



# Thin-Film RF/Microwave Capacitor Technology

Accu-P®

## Thin-Film Technology

### 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-P® and Accu-P® to provide high frequency capacitors exhibiting truly ideal characteristics.

The main features of 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.

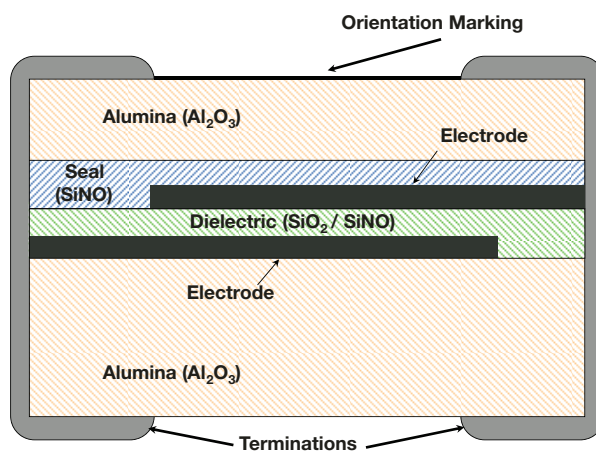
This accuracy sets apart these Thin-Film capacitors from ceramic capacitors so that the term Accu has been employed as the designation for this series of devices, an abbreviation for “accurate.”

### 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.



ACCU-P® CAPACITOR STRUCTURE

## Thin-Film Chip Capacitors

### ACCU-P® 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-P® properties are:

- Internationally agreed sizes with excellent dimensional control.
- Ultra small size chip capacitors (01005) are available.
- Ultra tight capacitance tolerances.
- Low ESR at VHF, UHF and microwave frequencies.
- Enhanced RF power handling capability.
- High stability with respect to time, temperature, frequency and voltage variation.
- Nickel/solder-coated terminations to provide excellent solderability and leach resistance.

### ACCU-P® FEATURES

Accu-P® 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-P® is currently unique in its ability to offer very low capacitance values (0.05pF) and very tight capacitance tolerances ( $\pm 0.01\text{pF}$ ).

- The RF power handling capability of the Accu-P® allows for its usage in both small signal and RF power applications.
- Thin Film Technology guarantees minimal batch to batch variability of parameters at high frequency.
- Inspection test and quality control procedures in accordance with ISO 9001, CECC, IECQ and USA MIL Standards yield products 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.

### APPLICATIONS

Cellular Communications  
 CT2/PCN (Cordless Telephone/Personal Comm. Networks)  
 Satellite TV  
 Cable TV  
 GPS (Global Positioning Systems)  
 Vehicle Location Systems  
 Vehicle Alarm Systems  
 Paging  
 Military Communications

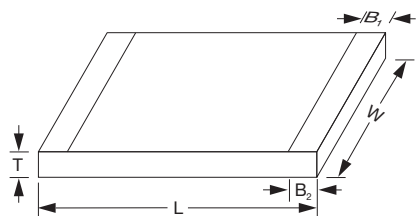
Radar Systems  
 Video Switching  
 Test & Measurements  
 Filters  
 VCO's  
 Matching Networks  
 RF Amplifiers

### APPROVALS

ISO 9001

# Accu-P®

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



### ACCUP® (Signal and Power Type Capacitors)

|                | 01005*                                                                               | 0201*                         | 0402*                                                                                | 0603*                      | 0805*                     | 1210                      |
|----------------|--------------------------------------------------------------------------------------|-------------------------------|--------------------------------------------------------------------------------------|----------------------------|---------------------------|---------------------------|
| L              | 0.405±0.020<br>(0.016±0.001)                                                         | 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) |
| W              | 0.215 ± 0.020<br>(0.0085 ± 0.001)                                                    | 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)  |
| T              | 0.145 ± 0.020<br>(0.006 ± 0.001)                                                     | 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 <sub>1</sub> | 0.00 <sup>+0.1</sup> <sub>-0.0</sub><br>(0.000 <sup>+0.004</sup> <sub>-0.000</sub> ) | 0.10±0.10<br>(0.004±0.004)    | 0.00 <sup>+0.1</sup> <sub>-0.0</sub><br>(0.000 <sup>+0.004</sup> <sub>-0.000</sub> ) | 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 <sub>2</sub> | 0.10 ± 0.03<br>(0.004 ± 0.001)                                                       | 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

**0402**

**Size**  
C005  
0201  
0402  
0603  
0805  
1210\*

**3**

**Voltage**  
2 = 200V  
1 = 100V  
5 = 50V  
3 = 25V  
Y = 16V  
Z = 10V

**J**

**Temperature Coefficient (1)**  
J = 0±30ppm/°C  
(-55°C to +125°C)  
K = 0±60ppm/°C  
(-55°C to +125°C)

**4R7**

**Capacitance**  
Capacitance expressed in pF.  
(2 significant digits + number of zeros)  
**for values <10pF**, letter R denotes decimal point.  
Example:  
68pF = 680  
8.2pF = 8R2

**A**

**Tolerance for C≤2.0pF\***  
Z = ±0.01pF  
P = ±0.02pF  
Q = ±0.03pF  
A = ±0.05pF  
B = ±0.1pF  
C = ±0.25pF

**for C≤3.0pF**  
Q = ±0.03pF  
A = ±0.05pF  
B = ±0.1pF  
C = ±0.25pF

**for C≤5.6pF**  
A = ±0.05pF  
B = ±0.1pF  
C = ±0.25pF

**for 5.6pF<C<10pF**  
B = ±0.1pF  
C = ±0.25pF  
D = ±0.5pF

**for C≥10pF**  
F = ±1%  
G = ±2%  
J = ±5%

**B**

**Specification Code**  
B = Accu-P® technology

**S**

**Termination Code**

W = Nickel/Solder Coated  
**Accu-P® 0402** Sn90, Pb10\*\*\*  
T = Nickel/High Temperature Solder Coated  
**Accu-P® 0805\*\*, 1210\*\*** Sn96, Ag4  
Nickel/Solder Coated  
**Accu-P® 0603\*\*\*** Sn63, Pb37  
\*\*S = Nickel/Lead Free Solder Coated  
**Accu-P® 01005, 0201, 0402, 0603** Sn100

\*\*RoHS compliant

\*\*\* Not RoHS Compliant

**TR**

**Packaging Code**

TR = Tape & Reel

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

**Engineering Kits Available  
see pages 114-115**

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



For RoHS compliant products,  
please select correct termination style.

## ELECTRICAL SPECIFICATIONS

|                                         |                                                                        |
|-----------------------------------------|------------------------------------------------------------------------|
| Operating and Storage Temperature Range | -55°C to +125°C                                                        |
| Temperature Coefficients <sup>(1)</sup> | 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%                                                                  |

## Signal and Power Type Capacitors

### Accu-P® Capacitance Ranges (pF)

#### TEMP. COEFFICIENT CODE

“J” = 0±30ppm/°C (-55°C to +125°C)<sup>(2)</sup> “K” = 0±60ppm/°C (-55°C to +125°C)<sup>(2)</sup>

| Size                        |   |             |      |      |    |    |    |    |      |     |    |    |    |      |     |     |    |      |     |    |      |     |    |
|-----------------------------|---|-------------|------|------|----|----|----|----|------|-----|----|----|----|------|-----|-----|----|------|-----|----|------|-----|----|
| Size Code                   |   |             | C005 | 0201 |    |    |    |    | 0402 |     |    |    |    | 0603 |     |     |    | 0805 |     |    | 1210 |     |    |
| Voltage                     |   |             | 16   | 100  | 50 | 25 | 16 | 10 | 200  | 100 | 50 | 25 | 16 | 10   | 200 | 100 | 50 | 25   | 100 | 50 | 25   | 100 | 50 |
| Cap in<br>pF <sup>(1)</sup> |   | Cap<br>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         |      |      |    |    |    |    |      |     |    |    |    |      |     |     |    |      |     |    |      |     |    |
| 19.0                        | — | 190         |      |      |    |    |    |    |      |     |    |    |    |      |     |     |    |      |     |    |      |     |    |
| 20.0                        | — | 200         |      |      |    |    |    |    |      |     |    |    |    |      |     |     |    |      |     |    |      |     |    |
| 21.0                        | — | 210         |      |      |    |    |    |    |      |     |    |    |    |      |     |     |    |      |     |    |      |     |    |
| 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.

Intermediate values are available within the indicated range.

## 0201 Typical Electrical Tables

| Capacitance<br>@ 1MHz<br>and Tolerance |       | Self<br>Resonance<br>Frequency<br>(GHz)<br>Typ. | Q Standard Value<br>@ 1GHz |      | Frequency<br>900MHz |           |                    | Frequency<br>1900MHz |           |                    | Frequency<br>2400MHz |           |                    |
|----------------------------------------|-------|-------------------------------------------------|----------------------------|------|---------------------|-----------|--------------------|----------------------|-----------|--------------------|----------------------|-----------|--------------------|
| C (pF)                                 | Tol.  |                                                 | Typ.                       | Min. | C(eff)<br>(pF) Typ. | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. |
| 0.05                                   | ±0.02 | 20.9                                            | 599                        | 402  | 0.055               | 650       | 3220               | 0.056                | 265       | 4010               | 0.057                | 195       | 4450               |
| 0.1                                    | ±0.02 | 19.4                                            | 574                        | 316  | 0.110               | 614       | 2682               | 0.112                | 246       | 3036               | 0.113                | 188       | 3113               |
| 0.15                                   | ±0.02 | 17.9                                            | 510                        | 280  | 0.163               | 550       | 2087               | 0.166                | 220       | 2404               | 0.168                | 170       | 2441               |
| 0.2                                    | ±0.02 | 16.4                                            | 445                        | 245  | 0.216               | 520       | 1693               | 0.220                | 210       | 1971               | 0.223                | 160       | 1970               |
| 0.25                                   | ±0.02 | 15.5                                            | 436                        | 240  | 0.262               | 510       | 1371               | 0.268                | 204       | 1604               | 0.272                | 153       | 1646               |
| 0.3                                    | ±0.02 | 14.6                                            | 427                        | 235  | 0.309               | 500       | 1149               | 0.316                | 199       | 1337               | 0.320                | 146       | 1421               |
| 0.35                                   | ±0.02 | 14.1                                            | 423                        | 232  | 0.360               | 494       | 1001               | 0.369                | 196       | 1177               | 0.374                | 144       | 1265               |
| 0.4                                    | ±0.02 | 12.5                                            | 418                        | 230  | 0.411               | 489       | 874                | 0.421                | 193       | 1038               | 0.427                | 142       | 1129               |
| 0.45                                   | ±0.02 | 11.9                                            | 413                        | 227  | 0.461               | 484       | 819                | 0.473                | 191       | 972                | 0.481                | 140       | 1066               |
| 0.5                                    | ±0.02 | 11.3                                            | 408                        | 224  | 0.512               | 478       | 765                | 0.526                | 188       | 906                | 0.535                | 138       | 1003               |
| 0.55                                   | ±0.02 | 10.9                                            | 403                        | 222  | 0.563               | 473       | 710                | 0.578                | 186       | 840                | 0.588                | 137       | 940                |
| 0.6                                    | ±0.02 | 10.4                                            | 398                        | 219  | 0.614               | 468       | 667                | 0.631                | 183       | 791                | 0.642                | 135       | 882                |
| 0.65                                   | ±0.02 | 10.0                                            | 394                        | 217  | 0.664               | 462       | 624                | 0.683                | 181       | 742                | 0.695                | 133       | 825                |
| 0.7                                    | ±0.02 | 9.5                                             | 389                        | 214  | 0.715               | 457       | 580                | 0.735                | 178       | 693                | 0.749                | 131       | 767                |
| 0.75                                   | ±0.02 | 9.3                                             | 384                        | 211  | 0.766               | 452       | 557                | 0.788                | 176       | 664                | 0.802                | 129       | 729                |
| 0.8                                    | ±0.02 | 9.1                                             | 379                        | 209  | 0.817               | 446       | 534                | 0.840                | 173       | 635                | 0.856                | 127       | 692                |
| 0.85                                   | ±0.02 | 8.9                                             | 374                        | 206  | 0.868               | 441       | 511                | 0.893                | 171       | 606                | 0.909                | 126       | 654                |
| 0.9                                    | ±0.02 | 8.8                                             | 370                        | 203  | 0.918               | 436       | 487                | 0.945                | 168       | 577                | 0.963                | 124       | 616                |
| 0.95                                   | ±0.02 | 8.6                                             | 365                        | 201  | 0.969               | 430       | 464                | 0.998                | 166       | 548                | 1.016                | 122       | 579                |
| 1                                      | ±0.02 | 8.4                                             | 360                        | 198  | 1.020               | 425       | 441                | 1.050                | 163       | 519                | 1.070                | 120       | 541                |
| 1.05                                   | ±0.02 | 8.2                                             | 358                        | 197  | 1.078               | 421       | 426                | 1.112                | 161       | 502                | 1.134                | 119       | 523                |
| 1.1                                    | ±0.02 | 8.0                                             | 355                        | 195  | 1.135               | 418       | 410                | 1.173                | 159       | 486                | 1.199                | 117       | 505                |
| 1.15                                   | ±0.02 | 7.8                                             | 353                        | 194  | 1.193               | 414       | 395                | 1.235                | 157       | 469                | 1.263                | 116       | 488                |
| 1.2                                    | ±0.02 | 7.6                                             | 350                        | 193  | 1.251               | 411       | 379                | 1.296                | 155       | 452                | 1.327                | 115       | 470                |
| 1.25                                   | ±0.02 | 7.5                                             | 348                        | 191  | 1.308               | 407       | 364                | 1.358                | 153       | 436                | 1.392                | 114       | 452                |
| 1.3                                    | ±0.02 | 7.4                                             | 345                        | 190  | 1.366               | 403       | 348                | 1.419                | 151       | 419                | 1.456                | 112       | 434                |
| 1.35                                   | ±0.02 | 7.3                                             | 343                        | 189  | 1.424               | 400       | 333                | 1.481                | 149       | 402                | 1.520                | 111       | 416                |
| 1.4                                    | ±0.02 | 7.2                                             | 340                        | 187  | 1.481               | 396       | 317                | 1.542                | 147       | 386                | 1.585                | 110       | 398                |
| 1.45                                   | ±0.02 | 7.1                                             | 338                        | 186  | 1.539               | 393       | 302                | 1.604                | 145       | 369                | 1.649                | 109       | 381                |
| 1.5                                    | ±0.02 | 7.0                                             | 335                        | 184  | 1.597               | 389       | 287                | 1.665                | 144       | 353                | 1.713                | 107       | 363                |
| 1.55                                   | ±0.02 | 6.8                                             | 332                        | 183  | 1.642               | 386       | 282                | 1.714                | 142       | 347                | 1.764                | 106       | 358                |
| 1.6                                    | ±0.02 | 6.7                                             | 330                        | 181  | 1.687               | 382       | 277                | 1.762                | 141       | 342                | 1.815                | 105       | 352                |
| 1.65                                   | ±0.02 | 6.6                                             | 327                        | 180  | 1.732               | 378       | 272                | 1.810                | 140       | 337                | 1.866                | 104       | 347                |
| 1.7                                    | ±0.02 | 6.5                                             | 324                        | 178  | 1.777               | 375       | 267                | 1.859                | 138       | 331                | 1.917                | 103       | 342                |
| 1.75                                   | ±0.02 | 6.4                                             | 321                        | 176  | 1.822               | 371       | 262                | 1.907                | 137       | 326                | 1.968                | 102       | 337                |
| 1.8                                    | ±0.02 | 6.3                                             | 318                        | 175  | 1.866               | 367       | 257                | 1.955                | 136       | 321                | 2.018                | 101       | 331                |
| 1.85                                   | ±0.02 | 6.2                                             | 315                        | 173  | 1.911               | 364       | 252                | 2.003                | 134       | 316                | 2.069                | 100       | 326                |
| 1.9                                    | ±0.02 | 6.2                                             | 312                        | 172  | 1.956               | 360       | 247                | 2.052                | 133       | 310                | 2.120                | 99        | 321                |
| 1.95                                   | ±0.02 | 6.1                                             | 309                        | 170  | 2.001               | 357       | 242                | 2.100                | 132       | 305                | 2.171                | 98        | 316                |
| 2                                      | ±0.03 | 6.0                                             | 306                        | 168  | 2.046               | 353       | 237                | 2.148                | 131       | 300                | 2.222                | 97        | 310                |
| 2.1                                    | ±0.03 | 5.9                                             | 301                        | 166  | 2.150               | 348       | 232                | 2.263                | 128       | 293                | 2.344                | 95        | 303                |
| 2.2                                    | ±0.03 | 5.7                                             | 296                        | 163  | 2.254               | 343       | 227                | 2.377                | 125       | 287                | 2.467                | 93        | 296                |
| 2.3                                    | ±0.03 | 5.6                                             | 292                        | 160  | 2.358               | 337       | 222                | 2.491                | 122       | 281                | 2.590                | 91        | 289                |
| 2.4                                    | ±0.03 | 5.5                                             | 287                        | 158  | 2.462               | 332       | 217                | 2.606                | 120       | 274                | 2.712                | 89        | 282                |
| 2.5                                    | ±0.03 | 5.4                                             | 282                        | 155  | 2.566               | 327       | 212                | 2.720                | 117       | 268                | 2.835                | 87        | 275                |
| 2.6                                    | ±0.03 | 5.3                                             | 277                        | 152  | 2.670               | 322       | 207                | 2.834                | 114       | 262                | 2.958                | 85        | 268                |
| 2.7                                    | ±0.03 | 5.2                                             | 272                        | 150  | 2.773               | 317       | 202                | 2.949                | 112       | 255                | 3.080                | 83        | 261                |
| 2.8                                    | ±0.03 | 5.1                                             | 269                        | 148  | 2.878               | 312       | 199                | 3.066                | 110       | 252                | 3.209                | 81        | 258                |
| 2.9                                    | ±0.03 | 5.0                                             | 265                        | 146  | 2.983               | 308       | 196                | 3.184                | 108       | 248                | 3.337                | 80        | 254                |
| 3                                      | ±0.03 | 4.9                                             | 261                        | 144  | 3.088               | 304       | 193                | 3.301                | 106       | 245                | 3.465                | 78        | 251                |
| 3.1                                    | ±0.05 | 4.8                                             | 257                        | 141  | 3.192               | 299       | 190                | 3.419                | 105       | 241                | 3.593                | 77        | 247                |
| 3.2                                    | ±0.05 | 4.7                                             | 253                        | 139  | 3.297               | 295       | 187                | 3.536                | 103       | 238                | 3.722                | 76        | 244                |
| 3.3                                    | ±0.05 | 4.6                                             | 250                        | 137  | 3.402               | 291       | 185                | 3.654                | 101       | 234                | 3.850                | 74        | 240                |
| 3.4                                    | ±0.05 | 4.6                                             | 246                        | 135  | 3.506               | 286       | 182                | 3.771                | 99        | 231                | 3.978                | 73        | 237                |
| 3.5                                    | ±0.05 | 4.5                                             | 242                        | 133  | 3.611               | 282       | 179                | 3.889                | 98        | 227                | 4.107                | 71        | 233                |
| 3.6                                    | ±0.05 | 4.5                                             | 238                        | 131  | 3.716               | 278       | 176                | 4.006                | 96        | 224                | 4.235                | 70        | 230                |
| 3.7                                    | ±0.05 | 4.4                                             | 234                        | 129  | 3.820               | 273       | 173                | 4.124                | 94        | 220                | 4.363                | 69        | 226                |
| 3.8                                    | ±0.05 | 4.4                                             | 230                        | 127  | 3.925               | 269       | 170                | 4.241                | 92        | 217                | 4.492                | 67        | 223                |
| 3.9                                    | ±0.05 | 4.3                                             | 227                        | 125  | 4.030               | 265       | 167                | 4.359                | 91        | 213                | 4.620                | 66        | 219                |

