TO Messrs. ALMAR ENTERPRISES CO., LTD.

ALUMINUM ELECTROLYTIC CAPACITORS SPECIFICATION SHEET

CUSTOMER PART No.		
Rubycon PART No.	PK SERIES	
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REVISIONS

ISSUE No.	REVISION MARK	DATE	DESCRIPTION	CH.	APP.
2		25 Apr. 2008	• Added one more condition to Fumigation and halogenated flame retardant • Changed Safety Application Guide to EIAJ RCR-2367C from 2367B	T.M.	Y.S.

1.Scope.
This specification covers polarized aluminum electrolytic capacitors with non-solid electrolyte for use in electronic equipments .

2. Reference Standard
JIS C 5141 (1991) and JIS C 5102 (1994) methods for testing.

3. Operating Temperature Range
-40°C to +85°C (6.3 to 400 V.DC.), -25°C to +85°C (450 V.DC.)

4. Performance Refer to Table-1

5. Style and Numbering System
(1) Style CE 04 (Radial Leaded)

(2) Numbering System

Rated Voltage	Series	Nominal Capacitance	Tolerance	Lead Forming	Case Size
□□□	PK	□□□	M	□□	□□X□□

6. Marking
Unless otherwise specified, capacitor shall be clearly marked the following items on its body.
Sleeve color: Black
Lettering color: White

(1) Trade mark	Rubycon
(2) Rated Voltage	V
(3) Nominal Capacitance	μF
(4) Polarity	(Negative Polarity)
(5) Series	PK
(6) Lot Number	
(7) Maximum Operating Temperature	85°C

7. Vent
On capacitors whose diameter is 6.3mm and greater, a safety vent shall be provided.

8. Notes on use of aluminum electrolytic capacitors
(1) Charge and discharge
Do not use for the circuit that repeats quick charge or discharge.

(2) External stress
Do not apply excessive force of pushing, pulling bending, and/or twisting to the main body, lead wire and terminals.

(3) Heat resistance at soldering process
In the soldering process of PC board with Capacitors mounted, secondary shrinkage or crack of sleeve may be observed when soldering temperature is too high and /or soldering time is too long.
If lead wire of other components or pattern of double sided PC board touches the capacitor, the similar failure may be also originated at pre-heating, heating at hardening process of adhesive and soldering process.

(4) Insulation and PC board mounting
Sleeve is for marking purpose only.
It is not recognized as insulation materials.
When double sided PC board is employed, note that it could cause a short circuit if lead wire of other components or pattern of double sided PC board touches capacitor. Please avoid circuit pattern runs underneath capacitor.
In addition, case and cathode terminal are not insulated.

(5) Adhesives and coating materials
Do not use the adhesives and coating materials that contain halogenated organic solvents or chloroprene as polymer.

(6) Storage
Keep at a normal temperature and humidity. During a long storage time, leakage current will be increased. To prevent heat rise or any trouble that high leakage current possibly causes, voltage treatment is recommended for the capacitors that have been stored for a long time.
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<Storage Condition>
*Aluminum electrolytic capacitors should not be stored in high temperatures or where there is a high level of humidity. The suitable storage condition is 5°C-35°C and less than 75% in relative humidity.
*Aluminum electrolytic capacitors should not be stored in damp conditions such as water, saltwater spray or oil spray.
*Do not store aluminum electrolytic capacitors in an environment full of hazardous gas (hydrogen sulfide, sulfurous acid gas, nitrous acid, chlorine gas, ammonia or bromine gas).
*Aluminum electrolytic capacitors should not be stored under exposure to ozone, ultraviolet rays or radiation.

(7) Fumigation and halogenated flame retardant

It may cause corrosion of internal electrodes, aluminum cases and terminal surface when the following conditions exist.

*Fumigation of wooden pallets before shipment to disinfect vermin.

*Existence of components or parts that contain halogenated flame retardant agent (bromine etc.) together with capacitors.

*When halogenated detergents or antiseptics for preventing infection of epidemic diseases contact directly to capacitors.

(8) PC board cleaning after soldering

Please consult us when cleaning is subjected.

♦Guide to application except the above are described in our catalog and EIAJ RCR-2367C .

EIAJ RCR-2367C: Safety Application Guide for fixed aluminum electrolytic capacitors for use in electronic equipment."

Published by Japan Electronics and Information Technology Industries Association.

