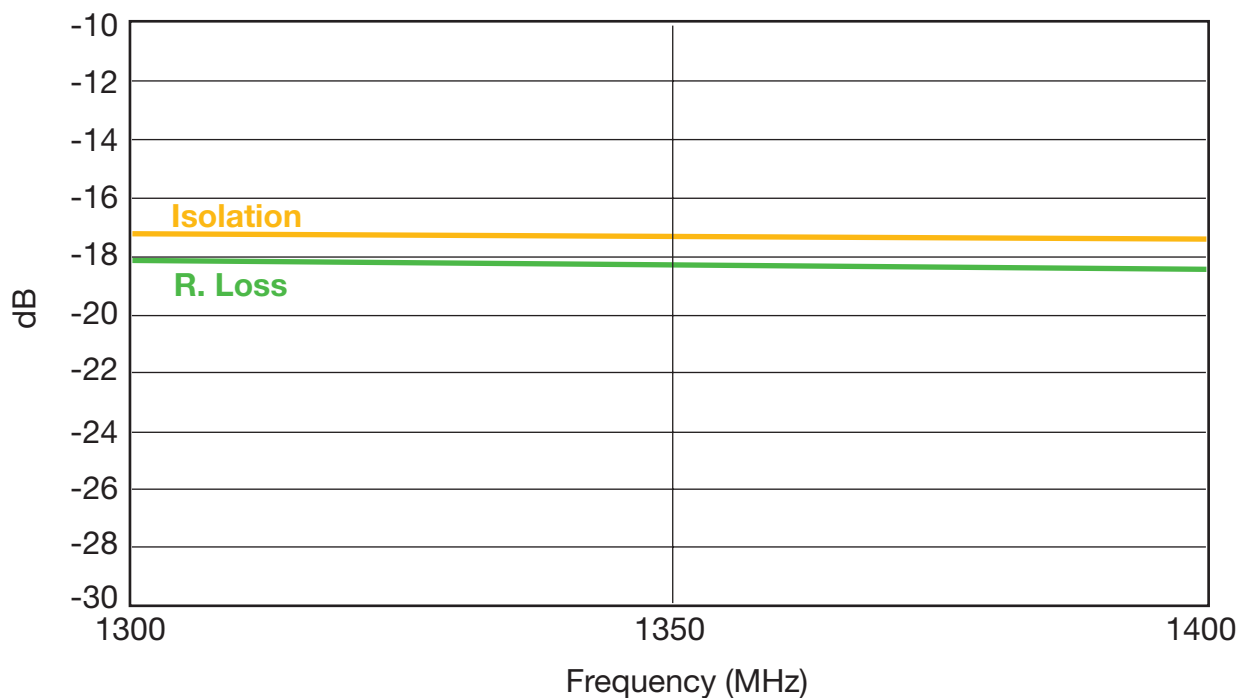


## DB0805 3dB 90° Couplers

1350 ± 50MHz DB0805A1350AWTR



3

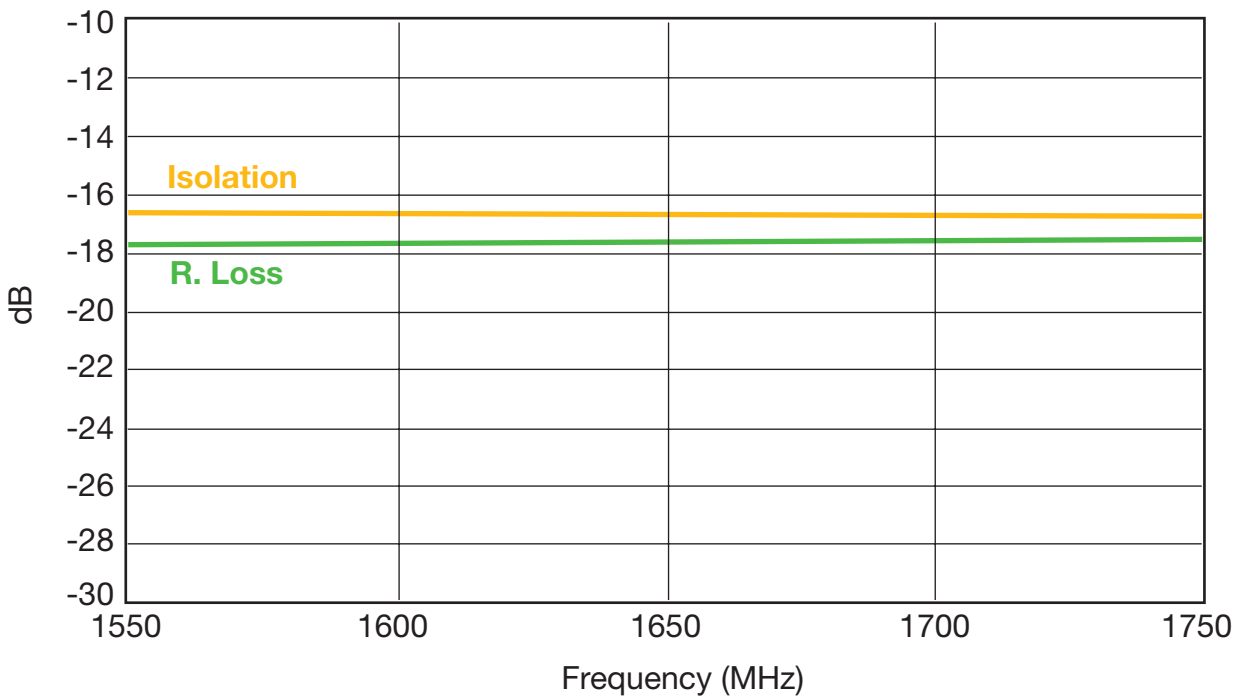
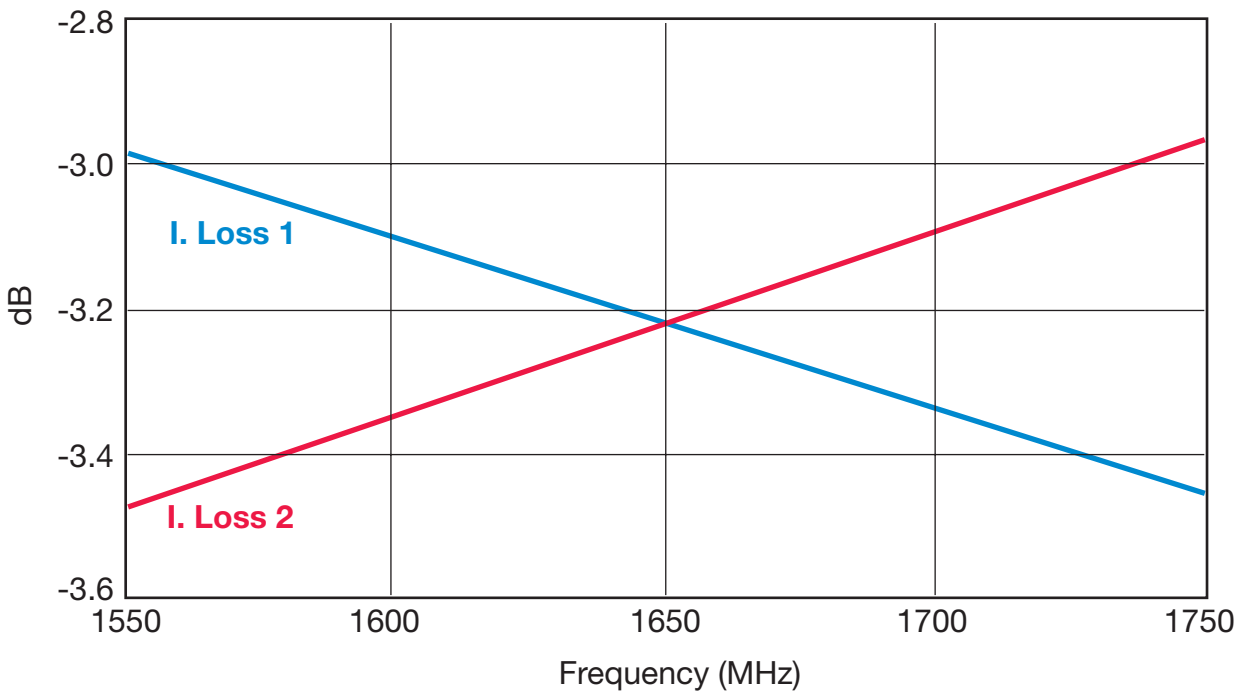


# Thin-Film Directional Couplers



## DB0805 3dB 90° Couplers

1650 ± 50MHz DB0805A1650AWTR

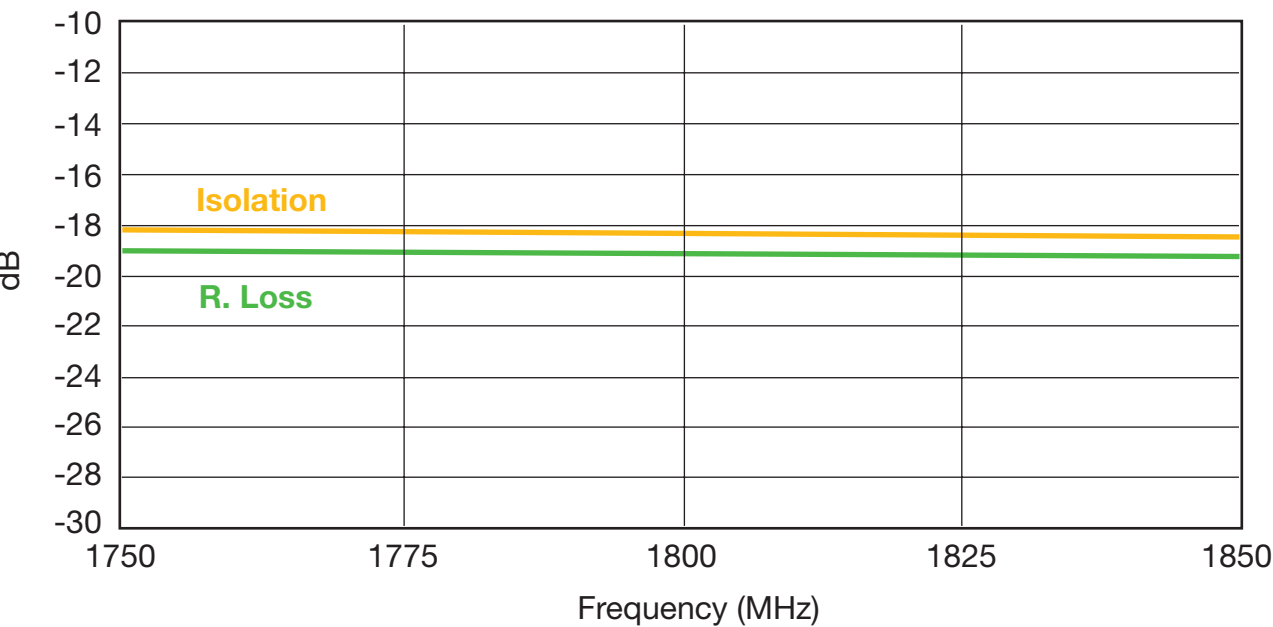
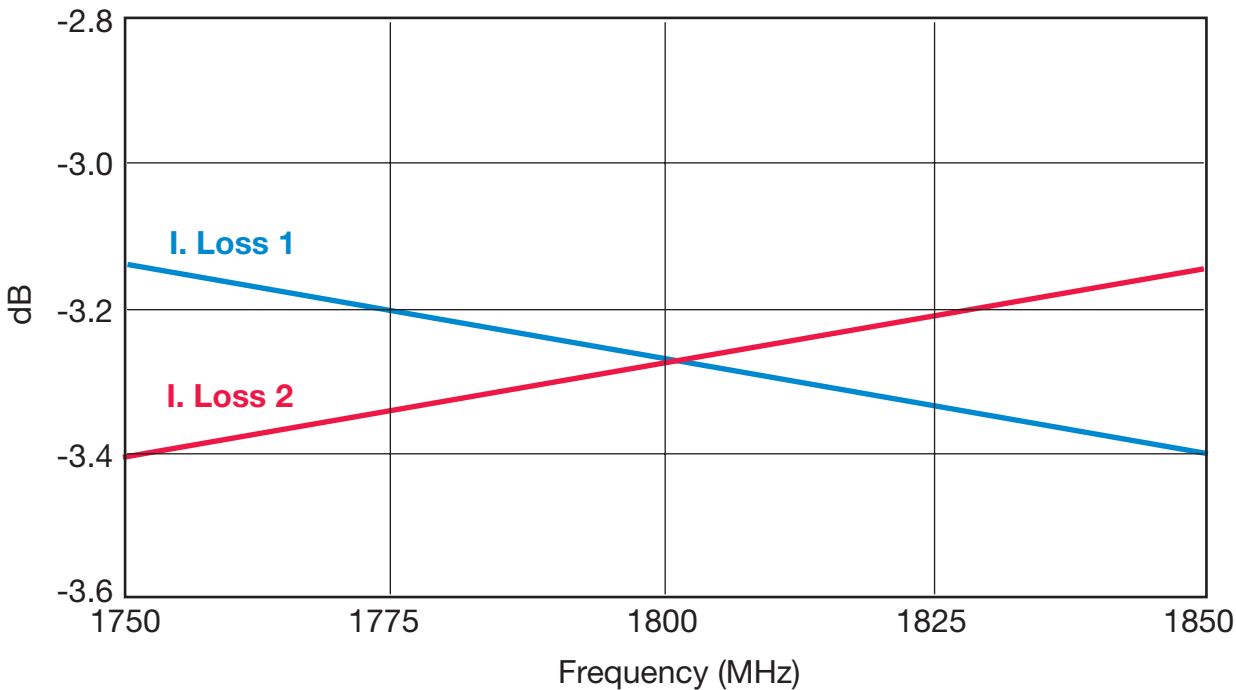


# Thin-Film Directional Couplers



## DB0805 3dB 90° Couplers

1800 ± 50MHz DB0805A1800AWTR



3

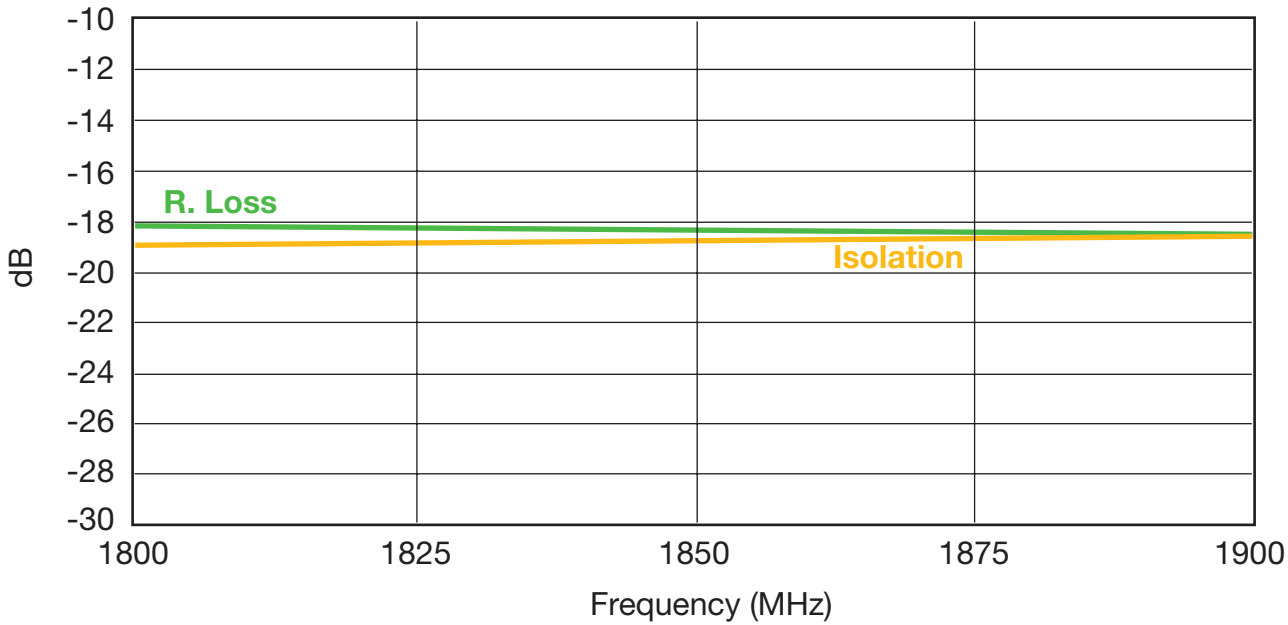
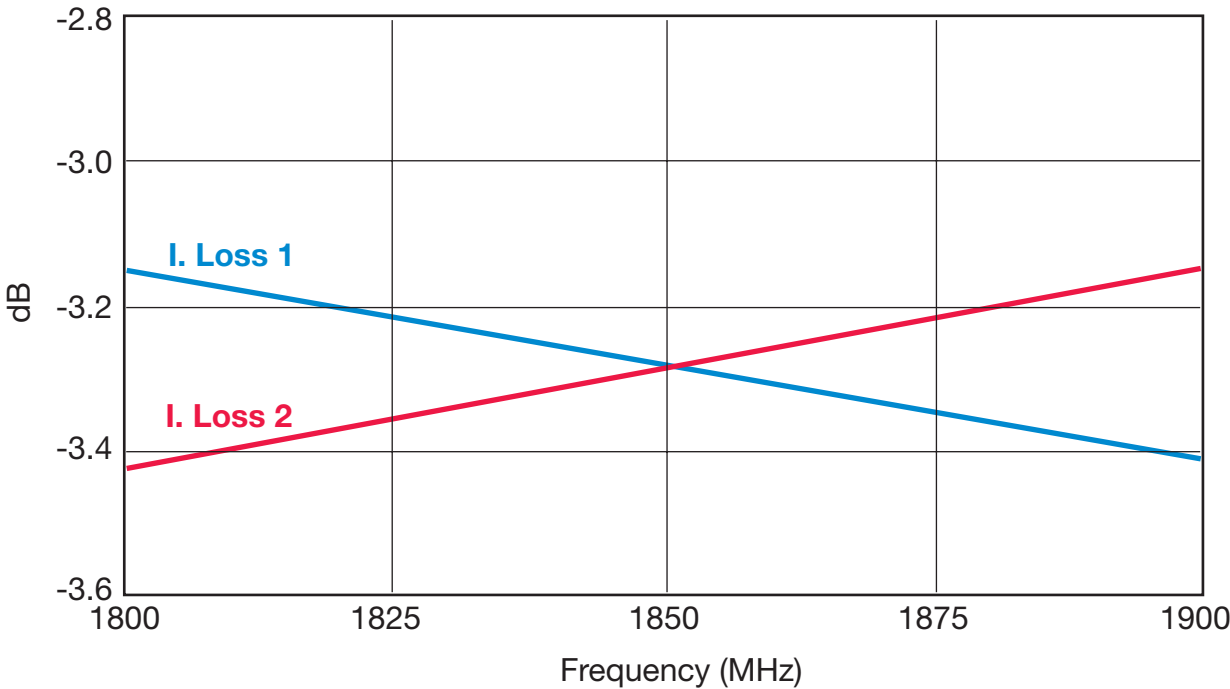


# Thin-Film Directional Couplers



## DB0805 3dB 90° Couplers

1850 ± 50MHz DB0805A1850AWTR

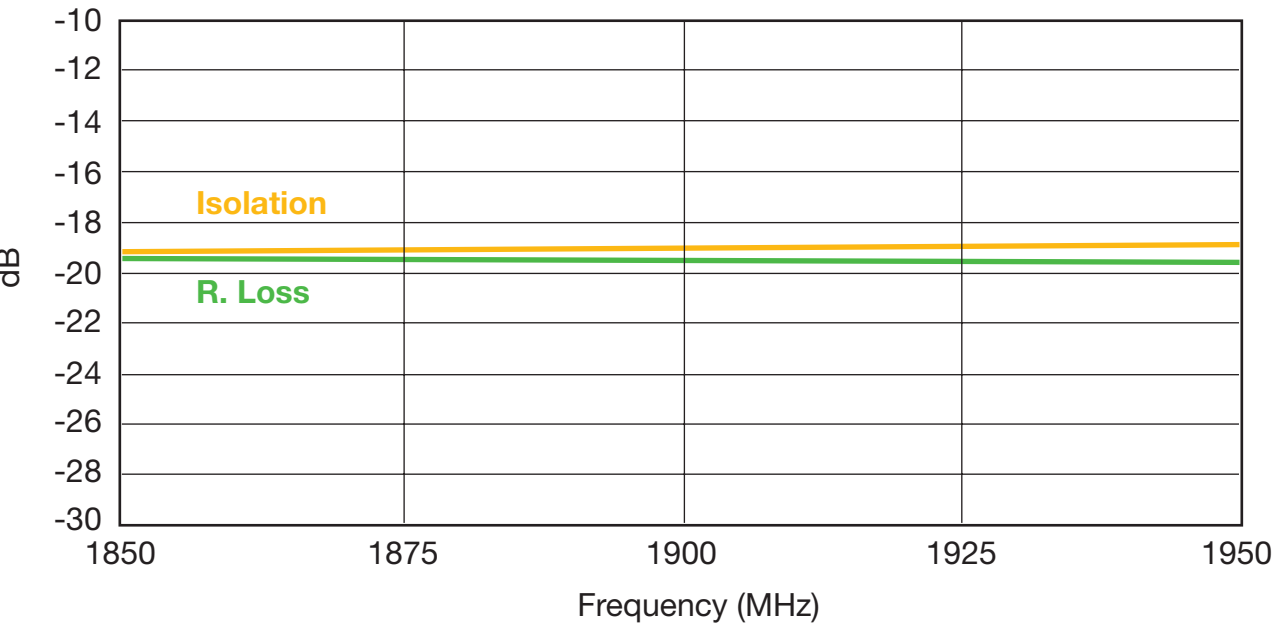
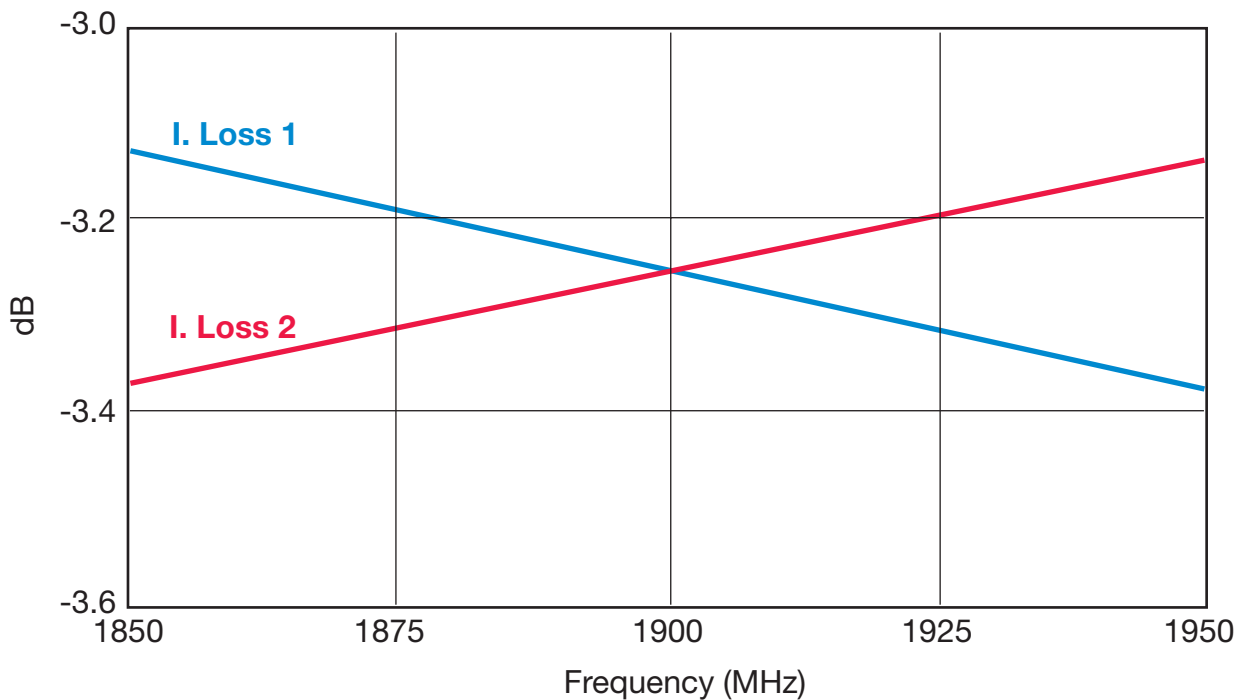


# Thin-Film Directional Couplers



## DB0805 3dB 90° Couplers

1900 ± 50MHz DB0805A1900AWTR



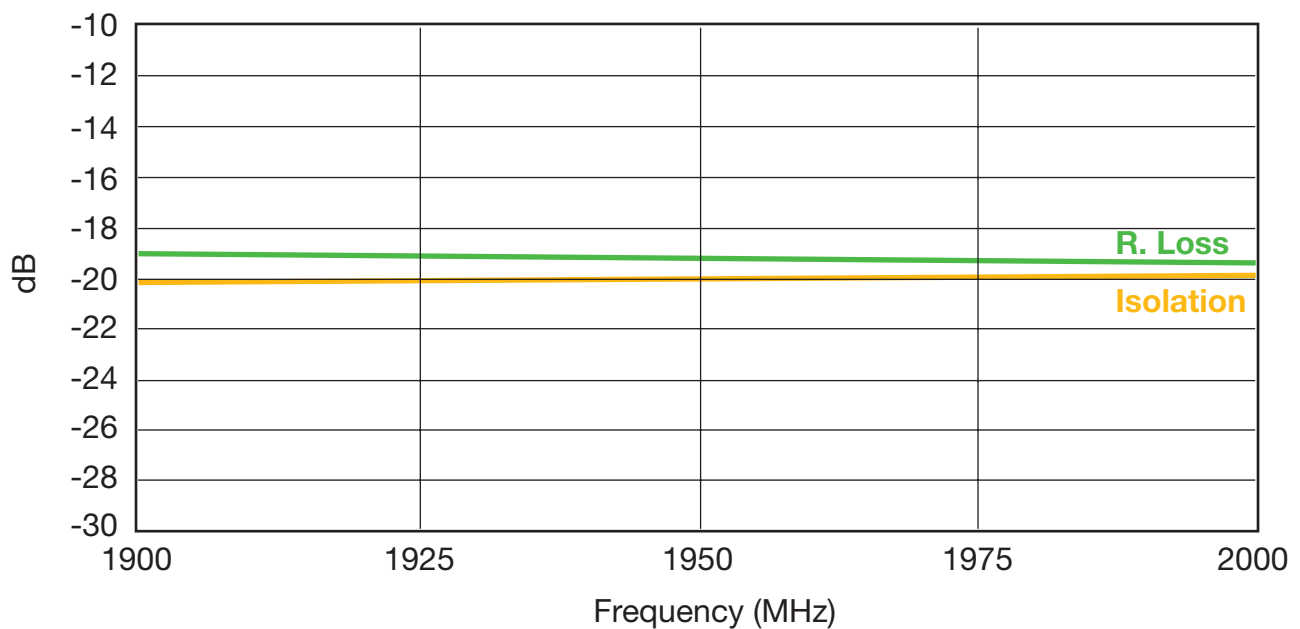
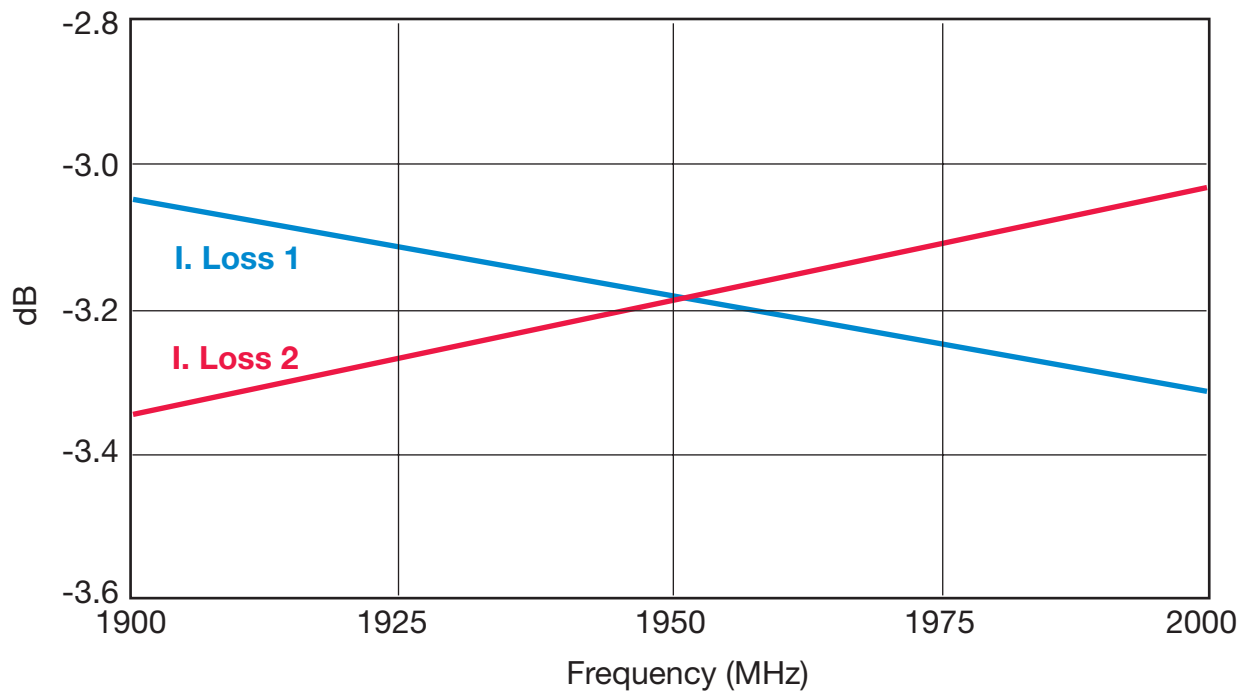
3