## 0201 Typical Electrical Tables

| Capacitance<br>@ 1MHz<br>and Tolerance |       | Self<br>Tesonance<br>Frequency<br>(GHz)<br>Typ. | Q Standard Value<br>@ 1GHz |      | Frequency<br>900MHz |           |                    | Frequency<br>1900MHz |           |                    | Frequency<br>2400MHz |           |                    |
|----------------------------------------|-------|-------------------------------------------------|----------------------------|------|---------------------|-----------|--------------------|----------------------|-----------|--------------------|----------------------|-----------|--------------------|
| C (pF)                                 | Tol.  |                                                 | Typ.                       | Min. | C(eff)<br>(pF) Typ. | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. |
| 4                                      | ±0.05 | 4.3                                             | 224                        | 123  | 4.138               | 262       | 165                | 4.484                | 89        | 210                | 4.760                | 65        | 216                |
| 4.1                                    | ±0.05 | 4.2                                             | 222                        | 122  | 4.247               | 259       | 162                | 4.610                | 88        | 207                | 4.901                | 64        | 213                |
| 4.2                                    | ±0.05 | 4.2                                             | 220                        | 121  | 4.356               | 257       | 159                | 4.735                | 87        | 204                | 5.041                | 63        | 210                |
| 4.3                                    | ±0.05 | 4.1                                             | 218                        | 120  | 4.464               | 254       | 157                | 4.860                | 86        | 201                | 5.181                | 62        | 207                |
| 4.4                                    | ±0.05 | 4.1                                             | 216                        | 119  | 4.573               | 252       | 154                | 4.986                | 85        | 198                | 5.322                | 61        | 204                |
| 4.5                                    | ±0.05 | 4.0                                             | 214                        | 118  | 4.682               | 249       | 152                | 5.111                | 83        | 195                | 5.462                | 60        | 201                |
| 4.6                                    | ±0.05 | 4.0                                             | 212                        | 116  | 4.790               | 246       | 149                | 5.237                | 82        | 192                | 5.602                | 59        | 198                |
| 4.7                                    | ±0.05 | 3.9                                             | 209                        | 115  | 4.899               | 244       | 147                | 5.362                | 81        | 189                | 5.743                | 58        | 195                |
| 5.1                                    | ±0.05 | 3.8                                             | 201                        | 110  | 5.334               | 233       | 136                | 5.863                | 76        | 178                | 6.304                | 54        | 183                |
| 5.6                                    | ±0.05 | 3.6                                             | 190                        | 105  | 5.877               | 220       | 124                | 6.490                | 70        | 163                | 7.006                | 49        | 168                |
| 6.2                                    | ±0.1  | 3.5                                             | 177                        | 97   | 6.488               | 208       | 126                | 7.290                | 65        | 167                | 7.993                | 45        | 174                |
| 6.8                                    | ±0.1  | 3.3                                             | 164                        | 90   | 7.100               | 195       | 128                | 8.090                | 60        | 171                | 8.980                | 41        | 179                |
| 7.5                                    | ±0.1  | 3.2                                             | 153                        | 84   | 7.901               | 182       | 125                | 9.129                | 56        | 166                | 10.27                | 38        | 173                |
| 8.2                                    | ±0.1  | 3.0                                             | 142                        | 78   | 8.701               | 168       | 121                | 10.17                | 52        | 160                | 11.56                | 34        | 167                |
| 9.1                                    | ±0.1  | 2.9                                             | 135                        | 74   | 9.676               | 159       | 118                | 11.57                | 49        | 154                | 13.49                | 32        | 161                |
| 10                                     | ±1%   | 2.8                                             | 128                        | 70   | 10.65               | 151       | 114                | 12.96                | 45        | 148                | 15.41                | 29        | 155                |
| 11                                     | ±1%   | 2.7                                             | 120                        | 66   | 11.73               | 141       | 110                | 14.52                | 42        | 142                | 17.55                | 27        | 148                |
| 12                                     | ±1%   | 2.5                                             | 112                        | 62   | 12.82               | 132       | 105                | 16.07                | 39        | 135                | 19.68                | 24        | 141                |
| 13                                     | ±1%   | 2.4                                             | 105                        | 58   | 13.92               | 124       | 104                | 17.82                | 36        | 135                | 22.38                | 22        | 142                |
| 14                                     | ±1%   | 2.4                                             | 98                         | 54   | 15.02               | 116       | 103                | 19.57                | 32        | 135                | 25.08                | 19        | 142                |
| 15                                     | ±1%   | 2.3                                             | 91                         | 50   | 16.12               | 108       | 102                | 21.32                | 29        | 135                | 27.78                | 17        | 143                |
| 16                                     | ±1%   | 2.2                                             | 86                         | 47   | 17.37               | 102       | 103                | 24.04                | 27        | 135                | NA                   | NA        | NA                 |
| 17                                     | ±1%   | 2.2                                             | 81                         | 44   | 18.63               | 96        | 105                | 26.76                | 25        | 136                | NA                   | NA        | NA                 |
| 18                                     | ±1%   | 2.1                                             | 76                         | 42   | 19.88               | 90        | 106                | 29.48                | 23        | 136                | NA                   | NA        | NA                 |
| 19                                     | ±1%   | 2.1                                             | 71                         | 39   | 21.14               | 83        | 108                | 32.20                | 21        | 136                | NA                   | NA        | NA                 |
| 20                                     | ±1%   | 2.1                                             | 65                         | 36   | 22.39               | 77        | 109                | 34.92                | 19        | 136                | NA                   | NA        | NA                 |
| 22                                     | ±1%   | 2.0                                             | 55                         | 30   | 24.90               | 65        | 112                | 40.36                | 15        | 137                | NA                   | NA        | NA                 |

