

EIA RS-395

EIA STANDARD

*Polarized Aluminum
Electrolytic Capacitors
for Long Life (Type 1) and for
General Purpose Application (Type 2)*

RS-395
(Revision of RS-154-B
and RS-205)



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POLARIZED ALUMINUM ELECTROLYTIC CAPACITORS FOR LONG LIFE (TYPE 1) AND FOR GENERAL PURPOSE APPLICATION (TYPE 2)

(From EIA Standards RS-154-B and RS-205, and Standards Proposals No. 1073 and 1098, formulated under the cognizance of Working Group P-2.4 on Aluminum Electrolytic Capacitors.)

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PREFACE

Scope:

This standard covers polarized aluminum electrolytic capacitors intended for long life application (Type 1) and general purpose application (Type 2), both for use in low frequency filter and by-pass circuits where the service is normally direct current.

Standard styles, mountings (where applicable), ratings, temperature ranges, case sizes, test methods, and requirements are specified. This standard does not relate capacitance and voltage ratings to specific case sizes. The actual ratings for particular case sizes are a matter of negotiation between the manufacturer and his customer.

Capacitors for use in pulse discharge, photoflash, or similar devices are excluded.

If more stringent environmental performance is required, it is recommended that applicable military specifications be referenced.

Object:

To establish uniform requirements for judging the electrical, mechanical, and environmental properties of these two types of capacitors, to describe test methods, and to give recommendations for standard ratings and dimensions. Another object is to encourage the use of this standard as a procurement document. Where special or added requirements are required, it can be used as a reference or base document from which the user might want to generate his own in-house document.

SECTION ONE – DEFINITIONS

1.1 Type 1 Capacitors:

Type 1 capacitors cover polarized aluminum electrolytic capacitors, intended primarily for such applications as industrial, telecommunication, and avionics equipment where a high degree of stability of characteristics over a long life is essential.

1.2 Type 2 Capacitors:

Type 2 capacitors cover polarized aluminum electrolytic capacitors, intended for general purpose applications where requirements of Type 1 are not necessary.

1.3 Rated Temperature Range:

The rated temperature range is the range of ambient temperatures for which the capacitor has been designed to operate continuously.

1.4 Maximum Rated Temperature:

The maximum rated temperature is the maximum ambient temperature for which the capacitor has been designed to operate continuously.

1.5 Minimum Rated Temperature:

The minimum rated temperature is the minimum ambient temperature for which the capacitor has been designed to operate continuously.

1.6 Rated Capacitance:

The rated capacitance of the capacitor is the value which is indicated upon it.

NOTE: The capacitance of an electrolytic capacitor is the capacitance of an equivalent circuit having capacitance and resistance in series, measured with alternating current of approximately sinusoidal wave form at a specified frequency.

1.7 Rated DC Voltage:

The rated DC voltage is the operating voltage which is indicated upon the capacitor and which may be applied continuously to the terminals of the capacitor at temperatures within the applicable rated temperature range.

NOTE: (a) The sum of the direct current voltage and the peak alternating voltage applied to the capacitor shall not exceed the rated voltage. The AC voltage is limited by the permissible ripple current (see para. 1.9).

(b) For short periods, however, the rated voltage may be exceeded (see para. 1.11).

1.8 Leakage Current:

The leakage current is the conduction current flowing through the capacitor when a direct voltage is applied.

1.9 Ripple Current:

The ripple current is the RMS value of the alternating current component flowing through the capacitor as measured by means of a thermocouple instrument. The maximum permissible ripple current is related to the capacitor rating, physical size, and certain design factors. Ambient temperature and ripple current frequency are added factors which determine the allowable ripple current limits.

1.10 Dissipation Factor (DF):

The dissipation factor is the power loss of the capacitor divided by the reactive power of the capacitor at a sinusoidal voltage of specified frequency.

NOTE: Equivalent series resistance (ESR) may also be used as a means to define a single resistance representing all the ohmic losses in the capacitor. The relationship between ESR and DF can be expressed as follows:

$$\text{ESR (ohms)} = \frac{\text{DF}}{2 \pi f c \times 100}$$

Where DF = measured dissipation factor in %

f = Hz measurement frequency

c = measured capacitance in farads

Power Factor is the ratio of the capacitor equivalent series resistance (ESR) to the capacitor impedance (Z).

$$\text{PF} = \frac{\text{ESR}}{Z}$$

For most purposes, per cent dissipation factor and per cent power factor may be assumed equivalent up to 20%.

1.11 Rated Surge Voltage:

The surge voltage rating is the maximum DC over-voltage to which the capacitor may be subjected at normal room temperature for short periods not exceeding approximately 30 seconds at infrequent intervals of not less than five minutes.

NOTE: Factors which can affect the magnitude of the capacitor surge voltage are above normal power source (line/battery) voltages, impedance of power source, time delay before current drain of other components in the circuit, and open circuit failure of components that normally draw appreciable current.

1.12 Operating Life:

Capacitors covered by this standard and capable of meeting their specified performance requirements are expected to have estimated useful operating life in electronic equipment as indicated below provided they are operated within their rated conditions.

1.12.1 Type 1 Capacitors — 10 years.

1.12.2 Type 2 Capacitors — 3 to 5 years.

1.12.3 Longer operating life can be expected at reduced ambient temperatures and/or reduced operating voltages.

1.13 Shelf Life:

General shelf life expectancy for capacitors covered by this standard and capable of meeting their



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performance requirements is of the order indicated below provided storage temperatures do not exceed +40°C. (Storage at higher temperatures may decrease shelf life.)