# Thin-Film Directional Couplers

## DB0805 3dB 90° Couplers



1950 ± 50MHz DB0805A1950AWTR

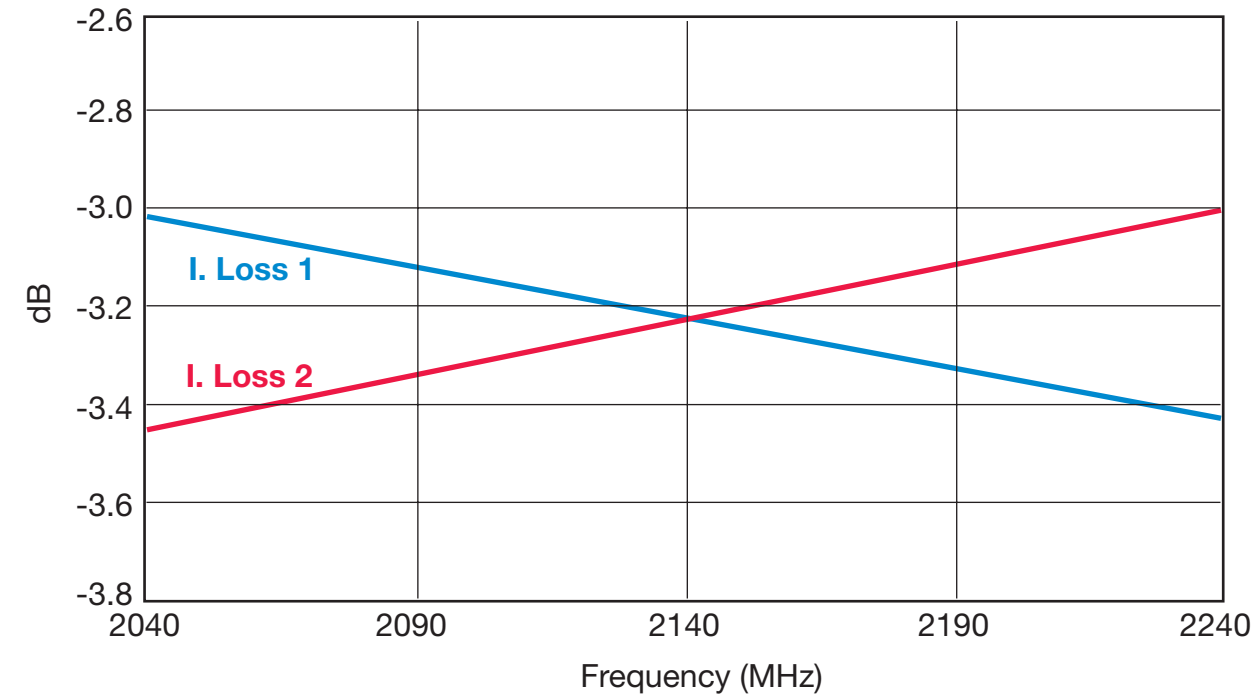


# Thin-Film Directional Couplers

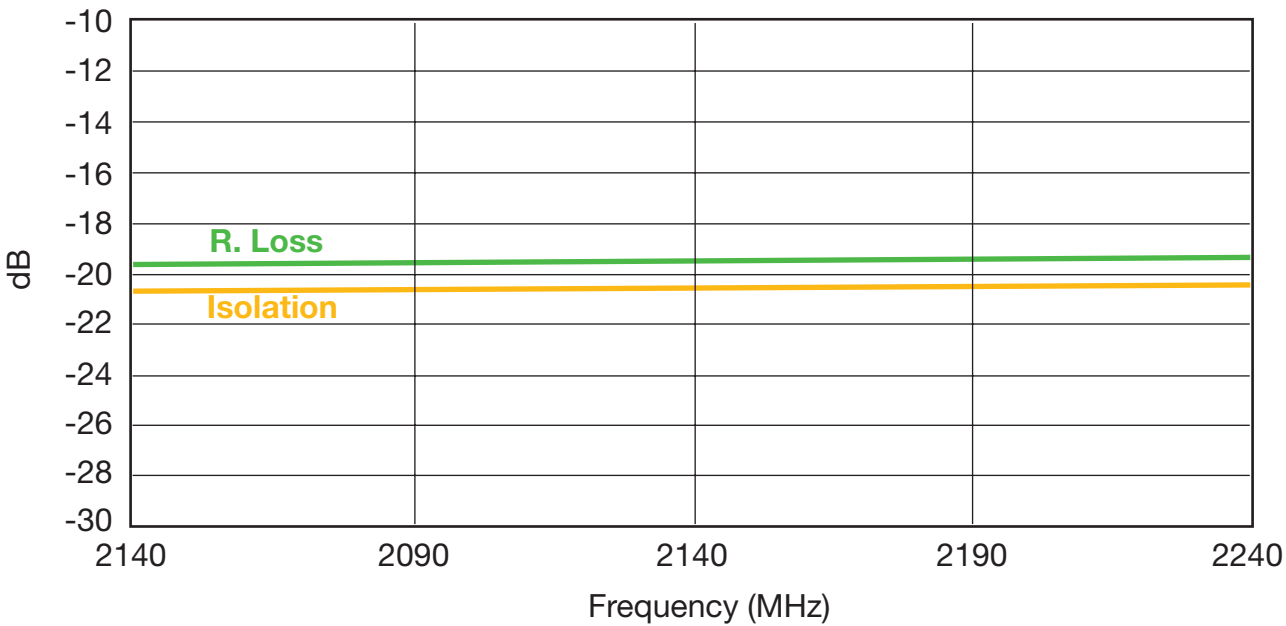


## DB0805 3dB 90° Couplers

2140 ± 50MHz DB0805A2140AWTR



3

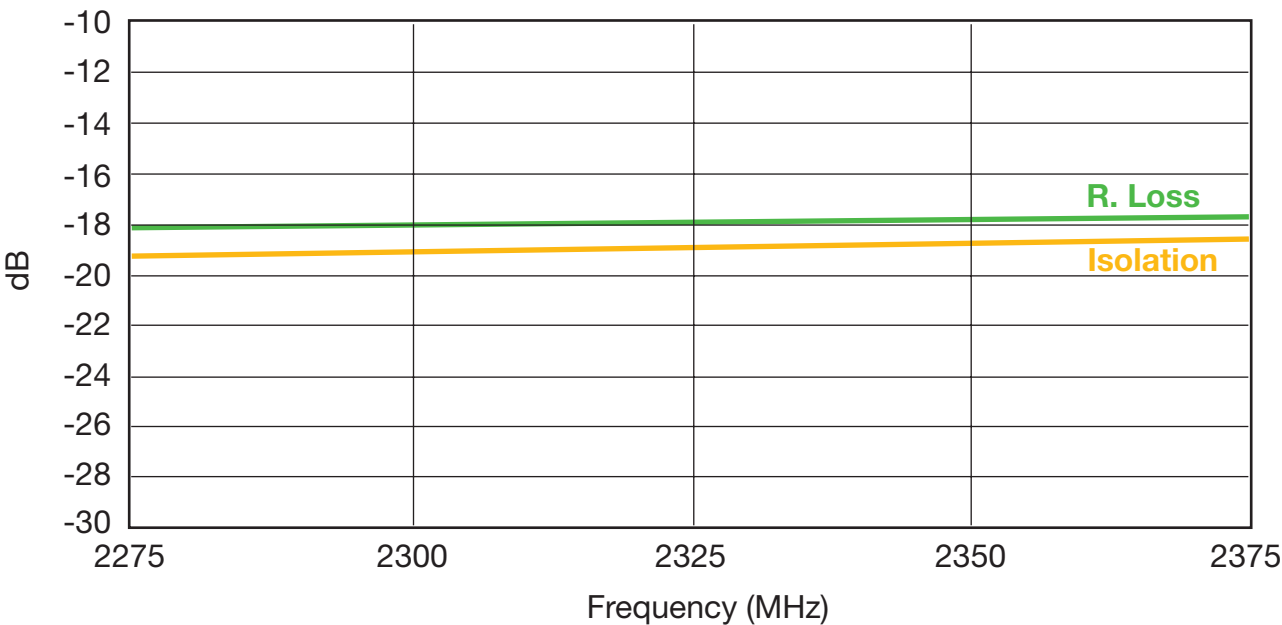
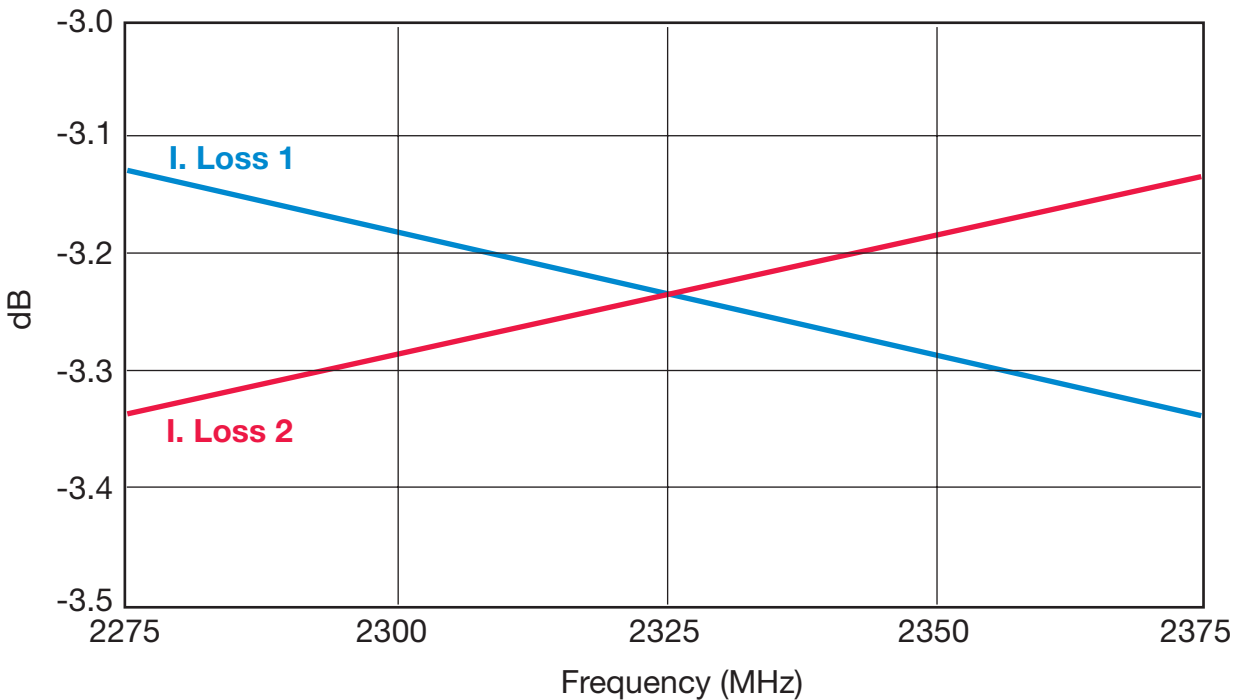


# Thin-Film Directional Couplers



## DB0805 3dB 90° Couplers

2325 ± 50MHz DB0805A2325AWTR



# Thin-Film Directional Couplers



## DB0805 3dB 90° Test Jigs

### GENERAL DESCRIPTION

These jigs are designed for testing the DB0805 3dB 90° Couplers using a Vector Network Analyzer.

They consist of a dielectric substrate, having 50Ω microstrips as conducting lines and a bottom ground plane located at a distance of 0.254mm from the microstrips.

The substrate used is Neltec's NH9338ST0254C1BC.

The connectors are SMA type (female), 'Johnson Components Inc.' Product P/N: 142-0701-841.

Both a measurement jig and a calibration jig are provided.

The calibration jig is designed for a full 2-port calibration, and consists of an open line, short line and through line. LOAD calibration can be done by a 50Ω SMA termination.

### MEASUREMENT PROCEDURE

When measuring a component, it can be either soldered or pressed using a non-metallic stick until all four ports touch the appropriate pads. Set the VNA to the relevant frequency band. Connect the VNA using a 10dB attenuator on the jig

terminal connected to port 2. Follow the VNA's instruction manual and use the [calibration jig](#) to perform a full 2-port calibration in the required bandwidths.

3

**Place the coupler on the [measurement jig](#) as follows:**

Input (Coupler) → Connector 1 (Jig)      Output 1 (Coupler) → Connector 3 (Jig)  
50Ω (Coupler) → Connector 2 (Jig)      Output 2 (Coupler) → Connector 4 (Jig)

**To measure [R. Loss](#) and [I. Loss 1](#) connect:**

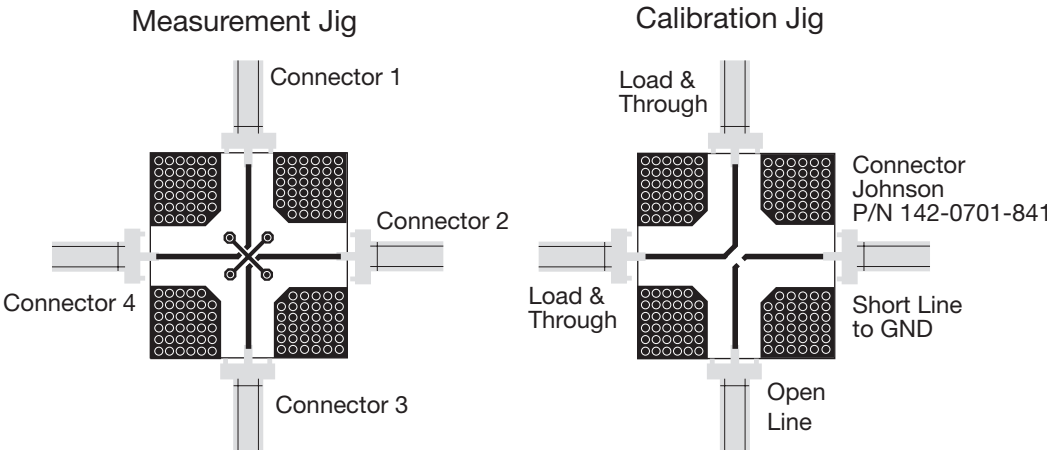
Connector 1 (Jig) → Port 1 (VNA)      Connector 3 (Jig) → Port 2 (VNA)  
Connector 2 (Jig) → 50Ω      Connector 4 (Jig) → 50Ω

**To measure [R. Loss](#) and [I. Loss 2](#) connect:**

Connector 1 (Jig) → Port 1 (VNA)      Connector 3 (Jig) → 50Ω  
Connector 2 (Jig) → 50Ω      Connector 4 (Jig) → Port 2 (VNA)

**To measure [Isolation](#) connect:**

Connector 1 (Jig) → 50Ω      Connector 3 (Jig) → Port 1 (VNA)  
Connector 2 (Jig) → 50Ω      Connector 4 (Jig) → Port 2 (VNA)





# Thin-Film Technology

Integrated Thin-Film  
Low-Pass Filters

4

# Thin-Film Low Pass Filter

## LP0603 Lead-Free LGA Type

### GENERAL DESCRIPTION

The LP0603 ITF (Integrated Thin Film) Lead-Free LGA Low Pass Filter is based on thin-film multilayer technology. The technology provides a miniature part with excellent high frequency performance and rugged construction for reliable automatic assembly.

The ITF Low Pass Filters are offered in a variety of frequency bands compatible with various types of high frequency wireless systems.

### FEATURES

- Miniature Size: 0603
- Frequency Range: 900MHz -2.4GHz
- Characteristic Impedance: 50 Ohm
- Operating/Storage Temperature: -40°C to +85°C
- Power Rating: 3W Continuous
- Low Profile
- Rugged Construction
- Lead Free
- Taped and Reeled

### APPLICATIONS

- Mobile communications
- Satellite TV receivers
- GPS
- Vehicle location systems
- Wireless LANs
- RFID

### LAND GRID ARRAY ADVANTAGES

- Inherent Low Profile
- Self Alignment during Reflow
- Excellent Solderability
- Low Parasitics
- Better Heat Dissipation

### HOW TO ORDER

**LP**  
T  
Style

**0603**  
T  
Size  
0603

**A**  
T  
Type

**XXXX**  
T  
Frequency  
MHz

**A**  
T  
Sub-Type

**N**  
T  
Termination  
LGA  
Ni/Lead Free Solder

**TR**  
T  
Taped & Reeled

4

### FINAL QUALITY INSPECTION

Finished parts are 100% tested for electrical parameters and visual characteristics. Each production lot is evaluated on a sample basis for:

- Static Humidity: 85°C, 85% RH, 160 hours
- Endurance: 125°C, IR, 4 hours

### TERMINATION

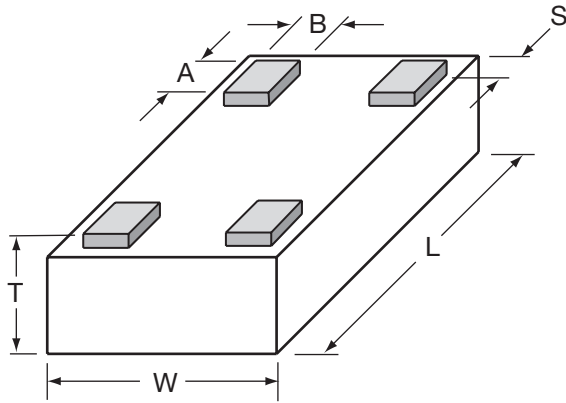
Nickel/Lead-Free Solder coating compatible with automatic soldering technologies: reflow, wave soldering, vapor phase and manual.

# Thin-Film Low Pass Filter

## LP0603 Lead-Free LGA Type

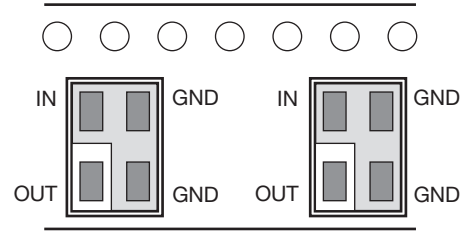


### DIMENSIONS: millimeters (inches) (Bottom View)

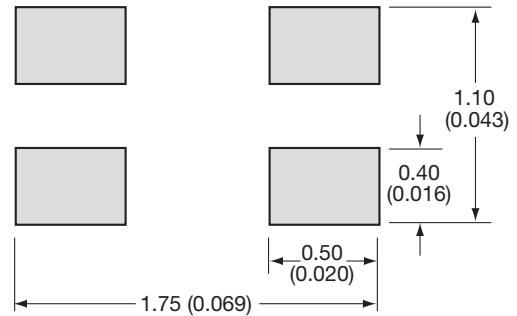


|          |                           |          |                            |
|----------|---------------------------|----------|----------------------------|
| <b>L</b> | 1.6±0.1<br>(0.063±0.004)  | <b>A</b> | 0.25±0.05<br>(0.010±0.002) |
| <b>W</b> | 0.84±0.1<br>(0.033±0.004) | <b>B</b> | 0.20±0.05<br>(0.008±0.002) |
| <b>T</b> | 0.60±0.1<br>(0.024±0.004) | <b>S</b> | 0.05±0.05<br>(0.002±0.002) |

### TERMINALS AND ORIENTATION IN TAPE (Top View)



### RECOMMENDED PAD LAYOUT (mm)



### ELECTRICAL CHARACTERISTICS

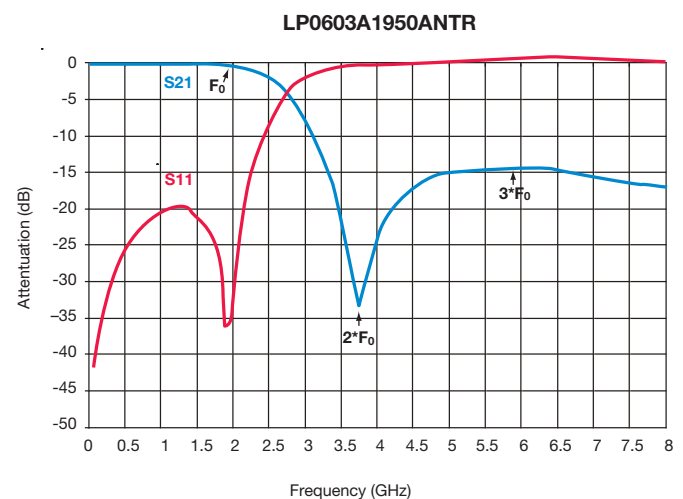
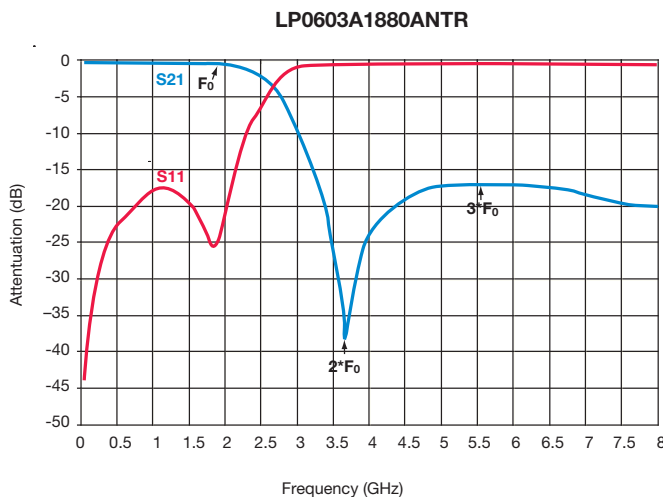
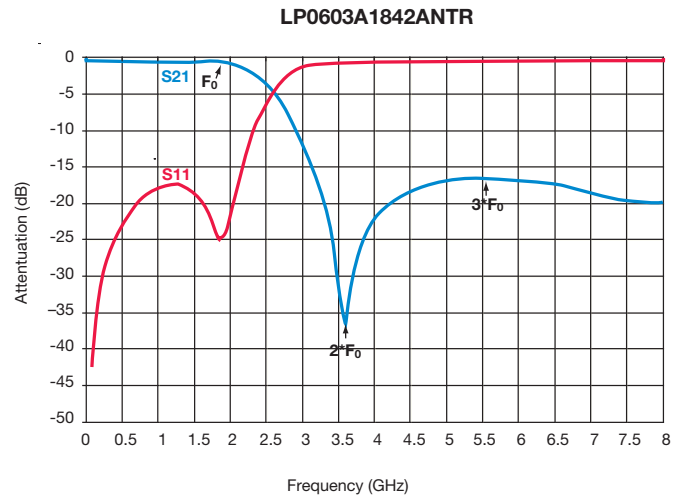
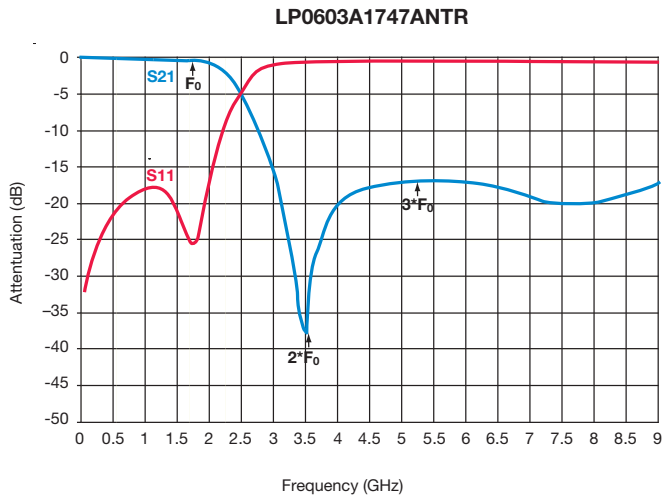
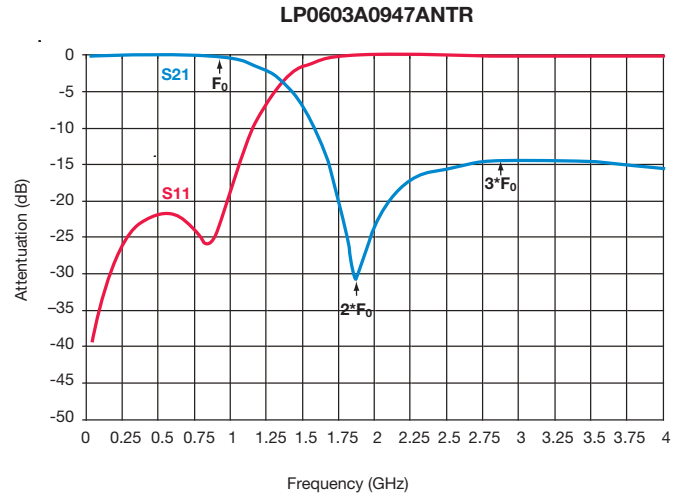
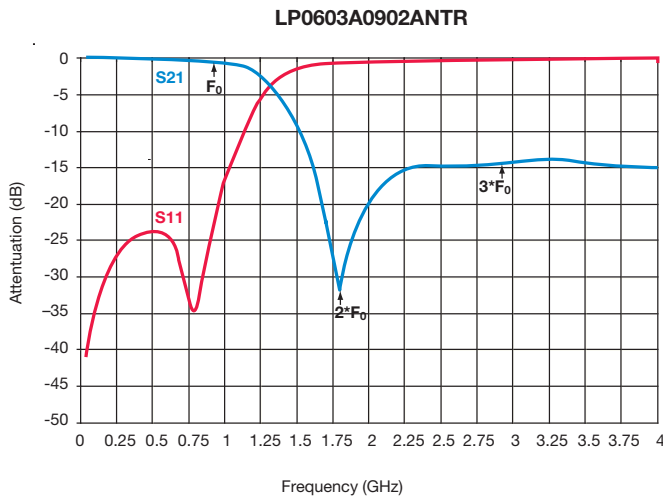
(Guaranteed over -40°C to +85°C Operating Temperature Range)

| P/N             | Frequency Band [MHz] | I. Loss [dB]          | VSWR max [dB] | Attenuation typ. [dB]                          |
|-----------------|----------------------|-----------------------|---------------|------------------------------------------------|
| LP0603A0902ANTR | 890-915              | 0.35 typ<br>(0.5 max) | 1.4           | 25 @ 2xF <sub>0</sub><br>14 @ 3xF <sub>0</sub> |
| LP0603A0947ANTR | 935-960              | 0.35 typ<br>(0.5 max) | 1.4           | 25 @ 2xF <sub>0</sub><br>17 @ 3xF <sub>0</sub> |
| LP0603A1747ANTR | 1710-1785            | 0.3 typ<br>(0.5 max)  | 1.4           | 25 @ 2xF <sub>0</sub><br>17 @ 3xF <sub>0</sub> |
| LP0603A1842ANTR | 1805-1880            | 0.3 typ<br>(0.5 max)  | 1.4           | 27 @ 2xF <sub>0</sub><br>15 @ 3xF <sub>0</sub> |
| LP0603A1880ANTR | 1840-1920            | 0.3 typ<br>(0.5 max)  | 1.4           | 25 @ 2xF <sub>0</sub><br>17 @ 3xF <sub>0</sub> |
| LP0603A1950ANTR | 1920-1980            | 0.3 typ<br>(0.5 max)  | 1.4           | 27 @ 2xF <sub>0</sub><br>15 @ 3xF <sub>0</sub> |
| LP0603A2140ANTR | 2110-2170            | 0.3 typ<br>(0.5 max)  | 1.4           | 27 @ 2xF <sub>0</sub><br>17 @ 3xF <sub>0</sub> |
| LP0603A2442ANTR | 2412-2472            | 0.3 typ<br>(0.5 max)  | 1.4           | 25 @ 2xF <sub>0</sub><br>17 @ 3xF <sub>0</sub> |

Note: additional frequencies available upon request

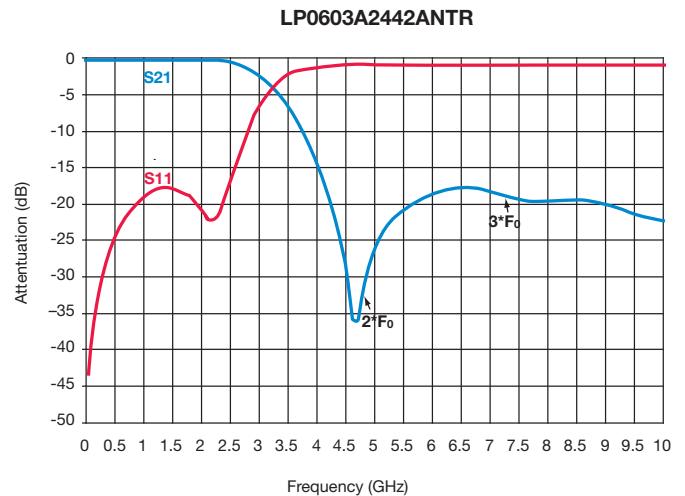
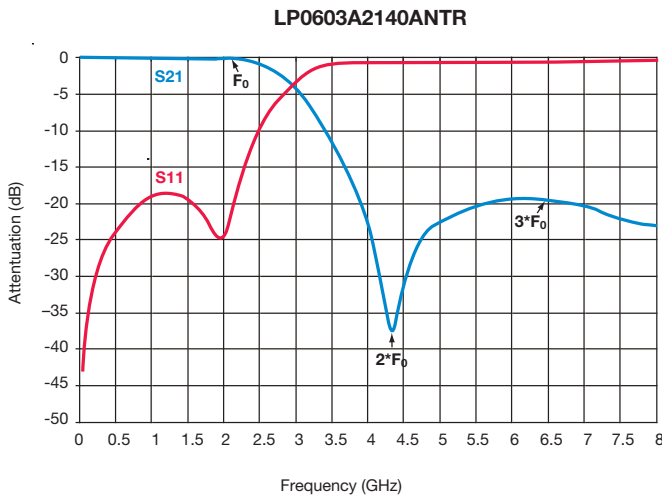
# Thin-Film Low Pass Filter

## LP0603 Lead-Free LGA Type Test Jig



# Thin-Film Low Pass Filter

## LP0603 Lead-Free LGA Type Test Jig



## TEST JIG FOR LP0603 LEAD-FREE LGA LOW PASS FILTER

### GENERAL DESCRIPTION

These jigs are designed for testing the LP0603 LGA Low Pass Filters using a Vector Network Analyzer.

They consist of a dielectric substrate, having 50Ω microstrips as conducting lines and a bottom ground plane located at a distance of 0.127mm from the microstrips.

The substrate used is Neltec's NH9338ST0127C1BC (or similar).

The connectors are SMA type (female), 'Johnson Components Inc.' Product P/N: 142-0701-841 (or similar).

Both a measurement jig and a calibration jig are provided.

The calibration jig is designed for a full 2-port calibration, and consists of an open line, short line and through line. LOAD calibration can be done by a 50Ω SMA termination.

### MEASUREMENT PROCEDURE

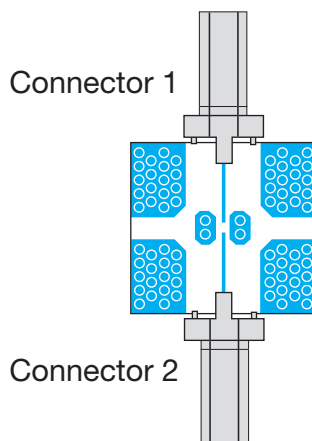
Follow the VNA's instruction manual and use the [calibration jig](#) to perform a full 2-Port calibration in the required bandwidths.

Solder the filter to the [measurement jig](#) as follows:

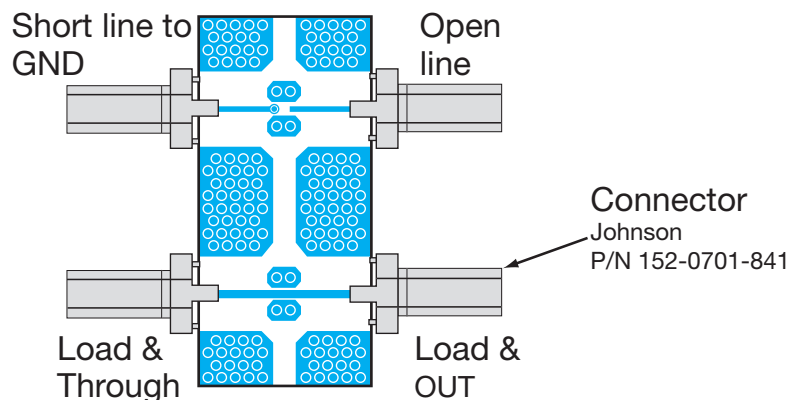
|                                     |                          |
|-------------------------------------|--------------------------|
| Input (Filter) ➡ Connector 1 (Jig)  | GND (Filter) ➡ GND (Jig) |
| Output (Filter) ➡ Connector 2 (Jig) | GND (Filter) ➡ GND (Jig) |

Set the VNA to the relevant frequency band. Connect the VNA using a 10dB attenuator on the jig terminal connected to port 2 (using an RF cable).

### Measurement



### Calibration Jig



# Thin-Film Low Pass Filter

## LP0805 Type Harmonic

### GENERAL DESCRIPTION

The ITF (Integrated Thin-Film) SMD Filter is based on thin-film multilayer technology. The technology provides a miniature part with excellent high frequency performance and rugged construction for reliable automatic assembly.

The ITF Filter is offered in a variety of frequency bands compatible with various types of high frequency wireless systems.

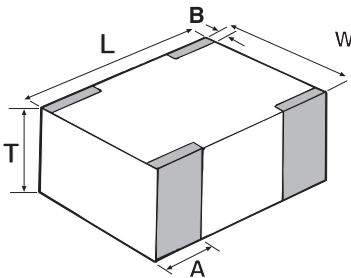
### FEATURES

- Small Size: 0805
- Frequency Range: 800MHz - 3.5GHz
- Characteristic Impedance: 50Ω
- Operating / Storage Temp.: -40°C to +85°C
- Power Rating: 3W Continuous
- Low Profile
- Rugged Construction
- Taped and Reeled

### APPLICATIONS

- Mobile Communications
- Satellite TV Receivers
- GPS
- Vehicle Location Systems
- Wireless LAN's

### DIMENSIONS: millimeters (inches)



|          |                            |
|----------|----------------------------|
| <b>L</b> | 2.03±0.1<br>(0.080±0.004)  |
| <b>W</b> | 1.55±0.1<br>(0.061±0.004)  |
| <b>T</b> | 1.02±0.1<br>(0.040±0.004)  |
| <b>A</b> | 0.56±0.25<br>(0.022±0.010) |
| <b>B</b> | 0.35±0.15<br>(0.014±0.006) |

### FINAL QUALITY INSPECTION

Finished parts are 100% tested for electrical parameters and visual/mechanical characteristics. Each production lot is evaluated on a sample basis for:

- Static Humidity: 85°C, 85% RH, 160 hours
- Endurance: 125°C,  $I_R$  4 hours

### TERMINATION

Nickel/Solder coating (Sn, Pb) compatible with automatic soldering technologies: reflow, wave soldering, vapor phase and manual.