♦Table-1 PERFORMANCE

	ITEMS	PERFORMANCE
1	Rated Voltage(WV) Surge Voltage (SV)	<table><tr><td>WV(V.DC)</td><td>6.3</td><td>10</td><td>16</td><td>25</td><td>35</td><td>50</td><td>63</td><td>100</td><td>160</td><td>200</td></tr><tr><td>SV(V.DC)</td><td>8</td><td>13</td><td>20</td><td>32</td><td>44</td><td>63</td><td>79</td><td>125</td><td>200</td><td>250</td></tr></table> <table><tr><td>WV(V.DC)</td><td>250</td><td>350</td><td>400</td><td>450</td></tr><tr><td>SV(V.DC)</td><td>300</td><td>400</td><td>450</td><td>500</td></tr></table>
2	Nominal Capacitance (Tolerance)	<Criteria> 0.47 to 33000μF(±20%) <Condition> Measuring Frequency : 120Hz±20% Measuring Voltage : Not more than 0.5Vrms + 1.5 to 2.0V.DC Measuring Temperature : 20 ± 2 °C
3	Leakage Current	<Condition> The rated voltage shall be applied between terminals of capacitor such that the terminal voltage will reach the rated voltage within one minute and the leakage current shall be measured at following time after the voltage has reached the rated voltage across a 1000 ±10 Ω series protection resister. Then the current value shall not exceed value calculated from following formula. <Criteria> • 6.3 to 100V. DC (after 2minutes) I=0.01CV or 3μA whichever is greater • 160 to 450V. DC (after 1 minute) (after 5minutes) I=0.1CV +40μA (CV≤1000) I=0.03CV +15μA (CV≤1000) I=0.04CV +100μA (CV>1000) I=0.02CV +25μA (CV>1000) where I : Leakage current in μA. C : Nominal capacitance in μF. V : Rated voltage in V.DC.
4	Dissipation Factor (tanδ:Tangent of loss angle)	<Criteria> <table><tr><td>WV(V.DC)</td><td>6.3</td><td>10</td><td>16</td><td>25</td><td>35</td><td>50</td><td>63</td><td>100</td><td>160 to 250</td><td>350 to 450</td></tr><tr><td>tanδ</td><td>0.28</td><td>0.24</td><td>0.20</td><td>0.16</td><td>0.14</td><td>0.12</td><td>0.10</td><td>0.10</td><td>0.20</td><td>0.25</td></tr></table> When nominal capacitance is over 1000μF, tanδ shall be added 0.02 to the listed value with increase of every 1000μF. <Condition> See ITEM 2, Nominal Capacitance, for measuring frequency, voltage and temperature.

5 Terminal Strength

<Condition>

Tensile Strength of Terminals

The body of capacitor shall be fixed and the tensile force of following table shall be applied to the terminal in lead out direction of the terminal for 10±1 seconds.

Bending Strength of Terminals

The body of capacitor shall be held in such a way that the regular lead-out axis of lead wire terminal becomes vertical. The weight of following table shall be suspended from the end of terminal. In this condition, after the body of sample is bent through 90 degrees, it shall be returned to the original position. Next the body shall be reversibly bent through 90 degrees and again returned to the original position.

Diameter of lead wire	Tensile force N{kgf}	Bending force N{kgf}
0.5mm and less	5{0.51}	2.5{0.25}
Over 0.5mm to 0.8mm incl	10{1.0}	5 {0.51}

<Criteria>

Notable changes shall not be found, as breakage or looseness in the terminal.

6 Temperature Coefficient and Drift

<Condition>

STEP	Testing Temperature (°C)	Time
1	20±2	Time to reach thermal equilibrium
2	-40±3	//
3	-25±3	//
4	20±2	//
5	85±2	2 hrs.
6	20±2	Time to reach thermal equilibrium

Capacitance, D.F. and Impedance shall be measured at 120Hz.
Rated voltage 450 WV : Except Step 2.

<Criteria>

STEP 2,3	Impedance Ratio	The value of ratio to STEP 1 not more than value of following table.
STEP 5	Capacitance Change	6.3 to 100WV : Within ±25% of the value of STEP 1 160 to 450WV : Within ±20% of the value of STEP 1
	Dissipation Factor	Not more than the specified value
	Leakage Current	Not more than 5 times the specified value
STEP 6	Capacitance Change	Within ±10% of the value of STEP 1
	Dissipation Factor	Not more than the specified value
	Leakage Current	Not more than the specified value

WV(V.DC)	6.3	10	16	25	35	50	63	100	160
Z(-25°C)/Z(+20°C)	5	4	3	2	2	2	2	2	3
Z(-40°C)/Z(+20°C)	12	10	8	5	4	3	3	3	4

WV(V.DC)	200	250	350	400	450
Z(-25°C)/Z(+20°C)	3	4	5	5	7
Z(-40°C)/Z(+20°C)	4	8	8	10	—

7	Load Life Test	<Condition> Capacitors shall be applied the rated voltage continuously through 1000 Ω series protective resistor (with maximum ripple current) at 85±2°C for 2000^{+72}_{0} hours. After the test and returned in standard condition for 1 to 2 hours, and the capacitor shall meet following requirements. <Criteria>