1.13.1 Type 1 Capacitors — 2 years.

1.13.2 Type 2 Capacitors — 1 year.

1.13.3 Prior to their being used, it is recommended that capacitors having more storage time than indicated in paragraph 1.13.1 and 1.13.2 as applicable be tested at room temperature for leakage current in accordance with paragraph 2.10 of this standard. Capacitors which fail to meet this test may be reconditioned by applying a gradually increasing DC voltage across a 1000 ohm current limiting resistor in series with the capacitor until rated voltage is reached after which this condition is held for 30 minutes $\pm$ 3 minutes.

1.14 Style:

A capacitor style comprises capacitors having similar design features and falling within a manufacturer's usual range of ratings for those products. These styles are identified in the individual detail specification sheets in this standard. Each of these basic styles may be divided into a number of sub-styles depending on the details of construction and characteristics.

NOTE: (a) Mounting accessories are ignored, provided they have no significant effect on test results.

(b) Actual capacitance and voltage ratings within given case sizes and rated temperature ranges shall be agreed upon between the manufacturer and his customer.

(c) In the event of any conflict between the requirements of the general document and the requirements of the detailed specification, the latter shall govern.

1.15 Qualification Test:

Qualification test is a complete series of tests to be carried out on a number of samples representative of the style with the object of determining whether a particular manufacturer is qualified to produce capacitors of a given style meeting this standard.

The sample size, allowable failures, and the extent to which the samples must conform to the requirements of this standard shall be a matter of agreement between the manufacturer and his customer.

1.16 Acceptance Tests:

Acceptance tests are carried out to determine the acceptability of a consignment. These may be performed on a sampling or 100% basis, by either the manufacturer or his customer.

The selection of tests, sample size, and the extent to which the samples must conform to the requirements for the selected tests shall be a matter of agreement between the manufacturer and his customer.

SECTION TWO – GENERAL REQUIREMENTS AND METHODS OF MEASUREMENT

2.1 Standard Capacitance Ratings:

The standard capacitance values shall be taken from the following series all of which are in microfarads:

1	8	50	100	600	1500
2	10	60	200	700	2000
3	20	70	300	800	3000
4	30	80	400	900	4000
5	40	90	500	1000	5000

Values above 5000 shall be in 5000 μ F steps.

NOTE: For future standardization, consideration should be given to using values taken from IEC Publication 63-E6 series. This series is 1 – 1.5 – 2.2 – 3.3 – 4.7 – 6.8 – 10 and their decimal multiples.

2.2 Standard Capacitance Tolerances:

The tolerance for capacitance stated in per cent of the nominal rated value is shown below for the appropriate voltage rating and construction detail.

<u>Rated DC Voltage</u>	<u>Single Section Tolerance</u>	<u>Multi-Section Tolerance</u>
3 thru 100V	-10% + 100%	-10% + 150%
101 thru 300V	-10% + 75%	-10% + 100%
301 thru 450V	-10% + 50%	-10% + 50%

2.3 Standard DC Rated Voltages and Surge Voltages:

Table I lists standard rated voltages and surge voltages.

TABLE I

<u>Rated DC Voltage</u>	<u>DC Surge Voltage</u>	<u>Rated DC Voltage</u>	<u>DC Surge Voltage</u>
3 volts	4 volts	100	125
5	7	150	175
6	8	175	200
10	12	200	250
15	20	250	300
25	30	300	350
35	45	350	400
50	65	400	475
75	95	450	525



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2.4 Standard Temperature Ranges:

2.4.1 The standard temperature ranges for both Type 1 and Type 2 capacitors shall be:

-20 to +65°C	-30 to +65°C	-40 to +65°C
-20 to +85°C	-30 to +85°C	-30 to +85°C

2.5 Product Qualification:

2.5.1 This standard covers procedures for qualification tests only. The samples shall be representative of the range of ratings of the style under consideration.

2.5.2 Capacitors that have been subjected to qualification testing shall not be used in equipment or returned to parts stock.

2.6 Schedule of Qualification Tests:

2.6.1 All samples shall be subjected to the following tests in the order stated below:

<u>Test</u>	<u>Paragraph of this Std.</u>
Visual Examination and Mechanical Inspection	2.9
DC Leakage Current	2.10
Capacitance	2.11
Dissipation Factor	2.12

2.6.2 After completion of the above tests, the sample lot shall be divided into four groups and all capacitors in each group (and sub-group) shall be subjected to the following tests in the order stated hereafter:

<u>Test Group</u>	<u>Test</u>	<u>Paragraph of this Standard</u>
1 (Half of Group 1 (Other Half of Group 1 (Half of Group 2	{ Solderability	2.14
	{ Strength of Terminations	2.15
	Vent (if applicable)	2.16
	Vibration	2.17
2 (Other Half of Group 2 (Half of Group 3	{ Humidity	2.18
	{ Case Insulation (if applicable)	2.19
3 (Other Half of Group 3	{ Coupling Impedance (if applicable)	2.20
	{ Seal (Type 1 only)	2.21
	{ Characteristics at Minimum and Maximum Temperatures	2.22
4 (Half of Group 4 (Other Half of Group 4	Surge Test	2.23
	Life	2.24
	Shelf Life	2.25