### HOW TO ORDER

**LP**  
T  
**Style**  
Low Pass

**0805A**  
T  
**Size**  
0805

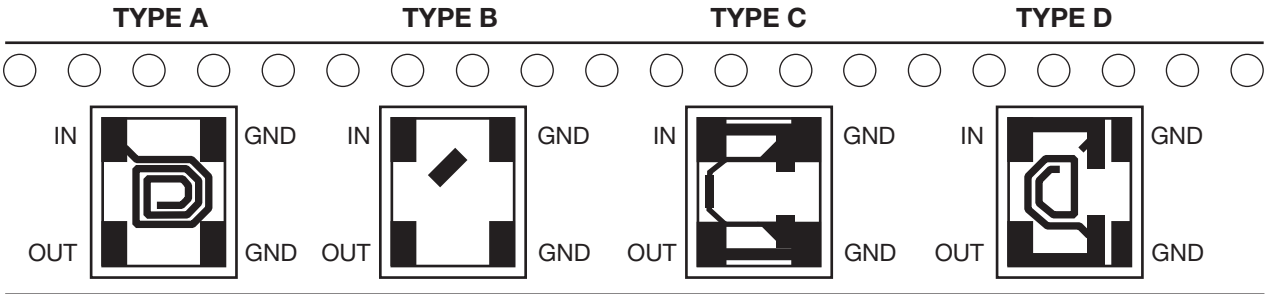
**0902**  
T  
**Frequency**  
MHz

**AW**  
T  
**Termination**  
Nickel/Solder (Sn/Pb)

**TR**  
T  
**Packaging Code**  
TR = Tape and Reel

### TERMINALS AND LAYOUT (Top View)

#### Orientation in Tape



# Thin-Film Low Pass Filter

## LP0805 Type Harmonic

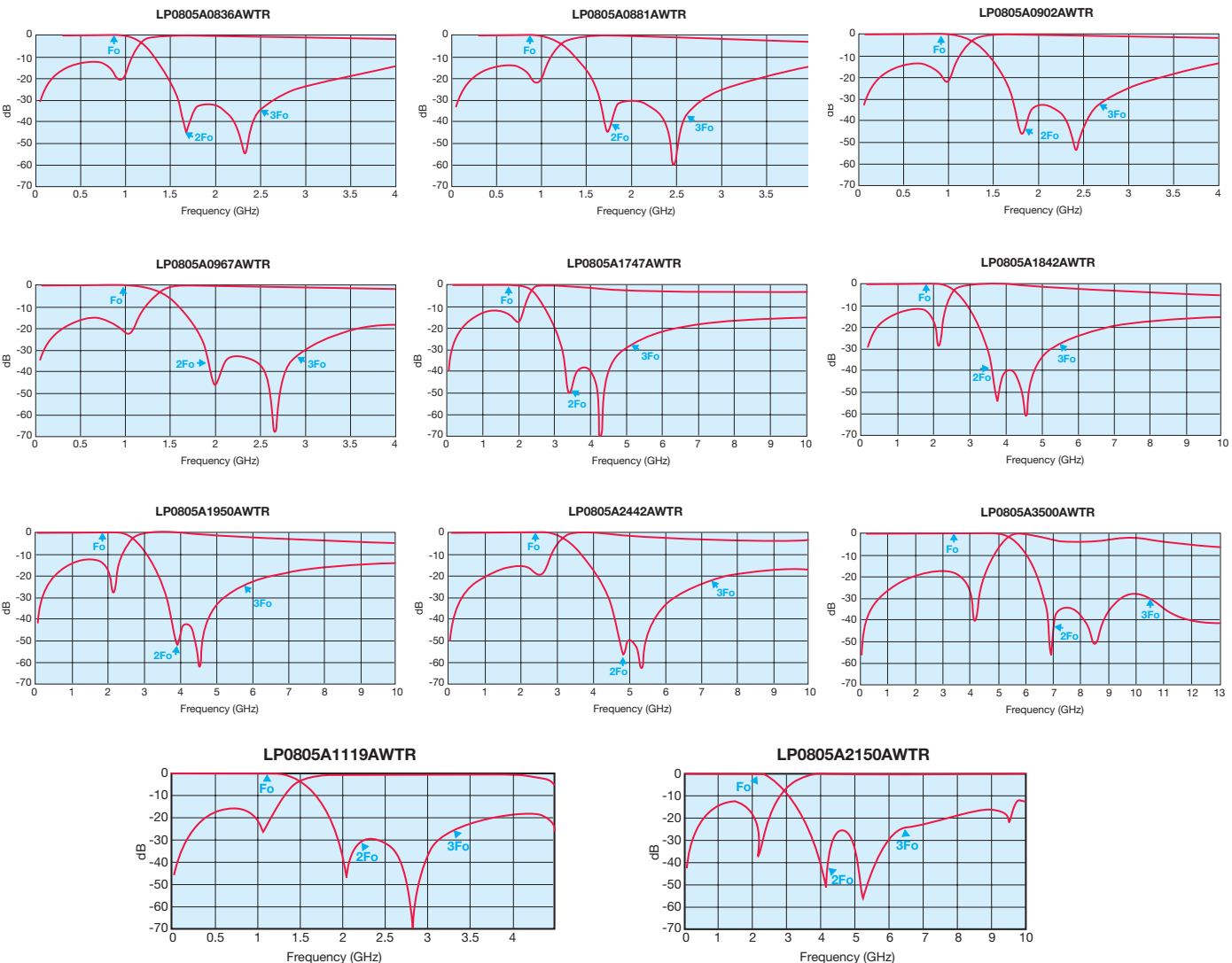


### ELECTRICAL CHARACTERISTICS

| Application  | Part Number   | Frequency Band (MHz) | I. Loss max          | VSWR max | Attenuation (dB) Typical                       | Layout Type |
|--------------|---------------|----------------------|----------------------|----------|------------------------------------------------|-------------|
| E-GSM        | LP0805A0897AW | 880 - 915            | 0.4dB<br>(0.3dB typ) | 1.7      | 30 @ 2X <sub>Fo</sub><br>20 @ 3x <sub>Fo</sub> | A           |
|              | LP0805A0942AW | 925 - 960            |                      |          |                                                | A           |
| GSM          | LP0805A0902AW | 890 - 915            |                      |          |                                                | A           |
|              | LP0805A0947AW | 935 - 960            |                      |          |                                                | A           |
|              | LP0805A1119AW | 1007 - 1231          |                      |          |                                                | A           |
| AMPS         | LP0805A0836AW | 824 - 849            |                      |          |                                                | A           |
|              | LP0805A0881AW | 869 - 894            |                      |          |                                                | A           |
| PCN          | LP0805A1747AW | 1710 - 1785          |                      |          |                                                | D           |
|              | LP0805A1842AW | 1805 - 1880          |                      |          |                                                | D           |
| PCS          | LP0805A1880AW | 1850 - 1910          |                      |          |                                                | D           |
|              | LP0805A1960AW | 1930 - 1990          |                      |          |                                                | D           |
| PHP          | LP0805A1907AW | 1895 - 1920          |                      |          |                                                | D           |
| DECT         | LP0805A1890AW | 1880 - 1900          |                      |          |                                                | D           |
| 3G           | LP0805A2150AW | 1935 - 2365          |                      |          |                                                | B           |
| Wireless LAN | LP0805A2442AW | 2400 - 2484          |                      |          |                                                | B           |
| WLL          | LP0805A3500AW | 3400 ~ 3600          |                      |          |                                                | C           |

### Typical Electrical Performance

4



# Thin-Film Low Pass Filter



## LP0805 Test Jig

### ITF TEST JIG FOR LOW PASS FILTER 0805

#### GENERAL DESCRIPTION

This jig is designed for the testing of the 0805 Low Pass Filter using a vector network analyzer.

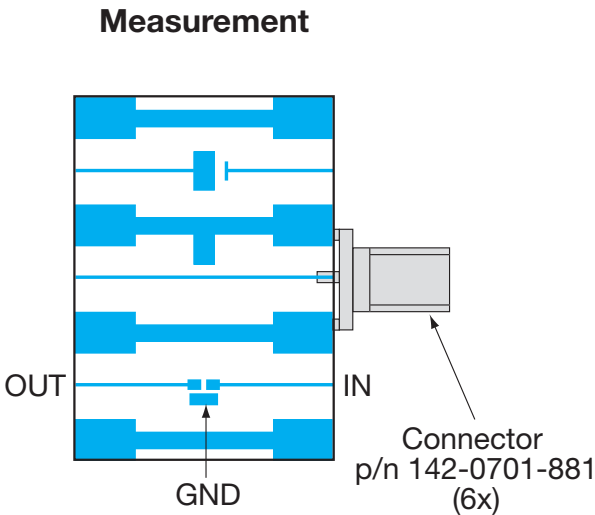
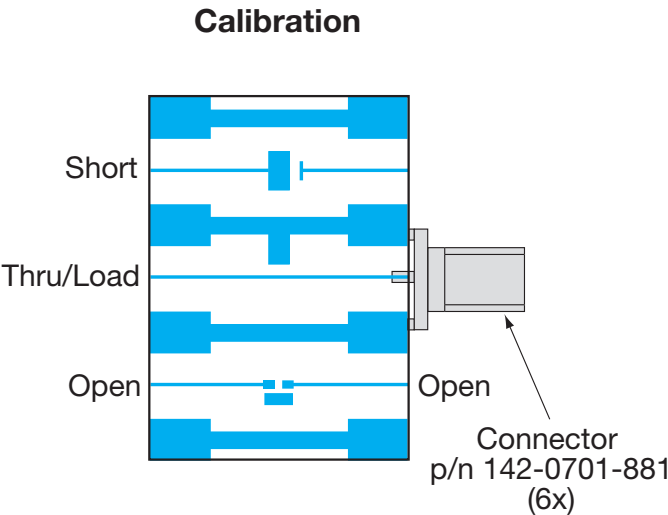
It consists of a FR4 multi-layer substrate, having 50Ω microstrips as conducting lines and a ground plane in the middle layer, located at a distance of 0.2mm from the microstrips.

The connectors are SMA type (female), 'Johnson Components Inc.' Product P/N: 142-0701-881.

#### CALIBRATION AND MEASUREMENT PROCEDURE

The jig is designed for a full 2-port calibration. LOAD calibration is carried out using a 50Ω SMA termination.

To measure a component, it can be either soldered or pressed down by a non-metallic stick until all four ports touch the appropriate pads.





# Thin-Film Products Designer Kits

Accu-P<sup>®</sup>/Accu-L<sup>®</sup> Kits

**Accu-P®**  
Designer Kit Type 1700  
Order Number: Accu-P® 0201KIT02

| Volts | Capacitors Value pF | Tolerance |
|-------|---------------------|-----------|
| 25    | 0.1                 | A         |
|       | 0.2                 | A         |
|       | 0.3                 | A         |
|       | 0.4                 | B         |
|       | 0.5                 | B         |
|       | 0.6                 | B         |
|       | 0.7                 | B         |
|       | 0.8                 | B         |
|       | 0.9                 | B         |
|       | 1.0                 | B         |
|       | 1.1                 | B         |
|       | 1.2                 | B         |
|       | 1.3                 | B         |
|       | 1.5                 | B         |
|       | 1.8                 | B         |
| 16    | 2.0                 | B         |
|       | 2.2                 | B         |
|       | 2.4                 | B         |
|       | 2.7                 | B         |
| 10    | 3.0                 | B         |
|       | 3.3                 | B         |
|       | 3.6                 | B         |
|       | 3.9                 | B         |
|       | 4.7                 | B         |
|       | 5.6                 | B         |
|       | 6.8                 | B         |
|       | 7.5                 | B         |
| 10    | 8.2                 | B         |
|       | 10.0                | G         |
|       | 12.0                | G         |

600 Capacitors, 20 each of 30 values  
**Tolerance** A =  $\pm 0.05\text{pF}$   
 B =  $\pm 0.1\text{pF}$   
 G =  $\pm 2\%$

**Accu-P®**  
Designer Kit Type 1800  
Order Number: Accu-P® 0201KIT03

| Volts | Capacitors Value pF | Tolerance |
|-------|---------------------|-----------|
| 25    | 1.0                 | A         |
|       | 1.1                 | A         |
|       | 1.2                 | A         |
|       | 1.3                 | A         |
|       | 1.4                 | A         |
|       | 1.5                 | A         |
|       | 1.6                 | A         |
|       | 1.7                 | A         |
|       | 1.8                 | A         |
|       | 1.9                 | A         |
|       | 2.0                 | A         |
|       | 2.1                 | B         |
|       | 2.2                 | B         |
|       | 2.3                 | B         |
|       | 2.4                 | B         |
| 16    | 2.5                 | B         |
|       | 2.6                 | B         |
|       | 2.7                 | B         |
|       | 2.8                 | B         |
|       | 2.9                 | B         |
|       | 3.0                 | B         |
| 16    | 3.1                 | B         |
|       | 3.3                 | B         |
|       | 3.4                 | B         |
|       | 3.6                 | B         |
|       | 3.9                 | B         |
| 10    | 4.1                 | B         |
|       | 4.3                 | B         |
|       | 4.5                 | B         |
|       | 4.7                 | B         |

600 Capacitors, 20 each of 30 values  
**Tolerance** A =  $\pm 0.05\text{pF}$   
 B =  $\pm 0.1\text{pF}$

**Accu-P®**  
Designer Kit Type 1300  
Order Number: Accu-P® 0402KIT01

| Volts | Capacitors Value pF | Tolerance |
|-------|---------------------|-----------|
| 25    | 0.1                 | A         |
|       | 0.2                 | A         |
|       | 0.3                 | A         |
|       | 0.4                 | B         |
|       | 0.5                 | B         |
|       | 0.6                 | B         |
|       | 0.7                 | B         |
|       | 0.8                 | B         |
|       | 0.9                 | B         |
|       | 1.0                 | B         |
|       | 1.1                 | B         |
|       | 1.2                 | B         |
|       | 1.5                 | B         |
|       | 1.8                 | B         |
|       | 2.0                 | B         |
| 16    | 2.2                 | B         |
|       | 2.4                 | B         |
|       | 2.7                 | B         |
|       | 3.0                 | B         |
|       | 3.3                 | B         |
| 16    | 3.9                 | B         |
|       | 4.7                 | B         |
|       | 5.6                 | B         |
|       | 6.8                 | B         |
| 10    | 8.2                 | B         |
|       | 10.0                | G         |
|       | 12.0                | G         |
| 10    | 15.0                | G         |
|       | 18.0                | G         |
|       | 22.0                | G         |

600 Capacitors, 20 each of 30 values  
**Tolerance** A =  $\pm 0.05\text{pF}$   
 B =  $\pm 0.1\text{pF}$   
 G =  $\pm 2\%$

**Accu-P®**  
Designer Kit Type 1400  
Order Number: Accu-P® 0402KIT02

| Volts | Capacitors Value pF | Tolerance |
|-------|---------------------|-----------|
| 25    | 1.0                 | A         |
|       | 1.1                 | A         |
|       | 1.2                 | A         |
|       | 1.3                 | A         |
|       | 1.4                 | A         |
|       | 1.5                 | A         |
|       | 1.6                 | A         |
|       | 1.7                 | A         |
|       | 1.8                 | A         |
|       | 1.9                 | A         |
|       | 2.0                 | A         |
|       | 2.1                 | B         |
|       | 2.2                 | B         |
|       | 2.3                 | B         |
|       | 2.4                 | B         |
|       | 2.5                 | B         |
|       | 2.6                 | B         |
|       | 2.7                 | B         |
|       | 2.8                 | B         |
|       | 2.9                 | B         |
|       | 3.0                 | B         |
|       | 3.1                 | B         |
|       | 3.3                 | B         |
|       | 3.4                 | B         |
|       | 3.6                 | B         |
|       | 3.9                 | B         |
| 25    | 4.1                 | B         |
|       | 4.3                 | B         |
|       | 4.5                 | B         |
|       | 4.7                 | B         |

600 Capacitors, 20 each of 30 values  
**Tolerance** A =  $\pm 0.05\text{pF}$   
 B =  $\pm 0.1\text{pF}$

**Accu-P®**  
Designer Kit Type 900  
Order Number: Accu-P® 0603KIT01

| Volts | Capacitors Value pF | Tolerance |
|-------|---------------------|-----------|
| 50    | 0.1                 | A         |
|       | 0.2                 | A         |
|       | 0.3                 | A         |
|       | 0.4                 | B         |
|       | 0.5                 | B         |
|       | 0.6                 | B         |
|       | 0.7                 | B         |
|       | 0.8                 | B         |
|       | 0.9                 | B         |
|       | 1.0                 | B         |
|       | 1.1                 | B         |
|       | 1.2                 | B         |
|       | 1.5                 | B         |
|       | 1.8                 | B         |
|       | 2.0                 | B         |
|       | 2.2                 | B         |
|       | 2.4                 | B         |
|       | 2.7                 | B         |
|       | 3.0                 | B         |
|       | 3.3                 | B         |
| 25    | 3.9                 | B         |
|       | 4.7                 | B         |
|       | 5.6                 | B         |
|       | 6.8                 | B         |
|       | 8.2                 | B         |
|       | 10.0                | G         |
|       | 12.0                | G         |
|       | 15.0                | G         |
| 25    | 18.0                | G         |
|       | 22.0                | G         |

600 Capacitors, 20 each of 30 values  
**Tolerance** A =  $\pm 0.05\text{pF}$   
 B =  $\pm 0.1\text{pF}$   
 G =  $\pm 2\%$

**Accu-P®**  
Designer Kit Type 800  
Order Number: Accu-P® 0805KIT02

| Volts | Capacitors Value pF | Tolerance |
|-------|---------------------|-----------|
| 100   | 0.1                 | A         |
|       | 0.2                 | A         |
|       | 0.3                 | A         |
|       | 0.4                 | A         |
|       | 0.5                 | B         |
|       | 0.7                 | B         |
|       | 0.8                 | B         |
|       | 0.9                 | B         |
|       | 1.0                 | B         |
|       | 1.2                 | B         |
|       | 1.5                 | B         |
|       | 1.8                 | B         |
|       | 2.0                 | B         |
|       | 2.2                 | B         |
|       | 2.7                 | B         |
| 50    | 3.3                 | B         |
|       | 3.9                 | B         |
|       | 4.7                 | B         |
|       | 5.6                 | B         |
|       | 6.8                 | B         |
|       | 8.2                 | B         |
|       | 10.0                | G         |
| 50    | 12.0                | G         |
|       | 15.0                | G         |
|       | 18.0                | G         |
|       | 22.0                | G         |
| 25    | 27.0                | J         |
|       | 33.0                | J         |
|       | 39.0                | J         |
|       | 47.0                | J         |

300 Capacitors, 10 each of 30 values  
**Tolerance** A =  $\pm 0.05\text{pF}$  G =  $\pm 2\%$   
 B =  $\pm 0.1\text{pF}$  J =  $\pm 5\%$

# RF/Microwave Thin-Film Products



Designer Kits *(Special Kits Available Upon Request)*

## Accu-P®

Designer Kit Type 700

Order Number: Accu-P® 1210KIT02

| Volts | Capacitors Value pF | Tolerance |
|-------|---------------------|-----------|
| 100   | 1.0                 | B         |
|       | 1.5                 | B         |
|       | 1.8                 | B         |
|       | 2.2                 | B         |
|       | 2.7                 | B         |
|       | 3.3                 | B         |
|       | 4.7                 | B         |
|       | 5.6                 | B         |
|       | 6.8                 | B         |
|       | 10.0                | G         |
|       | 12.0                | G         |
|       | 18.0                | G         |
|       | 22.0                | G         |
|       | 27.0                | G         |
|       | 33.0                | G         |

150 Capacitors, 10 each of 15 values

**Tolerance** B =  $\pm 0.1\text{pF}$   
G =  $\pm 2\%$

## Accu-P®

Designer Kit Type 2100

Order Number: Accu-P® 0402KIT03

| Volts | Capacitors Value pF | Tolerance |
|-------|---------------------|-----------|
| 25    | 0.05                | P         |
|       | 0.10                | P         |
|       | 0.15                | P         |
|       | 0.20                | P         |
|       | 0.25                | P         |
|       | 0.30                | P         |
|       | 0.35                | P         |
|       | 0.40                | P         |
|       | 0.45                | P         |
|       | 0.50                | P         |
|       | 0.55                | P         |
|       | 0.60                | P         |
|       | 0.65                | P         |
|       | 0.70                | P         |
|       | 0.75                | P         |

300 Capacitors, 20 each of 15 values

**Tolerance** P =  $\pm 0.02\text{pF}$

## Accu-P®

Designer Kit Type 2200

Order Number: Accu-P® 0603KIT02

| Volts | Capacitors Value pF | Tolerance |
|-------|---------------------|-----------|
| 50    | 0.05                | P         |
|       | 0.10                | P         |
|       | 0.15                | P         |
|       | 0.20                | P         |
|       | 0.25                | P         |
|       | 0.30                | P         |
|       | 0.35                | P         |
|       | 0.40                | P         |
|       | 0.45                | P         |
|       | 0.50                | P         |
|       | 0.55                | P         |
|       | 0.60                | P         |
|       | 0.65                | P         |
|       | 0.70                | P         |
|       | 0.75                | P         |

300 Capacitors, 20 each of 15 values

**Tolerance** P =  $\pm 0.02\text{pF}$

## Accu-P®

Designer Kit Type 2000

Order Number: Accu-P® 0201KIT04

| Volts | Capacitors Value pF | Tolerance |
|-------|---------------------|-----------|
| 25    | 0.05                | P         |
|       | 0.10                | P         |
|       | 0.15                | P         |
|       | 0.20                | P         |
|       | 0.25                | P         |
|       | 0.30                | P         |
|       | 0.35                | P         |
|       | 0.40                | P         |
|       | 0.45                | P         |
|       | 0.50                | P         |
|       | 0.55                | P         |
|       | 0.60                | P         |
|       | 0.65                | P         |
|       | 0.70                | P         |
|       | 0.75                | P         |

300 Capacitors, 20 each of 15 values

**Tolerance** P =  $\pm 0.02\text{pF}$

## Accu-L®

Designer Kit Type 1600

Order Number: Accu-L® 0603KIT02

| Inductance Value (nH) | Tolerance |
|-----------------------|-----------|
| 1.2                   | C         |
| 1.5                   | C         |
| 1.8                   | C         |
| 2.2                   | C         |
| 2.7                   | C         |
| 3.3                   | C         |
| 3.9                   | C         |
| 4.7                   | C         |
| 5.6                   | C         |
| 6.8                   | C         |
| 8.2                   | C         |
| 10                    | G         |
| 12                    | G         |
| 15                    | G         |

280 Inductors, 20 each of 14 values

**Tolerance** C =  $\pm 0.2\text{nH}$   
G =  $\pm 2\%$

## Accu-L®

Designer Kit Type 1100

Order Number: Accu-L® 0805KIT02

| Inductance Value (nH) | Tolerance |
|-----------------------|-----------|
| 1.8                   | C         |
| 2.2                   | C         |
| 2.7                   | C         |
| 3.3                   | C         |
| 3.9                   | C         |
| 4.7                   | C         |
| 5.6                   | C         |
| 6.8                   | D         |
| 8.2                   | D         |
| 10.0                  | J         |
| 12.0                  | J         |
| 15.0                  | J         |
| 18.0                  | J         |
| 22.0                  | J         |

280 Inductors, 20 each of 14 values

**Tolerance** C =  $\pm 0.2\text{nH}$   
D =  $\pm 0.5\text{nH}$   
J =  $\pm 5\%$



# RF/Microwave MLC's

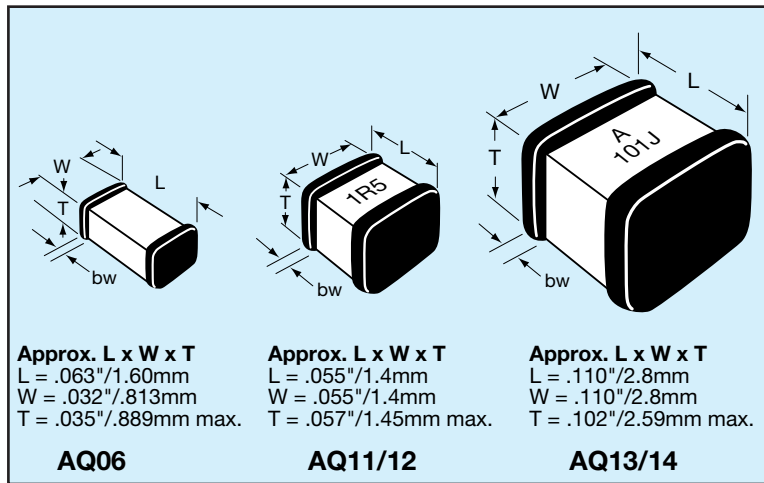
AQ Series  
CDR Series  
Porcelain and Ceramic  
RF/Microwave  
Multilayer Capacitors  
High Voltage RF Power Capacitors

6

# Microwave MLC's



## AQ Series



These porcelain and ceramic dielectric multilayer capacitor (MLC) chips are best suited for RF/Microwave applications typically ranging from 10 MHz to 4.2 GHz. Characteristic is a fine grained, high density, high purity dielectric material impervious to moisture with heavy internal palladium electrodes.

These characteristics lend well to applications requiring:

- 1) high current carrying capabilities;
- 2) high quality factors;
- 3) very low equivalent series resistance;
- 4) very high series resonance;
- 5) excellent stability under stresses of changing voltage, frequency, time and temperature.

## MECHANICAL DIMENSIONS: inches (millimeters)

| Case | Length (L)                                | Width (W)                | Thickness (T)            | Band Width (bw)                         |
|------|-------------------------------------------|--------------------------|--------------------------|-----------------------------------------|
| AQ06 | .063±.006<br>(1.60±.152)                  | .032±.006<br>(.813±.152) | .035 Max.<br>(.889)      | .014±.006<br>(.357 ±.152)               |
| AQ11 | .055±.015<br>(1.40±.381)                  | .055±.015<br>(1.40±.381) | .020/.057<br>(.508/1.45) | .010 + .010 -.005<br>(.254 +.254 -.127) |
| AQ12 | .055 + .015 - .010<br>(1.40+ .381 - .254) | .055±.015<br>(1.40±.381) | .020/.057<br>(.508/1.45) | .010 + .010 -.005<br>(.254 +.254 -.127) |
| AQ13 | .110±.020<br>(2.79±.508)                  | .110±.020<br>(2.79±.508) | .030/.102<br>(.762/2.59) | .015±.010<br>(.381±.254)                |
| AQ14 | .110 + .020 - .010<br>(2.79 +.889 -.254)  | .110±.010<br>(2.79±.508) | .030/.102<br>(.762/2.59) | .015±.010<br>(.381±.254)                |

\*For Tape and Reel packaging details see page 88

## HOW TO ORDER

**AQ**

**AVX Style**  
 AQ06, AQ11,  
 AQ12, AQ13,  
 AQ14

**11**

**Case Size**  
 (See Chart)

**E**

**Voltage Code**

5 = 50V  
 1 = 100V  
 E = 150V  
 2 = 200V  
 V = 250V  
 9 = 300V  
 7 = 500V

**M**

**Temperature Coefficient Code**

M = +90±20ppm/°C (AQ06/11/12/13/14)  
 A = 0±30ppm/°C (AQ11/12/13/14)  
 C = 15% ("J" Termination only) (AQ12/14)

**100**

**Capacitance**

EIA Capacitance Code in pF.  
 First two digits = significant figures or "R" for decimal place.  
 Third digit = number of zeros or after "R" significant figures.

**J**

**Capacitance Tolerance Code**

A = ±.05 pF  
 B = ±.1 pF  
 C = ±.25 pF  
 D = ±.5 pF  
 F = ±1%  
 G = ±2%  
 J = ±5%  
 K = ±10%  
 M = ±20%  
 N = ±30%

**A**

**Failure Rate Code**

A = Not Applicable

**1**

**Termination Style Code**

1 = Pd/Ag (AQ11/13 only)  
 7 = Ag/Ni/Au (AQ11/13 only)  
 J = Nickel Barrier Sn/Pb (60/40) - (AQ06/12/14 only)

**ME**

**Packaging\* Code**

3A = 13" Reel (AQ06 only)  
 6A = Waffle Pack (AQ06 only)  
 ME = 7" Reel  
 RE = 13" Reel  
 WE = Waffle Pack  
 1A = 7" Reel (AQ06 only)

## PACKAGING

Standard Packaging = Waffle Pack (for T&R packaging see page 88)

AQ11/12 maximum quantity per waffle pack is 100.

AQ13/14 maximum quantity is 80.



### ELECTRICAL SPECIFICATIONS

| AQ06, AQ11, AQ12, AQ13, AQ14         |                                                                                                                                                                                                           |                                                                                        |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
|                                      | M & A                                                                                                                                                                                                     | C                                                                                      |
| Temperature Coefficient              | (M) +90 ±20PPM/°C and<br>(A) 0 ±30PPM/°C                                                                                                                                                                  | ±15%                                                                                   |
| Capacitance Range                    | 0.1 pF to 5100 pF                                                                                                                                                                                         | 0.001µF to 0.1µF                                                                       |
| Capacitance Tolerance                | ±0.1 pF to ±20%                                                                                                                                                                                           | ±10%, ±20%, ±30%                                                                       |
| Operating Temperature                | -55°C + 125°C                                                                                                                                                                                             | -55°C to +125°C                                                                        |
| Quality Factor or Dissipation Factor | Per MIL-PRF-55681/4                                                                                                                                                                                       | 2.5% @ 1kHz                                                                            |
| Insulation Resistance                | Per MIL-PRF-55681<br>10 <sup>6</sup> megohm to 470 pF @ +25°C<br>10 <sup>5</sup> megohm to 470 pF @ +125°C<br>10 <sup>6</sup> megohm above 470 pF @ +25°C<br>10 <sup>4</sup> megohm above 470 pF @ +125°C | 10 <sup>4</sup> megohm min @ 25°C & R VDC<br>10 <sup>3</sup> megohm min @ 25°C & R VDC |
| Aging                                | None                                                                                                                                                                                                      | <3% per decade hour                                                                    |
| Piezoelectric Effects                | None                                                                                                                                                                                                      | None                                                                                   |
| Dielectric Withstanding Voltage      | 2.5 x rated voltage<br>(for 500V rated 1.5 x rated voltage)                                                                                                                                               | 2.5 x rated voltage<br>(for 500V rated 1.5 x rated voltage)                            |

### ENVIRONMENTAL CHARACTERISTICS

Will meet or exceed performance characteristics as outlined in MIL-PRF-55681/4.

| REQUIREMENT                  | MIL-STD-202 METHOD |
|------------------------------|--------------------|
| Life                         | 108, Condition F   |
| Shock                        | 213, Condition J   |
| Vibration                    | 204, Condition B   |
| Immersion                    | 104, Condition B   |
| Salt Spray                   | 101, Condition B   |
| Solderability                | 208                |
| Thermal Shock                | 107, Condition B   |
| Terminal Strength            | 211                |
| Temperature Cycling          | 102, Condition C   |
| Moisture Resistance          | 106                |
| Barometric Pressure          | 105, Condition B   |
| Resistance to Soldering Heat | 210, Condition C   |

### QUALITY FACTOR vs. FREQUENCY (Typical)

| Capacitance | @ 30 MHz | @ 150 MHz | @ 500 MHz | @ 1000 MHz |
|-------------|----------|-----------|-----------|------------|
| 1 pF        | 30000    | 4000      | 800       | 350        |
| 10 pF       | 9000     | 2000      | 400       | 150        |
| 30 pF       | 5000     | 800       | 200       | 60         |
| 100 pF      | 2800     | 400       | 70        | 25         |
| 200 pF      | 1500     | 250       | 40        | 12         |

### CAPACITANCE AND SIZE vs. SERIES SELF RESONANT FREQUENCY (Typical)

**DIMENSIONS:** inches (millimeters)

| Case    | Size (Nominal)                             | 1 pF    | 10 pF   | 50 pF   | 100 pF  |
|---------|--------------------------------------------|---------|---------|---------|---------|
| AQ06    | .063 x .032 x .035<br>(1.60 x .813 x .889) | 9.6 GHz | 3.2 GHz | 1.5 GHz | 1.0 GHz |
| AQ11/12 | .055 x .055 x .057<br>(1.40 x 1.40 x 1.45) | 9.6 GHz | 3.2 GHz | 1.5 GHz | 1.0 GHz |
| AQ13/14 | .110 x .110 x .102<br>(2.79 x 2.79 x 2.59) | 6.4 GHz | 2.2 GHz | 1.0 GHz | 0.7 GHz |

# Microwave MLC's



AQ Series Available Capacitance/Size/WVDC/T.C.

