ELECTRON PRODUCTS INC.

INFORMATION BROCHURE

FILM CAPACITORS

ELECTRON PRODUCTS INC.:

Electron Products has been serving the Film Capacitor Market for over 50 years with both custom designs as well as catalog styles. Electron Products, also known in the past as Marshall Industries, ITT Jennings, W-K industries and TRW, has always been proud to supply the highest quality capacitors available anywhere with the best possible delivery.

Capacitors are supplied in all dielectric systems and configurations, solving difficult size and voltage applications. The manufacturing facility located in Irwindale, California, utilizes the most modern equipment, Clean Room Class 100 flow hoods are utilized in the winding process which enables us to provide extremely high quality capacitors, including capacitors that previously have been impossible to obtain.

ENGINEERING:

We have a highly experienced engineering staff in capacitor design and application. Designs are handled quickly through the use of computer aided design (CAD), obtaining the optimum design for both price and performance. If Electron can't help you, FOR ANY REASON, we'll give you the name of someone who can. We'll give you ALL the alternatives.

QUALITY ASSURANCE:

Electron is approved to Mil-I-45208, FSCM 99515 (CAGE Code). Each capacitor is 100% tested twice, first in section form, then in finished form. Our quality is closely monitored by our Q.A. department throughout the manufacturing process with a final AQL inspection performed prior to every shipment. Our Q.A. manager has over 35 years experience in Q.A.

AC CAPACITORS:

AC rated metallized units with greater than 3 times the normal current capability, high corona start voltage and operation to 1 Megahertz are readily available.

HIGH VOLTAGE:

High voltage capacitors are available in standard industrial sizes and voltages along with an ultra miniature series which is usually less than 50% of the standard size, in some cases 25% of the standard size. Custom shapes and sizes with much shorter lengths are readily available.

WRAP & FILL:

Capacitors are wrapped in a skin tight plastic tape and then filled with epoxy on the ends. The most economical of the packaging methods. Available in Axial Leaded, Oval; Axial Leaded, Round (Style C); Radial Leaded, Oval (Style V); and Radial Leaded, Round (Style U).

EPOXY CASE:

Capacitors are encased in a molded epoxy/plastic shell with epoxy fill. Available in Axial Leaded, Rectangular (Style E); Radial Leaded, Rectangular (Style 2E); and Axial Leaded, Round (Style T). They are also available in as special sizes and shapes.

FEED THROUGH:

Round Feed Through capacitors, in a skin tight plastic wrap with solderable ends (Style Q). The Feed Through tube in the center of the capacitor is either a Teflon Tube, Paper Tube or Phenolic Tube ranging in sizes from just a wire to fit through to a large threaded stud to fit through.

Round Wrap and Fill Feed Through capacitors have a terminal on one end and a lead on the other end (Style N). The terminal can be either a threaded neck type or a soldered type. The majority of Feed Throughs are custom made to exact customer requirements. They are very popular in EMI filter applications.

HERMETIC SEAL:

Hermetically sealed capacitors are supplied in both the standard Floating case Round Metal Tube (Style L); and the Floating case Rectangular Metal Tube (Style G); along with Case Grounded, Case Terminal, and Feed Through. Also available are the standard Bath Tub Metal Cans along with Metal Cans of any size or shape needed for special customer applications.

MILITARY SPECIFICATIONS:

Electron Products manufactures capacitors to meet several of the Mil-Specs including the following:

MIL-C-25	Fixed Paper Dielectric, DC, Hermetically Sealed in Metal Cases.
MIL-C-11693	Fixed Paper/Film Dielectric, Feed-Through, Hermetically Sealed in Metal Cases.
MIL-C-14157	Fixed Paper, Paper/Plastic or Plastic Dielectric, DC, Hermetically Sealed in Metal Cases.
MIL-C-18312	Fixed Metallized Paper, Paper/Plastic or Plastic Film Dielectric, DC, Hermetically Sealed in Metal Cases.
MIL-C-19978	Fixed Plastic or Paper/Plastic Dielectric, Hermetically Sealed in Metal, Ceramic or Glass Cases.
MIL-C-27287	Fixed Plastic Dielectric, DC, in Non-Metallic Cases.
MIL-C-39022	Fixed Metallized Paper/Plastic Film or Plastic Film Dielectric, DC and AC, Hermetically Sealed in Metal Cases.
MIL-C-55514	Fixed Plastic or Metallized Plastic Dielectric, DC, in Non-Metallic Cases.
MIL-C-83421	Fixed SuperMetallized Plastic Film Dielectric, DC, AC and AC-DC, Hermetically Sealed in Metal Cases.
MIL-C-83439	Fixed Feed-Through, EMI suppression, DC, AC and AC-DC, Hermetically Sealed in Metal Cases.
MIL-STD-202	Military Standard. Test methods for electronic and electrical component parts.

