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EIA STANDARD

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FIXED PAPER AND FILM-PAPER DIELECTRIC
CAPACITORS WITH NON-PCB IMPREGNANTS
FOR ALTERNATING CURRENT APPLICATIONS

RS-454



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Engineering Department

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FIXED PAPER AND FILM-PAPER DIELECTRIC CAPACITORS
WITH NON-PCB IMPREGNANTS FOR ALTERNATING CURRENT APPLICATIONS

(From Standards Proposal No. 1294, formulated under the cognizance of EIA Working Group P-2.2 on Film, Paper and Plastic Dielectric.)

1. SCOPE

This Standard describes the requirements for paper and film-paper dielectric capacitors with other than polychlorinated biphenyl (PCB) impregnants, hermetically sealed in metal cases for general purpose applications on ac voltages. They are intended for use with motors, high intensity discharge (HID) lighting ballasts, ferro resonant transformer power supplies, some power factor correction, and other applications. The capacitors are rated for service in 50 Hz or 60 Hz circuits and may be operated at case temperatures shown in 3.4.

2. DEFINITIONS

2.1 Rated Voltage

Rated voltage is the design steady state RMS operating voltage marked on the capacitor that may be applied between the terminals of the capacitor (See 23.1.1)

2.2 Rated Case Temperature

Rated case temperature is the maximum allowable hot spot temperature developed at any point on the case surface, during maximum operating conditions (See 23.1.2)

2.3 Outside Foil Terminal

Outside foil terminal is that capacitor terminal which is connected to the outer turn of foil of the capacitor section. Purpose of this is described in 23.1.7.

2.4 Service Life Objective *

Service life objective of Characteristic D and M capacitors operated at rated voltage and rated case temperature shall be not less than 94% survival after 60,000 hours operation. After 5000 hours operation, Characteristic D and M capacitor survival shall be not less than 99.5% with capacitors operating at rated conditions stated. Service life objective for Characteristics K and L capacitors operated at rated voltage and rated case temperature shall be not less than 90% survival after 60,000 hours operation. After 5000 hours operation, Characteristics K and L capacitor survival shall be not less than 99.0% with capacitors operating at rated conditions stated.

* As used in this Standard, service life objectives are intended to be guidelines. (See Application Note 23.1.)

3. STANDARD DESIGNATION

3.1 EIA Standard Designation shall consist of six constituent parts as illustrated below and options indicated.

D O 7 8 D P 3 H						P R G L S or F
						OPTIONS
D	078	D	P	3	H	
Case	Rating Number	Temperature Characteristic	Finish	Terminal	Capacitance Tolerance	Options
						P - Protective Device R - Resistor G - Ground Lug K or L - Low Leakage S - Room Temp Life Test F - Current Fuse

3.2 Case type shall be identified by a single letter. All cases shall be of deep drawn or extruded construction with double rolled cover seams.

Case	NOMINAL DIMENSION OVER SEAM COVER		Shape
	Inches	Millimeters	
A	2.16 x 1.31	54.8 x 33.4	(1 - 1/4") Flat Oval
B	2.69 x 1.56	68.3 x 39.7	(1 - 1/2") Flat Oval
C	2.91 x 1.91	73.8 x 48.4	(1 - 3/4") Flat Oval
D	3.66 x 1.97	92.9 x 50.3	(2") Flat Oval
E	4.56 x 2.84	115.8 x 72.3	Rectangular
J	2.16 x 1.31	54.8 x 33.4	(1 - 1/4") Formed Oval

3.3 Rating numbers are noted on parts lists sheets of appendix for capacitance and voltage rating. This is a three digit sequential non-significant number which has been assigned by EIA.

3.4 Characteristic shall be identified by a single letter to denote the rated case temperature range of the capacitor as shown below:

Characteristic	Case Temperature Range
D	-55°C to +70°C
K	-55°C to +85°C
L	-55°C to +90°C
M	-55°C to +60°C

3.5 Finish shall be identified by a single letter as shown below:

Letter	Type of Finish
N	No finish subsequent to case fabrication
P	Underwriters' Laboratories Recognized Paint
Q	Underwriters' Laboratories Recognized Plating

3.6 Terminals shall be identified by a single digit code as shown below:

<u>Code</u>	<u>Terminal Type</u>
1	Insulating cup 1/4" quick-connect - two tines
2	Insulating cup 1/4" quick-connect - four tines
3	Insulating cup 1/4" quick-connect - two or three tines and forked solder lug
4	Code 1 and Code 2 on same capacitor
5	Insulating cup 1/4" quick-connect - three tines
6	Code 1 and Code 5 on same capacitor

NOTE: Outside foil where required shall be identified by a significant mark near the terminal connected to the outside foil of the capacitor winding.