## 0402 Typical Electrical Tables

| Capacitance<br>@ 1MHz<br>and Tolerance |       | Self<br>Resonance<br>Frequency<br>(GHz)<br>Typ. | Q Standard Value<br>@ 1GHz |      | Frequency<br>900MHz |           |                    | Frequency<br>1900MHz |           |                    | Frequency<br>2400MHz |           |                    |
|----------------------------------------|-------|-------------------------------------------------|----------------------------|------|---------------------|-----------|--------------------|----------------------|-----------|--------------------|----------------------|-----------|--------------------|
| C (pF)                                 | Tol.  |                                                 | Typ.                       | Min. | C(eff)<br>(pF) Typ. | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. |
| 0.05                                   | ±0.02 | 20.9                                            | 856                        | 471  | 0.06                | 881       | 1411               | 0.06                 | 562       | 1216               | 0.06                 | 498       | 983                |
| 0.1                                    | ±0.02 | 19.4                                            | 848                        | 466  | 0.11                | 873       | 1316               | 0.11                 | 554       | 1115               | 0.11                 | 490       | 914                |
| 0.15                                   | ±0.02 | 17.9                                            | 840                        | 462  | 0.16                | 866       | 1222               | 0.16                 | 547       | 1013               | 0.16                 | 482       | 845                |
| 0.2                                    | ±0.02 | 16.4                                            | 832                        | 457  | 0.21                | 858       | 1128               | 0.21                 | 539       | 912                | 0.22                 | 474       | 776                |
| 0.25                                   | ±0.02 | 15.5                                            | 823                        | 453  | 0.26                | 850       | 1033               | 0.27                 | 532       | 810                | 0.27                 | 465       | 707                |
| 0.3                                    | ±0.02 | 14.6                                            | 815                        | 448  | 0.31                | 842       | 939                | 0.32                 | 525       | 708                | 0.32                 | 457       | 638                |
| 0.35                                   | ±0.02 | 14.1                                            | 807                        | 444  | 0.36                | 834       | 844                | 0.37                 | 517       | 607                | 0.37                 | 449       | 569                |
| 0.4                                    | ±0.02 | 12.5                                            | 799                        | 439  | 0.41                | 827       | 750                | 0.42                 | 510       | 505                | 0.42                 | 441       | 500                |
| 0.45                                   | ±0.02 | 11.9                                            | 791                        | 435  | 0.46                | 819       | 667                | 0.47                 | 502       | 458                | 0.48                 | 432       | 453                |
| 0.5                                    | ±0.02 | 11.3                                            | 783                        | 430  | 0.51                | 811       | 583                | 0.52                 | 495       | 410                | 0.53                 | 424       | 407                |
| 0.55                                   | ±0.02 | 10.9                                            | 774                        | 426  | 0.57                | 803       | 500                | 0.57                 | 487       | 363                | 0.58                 | 416       | 360                |
| 0.6                                    | ±0.02 | 10.4                                            | 766                        | 421  | 0.62                | 796       | 465                | 0.62                 | 480       | 343                | 0.63                 | 408       | 339                |
| 0.65                                   | ±0.02 | 10.0                                            | 758                        | 417  | 0.67                | 788       | 431                | 0.67                 | 472       | 322                | 0.68                 | 399       | 317                |
| 0.7                                    | ±0.02 | 9.5                                             | 750                        | 413  | 0.72                | 780       | 396                | 0.72                 | 465       | 302                | 0.73                 | 391       | 296                |
| 0.75                                   | ±0.02 | 9.3                                             | 746                        | 410  | 0.77                | 776       | 375                | 0.78                 | 456       | 290                | 0.79                 | 381       | 285                |
| 0.8                                    | ±0.02 | 9.1                                             | 743                        | 408  | 0.82                | 772       | 354                | 0.83                 | 447       | 277                | 0.84                 | 370       | 273                |
| 0.85                                   | ±0.02 | 9.0                                             | 739                        | 406  | 0.87                | 768       | 334                | 0.88                 | 438       | 265                | 0.89                 | 360       | 262                |
| 0.9                                    | ±0.02 | 8.8                                             | 735                        | 404  | 0.92                | 764       | 313                | 0.93                 | 429       | 253                | 0.95                 | 350       | 250                |
| 0.95                                   | ±0.02 | 8.4                                             | 732                        | 402  | 0.97                | 760       | 292                | 0.98                 | 420       | 240                | 1.00                 | 339       | 239                |
| 1                                      | ±0.02 | 8.0                                             | 728                        | 400  | 1.02                | 756       | 271                | 1.04                 | 411       | 228                | 1.05                 | 329       | 227                |
| 1.05                                   | ±0.02 | 7.9                                             | 725                        | 398  | 1.07                | 752       | 258                | 1.09                 | 406       | 221                | 1.11                 | 323       | 221                |
| 1.1                                    | ±0.02 | 7.8                                             | 721                        | 397  | 1.12                | 749       | 245                | 1.14                 | 401       | 214                | 1.16                 | 318       | 214                |
| 1.15                                   | ±0.02 | 7.6                                             | 718                        | 395  | 1.17                | 745       | 232                | 1.20                 | 396       | 207                | 1.22                 | 312       | 208                |
| 1.2                                    | ±0.02 | 7.4                                             | 714                        | 393  | 1.22                | 742       | 218                | 1.25                 | 391       | 200                | 1.27                 | 306       | 202                |
| 1.25                                   | ±0.02 | 7.2                                             | 711                        | 391  | 1.27                | 738       | 205                | 1.31                 | 386       | 193                | 1.32                 | 301       | 195                |
| 1.3                                    | ±0.02 | 7.0                                             | 707                        | 389  | 1.32                | 734       | 192                | 1.36                 | 381       | 185                | 1.38                 | 295       | 189                |
| 1.35                                   | ±0.02 | 6.9                                             | 704                        | 387  | 1.37                | 731       | 179                | 1.41                 | 376       | 178                | 1.43                 | 289       | 183                |
| 1.4                                    | ±0.02 | 6.8                                             | 700                        | 385  | 1.42                | 727       | 165                | 1.47                 | 371       | 171                | 1.49                 | 283       | 177                |
| 1.45                                   | ±0.02 | 6.7                                             | 697                        | 383  | 1.47                | 724       | 152                | 1.52                 | 366       | 164                | 1.54                 | 278       | 170                |
| 1.5                                    | ±0.02 | 6.5                                             | 693                        | 381  | 1.52                | 720       | 139                | 1.58                 | 361       | 157                | 1.60                 | 272       | 164                |
| 1.55                                   | ±0.02 | 6.5                                             | 690                        | 379  | 1.56                | 716       | 135                | 1.62                 | 358       | 153                | 1.65                 | 269       | 159                |
| 1.6                                    | ±0.02 | 6.5                                             | 686                        | 377  | 1.61                | 713       | 130                | 1.67                 | 355       | 148                | 1.70                 | 267       | 155                |
| 1.65                                   | ±0.02 | 6.5                                             | 683                        | 375  | 1.66                | 709       | 126                | 1.72                 | 352       | 143                | 1.76                 | 264       | 150                |
| 1.7                                    | ±0.02 | 6.4                                             | 679                        | 373  | 1.71                | 705       | 122                | 1.77                 | 349       | 139                | 1.81                 | 261       | 146                |
| 1.75                                   | ±0.02 | 6.3                                             | 676                        | 372  | 1.75                | 702       | 118                | 1.82                 | 347       | 134                | 1.86                 | 259       | 141                |
| 1.8                                    | ±0.02 | 6.2                                             | 672                        | 370  | 1.80                | 698       | 113                | 1.87                 | 344       | 130                | 1.92                 | 256       | 137                |
| 1.85                                   | ±0.02 | 6.1                                             | 669                        | 368  | 1.85                | 694       | 109                | 1.92                 | 341       | 125                | 1.97                 | 253       | 132                |
| 1.9                                    | ±0.02 | 6.0                                             | 665                        | 366  | 1.90                | 690       | 105                | 1.97                 | 338       | 121                | 2.02                 | 251       | 128                |
| 1.95                                   | ±0.02 | 5.9                                             | 662                        | 364  | 1.94                | 687       | 101                | 2.01                 | 335       | 116                | 2.08                 | 248       | 123                |
| 2                                      | ±0.03 | 5.7                                             | 658                        | 362  | 1.99                | 683       | 96                 | 2.06                 | 332       | 112                | 2.13                 | 245       | 119                |
| 2.1                                    | ±0.03 | 5.4                                             | 651                        | 358  | 2.10                | 676       | 93                 | 2.18                 | 326       | 108                | 2.26                 | 241       | 115                |
| 2.2                                    | ±0.03 | 5.1                                             | 643                        | 354  | 2.21                | 669       | 89                 | 2.30                 | 321       | 104                | 2.38                 | 236       | 112                |
| 2.3                                    | ±0.03 | 5.0                                             | 636                        | 350  | 2.31                | 662       | 85                 | 2.42                 | 315       | 101                | 2.51                 | 231       | 109                |
| 2.4                                    | ±0.03 | 4.9                                             | 629                        | 346  | 2.42                | 656       | 81                 | 2.54                 | 309       | 97                 | 2.64                 | 226       | 106                |
| 2.5                                    | ±0.03 | 4.7                                             | 622                        | 342  | 2.53                | 649       | 77                 | 2.65                 | 303       | 94                 | 2.76                 | 221       | 102                |
| 2.6                                    | ±0.03 | 4.6                                             | 614                        | 338  | 2.64                | 642       | 74                 | 2.77                 | 298       | 90                 | 2.89                 | 216       | 99                 |
| 2.7                                    | ±0.03 | 4.5                                             | 607                        | 334  | 2.75                | 635       | 70                 | 2.89                 | 292       | 86                 | 3.02                 | 211       | 96                 |
| 2.8                                    | ±0.03 | 4.5                                             | 600                        | 330  | 2.85                | 628       | 68                 | 3.01                 | 288       | 83                 | 3.15                 | 207       | 92                 |
| 2.9                                    | ±0.03 | 4.4                                             | 592                        | 326  | 2.95                | 621       | 66                 | 3.13                 | 283       | 80                 | 3.28                 | 203       | 88                 |
| 3                                      | ±0.03 | 4.4                                             | 585                        | 322  | 3.06                | 614       | 64                 | 3.24                 | 279       | 76                 | 3.41                 | 200       | 84                 |
| 3.1                                    | ±0.05 | 4.4                                             | 578                        | 318  | 3.16                | 607       | 62                 | 3.36                 | 274       | 73                 | 3.54                 | 196       | 80                 |
| 3.2                                    | ±0.05 | 4.3                                             | 570                        | 314  | 3.27                | 600       | 60                 | 3.48                 | 270       | 70                 | 3.67                 | 192       | 76                 |
| 3.3                                    | ±0.05 | 4.3                                             | 563                        | 310  | 3.37                | 593       | 58                 | 3.60                 | 265       | 67                 | 3.80                 | 188       | 72                 |
| 3.4                                    | ±0.05 | 4.3                                             | 556                        | 306  | 3.47                | 586       | 57                 | 3.71                 | 261       | 63                 | 3.93                 | 184       | 68                 |
| 3.5                                    | ±0.05 | 4.2                                             | 548                        | 302  | 3.58                | 579       | 55                 | 3.83                 | 256       | 60                 | 4.06                 | 180       | 64                 |
| 3.6                                    | ±0.05 | 4.2                                             | 541                        | 298  | 3.68                | 572       | 53                 | 3.95                 | 252       | 57                 | 4.19                 | 177       | 60                 |
| 3.7                                    | ±0.05 | 4.1                                             | 534                        | 294  | 3.78                | 565       | 51                 | 4.06                 | 247       | 54                 | 4.32                 | 173       | 56                 |
| 3.8                                    | ±0.05 | 4.0                                             | 526                        | 289  | 3.89                | 558       | 49                 | 4.18                 | 243       | 50                 | 4.45                 | 169       | 52                 |
| 3.9                                    | ±0.05 | 3.9                                             | 519                        | 285  | 3.99                | 551       | 47                 | 4.30                 | 238       | 47                 | 4.58                 | 165       | 48                 |

## 0402 Typical Electrical Tables

| Capacitance<br>@ 1MHz<br>and Tolerance |       | Self<br>Resonance<br>Frequency<br>(GHz)<br>Typ. | Q Standard Value<br>@ 1GHz |      | Frequency<br>900MHz |           |                    | Frequency<br>1900MHz |           |                    | Frequency<br>2400MHz |           |                    |
|----------------------------------------|-------|-------------------------------------------------|----------------------------|------|---------------------|-----------|--------------------|----------------------|-----------|--------------------|----------------------|-----------|--------------------|
| C (pF)                                 | Tol.  |                                                 | Typ.                       | Min. | C(eff)<br>(pF) Typ. | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. |
| 4                                      | ±0.05 | 3.9                                             | 513                        | 282  | 4.10                | 545       | 47                 | 4.42                 | 235       | 47                 | 4.73                 | 162       | 48                 |
| 4.1                                    | ±0.05 | 3.8                                             | 507                        | 279  | 4.20                | 539       | 47                 | 4.55                 | 232       | 46                 | 4.87                 | 160       | 48                 |
| 4.2                                    | ±0.05 | 3.8                                             | 501                        | 275  | 4.30                | 534       | 46                 | 4.67                 | 228       | 46                 | 5.01                 | 157       | 48                 |
| 4.3                                    | ±0.05 | 3.7                                             | 495                        | 272  | 4.41                | 528       | 46                 | 4.79                 | 225       | 46                 | 5.16                 | 154       | 48                 |
| 4.4                                    | ±0.05 | 3.7                                             | 489                        | 269  | 4.51                | 522       | 46                 | 4.92                 | 222       | 46                 | 5.30                 | 151       | 47                 |
| 4.5                                    | ±0.05 | 3.6                                             | 483                        | 265  | 4.61                | 516       | 46                 | 5.04                 | 219       | 45                 | 5.44                 | 149       | 47                 |
| 4.6                                    | ±0.05 | 3.6                                             | 477                        | 262  | 4.72                | 511       | 45                 | 5.16                 | 216       | 45                 | 5.59                 | 146       | 47                 |
| 4.7                                    | ±0.05 | 3.5                                             | 471                        | 259  | 4.82                | 505       | 45                 | 5.29                 | 213       | 45                 | 5.73                 | 143       | 47                 |
| 5.1                                    | ±0.05 | 3.4                                             | 446                        | 245  | 5.23                | 482       | 44                 | 5.78                 | 200       | 43                 | 6.30                 | 133       | 47                 |
| 5.6                                    | ±0.05 | 3.3                                             | 416                        | 229  | 5.75                | 453       | 43                 | 6.40                 | 184       | 42                 | 7.02                 | 119       | 46                 |
| 6.2                                    | ±0.1  | 3.0                                             | 388                        | 213  | 6.41                | 427       | 44                 | 7.26                 | 167       | 44                 | 8.11                 | 107       | 47                 |
| 6.8                                    | ±0.1  | 2.8                                             | 360                        | 198  | 7.07                | 400       | 44                 | 8.12                 | 150       | 45                 | 9.19                 | 95        | 48                 |
| 7.5                                    | ±0.1  | 2.7                                             | 338                        | 186  | 7.85                | 378       | 45                 | 9.17                 | 139       | 47                 | 10.57                | 86        | 49                 |
| 8.2                                    | ±0.1  | 2.6                                             | 315                        | 173  | 8.62                | 356       | 45                 | 10.22                | 128       | 48                 | 11.95                | 77        | 50                 |
| 9.1                                    | ±0.1  | 2.5                                             | 292                        | 160  | 9.63                | 333       | 45                 | 11.75                | 115       | 47                 | 14.23                | 69        | 50                 |
| 10                                     | ±1%   | 2.4                                             | 268                        | 148  | 10.65               | 310       | 45                 | 13.28                | 103       | 47                 | 16.50                | 61        | 49                 |
| 11                                     | ±1%   | 2.3                                             | 242                        | 133  | 11.77               | 285       | 44                 | 14.98                | 89        | 46                 | 19.04                | 51        | 49                 |
| 12                                     | ±1%   | 2.2                                             | 217                        | 119  | 12.90               | 259       | 44                 | 16.68                | 75        | 45                 | 21.57                | 42        | 48                 |
| 13                                     | ±1%   | 2.2                                             | 202                        | 111  | 14.03               | 241       | 44                 | 18.83                | 68        | 47                 | 25.73                | 38        | 49                 |
| 14                                     | ±1%   | 2.1                                             | 187                        | 103  | 15.17               | 223       | 44                 | 20.97                | 62        | 49                 | 29.89                | 33        | 49                 |
| 15                                     | ±1%   | 2.1                                             | 172                        | 94   | 16.30               | 204       | 45                 | 23.12                | 56        | 51                 | 34.05                | 29        | 50                 |
| 16                                     | ±1%   | 2.0                                             | 157                        | 87   | 17.53               | 187       | 44                 | 25.91                | 50        | 49                 | 41.44                | 25        | 49                 |
| 17                                     | ±1%   | 1.9                                             | 143                        | 79   | 18.75               | 169       | 43                 | 28.70                | 45        | 46                 | 48.82                | 21        | 47                 |
| 18                                     | ±1%   | 1.8                                             | 129                        | 71   | 19.98               | 152       | 42                 | 31.49                | 39        | 44                 | 56.21                | 17        | 46                 |
| 19                                     | ±1%   | 1.8                                             | 121                        | 67   | 21.11               | 143       | 42                 | 33.51                | 36        | 44                 | 60.92                | 15        | 47                 |
| 20                                     | ±1%   | 1.8                                             | 110                        | 61   | 22.25               | 131       | 41                 | 35.53                | 33        | 43                 | 65.63                | 14        | 48                 |
| 22                                     | ±1%   | 1.8                                             | 98                         | 54   | 24.51               | 116       | 41                 | 39.57                | 26        | 42                 | 75.05                | 10        | 51                 |
| 24                                     | ±1%   | 1.8                                             | 87                         | 48   | 27.51               | 104       | 37                 | 54.94                | 21        | 35                 | NA                   | NA        | NA                 |
| 27                                     | ±1%   | 1.7                                             | 70                         | 39   | 32.01               | 85        | 32                 | 77.98                | 13        | 23                 | NA                   | NA        | NA                 |
| 30                                     | ±1%   | 1.7                                             | 65                         | 36   | 35.89               | 78        | 28                 | 106.50               | 10        | 12                 | NA                   | NA        | NA                 |
| 33                                     | ±1%   | 1.7                                             | 60                         | 33   | 40.05               | 74        | 27                 | NA                   | NA        | NA                 | NA                   | NA        | NA                 |
| 36                                     | ±1%   | 1.7                                             | 58                         | 32   | 45.13               | 71        | 28                 | NA                   | NA        | NA                 | NA                   | NA        | NA                 |
| 39                                     | ±1%   | 1.7                                             | 56                         | 31   | 50.21               | 69        | 28                 | NA                   | NA        | NA                 | NA                   | NA        | NA                 |
| 43                                     | ±1%   | 1.6                                             | 53                         | 29   | 56.98               | 66        | 29                 | NA                   | NA        | NA                 | NA                   | NA        | NA                 |
| 47                                     | ±1%   | 1.6                                             | 50                         | 28   | 63.75               | 63        | 30                 | NA                   | NA        | NA                 | NA                   | NA        | NA                 |
| 51                                     | ±1%   | 1.6                                             | 48                         | 26   | 70.53               | 60        | 31                 | NA                   | NA        | NA                 | NA                   | NA        | NA                 |
| 56                                     | ±1%   | 1.6                                             | 44                         | 24   | 78.99               | 56        | 33                 | NA                   | NA        | NA                 | NA                   | NA        | NA                 |
| 58                                     | ±1%   | 1.6                                             | 42                         | 23   | 83.54               | 54        | 34                 | NA                   | NA        | NA                 | NA                   | NA        | NA                 |
| 68                                     | ±1%   | 1.6                                             | 32                         | 18   | 106.28              | 42        | 40                 | NA                   | NA        | NA                 | NA                   | NA        | NA                 |