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DIELECTRICS

MYLAR (POLYESTER):
A good general purpose dielectric with relativity low cost and high volumetric efficiency. Still the most popular of the dielectrics. Available in both Metallized and Foil designs.

COMBINATION FILM:
Combination Mylar and Polypropylene. Extremely low temperature coefficient in the 0°C to 85°C temperature range. Volumetric efficiency similar to polycarbonate.

KF (POLYMER):
Extremely high volumetric efficiency with about 4 times the "*K* Factor" of Mylar, making it about 1/4 the size. Higher DF and lower IR are its disadvantages along with cost.

POLYCARBONATE:
Lower DF, higher IR, better temperature coefficient and better stability than Mylar with a slightly lower volumetric efficiency. Metallized Polycarbonate is an excellent choice for close tolerance applications. Second most popular Dielectric.

KAPTON:
Electrical properties similar to Mylar with a much higher operating temperature going up to 250°C. A higher cost than Mylar limits its use to higher temperature applications.

POLYPROPYLENE:
Very good temperature coefficient, high IR, and low DF make it good for AC operation. Usable to 105°C without derating. Has become increasingly popular for AC applications. Available in both Metallized and Foil constructions.

POLYSULFONE:
Electrical properties similar to polycarbonate with a very good temperature coefficient and higher operating temperature. Very limited availability in the last few years has limited its use. New dielectrics are now replacing Polysulfone for high temperature applications.

POLYSTYRENE:
Very good electrical properties and excellent stability are its advantages. Its big disadvantage is its operation is limited to below 85°C and it is available in foil construction only.

SUPERMETALLIZED POLYPROPYLENE:
A very high current design for very high frequencies up to 1 Megahertz. The ultimate in high current, significantly larger than SuperMetallized Polypulse. Very useful for the smaller capacitance values. Also popular in snubber applications, has a very high DV/DT ratings.

SUPERMETALLIZED POLYPULSE:
Developed specifically for switching power supply type applications. They are used for input filtering, high frequency transformer DC blocking and output filtering. They are dry-section non-polar metallized film dielectric with special high current end terminations resulting in very low ESR values and very high DV/DT ratings. They are significantly smaller than metallized polypropylene capacitors and have a 100% voltage rating from -55°C to +125°C. Capacitance change over temperature is 4 times better than with polypropylene.

TEFLON:
The best electrical properties of all the Dielectrics. Extremely high IR, low DF and operation to 250°C. Available in both Metallized and Foil constructions.

TECHNICAL TERMS

CAPACITANCE:
A measure of the energy storage ability of a capacitor, given as $C = K\,A/D$, where A is the area of the electrodes, D is their separation, and K is a function of the dielectric between the electrodes. The formula yields a result in farads (F), but a farad is so large that the most commonly used values are expressed in microfarads (μf = $10^{-6}F$) or picofarads (pf = $10^{-12}F$).

WORKING VOLTAGE (WVDC, WVAC):
The maximum continuous voltage that should be applied to a capacitor. Rated voltages for DC and AC operation are usually not the same. AC rated capacitors must avoid Corona.

TEMPERATURE COEFFICIENT (TC):
The change in capacitance with temperature expressed linearly as parts per million per degree centigrade (PPM/°C), or as a percent change over a specified temperature range. Most film capacitors are not linear and TC is expressed in percent.

DISSIPATION FACTOR (DF):
A measure of the power factor (or losses) of a capacitor, given as $DF = 2\,\pi\,fRC$ X 100%, where R is the equivalent series resistance of the capacitor, f is the frequency, and C is capacitance. Dissipation factor varies with frequency and temperature. Commonly expressed in Percent (%) DF.

EQUIVALENT SERIES RESISTANCE (ESR):
A measure of the total lossiness of a capacitor which includes the leads, electrodes, dielectric losses, leakage (IR) and most important, the end spray connecting the leads to the metallized film. The lower the ESR the higher the RMS current carrying ability the capacitor will have.

