NIPPON CHEMI-CON

# ALUMINUM ELECTROLYTIC CAPACITORS

CAT. No. E1001G (Ver.3)


| INDEX | | |
|---|---|---|
| PRODUCT SEARCH | SERIES TABLE | |
| | GROUP CHART | |
| PRODUCTION GUIDE | PRECAUTIONS AND GUIDELINES (Conductive Polymer) | |
| | PRECAUTIONS AND GUIDELINES (Aluminum Electrolytic Capacitor) | |
| | PART NUMBERING SYSTEM | |
| | ENVIRONMENTAL CONSIDERATION | |
| | PACKAGING | |
| | TAPING SPECIFICATIONS | |
| | AVAILABLE TERMINALS FOR SNAP-IN TYPE | |
| | RECOMMENDED REFLOW CONDITION | |
| | STANDARDIZATION | |
| | WORLD-WIDE MANUFACTURING LOCATIONS | |

NIPPON CHEMI-CON

# CAPACITOR SERIES TABLE, CONTENTS

Next page

| Series | | | Features | Endurance (+R=With ripple) | Standard type | Low impedance | Solvent resistant | Terminal type | Rated voltage range (Vdc) | Capacitance range (µF) |
|---|---|---|---|---|---|---|---|---|---|---|
| Conductive Polymer Electrolyte Type | | PXF NEW! | Vertical type, super low ESR | 105℃ 2,000 hours | | ● | ● | SMD | 2.5 to 6.3 | 220 to 1,000 |
| | | PXE Upgrade! | Vertical type, super low ESR | 105℃ 2,000 hours | | ● | ● | SMD | 2.5 to 16 | 33 to 2,700 |
| | | PXA Upgrade! | Vertical type, super low ESR | 105℃ 1,000 to 2,000 hours | ● | ● | ● | SMD | 2.5 to 25 | 3.3 to 1,500 |
| | | PXH | 125℃ Vertical type | 125℃ 1,000 hours | | ● | ● | SMD | 2.5 to 20 | 22 to 1,000 |
| | | PSC Upgrade! | Radial lead type, super low ESR, high ripple current | 105℃ 2,000 hours | | ● | ● | Radial | 2.5 to 16 | 270 to 2,700 |
| | | PSA | Super low ESR, high ripple current | 105℃ 2,000 hours | | ● | ● | Radial | 2.5 to 16 | 47 to 1,000 |
| | | PS Upgrade! | Radial lead type, super low ESR | 105℃ 2,000 hours | ● | ● | ● | Radial | 2.5 to 35 | 18 to 1,500 |
| Surface Mount | Vertical Type | MVS | 4.5mm height | 85℃ 2,000 hours | ● | | ● | SMD | 4 to 50 | 0.1 to 220 |
| | | MVA | 5.5 to 22.0mm max. height, downsized | 85℃ 2,000 hours | | | ▲ | SMD | 4 to 450 | 0.1 to 10,000 |
| | | MV | 5.5 to 10.5mm max. height | 85℃ 1,000 to 2,000 hours | ● | | ● | SMD | 4 to 63 | 0.1 to 1,000 |
| | | MVE | 5.5 to 22.0mm max. height, downsized | 105℃ 1,000 to 2,000 hours | | | ▲ | SMD | 6.3 to 450 | 0.47 to 6,800 |
| | | MVK | 5.5 to 10.5mm max. height | 105℃ 1,000 to 2,000 hours | ● | | ● | SMD | 6.3 to 50 | 0.1 to 1,000 |
| | | MKA | 5.5 to 10.5mm max. height | 105℃ 1,000 to 2,000 hours | | | ● | SMD | 6.3 to 50 | 0.1 to 1,000 |
| | | MZA | 6.1 to 10.5mm max. height, very low impedance | 105℃ 2,000 hours | | ● | ● | SMD | 6.3 to 80 | 3.3 to 1,500 |
| | | MVY | 5.5 to 22.0mm max. height | 105℃ 1,000 to 5,000 hours | | ● | ▲ | SMD | 6.3 to 100 | 1.0 to 8,200 |
| | | MZD NEW! | 105℃5,000 hours, low impedance, long life | 105℃ 5,000 hours | | ● | ● | SMD | 6.3 to 50 | 10 to 470 |
| | | MLA | Low impedance, long life | 105℃ 3,000 hours | | ● | ● | SMD | 6.3 to 50 | 10 to 1,000 |
| | | MVJ | 6.0mm max. height | 105℃ 2,000 hours | | | ● | SMD | 6.3 to 50 | 0.1 to 100 |
| | | MLD NEW! | 105℃5,000 hours, long life | 105℃ 5,000 hours | | | ● | SMD | 6.3 to 50 | 0.1 to 1,000 |
| | | MVL | 6.0 to 10.5mm max. height | 105℃ 3,000 to 5,000 hours | | | ● | SMD | 6.3 to 50 | 0.1 to 1,000 |
| | | MVH | 6.0 to 22.0mm max. height | 125℃ 1,000 to 5,000 hours | | | ▲ | SMD | 10 to 450 | 3.3 to 4,700 |
| | | MHB NEW! | 10.5mm max. height (Ask Engineering No767 in detail) | 125℃ 2,000 hours | | | ● | SMD | 10 to 35 | 47 to 470 |
| | | MKB NEW! | 10.5mm max. height | 105℃ 3,000 hours | | | ● | SMD | 400 | 2.2 to 4.7 |
| | | MV-BP | 5.5mm max. height, bi-polar | 85℃ 2,000 hours | | | ● | SMD | 4 to 50 | 0.1 to 47 |
| | | MVK-BP | 6.0mm max. height, bi-polar | 105℃ 1,000 hours | | | ● | SMD | 6.3 to 50 | 0.1 to 47 |
| Miniature | Low Profile | SRM | 5mm height, downsized | 85℃ 1,000 hours | | | ● | Radial | 4 to 50 | 0.1 to 330 |
| | | SRE | 5mm height | 85℃ 1,000 hours | ● | | | Radial | 4 to 50 | 0.1 to 100 |
| | | KRE | 5mm height | 105℃ 1,000 hours | ● | | ● | Radial | 6.3 to 50 | 0.1 to 100 |
| | | SRA | 7mm height | 85℃ 1,000 hours | ● | | | Radial | 4 to 63 | 0.1 to 470 |
| | | KMA | 7mm height | 105℃ 1,000 hours | ● | | ● | Radial | 4 to 63 | 0.1 to 220 |
| | | SRG | ϕ4×7 to ϕ18×25mm, low profile | 85℃ 1,000 to 2,000 hours | | | ● | Radial | 4 to 50 | 0.1 to 10,000 |
| | | KRG | ϕ4×7 to ϕ18×25mm, low profile | 105℃ 1,000 hours | | | ● | Radial | 6.3 to 50 | 0.1 to 10,000 |
| | General Purpose | SMQ | Downsized | 85℃ 2,000 hours | ● | | | Radial | 6.3 to 450 | 0.1 to 47,000 |
| | | KMQ | Downsized | 105℃ 1,000 to 2,000 hours +R | ● | | ▲ | Radial | 6.3 to 450 | 0.1 to 47,000 |
| | | SMG | General, downsized | 85℃ 2,000 hours | ● | | ▲ | Radial | 6.3 to 450 | 0.1 to 39,000 |
| | | KMG | General, downsized | 105℃ 1,000 to 2,000 hours +R | ● | | ▲ | Radial | 6.3 to 450 | 0.1 to 22,000 |
| | | SME | General (Ask Engineering Bulletin No511 in detail) | 85℃ 2,000 hours | | | ▲ | Radial | 6.3 to 450 | 0.1 to 15,000 |
| | | KME | General (Ask Engineering Bulletin No512 in detail) | 105℃ 1,000 hours +R | | | ▲ | Radial | 6.3 to 400 | 0.1 to 15,000 |
| | | SME-BP | Bi-polar, general | 85℃ 2,000 hours | ● | | ● | Radial | 6.3 to 100 | 0.47 to 6,800 |
| | | KME-BP | Bi-polar, general | 105℃ 1,000 hours | ● | | ● | Radial | 6.3 to 100 | 0.47 to 6,800 |
| | High Frequency Use | KZM | Lowest impedance, long life | 105℃ 6,000 to 10,000 hours +R | | ● | | Radial | 6.3 to 50 | 27 to 10,000 |
| | | KZH | Lowest impedance, long life | 105℃ 5,000 to 6,000 hours +R | | ● | | Radial | 6.3 to 35 | 47 to 8,200 |
| | | KZE | Lowest impedance, long life | 105℃ 1,000 to 5,000 hours +R | | ● | | Radial | 6.3 to 100 | 6.8 to 6,800 |
| | | KY | Low impedance, long life | 105℃ 4,000 to 10,000 hours +R | | ● | | Radial | 6.3 to 100 | 0.47 to 18,000 |
| | | LXZ | Low impedance, downsized | 105℃ 2,000 to 8,000 hours +R | | ● | ● | Radial | 6.3 to 63 | 12 to 18,000 |
| | | LXY | Low impedance, high reliability | 105℃ 2,000 to 8,000 hours +R | ● | ● | ● | Radial | 10 to 63 | 10 to 8,200 |
| | | LXV | Low impedance | 105℃ 2,000 to 5,000 hours +R | | ● | ● | Radial | 6.3 to 100 | 5.6 to 15,000 |
| | | KMF | Low impedance, high CV, general (Ask Engineering Bulletin No630 in detail) | 105℃ 2,000 hours +R | | ● | | Radial | 160 to 450 | 2.2 to 220 |

: Promotional products

▲ : Some of range are solvent resistant.

