CAPACITORS comprise the largest variety of electronic components. There are numerous capacitors types, great variations in performance, many methods of marking and packaging, and dozens of manufacturers. Emphasis is given to capacitors herein to assist the builder with identification, ordering guidance, and a general overview of the various capacitor families.

PRINCIPAL CAPACITOR TYPES

CERAMICS

DISK CERAMICS consists of two metallic plates, separated by a ceramic dielectric, whose area and spacing determines the capacitance. Their main disadvantage is high cost over the temperature range (high temperature coefficients). They are low cost and suitable for many applications.

MONOLITHIC CERAMICS are made of alternating layers of ceramic dielectric and the electrode layers. It is encapsulated with an epoxy or resin compound. Characteristics are very similar to ceramics, including cost. Monolithics have higher capacitances per unit volume, and therefore physically smaller.

FILM DIELECTRICS

POLYESTER FILMS use layers of metal and polyester (mylar) dielectric to make a wide range of capacitances. They have become the standard for DC applications. They have changes at extreme temperatures and high loss factors - precluding their use at

POLYPROPYLENE FILMS use layers of metal and polypropylene dielectric for high breakdown voltages. They have low loss factors and good stability for high frequency applications. The disadvantage is that polypropylene has a low dielectric, resulting in larger physical sizes for comparable capacitances and voltage ratings from other processes.

SILVER MICA CAPACITORS use a mica film dielectric with a thin layer of deposited silver forming the electrodes. They are very stable capacitors for high frequency circuits and excellent for oscillator and VFO circuits. The main disadvantages are their higher cost and low working voltages.

POLYCARBONATE FILMS are layers of metalized film and polycarbonate dielectric for almost ideal capacitor characteristics. These capacitors have become the standard for Military Spec film dielectrics. The chief disadvantage is their higher cost for hobbyists.

ELECTROTLYC CAPACITORS

ALUMINUM ELECTROLYTICS use aluminum foil plates “wetted” with a chemical agent to assist conduction. The dielectric is a thin layer of insulating material that “forms” on the aluminum when DC voltage is applied. The aluminum foil is rolled or formed into layers to increase the effective plate area. Combined with the very thin layer of dielectric, this forms very high capacitances in small packages.

TANTALUM CAPACITORS are highly reliable capacitors with a long service life. Tantalum pentoxide powder is mixed with antimony dioxide electrolyte and pressed into a pellet - forming both the dielectric and the positive electrode plate. Graphite or silver plating forms the negative plate. This “pellet” forms a very large effective plate area and thus large capacitances in very small packages. Both wet and dry electrolytes are used. The chief disadvantage is a higher cost due to the complicated manufacturing process.

Ref.: Mallory Electronic Component Catalog; Sprague Film Capacitor Catalog; Sprague Capacitor Designers Guide to Engineers; MuRate/Erie Ceramic Capacitor Catalog
### STANDARD CAPACITOR VALUES

**Non-polarized/non-electrolytic values**

<table>
<thead>
<tr>
<th>Value (pF)</th>
<th>Value (µF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>100</td>
</tr>
<tr>
<td>2.2</td>
<td>0.01</td>
</tr>
<tr>
<td>6.8</td>
<td>0.001</td>
</tr>
<tr>
<td>10</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

### CAPACITOR IDENTIFICATION

#### 1. EIA IDENTIFICATION MARKINGS FOR CERAMICS

**EIA TEMPERATURE CHARACTERISTIC CODES**

<table>
<thead>
<tr>
<th>Code</th>
<th>Minimum Temperature</th>
<th>Maximum Temperature</th>
<th>Capacitance Change over the Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z5U</td>
<td>X=-55°C  Y=30°C</td>
<td>Z=+10°C</td>
<td>A=±1.8% B=±1.5% C=±2.2%...T=±20%</td>
</tr>
</tbody>
</table>

**Example:**

- **Z5U = Capacitance change is -56% to +22% over the temperature range +10°C to +85°C**

**Tolerance Codes:**

<table>
<thead>
<tr>
<th>Code</th>
<th>Value in pF</th>
<th>Tolerance %</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>±2.5 pF</td>
<td>±5%</td>
</tr>
<tr>
<td>D</td>
<td>±5.0 pF</td>
<td>±10%</td>
</tr>
<tr>
<td>F</td>
<td>±1.0 pF</td>
<td>±15%</td>
</tr>
<tr>
<td>G</td>
<td>±2.0 pF</td>
<td>±20%</td>
</tr>
</tbody>
</table>

**EIA DECADE VALUES:**

- **100 = 1 pF**
- **1001 = 100 pF**
- **1002 = 1000 pF**

**Examples:**

- 203 = 0.22 µF, 473 = 47 µF, 503 = 0.56 µF
- 5R1 = 5 pF, 220 = 22 pF, 221 = 220 pF, etc.

### TYPICAL CIRCUIT APPLICATIONS

- **Blocking** - high series impedance to low frequency AC or DC. (Blocks DC, passes AC).
- **Coupling** - low series impedance to AC to transfer power from one circuit to another.
- **Bypassing** - low impedance AC path around a circuit component or element.
- **Tuning capacitor** - with another element to cause a network to oscillate.
- **Filtering network** - designed to pass or attenuate a frequency band.
- **Timing & oscillator** - capacitors introduce a phase shift to induce oscillation or affix the timing of an I.C. oscillator.
- **DC Filtering/storage** - stores and maintains a DC voltage.

### CAPACITOR FUNCTION SELECTION CRITERIA

- **High insulation resistance**
- **Proper working voltage**
- **Low dissipation factor**
- **Low inductance**
- **Proper working voltage**
- **Low temperature coefficient**
- **Good stability & tolerance**
- **Low dissipation factor**
- **Proper working voltage**
- **Capacitor stability**
- **Good tolerance**
- **Low temperature coefficient**
- **Low dissipation factor**
- **Proper working voltage**