INSULATION RESISTANCE (IR):
A measure of the resistance to a DC current flow through the capacitor under steady state conditions. Values for film capacitors are usually expressed in megohm-microfarads for a given design and dielectric. The actual resistance of the capacitor is obtained by dividing the megohm-microfarads by the capacitance. A very good "Quality" indicator.

DIELECTRIC ABSORPTION (DA):
An apparent "recovery voltage" measured after the capacitor is discharged and expressed as a percent of the initial charge voltage. DA is due largely to the dipole moment of the dielectric and to a lesser degree the migration of free electrons to the surface of the dielectric.

VOLUMETRIC EFFICIENCY:
Energy density in μf-volts per cubic inch, from: (capacitance) X (working voltage) ÷ (volume).
Longer capacitors are more efficient than shorter units, because of volume used by encapsulation and unused dielectric at the capacitor ends (The margins). Cylindrical units have a smaller volume than rectangular units, although rectangular units can be stacked more compactly.

CORONA:
Any electrically detectable, field intensified ionization that does not result immediately in complete breakdown of the insulation and electrode system in which it occurs. Its incidence can be reduced or avoided through special designs. The corona start voltage should never be exceeded; capacitors in even low corona can fail after only a few months in the field.

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ELECTRON PRODUCTS PART NUMBER DESCRIPTION

D M G 1 - 205 E * -3

DIELECTRICS

A = Paper/Mylar, Impregnated, Low-Voltage
BW = Paper/Mylar, Impregnated, High-Voltage
C = Metallized Mylar & Polypropylene
D = Metallized Mylar (Polyester)
E = Mylar & Foil (Polyester)
F = K F Film Polymer
G = Metallized K F Film Polymer
H = Metallized Polycarbonate
K = Kapton & Foil
M = Metallized Paper and/or Plastic Film
N = Metallized Polypropylene
P = Plastic Film & Foil
R = Metallized Teflon
S = Metallized Polysulfone
T = Teflon & Foil
W = Metallized Paper and/or Plastic Film
X = Polystyrene & Foil
Y = Polypropylene & Foil
V = SuperMetallized Polypropylene
Z = SuperMetallized Polypulse

Other Dielectrics or combinations of Dielectrics are available, please contact Electron's Engineering Department.

VOLTAGES

.35 = 35V
.5 = 50V
1 = 100V
2 = 200V
3 = 300V
4 = 400V
6 = 600V
7 = 700V
8 = 800V
10 = 1000V
20 = 2000V
30 = 3000V
50 = 5000V
80 = 8000V
100 = 10000V
120 = 12000V
150 = 15000V
200 = 20000V
250 = 25000V
300 = 30000V

Multiply the Voltage Code by 100 times to get the rated voltage.

Adders
Z = AC Rated

TOLERANCE

None = ± 20%
A = ± 1% ♦
B = ± 2% ♦
C = ± 3% ♦
D = ± 5%
E = ± 10%

N = ± 30%
P = GMV
S = -10% +30%
T = -10% +50%
V = -10% +20%
X = Special Tolerance

♦ Temperature Stabilized

CAPACITANCE

In Picofarads - The First two digits indicate the value; The third digit (or the last digit if more than three digits) is the multiplier.

Symbol		Multiplier
0	=	1
1	=	10
2	=	100
3	=	1,000
4	=	10,000
5	=	100,000
6	=	1,000,000
7	=	10,000,000

SIZE / CONFIGURATION

None = Regular
M = Miniature
S = Special (Other Non-Catalog Sizes and Configurations, may indicate special testing or special stamp, etc.)

* When the size code is a "S" indicating a Special, then another sequenced number will follow the tolerance letter. (With no dash "-")

Custom Sizes and configurations are available to meet customer requirements.

STYLE

None = Oval Wrap & Fill Axial
C = Round Wrap & Fill Axial
E = Epoxy Case Axial
2E = Epoxy Case Radial
F = Metal Tube Rectangular Case Grounded
G = Metal Tube Rectangular Floating Case
H = Metal Tube Rectangular Case Terminal
J = Metal Can
K = Metal Tube Round Case Grounded
L = Metal Tube Round Floating Case
N = Feed Through Round Wrap & Fill
P = Metal Tube Round Case Terminal
Q = Feed Through Round Wrap No Fill
R = Metal Tube Rnd Feed-Thru(Threaded Neck)
T = Round Epoxy Case Axial
U = Round Wrap & Fill Radial
V = Oval Wrap & Fill Radial

Other Styles are readily available, please contact Electron's Engineering Department with your special requirements.

