

JIS

JAPANESE INDUSTRIAL STANDARD

**General rules of fixed
electrolytic capacitors for use in
electronic equipment**

JIS C 5140—1995

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In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

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General rules of fixed electrolytic capacitors for use in electronic equipment C 5140-1995

1. Scope This Japanese Industrial Standard is the sectional specification of fixed electrolytic capacitors mainly used for electronic equipment (hereafter referred to as capacitors) and specifies the basis for type designation, ratings, materials, construction, dimensions, markings, performances and for requirements to be specified in detail specifications.

Remarks 1. The following standards are cited in this Standard:

JIS B 0205	Metric coarse screw threads
JIS B 0207	Metric fine screw threads
JIS C 0805	Packaging of electronic components on continuous tapes (components with axial type and radial wire lead terminals)
JIS C 0806	Packaging of electronic components on continuous tapes (surface mounting devices)
JIS C 5001	General rules for electronic components
JIS C 5003	General test procedure of failure rate for electronic components
JIS C 5101	General rules of fixed capacitors for use in electronic equipment
JIS C 5102	Test methods of fixed capacitors for use in electronic equipment
JIS C 5602	Glossary of passive components for electronic equipment
JIS Z 8601	Preferred numbers
JIS Z 9015	Sampling inspection procedures and tables by attributes with severity adjustment (receiving inspection where a consumer can select suppliers)

2. The International standards corresponding to this Standard are given below.

These standards are called generically IEC 384 hereafter.

IEC 384-3: 1989	Fixed capacitors for use in electronic equipment Part 3: Sectional specification : Fixed tantalum chip capacitors
IEC 384-4: 1985	Fixed capacitors for use in electronic equipment Part 4: Sectional specification: Aluminium electrolytic capacitors with solid and non-solid electrolyte Amendment 1 (1992)
IEC 384-15: 1982	Fixed capacitors for use in electronic equipment Part 15: Sectional specification: Fixed tantalum capacitors with non-solid or solid electrolyte Amendment 1 (1987) Amendment 2 (1992)
IEC 384-18: 1993	Fixed capacitors for use in electronic equipment Part 18: Sectional specification: Fixed aluminium electrolytic chip capacitors with solid and non-solid electrolyte

2. **Definitions** For the purpose of this Standard the definitions given in JIS C 5101 and JIS C 5602 shall apply.

The definitions for principal terms and symbols are given below.

- (1) **leakage current** The current which flows through a capacitor after lapse of a specified time from application of a specified d.c. voltage across terminations of the capacitor.
- (2) **equivalent series resistance** The resistance component when the impedance of a capacitor is expressed equivalently by a series circuit consisting of a resistance component and a reactance component. It is expressed by the following formula:

$$R = \sqrt{Z^2 - X^2} = \frac{\tan \delta}{2\pi f C}$$

where, R : equivalent series resistance (Ω)

Z : absolute value of impedance (Ω)

X : equivalent reactance (Ω) = $\frac{1}{2\pi f C}$ (Ω)

$\tan \delta$: tangent of loss angle

C : capacitance (F)

f : measuring frequency (Hz)

- (3) **tangent of loss angle ($\tan \delta$)** Tangent of loss angle of a capacitor. It is expressed by the following formula:

$$\tan \delta = \frac{R}{X} = 2\pi f C R$$

where, $\tan \delta$: tangent of loss angle

R : equivalent series resistance (Ω)

X : equivalent reactance (Ω) = $\frac{1}{2\pi f C}$ (Ω)

C : capacitance (F)

f : measuring frequency (Hz)

- (4) **surge voltage** The maximum d.c. voltage to which a capacitor can withstand in such procedures that a d.c. voltage is applied for 30 s in a period of 6 min specified times to the capacitor.
- (5) **rated temperature** The maximum value of ambient temperature at which a capacitor can be used continuously while the rated voltage is applied to the capacitor.
- (6) **maximum ripple current** The r.m.s. value of maximum allowable alternating current of a specified frequency at which the capacitor may be operated continuously with the rated voltage applied at the rated temperature.

- (7) rated ripple voltage The r.m.s. value of the maximum allowable alternating voltage of a specified frequency superimposed on the d.c. voltage at which the capacitor may be operated continuously at a specified temperature.
- (8) temperature derated voltage The maximum value of d.c. voltage that may be applied continuously to a capacitor at a temperature exceeding the rated temperature (within the upper category temperature).
- (9) category voltage (U_c) The maximum value of d.c. voltage which may be applied continuously to a capacitor at its upper category temperature.

Informative reference: The terms and symbols used in IEC 384 are shown.