TABLE I: TC: M (+90±20PPM/°C)  
CASE SIZE 06, 11, 12, 13 & 14

DIMENSIONS: inches (millimeters)

| Case | Length                                | Width                 | Thickness             | Band Width                          | Avail. Term. |
|------|---------------------------------------|-----------------------|-----------------------|-------------------------------------|--------------|
| 06   | .063±.006 (1.60±.152)                 | .032±.006 (.813±.152) | .035 Max. (.889)      | .014±.006 (.357 ±.152)              | J            |
| 11   | .055±.015 (1.40±.381)                 | .055±.015 (1.40±.381) | .020/.057 (.508/1.45) | .010 +.010 -.005 (.254 +.254 -.127) | 1 & 7        |
| 12   | .055±.025 (1.40±.635)                 | .055±.015 (1.40±.381) | .020/.057 (.508/1.45) | .010 +.010 -.005 (.254 +.254 -.127) | J            |
| 13   | .110±.020 (2.79±.508)                 | .110±.020 (2.79±.508) | .030/.102 (.762/2.59) | .015±.010 (.381±.254)               | 1 & 7        |
| 14   | .110 +0.035 -0.020 (2.79 +.889 -.508) | .110±.020 (2.79±.508) | .030/.102 (.762/2.59) | .015±.010 (.381±.254)               | J            |

| Case: AQ06 |               |      | Case: AQ11, AQ12 |               |      | Case: AQ13, AQ14 |               |      |         |               |      |
|------------|---------------|------|------------------|---------------|------|------------------|---------------|------|---------|---------------|------|
| Cap. pF    | Cap. Tol.     | WVDC | Cap. pF          | Cap. Tol.     | WVDC | Cap. pF          | Cap. Tol.     | WVDC | Cap. pF | Cap. Tol.     | WVDC |
| 0.1        | B             | 250  | 0.1              | B             | 150  | 0.1              | B             | 500  | 100     | F, G, J, K, M | 500  |
| 0.2        | B             | 250  | 0.2              | B             | 150  | 0.2              | B             | 500  | 110     | F, G, J, K, M | 300  |
| 0.3        | B,C           | 250  | 0.3              | B,C           | 150  | 0.3              | B,C           | 500  | 120     | F, G, J, K, M | 300  |
| 0.4        | B,C           | 250  | 0.4              | B,C           | 150  | 0.4              | B,C           | 500  | 130     | F, G, J, K, M | 300  |
| 0.5        | B, C, D       | 250  | 0.5              | B, C, D       | 150  | 0.5              | B, C, D       | 500  | 150     | F, G, J, K, M | 300  |
| 0.6        | B, C, D       | 250  | 0.6              | B, C, D       | 150  | 0.6              | B, C, D       | 500  | 160     | F, G, J, K, M | 300  |
| 0.7        | B, C, D       | 250  | 0.7              | B, C, D       | 150  | 0.7              | B, C, D       | 500  | 180     | F, G, J, K, M | 300  |
| 0.8        | B, C, D       | 250  | 0.8              | B, C, D       | 150  | 0.8              | B, C, D       | 500  | 200     | F, G, J, K, M | 300  |
| 0.9        | B, C, D       | 250  | 0.9              | B, C, D       | 150  | 0.9              | B, C, D       | 500  | 220     | F, G, J, K, M | 200  |
| 1.0        | B, C, D       | 250  | 1.0              | B, C, D       | 150  | 1.0              | B, C, D       | 500  | 240     | F, G, J, K, M | 200  |
| 1.1        | B, C, D       | 250  | 1.1              | B, C, D       | 150  | 1.1              | B, C, D       | 500  | 270     | F, G, J, K, M | 200  |
| 1.2        | B, C, D       | 250  | 1.2              | B, C, D       | 150  | 1.2              | B, C, D       | 500  | 300     | F, G, J, K, M | 200  |
| 1.3        | B, C, D       | 250  | 1.3              | B, C, D       | 150  | 1.3              | B, C, D       | 500  | 330     | F, G, J, K, M | 200  |
| 1.4        | B, C, D       | 250  | 1.4              | B, C, D       | 150  | 1.4              | B, C, D       | 500  | 360     | F, G, J, K, M | 200  |
| 1.5        | B, C, D       | 250  | 1.5              | B, C, D       | 150  | 1.5              | B, C, D       | 500  | 390     | F, G, J, K, M | 200  |
| 1.6        | B, C, D       | 250  | 1.6              | B, C, D       | 150  | 1.6              | B, C, D       | 500  | 430     | F, G, J, K, M | 200  |
| 1.7        | B, C, D       | 250  | 1.7              | B, C, D       | 150  | 1.7              | B, C, D       | 500  | 470     | F, G, J, K, M | 200  |
| 1.8        | B, C, D       | 250  | 1.8              | B, C, D       | 150  | 1.8              | B, C, D       | 500  | 510     | F, G, J, K, M | 150  |
| 1.9        | B, C, D       | 250  | 1.9              | B, C, D       | 150  | 1.9              | B, C, D       | 500  | 560     | F, G, J, K, M | 150  |
| 2.0        | B, C, D       | 250  | 2.0              | B, C, D       | 150  | 2.0              | B, C, D       | 500  | 620     | F, G, J, K, M | 150  |
| 2.2        | B, C, D       | 250  | 2.2              | B, C, D       | 150  | 2.2              | B, C, D       | 500  | 680     | F, G, J, K, M | 150  |
| 2.4        | B, C, D       | 250  | 2.4              | B, C, D       | 150  | 2.4              | B, C, D       | 500  | 750     | F, G, J, K, M | 150  |
| 2.7        | B, C, D       | 250  | 2.7              | B, C, D       | 150  | 2.7              | B, C, D       | 500  | 820     | F, G, J, K, M | 150  |
| 3.0        | B, C, D       | 250  | 3.0              | B, C, D       | 150  | 3.0              | B, C, D       | 500  | 910     | F, G, J, K, M | 150  |
| 3.3        | B, C, D       | 250  | 3.3              | B, C, D       | 150  | 3.3              | B, C, D       | 500  | 1000    | F, G, J, K, M | 150  |
| 3.6        | B, C, D       | 250  | 3.6              | B, C, D       | 150  | 3.6              | B, C, D       | 500  |         |               |      |
| 3.9        | B, C, D       | 250  | 3.9              | B, C, D       | 150  | 3.9              | B, C, D       | 500  |         |               |      |
| 4.3        | B, C, D       | 250  | 4.3              | B, C, D       | 150  | 4.3              | B, C, D       | 500  |         |               |      |
| 4.7        | B, C, D       | 250  | 4.7              | B, C, D       | 150  | 4.7              | B, C, D       | 500  |         |               |      |
| 5.1        | B, C, D       | 250  | 5.1              | B, C, D       | 150  | 5.1              | B, C, D       | 500  |         |               |      |
| 5.6        | B, C, D       | 250  | 5.6              | B, C, D       | 150  | 5.6              | B, C, D       | 500  |         |               |      |
| 6.2        | B, C, D       | 250  | 6.2              | B, C, D       | 150  | 6.2              | B, C, D       | 500  |         |               |      |
| 6.8        | B, C, J, K, M | 250  | 6.8              | B, C, J, K, M | 150  | 6.8              | B, C, J, K, M | 500  |         |               |      |
| 7.5        | B, C, J, K, M | 250  | 7.5              | B, C, J, K, M | 150  | 7.5              | B, C, J, K, M | 500  |         |               |      |
| 8.2        | B, C, J, K, M | 250  | 8.2              | B, C, J, K, M | 150  | 8.2              | B, C, J, K, M | 500  |         |               |      |
| 9.1        | B, C, J, K, M | 250  | 9.1              | B, C, J, K, M | 150  | 9.1              | B, C, J, K, M | 500  |         |               |      |
| 10         | F, G, J, K, M | 250  | 10               | F, G, J, K, M | 150  | 10               | F, G, J, K, M | 500  |         |               |      |
| 11         | F, G, J, K, M | 250  | 11               | F, G, J, K, M | 150  | 11               | F, G, J, K, M | 500  |         |               |      |
| 12         | F, G, J, K, M | 250  | 12               | F, G, J, K, M | 150  | 12               | F, G, J, K, M | 500  |         |               |      |
| 13         | F, G, J, K, M | 250  | 13               | F, G, J, K, M | 150  | 13               | F, G, J, K, M | 500  |         |               |      |
| 15         | F, G, J, K, M | 250  | 15               | F, G, J, K, M | 150  | 15               | F, G, J, K, M | 500  |         |               |      |
| 16         | F, G, J, K, M | 250  | 16               | F, G, J, K, M | 150  | 16               | F, G, J, K, M | 500  |         |               |      |
| 18         | F, G, J, K, M | 250  | 18               | F, G, J, K, M | 150  | 18               | F, G, J, K, M | 500  |         |               |      |
| 20         | F, G, J, K, M | 250  | 20               | F, G, J, K, M | 150  | 20               | F, G, J, K, M | 500  |         |               |      |
| 22         | F, G, J, K, M | 250  | 22               | F, G, J, K, M | 150  | 22               | F, G, J, K, M | 500  |         |               |      |
| 24         | F, G, J, K, M | 250  | 24               | F, G, J, K, M | 150  | 24               | F, G, J, K, M | 500  |         |               |      |
| 27         | F, G, J, K, M | 250  | 27               | F, G, J, K, M | 150  | 27               | F, G, J, K, M | 500  |         |               |      |
| 30         | F, G, J, K, M | 250  | 30               | F, G, J, K, M | 150  | 30               | F, G, J, K, M | 500  |         |               |      |
| 33         | F, G, J, K, M | 250  | 33               | F, G, J, K, M | 150  | 33               | F, G, J, K, M | 500  |         |               |      |
| 36         | F, G, J, K, M | 50   | 36               | F, G, J, K, M | 150  | 36               | F, G, J, K, M | 500  |         |               |      |
| 39         | F, G, J, K, M | 50   | 39               | F, G, J, K, M | 150  | 39               | F, G, J, K, M | 500  |         |               |      |
| 43         | F, G, J, K, M | 50   | 43               | F, G, J, K, M | 150  | 43               | F, G, J, K, M | 500  |         |               |      |
| 47         | F, G, J, K, M | 50   | 47               | F, G, J, K, M | 150  | 47               | F, G, J, K, M | 500  |         |               |      |
| 51         | F, G, J, K, M | 50   | 51               | F, G, J, K, M | 150  | 51               | F, G, J, K, M | 500  |         |               |      |
| 56         | F, G, J, K, M | 50   | 56               | F, G, J, K, M | 150  | 56               | F, G, J, K, M | 500  |         |               |      |
| 62         | F, G, J, K, M | 50   | 62               | F, G, J, K, M | 150  | 62               | F, G, J, K, M | 500  |         |               |      |
| 68         | F, G, J, K, M | 50   | 68               | F, G, J, K, M | 150  | 68               | F, G, J, K, M | 500  |         |               |      |
| 75         | F, G, J, K, M | 50   | 75               | F, G, J, K, M | 150  | 75               | F, G, J, K, M | 500  |         |               |      |
| 82         | F, G, J, K, M | 50   | 82               | F, G, J, K, M | 150  | 82               | F, G, J, K, M | 500  |         |               |      |
| 91         | F, G, J, K, M | 50   | 91               | F, G, J, K, M | 150  | 91               | F, G, J, K, M | 500  |         |               |      |
| 100        | F, G, J, K, M | 50   | 100              | F, G, J, K, M | 150  |                  |               |      |         |               |      |
| 120        | F, G, J, K, M | 50   |                  |               |      |                  |               |      |         |               |      |





**TABLE II: TC: A ( $0 \pm 30 \text{PPM}/^\circ\text{C}$ )  
CASE SIZE 06, 11, 12, 13 & 14**

**DIMENSIONS:** inches (millimeters)

| Case | Length                              | Width                 | Thickness             | Band Width                          | Avail. Term. |
|------|-------------------------------------|-----------------------|-----------------------|-------------------------------------|--------------|
| 06   | .063±.006 (.160±.152)               | .032±.006 (.813±.152) | .035 Max. (.889)      | .014±.006 (.357 +.152)              | J            |
| 11   | .055±.015 (.140±.381)               | .055±.015 (.140±.381) | .020/.057 (.508/1.45) | .010 +.010 -.005 (.254 +.254 -.127) | 1 & 7        |
| 12   | .055±.025 (.140±.635)               | .055±.015 (.140±.381) | .020/.057 (.508/1.45) | .010 +.010 -.005 (.254 +.254 -.127) | J            |
| 13   | .110±.020 (2.79±.508)               | .110±.020 (2.79±.508) | .030/.102 (.762/2.59) | .015±.010 (.381±.254)               | 1 & 7        |
| 14   | .110 +.035 -.020 (2.79 +.889 -.508) | .110±.020 (2.79±.508) | .030/.102 (.762/2.59) | .015±.010 (.381±.254)               | J            |

| Case: AQ06 |               |      |
|------------|---------------|------|
| Cap. pF    | Cap. Tol.     | WVDC |
| 0.1        | B             | 250  |
| 0.2        | B             | 250  |
| 0.3        | B,C           | 250  |
| 0.4        | B,C           | 250  |
| 0.5        | B, C, D       | 250  |
| 0.6        | B, C, D       | 250  |
| 0.7        | B, C, D       | 250  |
| 0.8        | B, C, D       | 250  |
| 0.9        | B, C, D       | 250  |
| 1.0        | B, C, D       | 250  |
| 1.1        | B, C, D       | 250  |
| 1.2        | B, C, D       | 250  |
| 1.3        | B, C, D       | 250  |
| 1.4        | B, C, D       | 250  |
| 1.5        | B, C, D       | 250  |
| 1.6        | B, C, D       | 250  |
| 1.7        | B, C, D       | 250  |
| 1.8        | B, C, D       | 250  |
| 1.9        | B, C, D       | 250  |
| 2.0        | B, C, D       | 250  |
| 2.2        | B, C, D       | 250  |
| 2.4        | B, C, D       | 250  |
| 2.7        | B, C, D       | 250  |
| 3.0        | B, C, D       | 250  |
| 3.3        | B, C, D       | 250  |
| 3.6        | B, C, D       | 250  |
| 3.9        | B, C, D       | 250  |
| 4.3        | B, C, D       | 250  |
| 4.7        | B, C, D       | 250  |
| 5.1        | B, C, D       | 250  |
| 5.6        | B, C, D       | 250  |
| 6.2        | B, C, D       | 250  |
| 6.8        | B, C, J, K, M | 250  |
| 7.5        | B, C, J, K, M | 250  |
| 8.2        | B, C, J, K, M | 250  |
| 9.1        | B, C, J, K, M | 250  |
| 10         | F, G, J, K, M | 250  |
| 11         | F, G, J, K, M | 250  |
| 12         | F, G, J, K, M | 250  |
| 13         | F, G, J, K, M | 250  |
| 15         | F, G, J, K, M | 250  |
| 16         | F, G, J, K, M | 250  |
| 18         | F, G, J, K, M | 250  |
| 20         | F, G, J, K, M | 250  |
| 22         | F, G, J, K, M | 250  |
| 24         | F, G, J, K, M | 250  |
| 27         | F, G, J, K, M | 250  |
| 30         | F, G, J, K, M | 250  |
| 33         | F, G, J, K, M | 250  |
| 36         | F, G, J, K, M | 50   |
| 39         | F, G, J, K, M | 50   |
| 43         | F, G, J, K, M | 50   |
| 47         | F, G, J, K, M | 50   |
| 51         | F, G, J, K, M | 50   |
| 56         | F, G, J, K, M | 50   |
| 62         | F, G, J, K, M | 50   |
| 68         | F, G, J, K, M | 50   |
| 75         | F, G, J, K, M | 50   |
| 82         | F, G, J, K, M | 50   |
| 91         | F, G, J, K, M | 50   |
| 100        | F, G, J, K, M | 50   |
| 120        | F, G, J, K, M | 50   |

| Cap. pF | Cap. Tol.     | WVDC | Cap. pF | Cap. Tol.     | WVDC |
|---------|---------------|------|---------|---------------|------|
| 0.1     | B             | 150  | 24      | F, G, J, K, M | 150  |
| 0.2     | B             | 150  | 27      | F, G, J, K, M | 150  |
| 0.3     | B,C           | 150  | 30      | F, G, J, K, M | 150  |
| 0.4     | B,C           | 150  | 33      | F, G, J, K, M | 150  |
| 0.5     | B, C, D       | 150  | 36      | F, G, J, K, M | 150  |
| 0.6     | B, C, D       | 150  | 39      | F, G, J, K, M | 150  |
| 0.7     | B, C, D       | 150  | 43      | F, G, J, K, M | 150  |
| 0.8     | B, C, D       | 150  | 47      | F, G, J, K, M | 150  |
| 0.9     | B, C, D       | 150  | 51      | F, G, J, K, M | 150  |
| 1.0     | B, C, D       | 150  | 56      | F, G, J, K, M | 150  |
| 1.1     | B, C, D       | 150  | 62      | F, G, J, K, M | 150  |
| 1.2     | B, C, D       | 150  | 68      | F, G, J, K, M | 150  |
| 1.3     | B, C, D       | 150  | 75      | F, G, J, K, M | 150  |
| 1.4     | B, C, D       | 150  | 82      | F, G, J, K, M | 150  |
| 1.5     | B, C, D       | 150  | 91      | F, G, J, K, M | 150  |
| 1.6     | B, C, D       | 150  | 100     | F, G, J, K, M | 150  |
| 1.7     | B, C, D       | 150  | 110     | F, G, J, K, M | 50   |
| 1.8     | B, C, D       | 150  | 120     | F, G, J, K, M | 50   |
| 1.9     | B, C, D       | 150  | 130     | F, G, J, K, M | 50   |
| 2.0     | B, C, D       | 150  | 150     | F, G, J, K, M | 50   |
| 2.2     | B, C, D       | 150  | 160     | F, G, J, K, M | 50   |
| 2.4     | B, C, D       | 150  | 180     | F, G, J, K, M | 50   |
| 2.7     | B, C, D       | 150  | 200     | F, G, J, K, M | 50   |
| 3.0     | B, C, D       | 150  | 220     | F, G, J, K, M | 50   |
| 3.3     | B, C, D       | 150  | 240     | F, G, J, K, M | 50   |
| 3.6     | B, C, D       | 150  | 270     | F, G, J, K, M | 50   |
| 3.9     | B, C, D       | 150  | 300     | F, G, J, K, M | 50   |
| 4.3     | B, C, D       | 150  | 330     | F, G, J, K, M | 50   |
| 4.7     | B, C, D       | 150  | 360     | F, G, J, K, M | 50   |
| 5.1     | B, C, D       | 150  | 390     | F, G, J, K, M | 50   |
| 5.6     | B, C, D       | 150  | 430     | F, G, J, K, M | 50   |
| 6.2     | B, C, D       | 150  | 470     | F, G, J, K, M | 50   |
| 6.8     | B, C, J, K, M | 150  | 510     | F, G, J, K, M | 50   |
| 7.5     | B, C, J, K, M | 150  | 560     | F, G, J, K, M | 50   |
| 8.2     | B, C, J, K, M | 150  | 620     | F, G, J, K, M | 50   |
| 9.1     | B, C, J, K, M | 150  | 680     | F, G, J, K, M | 50   |
| 10      | F, G, J, K, M | 150  | 750     | F, G, J, K, M | 50   |
| 11      | F, G, J, K, M | 150  | 820     | F, G, J, K, M | 50   |
| 12      | F, G, J, K, M | 150  | 910     | F, G, J, K, M | 50   |
| 13      | F, G, J, K, M | 150  | 1000    | F, G, J, K, M | 50   |
| 15      | F, G, J, K, M | 150  |         |               |      |
| 16      | F, G, J, K, M | 150  |         |               |      |
| 18      | F, G, J, K, M | 150  |         |               |      |
| 20      | F, G, J, K, M | 150  |         |               |      |
| 22      | F, G, J, K, M | 150  |         |               |      |

| Case: AQ13, AQ14 |               |      |         |               |      |
|------------------|---------------|------|---------|---------------|------|
| Cap. pF          | Cap. Tol.     | WVDC | Cap. pF | Cap. Tol.     | WVDC |
| 0.1              | B             | 500  | 51      | F, G, J, K, M | 500  |
| 0.2              | B             | 500  | 56      | F, G, J, K, M | 500  |
| 0.3              | B, C          | 500  | 62      | F, G, J, K, M | 500  |
| 0.4              | B, C          | 500  | 68      | F, G, J, K, M | 500  |
| 0.5              | B, C, D       | 500  | 75      | F, G, J, K, M | 500  |
| 0.6              | B, C, D       | 500  | 82      | F, G, J, K, M | 500  |
| 0.7              | B, C, D       | 500  | 91      | F, G, J, K, M | 500  |
| 0.8              | B, C, D       | 500  | 100     | F, G, J, K, M | 500  |
| 0.9              | B, C, D       | 500  | 110     | F, G, J, K, M | 300  |
| 1.0              | B, C, D       | 500  | 120     | F, G, J, K, M | 300  |
| 1.1              | B, C, D       | 500  | 130     | F, G, J, K, M | 300  |
| 1.2              | B, C, D       | 500  | 150     | F, G, J, K, M | 300  |
| 1.3              | B, C, D       | 500  | 160     | F, G, J, K, M | 300  |
| 1.4              | B, C, D       | 500  | 180     | F, G, J, K, M | 300  |
| 1.5              | B, C, D       | 500  | 200     | F, G, J, K, M | 300  |
| 1.6              | B, C, D       | 500  | 220     | F, G, J, K, M | 200  |
| 1.7              | B, C, D       | 500  | 240     | F, G, J, K, M | 200  |
| 1.8              | B, C, D       | 500  | 270     | F, G, J, K, M | 200  |
| 1.9              | B, C, D       | 500  | 300     | F, G, J, K, M | 200  |
| 2.0              | B, C, D       | 500  | 330     | F, G, J, K, M | 200  |
| 2.2              | B, C, D       | 500  | 360     | F, G, J, K, M | 200  |
| 2.4              | B, C, D       | 500  | 390     | F, G, J, K, M | 200  |
| 2.7              | B, C, D       | 500  | 430     | F, G, J, K, M | 200  |
| 3.0              | B, C, D       | 500  | 470     | F, G, J, K, M | 200  |
| 3.3              | B, C, D       | 500  | 510     | F, G, J, K, M | 150  |
| 3.6              | B, C, D       | 500  | 560     | F, G, J, K, M | 150  |
| 3.9              | B, C, D       | 500  | 620     | F, G, J, K, M | 150  |
| 4.3              | B, C, D       | 500  | 680     | F, G, J, K, M | 150  |
| 4.7              | B, C, D       | 500  | 750     | F, G, J, K, M | 150  |
| 5.1              | B, C, D       | 500  | 820     | F, G, J, K, M | 150  |
| 5.6              | B, C, D       | 500  | 910     | F, G, J, K, M | 150  |
| 6.2              | B, C, D       | 500  | 1000    | F, G, J, K, M | 150  |
| 6.8              | B, C, J, K, M | 500  | 1100    | F, G, J, K, M | 50   |
| 7.5              | B, C, J, K, M | 500  | 1200    | F, G, J, K, M | 50   |
| 8.2              | B, C, J, K, M | 500  | 1300    | F, G, J, K, M | 50   |
| 9.1              | B, C, J, K, M | 500  | 1500    | F, G, J, K, M | 50   |
| 10               | F, G, J, K, M | 500  | 1600    | F, G, J, K, M | 50   |
| 11               | F, G, J, K, M | 500  | 1800    | F, G, J, K, M | 50   |
| 12               | F, G, J, K, M | 500  | 2000    | F, G, J, K, M | 50   |
| 13               | F, G, J, K, M | 500  | 2200    | F, G, J, K, M | 50   |
| 15               | F, G, J, K, M | 500  | 2400    | F, G, J, K, M | 50   |
| 16               | F, G, J, K, M | 500  | 2700    | F, G, J, K, M | 50   |
| 18               | F, G, J, K, M | 500  | 3000    | F, G, J, K, M | 50   |
| 20               | F, G, J, K, M | 500  | 3300    | F, G, J, K, M | 50   |
| 22               | F, G, J, K, M | 500  | 3600    | F, G, J, K, M | 50   |
| 24               | F, G, J, K, M | 500  | 3900    | F, G, J, K, M | 50   |
| 27               | F, G, J, K, M | 500  | 4300    | F, G, J, K, M | 50   |
| 30               | F, G, J, K, M | 500  | 4700    | F, G, J, K, M | 50   |
| 33               | F, G, J, K, M | 500  | 5000    | F, G, J, K, M | 50   |
| 36               | F, G, J, K, M | 500  | 5100    | F, G, J, K, M | 50   |
| 39               | F, G, J, K, M | 500  |         |               |      |
| 43               | F, G, J, K, M | 500  |         |               |      |
| 47               | F, G, J, K, M | 500  |         |               |      |

**TABLE III: TC: C ( $\pm 15\%$ )      CASE SIZE 12 & 14**

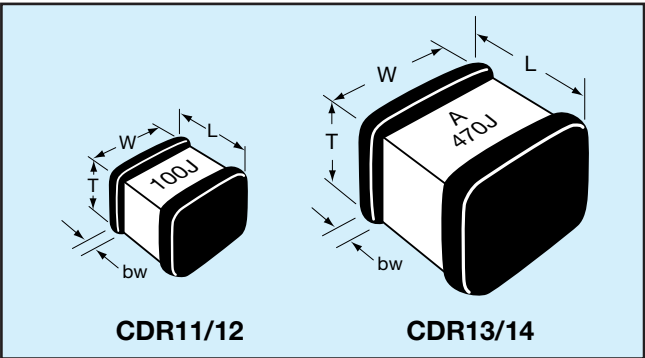
| Case: AQ12 |           |      |         |           |      |         |           |      | Case: AQ14 |           |      |         |           |      |         |           |      |
|------------|-----------|------|---------|-----------|------|---------|-----------|------|------------|-----------|------|---------|-----------|------|---------|-----------|------|
| Cap. pF    | Cap. Tol. | WVDC | Cap. pF | Cap. Tol. | WVDC | Cap. pF | Cap. Tol. | WVDC | Cap. pF    | Cap. Tol. | WVDC | Cap. pF | Cap. Tol. | WVDC | Cap. pF | Cap. Tol. | WVDC |
| 1000       | K, M, N   | 50   | 2200    | K, M, N   | 50   | 5100    | K, M, N   | 50   | 5000       | K, M, N   | 50   | 15000   | K, M, N   | 50   | 47000   | K, M, N   | 50   |
| 1200       | K, M, N   | 50   | 2700    | K, M, N   | 50   | 5600    | K, M, N   | 50   | 6800       | K, M, N   | 50   | 18000   | K, M, N   | 50   | 68000   | K, M, N   | 50   |
| 1500       | K, M, N   | 50   | 3300    | K, M, N   | 50   | 6800    | K, M, N   | 50   | 8200       | K, M, N   | 50   | 27000   | K, M, N   | 50   | 82000   | K, M, N   | 50   |
| 1800       | K, M, N   | 50   | 3900    | K, M, N   | 50   | 8200    | K, M, N   | 50   | 10000      | K, M, N   | 50   | 33000   | K, M, N   | 50   | 100000  | K, M, N   | 50   |
| 2000       | K, M, N   | 50   | 4700    | K, M, N   | 50   | 10000   | K, M, N   | 50   | 12000      | K, M, N   | 50   | 39000   | K, M, N   | 50   |         |           |      |

# Microwave MLC's



## CDR Series — MIL-PRF-55681 (RF/Microwave Chips)

### MILITARY DESIGNATION PER MIL-PRF-55681



### CROSS REFERENCE: AVX/MIL-PRF-55681

| Per MIL-C-55681 | AVX Style | Length (L)                             | Width (W)                | Thickness (T)  |                | Termination Band (bw) |                |
|-----------------|-----------|----------------------------------------|--------------------------|----------------|----------------|-----------------------|----------------|
|                 |           |                                        |                          | Max            | Min            | Max                   | Min            |
| CDR11           | AQ11      | .055±.015<br>(1.40±.381)               | .055±.015<br>(1.40±.381) | .057<br>(1.45) | .020<br>(.508) | .020<br>(.508)        | .005<br>(.127) |
| CDR12           | AQ12      | .055±.025<br>(1.40±.635)               | .055±.015<br>(1.40±.381) | .057<br>(1.45) | .020<br>(.508) | .020<br>(.508)        | .005<br>(.127) |
| CDR13           | AQ13      | .110±.020<br>(2.79±.508)               | .110±.020<br>(2.79±.508) | .102<br>(2.59) | .030<br>(.762) | .025<br>(.635)        | .005<br>(.127) |
| CDR14           | AQ14      | .110 +.035 -0.20<br>(2.79 +.889 -.508) | .110±.020<br>(2.79±.508) | .102<br>(2.59) | .030<br>(.762) | .025<br>(.635)        | .005<br>(.127) |

### HOW TO ORDER

**CDR12**

**MIL Style**  
CDR11, CDR12,  
CDR13, CDR14

**BG**

**Voltage  
Temperature  
Limits**

BG = +90±20 ppm/°C  
with and without  
rated voltage from  
-55°C to +125°C  
BP = 0±30ppm/°C  
with and without  
rated voltage from  
-55°C to +125°C

**101**

**Capacitance**

EIA Capacitance Code in pF.  
First two digits = significant figures  
or "R" for decimal place.  
Third digit = number of zeros or  
after "R" significant figures.

**A**

**Rated Voltage  
Code**

A = 50V  
B = 100V  
C = 200V  
D = 300V  
E = 500V

**K**

**Capacitance  
Tolerance Code**

B = ±.1 pF  
C = ±.25 pF  
D = ±.5 pF  
F = ±1%  
G = ±2%  
J = ±5%  
K = ±10%  
M = ±20%

**U**

**Termination  
Finish (Military  
Designations)  
Code**

M = Palladium/Silver  
(CDR11 & 13 only)  
N = Silver, Nickel, Gold  
(CDR11 & 13 only)  
S = Solder Coated, Final  
(CDR12 & 14 only)  
U = Base Metalization, Barrier Metal,  
Solder Coated.  
(Solder M.P. 200°C or less)  
(CDR12 & 14 only)  
W = Base Metalization, Barrier Metal,  
Tinned (Tin or Tin/Lead Alloy)  
(CDR12 & 14 only)  
Y = 100% Tin  
Z = Base Metalization, Barrier Metal  
(Tin Lead Alloy With 4% Lead Min.)

**S**

**Failure Rate  
Level**

M = 1.0%  
P = .1%  
R = .01%  
S = .001%

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### PACKAGING

Standard Packaging = Waffle Pack (for T&R packaging see page 88)  
AQ11/12 maximum quantity per waffle pack is 100.  
AQ13/14 maximum quantity is 80.