NIPPON CHEMI-CON

# CAPACITOR SERIES TABLE, CONTENTS

Previous page

| Series | | | Features | Endurance (+R=With ripple) | Standard type | Low impedance | Solvent resistant | Terminal type | Rated voltage range (Vdc) | Capacitance range (µF) |
|---|---|---|---|---|---|---|---|---|---|---|
| Miniature | High Reliability | KXJ (Upgrade!) | Downsized, long life, for input filtering | 105℃ 10,000 to 12,000 hours +R | | ● | | Radial | 160 to 450 | 6.8 to 680 |
| | | KXG | Downsized, long life, for input filtering | 105℃ 8,000 to 10,000 hours +R | | ● | | Radial | 160 to 450 | 6.8 to 330 |
| | | KMX | Long life, for input filtering (Ask Engineering Bulletin No 646 in detail) | 105℃ 8,000 to 10,000 hours +R | | ● | | Radial | 160 to 450 | 3.3 to 680 |
| | | SMH | ϕ20×20 to ϕ22×50mm | 85℃ 2,000 hours +R | ● | | | Radial | 160 to 450 | 33 to 470 |
| | | KMH | ϕ20×20 to ϕ22×50mm | 105℃ 2,000 hours +R | ● | | | Radial | 160 to 450 | 33 to 470 |
| | | PAG | Low profile, for input filtering | 105℃ 2,000 hours +R | | | | Radial | 200 to 450 | 18 to 560 |
| | | KLJ | Downsized, no sparks with DC overvoltage | 105℃ 2,000 hours +R | | | | Radial | 200 & 400 | 4.7 to 330 |
| | | KLG | No sparks with DC overvoltage | 105℃ 2,000 hours +R | | | | Radial | 200 & 400 | 22 to 330 |
| | | FL | Long life | 105℃ 3,000 hours +R | | | ● | Radial | 6.3 to 50 | 0.47 to 270 |
| | | GPA | 125℃, downsized, low impedance | 125℃ 3,000 to 5,000 hours +R | | ● | ● | Radial | 25 to 50 | 470 to 6,800 |
| | | GXE | 125℃, downsize, low impedance | 125℃ 2,000 to 5,000 hours +R | | ● | ▲ | Radial | 10 to 450 | 4.7 to 4,700 |
| | | GXL | 125℃ Long life | 125℃ 5,000 hours +R | | | ● | Radial | 10 to 50 | 100 to 1,000 |
| | Special Application | LBG | For airbag | 105℃ 5,000 hours +R | | ● | ● | Radial | 25 & 35 | 1,000 to 11,000 |
| | | KZG | For PC motherboard | 105℃ 2,000 hours +R | | ● | | Radial | 6.3 to 16 | 470 to 3,300 |
| | | LLA | Low DC leakage, general | 85℃ 1,000 hours | | | ● | Radial | 6.3 to 50 | 0.1 to 15,000 |
| | | PH | For photo flash | 55℃ 5,000 times charging | | | | Radial | 300 & 330 | — |
| Large Sized | General Purpose | KMR | 105℃, Snap-in terminal, super downsized | 105℃ 2,000 hours +R | ● | | | Pin | 160 to 450 | 100 to 3,900 |
| | | SMQ | Snap-in terminal, more downsized | 85℃ 2,000 hours +R | ● | | | Pin | 160 to 450 | 82 to 3,900 |
| | | KMQ | Snap-in terminal, more downsized | 105℃ 2,000 hours +R | ● | | | Pin | 35, 50, 160 to 450 | 68 to 33,000 |
| | | SMM | Snap-in terminal, downsized | 85℃ 3,000 hours +R | ● | | | Pin | 160 to 450 | 47 to 3,300 |
| | | KMS (NEW!) | Snap-in terminal, downsized | 105℃ 3,000 hours +R | ● | | | Pin | 160 to 450 | 82 to 3,300 |
| | | KMM | Snap-in terminal, downsized | 105℃ 2,000 to 3,000 hours +R | ● | | | Pin | 160 to 450 | 39 to 3,300 |
| | | SMH | Snap-in terminal, general (Refer Engineering Bulletin No585 for 160 to 450V) | 85℃ 2,000 hours +R | ● | | | Pin | 6.3 to 100 | 820 to 100,000 |
| | | KMH | Snap-in terminal, general (Refer Engineering Bulletin No584 for 160 to 450V) | 105℃ 2,000 hours +R | ● | | | Pin | 6.3 to 100 | 560 to 82,000 |
| | Low Profile | SLM | 15mm height | 85℃ 2,000 hours +R | | | | Pin | 160 to 400 | 47 to 560 |
| | | KLM | 15mm height | 105℃ 2,000 hours +R | | | | Pin | 160 to 400 | 39 to 390 |
| | High Reliability | LXM | Long life | 105℃ 7,000 hours +R | | | | Pin | 160 to 450 | 47 to 2,200 |
| | | LXS (NEW!) | Snap-in terminal downsized | 105℃ 5,000 hours +R | ● | | | Pin | 160 to 450 | 82 to 3,300 |
| | | LXQ | Long life, downsized | 105℃ 5,000 hours +R | | | | Pin | 160 to 450 | 82 to 2,700 |
| | | LXG | Long life | 105℃ 5,000 hours +R | | | | Pin | 10 to 100 | 390 to 47,000 |
| | | CHA (Upgrade!) | No sparks with DC overvoltage, downsized | 105℃ 2,000 hours +R | | | | Pin | 200 to 450 | 56 to 1,200 |
| | | LXH | No sparks with DC overvoltage | 105℃ 3,000/5,000 hours +R | | | | Pin | 200 & 400 | 68 to 1,500 |
| | | RWE-LR | For air-conditioning (Ask Engineering Bulletin No768 in detail) | 85℃ 3,000 hours +R | | | | Lug | 250 to 450 | 330 to 2,200 |
| Screw-mount Terminal Type | General Purpose | SME | Screw terminal, general | 85℃ 2,000 hours +R | ● | | | Screw | 10 to 250 | 560 to 680,000 |
| | | KMH | Screw terminal, general | 105℃ 2,000 hours +R | ● | | | Screw | 10 to 400 | 180 to 680,000 |
| | For Inverter | RWG | 85℃, high ripple, downsized, long life | 85℃ 5,000 hours +R | | | | Screw | 350 to 450 | 1,500 to 18,000 |
| | | RWF | High ripple, long life | 85℃ 5,000 hours +R | | | | Screw | 350 to 450 | 820 to 22,000 |
| | | RWE | High ripple | 85℃ 2,000 hours +R | ● | | | Screw | 350 to 550 | 100 to 12,000 |
| | | RWY | High ripple, long life, low cost | 85℃ 5,000 hours +R | | | | Screw | 350 to 450 | 500 to 14,000 |
| | | RWL | High ripple, long life | 85℃ 20,000 hours +R | | | | Screw | 350 to 450 | 2,200 to 12,000 |
| | | FTP | Ellips can shape, high ripple | 85℃ 5,000 hours +R | | | | Screw | 63 to 450 | 270 to 21,000 |
| | | LXA | Long life | 105℃ 2,000/5,000 hours +R | | | | Screw | 10 to 525 | 330 to 390,000 |
| | | LXR | High ripple, long life | 105℃ 5,000 hours +R | | | | Screw | 350 to 450 | 2,200 to 15,000 |
| | | LWY | Low cost (Ask Engineering Bulletin No714 in detail) | 105℃ 5,000 hours +R | | | | Screw | 350 to 450 | 460 to 13,000 |

: Promotional products

▲ : Some of range are solvent resistant.

NIPPON CHEMI-CON

# GROUP CHART

Next page

## CONDUCTIVE POLYMER ALUMINUM SOLID CAPACITORS

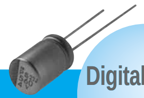
### ◆SURFACE MOUNT

**Vertical SMD**
- PXA (Upgrade!) → Lower ESR → PXE (Upgrade!) → Lower ESR → PXF (NEW!)

→ **High Temperature**
- PXH

Digitalization / Super Low ESR

### ◆RADIAL LEAD



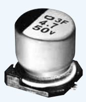
**Radial type**
- PS (Upgrade!) → Lower ESR → PSA → Lower ESR → PSC (Upgrade!)