3. Priority of standards If there are any different provisions in the following specifications, priority shall be given in the following order:

- (1) Detail specification
- (2) Sectional specification (JIS C 5140)
- (3) Generic specification (JIS C 5101)
- (4) Basic specification (JIS C 5001)

4. Type designation

4.1 Structure of type designation The type designation shall be formed in the following arrangement:

Symbol denoting class of capacitor	Symbol denoting style	Symbol denoting character- istics	Symbol denoting rated voltage	Symbol denoting rated capacitance	Symbol denoting tolerance on capaci- tance	Symbol denoting grade	Symbol denoting failure rate level	Symbol denoting other necessary items
4.2.1	4.2.2	4.2.3	4.2.4	4.2.5	4.2.6	4.2.7	4.2.8	4.2.9

Example: 1

CE 04 WG 1H 1R0 M C X 7L

Example: 2

CS 02 HB 1H 225 M E P

4.2 Symbols

4.2.1 Class of capacitor Capacitors shall be classified and symbolized by two English capital letters as given in Table 1, according to the material of anode and internal construction. Capacitors shall be further classified by adding one English capital letter to the said two English capital letters, if there is such provision in the detail specification.

Table 1. Classification of capacitor

Symbol	Class of capacitor
CA	Aluminium solid electrolytic capacitor
CE	Aluminium non-solid electrolytic capacitor
CL	Tantalum non-solid electrolytic capacitor
CS	Tantalum solid electrolytic capacitor

4.2.2 Style The symbol denoting style shall consist of two numerals as given in Table 2. If specified in the detail specification, the connection of element, existence of insulation, mounting method, electrode, construction, etc. are identified by adding the third numeral after these two numerals.

Table 2. Style

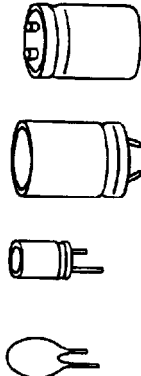
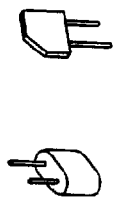
Symbol	Style	Enclosure	Termination		Remarks	Drawing for informative reference
			Kind	Direction		
01	Cylindrical	Metal case	Lead wire	Opposite	—	
02		Non-metal case			With sleeve	
05					—	
27	Cylindrical (chip)	Non-metal enclosure	Surface mounting terminations (or electrodes)	Opposite	—	
28		Non-metal case				
29		No enclosure				
04	Cylindrical	Metal case	Lead wire	Same	With sleeve	
15		Non-metal enclosure			—	
33		Metal case	Screw		With sleeve	
62			Lug		With sleeve	
69			For printed circuit board (self-standing)		With sleeve	

Table 2. Style (continued)

Symbol	Style	Enclosure	Termination		Remarks	Drawing for informative reference
			Kind	Direction		
30	Cylindrical [horizontal chip]	Metal case	Surface mount- ing lead-wire termination	Same	With sleeve	
32	Cylindrical [with base plate, vertical chip]	Metal case	Surface mount- ing termination	Same	Including capacitors with sleeve and coated with resin	
95	Square	Metal case	Lead wire termination	Same	—	
99		Non-metal case				
72	Square (chip)	No enclosure	Surface mount- ing terminations (or electrodes)	Opposite	—	
73		Non-metal enclosure				
77		Non-metal case				
88	Square [horizontal chip]	Non-metal case	Surface mount- ing termination	Same	—	

- Remarks
1. Resin mold is included in non-metal case.
 2. No enclosure means bare element or a capacitor painted without guarantee of insulation.
 3. Non-metal enclosure means an enclosure formed by thick dipped coating or by taping with insulating material.
 4. Lug termination includes plate termination and wrapping termination.
 5. Lead wire termination includes lead frame.
 6. Screw termination includes that with female thread together with that with male thread.
 7. Square type includes rectangular type.

4.2.3 Characteristics The symbol denoting characteristics shall consist of a combination of two or three English capital letters.

- (1) **Two letters** The first letter shall be an English capital letter excluding I and O, and shall express the performances of capacitor and requirement of applicable test items.

The second letter shall express the category temperature range as given in Table 3.

- (2) **Three letters** If it is necessary to further classify the conditions shown by the first letter in the case of two letter system, such classification shall be made by adding the second letter to the first letter.

The third letter shall express the category temperature range as given in Table 3.

The first letter and the second letter in the case of three letter system shall be specified in detail specifications.