3.7 Capacitance tolerance shall be identified with a single letter as shown below:

<u>Code Letter</u>	<u>Capacitance Tolerance</u>
H	$\pm 6\%$
K	$\pm 10\%$

Tolerance color code may be requested for certain applications but shall only apply to code letter H ($\pm 6\%$). Color tolerance dot shall be placed on the cover surface of the capacitor. The color code shall be as shown below:

<u>Color Code</u>	<u>Capacitance Range From Nominal</u>
Black	-6% to -3%
White	-3% to 0
Yellow	0 to +3%
Red	+3% to +6%

3.8 Design options are described in 3.8.1 through 3.8.6.

3.8.1 The protective device shall be identified by the letter "P".

3.8.1.1 This protective device is intended to prevent case rupture and expulsion of internal material when used within the current and voltage fault rating of this device.

3.8.1.2 A minimum clearance above the capacitor terminals is required for effective operation of the protective device. Manufacturer should be consulted for minimum recommended clearance after installation (See 23.3 and 23.4).

3.8.2 Internal current fuses shall be identified by the letter "F" and shall have the following performance characteristics.

3.8.2.1 An internally fused capacitor shall be capable of operating continuously at currents up to 125% of its nominal rated current at 60 Hz at a case temperature of 75°C. This is the "must hold" current.

3.8.2.2 With the capacitor stabilized at 23°C, the fuse shall be capable of opening in five seconds or less at a steady state current equal to 4.0 times the "must hold" current as defined in 3.8.2.1.

3.8.2.3 Fused capacitors shall be capable of being charged with direct current to 130% of the ac rated voltage and discharged through zero resistance ten times with a minimum of thirty seconds delay between discharges without opening the fuse.

3.8.2.4 Mounting position of the capacitor shall not affect the operation of the fuse.

3.8.2.5 Single section capacitors shall have the fuse connected to the inside foil terminal (the unmarked terminal). Dual section compressor capacitors (those in which two capacitors act in combination for one function and singly for another), shall have the fuse connected to the common bushing marked "C". Dual section shared capacitors (those in which there are two capacitors and each is for a separate function), shall have the fuse connected to the unmarked terminal on the compressor section opposite to "C".

3.8.3 Discharge resistor shall be identified by the letter "R" and shall discharge the capacitor to 50 volts or less within one minute after disconnection of the capacitor from the voltage supply.

3.8.4 Ground lug shall be identified by the letter "G". (See Appendix C for ground lug details.)

3.8.5 Leakage current to case.

3.8.5.1 Low leakage current to case, required by UL1012 and UL1029, for some lighting and power supply applications shall be identified by the letter "K". The leakage current value shall be determined by agreement between the supplier and the user.

3.8.5.2 Low leakage current to case for motor application shall be identified by the option letter "L". When 115 volts 60 Hz is applied between the shorted capacitor terminals and the bare case, the leakage current shall not exceed the following values:

<u>Nominal Capacitance</u>	<u>Voltage Rating</u>	<u>Max. Leakage microamperes</u>
0-14 μ F	0-500	60
14.1-20 μ F	0-500	70
20.1 to 35 μ F	0-500	100
35.1 to 55 μ F	0-500	150
0 to 10 μ F	501-660	100

3.8.6 Room temperature life test - where room temperature life tests are required, they shall be identified by the option letter "S". The test described in Section 22 shall be identified by the letter "S".

4. APPLICABLE DOCUMENTS

The latest revisions of the following standards when specified, form part of this document.

- (a) EIA Standard RS-186, Standard Test Methods for Electronic Component Parts
- (b) EIA Source Code and Date Book
- (c) NEMA Standard Publication DC2-1970, Residential Controls (Quick-Connect Terminals)
- (d) U. L. Standards UL1012 and UL1029

EIA publications may be obtained from the Electronic Industries Association, 2001 Eye Street, N.W., Washington, D.C. 20006.

NEMA publications may be obtained from the National Electrical Manufacturers Association, 155 East 44th St., New York, NY 10017.

U. L. Standards may be obtained from Underwriters' Laboratories, Inc., Publications Department 207 East Ohio Street, Chicago, IL 60611.

5. STANDARD TEST CONDITIONS

Standard atmospheric conditions under which tests are to be conducted or referred to shall be as shown below unless otherwise specified.