Digitalization / Super Low ESR

## ALUMINUM ELECTROLYTIC CAPACITORS

### ◆SURFACE MOUNT

**SURFACE MOUNT (Vertical)**



- MV 85℃
- MVK 105℃ → Higher Reflow Temp. → MKA 105℃

**Downsized**
- MVA 85℃ High CV
- MVE 105℃ High CV

**Low Profile**
- MVS 4.5mmL

**Low Impedance** (Digitalization)
- MLA 105℃ 3,000H → Longer life → MZD 105℃ 5,000H (NEW!)
- MVY 105℃ → Longer life → MLA
- MVY 105℃ → Lower Z → MZA 105℃ 2,000H

**Large size (ϕ12.5 to ϕ18)**
- MVA 85℃ High CV
- MVE 105℃ High CV
- MVY 105℃ Low Z
- MVH 125℃

**105℃ Long Life**
- MVJ 2,000H → Longer life → MVL 3,000/5,000H → Longer life → MLD 5,000H (NEW!)
- MKB 3,000H (NEW!)

→ **High Temperature** (Automotive Application)
- MHB 125℃ (NEW!)
- MVH 125℃

### ◆RADIAL LEAD

**RADIAL TYPE STANDARD**

- SMG 85℃ Standard
- KMG 105℃ Standard
- SMH 160 to 450V
- KMH 160 to 450V
- SMQ 85℃ Downsize
- KMQ 105℃ Downsize

**5mmL** (Low Profile)
- SRE 85℃ → High CV → SRM 85℃
- KRE 105℃

**7mmL & Low Profile**
- SRA 85℃ → High CV → SRG 85℃
- KMA 105℃
- KRG 105℃

**105℃ Low Impedance** (Power Supply Output Filter)
- LXV Low Z → LXY High Reliability → LXZ High Reliability
- Lower Z: KY Long Life · Low Z → KZE Lower Z → KZH Lower Z → KZM Long Life · Low Z

**No Sparks against Over-voltage**
- KLG 2,000H → Downsized → KLJ 2,000H

**High Ripple Current / Longlife** (Adapter/ Ballast)
- PAG 2,000H → Downsized → KXG 8,000/10,000H → KXJ 10,000/12,000H (Upgrade!)

**For Strobe**
- PH

**For Motherboard**
- KZG

**Low LC**
- LLA 85℃

**Long Life**
- FL 3,000H

**High Temperature (125℃)** (Automotive Application)
- GXE 2,000 to 5,000H
- GXL 5,000H
- GPA 3,000/5,000H

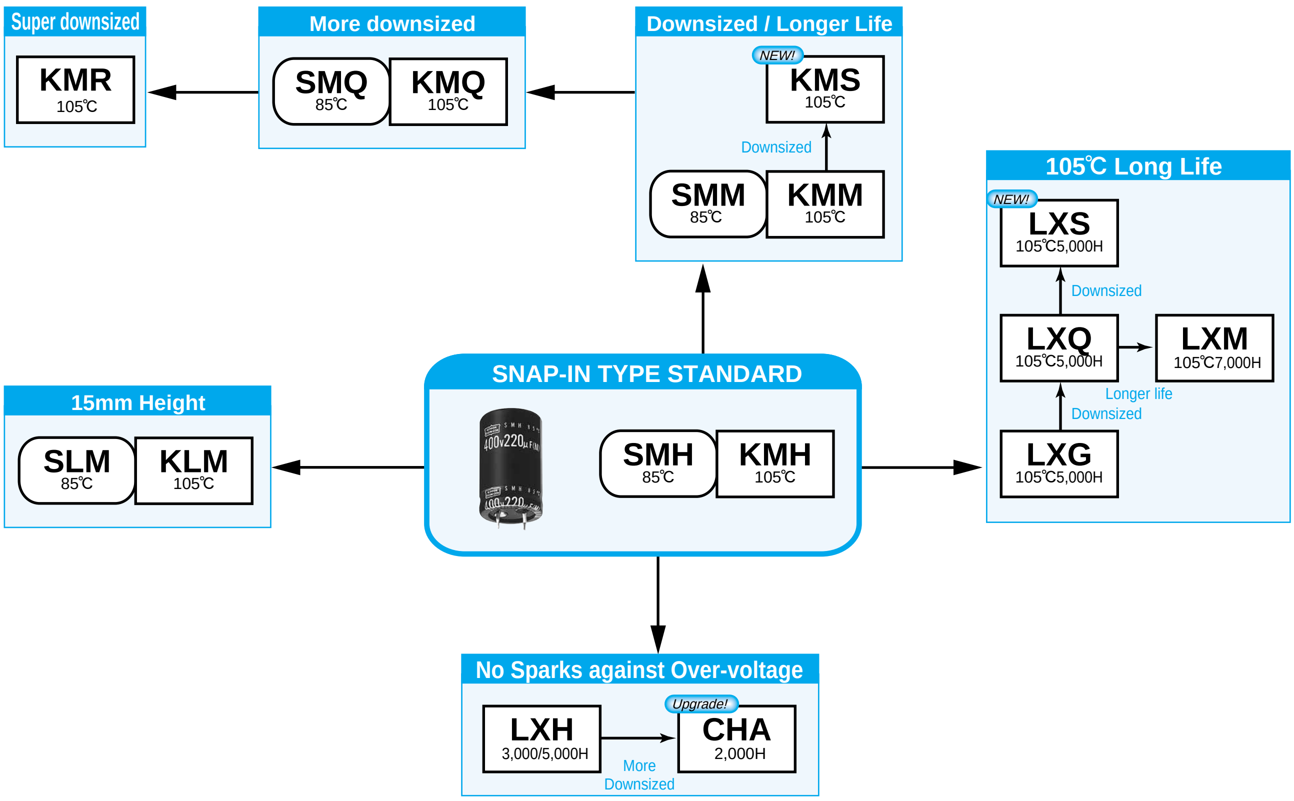
**For Airbag**
- LBG

# GROUP CHART

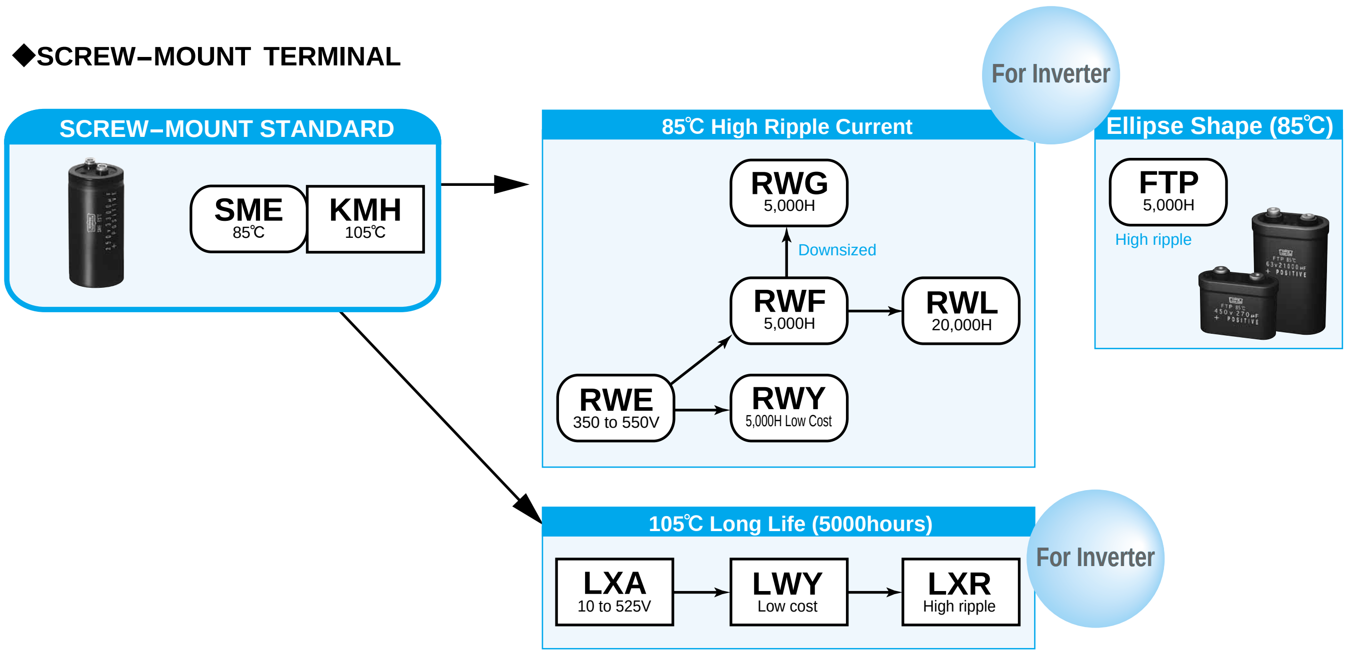
Previous page

## ALUMINUM ELECTROLYTIC CAPACITORS

### ◆SNAP-IN




### ◆SCREW–MOUNT TERMINAL



# PART NUMBERING SYSTEM

## Global code system

**The current part numbering system has been changed to a new system for global coding.**
**We assigned an environment friendly specification to applicable standard products.**

### ●Categories

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

| Code | Details |
|---|---|
| **A** | Conductive Polymer Aluminum Solid Capacitors (Polar) |
| **E** | Aluminum Electrolytic Capacitors (Polar) |
| **B** | Aluminum Electrolytic Capacitors (Bi-polar) |
| **K** | Multilayer Ceramic Capacitors |
| **F,W** | Film Capacitors |
| **D** | Electric Double Layer Capacitors |
| **T** | Metal Oxide Varistors |
| **L** | Amorphous Choke Coils |

* For digits 2 to 18, please see "Product code guide".