Table 3. Category temperature range

Unit: °C

Symbol	Category temperature range	Symbol	Category temperature range
A	-55 to +155	J	-25 to +85
B	-55 to +125	P	-55 to +105
D	-55 to +85	Q	-40 to +105
E	-40 to +125	R	-25 to +105
G	-40 to +85	—	—

4.2.4 Rated voltage The symbol denoting the rated voltage, that also indicates the surge voltage corresponding to the rated voltage, shall consist of a combination of two characters the first one being a numeral and the second one being an English capital letter as given in Table 4.

Table 4. Rated voltage and surge voltage

Unit: V

Symbol	Rated voltage	Surge voltage	Symbol	Rated voltage	Surge voltage
0D	2	2.6	1H	50	63
0E	2.5	3.2	1J	63	79
0F	3.15	4	1K	80	100
0G	4	5	2A	100	125
0J	6.3	8	2C	160	200
1A	10	13	2D	200	250
1C	16	20	2E	250	300
1D	20	26	2F	315	365
1E	25	32	2V	350	400
1V	35	44	2G	400	450
1G	40	50	2W	450	500

4.2.5 Rated capacitance The symbol denoting rated capacitance shall consist of three numerals. The first and second numerals shall be the significant figures of rated capacitance expressed in the unit of picofarad (pF) or microfarad (μ F), and the third numeral indicates the number of zeros following the significant figures. If there is a decimal point, it shall be expressed by an English capital letter R, and all the numerals, in this case, shall be significant figures.

Examples: R10 or 104 0.1 μ F R47 or 474 0.47 μ F
 1R0 or 105 1 μ F 2R2 or 225 2.2 μ F
 100 or 106 10 μ F 330 or 336 33 μ F
 151 or 157 150 μ F 472 or 478 4700 μ F

Remarks: The detail specification shall specify either of picofarad (pF) or microfarad (μ F) as the unit.

4.2.6 Tolerance on capacitance The symbol denoting tolerance on capacitance shall consist of an English capital letter as given in Table 5.

Table 5. Tolerance on capacitance

Unit: %

Symbol	J	K	M	Q	T	V
Tolerance on capacitance	± 5	± 10	± 20	+30 -10	+50 -10	+20 -10

4.2.7 Grade The symbol denoting grade shall consist of one English capital letter as given in Table 6.

Table 6. Grade

Symbol	Description of grade
C	A simplified level applicable to capacitors for which the quality assurance program in Annex 1 of JIS C 5101, quality level, test details, etc. are required at a level lower than the general level and some parts of test items may be omitted.
E	A level corresponding to the "assessment level E" in the corresponding International standard.
X	A level to which the quality assurance specified in Annexes of this Standard (JIS C 5140) is not applicable.

Informative reference: The "assessment level E" of corresponding International standard in the row of symbol E means the "assessment level E" specified in the sectional specifications based on IEC 384.

4.2.8 Failure rate level The symbol denoting failure rate level shall consist of one English capital letter as given in Table 7.

Table 7. Failure rate level

Unit: %/1000 h

Symbol	Failure rate
M	1.0
P	0.1
R	0.01
X	Not specified

4.2.9 Other necessary items The symbol denoting other necessary items is applicable for expression of performance, construction, dimension, materials and other necessary matters which cannot be denoted by the symbols given in 4.2.1 to 4.2.8 and shall be specified in the detail specification. However, the symbols given in Table 7 shall not be used.

5. Ratings

5.1 Category temperature range The category temperature ranges shall be as given in Table 3. The rated temperature shall be specified in the detail specification.

5.2 Rated voltage and surge voltage The rated voltages and surge voltages shall be as given in Table 4.

The detail specification shall specify the temperature derated voltage of a capacitor, at which the capacitor can operate at a temperature exceeding the rated temperature, and the surge voltage corresponding thereto.

5.3 Rated capacitance The rated capacitance shall be expressed in microfarad (μF). The numerical values taken from E3 to E12 series of Table 8 multiplied by 10^n (n is an integer) shall be used.

Table 8. Preferred number series E3 to E12

E 3	1				2.2				4.7			
E 6	1		1.5		2.2		3.3		4.7		6.8	
E12	1	1.2	1.5	1.8	2.2	2.7	3.3	3.9	4.7	5.6	6.8	8.2

5.4 Tolerance on capacitance The tolerances on capacitance shall be as given in Table 5.

5.5 Maximum ripple current and/or rated ripple voltage The maximum ripple current and/or rated ripple voltage shall be specified in the detail specification.

6. Materials, construction and dimensions

6.1 Materials The materials for each component of a capacitor shall be free from detrimental impurities which influence on the function of the capacitor, shall be stable electrically and chemically, and shall satisfy the provisions of detail specification.