**TABLE I: STYLES CDR11 AND CDR12 CAPACITOR CHARACTERISTICS**

| Type<br>Designation<br>1/ | Capacitance<br>in pF | Capacitance<br>tolerance | Rated temperature<br>and<br>V/Temperature | WVDC | Type<br>Designation<br>1/ | Capacitance<br>in pF | Capacitance<br>tolerance | Rated temperature<br>and<br>V/Temperature | WVDC |
|---------------------------|----------------------|--------------------------|-------------------------------------------|------|---------------------------|----------------------|--------------------------|-------------------------------------------|------|
| CDR1 -B-0R1AB--           | 0.1                  | B                        | BG, BP                                    | 50   | CDR1 -B-300A---           | 30                   | F, G, J, K, M            | BG, BP                                    | 50   |
| CDR1 -B-0R2AB--           | 0.2                  | B                        | BG, BP                                    | 50   | CDR1 -B-330A---           | 33                   | F, G, J, K, M            | BG, BP                                    | 50   |
| CDR1 -B-0R3A---           | 0.3                  | B, C                     | BG, BP                                    | 50   | CDR1 -B-360A---           | 36                   | F, G, J, K, M            | BG, BP                                    | 50   |
| CDR1 -B-0R4A---           | 0.4                  | B, C                     | BG, BP                                    | 50   | CDR1 -B-390A---           | 39                   | F, G, J, K, M            | BG, BP                                    | 50   |
| CDR1 -B-0R5A---           | 0.5                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-430A---           | 43                   | F, G, J, K, M            | BG, BP                                    | 50   |
| CDR1 -B-0R6A---           | 0.6                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-470A---           | 47                   | F, G, J, K, M            | BG, BP                                    | 50   |
| CDR1 -B-0R7A---           | 0.7                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-510A---           | 51                   | F, G, J, K, M            | BG, BP                                    | 50   |
| CDR1 -B-0R8A---           | 0.8                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-560A---           | 56                   | F, G, J, K, M            | BG, BP                                    | 50   |
| CDR1 -B-0R9A---           | 0.9                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-620A---           | 62                   | F, G, J, K, M            | BG, BP                                    | 50   |
| CDR1 -B-1R0A---           | 1.0                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-680A---           | 68                   | F, G, J, K, M            | BG, BP                                    | 50   |
| CDR1 -B-1R1A---           | 1.1                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-750A---           | 75                   | F, G, J, K, M            | BG, BP                                    | 50   |
| CDR1 -B-1R2A---           | 1.2                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-820A---           | 82                   | F, G, J, K, M            | BG, BP                                    | 50   |
| CDR1 -B-1R3A---           | 1.3                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-910A---           | 91                   | F, G, J, K, M            | BG, BP                                    | 50   |
| CDR1 -B-1R4A---           | 1.4                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-101A---           | 100                  | F, G, J, K, M            | BG, BP                                    | 50   |
| CDR1 -B-1R5A---           | 1.5                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-111A---           | 110                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-1R6A---           | 1.6                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-121A---           | 120                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-1R7A---           | 1.7                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-131A---           | 130                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-1R8A---           | 1.8                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-151A---           | 150                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-1R9A---           | 1.9                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-161A---           | 160                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-2R0A---           | 2.0                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-181A---           | 180                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-2R1A---           | 2.1                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-201A---           | 200                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-2R2A---           | 2.2                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-221A---           | 220                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-2R4A---           | 2.4                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-241A---           | 240                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-2R7A---           | 2.7                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-271A---           | 270                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-3R0A---           | 3.0                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-301A---           | 300                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-3R3A---           | 3.3                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-331A---           | 330                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-3R6A---           | 3.6                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-361A---           | 360                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-3R9A---           | 3.9                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-391A---           | 390                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-4R3A---           | 4.3                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-431A---           | 430                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-4R7A---           | 4.7                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-471A---           | 470                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-5R1A---           | 5.1                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-511A---           | 510                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-5R6A---           | 5.6                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-561A---           | 560                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-6R2A---           | 6.2                  | B, C, D                  | BG, BP                                    | 50   | CDR1 -B-621A---           | 620                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-6R8A---           | 6.8                  | B, C, J, K, M            | BG, BP                                    | 50   | CDR1 -B-681A---           | 680                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-7R5A---           | 7.5                  | B, C, J, K, M            | BG, BP                                    | 50   | CDR1 -B-751A---           | 750                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-8R2A---           | 8.2                  | B, C, J, K, M            | BG, BP                                    | 50   | CDR1 -B-821A---           | 820                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-9R1A---           | 9.1                  | B, C, J, K, M            | BG, BP                                    | 50   | CDR1 -B-911A---           | 910                  | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-100A---           | 10                   | F, G, J, K, M            | BG, BP                                    | 50   | CDR1 -B-102A---           | 1000                 | F, G, J, K, M            | BP                                        | 50   |
| CDR1 -B-110A---           | 11                   | F, G, J, K, M            | BG, BP                                    | 50   |                           |                      |                          |                                           |      |
| CDR1 -B-120A---           | 12                   | F, G, J, K, M            | BG, BP                                    | 50   |                           |                      |                          |                                           |      |
| CDR1 -B-130A---           | 13                   | F, G, J, K, M            | BG, BP                                    | 50   |                           |                      |                          |                                           |      |
| CDR1 -B-150A---           | 15                   | F, G, J, K, M            | BG, BP                                    | 50   |                           |                      |                          |                                           |      |
| CDR1 -B-160A---           | 16                   | F, G, J, K, M            | BG, BP                                    | 50   |                           |                      |                          |                                           |      |
| CDR1 -B-180A---           | 18                   | F, G, J, K, M            | BG, BP                                    | 50   |                           |                      |                          |                                           |      |
| CDR1 -B-200A---           | 20                   | F, G, J, K, M            | BG, BP                                    | 50   |                           |                      |                          |                                           |      |
| CDR1 -B-220A---           | 22                   | F, G, J, K, M            | BG, BP                                    | 50   |                           |                      |                          |                                           |      |
| CDR1 -B-240A---           | 24                   | F, G, J, K, M            | BG, BP                                    | 50   |                           |                      |                          |                                           |      |
| CDR1 -B-270A---           | 27                   | F, G, J, K, M            | BG, BP                                    | 50   |                           |                      |                          |                                           |      |

1/Complete type designation will include additional symbols to indicate style, voltage-temperature limits, capacitance tolerance (where applicable), termination finish ("M" or "N" for style CDR11, and "S", "U" or "W" for style CDR12) and failure rate level.

# Microwave MLC's



## CDR Series — MIL-PRF-55681 (RF/Microwave Chips)

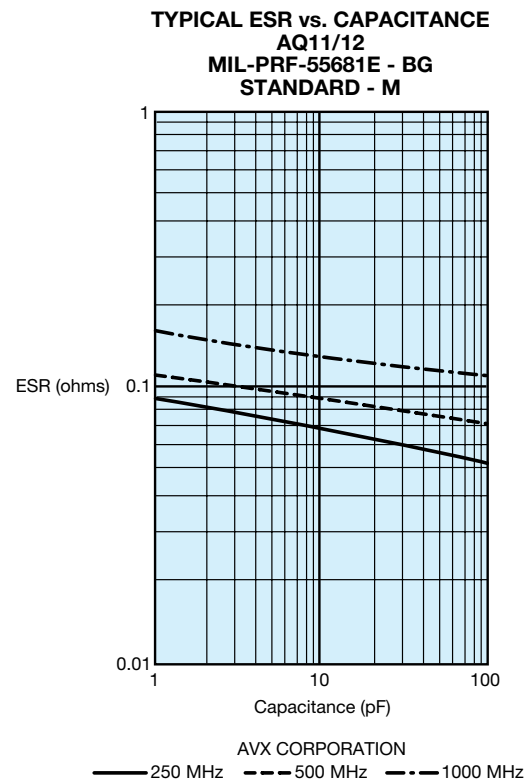
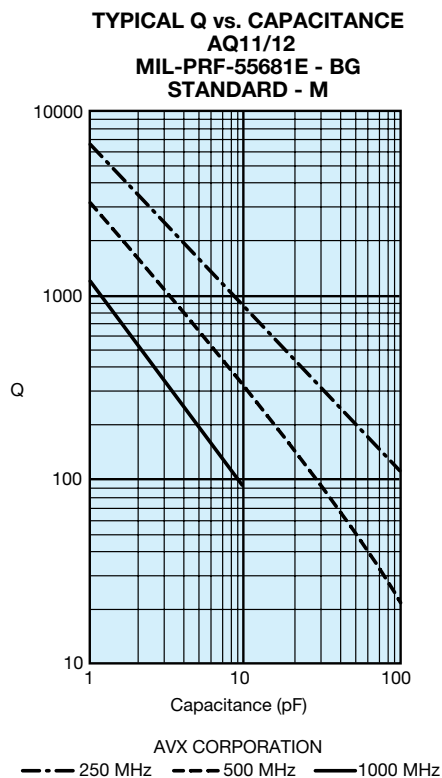
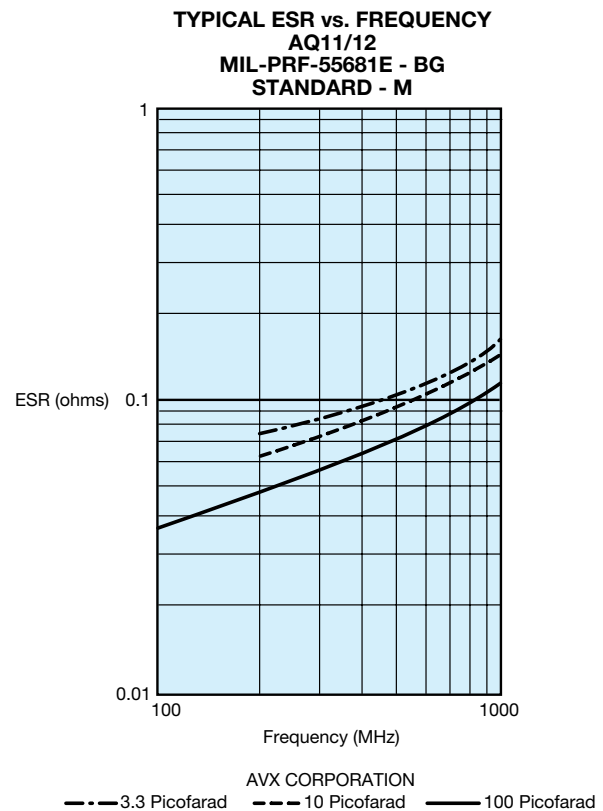
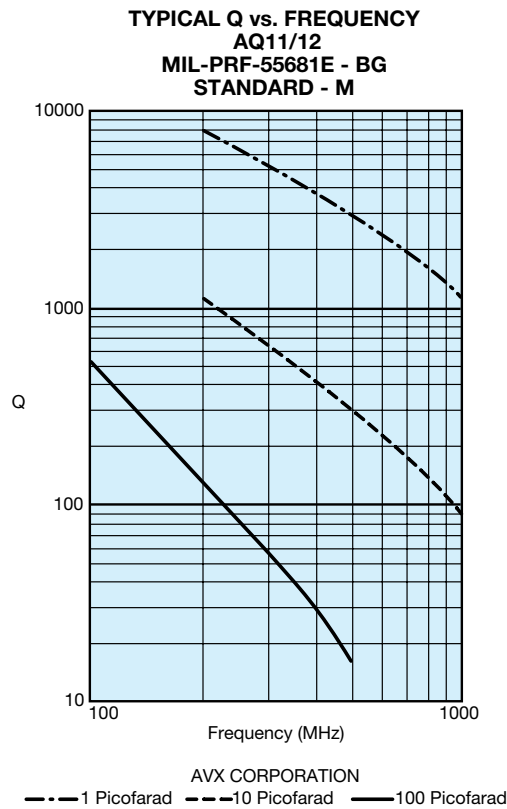
**TABLE II: STYLES CDR13 AND CDR14 CAPACITOR CHARACTERISTICS**

| Type<br>Designation<br>1/ | Capacitance<br>in pF | Capacitance<br>tolerance | Rated temperature<br>and<br>V/Temperature | WVDC    | Type<br>Designation<br>1/ | Capacitance<br>in pF | Capacitance<br>tolerance | Rated temperature<br>and<br>V/Temperature | WVDC    |
|---------------------------|----------------------|--------------------------|-------------------------------------------|---------|---------------------------|----------------------|--------------------------|-------------------------------------------|---------|
| CDR1 -B-0R1B---           | 0.1                  | B                        | BG, BP                                    | 200/500 | CDR1 -B-560---            | 56                   | F, G, J, K, M            | BG, BP                                    | 200/500 |
| CDR1 -B-0R2B---           | 0.2                  | B                        | BG, BP                                    | 200/500 | CDR1 -B-620---            | 62                   | F, G, J, K, M            | BG, BP                                    | 200/500 |
| CDR1 -B-0R3---            | 0.3                  | B, C                     | BG, BP                                    | 200/500 | CDR1 -B-680---            | 68                   | F, G, J, K, M            | BG, BP                                    | 200/500 |
| CDR1 -B-0R4---            | 0.4                  | B, C                     | BG, BP                                    | 200/500 | CDR1 -B-750---            | 75                   | F, G, J, K, M            | BG, BP                                    | 200/500 |
| CDR1 -B-0R5---            | 0.5                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-820---            | 82                   | F, G, J, K, M            | BG, BP                                    | 200/500 |
| CDR1 -B-0R6---            | 0.6                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-910---            | 91                   | F, G, J, K, M            | BG, BP                                    | 200/500 |
| CDR1 -B-0R7---            | 0.7                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-101---            | 100                  | F, G, J, K, M            | BG, BP                                    | 200/500 |
| CDR1 -B-0R8---            | 0.8                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-111±---           | 110                  | F, G, J, K, M            | BG, BP                                    | 200/300 |
| CDR1 -B-0R9---            | 0.9                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-121±---           | 120                  | F, G, J, K, M            | BG, BP                                    | 200/300 |
| CDR1 -B-1R0---            | 1.0                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-131±---           | 130                  | F, G, J, K, M            | BG, BP                                    | 200/300 |
| CDR1 -B-1R1---            | 1.1                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-151±---           | 150                  | F, G, J, K, M            | BG, BP                                    | 200/300 |
| CDR1 -B-1R2---            | 1.2                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-161±---           | 160                  | F, G, J, K, M            | BG, BP                                    | 200/300 |
| CDR1 -B-1R3---            | 1.3                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-181±---           | 180                  | F, G, J, K, M            | BG, BP                                    | 200/300 |
| CDR1 -B-1R4---            | 1.4                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-201±---           | 200                  | F, G, J, K, M            | BG, BP                                    | 200/300 |
| CDR1 -B-1R5---            | 1.5                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-221C---           | 220                  | F, G, J, K, M            | BG, BP                                    | 200     |
| CDR1 -B-1R6---            | 1.6                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-241C---           | 240                  | F, G, J, K, M            | BG, BP                                    | 200     |
| CDR1 -B-1R7---            | 1.7                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-271C---           | 270                  | F, G, J, K, M            | BG, BP                                    | 200     |
| CDR1 -B-1R8---            | 1.8                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-301C---           | 300                  | F, G, J, K, M            | BG, BP                                    | 200     |
| CDR1 -B-1R9---            | 1.9                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-331C---           | 330                  | F, G, J, K, M            | BG, BP                                    | 200     |
| CDR1 -B-2R0---            | 2.0                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-361C---           | 360                  | F, G, J, K, M            | BG, BP                                    | 200     |
| CDR1 -B-2R1---            | 2.1                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-391C---           | 390                  | F, G, J, K, M            | BG, BP                                    | 200     |
| CDR1 -B-2R2---            | 2.2                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-431C---           | 430                  | F, G, J, K, M            | BG, BP                                    | 200     |
| CDR1 -B-2R4---            | 2.4                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-471C---           | 470                  | F, G, J, K, M            | BG, BP                                    | 200     |
| CDR1 -B-2R7---            | 2.7                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-511B---           | 510                  | F, G, J, K, M            | BG, BP                                    | 100     |
| CDR1 -B-3R0---            | 3.0                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-561B---           | 560                  | F, G, J, K, M            | BG, BP                                    | 100     |
| CDR1 -B-3R3---            | 3.3                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-621B---           | 620                  | F, G, J, K, M            | BG, BP                                    | 100     |
| CDR1 -B-3R6---            | 3.6                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-681A---           | 680                  | F, G, J, K, M            | BG, BP                                    | 50      |
| CDR1 -B-3R9---            | 3.9                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-751A---           | 750                  | F, G, J, K, M            | BG, BP                                    | 50      |
| CDR1 -B-4R3---            | 4.3                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-821A---           | 820                  | F, G, J, K, M            | BG, BP                                    | 50      |
| CDR1 -B-4R7---            | 4.7                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-911A---           | 910                  | F, G, J, K, M            | BG, BP                                    | 50      |
| CDR1 -B-5R1---            | 5.1                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-102A---           | 1000                 | F, G, J, K, M            | BG, BP                                    | 50      |
| CDR1 -B-5R6---            | 5.6                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-112A---           | 1100                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-6R2---            | 6.2                  | B, C, D                  | BG, BP                                    | 200/500 | CDR1 -B-122A---           | 1200                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-6R8---            | 6.8                  | B, C, J, K, M            | BG, BP                                    | 200/500 | CDR1 -B-132A---           | 1300                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-7R5---            | 7.5                  | B, C, J, K, M            | BG, BP                                    | 200/500 | CDR1 -B-152A---           | 1500                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-8R2---            | 8.2                  | B, C, J, K, M            | BG, BP                                    | 200/500 | CDR1 -B-162A---           | 1600                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-9R1---            | 9.1                  | B, C, J, K, M            | BG, BP                                    | 200/500 | CDR1 -B-182A---           | 1800                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-100---            | 10                   | F, G, J, K, M            | BG, BP                                    | 200/500 | CDR1 -B-202A---           | 2000                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-110---            | 11                   | F, G, J, K, M            | BG, BP                                    | 200/500 | CDR1 -B-222A---           | 2200                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-120---            | 12                   | F, G, J, K, M            | BG, BP                                    | 200/500 | CDR1 -B-242A---           | 2400                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-130---            | 13                   | F, G, J, K, M            | BG, BP                                    | 200/500 | CDR1 -B-272A---           | 2700                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-150---            | 15                   | F, G, J, K, M            | BG, BP                                    | 200/500 | CDR1 -B-302A---           | 3000                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-160---            | 16                   | F, G, J, K, M            | BG, BP                                    | 200/500 | CDR1 -B-332A---           | 3300                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-180---            | 18                   | F, G, J, K, M            | BG, BP                                    | 200/500 | CDR1 -B-362A---           | 3600                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-200---            | 20                   | F, G, J, K, M            | BG, BP                                    | 200/500 | CDR1 -B-392A---           | 3900                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-220---            | 22                   | F, G, J, K, M            | BG, BP                                    | 200/500 | CDR1 -B-432A---           | 4300                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-240---            | 24                   | F, G, J, K, M            | BG, BP                                    | 200/500 | CDR1 -B-472A---           | 4700                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-270---            | 27                   | F, G, J, K, M            | BG, BP                                    | 200/500 | CDR1 -B-502A---           | 5000                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-300---            | 30                   | F, G, J, K, M            | BG, BP                                    | 200/500 | CDR1 -B-512A---           | 5100                 | F, G, J, K, M            | BP                                        | 50      |
| CDR1 -B-330---            | 33                   | F, G, J, K, M            | BG, BP                                    | 200/500 |                           |                      |                          |                                           |         |
| CDR1 -B-360---            | 36                   | F, G, J, K, M            | BG, BP                                    | 200/500 |                           |                      |                          |                                           |         |
| CDR1 -B-390---            | 39                   | F, G, J, K, M            | BG, BP                                    | 200/500 |                           |                      |                          |                                           |         |
| CDR1 -B-430---            | 43                   | F, G, J, K, M            | BG, BP                                    | 200/500 |                           |                      |                          |                                           |         |
| CDR1 -B-470---            | 47                   | F, G, J, K, M            | BG, BP                                    | 200/500 |                           |                      |                          |                                           |         |
| CDR1 -B-510---            | 51                   | F, G, J, K, M            | BG, BP                                    | 200/500 |                           |                      |                          |                                           |         |

1/Complete type designation will include additional symbols to indicate style, voltage-temperature limits, capacitance tolerance (where applicable), termination finish ("M" or "N" for style CDR13, and "S", "U" or "W" for style CDR14) and failure rate level.

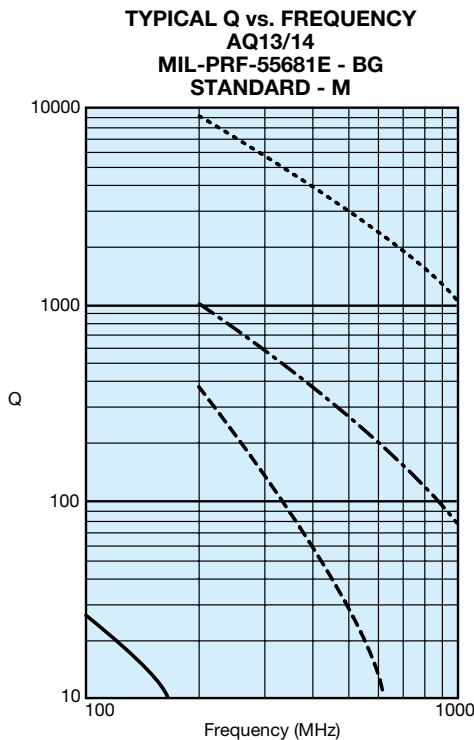
\*C=200V; E=500V.

‡C=200V; D=300V.

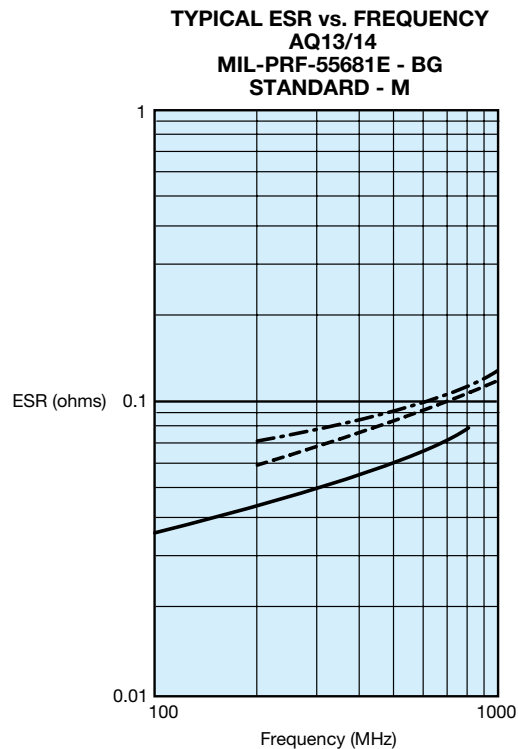


# Microwave MLC's

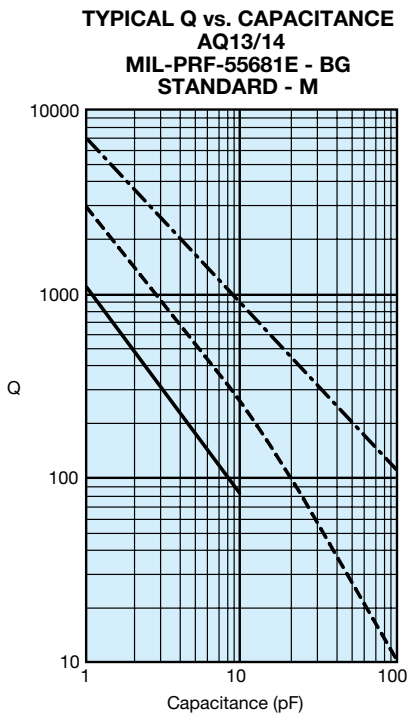
## Performance Curves



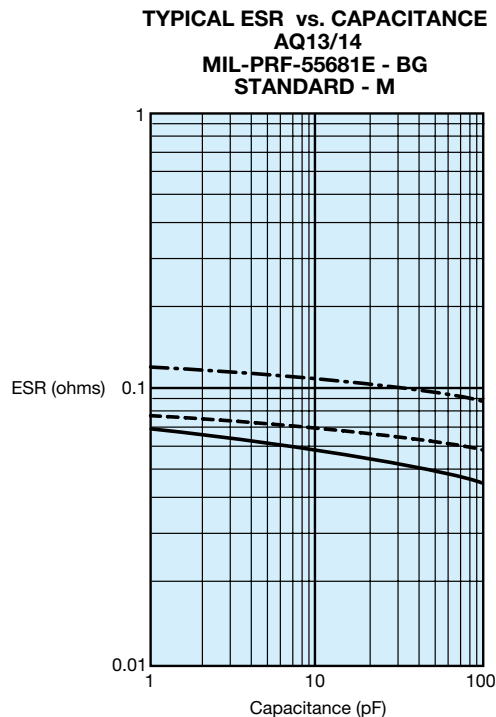
AVX CORPORATION  
 ..... 1 Picofarad    -.-.- 10 Picofarad    - - - 47 Picofarad    — 330 Picofarad



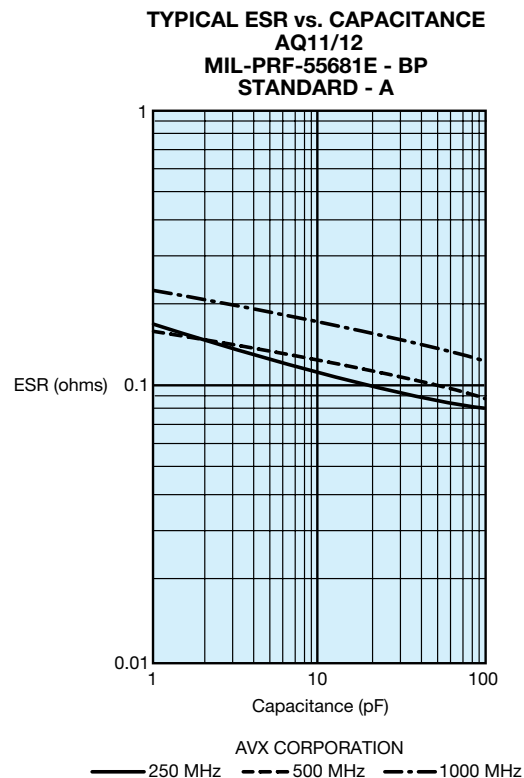
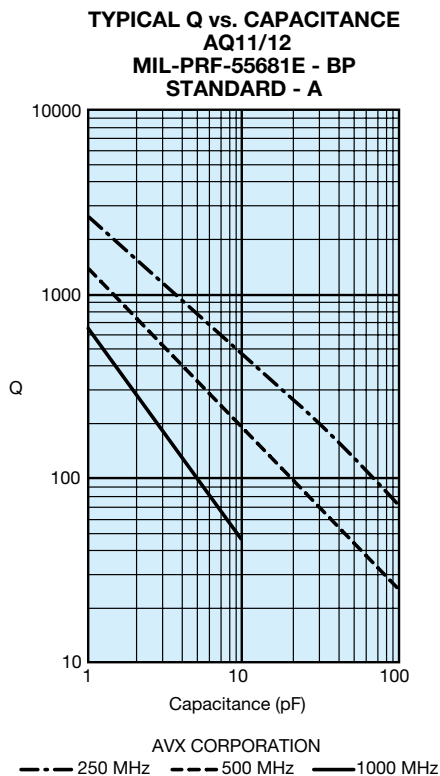
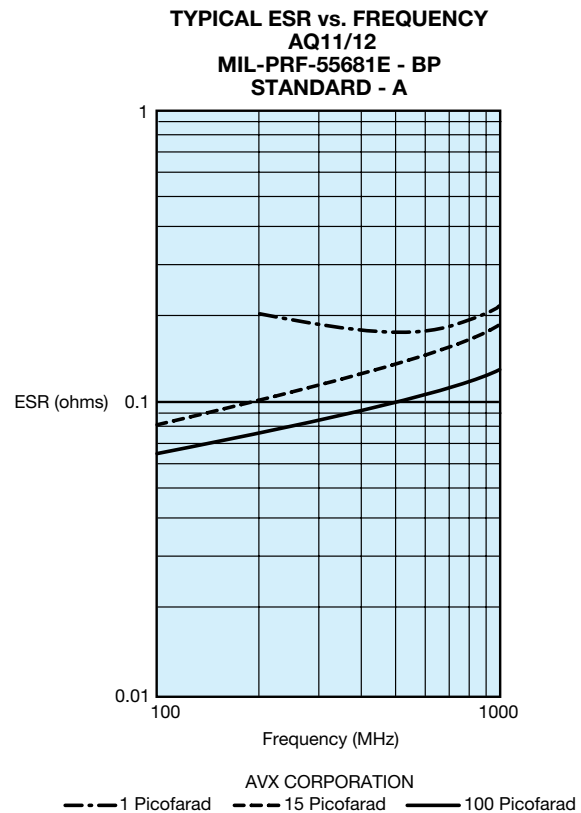
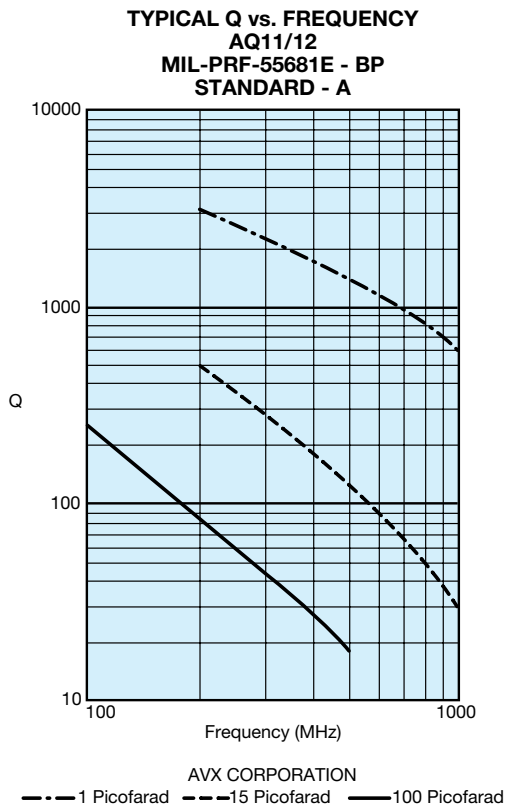
AVX CORPORATION  
 ..... 1 Picofarad    - - - 15 Picofarad    — 100 Picofarad

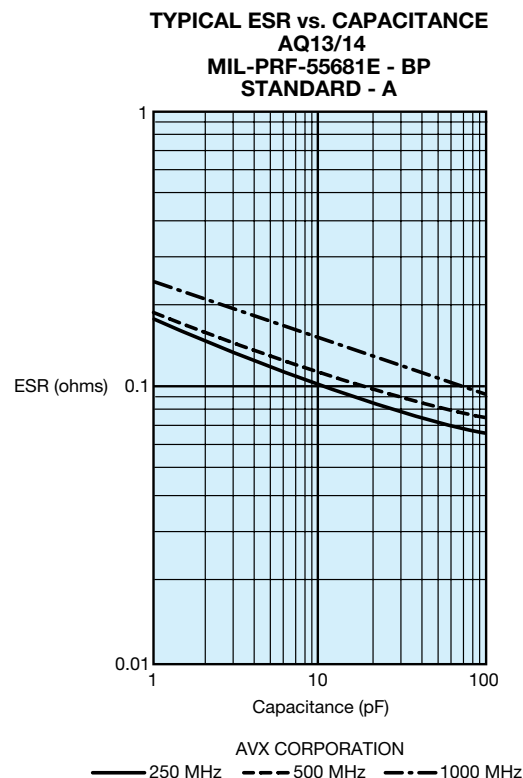
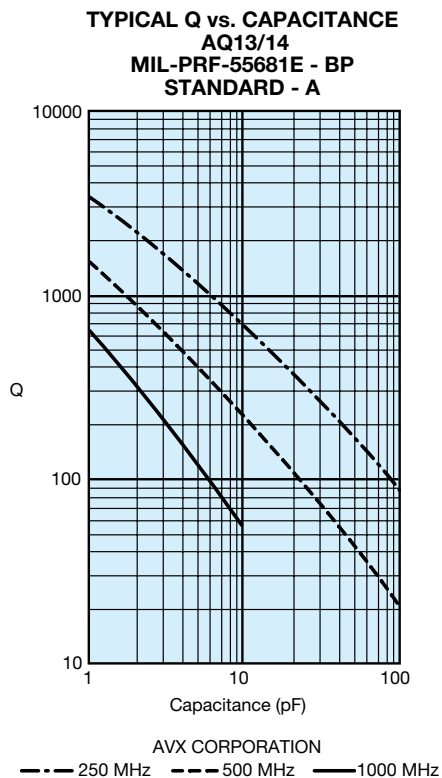
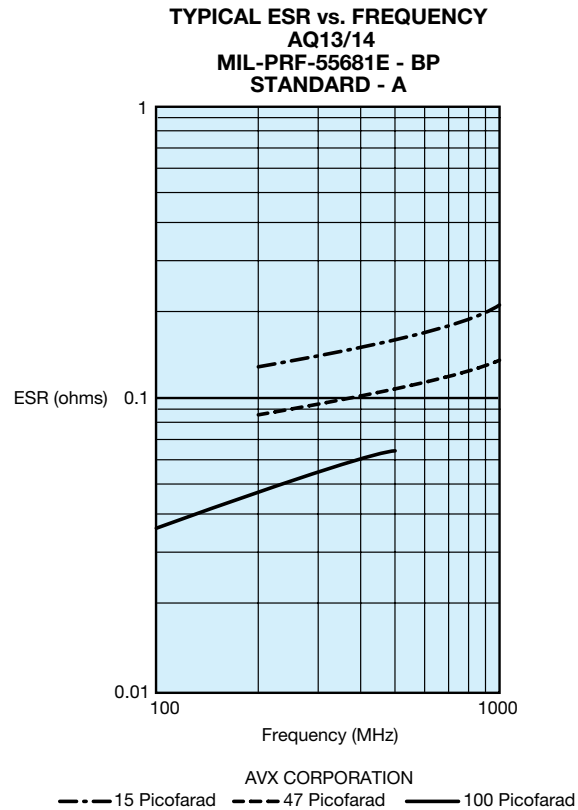
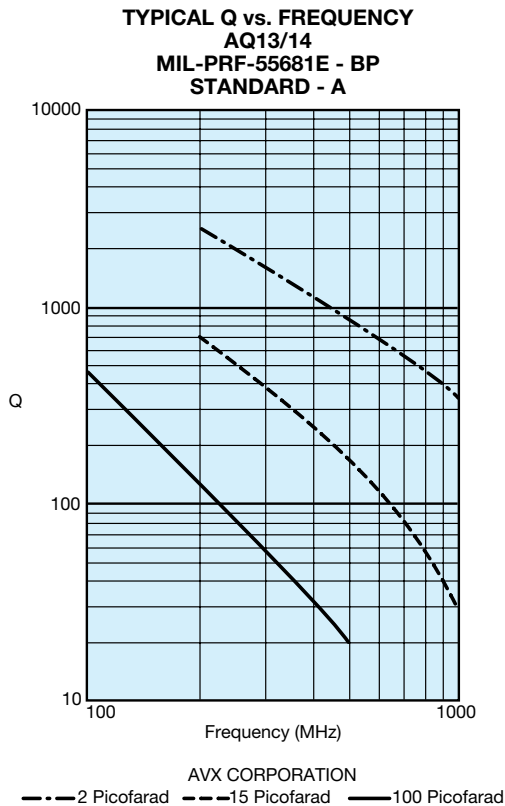