### ●Example

| Product type | Global code (Example) | Conventional part number (Ref.) |
|---|---|---|
| **Surface mount type** | EMV-160ADA100MD55G | MV16VC10MD55E0 |
| **Radial lead type** | ESMG6R3ETC102MHB5D | TC04RSMG6. 3VB1000MF50E0 |
| **Snap-in type** | ESMQ201VSN471MP30S | SMQ200VSSN470M22BE0 |
| **Screw mount terminal type** | ERWE551LGC821MCD0M | RWE550LGSN820MCC13EA |

NIPPON CHEMI-CON

# ENVIRONMENTAL CONSIDERATION

## Environment friendly capacitors

Nippon Chemi-Con always considers the environment in product materials, designs and manufacturing. In fact, our factories already have received ISO 14000 certificate. Cadmium, Mercury, Hexavalent Chromium, PBB and PBDE have never been used in our products. Furthermore, since 2004, lead-containing materials have been eliminated from all our aluminum electrolytic capacitors including Conductive Polymer Aluminum Solid Capacitors to comply with RoHS.

### ◆Lead free and Non-PVC Products

**1. Lead wire (Plating)**

| Category | | Plating material on lead wires | |
|---|---|---|---|
| | | **Original type** | **Lead-free type** |
| **Chip** | **case code : B55 to JA0** | Sn-Pb | Sn-Bi |
| | **case code : KE0 to MN0** | | Sn100% |
| **Radial** | **case dia : ～ϕ8** | | Sn-Bi |
| | **case dia : ϕ10～** | | Sn100% |
| **Snap-in** | | | Sn100% |
| **Screw-Mount** | | Originally lead free | Originally lead free |

*Please consult with us when you need "Lead-free parts" other than the above mentioned terminal plating materials.
(Note) **Pb** : lead, **Sn** : Tin, **Bi** : Bismuth

**2. Sleeve**

| Category | | Sleeve material | |
|---|---|---|---|
| | | **Original type** | **Lead-free type** |
| **Chip** | | Sleeveless(Resin case) | Sleeveless(Resin case) |
| **Radial** | **ϕ8X5L** | Sleeveless(Coating case) | Sleeveless(Coating case) |
| | **except ϕ8X5L** | PVC | PET |
| **Snap-in** | | PVC | PET |
| **Screw-Mount** | | PVC | PVC(Lead-free) |

* Please consult with us when you need "Non-PVC parts" other than the above mentioned outer sleeve materials.

The colors of a PET sleeve are "Black", "Brown", and "Dark blue".
Standard designs of "lead-free" Snap-in type are not equipped with a top disk.
Please consult with us when you need nonflammable grade for outer sleeve material.

Identification of friendly parts is given by a supplement code (18th digit) of the global code.
For details, please refer to "Product code guide" for each type.

NIPPON CHEMI-CON

# PACKAGING

## TAPING SPECIFICATIONS

### SURFACE MOUNT TYPE (TAPING)

### ◆CARRIER TAPE [mm]

Fig.1

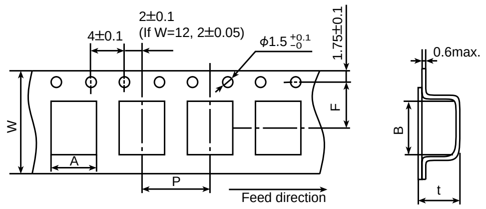



Fig.2

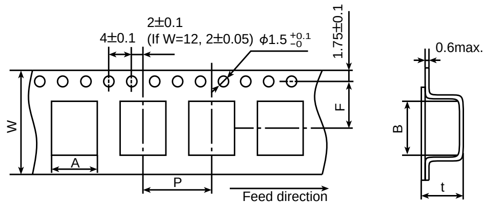



Fig.3

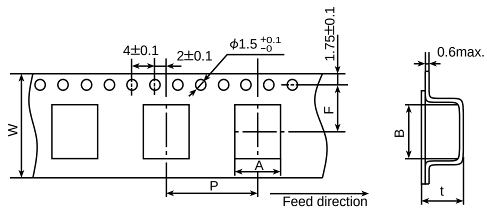
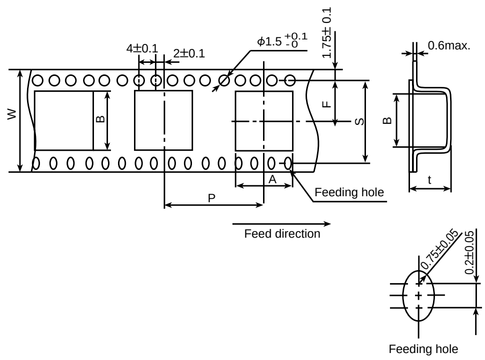



Fig.4




[mm]

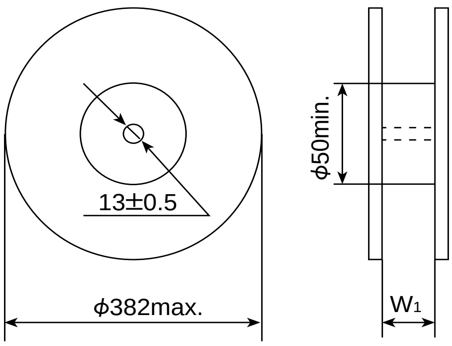
| Series | | W ±0.3 | A ±0.2 | B ±0.2 | F ±0.1 | P ±0.1 | t ±0.2 | S ±0.1 | Fig. |
|---|---|---|---|---|---|---|---|---|---|
| Alchip™ MVS/MVA MV/MVE MVK/MKA MZA/MVY MZD/MLA MVJ/MLD MVL/MVH MKB/MV-BP MVK-BP NPCAP™ PXF/PXE PXA/PXH | B55 | 12.0 | 3.5 | 3.5 | 5.5 | 8.0 | 5.9 | — | 1 |
| | D46 | 12.0 | 4.7 | 4.7 | 5.5 | 8.0 | 4.9 | — | 1 |
| | D55 | 12.0 | 4.7 | 4.7 | 5.5 | 8.0 | 5.7 | — | 1 |
| | D60,D61 | 12.0 | 4.7 | 4.7 | 5.5 | 8.0 | 6.3 | — | 1 |
| | D73 | 12.0 | 4.7 | 4.7 | 5.5 | 8.0 | 7.5 | — | 1 |
| | E46 | 12.0 | 5.7 | 5.7 | 5.5 | 12.0 | 4.9 | — | 2 |
| | E55 | 12.0 | 5.7 | 5.7 | 5.5 | 12.0 | 5.7 | — | 2 |
| | E60,E61 | 12.0 | 5.7 | 5.7 | 5.5 | 12.0 | 6.3 | — | 2 |
| | E73 | 16.0 | 5.7 | 5.7 | 7.5 | 12.0 | 7.5 | — | 2 |
| | F45 | 16.0 | 7.0 | 7.0 | 7.5 | 12.0 | 4.8 | — | 2 |
| | F46 | 16.0 | 7.0 | 7.0 | 7.5 | 12.0 | 4.9 | — | 2 |
| | F55 | 16.0 | 7.0 | 7.0 | 7.5 | 12.0 | 5.7 | — | 2 |
| | F60,F61 | 16.0 | 7.0 | 7.0 | 7.5 | 12.0 | 6.3 | — | 2 |
| | F73 | 16.0 | 7.0 | 7.0 | 7.5 | 12.0 | 7.5 | — | 2 |
| | F80 | 16.0 | 7.0 | 7.0 | 7.5 | 12.0 | 8.2 | — | 2 |
| | F90 | 16.0 | 7.0 | 7.0 | 7.5 | 12.0 | 9.2 | — | 2 |
| | H63 | 16.0 | 8.7 | 8.7 | 7.5 | 12.0 | 6.8 | — | 2 |
| | H70 | 24.0 | 8.7 | 8.7 | 11.5 | 12.0 | 7.3 | — | 2 |
| | H80 | 24.0 | 8.7 | 8.7 | 11.5 | 12.0 | 8.3 | — | 2 |
| | HA0 | 24.0 | 8.7 | 8.7 | 11.5 | 16.0 | 11.0 | — | 3 |
| | HC0 | 24.0 | 8.7 | 8.7 | 11.5 | 16.0 | 12.8 | — | 3 |
| | J80 | 24.0 | 10.7 | 10.7 | 11.5 | 16.0 | 8.3 | — | 3 |
| | JA0 | 24.0 | 10.7 | 10.7 | 11.5 | 16.0 | 11.0 | — | 3 |
| | JC0 | 24.0 | 10.7 | 10.7 | 11.5 | 16.0 | 12.8 | — | 3 |
| | KE0 | 32.0 | 13.4 | 13.4 | 14.2 | 24.0 | 14.0 | 28.4 | 4 |
| | KG5 | 32.0 | 13.4 | 13.4 | 14.2 | 24.0 | 16.5 | 28.4 | 4 |
| | LH0 | 44.0 | 17.5 | 17.5 | 20.2 | 28.0 | 16.8 | 40.4 | 4 |
| | LN0 | 44.0 | 17.5 | 17.5 | 20.2 | 28.0 | 22.1 | 40.4 | 4 |
| | MH0 | 44.0 | 19.5 | 19.5 | 20.2 | 32.0 | 17.1 | 40.4 | 4 |
| | MN0 | 44.0 | 19.5 | 19.5 | 20.2 | 32.0 | 22.1 | 40.4 | 4 |

* Regarding to taping for LH0/LN0/MH0/MN0, please consult with us.