## 0603 Typical Electrical Tables

| Capacitance<br>@ 1MHz<br>and Tolerance |       | Self<br>Resonance<br>Frequency<br>(GHz)<br>Typ. | Q Standard Value<br>@ 1GHz |      | Frequency<br>900MHz |           |                    | Frequency<br>1900MHz |           |                    | Frequency<br>2400MHz |           |                    |
|----------------------------------------|-------|-------------------------------------------------|----------------------------|------|---------------------|-----------|--------------------|----------------------|-----------|--------------------|----------------------|-----------|--------------------|
| C (pF)                                 | Tol.  |                                                 | Typ.                       | Min. | C(eff)<br>(pF) Typ. | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. |
| 0.05                                   | ±0.02 | 25.6                                            | 1200                       | 660  | 0.00                | 1333      | 945                | 0.00                 | 556       | 832                | 0.00                 | 397       | 880                |
| 0.1                                    | ±0.02 | 18.1                                            | 1156                       | 636  | 0.00                | 1284      | 675                | 0.00                 | 535       | 628                | 0.00                 | 382       | 667                |
| 0.15                                   | ±0.02 | 14.8                                            | 1111                       | 611  | 0.00                | 1235      | 555                | 0.00                 | 514       | 533                | 0.00                 | 367       | 567                |
| 0.2                                    | ±0.02 | 12.8                                            | 1067                       | 587  | 0.00                | 1185      | 483                | 0.00                 | 494       | 474                | 0.00                 | 353       | 505                |
| 0.25                                   | ±0.02 | 11.4                                            | 1022                       | 562  | 0.00                | 1136      | 433                | 0.00                 | 473       | 433                | 0.00                 | 338       | 462                |
| 0.3                                    | ±0.02 | 10.4                                            | 978                        | 538  | 0.31                | 1086      | 397                | 0.32                 | 453       | 402                | 0.32                 | 323       | 430                |
| 0.35                                   | ±0.02 | 9.7                                             | 933                        | 513  | 0.00                | 1037      | 368                | 0.00                 | 432       | 378                | 0.00                 | 309       | 404                |
| 0.4                                    | ±0.02 | 9.0                                             | 889                        | 489  | 0.00                | 988       | 345                | 0.00                 | 412       | 358                | 0.00                 | 294       | 383                |
| 0.45                                   | ±0.02 | 8.5                                             | 844                        | 464  | 0.00                | 938       | 326                | 0.00                 | 391       | 341                | 0.00                 | 279       | 365                |
| 0.5                                    | ±0.02 | 8.1                                             | 800                        | 440  | 0.00                | 889       | 310                | 0.00                 | 370       | 327                | 0.00                 | 265       | 350                |
| 0.55                                   | ±0.02 | 7.7                                             | 788                        | 434  | 0.00                | 875       | 296                | 0.00                 | 363       | 315                | 0.00                 | 261       | 337                |
| 0.6                                    | ±0.02 | 7.4                                             | 777                        | 427  | 0.00                | 860       | 283                | 0.00                 | 356       | 304                | 0.00                 | 258       | 326                |
| 0.65                                   | ±0.02 | 7.1                                             | 765                        | 421  | 0.00                | 846       | 273                | 0.00                 | 348       | 294                | 0.00                 | 255       | 315                |
| 0.7                                    | ±0.02 | 6.8                                             | 754                        | 414  | 0.72                | 832       | 263                | 0.72                 | 341       | 285                | 0.73                 | 252       | 306                |
| 0.75                                   | ±0.02 | 6.6                                             | 742                        | 408  | 0.00                | 817       | 254                | 0.00                 | 334       | 277                | 0.00                 | 248       | 298                |
| 0.8                                    | ±0.02 | 6.4                                             | 730                        | 402  | 0.00                | 803       | 247                | 0.00                 | 326       | 270                | 0.00                 | 245       | 290                |
| 0.85                                   | ±0.02 | 6.2                                             | 719                        | 395  | 0.00                | 789       | 239                | 0.00                 | 319       | 264                | 0.00                 | 242       | 283                |
| 0.9                                    | ±0.02 | 6.0                                             | 707                        | 389  | 0.00                | 775       | 233                | 0.00                 | 312       | 258                | 0.00                 | 239       | 277                |
| 0.95                                   | ±0.02 | 5.9                                             | 696                        | 383  | 0.00                | 760       | 227                | 0.00                 | 304       | 252                | 0.00                 | 235       | 271                |
| 1                                      | ±0.02 | 5.7                                             | 684                        | 376  | 1.019               | 746       | 216                | 1.061                | 297       | 242                | 1.101                | 232       | 260                |
| 1.05                                   | ±0.02 | 5.6                                             | 667                        | 367  | 1.076               | 731       | 213                | 1.126                | 290       | 239                | 1.171                | 226       | 256                |
| 1.1                                    | ±0.02 | 5.4                                             | 649                        | 357  | 1.134               | 717       | 210                | 1.190                | 282       | 236                | 1.241                | 220       | 253                |
| 1.15                                   | ±0.02 | 5.3                                             | 632                        | 347  | 1.192               | 702       | 206                | 1.254                | 275       | 233                | 1.311                | 214       | 250                |
| 1.2                                    | ±0.02 | 5.2                                             | 614                        | 338  | 1.250               | 687       | 203                | 1.318                | 267       | 230                | 1.381                | 209       | 247                |
| 1.25                                   | ±0.02 | 5.1                                             | 605                        | 333  | 1.307               | 677       | 200                | 1.382                | 262       | 227                | 1.451                | 203       | 244                |
| 1.3                                    | ±0.02 | 5.0                                             | 596                        | 328  | 1.365               | 667       | 197                | 1.446                | 257       | 224                | 1.521                | 197       | 241                |
| 1.35                                   | ±0.02 | 4.9                                             | 587                        | 323  | 1.423               | 658       | 194                | 1.511                | 252       | 221                | 1.591                | 191       | 238                |
| 1.4                                    | ±0.02 | 4.8                                             | 578                        | 318  | 1.481               | 648       | 190                | 1.575                | 247       | 218                | 1.661                | 185       | 235                |
| 1.45                                   | ±0.02 | 4.8                                             | 569                        | 313  | 1.538               | 638       | 187                | 1.639                | 242       | 215                | 1.731                | 179       | 232                |
| 1.5                                    | ±0.02 | 4.7                                             | 560                        | 308  | 1.596               | 628       | 184                | 1.703                | 237       | 212                | 1.801                | 173       | 229                |
| 1.55                                   | ±0.02 | 4.6                                             | 551                        | 303  | 1.645               | 620       | 181                | 1.760                | 233       | 209                | 1.866                | 170       | 226                |
| 1.6                                    | ±0.02 | 4.5                                             | 542                        | 298  | 1.694               | 611       | 178                | 1.817                | 228       | 206                | 1.930                | 166       | 222                |
| 1.65                                   | ±0.02 | 4.5                                             | 534                        | 293  | 1.743               | 603       | 175                | 1.874                | 224       | 203                | 1.995                | 163       | 219                |
| 1.7                                    | ±0.02 | 4.4                                             | 525                        | 289  | 1.792               | 595       | 172                | 1.931                | 219       | 200                | 2.060                | 159       | 216                |
| 1.75                                   | ±0.02 | 4.3                                             | 516                        | 284  | 1.841               | 587       | 169                | 1.988                | 215       | 197                | 2.124                | 156       | 213                |
| 1.8                                    | ±0.02 | 4.2                                             | 507                        | 279  | 1.890               | 578       | 166                | 2.045                | 211       | 194                | 2.189                | 153       | 209                |
| 1.85                                   | ±0.02 | 4.2                                             | 498                        | 274  | 1.939               | 570       | 163                | 2.102                | 206       | 191                | 2.253                | 149       | 206                |
| 1.9                                    | ±0.02 | 4.1                                             | 490                        | 269  | 1.988               | 562       | 160                | 2.158                | 202       | 188                | 2.318                | 146       | 203                |
| 1.95                                   | ±0.02 | 4.1                                             | 481                        | 264  | 2.037               | 553       | 157                | 2.215                | 197       | 185                | 2.383                | 142       | 199                |
| 2                                      | ±0.03 | 4.0                                             | 472                        | 260  | 2.086               | 545       | 154                | 2.272                | 193       | 182                | 2.447                | 139       | 196                |
| 2.1                                    | ±0.03 | 3.9                                             | 462                        | 254  | 2.190               | 535       | 151                | 2.402                | 187       | 180                | 2.604                | 134       | 193                |
| 2.2                                    | ±0.03 | 3.8                                             | 452                        | 249  | 2.295               | 524       | 148                | 2.532                | 181       | 177                | 2.761                | 129       | 191                |
| 2.3                                    | ±0.03 | 3.8                                             | 442                        | 243  | 2.400               | 514       | 145                | 2.662                | 175       | 175                | 2.917                | 124       | 188                |
| 2.4                                    | ±0.03 | 3.7                                             | 433                        | 238  | 2.504               | 503       | 143                | 2.793                | 168       | 172                | 3.074                | 118       | 186                |
| 2.5                                    | ±0.03 | 3.6                                             | 423                        | 232  | 2.609               | 493       | 140                | 2.923                | 162       | 170                | 3.230                | 113       | 183                |
| 2.6                                    | ±0.03 | 3.6                                             | 413                        | 227  | 2.714               | 482       | 137                | 3.053                | 156       | 167                | 3.387                | 108       | 181                |
| 2.7                                    | ±0.03 | 3.5                                             | 403                        | 222  | 2.818               | 472       | 134                | 3.183                | 150       | 165                | 3.543                | 103       | 178                |
| 2.8                                    | ±0.03 | 3.4                                             | 395                        | 217  | 2.933               | 463       | 133                | 3.336                | 147       | 164                | 3.742                | 100       | 177                |
| 2.9                                    | ±0.03 | 3.4                                             | 388                        | 213  | 3.047               | 453       | 131                | 3.489                | 144       | 162                | 3.940                | 97        | 175                |
| 3                                      | ±0.03 | 3.3                                             | 380                        | 209  | 3.162               | 444       | 130                | 3.642                | 140       | 161                | 4.139                | 95        | 174                |
| 3.1                                    | ±0.05 | 3.2                                             | 372                        | 205  | 3.276               | 435       | 129                | 3.795                | 137       | 160                | 4.337                | 92        | 172                |
| 3.2                                    | ±0.05 | 3.2                                             | 365                        | 201  | 3.391               | 425       | 127                | 3.947                | 134       | 159                | 4.536                | 89        | 171                |
| 3.3                                    | ±0.05 | 3.1                                             | 357                        | 196  | 3.506               | 416       | 126                | 4.100                | 131       | 157                | 4.734                | 86        | 169                |
| 3.4                                    | ±0.05 | 3.1                                             | 349                        | 192  | 3.620               | 407       | 125                | 4.253                | 128       | 156                | 4.933                | 84        | 168                |
| 3.5                                    | ±0.05 | 3.1                                             | 342                        | 188  | 3.735               | 397       | 123                | 4.406                | 125       | 155                | 5.131                | 81        | 166                |
| 3.6                                    | ±0.05 | 3.0                                             | 334                        | 184  | 3.849               | 388       | 122                | 4.559                | 121       | 154                | 5.330                | 78        | 165                |
| 3.7                                    | ±0.05 | 3.0                                             | 326                        | 179  | 3.964               | 379       | 121                | 4.712                | 118       | 152                | 5.528                | 75        | 164                |
| 3.8                                    | ±0.05 | 3.0                                             | 318                        | 175  | 4.078               | 369       | 119                | 4.865                | 115       | 151                | 5.727                | 73        | 162                |
| 3.9                                    | ±0.05 | 2.9                                             | 311                        | 171  | 4.193               | 360       | 118                | 5.018                | 112       | 150                | 5.925                | 70        | 161                |