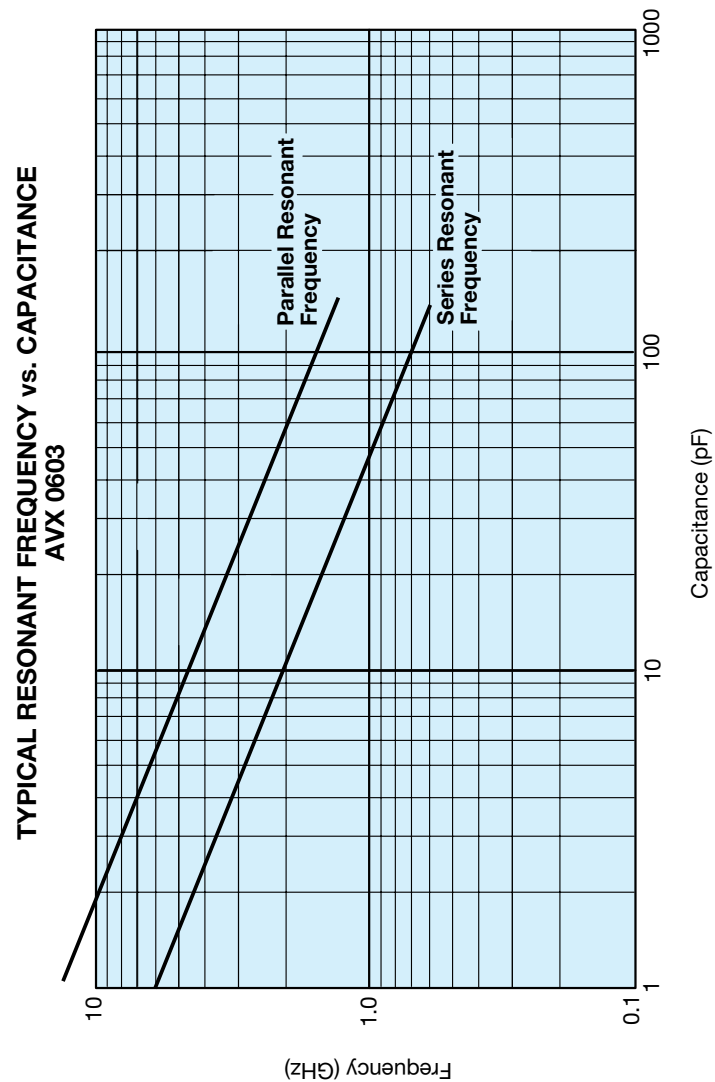
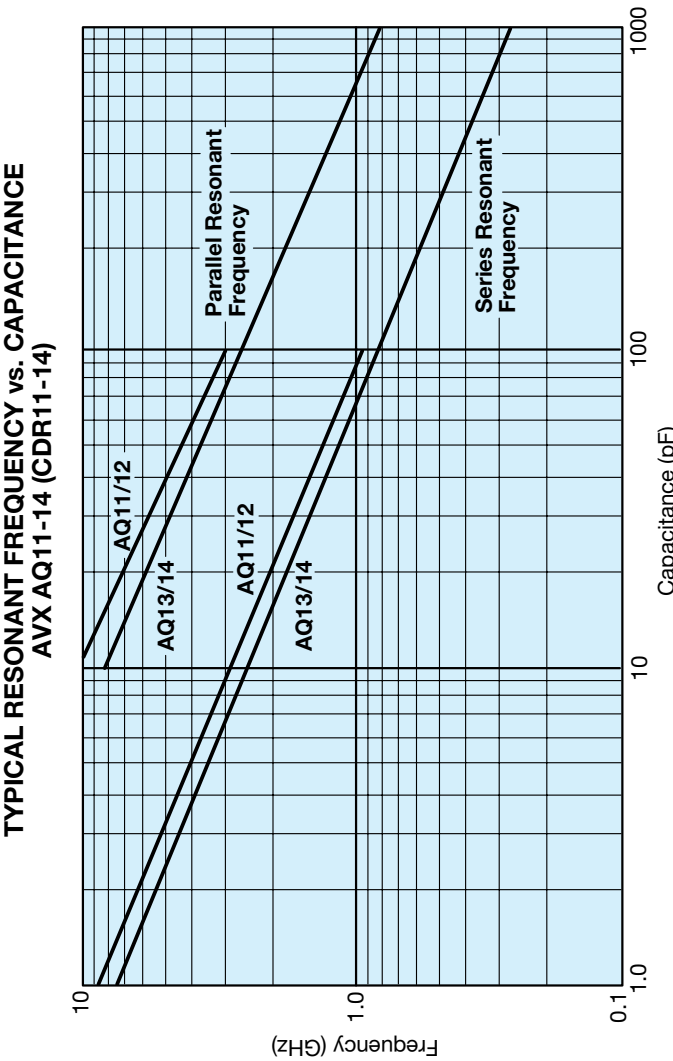
AVX CORPORATION  
 ..... 250 MHz    - - - 500 MHz    — 1000 MHz



AVX CORPORATION  
 — 250 MHz    - - - 500 MHz    ..... 1000 MHz







# Microwave MLC's

## Automatic Insertion Packaging

**TAPE & REEL:** All tape and reel specifications are in compliance with EIA RS481 (equivalent to IEC 286 part 3).

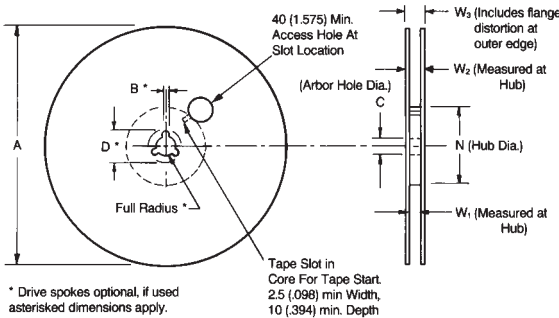
Sizes AQ11/12 through 13/14, CDR11/12 through 13/14.

- 8mm carrier
- 7" reel:  $\leq 0.040$ " thickness = 2000 pcs  
 $\leq 0.075$ " thickness = 2000 pcs
- 13" reel:  $\leq 0.075$ " thickness = 10,000 pcs

"U" Series - 0603/0805/1210 Size Chips

- 8mm carrier
- 7" reel: 0603 & 0805  $\leq 0.40$ " thickness = 4000 pcs  
0805 . 0.040" thickness & 1210= 2000 pcs
- 13" reel:  $\leq 0.075$ " thickness = 10,000 pcs

### REEL DIMENSIONS: millimeters (inches)



| Tape Size <sup>(1)</sup> | A Max.          | B* Min.       | C                        | D* Min.        | N Min.        | W <sub>1</sub>                                                                    | W <sub>2</sub> Max. | W <sub>3</sub>                             |
|--------------------------|-----------------|---------------|--------------------------|----------------|---------------|-----------------------------------------------------------------------------------|---------------------|--------------------------------------------|
| 8mm                      | 330<br>(12.992) | 1.5<br>(.059) | 13.0±0.20<br>(.512±.008) | 20.2<br>(.795) | 50<br>(1.969) | 8.4 <sup>+1.0</sup> <sub>-0.0</sub><br>(.331 <sup>+0.060</sup> <sub>-0.0</sub> )  | 14.4<br>(.567)      | 7.9 Min.<br>(.311)<br>10.9 Max.<br>(.429)  |
| 12mm                     |                 |               |                          |                |               | 12.4 <sup>+2.0</sup> <sub>-0.0</sub><br>(.488 <sup>+0.075</sup> <sub>-0.0</sub> ) | 18.4<br>(.724)      | 11.9 Min.<br>(.469)<br>15.4 Max.<br>(.607) |

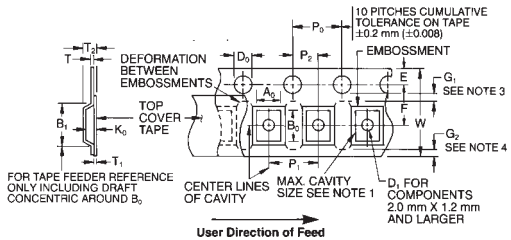
Metric dimensions will govern.  
English measurements rounded and for reference only.  
(1) For tape sizes 16mm and 24mm (used with chip size 3640) consult EIA RS-481 latest revision.

### EMBOSSED CARRIER CONFIGURATION

#### 8 & 12 MM TAPE ONLY

#### CONSTANT DIMENSIONS

| Tape Size    | D <sub>0</sub>                                                                    | E                            | P <sub>0</sub>              | P <sub>2</sub>              | T Max.          | T <sub>1</sub>         | G <sub>1</sub>                    | G <sub>2</sub>                    |
|--------------|-----------------------------------------------------------------------------------|------------------------------|-----------------------------|-----------------------------|-----------------|------------------------|-----------------------------------|-----------------------------------|
| 8mm and 12mm | 8.4 <sup>+0.10</sup> <sub>-0.0</sub><br>(.059 <sup>+0.004</sup> <sub>-0.0</sub> ) | 1.75 ± 0.10<br>(.069 ± .004) | 4.0 ± 0.10<br>(.157 ± .004) | 2.0 ± 0.05<br>(.079 ± .002) | 0.600<br>(.024) | 0.10<br>(.004)<br>Max. | 0.75<br>(.030)<br>Min. See Note 3 | 0.75<br>(.030)<br>Min. See Note 4 |

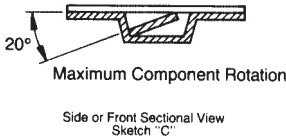
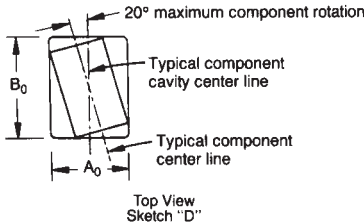


#### VARIABLE DIMENSIONS

| Tape Size | B <sub>1</sub> Max.<br>See Note 6 | D <sub>1</sub> Min.<br>See Note 5 | F                           | P <sub>1</sub>              | R Min.<br>See Note 2 | T <sub>2</sub>    | W                                                                                  | A <sub>0</sub> B <sub>0</sub> K <sub>0</sub> |
|-----------|-----------------------------------|-----------------------------------|-----------------------------|-----------------------------|----------------------|-------------------|------------------------------------------------------------------------------------|----------------------------------------------|
| 8mm       | 4.55<br>(.179)                    | 1.0<br>(.039)                     | 3.5 ± 0.05<br>(.138 ± .002) | 4.0 ± 0.10<br>(.157 ± .004) | 25<br>(.984)         | 2.5 Max<br>(.098) | 8.0 <sup>+0.3</sup> <sub>-0.1</sub><br>(.315 <sup>+0.012</sup> <sub>-0.004</sub> ) | See Note 1                                   |
| 12mm      | 8.2<br>(.323)                     | 1.5<br>(.059)                     | 5.5 ± 0.05<br>(.217 ± .002) | 4.0 ± 0.10<br>(.157 ± .004) | 30<br>(1.181)        | 6.5 Max<br>(.256) | 12.0 ± .30<br>(.472 ± .012)                                                        | See Note 1                                   |

#### NOTES:

- A<sub>0</sub>, B<sub>0</sub>, and K<sub>0</sub> are determined by the max. dimensions to the ends of the terminals extending from the component body and/or the body dimensions of the component. The clearance between the end of the terminals or body of the component to the sides and depth of the cavity (A<sub>0</sub>, B<sub>0</sub>, and K<sub>0</sub>) must be within 0.05 mm (.002) min. and 0.50 mm (.020) max. The clearance allowed must also prevent rotation of the component within the cavity of not more than 20 degrees (see sketches C & D).
- Tape with components shall pass around radius "R" without damage. The minimum trailer length (Note 2 Fig. 3) may require additional length to provide R min. for 12mm embossed tape for reels with hub diameters approaching N min. (Table 4).
- G<sub>1</sub> dimension is the flat area from the edge of the sprocket hole to either the outward deformation of the carrier tape between the embossed cavities or to the edge of the cavity whichever is less.
- G<sub>2</sub> dimension is the flat area from the edge of the carrier tape opposite the sprocket holes to either the outward deformation of the carrier tape between the embossed cavity or to the edge of the cavity whichever is less.
- The embossment hole location shall be measured from the sprocket hole controlling the location of the embossment. Dimensions of embossment location and hole location shall be applied independent of each other.
- B<sub>1</sub> dimension is a reference dimension for tape feeder clearance only.



# Hi-Q® High RF Power MLC Surface Mount Capacitors

For 600V to 4000V Application



## PRODUCT OFFERING

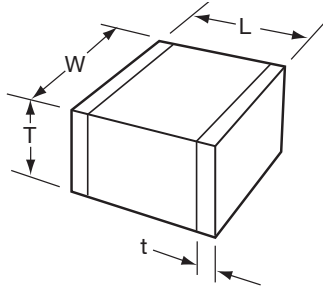
Hi-Q®, high RF power, surface mount MLC capacitors from AVX Corporation are characterized with ultra-low ESR and dissipation factor at high frequencies. They are designed to handle high power and high voltage levels for applications in RF power amplifiers, inductive heating, high magnetic field environments (MRI coils), medical and industrial electronics.

## HOW TO ORDER

| <b>HQCC</b>      | <b>A</b>       | <b>A</b>                       | <b>271</b>                            | <b>J</b>                     | <b>A</b>          | <b>T</b>             | <b>1</b>         | <b>A</b>            |
|------------------|----------------|--------------------------------|---------------------------------------|------------------------------|-------------------|----------------------|------------------|---------------------|
| <b>AVX Style</b> | <b>Voltage</b> | <b>Temperature Coefficient</b> | <b>Capacitance Code</b>               | <b>Capacitance Tolerance</b> | <b>Test Level</b> | <b>Termination</b>   | <b>Packaging</b> | <b>Special Code</b> |
| HQCC             | 600V = C       | COG = A                        | (2 significant digits + no. of zeros) | F = ±1%                      | A = Standard      | 1 = Pd/Ag            | 1 = 7" Reel      | A = Standard        |
| HQCE             | 1000V = A      |                                | Examples:                             | G = ±2%                      |                   | T = Solderable Plate | 3 = 13" Reel     |                     |
|                  | 1500V = S      |                                | 10 pF = 100                           | J = ±5%                      |                   |                      | 9 = Bulk         |                     |
|                  | 2000V = G      |                                | 100 pF = 101                          | K = ±10%                     |                   |                      |                  |                     |
|                  | 2500V = W      |                                | 1,000 pF = 102                        | M = ±20%                     |                   |                      |                  |                     |
|                  | 3000V = H      |                                | 22,000 pF = 223                       |                              |                   |                      |                  |                     |
|                  | 4000V = J      |                                |                                       |                              |                   |                      |                  |                     |

## DIMENSIONS

|                    | millimeters (inches)           |                                |
|--------------------|--------------------------------|--------------------------------|
| STYLE              | HQCC                           | HQCE                           |
| (L) Length         | 5.84 ± 0.51<br>(0.230 ± 0.020) | 9.4 ± 0.51<br>(0.370 ± 0.020)  |
| (W) Width          | 6.35 ± 0.51<br>(0.250 ± 0.020) | 9.9 ± 0.51<br>(0.390 ± 0.020)  |
| (T) Thickness Max. | 3.3 max.<br>(0.130 max.)       | 3.3 max.<br>(0.130 max.)       |
| (t) terminal       | 0.64 ± 0.38<br>(0.025 ± 0.015) | 0.64 ± 0.38<br>(0.025 ± 0.015) |



## DIELECTRIC PERFORMANCE CHARACTERISTICS

|                                    |                                                                          |
|------------------------------------|--------------------------------------------------------------------------|
| <b>Capacitance Range</b>           | 10pF to 6,800pF<br>(25°C, 1.0 ±0.2 Vrms at 1kHz, for ≤ 1000 pF use 1MHz) |
| <b>Capacitance Tolerances</b>      | ±1%, ±2%, ±5%, ±10%, ±20%                                                |
| <b>Dissipation Factor 25°C</b>     | 0.1% Max (+25°C, 1.0 ±0.2 Vrms at 1kHz, for ≤ 1000 pF use 1MHz)          |
| <b>Operating Temperature Range</b> | -55°C to +125°C                                                          |
| <b>Temperature Characteristic</b>  | COG: 0 ± 30 ppm/°C (-55°C to +125°C)                                     |
| <b>Voltage Ratings</b>             | 600, 1000, 1500, 2000, 2500, 3000, 4000VDC                               |
| <b>Insulation Resistance</b>       | 100K MΩ min. @ +25°C and 500VDC<br>10K MΩ min. @ +125°C and 500VDC       |
| <b>Dielectric Strength</b>         | 120% of rated WVDC                                                       |

## HIGH VOLTAGE CAPACITANCE VALUES (pF)

| Style | 600 WDC min./max. | 1000 WVDC min./max. | 1500 WVDC min./max. | 2000 WVDC min./max. | 2500 WVDC min./max. | 3000 WVDC min./max. | 4000 WVDC min./max. |
|-------|-------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| HQCC  | 2,200 - 2,700     | 1,500 - 1,800       | 820 - 1,200         | 470 - 680           | 330 - 390           | 10 - 270            |                     |
| HQCE  | 5,600 - 6,800     | 3,300 - 4,700       | 2,200 - 2,700       | 1,200 - 1,800       | 820 - 1,000         | 470-680             | 10-390              |



# RF/Microwave NP0 Capacitors

“U” Series  
Ceramic C0G (NP0) Microwave  
Multilayer Capacitors

# RF/Microwave C0G (NP0) Capacitors **AVX**

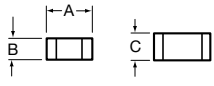
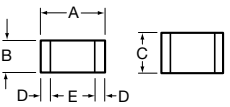
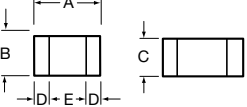
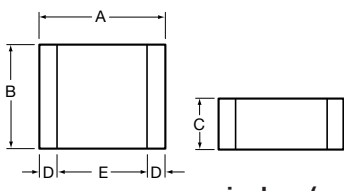
## Ultra Low ESR, “U” Series, C0G (NP0) Chip Capacitors

### GENERAL INFORMATION

“U” Series capacitors are C0G (NP0) chip capacitors specially designed for “Ultra” low ESR for applications in the communications market. Max ESR and effective capacitance

are met on each value producing lot to lot uniformity. Sizes available are EIA chip sizes 0603, 0805, and 1210.

### DIMENSIONS: inches (millimeters)

|      | 0402                                                                              | 0603                                                                              | 0805                                                                               | 1210                                                                                |                  |
|------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------|
|      |  |  |  |  |                  |
|      |                                                                                   |                                                                                   |                                                                                    |                                                                                     | inches (mm)      |
| Size | A                                                                                 | B                                                                                 | C                                                                                  | D                                                                                   | E                |
| 0402 | 0.039±0.004 (1.00±0.1)                                                            | 0.020±0.004 (0.50±0.1)                                                            | 0.024 (0.6) max                                                                    | N/A                                                                                 | N/A              |
| 0603 | 0.060±0.010 (1.52±0.25)                                                           | 0.030±0.010 (0.76±0.25)                                                           | 0.036 (0.91) max                                                                   | 0.010±0.005 (0.25±0.13)                                                             | 0.030 (0.76) min |
| 0805 | 0.079±0.008 (2.01±0.2)                                                            | 0.049±0.008 (1.25±0.2)                                                            | 0.040±0.005 (1.02±0.127)                                                           | 0.020±0.010 (0.51±0.254)                                                            | 0.020 (0.51) min |
| 1210 | 0.126±0.008 (3.2±0.2)                                                             | 0.098±0.008 (2.49±0.2)                                                            | 0.050±0.005 (1.27±0.127)                                                           | 0.025±0.015 (0.635±0.381)                                                           | 0.040 (1.02) min |

### HOW TO ORDER

|                                                  |                                                                   |                                   |                                                                                                                                                                                          |                                                                                                                                       |                                                |                                             |                                                                  |                                     |
|--------------------------------------------------|-------------------------------------------------------------------|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|---------------------------------------------|------------------------------------------------------------------|-------------------------------------|
| <b>0805</b>                                      | <b>1</b>                                                          | <b>U</b>                          | <b>100</b>                                                                                                                                                                               | <b>J</b>                                                                                                                              | <b>A</b>                                       | <b>T</b>                                    | <b>2</b>                                                         | <b>A</b>                            |
| <b>Case Size</b><br>0402<br>0603<br>0805<br>1210 | <b>Voltage Code</b><br>3 = 25V<br>5 = 50V<br>1 = 100V<br>2 = 200V | <b>Dielectric = Ultra Low ESR</b> | <b>Capacitance</b><br>EIA Capacitance Code in pF.<br>First two digits = significant figures or “R” for decimal place.<br>Third digit = number of zeros or after “R” significant figures. | <b>Capacitance Tolerance Code</b><br>B = ±0.1pF<br>C = ±0.25pF<br>D = ±0.5pF<br>F = ±1%<br>G = ±2%<br>J = ±5%<br>K = ±10%<br>M = ±20% | <b>Failure Rate Code</b><br>A = Not Applicable | <b>Termination</b><br>T = Plated Ni and Tin | <b>Packaging Code</b><br>2 = 7" Reel<br>4 = 13" Reel<br>9 = Bulk | <b>Special Code</b><br>A = Standard |

### ELECTRICAL CHARACTERISTICS

#### Capacitance Values and Tolerances:

Size 0402 - 0.2 pF to 22 pF @ 1 MHz  
Size 0603 - 1.0 pF to 100 pF @ 1 MHz  
Size 0805 - 1.6 pF to 160 pF @ 1 MHz  
Size 1210 - 2.4 pF to 1000 pF @ 1 MHz

#### Temperature Coefficient of Capacitance (TC):

0±30 ppm/°C (-55° to +125°C)

#### Insulation Resistance (IR):

10<sup>12</sup> Ω min. @ 25°C and rated WVDC  
10<sup>11</sup> Ω min. @ 125°C and rated WVDC

#### Working Voltage (WVDC):

Size Working Voltage  
0402 - 50, 25 WVDC  
0603 - 200, 100, 50 WVDC  
0805 - 200, 100 WVDC  
1210 - 200, 100 WVDC

#### Dielectric Working Voltage (DWV):

250% of rated WVDC

#### Equivalent Series Resistance Typical (ESR):

0402 - See Performance Curve, page 92  
0603 - See Performance Curve, page 92  
0805 - See Performance Curve, page 92  
1210 - See Performance Curve, page 92

**Marking:** Laser marking EIA J marking standard (except 0603) (capacitance code and tolerance upon request).

#### MILITARY SPECIFICATIONS

Meets or exceeds the requirements of MIL-C-55681

# RF/Microwave C0G (NP0) Capacitors



## Ultra Low ESR, “U” Series, C0G (NP0) Chip Capacitors

### CAPACITANCE RANGE

| Cap (pF) | Available Tolerance | Size |
|----------|---------------------|------|
| 0.2      | B, C                | 0402 |
| 0.3      | B, C                | 0603 |
| 0.4      | B, C                | 0805 |
| 0.5      | B, C                | 1210 |
| 0.6      | B, C, D             |      |
| 0.7      | B, C, D             |      |
| 0.8      | B, C, D             |      |
| 0.9      | B, C, D             |      |

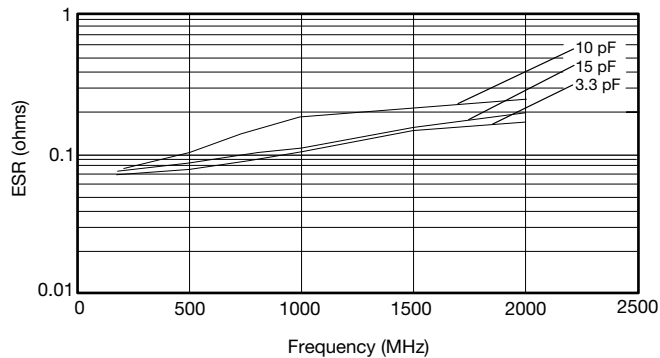
| Cap (pF) | Available Tolerance | Size |
|----------|---------------------|------|
| 1.0      | B, C, D             | 0402 |
| 1.1      | B, C, D             | 0603 |
| 1.2      | B, C, D             | 0805 |
| 1.3      | B, C, D             | 1210 |
| 1.4      | B, C, D             |      |
| 1.5      | B, C, D             |      |
| 1.6      | B, C, D             |      |
| 1.7      | B, C, D             |      |
| 1.8      | B, C, D             |      |
| 1.9      | B, C, D             |      |
| 2.0      | B, C, D             |      |
| 2.1      | B, C, D             |      |
| 2.2      | B, C, D             |      |
| 2.4      | B, C, D             |      |
| 2.7      | B, C, D             |      |
| 3.0      | B, C, D             |      |
| 3.3      | B, C, D             |      |
| 3.6      | B, C, D             |      |
| 3.9      | B, C, D             |      |
| 4.3      | B, C, D             |      |
| 4.7      | B, C, D             |      |
| 5.1      | B, C, D             |      |
| 5.6      | B, C, D             |      |
| 6.2      | B, C, D             |      |
| 6.8      | B, C, D             |      |

| Cap (pF) | Available Tolerance | Size |
|----------|---------------------|------|
| 7.5      | B, C, J, K, M       | 0402 |
| 8.2      | B, C, J, K, M       | 0603 |
| 9.1      | B, C, J, K, M       | 0805 |
| 10       | B, C, J, K, M       | 1210 |
| 11       | B, C, J, K, M       |      |
| 12       | B, C, J, K, M       |      |
| 13       | B, C, J, K, M       |      |
| 15       | B, C, J, K, M       |      |
| 18       | B, C, J, K, M       |      |
| 20       | B, C, J, K, M       |      |
| 22       | B, C, J, K, M       |      |
| 24       | B, C, J, K, M       |      |
| 27       | B, C, J, K, M       |      |
| 30       | B, C, J, K, M       |      |
| 33       | B, C, J, K, M       |      |
| 36       | B, C, J, K, M       |      |
| 39       | B, C, J, K, M       |      |
| 43       | B, C, J, K, M       |      |
| 47       | B, C, J, K, M       |      |
| 51       | B, C, J, K, M       |      |
| 56       | B, C, J, K, M       |      |
| 68       | B, C, J, K, M       |      |
| 75       | B, C, J, K, M       |      |
| 82       | B, C, J, K, M       |      |
| 91       | B, C, J, K, M       |      |

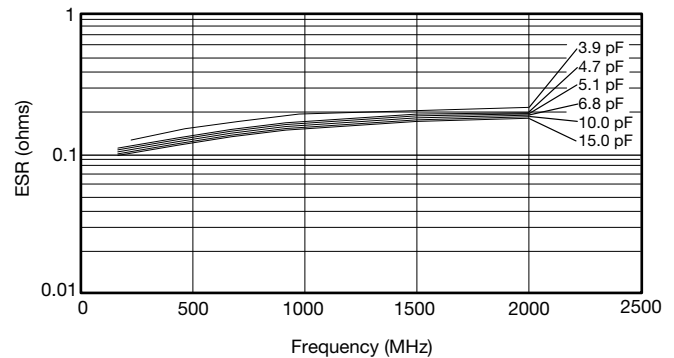
| Cap (pF) | Available Tolerance | Size |
|----------|---------------------|------|
| 100      | F, G, J, K, M       | 0402 |
| 110      | F, G, J, K, M       | 0603 |
| 120      | F, G, J, K, M       | 0805 |
| 130      | F, G, J, K, M       | 1210 |
| 140      | F, G, J, K, M       |      |
| 150      | F, G, J, K, M       |      |
| 160      | F, G, J, K, M       |      |
| 180      | F, G, J, K, M       |      |
| 200      | F, G, J, K, M       |      |
| 220      | F, G, J, K, M       |      |
| 270      | F, G, J, K, M       |      |
| 300      | F, G, J, K, M       |      |
| 330      | F, G, J, K, M       |      |
| 360      | F, G, J, K, M       |      |
| 390      | F, G, J, K, M       |      |
| 430      | F, G, J, K, M       |      |
| 470      | F, G, J, K, M       |      |
| 510      | F, G, J, K, M       |      |
| 560      | F, G, J, K, M       |      |
| 620      | F, G, J, K, M       |      |
| 680      | F, G, J, K, M       |      |
| 750      | F, G, J, K, M       |      |
| 820      | F, G, J, K, M       |      |
| 910      | F, G, J, K, M       |      |
| 1000     | F, G, J, K, M       |      |

### ULTRA LOW ESR, “U” SERIES

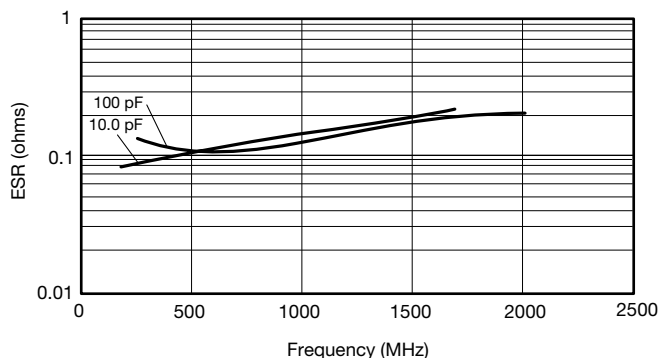
TYPICAL ESR vs. FREQUENCY  
0402 “U” SERIES



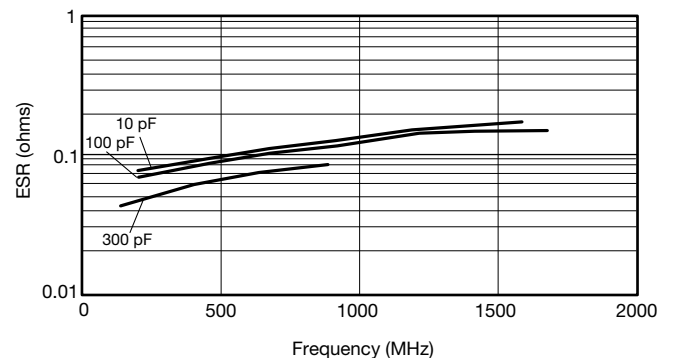
TYPICAL ESR vs. FREQUENCY  
0603 “U” SERIES



TYPICAL ESR vs. FREQUENCY  
0805 “U” SERIES



TYPICAL ESR vs. FREQUENCY  
1210 “U” SERIES

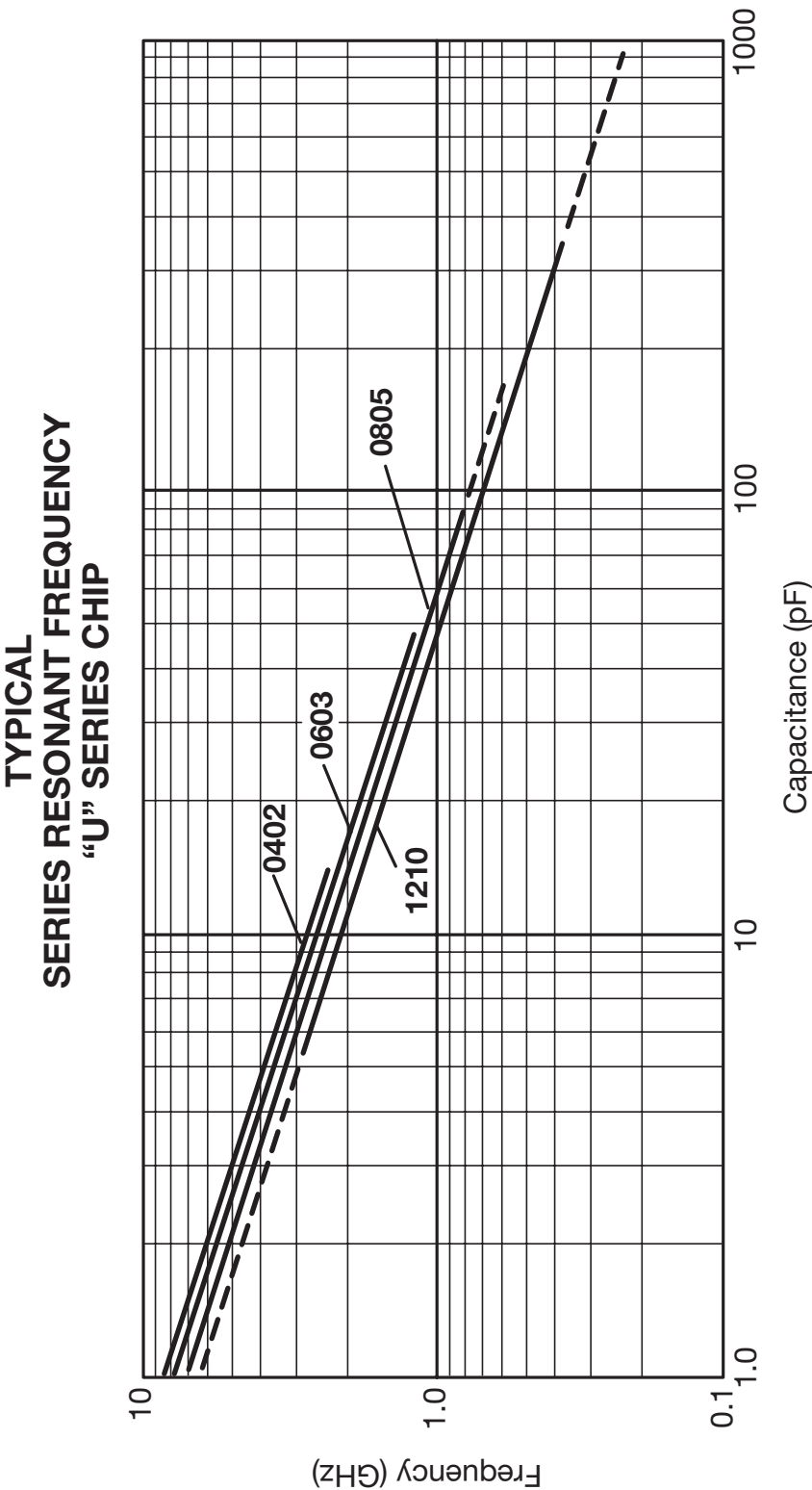


ESR Measured on the Boonton 34A

# RF/Microwave C0G (NP0) Capacitors



Ultra Low ESR, “U” Series, C0G (NP0) Chip Capacitors





## **RF/Microwave**

AQ 12 & 14 and “U” Series  
Designer Kits

### TUNING KITS

Solder Plated, Nickel Barrier

Porcelain (+90)