NIPPON CHEMI-CON

# PACKAGING

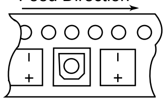
## ◆REEL DIMENSIONS [mm]




## ◆POLARITY

Alchip™- (Vertical) MVS/MVA/MV
MVE/MVK/MKA
MZA/MVY/MZD
MLA/MVJ/MLD
MVL/MVH/MKB
MV-BP/MVK-BP

NP CAP™ PXF/PXE/PXA/PXH

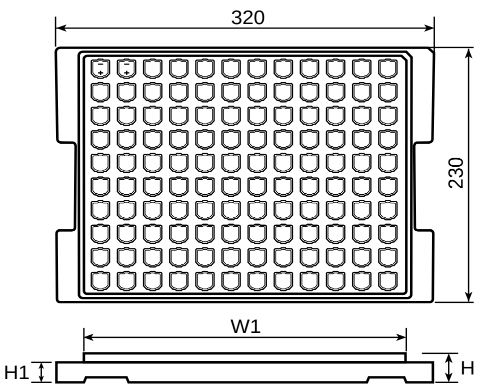



## ◆QUANTITY PER REEL/BOX

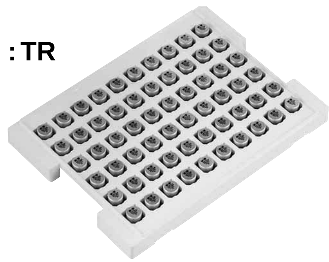
| Series | Size code | Quantity (pcs/reel) | Quantity (pcs/box) | $W_1$ (mm) |
|---|---|---|---|---|
| Alchip™ MVS/MVA MV/MVE MVK/MKA MZA/MVY MZD/MLA MVJ/MLD MVL/MVH MKB/MV-BP MVK-BP | B55 | 2,000 | 10,000 | 14 |
| | D46,D55,D60,D61 | 2,000 | 10,000 | 14 |
| | D73 | 1,500 | 7,500 | 14 |
| | E46,E55,E60,E61 | 1,000 | 5,000 | 14 |
| | E73 | 1,000 | 5,000 | 18 |
| | F46,F55,F60,F61,F73 | 1,000 | 5,000 | 18 |
| | F80 | 900 | 4,500 | 18 |
| | F90 | 800 | 4,000 | 18 |
| | H63 | 1,000 | 5,000 | 18 |
| | HA0 | 500 | 1,500 | 26 |
| | JA0 | 500 | 1,500 | 26 |
| | KE0 | 200 | 600 | 34 |
| | KG5 | 150 | 450 | 34 |
| | LH0 | 125 | 250 | 46 |
| | LN0 | 75 | 150 | 46 |
| | MH0 | 125 | 250 | 46 |
| | MN0 | 75 | 150 | 46 |
| NPCAP™ PXF/PXE PXA/PXH | D55 | 2,000 | 20,000 | 14 |
| | E60,E61 | 1,000 | 10,000 | 14 |
| | F45,F55,F60,F61 | 1,000 | 7,000 | 18 |
| | F80 | 900 | 6,300 | 18 |
| | H70 | 1,000 | 6,000 | 26 |
| | H80 | 900 | 5,400 | 26 |
| | HA0 | 500 | 3,000 | 26 |
| | HC0 | 400 | 1,200 | 26 |
| | J80 | 500 | 3,000 | 26 |
| | JA0 | 500 | 3,000 | 26 |
| | JC0 | 400 | 1,200 | 26 |

# SURFACE MOUNT TYPE (TRAY)

## ◆DIMENSIONS [mm]




●TRAY CODE : TR

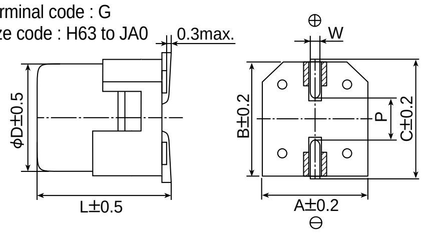


| Size code | H [mm] | W1 [mm] | H1 [mm] | Quantity [pcs/tray] | Quantity [pcs/box] |
|---|---|---|---|---|---|
| KE0 & KG5 | 21.0 | 284 | 18.5 | 120 | 600 |
| LH0 & LN0 | 28.0 | 284 | 24.0 | 80 | 400 |
| MH0 & MN0 | 28.0 | 284 | 24.0 | 60 | 300 |

# VIBRATION RESISTANT STRUCTURE (Terminal code : G)

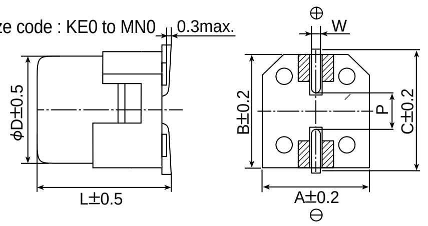
## ◆DIMENSIONS [mm]

●Terminal code : G
●Size code : H63 to JA0



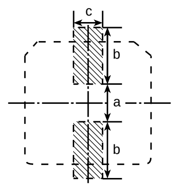

▨ : Dummy terminals

●Size code : KE0 to MN0




▨ : Dummy terminals

## ◆RECOMMENDED SOLDER LAND




▧ Solder land on PC board

| Size code | Dimensions of products (mm) | | | | | | | | | Solder land (mm) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | D | L | A | B | C | W | P | (a) | (b) | a | b | c |
| H63 | 8.0 | 6.0 | 8.3 | 8.3 | 9.0 | 0.5 to 0.8 | 2.3 | (0.4) | (1.5) | 2.3 | 4.5 | 2.5 |
| HA0 | 8.0 | 10.0 | 8.3 | 8.3 | 9.0 | 0.7 to 1.1 | 3.1 | (0.5) | (1.8) | 3.1 | 4.2 | 3.5 |
| JA0 | 10.0 | 10.0 | 10.3 | 10.3 | 11.0 | 0.7 to 1.1 | 4.5 | (0.5) | (2.1) | 4.5 | 4.4 | 3.5 |
| KE0 | 12.5 | 13.5 | 13.0 | 13.0 | 13.7 | 1.0 to 1.3 | 4.2 | (1.3) | (3.0) | 3.4 | 6.3 | 9.3 |
| KG5 | 12.5 | 16.0 | 13.0 | 13.0 | 13.7 | 1.0 to 1.3 | 4.2 | (1.3) | (3.0) | 3.4 | 6.3 | 9.3 |
| LH0 | 16.0 | 16.5 | 17.0 | 17.0 | 18.0 | 1.0 to 1.3 | 6.5 | (2.0) | (3.0) | 4.7 | 7.8 | 9.6 |
| LN0 | 16.0 | 21.5 | 17.0 | 17.0 | 18.0 | 1.0 to 1.3 | 6.5 | (2.0) | (3.0) | 4.7 | 7.8 | 9.6 |
| MH0 | 18.0 | 16.5 | 19.0 | 19.0 | 20.0 | 1.0 to 1.3 | 6.5 | (2.0) | (4.0) | 4.7 | 8.8 | 9.6 |
| MN0 | 18.0 | 21.5 | 19.0 | 19.0 | 20.0 | 1.0 to 1.3 | 6.5 | (2.0) | (4.0) | 4.7 | 8.8 | 9.6 |

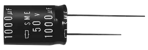
( ); Ref.