## 0603 Typical Electrical Tables

| Capacitance<br>@ 1MHz<br>and Tolerance |       | Self<br>Resonance<br>Frequency<br>(GHz)<br>Typ. | Q Standard Value<br>@ 1GHz |      | Frequency<br>900MHz |           |                    | Frequency<br>1900MHz |           |                    | Frequency<br>2400MHz |           |                    |
|----------------------------------------|-------|-------------------------------------------------|----------------------------|------|---------------------|-----------|--------------------|----------------------|-----------|--------------------|----------------------|-----------|--------------------|
| C (pF)                                 | Tol.  |                                                 | Typ.                       | Min. | C(eff)<br>(pF) Typ. | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. |
| 4                                      | ±0.05 | 2.9                                             | 307                        | 169  | 4.301               | 355       | 117                | 5.188                | 110       | 149                | 6.188                | 68        | 160                |
| 4.1                                    | ±0.05 | 2.8                                             | 303                        | 167  | 4.410               | 351       | 116                | 5.358                | 108       | 148                | 6.450                | 67        | 159                |
| 4.2                                    | ±0.05 | 2.8                                             | 299                        | 164  | 4.518               | 347       | 116                | 5.528                | 106       | 148                | 6.713                | 65        | 158                |
| 4.3                                    | ±0.05 | 2.7                                             | 295                        | 162  | 4.627               | 342       | 115                | 5.698                | 104       | 147                | 6.975                | 64        | 157                |
| 4.4                                    | ±0.05 | 2.7                                             | 291                        | 160  | 4.735               | 338       | 114                | 5.867                | 102       | 146                | 7.238                | 62        | 157                |
| 4.5                                    | ±0.05 | 2.7                                             | 287                        | 158  | 4.843               | 333       | 113                | 6.037                | 100       | 146                | 7.500                | 61        | 156                |
| 4.6                                    | ±0.05 | 2.6                                             | 283                        | 156  | 4.952               | 329       | 112                | 6.207                | 98        | 145                | 7.763                | 59        | 155                |
| 4.7                                    | ±0.05 | 2.6                                             | 279                        | 154  | 5.060               | 324       | 112                | 6.377                | 96        | 144                | 8.025                | 58        | 154                |
| 5.1                                    | ±0.05 | 2.5                                             | 263                        | 145  | 5.494               | 307       | 109                | 7.057                | 88        | 142                | 9.075                | 52        | 151                |
| 5.6                                    | ±0.05 | 2.4                                             | 244                        | 134  | 6.035               | 285       | 105                | 7.906                | 78        | 138                | 10.39                | 44        | 147                |
| 6.2                                    | ±0.1  | 2.3                                             | 228                        | 126  | 6.865               | 267       | 102                | 9.517                | 72        | 133                | 13.66                | 40        | 141                |
| 6.8                                    | ±0.1  | 2.2                                             | 213                        | 117  | 7.694               | 250       | 100                | 11.13                | 66        | 128                | 16.93                | 35        | 135                |
| 7.5                                    | ±0.1  | 2.1                                             | 195                        | 107  | 8.367               | 227       | 98                 | 12.63                | 57        | 125                | 20.91                | 28        | 132                |
| 8.2                                    | ±0.1  | 2.0                                             | 176                        | 97   | 9.041               | 205       | 96                 | 14.14                | 49        | 123                | 24.88                | 21        | 129                |
| 9.1                                    | ±0.1  | 1.9                                             | 161                        | 89   | 10.20               | 188       | 96                 | 18.09                | 42        | 122                | 40.00                | 16        | 128                |
| 10                                     | ±1%   | 1.8                                             | 146                        | 80   | 11.37               | 171       | 95                 | 22.05                | 36        | 121                | 70.00                | 12        | 127                |
| 11                                     | ±1%   | 1.7                                             | 129                        | 71   | 12.66               | 153       | 95                 | 26.44                | 29        | 120                | 140.0                | 6         | 126                |
| 12                                     | ±1%   | 1.6                                             | 112                        | 62   | 13.95               | 134       | 94                 | 30.83                | 22        | 119                | 231.3                | 1         | 125                |
| 13                                     | ±1%   | 1.6                                             | 102                        | 56   | 15.31               | 122       | 93                 | 40.37                | 18        | 118                | n/a                  | n/a       | n/a                |
| 14                                     | ±1%   | 1.5                                             | 92                         | 51   | 16.67               | 111       | 92                 | 49.91                | 15        | 118                | n/a                  | n/a       | n/a                |
| 15                                     | ±1%   | 1.5                                             | 82                         | 45   | 18.03               | 99        | 90                 | 59.44                | 11        | 117                | n/a                  | n/a       | n/a                |
| 16                                     | ±1%   | 1.4                                             | 79                         | 43   | 19.61               | 96        | 90                 | 80.00                | 8         | 117                | n/a                  | n/a       | n/a                |
| 17                                     | ±1%   | 1.4                                             | 76                         | 42   | 21.18               | 92        | 90                 | 120.0                | 6         | 116                | n/a                  | n/a       | n/a                |
| 18                                     | ±1%   | 1.3                                             | 73                         | 40   | 22.76               | 89        | 90                 | 190.0                | 4         | 116                | n/a                  | n/a       | n/a                |
| 19                                     | ±1%   | 1.3                                             | 69                         | 38   | 24.37               | 84        | 89                 | n/a                  | n/a       | n/a                | n/a                  | n/a       | n/a                |
| 20                                     | ±1%   | 1.2                                             | 65                         | 36   | 25.98               | 80        | 89                 | n/a                  | n/a       | n/a                | n/a                  | n/a       | n/a                |
| 22                                     | ±1%   | 1.2                                             | 57                         | 31   | 29.21               | 72        | 87                 | n/a                  | n/a       | n/a                | n/a                  | n/a       | n/a                |
| 24                                     | ±1%   | 1.2                                             | 48                         | 26   | 34.44               | 62        | 87                 | n/a                  | n/a       | n/a                | n/a                  | n/a       | n/a                |
| 27                                     | ±1%   | 1.1                                             | 43                         | 24   | 41.87               | 56        | 86                 | n/a                  | n/a       | n/a                | n/a                  | n/a       | n/a                |
| 30                                     | ±1%   | 1.0                                             | 37                         | 21   | 49.29               | 49        | 85                 | n/a                  | n/a       | n/a                | n/a                  | n/a       | n/a                |
| 33                                     | ±1%   | 1.0                                             | 32                         | 18   | 56.72               | 43        | 84                 | n/a                  | n/a       | n/a                | n/a                  | n/a       | n/a                |
| 36                                     | ±1%   | 1.0                                             | 27                         | 15   | 64.15               | 37        | 83                 | n/a                  | n/a       | n/a                | n/a                  | n/a       | n/a                |
| 39                                     | ±5%   | 1.0                                             | 21                         | 12   | 71.57               | 30        | 82                 | n/a                  | n/a       | n/a                | n/a                  | n/a       | n/a                |

## 0805 Typical Electrical Tables

| Capacitance<br>@ 1MHz<br>and Tolerance |       | Self<br>Resonance<br>Frequency<br>(GHz)<br>Typ. | Q Standard Value<br>@ 1GHz |      | Frequency<br>900MHz |           |                    | Frequency<br>1900MHz |           |                    | Frequency<br>2400MHz |           |                    |
|----------------------------------------|-------|-------------------------------------------------|----------------------------|------|---------------------|-----------|--------------------|----------------------|-----------|--------------------|----------------------|-----------|--------------------|
| C (pF)                                 | Tol.  |                                                 | Typ.                       | Min. | C(eff)<br>(pF) Typ. | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. |
| 0.1                                    | ±0.02 | 17.2                                            | 880                        | 484  | 0.125               | 890       | 3296               | 0.125                | 545       | 2417               | 0.126                | 447       | 2265               |
| 0.15                                   | ±0.02 | 14.1                                            | 872                        | 480  | 0.176               | 885       | 2073               | 0.178                | 530       | 1626               | 0.181                | 434       | 1546               |
| 0.2                                    | ±0.02 | 12.3                                            | 864                        | 475  | 0.228               | 880       | 1492               | 0.231                | 516       | 1227               | 0.235                | 420       | 1178               |
| 0.25                                   | ±0.02 | 11.0                                            | 857                        | 471  | 0.279               | 874       | 1156               | 0.284                | 501       | 986                | 0.290                | 407       | 955                |
| 0.3                                    | ±0.02 | 10.1                                            | 849                        | 467  | 0.331               | 869       | 938                | 0.337                | 487       | 825                | 0.344                | 394       | 804                |
| 0.35                                   | ±0.02 | 9.4                                             | 841                        | 462  | 0.382               | 864       | 787                | 0.390                | 472       | 710                | 0.399                | 380       | 695                |
| 0.4                                    | ±0.02 | 8.8                                             | 833                        | 458  | 0.433               | 859       | 675                | 0.443                | 458       | 623                | 0.453                | 367       | 613                |
| 0.45                                   | ±0.02 | 8.3                                             | 825                        | 454  | 0.485               | 853       | 590                | 0.496                | 443       | 555                | 0.508                | 353       | 549                |
| 0.5                                    | ±0.02 | 7.9                                             | 817                        | 450  | 0.536               | 848       | 523                | 0.549                | 429       | 501                | 0.562                | 340       | 497                |
| 0.55                                   | ±0.02 | 7.5                                             | 811                        | 446  | 0.584               | 843       | 469                | 0.600                | 420       | 456                | 0.616                | 331       | 454                |
| 0.6                                    | ±0.02 | 7.2                                             | 805                        | 443  | 0.631               | 838       | 425                | 0.651                | 411       | 419                | 0.670                | 322       | 418                |
| 0.65                                   | ±0.02 | 6.9                                             | 798                        | 439  | 0.679               | 834       | 387                | 0.702                | 402       | 387                | 0.724                | 313       | 388                |
| 0.7                                    | ±0.02 | 6.7                                             | 792                        | 436  | 0.726               | 829       | 356                | 0.753                | 393       | 360                | 0.778                | 304       | 362                |
| 0.75                                   | ±0.02 | 6.5                                             | 786                        | 432  | 0.774               | 824       | 329                | 0.804                | 384       | 337                | 0.832                | 295       | 339                |
| 0.8                                    | ±0.02 | 6.3                                             | 779                        | 429  | 0.822               | 819       | 306                | 0.855                | 375       | 316                | 0.886                | 286       | 319                |
| 0.85                                   | ±0.02 | 6.1                                             | 773                        | 425  | 0.869               | 814       | 285                | 0.906                | 366       | 298                | 0.940                | 277       | 301                |
| 0.9                                    | ±0.02 | 5.9                                             | 767                        | 422  | 0.917               | 810       | 267                | 0.957                | 357       | 282                | 0.994                | 268       | 285                |
| 0.95                                   | ±0.02 | 5.8                                             | 760                        | 418  | 0.964               | 805       | 251                | 1.008                | 348       | 267                | 1.049                | 260       | 271                |
| 1                                      | ±0.02 | 5.6                                             | 754                        | 415  | 1.012               | 800       | 231                | 1.059                | 339       | 235                | 1.103                | 251       | 242                |
| 1.05                                   | ±0.02 | 5.5                                             | 747                        | 411  | 1.065               | 794       | 223                | 1.120                | 335       | 228                | 1.170                | 247       | 235                |
| 1.1                                    | ±0.02 | 5.4                                             | 740                        | 407  | 1.119               | 788       | 215                | 1.181                | 330       | 221                | 1.237                | 244       | 228                |
| 1.15                                   | ±0.02 | 5.3                                             | 732                        | 403  | 1.172               | 782       | 208                | 1.242                | 326       | 214                | 1.304                | 240       | 220                |
| 1.2                                    | ±0.02 | 5.1                                             | 725                        | 399  | 1.225               | 776       | 200                | 1.304                | 322       | 207                | 1.371                | 237       | 213                |
| 1.25                                   | ±0.02 | 5.0                                             | 718                        | 395  | 1.279               | 770       | 192                | 1.365                | 318       | 200                | 1.438                | 233       | 206                |
| 1.3                                    | ±0.02 | 4.9                                             | 711                        | 391  | 1.332               | 764       | 184                | 1.426                | 313       | 193                | 1.505                | 230       | 199                |
| 1.35                                   | ±0.02 | 4.9                                             | 704                        | 387  | 1.386               | 758       | 176                | 1.487                | 309       | 186                | 1.573                | 226       | 192                |
| 1.4                                    | ±0.02 | 4.8                                             | 696                        | 383  | 1.439               | 752       | 169                | 1.548                | 305       | 179                | 1.640                | 223       | 184                |
| 1.45                                   | ±0.02 | 4.7                                             | 689                        | 379  | 1.492               | 746       | 161                | 1.609                | 300       | 172                | 1.707                | 219       | 177                |
| 1.5                                    | ±0.02 | 4.6                                             | 682                        | 375  | 1.546               | 740       | 153                | 1.670                | 296       | 165                | 1.774                | 216       | 170                |
| 1.55                                   | ±0.02 | 4.6                                             | 675                        | 371  | 1.600               | 733       | 151                | 1.734                | 292       | 163                | 1.850                | 212       | 168                |
| 1.6                                    | ±0.02 | 4.5                                             | 668                        | 367  | 1.654               | 726       | 148                | 1.799                | 287       | 161                | 1.927                | 208       | 165                |
| 1.65                                   | ±0.02 | 4.4                                             | 660                        | 363  | 1.708               | 719       | 146                | 1.864                | 283       | 159                | 2.003                | 204       | 163                |
| 1.7                                    | ±0.02 | 4.3                                             | 653                        | 359  | 1.762               | 712       | 143                | 1.928                | 278       | 157                | 2.079                | 200       | 160                |
| 1.75                                   | ±0.02 | 4.3                                             | 646                        | 355  | 1.816               | 705       | 141                | 1.993                | 274       | 155                | 2.156                | 197       | 158                |
| 1.8                                    | ±0.02 | 4.2                                             | 639                        | 351  | 1.870               | 698       | 139                | 2.058                | 269       | 152                | 2.232                | 193       | 155                |
| 1.85                                   | ±0.02 | 4.2                                             | 632                        | 347  | 1.924               | 691       | 136                | 2.122                | 265       | 150                | 2.308                | 189       | 153                |
| 1.9                                    | ±0.02 | 4.1                                             | 624                        | 343  | 1.978               | 684       | 134                | 2.187                | 260       | 148                | 2.385                | 185       | 150                |
| 1.95                                   | ±0.02 | 4.1                                             | 617                        | 339  | 2.033               | 677       | 131                | 2.252                | 256       | 146                | 2.461                | 181       | 148                |
| 2                                      | ±0.03 | 4.0                                             | 610                        | 336  | 2.087               | 670       | 129                | 2.316                | 251       | 144                | 2.537                | 177       | 145                |
| 2.1                                    | ±0.03 | 3.9                                             | 597                        | 328  | 2.183               | 658       | 127                | 2.440                | 245       | 142                | 2.690                | 171       | 143                |
| 2.2                                    | ±0.03 | 3.8                                             | 584                        | 321  | 2.280               | 646       | 124                | 2.563                | 239       | 139                | 2.843                | 165       | 141                |
| 2.3                                    | ±0.03 | 3.8                                             | 571                        | 314  | 2.377               | 634       | 122                | 2.687                | 233       | 137                | 2.996                | 159       | 139                |
| 2.4                                    | ±0.03 | 3.6                                             | 557                        | 307  | 2.474               | 623       | 119                | 2.810                | 227       | 135                | 3.149                | 154       | 136                |
| 2.5                                    | ±0.03 | 3.6                                             | 544                        | 299  | 2.571               | 611       | 117                | 2.934                | 221       | 133                | 3.301                | 148       | 134                |
| 2.6                                    | ±0.03 | 3.6                                             | 531                        | 292  | 2.668               | 599       | 114                | 3.057                | 215       | 130                | 3.454                | 142       | 132                |
| 2.7                                    | ±0.03 | 3.4                                             | 518                        | 285  | 2.764               | 587       | 112                | 3.181                | 209       | 128                | 3.607                | 136       | 130                |
| 2.8                                    | ±0.03 | 3.4                                             | 507                        | 279  | 2.875               | 575       | 111                | 3.348                | 204       | 127                | 3.850                | 132       | 129                |
| 2.9                                    | ±0.03 | 3.4                                             | 497                        | 273  | 2.987               | 564       | 110                | 3.514                | 199       | 125                | 4.093                | 129       | 127                |
| 3                                      | ±0.03 | 3.3                                             | 486                        | 267  | 3.098               | 552       | 109                | 3.681                | 194       | 124                | 4.335                | 125       | 126                |
| 3.1                                    | ±0.05 | 3.3                                             | 475                        | 261  | 3.209               | 540       | 108                | 3.848                | 189       | 123                | 4.578                | 121       | 125                |
| 3.2                                    | ±0.05 | 3.2                                             | 465                        | 256  | 3.320               | 528       | 107                | 4.014                | 183       | 122                | 4.821                | 118       | 123                |
| 3.3                                    | ±0.05 | 3.1                                             | 454                        | 250  | 3.431               | 517       | 106                | 4.181                | 178       | 120                | 5.064                | 114       | 122                |
| 3.4                                    | ±0.05 | 3.1                                             | 443                        | 244  | 3.542               | 505       | 105                | 4.348                | 173       | 119                | 5.307                | 110       | 121                |
| 3.5                                    | ±0.05 | 3.1                                             | 433                        | 238  | 3.653               | 493       | 104                | 4.515                | 168       | 118                | 5.549                | 107       | 119                |
| 3.6                                    | ±0.05 | 3.0                                             | 422                        | 232  | 3.764               | 481       | 103                | 4.681                | 163       | 116                | 5.792                | 103       | 118                |
| 3.7                                    | ±0.05 | 3.0                                             | 412                        | 226  | 3.875               | 470       | 102                | 4.848                | 158       | 115                | 6.035                | 99        | 116                |
| 3.8                                    | ±0.05 | 3.0                                             | 401                        | 220  | 3.986               | 458       | 101                | 5.015                | 153       | 114                | 6.278                | 96        | 115                |
| 3.9                                    | ±0.05 | 2.9                                             | 390                        | 215  | 4.097               | 446       | 100                | 5.182                | 148       | 113                | 6.521                | 92        | 114                |