6.2 Construction The construction shall comply with the following requirements together with the provisions of detail specification:

- (1) The capacitor element shall have such construction that the oxide film formed on the surface of anode metal by anodic oxidation is employed as the dielectric, and a solid or non-solid electrolyte in close contact with the dielectric is employed as the cathode.
- (2) Terminations of a capacitor shall be firmly connected with the capacitor element electrically and mechanically.
The termination shall withstand corrosion, and that connected by soldering shall be adequately treated so that the soldering is easy.
- (3) The sleeve made of plastics or the like applied to capacitors with metal case shall be classified into non-insulation type and insulation type and this classification shall be specified in the detail specification.
- (4) An aluminum non-solid electrolytic capacitor with a metal case shall be equipped with a safety device. However, this safety device may be omitted for capacitors with a nominal diameter less than 10 mm.

6.3 Dimensions

6.3.1 External dimensions The numerical values in the preferred numbers of R10 series multiplied by 10^n (n is an integer) given in JIS Z 8601 shall be used as the external dimensions. However, the numerical values in the preferred numbers of R20 series multiplied by 10^n may be used in a special case only.

The external dimensions of cylindrical capacitors, surface mounting square chip capacitors and cylindrical surface mounting vertical chip capacitor with base plate are given in (1) to (3), respectively.

The spacing between lead wire terminations in the same direction shall be $2.5 \times N$ (N is a positive integer) mm.

- (1) **Cylindrical capacitors** The external dimensions of cylindrical capacitors shall be as given in Attached Fig. 1.

Cylindrical means that the length exceeds 1/2 of the diameter.

- (2) **Surface mounting square chip capacitors** The external dimensions of surface mounting square chip capacitors shall be as given in Attached Fig. 2.

- (3) **Cylindrical surface mounting vertical chip capacitor with base plate** The external dimensions of cylindrical surface mounting vertical chip capacitor with base plate shall be as given in Attached Fig. 3.

6.3.2 Lead wire termination

- (1) **Dimensions of lead wire termination** The dimensions of lead wire termination shall be as given in Table 9.

Table 9. Dimensions of lead wire termination

Unit: mm

Nominal value of wire diameter	Tolerance on wire diameter	Length
0.3	+ 0.03 - 0.05	4.5 ^{+1.0} _{-0.5} , 10 min., 20 min., 25±5, 40±5
0.4	+ 0.04 - 0.05	
0.45		
0.5	± 0.05	
0.6	+ 0.06 - 0.05	
0.65		
0.8	+ 0.08 - 0.05	
1.0	+ 0.10 - 0.05	
1.2		

Remarks: The detail specification shall specify any one of the numerical values in this table as the length.

- (2) Shape of lead wire termination Shapes of lead wire termination are subjected to agreement between the parties concerned with acceptance.

6.3.3 Screw thread The screw thread shall be selected from those given in Table 10, or from those specified in JIS B 0205 and JIS B 0207 if other ones are desired.

Table 10. Screw thread

Coarse screw thread	M1.2	M2	M2.5	M3	M4	M5	M6	M8
Fine screw thread	M4×0.5	M5×0.5	M6×0.75	M8×0.75	M10×0.75	M12×1		

7. Performances and test methods

7.1 Appearance When the specimen is tested visually there shall be no abnormalities such as remarkable scratch and cracks on its appearance.

7.2 Dimensions When the specimen is tested in accordance with 6.2.3. of JIS C 5102, the dimensions so measured shall satisfy the provision of the detail specification.

7.3 Marking The marking shall satisfy the provision of 9. when checked visually.

7.4 Test methods The test methods shall be as specified in JIS C 5102. However, the method for failure rate test shall be as specified in JIS C 5003.

7.5 Performances The test items for electrical performances, mechanical performances and climatic performances shall be selected from the items specified in Tables 11 to 13, respectively, and shall be specified as a sequence of tests in the detail specification correlating with the characteristic and grade of the capacitor. However, selection of items in qualification approval test, quality conformance inspection and periodic approval maintenance test shall be as specified in Annex 2, Annex 4 and Annex 5, respectively.

Criteria of performance in the test item shall be specified in the detail specification.