NIPPON CHEMI-CON

# PACKAGING

## TAPING SPECIFICATIONS

### RADIAL LEAD TYPE (TAPING)



### ◆DIMENSION [mm]

**Fig.1**
Taping Code : TA, TC
ϕD=ϕ4 to 8

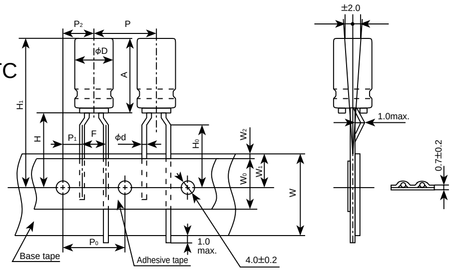



**Fig.2**
Taping Code : TD
ϕD=ϕ5
ϕD×L=ϕ4×7

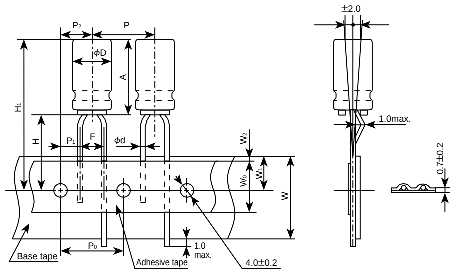



**Fig.3**
Taping Code : TD
ϕD=ϕ6.3 to 12.5

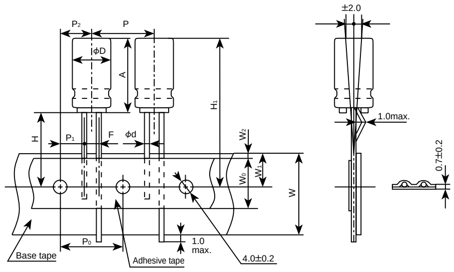
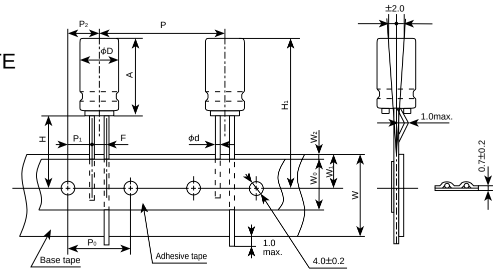



**Fig.4**
Taping Code : TE
ϕD=ϕ12.5




| Code | Taping Code | Case size ϕD | Case size A | ϕd | P | $P_0$ | $P_1$ | $P_2$ | F | W | $W_0$ | $W_1$ | $W_2$ | H | $H_0$ | $H_1$ | Fig. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tol. | | — | — | ±0.05 | ±1.0 | ±0.2 | ±0.7 | ±1.0 | +0.8 −0.2 | ±0.5 | min. | ±0.5 | max. | ±0.75 | ±0.5 | | |
| Nominal | TA | 4 | 5 | 0.45 | 12.7 | 12.7 | 5.1 | 6.35 | 2.5 | 18.0 | 6.0 | 9.0 | 1.5 | 18.5 | 16.0 | H1=H+A Check insertion machine specs. | 1 |
| | TC | 4 | 5 | 0.45 | 12.7 | 12.7 | 3.85 | 6.35 | 5 | 18.0 | 6.0 | 9.0 | 1.5 | 17.5 | 16.0 | | 1 |
| | TD | 4 | 7 | 0.45 | 12.7 | 12.7 | 5.1 | 6.35 | 2.5 | 18.0 | 6.0 | 9.0 | 1.5 | 18.5 *1 | 16.0 | | 2 |
| | TC | 4 | 7 | 0.45 | 12.7 | 12.7 | 3.85 | 6.35 | 5 | 18.0 | 6.0 | 9.0 | 1.5 | 17.5 | 16.0 | | 1 |
| | TD | 4 | 11.5 | 0.45 | 12.7 | 12.7 | 5.1 | 6.35 | 2.5 | 18.0 | 10.0 | 9.0 | 1.5 | 17.5 | 16.0 | | 1 |
| | TC | 4 | 11.5 | 0.45 | 12.7 | 12.7 | 3.85 | 6.35 | 5 | 18.0 | 10.0 | 9.0 | 1.5 | 17.5 | 16.0 | | 1 |
| | TD | 5 | 5 to 7 | 0.45 | 12.7 | 12.7 | 5.1 | 6.35 | 2.5 | 18.0 | 6.0 | 9.0 | 1.5 | 18.5 | — | | 2 |
| | TC | 5 | 5 to 7 | 0.45 | 12.7 | 12.7 | 3.85 | 6.35 | 5 | 18.0 | 6.0 | 9.0 | 1.5 | 17.5 | 16.0 | | 1 |
| | TD | 5 | 9 to 15 | 0.5 | 12.7 | 12.7 | 5.1 | 6.35 | 2.5 | 18.0 | 10.0 | 9.0 | 1.5 | 18.5 | — | | 2 |
| | TC | 5 | 9 to 15 | 0.5 | 12.7 | 12.7 | 3.85 | 6.35 | 5 | 18.0 | 10.0 | 9.0 | 1.5 | 18.5 | 16.0 | | 1 |
| | TD | 6.3 | 5 to 7 | 0.45 | 12.7 | 12.7 | 5.1 | 6.35 | 2.5 | 18.0 | 6.0 | 9.0 | 1.5 | 18.5 | — | | 3 |
| | TC | 6.3 | 5 to 7 | 0.45 | 12.7 | 12.7 | 3.85 | 6.35 | 5 | 18.0 | 6.0 | 9.0 | 1.5 | 17.5 | 16.0 | | 1 |
| | TD | 6.3 | 9 to 15 | 0.5 | 12.7 | 12.7 | 5.1 | 6.35 | 2.5 | 18.0 | 10.0 | 9.0 | 1.5 | 18.5 | — | | 3 |
| | TC | 6.3 | 9 to 15 | 0.5 | 12.7 | 12.7 | 3.85 | 6.35 | 5 | 18.0 | 10.0 | 9.0 | 1.5 | 18.5 | 16.0 | | 1 |
| | TD | 8 | 5 | 0.45 | 12.7 | 12.7 | 5.1 | 6.35 | 2.5 | 18.0 | 6.0 | 9.0 | 1.5 | 18.5 | — | | 3 |
| | TC | 8 | 5 | 0.45 | 12.7 | 12.7 | 3.85 | 6.35 | 5 | 18.0 | 6.0 | 9.0 | 1.5 | 17.5 | 16.0 | | 1 |
| | TC | 8 | 7 | 0.45 | 12.7 | 12.7 | 3.85 | 6.35 | 5 | 18.0 | 6.0 | 9.0 | 1.5 | 17.5 | 16.0 | | 1 |
| | TD | 8 | 9 to 20 | 0.6 | 12.7 | 12.7 | 3.85 | 6.35 | 3.5 | 18.0 | 10.0 | 9.0 | 1.5 | 20.0 | — | | 1 |
| | TC | 8 | 9 to 20 | 0.6 | 12.7 | 12.7 | 3.85 | 6.35 | 5 | 18.0 | 10.0 | 9.0 | 1.5 | 20.0 | 16.0 | | 1 |
| tol. | | ±0.5 | max. | ±0.05 | ±1.0 | ±0.3 | ±0.7 | ±1.3 | +0.8 −0.2 | ±0.5 | min. | ±0.5 | max. | +2.0 −0 | — | | |
| Nominal | TD | 10 | 21 | 0.6 | 12.7 | 12.7 | 3.85 | 6.35 | 5 | 18.0 | 12.5 | 9.0 | 1.5 | 18.0 | — | | 3 |
| | TD | 12.5 | 26 | 0.6 | *2 15 | 15 | 5.0 | 7.5 | 5 | 18.0 | 12.5 | 9.0 | 1.5 | 18.0 | — | | 3 |
| | TE | 12.5 | 26 | 0.6 | 25.4 | 12.7 | 3.85 | 6.35 | 5 | 18.0 | 12.5 | 9.0 | 1.5 | 18.0 | — | | 4 |

* 1 : For ϕ4×7 (A=7, F=25), shall be $18.5^{-0.5/+0.75}$ (Taping code : TD) at Fig.2.

* 2 : P=15 taping is not standard. Use P=25.4 taping.