## 0805 Typical Electrical Tables

| Capacitance<br>@ 1MHz<br>and Tolerance |       | Self<br>Resonance<br>Frequency<br>(GHz)<br>Typ. | Q Standard Value<br>@ 1GHz |      | Frequency<br>900MHz |           |                    | Frequency<br>1900MHz |           |                    | Frequency<br>2400MHz |           |                    |
|----------------------------------------|-------|-------------------------------------------------|----------------------------|------|---------------------|-----------|--------------------|----------------------|-----------|--------------------|----------------------|-----------|--------------------|
| C (pF)                                 | Tol.  |                                                 | Typ.                       | Min. | C(eff)<br>(pF) Typ. | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. |
| 4                                      | ±0.05 | 2.9                                             | 384                        | 211  | 4.214               | 440       | 99                 | 5.378                | 144       | 112                | 6.861                | 89        | 113                |
| 4.1                                    | ±0.05 | 2.9                                             | 378                        | 208  | 4.331               | 434       | 98                 | 5.574                | 141       | 112                | 7.201                | 86        | 113                |
| 4.2                                    | ±0.05 | 2.8                                             | 372                        | 205  | 4.448               | 428       | 98                 | 5.769                | 138       | 111                | 7.541                | 84        | 112                |
| 4.3                                    | ±0.05 | 2.7                                             | 366                        | 202  | 4.564               | 422       | 97                 | 5.965                | 134       | 111                | 7.881                | 81        | 111                |
| 4.4                                    | ±0.05 | 2.7                                             | 360                        | 198  | 4.681               | 415       | 96                 | 6.161                | 131       | 110                | 8.222                | 78        | 111                |
| 4.5                                    | ±0.05 | 2.7                                             | 355                        | 195  | 4.798               | 409       | 96                 | 6.357                | 128       | 110                | 8.562                | 75        | 110                |
| 4.6                                    | ±0.05 | 2.7                                             | 349                        | 192  | 4.915               | 403       | 95                 | 6.553                | 124       | 109                | 8.902                | 72        | 110                |
| 4.7                                    | ±0.05 | 2.6                                             | 343                        | 188  | 5.032               | 397       | 94                 | 6.749                | 121       | 109                | 9.242                | 69        | 109                |
| 5.1                                    | ±0.05 | 2.5                                             | 319                        | 175  | 5.499               | 373       | 91                 | 7.533                | 108       | 107                | 10.60                | 58        | 107                |
| 5.6                                    | ±0.05 | 2.4                                             | 289                        | 159  | 6.083               | 342       | 88                 | 8.513                | 91        | 104                | 12.30                | 44        | 104                |
| 6.2                                    | ±0.1  | 2.3                                             | 264                        | 145  | 6.842               | 313       | 86                 | 10.43                | 79        | 102                | 18.03                | 36        | 103                |
| 6.8                                    | ±0.1  | 2.2                                             | 239                        | 131  | 7.601               | 283       | 84                 | 12.35                | 68        | 101                | 23.76                | 28        | 102                |
| 7.5                                    | ±0.1  | 2.1                                             | 218                        | 120  | 8.468               | 259       | 83                 | 14.84                | 61        | 100                | 37.25                | 21        | 101                |
| 8.2                                    | ±0.1  | 2.0                                             | 198                        | 109  | 9.334               | 234       | 82                 | 17.32                | 55        | 100                | 50.74                | 15        | 100                |
| 9.1                                    | ±0.1  | 1.9                                             | 179                        | 99   | 10.57               | 213       | 82                 | 24.90                | 46        | 100                |                      |           |                    |
| 10                                     | ±1%   | 1.8                                             | 160                        | 88   | 11.80               | 191       | 81                 | 32.48                | 37        | 100                |                      |           |                    |
| 11                                     | ±1%   | 1.7                                             | 139                        | 77   | 13.17               | 167       | 81                 | 40.90                | 26        | 101                |                      |           |                    |
| 12                                     | ±1%   | 1.6                                             | 119                        | 65   | 14.54               | 143       | 80                 | 49.32                | 16        | 101                |                      |           |                    |
| 13                                     | ±1%   | 1.6                                             | 110                        | 60   | 16.17               | 134       | 80                 |                      |           |                    |                      |           |                    |
| 14                                     | ±1%   | 1.5                                             | 101                        | 55   | 17.79               | 125       | 80                 |                      |           |                    |                      |           |                    |
| 15                                     | ±1%   | 1.5                                             | 92                         | 51   | 19.42               | 116       | 80                 |                      |           |                    |                      |           |                    |
| 16                                     | ±1%   | 1.4                                             | 87                         | 48   | 21.13               | 110       | 79                 |                      |           |                    |                      |           |                    |
| 17                                     | ±1%   | 1.4                                             | 83                         | 46   | 22.85               | 104       | 78                 |                      |           |                    |                      |           |                    |
| 18                                     | ±1%   | 1.3                                             | 78                         | 43   | 24.57               | 99        | 77                 |                      |           |                    |                      |           |                    |
| 19                                     | ±1%   | 1.3                                             | 73                         | 40   | 26.41               | 92        | 77                 |                      |           |                    |                      |           |                    |
| 20                                     | ±1%   | 1.3                                             | 67                         | 37   | 28.26               | 85        | 76                 |                      |           |                    |                      |           |                    |
| 22                                     | ±1%   | 1.2                                             | 57                         | 31   | 31.95               | 72        | 76                 |                      |           |                    |                      |           |                    |
| 24                                     | ±1%   | 1.2                                             | 46                         | 25   | 35.64               | 59        | 75                 |                      |           |                    |                      |           |                    |
| 27                                     | ±1%   | 1.1                                             | 41                         | 22   | 44.94               | 54        | 74                 |                      |           |                    |                      |           |                    |
| 30                                     | ±1%   | 1.0                                             | 36                         | 20   | 54.24               | 48        | 73                 |                      |           |                    |                      |           |                    |
| 33                                     | ±1%   | 1.0                                             | 30                         | 17   | 63.54               | 42        | 72                 |                      |           |                    |                      |           |                    |
| 36                                     | ±1%   | 0.9                                             | 25                         | 14   | 72.84               | 37        | 71                 |                      |           |                    |                      |           |                    |
| 39                                     | ±1%   | 0.9                                             | 20                         | 11   | 82.14               | 31        | 70                 |                      |           |                    |                      |           |                    |
| 43                                     | ±1%   | 0.9                                             | 16                         | 9    | 102.9               | 27        | 66                 |                      |           |                    |                      |           |                    |
| 47                                     | ±1%   | 0.8                                             | 12                         | 7    | 123.7               | 23        | 63                 |                      |           |                    |                      |           |                    |