ACCESSORIES

For use with metal tubes & Style "R" only. (With a dash "-")

- 1 = Tangential Bracket
- 2 = Threaded Neck Term.
- 3 = Flat Lug Terminal
- 4 = 90° Lug Terminal
- 5 = Insulating Sleeve
- 6 = Stud Mounting

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DIELECTRIC SELECTION GUIDE

ELECTRON DIELECTRIC CODE	BW	C	D	E	F/G	H	K	N	V	S	T	X	Y	Z
Typical Characteristics of Capacitors	High Voltage Paper & Mylar	Combination Metallized Mylar & Polypropylene	Metallized Mylar	Mylar & Foil	KF Polymer F = Foil G = Metallized	Metallized Polycarbonate	Kapton & Foil	Metallized Polypropylene	Super Metallized Polypropylene	Metallized Polysulfone	Teflon & Foil	Polystyrene & Foil	Polypropylene & Foil	Super Metallized Polypulse
Capacitance Range in MFD	.001-1.0	.001-50.0	.001-100.0	.001-10.0	.10-100.0	.001-100.0	.001-10.0	.001-100.0	.001-100.0	.001-50.0	.001-5.0	.001-10.0	.001-5.0	.10-50.0
Standard Tolerance Ranges	5%-20%	1%-20%	1%-20%	1%-20%	10%-20%	1%-20%	5%-20%	1%-20%	1%-20%	1%-20%	1%-20%	1%-20%	1%-20%	1%-20%
DC Voltages	1000V-40,000V	100V-600V	25V-40,000V	10V-600V	200V-1000V	25V-4000V	100V-600V	100V-4000V	200V-2000V	50V-1000V	25V-1000V	50V-1000V	50V-1000V	50V-1000V
AC Voltages	400VAC-1200VAC	50VAC-250VAC	10VAC-2000VAC	10VAC-600VAC	N/A	10VAC-2000VAC	50VAC-1200VAC	25VAC-2000VAC	25VAC-2000VAC	50VAC-600VAC	10VAC-350VAC	50VAC-350VAC	10VAC-600VAC	25VAC-2000VAC
Dissipation Factor % at 60 HZ	.10	.10	.10	.15	5.0	.05	.25	.03	.03	.05	.03	.03	.03	.03
Dissipation Factor % at 1000 HZ	.40	.40	.40	.25	1.8	.15	.40	.10	.10	.15	.03	.03	.03	.10
Insulation Resistance, megohm-MFD at 25°C	30K	50K	30K	50K	1K	300K	50K	500K	200K	300K	10,000K	1000K	500K	200K
Dielectric Absorption at 25°C	.20	.20	.20	.20	N/A	.08	N/A	.03	.03	.08	.02	.02	.03	.08
Operating Range °C	-55° +125°	-55° +125°	-55° +125°	-55° +125°	-35° +180°	-55° +125°	-55° +250°	-55° +105°	-55° +105°	-55° +150°	-55° +250°	-55° +85°	-55° +105°	-55 +125°
Capacitance Change with Temperature *Cold* *Hot*	-8% +12%	-3% +6%	-6% +15%	-6% +15%	-50% +40%	-2% +2%	N/A	+2% -4%	+2% -4%	-2% +2%	+1% -1%	+1% -1%	+2% -4%	-2% +2%
Best Characteristics	High Voltage	Low T/C	Low Cost	Low Cost	Small Size	Good Electrical Properties	High Temperature	Good Electrical Properties	Very High Current	High IR	Excellent Electrical Properties	High Stability	Low DF	Very High Current
Relative Cost	Higher	Moderate	Lowest	Low	Highest	Higher	Higher	Moderate	Moderate	Higher	Highest	Higher	Moderate	Higher

This Dielectric selection guide is intended to give the engineer a quick reference of the electrical characteristics for many different dielectrics. Values shown are typical for each dielectric. If you're not sure which dielectric is best for your specific application, please contact the Electron Products sales staff, we have knowledgeable sales engineers that will be glad to help find exactly the right capacitor for your application. For specific Acceptance Criteria, Parametric Trend Curves, Environmental Data and Size information for all Case Styles refer to the Engineering Data Sheets available on the Dielectric you need.

Represented by:

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