Table 11. Electrical performance and test method

Item	Performance	Test method (JIS C 5102)
High surge current (applicable to solid electrolytic capacitors)	As specified in detail specifications.	7.19
Leakage current		7.7
Capacitance		7.8
Tangent of loss angle		7.9
Impedance		7.11
Surge voltage		7.14
Voltage proof (insulated type)		7.1
Insulation resistance (insulated type)		7.6
Variation of characteristic with temperature		7.12
Reverse voltage		7.18
Charge and discharge		7.17

Table 12. Mechanical performance and test method

Item		Performance	Test method (JIS C 5102)
Robustness of termination		As specified in detail specifications.	8.1
Resistance to vibration			8.2
Resistance to shock			8.3
Solderability			8.4
Resistance to soldering heat			8.5
Operation of safety equipment			8.10
			(Applicable to aluminum non-solid electrolytic capacitors)
Resistance to solvent	Performance		8.7
	Marking		
Applicable to surface mounting chip capacitors	Mounting to test printed-circuit board		Annex 1 (mounting of chip capacitor to test printed-circuit board)
	Robustness of termination	Resistance to bending of substrate	8.11.1
		Adhesion	8.11.2
		Peel strength	8.11.3
	Solderability		8.13
	Resistance to soldering heat		8.14
	Resistance to electrode erosion by soldering		8.15

Table 13. Climatic performance and test method

Item	Performance	Test method (JIS C 5102)
Change of temperature (cyclic)	As specified in detail specifications.	9.3
Resistance to damp heat (steady state)		9.5
Loading at elevated temperature		9.10
Climatic sequence		9.16
Storage at high temperature		9.17.1
Storage at low temperature		9.17.2

Remarks: In advance of the tests, surface mounting chip capacitors are mounted to the test printed circuit board in accordance with Annex 1 of JIS C 5102, the initial measurements are carried out, and then the tests shall be made.

8. Quality assessment and assurance Quality of capacitors with a grade symbol excluding X specified in 4.2.7 shall be assured in such means that the quality assurance program specified in Annex 1 of JIS C 5101 is prepared and the assurance is made in accordance with the procedure of quality assurance specified in Annex 1 of this Standard (JIS C 5140).

9. Marking

9.1 Marking on product

9.1.1 Items to be marked The following items shall be marked on the surface of each capacitor indelibly and clearly. However, details of marking items including omission of marking due to construction, dimensions, etc. of capacitor shall be specified in the detail specification.

Either of (11) or (12) may be omitted.

- (1) Class
- (2) Style
- (3) Characteristics
- (4) Rated voltage
- (5) Rated capacitance
- (6) Tolerance on capacitance
- (7) Grade
- (8) Failure rate level
- (9) Symbols denoting the other necessary items specified in 4.2.9
- (10) Polarity
- (11) Year and month or year and week of manufacture
- (12) Production lot number
- (13) Manufacturer's name or abbreviation

Remarks: Multi-termination capacitors shall be so marked that the items (4), (5) and (10) are clearly understood on each termination.

9.1.2 Marking of polarity The anode and cathode terminations shall be clearly identified by marking the polarity (+ or -) in the vicinity of the terminations.

When the polarity is identified by other methods, the following method shall be employed:

- (1) When the polarity is identified by color, black shall be used for cathode side.
- (2) When the polarity is indicated by an arrow mark, the arrow shall point at the cathode.

- (3) When the polarity is identified by the length of termination, cathode side one shall be shortened, and the polarity shall necessarily be marked by another method.
- (4) When the polarity is identified by a thick line only in a surface mounting square chip capacitor, the line shall be marked on anode side.

9.1.3 Symbolization of marking When the items specified in (1) to (9) of 9.1.1 are symbolized and marked, the symbols specified in 4.2 shall be used. If the area for marking is small, the simplified symbols specified in 9.1.4 may be used.

9.1.4 Marking with simplified symbols For small sized capacitors with a rated voltage less than 100 V, if the marking space is small, the marking may be made by a combination of total three characters, i.e. one English letter which denotes the rated voltage as shown in Table 14, and a combination of one English capital letter which denotes two significant figures of rated capacitance in the unit of picofarad (pF) as shown in Table 15 and a numeral which denotes the multiplier as shown in Table 16.

In such marking only the polarity shall be marked in addition.

Table 14. Symbol denoting rated voltage by one English letter

Symbol	d	e	f	g	j	A	C	E	V	H	J
Rated voltage V	2	2.5	3.15	4	6.3	10	16	25	35	50	63

Remarks: The style of penmanship of English small letters shall be as given in this table.

Table 15. Symbol denoting significant figures of rated capacitance by one English capital letter

Symbol	A	C	E	G	J	L	N	Q	S	U	W	Y
Numerical value	1.0	1.2	1.5	1.8	2.2	2.7	3.3	3.9	4.7	5.6	6.8	8.2

Table 16. Symbol denoting multiplier to numerical value of rated capacitance by one numeral

Symbol	5	6	7	8
Multiplier	10^5	10^6	10^7	10^8

Example: CA7..... 16 V 10 μ F