## TAPING CODE

### Example

1 E | 2 3 4 SMG | 5 6 7 500 | 8 E | 9 10 TC | 11 12 13 100 | 14 M | 15 16 17 E11 | 18 D

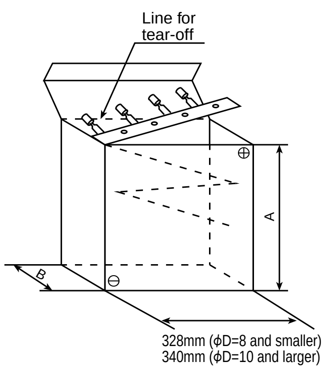
- 18 (D): Supplement code
- 15–17 (E11): Size code
- 14 (M): Capacitance tolerance code
- 11–13 (100): Nominal capacitance code
- 9–10 (TC): Lead forming code (Radial lead type)

| Type | Contents | Code 9th | Code 10th |
|---|---|---|---|
| Taping (Radial lead) | Straight | T | D |
| | Sloping clinch | T | D |
| | Straight(Skip a hole) | T | E |
| | Clinch(F=2.5mm) | T | A |
| | Clinch(F=3.5mm) | T | B |
| | Clinch(F=5.0mm) | T | C |

- 8 (E): Terminal code
- 5–7 (500): Rated voltage code
- 2–4 (SMG): Series code
- 1 (E): Category

## QUANTITY PER AMMO PACK

### Ammo pack box




### Typical example

| Case size ϕD×L(mm) | | A (mm) | B (mm) | Quantity (pcs.) |
|---|---|---|---|---|
| ϕ4 | L=5 & 7mm | 183 | 42 | 2,000 |
| | L=11.5mm | 183 | 51 | |
| ϕ5 | L=5 & 7mm | 232 | 42 | 2,000 |
| | L=9 to 15mm | 232 | 51 | |
| | L=17mm | 235 | 53 | |
| ϕ6.3 | L=5 & 7mm | 282 | 42 | 2,000 |
| | L=9 to 15mm | 284 | 51 | |
| | L=17mm | 284 | 55 | |
| ϕ8 | L=5 & 7mm | 232 | 42 | 1,000 |
| | L=9 to 15mm | 232 | 51 | |
| | L=17 & 20mm | 235 | 53 | |
| ϕ10 | L=≦16mm | 308 | 56 | 800(500)* |
| | L=17 to 20mm | 308 | 62 | 800 |
| | L=21 to 25mm | 308 | 67 | 800 |
| | L=26 to 30mm | 308 | 71 | 500 |
| ϕ12.5 | L=≦16mm | 308 | 62 | 500 |
| | L=17 to 25mm | 308 | 67 | 500 |

*Minimum order quantity for PSC/PSA/PS series

# PACKAGING

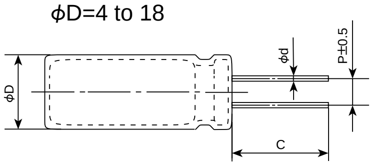
## RADIAL LEAD TYPE (CUT/FORMED LEAD)

**The following lead configurations are available. When ordering, please indicate the type of lead configurations by using the appropriate supplement code, such as C5, FC, MC or RC in the product part number.**

[mm]

### ●Lead code : C5

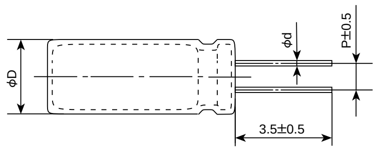
ϕD=4 to 18




| Case diameter | C:Lead length |
|---|---|
| ϕD=4 to 8 | : 5.0±0.5 |
| ϕD=10 to 18 | : $5.0^{+1.0}_{-0}$ |

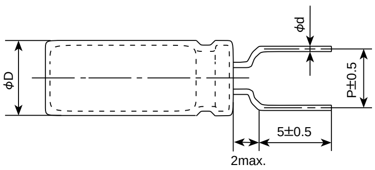
### ●Lead code : C3

ϕD=4 to 18



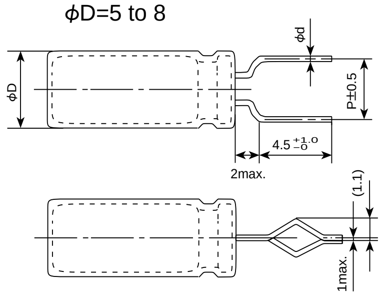

### ●Lead code : FC

ϕD=5 to 8



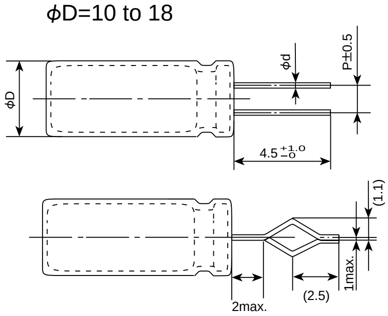

### ●Lead code : FM

ϕD=5 to 8



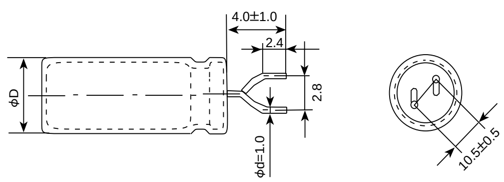

### ●Lead code : MC

ϕD=10 to 18




### ●Lead code : RC

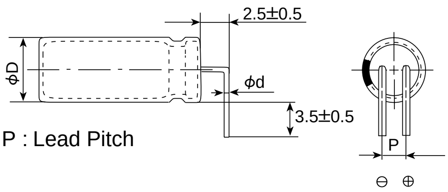
ϕD=20 & 22




### ●Lead code : BC

ϕD=10, 12.5 : P=5.0±0.5

ϕD=14.5, 16, 18 : P=7.5±0.5




P : Lead Pitch

# PACKAGING

## MINIMUM ORDER QUANTITY

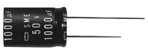
**Please order by minimum order quantity.**

### ◆SURFACE MOUNT

**●Vertical**

| Series | Size code | Quantity (pcs) | |
|---|---|---|---|
| | | Taping | Tray (pcs/box) |
| Alchip™<br>MVS/MVA/MV<br>MVE/MVK/MKA<br>MZA/MVY/MZD<br>MLA/MVJ/MLD<br>MVL/MVH/MKB<br>MV-BP/MVK-BP<br><br>NPCAP™<br>PXF/PXE/PXA<br>PXH | B55 | 2,000 | – |
| | D46, D55, D60, D61 | 2,000 | – |
| | D73 | 1,500 | – |
| | E46, E55, E60, E61, E73 | 1,000 | – |
| | F45, F46, F55, F60, F61, F73 | 1,000 | – |
| | F80, H80 | 900 | – |
| | F90 | 800 | – |
| | H63, H70 | 1,000 | – |
| | HA0 | 500 | – |
| | HC0 | 400 | – |
| | J80, JA0 | 500 | – |
| | JC0 | 400 | – |
| | KE0 | 200 | 600 |
| | KG5 | 150 | 600 |
| | LH0 | 125 | 400 |
| | LN0 | 75 | 400 |
| | MH0 | 125 | 300 |
| | MN0 | 75 | 300 |

### ◆RADIAL



| Size | | Quantity (pcs) | |
|---|---|---|---|
| | | Bagged*1 | Taping |
| ϕ4 | | 200 | 2,000 |
| ϕ5 | | 200 | 2,000 |
| ϕ6.3 | | 200 (200)*2 | 2,000 (2,000)*2 |
| ϕ8 | | 200 (100)*2 | 1,000 (1,000)*2 |
| ϕ10 | Height≦25mm | 200 (100)*2 | 800 (500)*2 |
| | Height≧30mm | 200 | 500 |
| ϕ12.5 | | 100 | 500 |
| ϕ14.5 | | 50 | 250 |
| ϕ16 | | 50 | 250 |
| ϕ18 | | 50 | 250 |

*1 Standard bagged quantity.
*2 Minimum order quantity for PSC/PSA/ PS series.

### ◆SNAP-IN

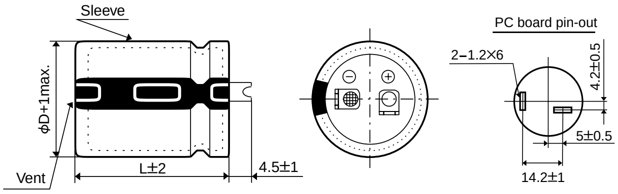
200 pieces

NIPPON CHEMI-CON **ALUMINUM ELECTROLYTIC CAPACITORS** AVAILABLE TERMINAL FOR SNAP-IN TYPE

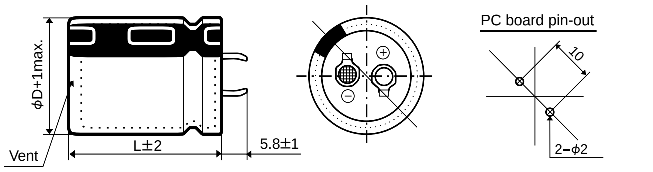
# AVAILABLE TERMINALS FOR SNAP-IN TYPE [mm]

The following terminal options can be selected.
Please consult with us before purchase.