Ceramic (NP0)

| AQ12               |            | AQ14               |            | AQ12               |            | AQ14               |            |
|--------------------|------------|--------------------|------------|--------------------|------------|--------------------|------------|
| Kit 1500 UZ        |            | Kit 2500 UZ        |            | Kit 1501 UZ        |            | Kit 2501 UZ        |            |
| Capacitor Value pF | Tolerance* | Capacitor Value pF | Tolerance* | Capacitor Value pF | Tolerance* | Capacitor Value pF | Tolerance* |
| 0.1                | B          | 0.1                | B          | 0.1                | B          | 0.1                | B          |
| 0.2                | B          | 0.2                | B          | 0.2                | B          | 0.2                | B          |
| 0.3                | B          | 0.3                | B          | 0.3                | B          | 0.3                | B          |
| 0.4                | B          | 0.4                | B          | 0.4                | B          | 0.4                | B          |
| 0.5                | B          | 0.5                | B          | 0.5                | B          | 0.5                | B          |
| 0.6                | B          | 0.6                | B          | 0.6                | B          | 0.6                | B          |
| 0.7                | B          | 0.7                | B          | 0.7                | B          | 0.7                | B          |
| 0.8                | B          | 0.8                | B          | 0.8                | B          | 0.8                | B          |
| 0.9                | B          | 0.9                | B          | 0.9                | B          | 0.9                | B          |
| 1.0                | B          | 1.0                | B          | 1.0                | B          | 1.0                | B          |
| 1.1                | B          | 1.1                | B          | 1.1                | B          | 1.1                | B          |
| 1.2                | B          | 1.2                | B          | 1.2                | B          | 1.2                | B          |
| 1.3                | B          | 1.3                | B          | 1.3                | B          | 1.3                | B          |
| 1.4                | B          | 1.4                | B          | 1.4                | B          | 1.4                | B          |
| 1.5                | B          | 1.5                | B          | 1.5                | B          | 1.5                | B          |
| 1.6                | B          | 1.6                | B          | 1.6                | B          | 1.6                | B          |
| 1.7                | B          | 1.7                | B          | 1.7                | B          | 1.7                | B          |
| 1.8                | B          | 1.8                | B          | 1.8                | B          | 1.8                | B          |
| 1.9                | B          | 1.9                | B          | 1.9                | B          | 1.9                | B          |
| 2.0                | B          | 2.0                | B          | 2.0                | B          | 2.0                | B          |
| 2.1                | B          | 2.1                | B          | 2.1                | B          | 2.1                | B          |
| 2.2                | B          | 2.2                | B          | 2.2                | B          | 2.2                | B          |
| 2.4                | B          | 2.4                | B          | 2.4                | B          | 2.4                | B          |
| 2.7                | B          | 2.7                | B          | 2.7                | B          | 2.7                | B          |
| 3.0                | B          | 3.0                | B          | 3.0                | B          | 3.0                | B          |
| 3.3                | C          | 3.3                | C          | 3.3                | C          | 3.3                | C          |
| 3.6                | C          | 3.6                | C          | 3.6                | C          | 3.6                | C          |
| 3.9                | C          | 3.9                | C          | 3.9                | C          | 3.9                | C          |
| 4.3                | C          | 4.3                | C          | 4.3                | C          | 4.3                | C          |
| 4.7                | C          | 4.7                | C          | 4.7                | C          | 4.7                | C          |
| 5.1                | C          | 5.1                | C          | 5.1                | C          | 5.1                | C          |
| 5.6                | C          | 5.6                | C          | 5.6                | C          | 5.6                | C          |
| 6.2                | C          | 6.2                | C          | 6.2                | C          | 6.2                | C          |
| 6.8                | J          | 6.8                | J          | 6.8                | J          | 6.8                | J          |
| 7.5                | J          | 7.5                | J          | 7.5                | J          | 7.5                | J          |
| 8.2                | J          | 8.2                | J          | 8.2                | J          | 8.2                | J          |
| 9.1                | J          | 9.1                | J          | 9.1                | J          | 9.1                | J          |
| 10.0               | J          | 10.0               | J          | 10.0               | J          | 10.0               | J          |

380 Capacitors 10 each of 38 values. All chips are laser marked.

\*Tolerance: B =±0.1pF, C =±0.25pF, J =±5%.

## Evaluation Kits: AQ12/AQ14 Series

### EVALUATION KITS

Solder Plated, Nickel Barrier

Porcelain (+90)

Ceramic (NP0)

**AQ12**

**AQ14**

**AQ12**

**AQ14**

| Kit 1000 UZ        |            |
|--------------------|------------|
| Capacitor Value pF | Tolerance* |
| .5                 | B          |
| 1.0                | B          |
| 1.2                | B          |
| 1.5                | B          |
| 1.8                | B          |
| 2.0                | B          |
| 2.2                | B          |
| 2.4                | C          |
| 2.7                | C          |
| 3.0                | C          |
| 3.3                | C          |
| 3.6                | C          |
| 3.9                | C          |
| 4.3                | C          |
| 4.7                | C          |
| 6.8                | J          |
| 8.2                | J          |
| 10.0               | J          |
| 12.0               | J          |
| 15.0               | J          |
| 18.0               | J          |
| 22.0               | J          |
| 27.0               | J          |
| 33.0               | J          |
| 39.0               | J          |
| 47.0               | J          |
| 56.0               | J          |
| 68.0               | J          |
| 82.0               | J          |
| 100.0              | J          |

300 Capacitors 10 each of 30 values.  
All chips are laser marked.

\*Tolerance: B =  $\pm 0.1$  pF, C =  $\pm 0.25$  pF, J =  $\pm 5\%$ .

| Kit 2000 UZ        |            |
|--------------------|------------|
| Capacitor Value pF | Tolerance* |
| 1.0                | B          |
| 1.2                | B          |
| 1.5                | B          |
| 1.8                | B          |
| 2.0                | B          |
| 2.2                | B          |
| 2.4                | C          |
| 2.7                | C          |
| 3.0                | C          |
| 3.3                | C          |
| 3.6                | C          |
| 3.9                | C          |
| 4.3                | C          |
| 4.7                | C          |
| 5.1                | C          |
| 5.6                | C          |
| 6.2                | C          |
| 6.8                | J          |
| 8.2                | J          |
| 10.0               | J          |
| 12.0               | J          |
| 15.0               | J          |
| 18.0               | J          |
| 22.0               | J          |
| 27.0               | J          |
| 33.0               | J          |
| 39.0               | J          |
| 47.0               | J          |
| 56.0               | J          |
| 68.0               | J          |
| 82.0               | J          |
| 100.0              | J          |
| 120.0              | J          |
| 150.0              | J          |
| 180.0              | J          |
| 220.0              | J          |
| 240.0              | J          |
| 270.0              | K          |
| 330.0              | K          |
| 390.0              | K          |
| 470.0              | K          |
| 560.0              | K          |
| 680.0              | K          |
| 820.0              | K          |
| 1000.0             | K          |

450 Capacitors 10 each of 45 values.  
All chips are laser marked.

\*Tolerance: B =  $\pm 0.1$  pF, C =  $\pm 0.25$  pF, J =  $\pm 5\%$ , K =  $\pm 10\%$

| Kit 1001 UZ        |            |
|--------------------|------------|
| Capacitor Value pF | Tolerance* |
| .5                 | B          |
| 1.0                | B          |
| 1.5                | B          |
| 1.8                | B          |
| 2.0                | B          |
| 2.2                | B          |
| 2.4                | C          |
| 2.7                | C          |
| 3.0                | C          |
| 3.3                | C          |
| 3.6                | C          |
| 3.9                | C          |
| 4.3                | C          |
| 4.7                | C          |
| 6.8                | J          |
| 8.2                | J          |
| 10.0               | J          |
| 12.0               | J          |
| 15.0               | J          |
| 22.0               | J          |
| 27.0               | J          |
| 33.0               | J          |
| 39.0               | J          |
| 47.0               | J          |
| 56.0               | J          |
| 68.0               | J          |
| 82.0               | J          |
| 100.0              | J          |
| 470.0              | J          |
| 1000.0             | J          |

300 Capacitors 10 each of 30 values.  
All chips are laser marked.

\*Tolerance: B =  $\pm 0.1$  pF, C =  $\pm 0.25$  pF, J =  $\pm 5\%$ .

| Kit 2001 UZ        |            |
|--------------------|------------|
| Capacitor Value pF | Tolerance* |
| 1.0                | B          |
| 1.5                | B          |
| 1.8                | B          |
| 2.0                | B          |
| 2.2                | B          |
| 2.4                | C          |
| 2.7                | C          |
| 3.0                | C          |
| 3.3                | C          |
| 3.6                | C          |
| 3.9                | C          |
| 4.3                | C          |
| 4.7                | C          |
| 5.1                | C          |
| 5.6                | C          |
| 6.2                | C          |
| 6.8                | J          |
| 8.2                | J          |
| 10.0               | J          |
| 12.0               | J          |
| 15.0               | J          |
| 22.0               | J          |
| 27.0               | J          |
| 33.0               | J          |
| 39.0               | J          |
| 47.0               | J          |
| 56.0               | J          |
| 68.0               | J          |
| 82.0               | J          |
| 100.0              | J          |
| 120.0              | J          |
| 150.0              | J          |
| 180.0              | J          |
| 220.0              | J          |
| 240.0              | J          |
| 270.0              | K          |
| 330.0              | K          |
| 390.0              | K          |
| 470.0              | K          |
| 560.0              | K          |
| 680.0              | K          |
| 820.0              | K          |
| 1000.0             | K          |
| 2700.0             | K          |
| 5100.0             | K          |

450 Capacitors 10 each of 45 values.  
All chips are laser marked.

\*Tolerance: B =  $\pm 0.1$  pF, C =  $\pm 0.25$  pF, J =  $\pm 5\%$ , K =  $\pm 10\%$

NOTE: Order by Kit Number  
Example: Kit 1000 UZ

### “U” SERIES KITS

Solder Plated, Nickel Barrier

#### 0402

| Kit 5000 UZ*     |       |                  |       |
|------------------|-------|------------------|-------|
| Cap. Value<br>pF | Tol.† | Cap. Value<br>pF | Tol.† |
| 0.5              | B     | 4.7              | B     |
| 1.0              | B     | 5.6              | B     |
| 1.5              | B     | 6.8              | B     |
| 1.8              | B     | 8.2              | B     |
| 2.2              | B     | 10.0             | J     |
| 2.4              | B     | 12.0             | J     |
| 3.0              | B     | 15.0             | J     |
| 3.6              | B     |                  |       |

\* 150 Capacitors 10 each of 15 values.

#### 0603

| Kit 4000 UZ**    |        |                  |        |
|------------------|--------|------------------|--------|
| Cap. Value<br>pF | Tol.†  | Cap. Value<br>pF | Tol.†  |
| 1.0              | ±.25pF | 6.8              | ±.25pF |
| 1.2              | ±.25pF | 7.5              | ±.25pF |
| 1.5              | ±.25pF | 8.2              | ±.25pF |
| 1.8              | ±.25pF | 10.0             | ±5%    |
| 2.0              | ±.25pF | 12.0             | ±5%    |
| 2.4              | ±.25pF | 15.0             | ±5%    |
| 2.7              | ±.25pF | 18.0             | ±5%    |
| 3.0              | ±.25pF | 22.0             | ±5%    |
| 3.3              | ±.25pF | 27.0             | ±5%    |
| 3.9              | ±.25pF | 33.0             | ±5%    |
| 4.7              | ±.25pF | 39.0             | ±5%    |
| 5.6              | ±.25pF | 47.0             | ±5%    |

\*\* 240 Capacitors 10 each of 24 values.

#### 0805

| Kit 3000 UZ***   |       |                  |       |                  |       |
|------------------|-------|------------------|-------|------------------|-------|
| Cap. Value<br>pF | Tol.† | Cap. Value<br>pF | Tol.† | Cap. Value<br>pF | Tol.† |
| 1.0              | C     | 7.5              | C     | 33               | J     |
| 1.5              | C     | 8.2              | C     | 36               | J     |
| 2.2              | C     | 9.1              | C     | 39               | J     |
| 2.4              | C     | 10.0             | J     | 47               | J     |
| 2.7              | C     | 12.0             | J     | 56               | J     |
| 3.0              | C     | 15.0             | J     | 68               | J     |
| 3.3              | C     | 18.0             | J     | 82               | J     |
| 3.9              | C     | 22.0             | J     | 100              | J     |
| 4.7              | C     | 24.0             | J     | 130              | J     |
| 5.6              | C     | 27.0             | J     | 160              | J     |

\*\*\* 300 Capacitors 10 each of 30 values.

#### 1210

| Kit 3500 UZ***   |       |                  |       |                  |       |
|------------------|-------|------------------|-------|------------------|-------|
| Cap. Value<br>pF | Tol.† | Cap. Value<br>pF | Tol.† | Cap. Value<br>pF | Tol.† |
| 2.2              | C     | 18               | J     | 68               | J     |
| 2.7              | C     | 20               | J     | 82               | J     |
| 4.7              | C     | 24               | J     | 100              | J     |
| 5.1              | C     | 27               | J     | 120              | J     |
| 6.8              | C     | 30               | J     | 130              | J     |
| 8.2              | C     | 36               | J     | 240              | J     |
| 9.1              | C     | 39               | J     | 300              | J     |
| 10               | J     | 47               | J     | 390              | J     |
| 13               | J     | 51               | J     | 470              | J     |
| 15               | J     | 56               | J     | 680              | J     |

†Tolerance – B = ±0.1pF  
C = ±0.25pF  
J = ±5%



# Introduction to Microwave Capacitors

# Introduction to Microwave Capacitors

## Microwave Capacitors in MICs

### Typical Microwave Circuit Applications

Microwave MLC, SLC, or Thin-Film capacitor applications in MIC circuits can be grouped into the following categories:

- DC Block (in series with an MIC transmission line)
- RF Bypass (in shunt with transmission lines)
- Source Bypass (in shunt with active device)
- Impedance Matching

This chapter discusses these applications and the performance parameters of microwave capacitors affecting these applications.

#### DC Block

In the DC block application, the chip capacitor is placed in series with the transmission line to prevent the DC voltage from one circuit from affecting another circuit.

The capacitance is chosen so that the reactance is only a fraction of an ohm at the lowest microwave frequency of interest.

The largest value capacitor is used as long as the self-resonant frequency is still much higher than the highest frequency of interest.

#### RF Bypass

The RF bypass application is used to effectively short out the RF to ground. The capacitor value is also picked to be as large as possible without approaching the self-resonance of the capacitor.

#### Source Bypass

The source bypass application is the same as the RF bypass except the capacitor is used in conjunction with an active device.

In this application the chip capacitor is butted up to the source of the microwave FET device mounted on the MIC circuit. This is done to minimize the length of the wire bond from the source of the FET to the capacitor. The shorter the wire bond, the lower the corresponding inductance.

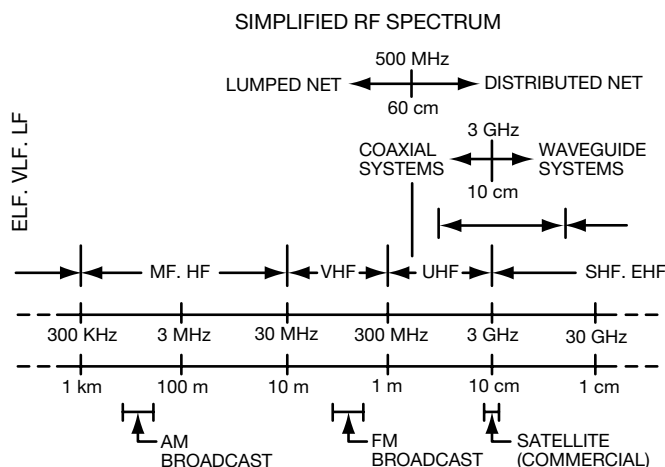


Figure 1

The top side of the capacitor should be completely metalized so that the bond wire from the FET to the edge of the capacitor is minimized.

The height of the capacitor must be less than or equal to the height of the FET, usually about 0.005 inches. If the capacitor is higher than the FET, the capacitor will interfere with the bonding tool when wire bonding to the FET.

#### Impedance Matching

The impedance matching application is to use the chip capacitor to provide the required reactance at a specific point in the circuit.

This is usually the most critical application in terms of the capacitor maintaining a tight tolerance over temperature and from unit-to-unit.

The other applications only require that the capacitance for the DC block and RF bypass maintains a low reactance and the tolerance can be as much as  $\pm 50\%$ . Whereas the impedance matching function often requires  $\pm 1\%$  tolerance.

In general, microwave capacitors should have the following properties:

- Low-loss
- Operate very much below the self-resonant frequency
- The power handling capability should be commensurate with the expected power performance of the circuit
- Capable of wire bonding and gap welding
- Low variation of capacitance over temperature
- Low unit-to-unit variations in capacitance
- Low dimensional variations from unit-to-unit

Typical SLC applications in MIC circuits are shown in:

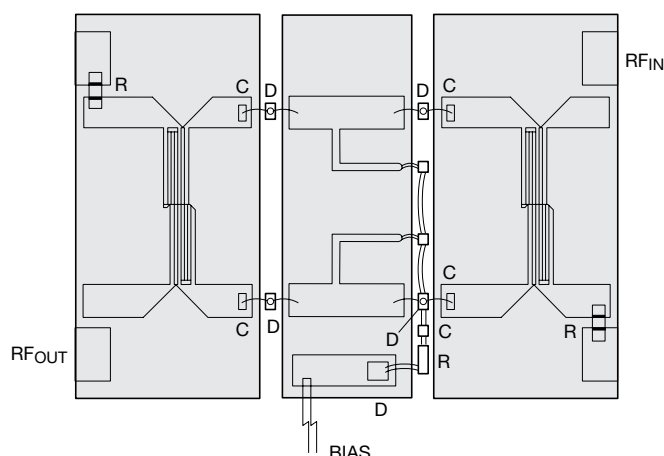


Figure 2. Typical MIC Microwave Attenuator Hybrid with SLC's. "C" indicates SLC locations.

# Introduction to Microwave Capacitors

## Microwave Parameters

### Scattering Parameters

Generally, transmission and reflections coefficient measurements completely characterize any black box or network. Transmission and reflections parameters — attenuation (gain), phase shift, and complex impedance — can be described in terms of a set of linear parameters called “scattering” or “s” parameters. Knowing these characteristic parameters, one can predict the response of cascaded or parallel networks accurately. Unlike y or h parameters which require short circuit and open circuit terminations, “s” parameters are determined with the input and output ports terminated in the characteristic impedance of the transmission line which is a much more practical condition to obtain at RF and microwave frequencies.

To summarize, “s” parameters are more useful at microwave frequencies because:

1. Equipment to measure total voltage and total currents at the ports of the networks is not readily available.
2. Short and open circuits are difficult to achieve over a broad band of frequencies because of lead inductance and capacitance. Furthermore, these measurements typically require tuning stubs separately adjusted at each frequency to reflect short and open circuits to the device terminals, and this makes the process inconvenient and tedious.
3. Active devices such as transistors and negative resistance diodes are very often not short- or open-circuit stable.

There are four scattering parameters for a two-port network: S11, S12, S21, and S22.

S11 is the reflection coefficient at the input port with the output port terminated in a 50 ohm load.

S12 is the reverse transmission coefficient in a 50 ohm system.

S21 is the forward transmission coefficient in a 50 ohm system.

S22 is the reflection coefficient at the output port with the input port terminated into a 50 ohm load.

The reflection coefficients can be directly related to the impedance of the device by the equation:

**Eq.1.**  $Z_{IN}/Z_0 = (1 + S_{11})/(1 - S_{11})$   
 where  $Z_{IN}$  = input impedance  
 $Z_0$  = characteristic impedance of the transmission line

This equation also defines the Smith Chart.

### Return Loss

Return loss is the ratio of the incident power to the reflected power at a point on the transmission line and is expressed in decibels. The reflected power from a discontinuity is expressed as a certain number of decibels below the incident power upon the discontinuity. It can be shown that

return loss can be related to the reflection coefficient and VSWR:

**Eq. 2.**  $RL \text{ (dB)} = 10 * \log (P_{inc}/P_{ref})$   
 $= 20 * \log (E_{inc}/E_{ref}) = 20 * \log (1/Rho)$

**Eq. 3.**  $Rho = (VSWR - 1)/(VSWR + 1)$

**Eq. 4.**  $VSWR = (1 + Rho)/(1 - Rho)$

where Rho = reflection coefficient

RL = return loss

Pinc = power incident

Pref = power reflected

Einc = voltage incident

Eref = voltage reflected

VSWR = voltage standing wave ratio

By the above equation, when the reflection coefficient is 1, the return loss is zero. In this case, no signal is lost and all the signal incident upon the discontinuity was returned to the source. As the reflection coefficient approaches zero, the return loss approaches infinity. That is, the more perfect the load, the less the reflection from that load.

The return loss can be improved by an attenuator.

Assume that we connect a perfectly matched 3 dB attenuator into a short circuit as shown in Figure 3.

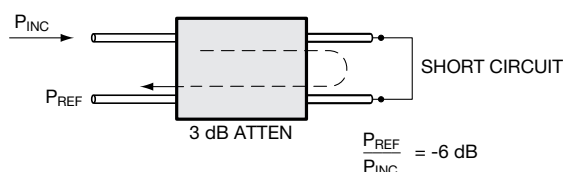


Figure 3

The indicated 100 mw is decreased to 50 mw at the output of the 3 dB attenuator. This 50 mw is reflected from the short circuit back through the attenuator in the reverse direction and one-half of this reflected power is lost in the 3 dB attenuator. The reflected power at the input is 25 mw. Notice the return loss is equal to twice the attenuation because it is the “round trip” loss. This example shows that VSWR is decreased when attenuation exists on a transmission line and also that a high VSWR can be decreased by placing an attenuator in the line.

### Mismatch Loss

Mismatch loss is a measure of power loss caused by reflection. It is the ratio of incident power to the difference between incident and reflected power and is expressed in dBs as follows:

**Eq. 5.**  $Mismatch \text{ loss (dB)} = 10 * \log [P_{inc}/(P_{inc} - P_{ref})]$   
 $= 10 * \log [1/(1 - Rho = 2)]$

# Introduction to Microwave Capacitors

## Microwave Parameters

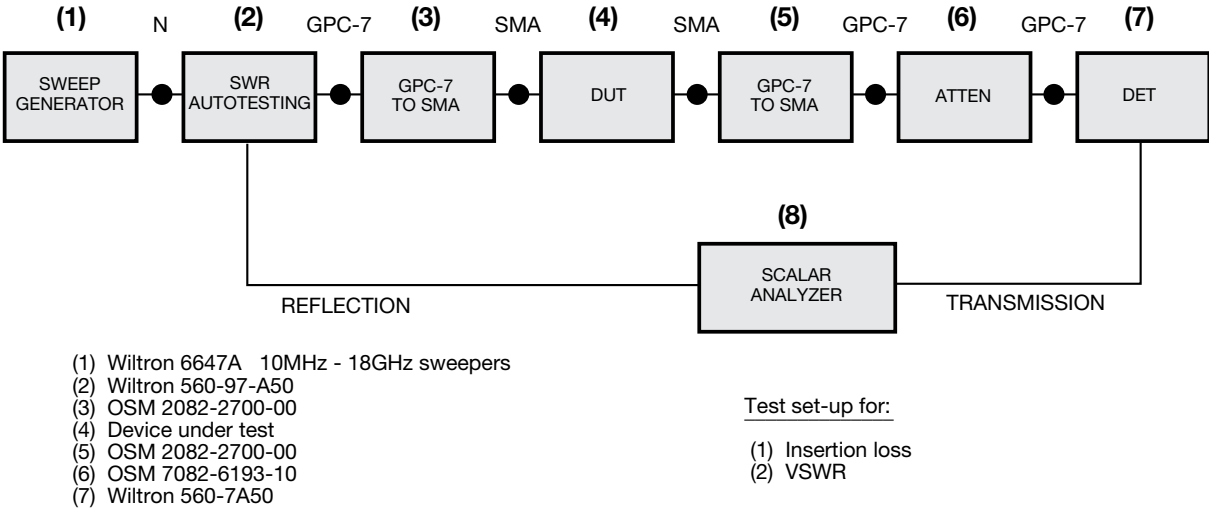


Figure 4

The mismatch loss for various values of VSWR is tabulated as follows:

Table I

| VSWR | Mismatch Loss |
|------|---------------|
| 1.00 | 0.00 dB       |
| 1.20 | 0.04 dB       |
| 1.40 | 0.12 dB       |
| 1.50 | 0.18 dB       |
| 1.70 | 0.30 dB       |
| 2.00 | 0.51 dB       |
| 2.50 | 0.88 dB       |
| 3.00 | 1.25 dB       |

### Insertion Loss Measurement

Insertion loss is measured by the substitution method. The insertion loss of the measurement system is used as a reference. Then the DUT (Device Under Test) is inserted into the setup and the new insertion loss is measured. The difference between the two losses is the insertion loss of the DUT.

The insertion loss is measured using the test setup as shown in Figure 5.

In order to accurately measure the insertion loss, source VSWR and load VSWR must be extremely low. It is assumed during calibration (loss of the measurement system with the DUT removed from the test setup) that the VSWR of the generator and the load does not contribute any mismatch losses. As discussed in the section on mismatch loss, any VSWR above 1.2:1 may cause a minimum error of 0.04 dB. In addition, the two VSWRs may be additive or subtractive depending on the phasing of the reflections. For example, source and load VSWRs of 1.2:1 can add to create an error of 0.08 dB. The mismatches usually exhibit themselves as amplitude ripple as a function of frequency. It is important when measuring low insertion losses that precautions are taken to ensure low source and load VSWRs and to keep the

mismatch losses due to the two VSWRs to a small fraction of the expected insertion loss of the DUT.

In using the scalar network analyzer it is a temptation to normalize the amplitude response regardless what the actual response is during calibration. It is advisable to eliminate the amplitude ripple first before normalizing the scalar analyzer. One way is to make use of the fact that VSWRs can be improved by the use of matched attenuators. Often, 10 dB attenuators are placed before and after the DUT to provide a minimum of 20 dB return loss which corresponds to source and load VSWRs of less than 1.20:1. This will reduce the uncertainties due to mismatch losses to less than 0.02 dB.

### Return Loss Measurement

The return loss is measured by the following method: The test port is terminated by a short circuit so that all the incident power is reflected. A detector on the bridge measures this power and this power is used as the reference for the incident power. The test port is then terminated by the DUT and the reflected power now measured. The difference between the power levels is the return loss.

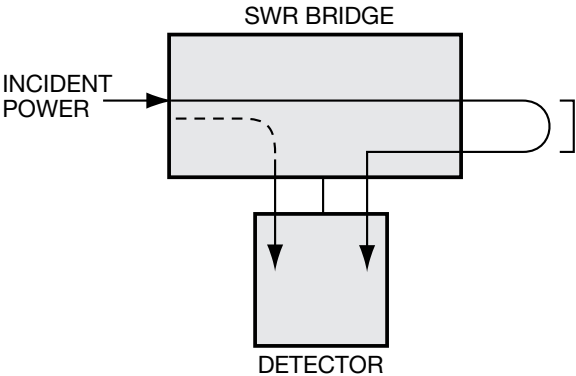


Figure 5. Return Loss Measurement:  
Establishing a Reference

# Introduction to Microwave Capacitors

## Microwave Parameters

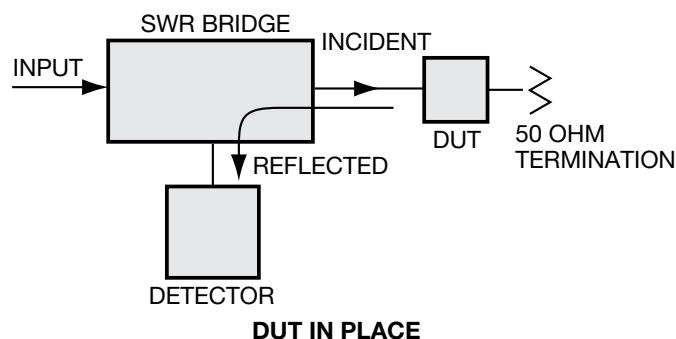


Figure 6

- All incident power is reflected at the short circuit.
- The detector measures the reflected power.
- An SWR bridge usually has a directivity of 35 to 40 dB. In other words, only a minute fraction of the incident power reaches the detector (the dotted line path) that is not reflected off the short circuit.
- The DUT is substituted for the short circuit and the opposite port is terminated by a matched termination (50 ohms).
- The reflected power depends on the DUT and is sensed by the detector.
- The return loss is the difference between this reflected power and that measured with a reference short circuit.
- A significant improvement in calibrating a 0 dB return loss reference by averaging the short circuit and open circuit reflected powers.
- The dotted line in the figure below shows the reflections due to an open circuit.
- The solid line in the figure below shows the reflections due to a short circuit.
- Since the phase difference between short circuit and open circuit is 180 degrees.
- By taking the average between these two voltages, the actual full reflection is very closely approximated.

### AVERAGING THE SHORT CIRCUIT AND OPEN CIRCUIT REFERENCES FOR HIGHER ACCURACY

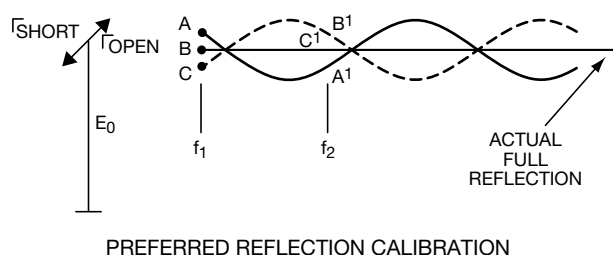


Figure 7

Note that the insertion loss and return loss can be measured simultaneously by using the dual trace feature of the Wiltron Scalar Analyzer. Furthermore, the two measurements can be done by using a controller such as the HP85 computer for semi-automatic testing.

The calibration for 0 dB return loss can be improved by averaging the short circuit and open circuit reflected powers. Since the phase difference is 180 degrees, the average closely approximates the actual full reflection.

## Decibels

The decibel, abbreviated "dB," is one-tenth of the international transmission unit known as the "bel." The origin of the bel is the logarithm to the base 10 of the power ratio. It is the power to which the number 10 must be raised in order to equal the given number. The number 10 is raised to the second power, or squared, in order to get 100. Therefore, the log of 100 is 2.