## 1210 Typical Electrical Tables

| Capacitance<br>@ 1MHz<br>and Tolerance |       | Self<br>Resonance<br>Frequency<br>(GHz)<br>Typ. | Q Standard Value<br>@ 1GHz |      | Frequency<br>900MHz |           |                    | Frequency<br>1900MHz |           |                    | Frequency<br>2400MHz |           |                    |
|----------------------------------------|-------|-------------------------------------------------|----------------------------|------|---------------------|-----------|--------------------|----------------------|-----------|--------------------|----------------------|-----------|--------------------|
| C (pF)                                 | Tol.  |                                                 | Typ.                       | Min. | C(eff)<br>(pF) Typ. | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. |
| 0.1                                    | ±0.02 | 15.6                                            | 1190                       | 654  | 0.136               | 1176      | 3633               | 0.136                | 606       | 2149               | 0.136                | 450       | 2068               |
| 0.15                                   | ±0.02 | 12.7                                            | 1179                       | 648  | 0.190               | 1166      | 2129               | 0.190                | 597       | 1407               | 0.191                | 444       | 1370               |
| 0.15                                   | ±0.03 | 12.7                                            | 1179                       | 648  | 0.190               | 1166      | 2129               | 0.190                | 597       | 1407               | 0.191                | 444       | 1370               |
| 0.2                                    | ±0.02 | 11.0                                            | 1168                       | 642  | 0.244               | 1156      | 1457               | 0.244                | 589       | 1042               | 0.246                | 438       | 1023               |
| 0.25                                   | ±0.02 | 9.8                                             | 1156                       | 636  | 0.297               | 1145      | 1086               | 0.299                | 581       | 826                | 0.301                | 432       | 816                |
| 0.3                                    | ±0.02 | 8.9                                             | 1145                       | 630  | 0.351               | 1135      | 854                | 0.353                | 573       | 683                | 0.356                | 426       | 678                |
| 0.35                                   | ±0.02 | 8.3                                             | 1134                       | 624  | 0.405               | 1125      | 697                | 0.408                | 565       | 581                | 0.411                | 421       | 580                |
| 0.4                                    | ±0.02 | 7.7                                             | 1123                       | 618  | 0.459               | 1115      | 584                | 0.462                | 557       | 505                | 0.466                | 415       | 506                |
| 0.45                                   | ±0.02 | 7.3                                             | 1112                       | 612  | 0.513               | 1105      | 500                | 0.516                | 549       | 447                | 0.521                | 409       | 449                |
| 0.5                                    | ±0.02 | 6.9                                             | 1101                       | 606  | 0.567               | 1095      | 435                | 0.571                | 541       | 400                | 0.576                | 403       | 404                |
| 0.55                                   | ±0.02 | 6.6                                             | 1090                       | 599  | 0.617               | 1084      | 384                | 0.621                | 532       | 362                | 0.627                | 397       | 366                |
| 0.6                                    | ±0.02 | 6.3                                             | 1079                       | 593  | 0.666               | 1074      | 342                | 0.672                | 524       | 331                | 0.679                | 391       | 335                |
| 0.65                                   | ±0.02 | 6.0                                             | 1068                       | 587  | 0.716               | 1064      | 308                | 0.723                | 516       | 304                | 0.731                | 385       | 309                |
| 0.7                                    | ±0.02 | 5.8                                             | 1057                       | 581  | 0.765               | 1054      | 279                | 0.774                | 508       | 282                | 0.783                | 379       | 287                |
| 0.75                                   | ±0.02 | 5.6                                             | 1046                       | 575  | 0.815               | 1044      | 255                | 0.824                | 500       | 262                | 0.834                | 374       | 267                |
| 0.8                                    | ±0.02 | 5.4                                             | 1035                       | 569  | 0.864               | 1034      | 234                | 0.875                | 492       | 245                | 0.886                | 368       | 250                |
| 0.85                                   | ±0.02 | 5.3                                             | 1023                       | 563  | 0.914               | 1024      | 216                | 0.926                | 484       | 230                | 0.938                | 362       | 236                |
| 0.9                                    | ±0.02 | 5.1                                             | 1012                       | 557  | 0.963               | 1013      | 201                | 0.976                | 476       | 217                | 0.989                | 356       | 222                |
| 0.95                                   | ±0.02 | 5.0                                             | 1001                       | 551  | 1.013               | 1003      | 187                | 1.027                | 467       | 205                | 1.041                | 350       | 210                |
| 1                                      | ±0.02 | 5.0                                             | 992                        | 546  | 1.062               | 983       | 167                | 1.078                | 459       | 170                | 1.093                | 344       | 177                |
| 1.05                                   | ±0.02 | 4.9                                             | 981                        | 539  | 1.107               | 975       | 163                | 1.124                | 451       | 167                | 1.141                | 338       | 174                |
| 1.1                                    | ±0.02 | 4.8                                             | 969                        | 533  | 1.152               | 966       | 158                | 1.170                | 443       | 165                | 1.189                | 331       | 172                |
| 1.15                                   | ±0.02 | 4.7                                             | 958                        | 527  | 1.196               | 958       | 154                | 1.217                | 435       | 162                | 1.236                | 325       | 169                |
| 1.2                                    | ±0.02 | 4.6                                             | 946                        | 521  | 1.241               | 950       | 150                | 1.263                | 427       | 160                | 1.284                | 318       | 167                |
| 1.25                                   | ±0.02 | 4.5                                             | 935                        | 514  | 1.285               | 942       | 146                | 1.309                | 419       | 157                | 1.332                | 312       | 164                |
| 1.3                                    | ±0.02 | 4.4                                             | 923                        | 508  | 1.330               | 933       | 142                | 1.355                | 410       | 155                | 1.380                | 305       | 162                |
| 1.35                                   | ±0.02 | 4.3                                             | 912                        | 502  | 1.375               | 925       | 138                | 1.402                | 402       | 152                | 1.428                | 299       | 159                |
| 1.4                                    | ±0.02 | 4.2                                             | 900                        | 495  | 1.419               | 917       | 134                | 1.448                | 394       | 150                | 1.476                | 293       | 156                |
| 1.45                                   | ±0.02 | 4.1                                             | 889                        | 489  | 1.464               | 908       | 129                | 1.494                | 386       | 147                | 1.524                | 286       | 154                |
| 1.5                                    | ±0.02 | 4.1                                             | 877                        | 483  | 1.508               | 900       | 125                | 1.541                | 378       | 144                | 1.572                | 280       | 151                |
| 1.55                                   | ±0.02 | 4.0                                             | 862                        | 474  | 1.567               | 890       | 123                | 1.618                | 371       | 143                | 1.638                | 274       | 150                |
| 1.6                                    | ±0.02 | 3.9                                             | 846                        | 465  | 1.626               | 881       | 122                | 1.694                | 363       | 142                | 1.704                | 268       | 149                |
| 1.65                                   | ±0.02 | 3.9                                             | 831                        | 457  | 1.685               | 871       | 120                | 1.771                | 356       | 140                | 1.770                | 262       | 148                |
| 1.7                                    | ±0.02 | 3.8                                             | 815                        | 448  | 1.743               | 862       | 118                | 1.848                | 349       | 139                | 1.836                | 256       | 147                |
| 1.75                                   | ±0.02 | 3.7                                             | 800                        | 440  | 1.802               | 852       | 116                | 1.925                | 342       | 138                | 1.902                | 250       | 145                |
| 1.8                                    | ±0.02 | 3.7                                             | 784                        | 431  | 1.861               | 843       | 114                | 2.002                | 334       | 136                | 1.968                | 244       | 144                |
| 1.85                                   | ±0.02 | 3.6                                             | 769                        | 423  | 1.920               | 833       | 112                | 2.079                | 327       | 135                | 2.034                | 239       | 143                |
| 1.9                                    | ±0.02 | 3.5                                             | 753                        | 414  | 1.978               | 824       | 110                | 2.156                | 320       | 134                | 2.100                | 233       | 142                |
| 1.95                                   | ±0.02 | 3.4                                             | 737                        | 406  | 2.037               | 814       | 108                | 2.233                | 313       | 132                | 2.167                | 227       | 141                |
| 2                                      | ±0.03 | 3.3                                             | 722                        | 397  | 2.096               | 805       | 107                | 2.310                | 305       | 131                | 2.233                | 221       | 139                |
| 2.1                                    | ±0.03 | 3.2                                             | 691                        | 380  | 2.213               | 786       | 103                | 2.464                | 291       | 128                | 2.365                | 209       | 137                |
| 2.2                                    | ±0.03 | 3.0                                             | 660                        | 363  | 2.331               | 767       | 99                 | 2.618                | 276       | 126                | 2.497                | 198       | 135                |
| 2.3                                    | ±0.03 | 2.9                                             | 644                        | 354  | 2.420               | 747       | 97                 | 2.681                | 268       | 123                | 2.613                | 191       | 132                |
| 2.4                                    | ±0.03 | 2.9                                             | 629                        | 346  | 2.508               | 728       | 96                 | 2.744                | 259       | 121                | 2.729                | 185       | 130                |
| 2.5                                    | ±0.03 | 2.8                                             | 614                        | 338  | 2.597               | 709       | 94                 | 2.807                | 251       | 118                | 2.845                | 179       | 128                |
| 2.6                                    | ±0.03 | 2.8                                             | 598                        | 329  | 2.686               | 689       | 93                 | 2.870                | 242       | 116                | 2.961                | 173       | 126                |
| 2.7                                    | ±0.03 | 2.7                                             | 583                        | 321  | 2.775               | 670       | 91                 | 2.933                | 234       | 114                | 3.077                | 167       | 123                |
| 2.8                                    | ±0.03 | 2.7                                             | 574                        | 316  | 2.875               | 659       | 90                 | 3.047                | 230       | 113                | 3.205                | 164       | 122                |
| 2.9                                    | ±0.03 | 2.7                                             | 566                        | 311  | 2.975               | 647       | 89                 | 3.162                | 227       | 112                | 3.334                | 161       | 121                |
| 3                                      | ±0.03 | 2.7                                             | 557                        | 306  | 3.075               | 636       | 88                 | 3.276                | 223       | 111                | 3.462                | 157       | 121                |
| 3.1                                    | ±0.05 | 2.7                                             | 548                        | 302  | 3.174               | 625       | 87                 | 3.390                | 220       | 110                | 3.590                | 154       | 120                |
| 3.2                                    | ±0.05 | 2.6                                             | 540                        | 297  | 3.274               | 613       | 87                 | 3.504                | 216       | 109                | 3.718                | 151       | 119                |
| 3.3                                    | ±0.05 | 2.6                                             | 531                        | 292  | 3.374               | 602       | 86                 | 3.619                | 213       | 108                | 3.847                | 148       | 118                |
| 3.4                                    | ±0.05 | 2.6                                             | 522                        | 287  | 3.474               | 591       | 85                 | 3.733                | 209       | 107                | 3.975                | 145       | 117                |
| 3.5                                    | ±0.05 | 2.6                                             | 514                        | 283  | 3.574               | 579       | 84                 | 3.847                | 206       | 106                | 4.103                | 141       | 116                |
| 3.6                                    | ±0.05 | 2.5                                             | 505                        | 278  | 3.674               | 568       | 83                 | 3.961                | 202       | 105                | 4.231                | 138       | 115                |
| 3.7                                    | ±0.05 | 2.5                                             | 496                        | 273  | 3.773               | 556       | 82                 | 4.076                | 198       | 104                | 4.359                | 135       | 114                |
| 3.8                                    | ±0.05 | 2.5                                             | 488                        | 268  | 3.873               | 545       | 81                 | 4.190                | 195       | 103                | 4.488                | 132       | 113                |
| 3.9                                    | ±0.05 | 2.4                                             | 479                        | 264  | 3.973               | 534       | 80                 | 4.304                | 191       | 102                | 4.616                | 129       | 112                |

| Capacitance<br>@ 1MHz<br>and Tolerance |       | Self<br>Resonance<br>Frequency<br>(GHz)<br>Typ. | Q Standard Value<br>@ 1GHz |      | Frequency<br>900MHz |           |                    | Frequency<br>1900MHz |           |                    | Frequency<br>2400MHz |           |                    |
|----------------------------------------|-------|-------------------------------------------------|----------------------------|------|---------------------|-----------|--------------------|----------------------|-----------|--------------------|----------------------|-----------|--------------------|
| C (pF)                                 | Tol.  |                                                 | Typ.                       | Min. | C(eff)<br>(pF) Typ. | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. | C(eff)<br>(pF) Typ.  | Q<br>Typ. | ESR<br>(mOhm) Typ. |
| 4                                      | ±0.05 | 2.4                                             | 473                        | 260  | 4.083               | 528       | 79                 | 4.435                | 189       | 101                | 4.768                | 127       | 112                |
| 4.1                                    | ±0.05 | 2.4                                             | 467                        | 257  | 4.192               | 522       | 78                 | 4.565                | 186       | 100                | 4.919                | 125       | 111                |
| 4.2                                    | ±0.05 | 2.4                                             | 462                        | 254  | 4.302               | 516       | 78                 | 4.695                | 183       | 100                | 5.071                | 123       | 110                |
| 4.3                                    | ±0.05 | 2.3                                             | 456                        | 251  | 4.411               | 511       | 77                 | 4.825                | 180       | 99                 | 5.223                | 121       | 110                |
| 4.4                                    | ±0.05 | 2.3                                             | 450                        | 247  | 4.521               | 505       | 76                 | 4.956                | 178       | 98                 | 5.375                | 119       | 109                |
| 4.5                                    | ±0.05 | 2.3                                             | 444                        | 244  | 4.630               | 499       | 75                 | 5.086                | 175       | 98                 | 5.526                | 117       | 108                |
| 4.6                                    | ±0.05 | 2.3                                             | 438                        | 241  | 4.740               | 493       | 75                 | 5.216                | 172       | 97                 | 5.678                | 115       | 108                |
| 4.7                                    | ±0.05 | 2.2                                             | 432                        | 238  | 4.849               | 487       | 74                 | 5.347                | 170       | 96                 | 5.830                | 113       | 107                |
| 5.1                                    | ±0.05 | 2.1                                             | 408                        | 225  | 5.288               | 464       | 71                 | 5.868                | 159       | 93                 | 6.437                | 106       | 105                |
| 5.6                                    | ±0.05 | 2.0                                             | 379                        | 208  | 5.835               | 435       | 67                 | 6.519                | 145       | 90                 | 7.195                | 96        | 102                |
| 6.2                                    | ±0.1  | 1.9                                             | 355                        | 195  | 6.440               | 408       | 65                 | 7.176                | 137       | 86                 | 7.897                | 91        | 96                 |
| 6.8                                    | ±0.1  | 1.8                                             | 330                        | 182  | 7.044               | 380       | 62                 | 7.832                | 129       | 83                 | 8.599                | 85        | 91                 |
| 7.5                                    | ±0.1  | 1.7                                             | 308                        | 169  | 7.823               | 351       | 61                 | 8.927                | 115       | 81                 | 10.08                | 74        | 89                 |
| 8.2                                    | ±0.1  | 1.7                                             | 285                        | 157  | 8.601               | 322       | 60                 | 10.02                | 100       | 78                 | 11.55                | 63        | 87                 |
| 9.1                                    | ±0.1  | 1.6                                             | 266                        | 146  | 9.600               | 304       | 58                 | 11.55                | 93        | 77                 | 13.93                | 57        | 85                 |
| 10                                     | ±1%   | 1.5                                             | 247                        | 136  | 10.60               | 285       | 57                 | 13.09                | 85        | 76                 | 16.30                | 50        | 84                 |
| 11                                     | ±1%   | 1.5                                             | 225                        | 124  | 11.71               | 265       | 56                 | 14.79                | 76        | 74                 | 18.94                | 43        | 82                 |
| 12                                     | ±1%   | 1.4                                             | 204                        | 112  | 12.82               | 244       | 54                 | 16.49                | 68        | 73                 | 21.57                | 36        | 81                 |
| 13                                     | ±1%   | 1.3                                             | 193                        | 106  | 13.97               | 230       | 53                 | 18.64                | 61        | 72                 | 26.09                | 32        | 80                 |
| 14                                     | ±1%   | 1.3                                             | 181                        | 99   | 15.13               | 215       | 53                 | 20.80                | 55        | 71                 | 30.61                | 28        | 79                 |
| 15                                     | ±1%   | 1.2                                             | 169                        | 93   | 16.28               | 200       | 52                 | 22.95                | 48        | 70                 | 35.13                | 24        | 78                 |
| 16                                     | ±1%   | 1.2                                             | 164                        | 90   | 17.51               | 195       | 51                 | 26.01                | 46        | 69                 | 46.51                | 22        | 76                 |
| 17                                     | ±1%   | 1.2                                             | 159                        | 88   | 18.75               | 189       | 50                 | 29.07                | 43        | 67                 | 57.90                | 19        | 75                 |
| 18                                     | ±1%   | 1.1                                             | 154                        | 85   | 19.98               | 183       | 49                 | 32.14                | 41        | 66                 | 69.29                | 17        | 73                 |
| 19                                     | ±1%   | 1.1                                             | 150                        | 82   | 21.21               | 178       | 49                 | 36.34                | 39        | 66                 |                      |           |                    |
| 20                                     | ±1%   | 1.1                                             | 145                        | 80   | 22.43               | 172       | 49                 | 40.55                | 38        | 65                 |                      |           |                    |
| 22                                     | ±1%   | 1.0                                             | 136                        | 75   | 24.88               | 162       | 49                 | 48.96                | 34        | 64                 |                      |           |                    |
| 24                                     | ±1%   | 1.0                                             | 126                        | 70   | 27.34               | 151       | 48                 | 57.38                | 31        | 63                 |                      |           |                    |
| 27                                     | ±1%   | 0.9                                             | 112                        | 62   | 31.02               | 135       | 48                 | 70.00                | 26        | 62                 |                      |           |                    |
| 30                                     | ±1%   | 0.9                                             | 101                        | 56   | 36.14               | 121       | 48                 |                      |           |                    |                      |           |                    |
| 33                                     | ±1%   | 0.8                                             | 90                         | 50   | 41.27               | 108       | 48                 |                      |           |                    |                      |           |                    |
| 36                                     | ±1%   | 0.8                                             | 79                         | 44   | 46.39               | 95        | 48                 |                      |           |                    |                      |           |                    |
| 39                                     | ±1%   | 0.8                                             | 68                         | 38   | 51.52               | 82        | 48                 |                      |           |                    |                      |           |                    |
| 43                                     | ±1%   | 0.7                                             | 54                         | 30   | 58.35               | 64        | 48                 |                      |           |                    |                      |           |                    |
| 47                                     | ±1%   | 0.7                                             | 39                         | 21   | 65.18               | 46        | 48                 |                      |           |                    |                      |           |                    |
| 82                                     |       | 0.7                                             | 17                         | 10   | 148.400             | 24        | 48                 |                      |           |                    |                      |           |                    |