Temperature: 20°C to 35°C (referred to 23°C values)
Barometric Pressure: 28 to 32 inches of mercury
Relative Humidity: Less than 80%

6. QUALITY ASSURANCE

6.1 Recommended order of tests shall be as shown in Table 1. No sample shall be subjected to more than one group of tests in Group 2, and Group 3 or Group 4.

6.2 Number of samples and allowable failures shall be as determined by agreement between the user and the supplier.

7. VISUAL AND MECHANICAL EXAMINATION

7.1 Dimensions shall be within the tolerances allowed.

7.2 Marking shall be legible, complete and correct.

7.3 Physical appearance shall be uniform in quality and capacitors shall be free from pits, corrosion, cracks, rough edges and other defects that will affect life, serviceability or appearance.

TABLE 1
QUALITY ASSURANCE TEST PROGRAMS

GROUP 1	(100% of Sample)	Requirements
Mechanical Inspection		Section 7
Marking		Section 8
Dielectric Withstanding Voltage		Section 9
Capacitance		Section 10
Dissipation Factor		Section 11
Seal		Section 12
Leakage Current to Case (where required)		Section 19
GROUP 2	(25% of Sample)	
Vibration		Section 13
Salt Spray (For plated or painted cases)		Section 14
GROUP 3	(25% of Sample)	
Solderability (where required)		Section 16
Terminal Strength		Section 17
Humidity (For plated or painted cases)		Section 15
Test of Protective Device or Current Fuse (where required)		Section 18
GROUP 4	(50% of Sample)	
Low Temperature Capacitance Change		Section 20
High Temperature Capacitance Change		Section 20
Room Temperature Life Test (where required)		Section 22
High Temperature Life Test		Section 21

8. MARKING

Marking shall be permanent ink or metal stamping and shall consist of the following items:

- (1) Nominal capacitance in microfarads (μF)
- (2) Rated voltage in volts (RMS)
- (3) Rated frequency in Hz
- (4) Name or symbol of manufacturer
- (5) Manufacturer's part number
- (6) EIA date code identification
- (7) Maximum temperature rating $^{\circ}C$ (where required)
- (8) Underwriters' Laboratories paint identification (where required)
- (9) Underwriters' Laboratories protective device or current fuse identification (where required)
- (10) Outside foil terminal (where required)
- (11) Terminal identification (where required) (Herm-C-Fan and dual capacitors)
- (12) Non-PCB identification

9. DIELECTRIC WITHSTANDING VOLTAGE TESTS

9.1 Between terminals - Capacitors shall be capable of withstanding the application of 2 x rated ac voltage for one minute. Capacitors shall be discharged through a 10,000 ohm resistor to limit the current.

9.2 Terminals to case - Capacitors shall be capable of withstanding the application of 2 x rated ac voltage plus 1000 volts for one minute.

9.3 Alternate tests to those outlined in 9.1 and 9.2 may be conducted at a dc voltage equal to the peak voltage of the specified ac test voltage.

10. CAPACITANCE TEST

Capacitance measurements shall be made on an ac bridge with 60 Hz rated voltage applied or shall be referred to such a measurement. Values of capacitance measured shall be within the specified tolerance at or referred to a temperature of 23°C. Accuracy of measurement shall be $\pm 0.5\%$.

11. DISSIPATION FACTOR TEST

Dissipation factor of each capacitor shall not exceed 0.6% for paper and 0.3% for film-paper dielectric when measured with 60 Hz rated voltage applied at any temperature between 23°C and 90°C. The average D.F. at 65°C shall not exceed the average D.F. at 23°C.

12. SEAL TEST

12.1 Capacitors shall be capable of withstanding a temperature of 90°C in circulating air for a 10 minute period past the time the entire capacitor has reached a temperature of 85°C without evidence of leakage of the impregnant.

12.2 Capacitors shall be capable of withstanding two thermal cycles each consisting of 24 hours at -55°C followed by 24 hours at room temperature without evidence of leakage of the impregnant.

13. VIBRATION TEST

13.1 Capacitors shall be capable of withstanding vibration of EIA Standard RS-186, Method 7, Type III test except for thirty minutes per plane without physical or electrical damage.

13.2 Capacitors shall be tested in accordance with Sections 9, 10 and 11.

14. SALT SPRAY TEST

Painted or plated finishes shall be capable of withstanding 500 hours salt spray test per EIA Standard RS-186, Method 5, Type II test, with less than 5% of the case surface showing finish breakdown or case failure when rust is removed. Test shall be conducted with 5% salt in the water at a temperature of 35°C.