Leakage Current	Not more than the specified value
Capacitance Change	Within ±25% of the initial value
Dissipation Factor	Not more than 200% of the specified value
Appearance	Notable changes shall not be found

8	Shelf Life Test	<Condition> Capacitors shall be stored at 85±2°C with no voltage applied for 1000^{+48}_{0} hours. After the test and returned in standard condition for 1 to 2 hours and the capacitor shall meet following requirements. (If any doubt arises on the judgment, the capacitors shall be subjected to voltage treatment specified in JIS C 5141,5.2.) <Criteria>

Leakage Current	Not more than the specified value
Capacitance Change	Within ±20% of the initial value
Dissipation Factor	Not more than 200% of the specified value
Appearance	Notable changes shall not be found

9	Surge Voltage	<Condition> Capacitors shall be applied the surge voltage through a $(100\pm50)/C_R$ [kΩ] resistor in series for 30±5 seconds in every 6±0.5 minutes at 15 to 35°C. Procedure shall be repeated 1000 times. Then the capacitors shall be left under normal humidity for 1 to 2 hours before measurement. [C_R : Nominal Capacitance (μF)] <Criteria>

Leakage Current	Not more than the specified value
Capacitance Change	Within ±15% of the initial value
Dissipation Factor	Not more than the specified value
Appearance	Notable changes shall not be found

◊This test simulates overvoltage at abnormal situations, and not be hypothesizing that overvoltage is always applied.

10	Vibration Test	<Condition> Testing shall be done out in 3 AXIS for 2 hours each (total 6 hours) as below. Fix lead wire at a point not more than 4mm from the body , use mounting device separately for the one with a diameter 12.5mm and greater or with a length 25mm and longer.

Vibration frequency range : 10 to 55Hz
Peak to peak amplitude : 1.5mm
Sweep rate : 10 to 55 to 10Hz, In about 1min.

<Criteria>

Capacitance (During test)	Measured value shall be stable. (The time from one end to the other of the vibration frequency within last 30 minutes at last direction.)
Capacitance Change	Within ±5% of the initial value
Appearance	Notable changes shall not be found

11 Solderability

<Condition>
Terminals of the capacitor shall be immersed in flux (ethanol solution of the rosin, 25 wt% rosin) for 5 to 10 seconds and shall be immersed in the solder bath (235±5°C) and held for 2±0.5 seconds, and pulled out at the same speed.

<Criteria>
At least 3/4 of circumferential surface of dipped portion of the terminal shall be covered with new solder.

12 Resistance to Solder Heat

<Condition>
Terminals of the capacitor shall be immersed into solder bath at 260±5°C for 10±1 seconds up to 1.5 to 2.0mm from the body of capacitor.
Then the capacitors shall be left under the normal temperature and normal humidity for 1 to 2 hours before measurement.

<Criteria>

Leakage Current	Not more than the specified value
Capacitance Change	Within ±10% of the initial value
Dissipation Factor	Not more than the specified value
Appearance	Notable changes shall not be found

13 Resistance to Damp Heat (Steady State)

<Condition>
Capacitor shall be stored in the ambient of 40±2°C and relative humidity 90 to 95% for 240±8 hours.
Then the capacitors shall be left under the normal temperature and normal humidity for 1 to 2 hours before measurement.

<Criteria>

Leakage Current	Not more than the specified value
Capacitance Change	6.3 to 100WV : Within ±15% of the initial value 160 to 450WV : Within ±10% of the initial value
Dissipation Factor	Not more than the specified value
Appearance	Notable changes shall not be found

14 Maximum Permissible Ripple Current

(1)The maximum permissible ripple current is the maximum A.C. current at 120Hz and can be applied at maximum operating temperature.
(2)The combined value of D.C. voltage and the peak A.C. voltage shall not exceed the rated voltage and shall not be reverse voltage.

<Frequency Coefficient>

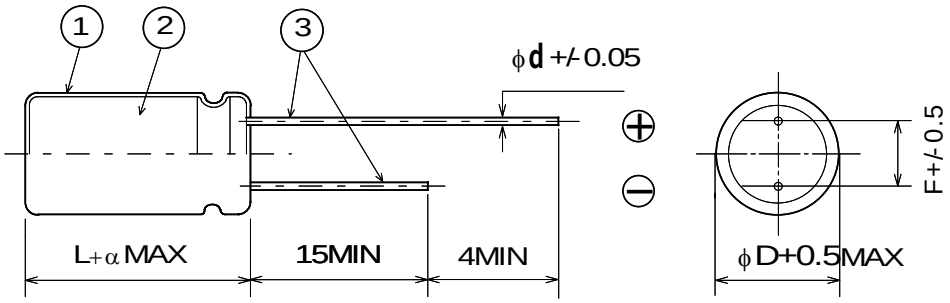
Frequency(Hz) / Capacitance(μF)	60(50)	120	500	1k	10k≤
0.47 to 1	0.50	1.00	1.20	1.30	1.50
2.2 to 4.7	0.65	1.00	1.20	1.30	1.50
10 to 47	0.80	1.00	1.20	1.30	1.50
100 to 1000	0.80	1.00	1.10	1.15	1.20
2200 to 33000	0.80	1.00	1.05	1.10	1.15