The decibel is expressed mathematically by the equation:

**Eq. 6**  $\text{dB} = 10 * \log (P_2/P_1)$   
 $P_2 = \text{larger power}$   
 $P_1 = \text{lower power}$

The use of log tables can be avoided in practical applications where exact values of the power are not required. One only needs to know that a factor of 2 is equal to 3 dB and a factor of 10 is equal to 10 dB and the rest of the conversions are derived from these two relationships. The use of dBs reduces multiplication into an addition. For example:

$$\begin{aligned} 3\text{dB} &= 2 \\ 6\text{dB} &= 2 \times 2 = 4 \\ 9\text{dB} &= 2 \times 2 \times 2 = 8 \\ 10\text{dB} &= 10 \\ 20\text{dB} &= 100 \end{aligned}$$

The technique is based on the fact that 3, 6, and/or 9 dB can be added or subtracted (in some combination) to any decibel value. Adding or subtracting 10 to a decibel value simply multiplies or divides the number by ten. Examples:

1.  $17\text{dB} = 20\text{dB} - 3\text{dB}$   
 $20\text{dB}$  is  $10\text{dB} + 10\text{dB}$  or is equal to 100.  
 $3\text{dB}$  is equal to 2

$$\text{Therefore, } 20\text{ dB} - 3\text{ dB} = 100/2 = 50$$

2.  $36\text{dB} = 30\text{dB} + 6\text{dB}$   
 $1000 \times 4 = 4000$

Decibel:

The decibel is not a unit of power but merely is a logarithmic expression of a ratio of two numbers. The unit of power may be expressed in terms of dBm, where "m" is the unit, meaning above or below one milliwatt. Since one mw is neither above nor below 1 mw,  $1\text{ mw} = 0\text{ dBm}$ .

Nepers:

An alternate unit called the neper is defined in terms of the logarithm to the base "e."  $e = 2.718$ .

$$1\text{ neper} = 8.686\text{dB}$$

$$1\text{ dB} = 0.1151\text{ neper}$$

# Introduction to Microwave Capacitors

## Electrical Model

### Capacitance

Microwave chip capacitors, although closely approximating an ideal capacitor, nonetheless also contain parasitic elements that are important at microwave frequencies. The equivalent circuit is shown below:

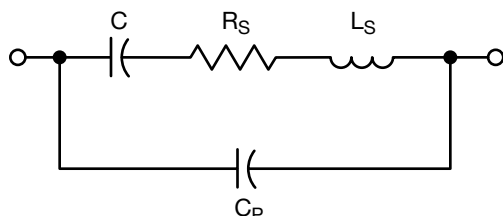


Figure 8. Equivalent Circuit of a Microwave Capacitor

where,  $C$  = desired capacitance  
 $L_s$  = parasitic series inductance  
 $R_s$  = series resistance  
 $C_p$  = parasitic parallel capacitance,

$R_p$ , the parallel resistance is not shown as it is of concern only at dc and low frequencies.

The primary capacitance,  $C$ , is typically determined by measurement at 1 MHz where the effects of  $R_s$ ,  $L_s$ , and  $C_p$  become negligible compared to the reactance of  $C$ . The value of  $C$  determined at this low frequency is also valid at microwave frequencies when the dielectric constant has a very low variation versus frequency, as is typical in the modern dielectrics employed in microwave capacitors.

The equivalent impedance of the capacitor at any frequency is:

$$\text{Eq. 7. } Z_s = \frac{1}{sC_p + \frac{1}{R_s + sL_s + \frac{1/s}{C_s}}}$$

where  $s = j2\pi f$ ,  $f$  = frequency

### Series and Parallel Resonance

Ideally, the impedance magnitude of a series mounted capacitor will vary monotonically from infinite at dc to zero at infinite frequency. However, the parasitics associated with any capacitor result in a nonideal response.

Figure 9 shows the magnitude,  $|Z(f)|$ , as a function of frequency.

Figure 10 shows  $Z(f)$  on the Smith Chart, which includes magnitude and phase.

**Eq. 8.** In general, an impedance is represented by  $Z = R + jX$ . The Smith Chart maps the entire impedance half plane for  $R > 0$  into the interior of a unit circle. The Smith Chart is a mapping of the reflection coefficient,  $S_{11}$ , of an impedance.  $S_{11} = (Z - Z_0) / (Z + Z_0)$ .  $Z_0$  is a reference impedance, typically 50 ohms, and is in the center of the chart. The central horizontal axis is for  $X = 0$ , with  $R < 50$  to the left of center, and  $R > 50$  to the right of center.

Figures 9 and 10 also show the point of series resonance (LS in series with C), and parallel resonance (LS in parallel with CP).

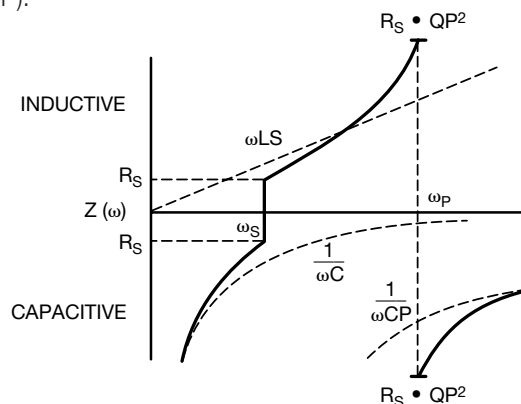


Figure 9. SLC Impedance Magnitude vs. Frequency

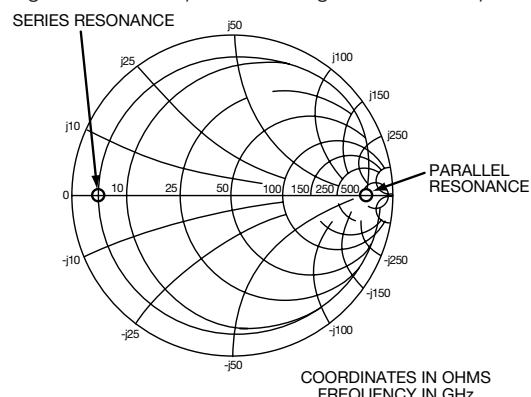


Figure 10. SLC Impedance on Smith Chart

Because there is always some parasitic inductance associated with capacitors, there will be a frequency at which the inductive reactance will equal that of the capacitor. This is known as the series resonant frequency (SRF). At the SRF, the capacitor will appear as a small resistor ( $R_s$ ). The transmission loss through a series mounted capacitor at its series resonant frequency will be low.

At frequencies above the SRF, the capacitor begins to act like an inductor.

When used as a DC block, the capacitor will begin to exhibit gradually higher insertion loss above the SRF. In other words, the capacitor will cause a high frequency rolloff of its transmission amplitude response.

When used as an RF bypass, as for the source of an FET, the inductance will cause the FET to become unstable which can cause oscillations or undesirable effects on the gain response of the FET amplifier.

Beyond the SRF, there is a frequency called the parallel resonant frequency (PRF). This occurs when the reactance of the series inductor equals that of the parallel capacitor.

# Introduction to Microwave Capacitors

## Electrical Model

At this parallel resonant frequency, the capacitor will appear as a large resistor whose value is RPRF defined as:

**Eq. 9.**  $R_{PRF} = R_s \times Q_p \times Q_p$ ; where,  $Q_p = 1/R_s \frac{W_p/C_p}{W_p} = 2\pi f_{PRF}$

The parasitic parallel capacitance is usually very small which results in a parallel resonant frequency that is much higher than the series resonance.

For capacitor usage in RF impedance matching and tuning applications, the maximum practical frequency for use is up to 0.5 times the SRF.

For DC filtering and RF shunting applications, best performance is obtained near the SRF.

At frequencies above the SRF, but below the PRF, the SLC can be used as a low loss inductor with a built-in DC block for bypassing and decoupling.

The series resonant frequency (SRF) of an SLC can be measured by mounting the capacitor in series on a 50 ohm transmission line as shown in Figure 11.

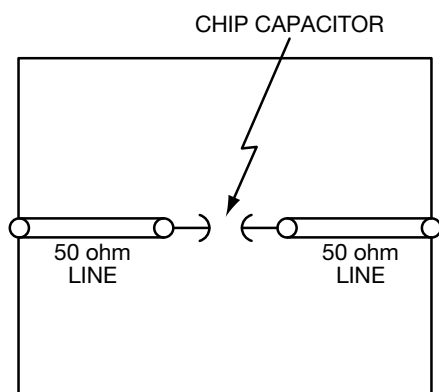


Figure 11

At its series resonant frequency (SRF), the SLC will appear as a small resistance. This measurement can be performed with a vector network analyzer such as the Hewlett Packard 8510. The SRF is at the frequency for which the phase of the input reflection coefficient, S11, is crossing the real axis on the Smith Chart at 180 degrees.

The resonant frequency will be lowered by the inductance associated with the bonding attachment to the capacitor (i.e., bonding wires, ribbons, leads, etc.). The actual resonant frequency of the capacitor by itself can be determined by taking out the effects of the bonding attachment inductance. Using the low frequency measurements of the primary capacitance alone, the inductance of the capacitor can be derived from the resonant frequency. With AVX SLC's, the inductance is low enough so that the practical operating frequencies achieved can be beyond 20 GHz.

## Equivalent Series Resistance

The equivalent series resistance is the RS in the electrical model. At the SRF, the ESR can be readily determined on the Smith Chart display of the capacitor's impedance. However, the ESR is not necessarily constant with frequency and its value is typically determined by an insertion loss measurement of the capacitor at the desired frequency.

The insertion loss is a combination of reflective and absorptive components. The absorptive component is the part associated with the value of the ESR (i.e., the loss in RS). Because of the low values of ESR in microwave capacitors (on the order of 0.01 ohm), the insertion loss measurement is very difficult to make, but can be made with a test fixture similar to that shown in Figure 11, but with the input and output 50 ohm impedances transformed down to some more convenient impedance level, Rref, to obtain a more accurate measurement.

When used as a DC block in the transmission line test fixture, the forward transmission coefficient, S21, and the input reflection coefficient, S11, can be measured to determine:

**Eq. 10.** Dissipative Loss.  
 $DL = (1 - |S_{11}|^2) / (|S_{21}|^2)$

**Eq. 11.** Reflection Loss.  
 $RL = (1 - |S_{11}|^2)$  where S11 and S21 are expressed as complex phasors.

From the dissipative loss, DL, the ESR can be determined as:

**Eq. 12.**  $ESR = R_{ref} * [1 - \sqrt{DL}] / [1 + \sqrt{DL}]$

The ESR typically increases with operating temperature and self-heating under high power. This increase can be seen directly in the lab by measuring the insertion loss of the capacitor as a function of temperature.

A low ESR is especially necessary in SLC's when used in series with transistors in low noise amplifiers, high gain amplifiers, or high power amplifiers. For example, an ESR of 1 ohm in series with a base input impedance of 1 ohm would result in a serious compromise in amplifier gain and noise figure by up to 3 dB.

## Power Rating

The RF power rating of chip capacitors is dependent on:

- Thermal Breakdown
- Voltage Breakdown

## Thermal Breakdown

Thermal breakdown is self-heating caused by RF power dissipated in the capacitor.

If the resultant heat generated is greater than what can be conducted away through the leads or other means of heat sinking, the capacitor temperature will rise.

# Introduction to Microwave Capacitors

## Electrical Model

As the capacitor temperature increases, the dissipation factor and ESR of the capacitor also increase which creates a thermal runaway situation.

The small signal insertion loss is used to determine the percentage of power which is dissipated in the capacitor.

For instance, if the insertion loss is:

- 0.01 dB then .2% of the incident power is lost as heat
- 0.10 dB then 2% of the incident power is lost as heat
- 1.00 dB then 20% of the incident power is lost as heat

The capacitor will heat up according to the amount of power dissipated in the capacitor and the heat sinking provided.

Even very low ESR, 0.01 ohm at 1 GHz, can be significant when passing power through a series mounted capacitor into a typically low impedance bipolar transistor base input with an input impedance of only 1 ohm. If 1% of 10 watts is dissipated in the capacitor, this 100 milliwatt of power causes a very large increase in the capacitor temperature dependent on its heat sinking in the MIC circuit.

## Voltage Breakdown

The voltage breakdown also limits the maximum power handling capability of the capacitor.

The voltage breakdown properties of the capacitors is dependent on the following:

- dielectric material
- voids in the material
- form factor
- separation of the electrodes

Most microwave capacitors have a DC voltage rating of 50 VDC. This is much greater than typical DC voltages of 3 to 15 volts present on an MIC circuit.

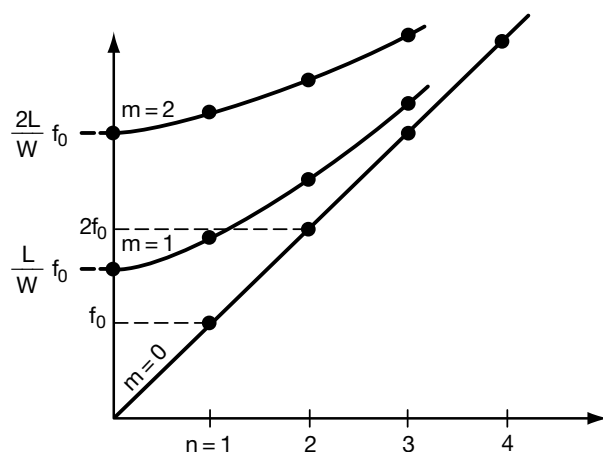


Figure 12

Dispersion Curve of a Rectangular Resonator

## Dielectric Constant Measurement at Microwave Frequencies

The measurement of dielectric constants at low frequencies is easily done by measuring the capacitance of a substrate of known dimensions and calculating the dielectric constant.

The resonance method is used in measuring dielectric constants at microwave frequencies of metallized ceramic substrates. This is based on the model of the high dielectric constant substrate as a parallel plate dielectrically loaded waveguide resonator. By observing the resonant frequencies and knowing the dimensions of the substrate, the dielectric constant is calculated by fitting the resonances into a table of expected fundamental and higher order modes. This method can be measured by connecting the corners of the substrates to the center conductors of either an APC-7 or Type N connector. The test setup is the same as for insertion loss measurements. This method as described in the literature for an alumina substrate with a dielectric constant of approximately 10 and a substrate height of 0.025 inches can be measured to an accuracy of 2%. The Napoli-Hughes Method uses an open circuit assumption for the unmetallized edges which can be radiative. This inaccuracy is reduced if thinner substrates or if higher dielectric constant substrates are used which will tend to reduce radiation. Higher accuracy can be achieved by metallizing all six sides of the substrate except for the corners where the RF is coupled to the substrate. This method as reported by Howell provided more consistent results.

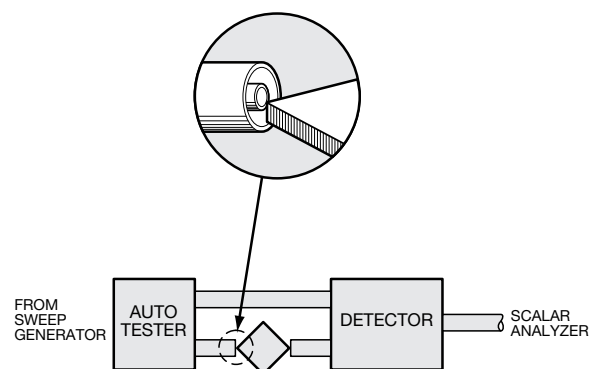


Figure 13

Test Configuration for Resonance Measurements

# Introduction to Microwave Capacitors

## Transmission Lines

### Propagation Constant and Characteristic Impedance

The incident waves of voltage and current decrease in magnitude and vary in phase as one goes toward the receiving end of the transmission line which has losses. The propagation constant is a measure of the phase shift and attenuation along the line.

- attenuation per unit length of line is called the attenuation constant. (dB or nepers per unit length)
- phase constant, phase shift per unit length. (radians per unit length)
- angular frequency,  $2 \cdot \pi \cdot f$

$(R+j\omega L)$  - complex series impedance per unit length of line.

$(G+j\omega C)$  - complex shunt admittance per unit length of line.

**Eq. 13.**  $Z_0 \rightarrow$  for lossless case:  $Z_0 = \sqrt{L/C}$

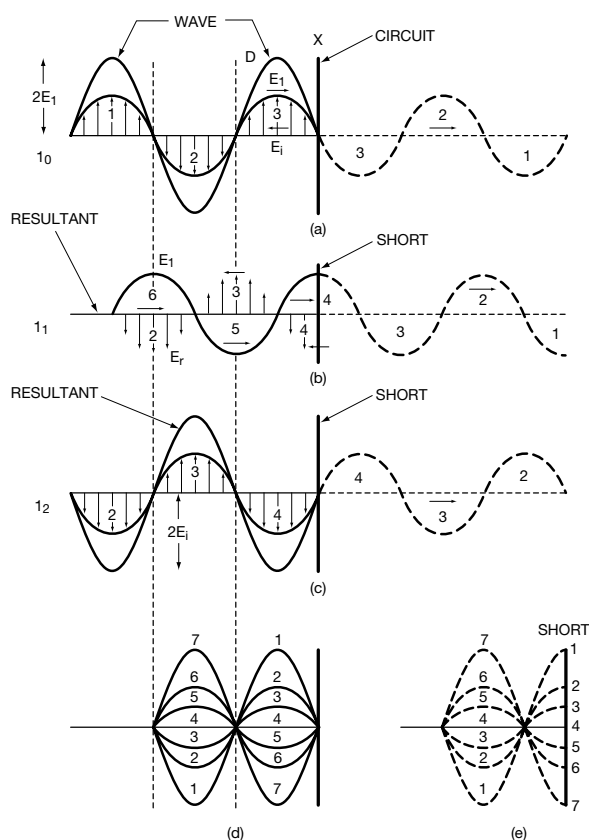


Figure 14

This figure shows generation of standing waves on a shorted transmission line. Dotted lines to the right of the short circuit represent the distance the wave would have traveled in absence of the short. Dotted vectors represent the reflected wave. The heavy solid line represents the vector sum of the incident and reflected waves. (d) and (e) represent instantaneous voltages and currents at different intervals of time.

### Standing Waves

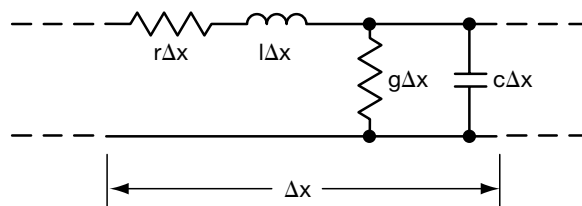
Standing waves on the lossless transmission line:

An incident wave will not be reflected if the transmission line is terminated in either matched load or if the transmission line is infinitely long. Otherwise, reflected waves will be present. In other words, any impedance will cause reflections.

Let us consider the case of a lossless transmission line terminated in a short line. In this case all of the incident wave will be reflected. See Figure 15.

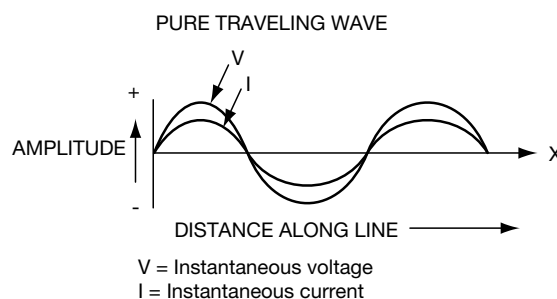
The dotted sine wave to the right of the short circuit in the diagram indicates the position and distance the wave would have traveled in the absence of the short circuit. With the short circuit placed at X, the wave travels the same distance back toward the generator. In order to satisfy the boundary conditions, the voltage at the short circuit must be zero at all times. This is accomplished by a reflected wave which is equal in magnitude and reversed in polarity (shown by the superimposed reflected wave and the resultant total voltage on the line). Note that the total voltage is twice the amplitude of the incident voltage at a quarter wavelength back toward the generator and the total voltage is zero at one-half wavelength from the short.

### DISTRIBUTED PARAMETER MODEL OF A SECTION OF TRANSMISSION LINES:



where  $G$  = Conductance per unit length  
 $R$  = Resistance per unit length  
 $C$  = Capacitance per unit length  
 $L$  = Inductance per unit length  
 $\Delta X$  = Incremental length

Figure 15



Pure traveling waves:  $V$  &  $I$  in the lossless case are in phase.  
 $V$  &  $I$  also reverse polarity every half wavelength.

Figure 16

# Introduction to Microwave Capacitors

## Transmission Lines

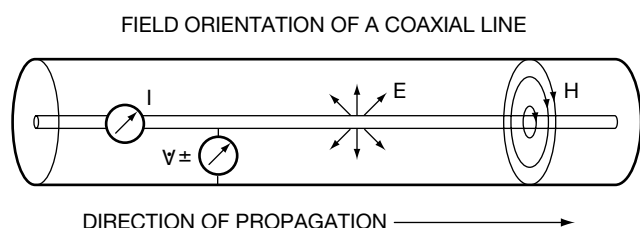


Figure 17

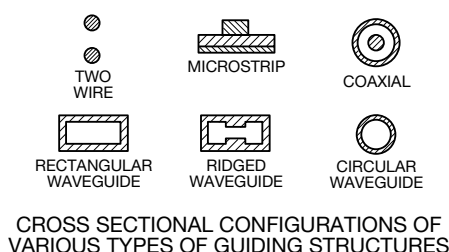


Figure 18

The total voltage pattern is called a standing wave. Standing waves exist as the result of two waves of the same frequency traveling in opposite directions on a transmission line.

The total voltage at any instant has a sine wave distribution along the line with zero voltage at the short and zero points at half wave intervals from the short circuit. The points of zero voltages are called voltage nodes and the points of maximum voltage halfway between these nodes are called antinodes.

### Open Circuit:

At a distance of one-quarter wavelength from the short, the voltage is found to be twice the amplitude of the incident voltage, which is equivalent to an open circuit. Therefore, this same distribution would be obtained if an open circuit were placed a quarter wavelength from the short. In the case the first node is located a quarter wavelength from the open and the first antinode is right as the open. The node-to-node spacing remains half wavelength as is the antinode-to-antinode spacing.

### Voltage Standing Wave Ratio:

The voltage standing wave ratio is defined as the ratio of the maximum voltage to the minimum voltage on a transmission line. This ratio is most frequently referred to as VSWR (Viswar).

$$\text{Eq. 14. } \text{VSWR} = \frac{E_{\max}}{E_{\min}} = \frac{E_i + E_r}{E_i - E_r} = \frac{1 + \text{Rho}}{1 - \text{Rho}}$$

where Rho = reflective coefficient

If the transmission line is terminated in a short or open circuit, the reflected voltage,  $E_r$ , is equal to the incident voltage,  $E_i$ . From the above equation the reflection coefficient is 1.0, and the VSWR is infinite. If a matched termination is connected to the line, the reflected wave is zero, the reflection coefficient is zero, and the VSWR is zero.

# Introduction to Microwave Capacitors

## Incorporation of Capacitors into Microwave Integrated Circuit Hybrids

### Microwave Integrated Circuit Hybrids

A Microwave Integrated Circuit Hybrid (MIC) is a microwave circuit that uses integrated circuit production techniques involving such factors as thin or thick films, substrates, dielectrics, conductors, resistors, and microstrip lines, to build passive assemblies on a dielectric. Active elements such as microwave diodes and transistors are usually added after photo resist, masking, etching, and deposition processes have been completed. MICs usually are enclosed as shielded microstrip to prevent electromagnetic interference with other components or systems. This section will discuss some of the important characteristics of MICs, such as:

- MIC substrates
- MIC metallization
- MIC components

### MIC Substrates:

Microstrip employs circuitry that is large compared to the wavelength of the frequency used with the circuit. For this reason, the etched metal patterns often are distributed circuits with transmission lines etched directly onto the MIC substrate. Figure 19 shows the pertinent dimensional parameters for a microstrip transmission line.

For the current discussion we are most interested in the higher microwave frequencies. The MIC circuit design requires a uniform and predictable substrate characteristic. Several types of substrates in common usage are: alumina, sapphire, quartz, and beryllium oxide. Key requirements for a MIC substrate are that it have:

- Low dielectric loss
- Uniform dielectric constant
- Smooth finish
- Low expansion coefficient

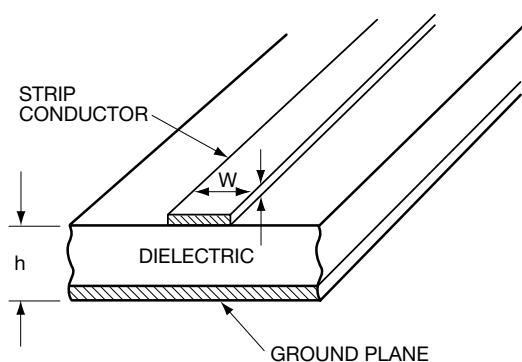


Figure 19. MIC Microstrip Outline

The characteristic impedance of the microstrip line is dependent primarily on the following:

- Width of the conductor: Increase in the width "W" of the conductor will decrease the ZO of the microstrip line.
- Height of the substrate: Increase in the height "H" of the substrate will increase the ZO of the microstrip line.

- Dielectric Constant: Increase of the dielectric constant of the substrate will decrease the ZO of the microstrip line.

Table II shows a brief listing of substrate properties.

Table II

| Material                                   | Alumina | Sapphire | Quartz | Beryllium Oxide |
|--------------------------------------------|---------|----------|--------|-----------------|
| Relative Dielectric Constant, $\epsilon_r$ | 9.8*    | 11.7     | 3.8    | 6.6             |
| Loss Tangent at 10 GHz                     | 0.0001  | 0.0001   | 0.0001 | 0.0001          |
| Thermal Conductivity K, in W/CM/Deg. C     | 0.3     | 0.4      | 0.01   | 2.5             |

\*Alumina  $\epsilon_r$  depends on vendor and purity.

The dependence of ZO to the above parameters is as shown:

**Eq. 15.**  $ZO(f) = 377 \cdot H(W)/\text{Sqrt}(\epsilon_r)$

where, H = height of the substrate

W = width of the microstrip conductor

$\epsilon_r$  = dielectric constant of the substrate

A graph of ZO versus W/H for several values of dielectric constants is shown below:

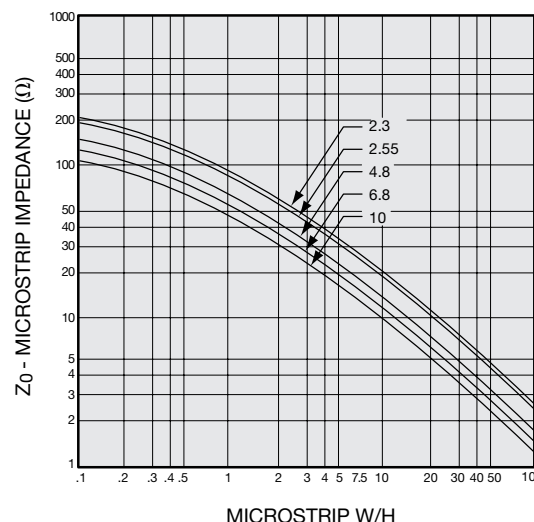


Figure 20

The most popular substrate material is alumina which has a dielectric constant of between 9.6 and 10.0 depending on the vendor and the purity. Other substrates are used where the specified unique properties of the material (beryllia for high power, ferrites for magnetic properties) are demanded by design.

# Introduction to Microwave Capacitors

## Incorporation of Capacitors into Microwave Integrated Circuit Hybrids

### MIC Metallization:

MIC metallization is a thin film of two or more layers of metals. A base metallization layer is deposited onto the substrate, another layer may be optionally deposited on top of this, and then a final gold layer is deposited onto the surface. The base metallization is chosen for its adhesion to the substrate and for compatibility with the next layer.

The base metallization is usually lossy at microwave frequencies. The losses due to this metallization can be kept to a minimum if its thickness does not exceed one "skin depth" of the metal.

Skin effect defines a phenomenon at microwave frequencies where the current travelling along a conductor does not penetrate the conductor but remains on the surface of the conductor. The "skin depth" indicates how far the microwave current will penetrate into the metal. The "skin depth" is smaller as the frequency increases.

By keeping the lossy metallization as thin as possible, more of the microwave current will propagate in the top metallization gold layer and loss is minimized.

Typical metallization schemes used in the industry are:

- Chromium-Gold: Cr-Au
- Nichrome-Gold: NiCr-Au
- Chromium-Copper-Gold: Cr-Cu-Au
- Titanium-Tungsten-Gold: TiW-Au
- Others

### MIC Components:

Microstrip has advantages over other microwave circuit topologies in that active semiconductors and passive components can easily be incorporated to make active hybrid circuits. It is possible to mix high and low frequency circuitry to attain a "system-on-a substrate."

### Passive Components:

On MIC circuits, the passive components are either distributed or lumped elements. The distributed components are usually realized by etched patterns on the substrate metallization. The lumped components are capacitors, resistors, and inductors; and whenever possible components are derived by etching them directly on the MIC metallization thin film. Chip components are used when they offer advantages such as:

- Component values are beyond that realizable by thin film techniques on the MIC substrates,
- Smaller size is required,
- High power capability is required.

Capacitors, resistors, and inductors are discussed in the following:

### Capacitors:

A lumped capacitor can be realized by the parallel gap capacitance of an area of metallization on the top of the substrate to the ground plane. Values of capacitance that can be obtained by this method are usually less than a few picofarads. At microwave frequencies if the capacitor size in any one dimension begins to approach a quarter-wavelength, a resonance will occur.

Large values of capacitance can be achieved with a dielectric constant between the capacitor plates while maintaining the small size required for MIC circuits.

Chip capacitors can be fabricated on substrate with a dielectric constant up to 5000. This higher dielectric constant allows a much smaller size capacitor for a given capacitance value which is a very desirable feature both from the real estate aspect and the self-resonance aspect.

### Resistors:

MIC resistors are often realized by using a resistive base layer on the MIC substrate metallization, and by etching the proper pattern to expose the resistive layer in the MIC circuitry.

The exact value of the resistor is determined by:

- resistivity of the resistive base layer, and
- length and width of the resistor.

Thin film resistive base layers are usually the following:

- tantalum nitride, or
- nickel-chrome (nichrome).

When chip resistors are used, they are mounted and connected in the same way as the chip capacitors.

### Inductors:

Inductors are often realized by using narrow etched microstrip lines which provides inductance on the order of 1 to 5 nanohenrys.

Higher values up to 50 nanohenrys are obtained by etching a round or square spiral onto the MIC metallization.

Even higher values can be obtained by using wound wire inductors or chip inductors which are wire coils encased in a ceramic.

Both types of discrete inductors are attached to the circuit by the same means as the capacitors.

# Introduction to Microwave Capacitors

## Incorporation of Capacitors into Microwave Integrated Circuit Hybrids

### Active components:

The active devices in the MIC circuit can be made of entirely different materials than the substrates and are usually attached to the substrates by eutectic soldering or conductive epoxy.

Typical active devices on MIC circuits are the following:

- GaAs FETs
- Bipolar Transistors
- Schottky Barrier Diodes
- PIN Diodes
- Various other Semiconductors

The active devices can be either in:

- a plastic or ceramic package with metal leads, or
- chip form.

The packaged devices are commonly used at a lower frequency range than the chip devices since they exhibit more parasitic circuit elements that limit their performance at higher frequency.

The advantages of packaged devices are protection of the devices during transport and mounting, ease of characterization, and ease of mounting onto the MIC circuit.

### Chip Component Attach:

The methods of attachment of the chip components to the substrate are usually by:

- eutectic solder die attach, and
- epoxy die attach.

#### 1. Eutectic Die Attach

The eutectic die attach method can be used with several alloys. Eutectic defines the exact alloy combination at which the solidus to liquidus transition takes place at one particular

temperature. Other combinations have transition states with wider temperature ranges. For instance, the eutectic temperature for the following alloys are:

**Table III**

| Alloy          | Eutectic Composition | Eutectic Temperature |
|----------------|----------------------|----------------------|
| Gold Germanium | 88% Au 12% Ge        | 356°C                |
| Gold Tin       | 80% Au 20% Sn        | 280°C                |

For best results, the eutectic attach is performed under an inert gas atmosphere, typically nitrogen, to reduce oxidation at high temperatures. The eutectic must be selected so that the die attach operations will not interfere with prior soldering operations and itself will not be disturbed by subsequent process steps. The metallization should be able to undergo 400°C without any blistering or other adhesion degradation.

#### 2. Epoxy Die Attach

The epoxy die attach method uses silver or gold conductive particles in an epoxy. The epoxy for chip attach on MIC circuits is a one-part type which cures at temperatures of from 125°C to 200°C. The curing time is a function of temperature. A cure time of 30 minutes at 150°C is a good compromise for high reliability and a reasonable cure time.

### Chip Components Interconnection:

The chip components are interconnected to the MIC circuit by means of:

- wire bonding, and
- miniature parallel gap welding.

## PASSIVES

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- Microwave
- Glass
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- Power Film
- Power Ceramic
- Ceramic Disc
- Trimmer
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