## High Frequency Characteristics

1

**Accu-P® 01005 Typical SRF vs Capacitance**



Measured on HP8720ES

**Accu-P® 01005 Typical ESR vs Frequency**



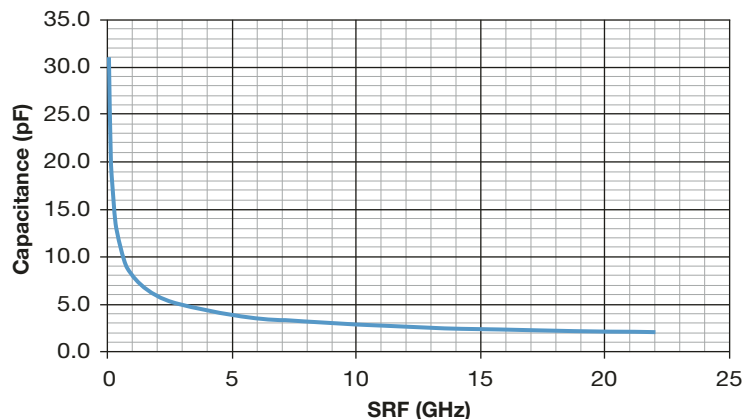
Measured on Agilent 4278A/4991A

**Accu-P® 01005 Typical Q vs Frequency**



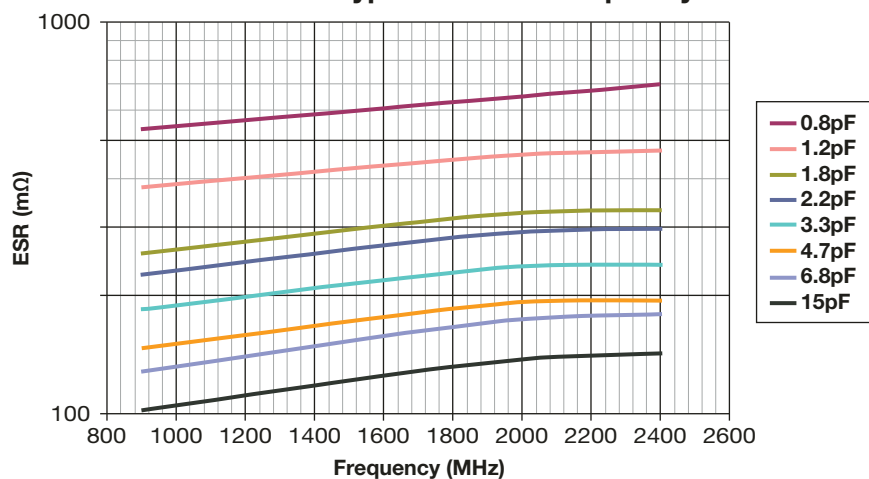
Measured on Agilent 4278A/4991A

**Accu-P® 0201 Typical SRF vs Capacitance**



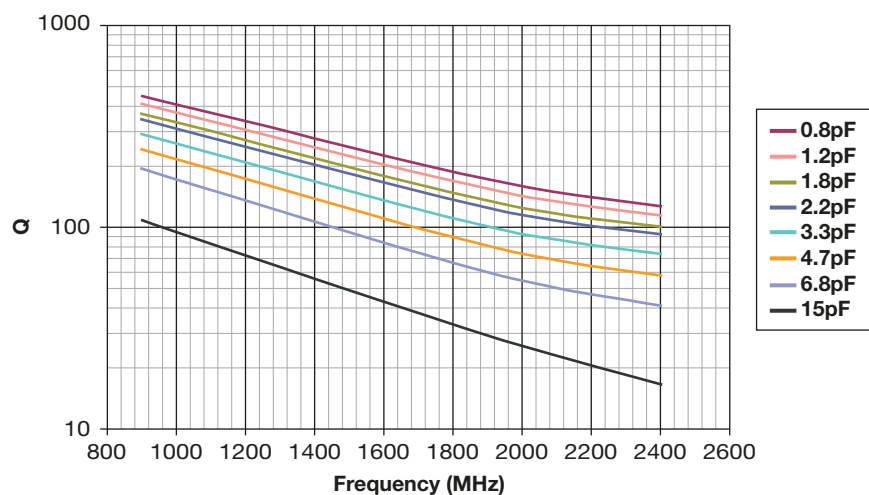
Measured on HP8720ES

**Accu-P® 0201 Typical ESR vs Frequency**



Measured on Agilent 4278A/4991A

**Accu-P® 0201 Typical Q vs Frequency**

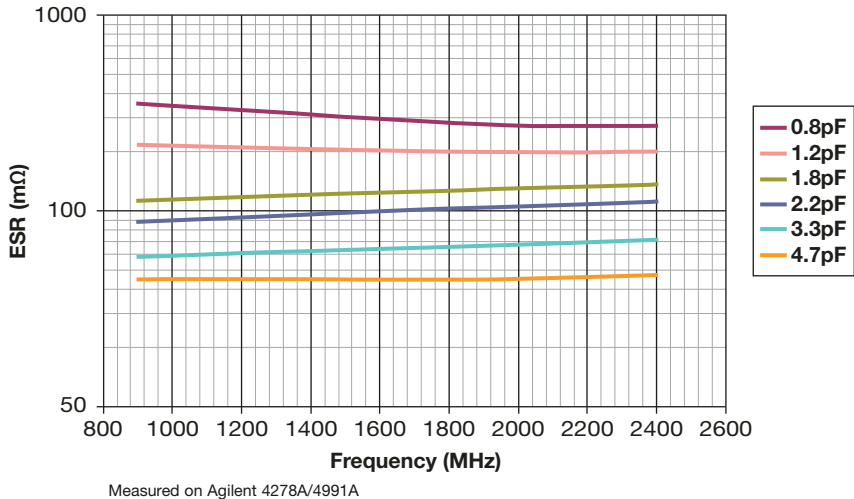


Measured on Agilent 4278A/4991A

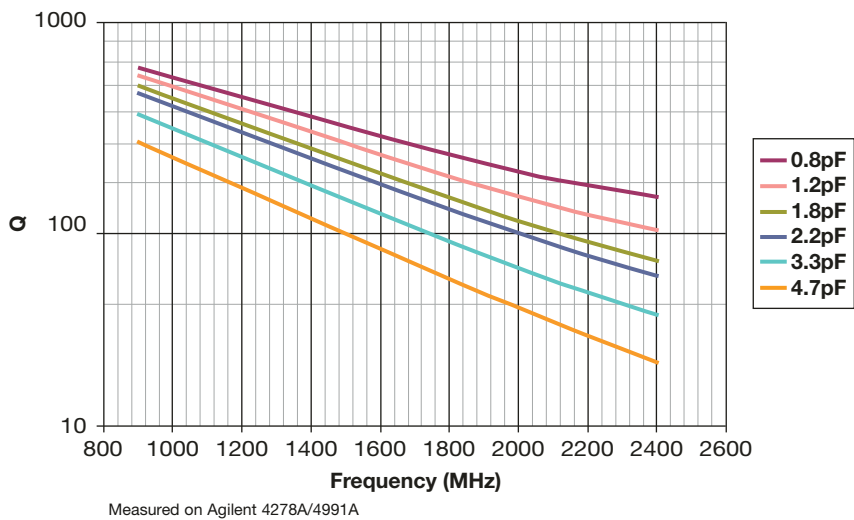
Accu-P<sup>®</sup> 0402 Typical SRF vs Capacitance



Accu-P<sup>®</sup> 0402 Typical ESR vs Frequency



Accu-P<sup>®</sup> 0402 Typical Q vs Frequency



**Accu-P® 0603 Typical SRF vs Capacitance**



Measured on HP8720ES

**Accu-P® 0603 Typical ESR vs Frequency**



Measured on Agilent 4278A/4991A

**Accu-P® 0603 Typical Q vs Frequency**



Measured on Agilent 4278A/4991A

## High Frequency Characteristics

1

Accu-P® 0805 Typical SRF vs Capacitance



Measured on HP8720ES

Accu-P® 0805 Typical ESR vs Frequency



Measured on Agilent 4278A/4991A

Accu-P® 0805 Typical Q vs Frequency



Measured on Agilent 4278A/4991A

**Accu-P® 1210 Typical SRF vs Capacitance**



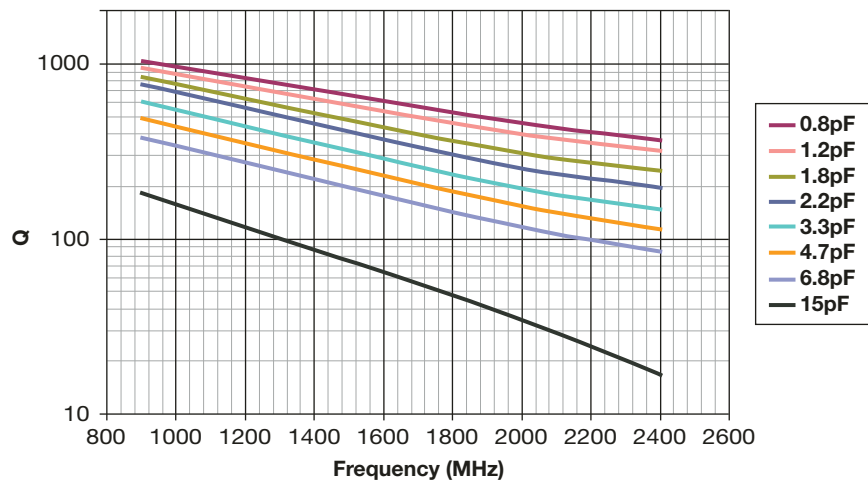
Measured on HP8720ES

**Accu-P® 1210 Typical ESR vs Frequency**



Measured on Agilent 4278A/4991A

**Accu-P® 1210 Typical Q vs Frequency**



Measured on Agilent 4278A/4991A

## 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®      | 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-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-P® are as follows:

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.

### REFLOW SOLDERING

#### PAD 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.

### 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

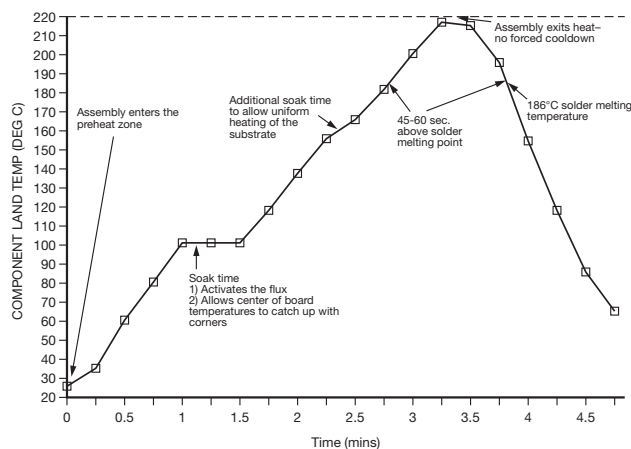
Recommended storage conditions for Accu-P® prior to use are as follows:

Temperature . . . . . 15°C to 35°C

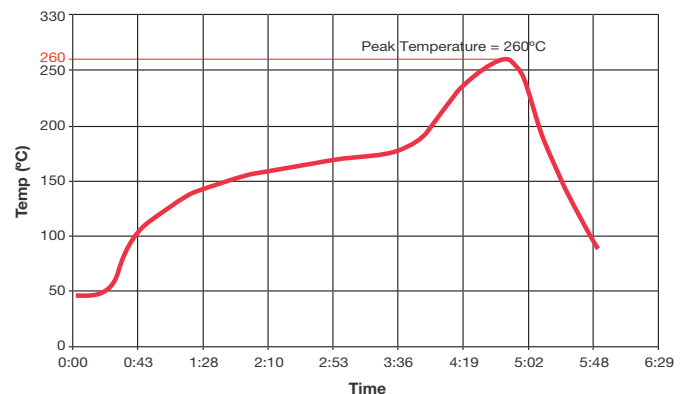
Humidity . . . . . ≤65%

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

### RECOMMENDED REFLOW SOLDERING PROFILE COMPONENTS WITH SnPb TERMINATIONS



### RECOMMENDED REFLOW SOLDERING PROFILE LEAD FREE COMPONENTS WITH Sn100 TERMINATIONS



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  
01005, 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.

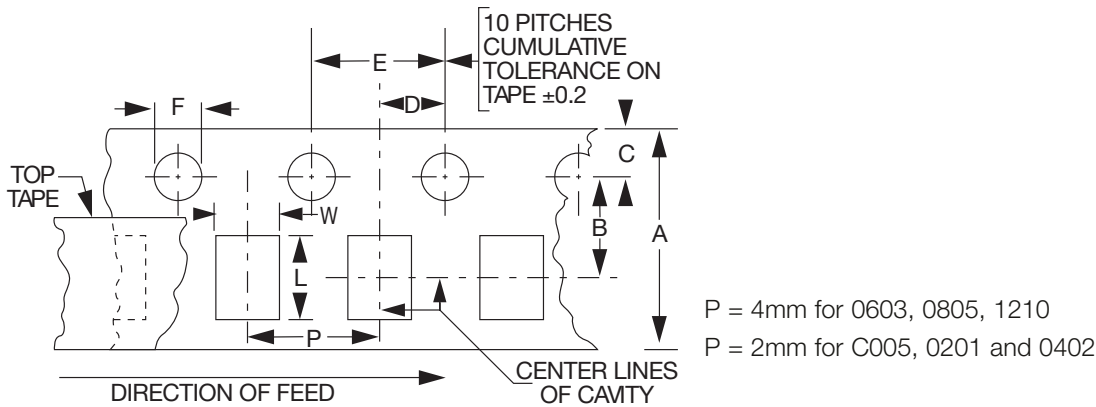


CARRIER

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> ) |

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



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