< Temperature Coefficient >

Ambient Temperature(°C)	85	70	50≥
Coefficient	1.0	1.6	2.0

◊Temperature coefficient shows a limit of ripple current exceeding the rated ripple current that can be passed through a capacitor at each temperature when the life expectancy of a capacitor becomes to be nearly equal with the lifetime at the rated maximum operating temperature.
◊Use of aluminum electrolytic capacitor under ripple voltage with wide amplitude is equivalent to quick charge-discharge operation.
When ripple voltage with the amplitude over 70Vp-p is expected for the products with rated voltage over 100V, please contact us.

9. Diagram of dimensions. :unit mm



♦Table-2

φD		6.3	8	10	12.5	16	18
F		2.5	3.5	5.0	5.0	7.5	7.5
φd		0.5	0.6	0.6	0.6	0.8	0.8
α	6.3 to 100WV	1.5				2.0	
	160 to 450WV	2.0					

♦Table-3

①	Sleeve	P.V.C. or P.E.T.
②	Case	Aluminum
③	Lead Wire	Tin plated

♦Table-4 Standard size, Maximum permissible ripple current

Size φDXL(mm), Ripple Current(mA r.m.s./85°C,120Hz)

WV / Cap (μF)	6.3		10		16		25		35	
	Size	Ripple	Size	Ripple	Size	Ripple	Size	Ripple	Size	Ripple
220									8X11.5	370
330					6.3X11	360	8X11.5	410	10X12.5	500
470					8X11.5	460	8X11.5	550	10X12.5	680
680	6.3X11	460	8X11.5	580	8X11.5	620	10X12.5	780	10X16	910
1000	8X11.5	590	8X11.5	660	10X12.5	720	10X16	870	10X20	1180
2200	10X16	920	10X16	1090	10X20	1320	12.5X20	1500	16X25	1810
3300	10X20	1200	10X20	1440	12.5X20	1600	16X25	2000	16X25	1990
4700	12.5X20	1550	12.5X20	1680	12.5X25	2050	16X25	2120	16X35.5	2500
6800	12.5X25	1920	12.5X25	2150	16X25	2250	16X31.5	2440	18X35.5	2740
10000	16X25	2370	16X25	2270	16X31.5	2660	18X35.5	2900		
15000	16X31.5	2550	16X35.5	2880	18X35.5	2950				
22000	16X35.5	2900	18X35.5	3100						
33000	18X40	3400								

Size ϕDXL(mm), Ripple Current(mA r.m.s./85°C,120Hz)

WV / Cap (μF)	50		63		100		160		200	
	Size	Ripple	Size	Ripple	Size	Ripple	Size	Ripple	Size	Ripple
4.7									6.3X11	51
10							8X11.5	80	8X11.5	85
22							10X12.5	130	10X16	150
33					8X11.5	185	10X16	180	10X20	205
47					8X11.5	220	10X20	230	10X20	220
100	8X11.5	270	8X11.5	290	10X16	380	12.5X25	430	12.5X25	320
220	10X12.5	435	10X16	490	12.5X20	610	16X31.5	645	16X31.5	540
330	10X16	590	10X20	710	12.5X25	760	18X35.5	700	18X35.5	800
470	10X20	760	12.5X20	900	16X25	1000	18X40	1200		
680	12.5X20	1000	12.5X25	1200	16X31.5	1100				
1000	12.5X25	1350	16X25	1350	18X31.5	1200				
2200	16X31.5	1980	18X31.5	1800						
3300	18X31.5	2100	18X40	2600						
4700	18X40	2800								

WV / Cap (μF)	250		350		400		450	
	Size	Ripple	Size	Ripple	Size	Ripple	Size	Ripple
0.47							6.3X11	8
1							6.3X11	16
2.2			6.3X11	30	8X11.5	31	8X11.5	29
3.3	6.3X11	45	8X11.5	45	8X11.5	48	8X11.5	33
4.7	6.3X11	54	8X11.5	55	10X12.5	56	10X12.5	46
10	10X12.5	90	10X16	90	10X16	90	10X20	84
22	10X16	150	12.5X20	185	12.5X20	200	12.5X25	140
33	10X20	205	12.5X25	240	12.5X25	240	16X25	180
47	12.5X20	260	16X25	300	16X25	250	16X31.5	220
100	16X25	450	18X31.5	520	18X35.5	420	18X40	280
220	18X35.5	680						