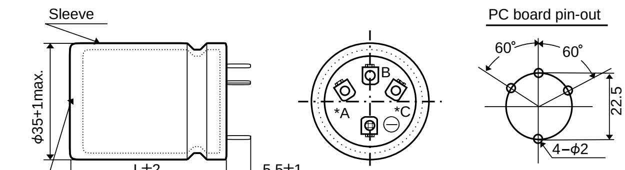
**D=ϕ30 to ϕ40mm** **Terminal Code : LIN**




**D=ϕ22 to ϕ35mm** **Terminal Code·Dummy Terminal Code : VNN**

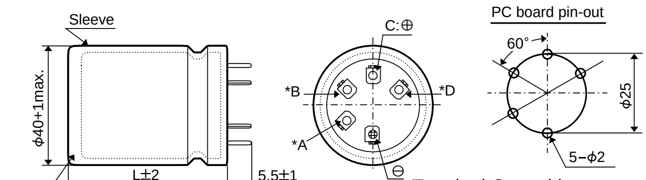



**D=ϕ35 & ϕ40mm** **Terminal Code·Dummy Terminal Code : VRD**

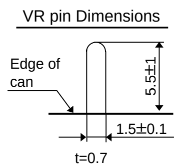



Terminal B=positive
Terminal A & C=blank

**D=ϕ40mm** **Terminal Code·Dummy Terminal Code : VRT**



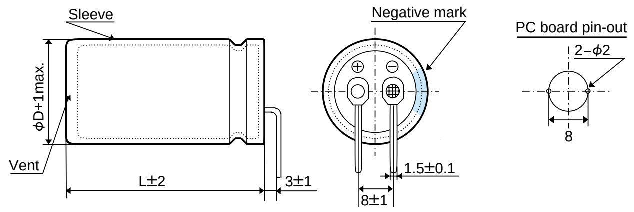

Terminal C=positive
Terminal A, B & D=blank




**CAUTION**

* Use the blank terminals for mechanical support only.
The blank terminals must not be connected to any copper trace on PC board.
Be sure to electrically isolate from the negative and the positive terminals.

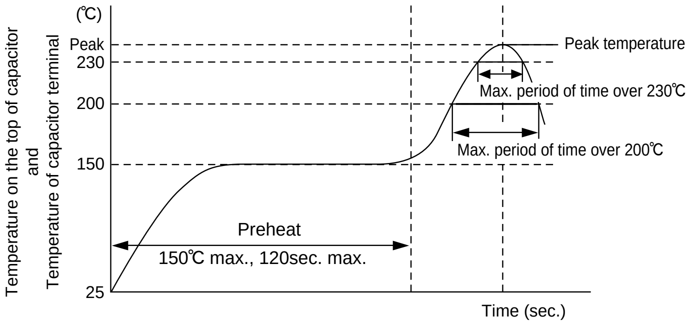
**D=ϕ20X30 to ϕ50 ℓ mm, ϕ22X30 to ϕ50 ℓ mm** **Terminal Code·Dummy Terminal Code : LCN**



# RECOMMENDED REFLOW SOLDERING CONDITIONS

## NPCAP™-PXF/PXE/PXA/PXH Series

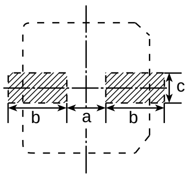
The following conditions are recommended for air or infrared reflow soldering PXF/PXE/PXA/PXH series onto a glass epoxy circuit board of 90×50×0.8mm (with resist) by cream solder. The temperatures shown are the surface temperature values on the top of the can and temperature of capacitor terminal.




| Series | Peak temp. | Max.Period of time over 230℃ | Max.Period of time over 200℃ | Remarks |
|---|---|---|---|---|
| PXF<br>PXE<br>PXA<br>PXH | 250℃<br>(240℃) | 40sec<br>(30sec) | 60sec<br>(50sec) | The times of reflow soldering : once |
| | 250℃<br>(240℃) | 30sec | 50sec | The times of reflow soldering : twice |

(　　) : Applies for 20V 82μF(J80) and 25V 39μF(J80)

### ●Recommended Solder Land on PC Board




Solder land on PC board

| Size code | a | b | c |
|---|---|---|---|
| D55 | 1.0 | 2.6 | 1.6 |
| E60,E61 | 1.4 | 3.0 | 1.6 |
| F45, F55, F60 F61, F80 | 1.9 | 3.5 | 1.6 |
| H70, H80, HA0, HC0 | 3.1 | 4.2 | 2.2 |
| J80, JA0, JC0 | 4.5 | 4.4 | 2.2 |

## ◆PRECAUTIONS FOR USERS

### Soldering method
The capacitors of NPCAP™-PXF/PXE/PXA/PXH series have no capability to withstand such dip or wave soldering as totally immersing components into a solder bath.

### Reflow soldering
Reflow the capacitors within Recommended Reflow Soldering Conditions. Verify there is no temperature stress to the capacitors because the following differences might degrade capacitors electrically and mechanically. Please consult with us if other reflow conditions are employed.

1.Location of components : Temperature increases at the edge of PC board more than the center.
2.Population of PC board : The lower the component population is, the more temperature rises.
3.Material of PC board : A ceramic-made board needs more heat than a glass epoxy-made board. The heat increase may cause damage to the capacitors.
4.Thickness of PC board : A thicker board needs more heat than a thinner board. The heat may damage the capacitors.
5.Size of PC board : A larger board needs more heat than a smaller board. The heat may damage the capacitors.
6.Solder thickness
If very thin cream solder paste is to be used for SMD types, please consult with us.
7.Location of infrared ray lamps : IR reflow as well as hot plate reflow heats only on the reverse side of the PC board to lessen heat stress to the capacitors.

### Rework of soldering
Use a soldering iron for rework. Do not exceed an iron tip temperature of 380±10℃ and an exposure time of 3±0.5 seconds.

### Mechanical stress
Do not grab the capacitors to lift the PC board and give stress to the capacitor. Avoid bending the PC board. This may damage the capacitors.

### Cleaning assembly board
Immediately after solvent cleaning, remove residual solvent with an air knife for at least 10 minutes. If the solvent is insufficiently dry, the capacitors may corrode.

### Coating on assembly board
1.Before curing coating material, remove the cleaning solvents from the assembly board.
2.Before conformal coating, a chloride free pre-coat material is recommended to decrease the stress on the capacitors.

### Molding with resin
Internal chemical reaction gradually produces gas in the capacitor; increasing internal pressure. If the end seal of the capacitor is completely coverd by resin the gas will be unable to escape causing a potentially dangerous situation. The chlorine in resin will penetrate the end seal, reach the element, and damage of the capacitor.

### Glue
The followings are requirements for glue.
1.A low curing temperature over a short period of time
2.Strong adhension and heat resistance after curing
3.Long shelf life
4.No corrosion

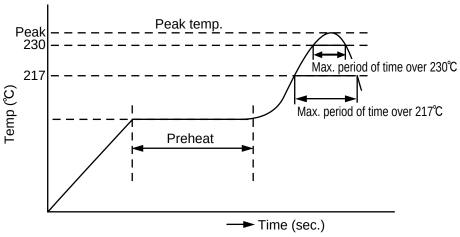
### Others
Refer to Precautions for Users of Aluminum Electrolytic Capacitors.

# RECOMMENDED REFLOW SOLDERING CONDITIONS

## Alchip™-MVS/MVA/MV/MVE/MVK/MKA/MZA/MVY/MZD/MLA/MVJ/MLD/MVL/MVH/MKB/MV-BP/MVK-BP

The following conditions are recommended for air convection and infrared reflow soldering on the SMD products on to a glass epoxy circuit boards by cream solder. The dimensions of the glass epoxy boards with resist are 90×50×0.8mm for B55 to KG5 case code SMD capacitors and 180×90×0.8mm for LH0 to MN0 case codes SMD capacitors.
The temperatures shown are the surface temperature values on the top of the can and on the capacitor terminals.
Reflow should be performed twice or less.
Please ensure that the capacitor became cold enough to the room temperature (5 to 35℃) before the second reflow.
Consult with us when performing reflow profile in IPC / JEDEC (J-STD-020)

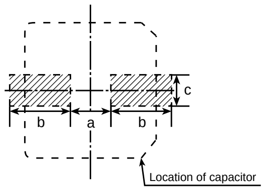
●Recommended soldering heat conditions (Except for Conductive Polymer Aluminum Solid Capacitors)




<table>
<tr><th colspan="3">Contents</th><th colspan="5">Lead-free type (high heat durability design)</th><th colspan="3">Original type</th></tr>
<tr><th rowspan="2">SMD type</th><th rowspan="2">Case code</th><th rowspan="2">Voltage range</th><th colspan="5">Use Supplement Code "G" for case code B55 to JA0, and "S" for case code KE0 to MN0</th><th colspan="3">Supplement Code "N"</th></tr>
<tr><th>Preheat</th><th>Time maintained above 217℃</th><th>Time maintained above 230℃</th><th>Peak temp.</th><th>Reflow number</th><th>Preheat</th><th>Time maintained above 200℃</th><th>Peak temp.</th></tr>
<tr><td rowspan="7">Vertical</td><td rowspan="2">B55 to F90</td><td>4 to 50V</td><td rowspan="7">150 to 180℃ 120sec. max.</td><td>90sec. max</td><td>60sec. max.</td><td>260℃max.</td><td>2 times or less</td><td rowspan="7">150℃max. 120sec. max.</td><td rowspan="7">20sec. max.</td><td>240℃max.</td></tr>
<tr><td>63 to 80V</td><td>60sec. max.</td><td>40sec. max.</td><td>250℃max.</td><td>2 times or less</td><td>—</td></tr>
<tr><td rowspan="2">H63 to JA0</td><td>4 to 50V</td><td>60sec. max.</td><td>30sec. max.</td><td>245℃max.</td><td>2 times or less</td><td>230℃max.</td></tr>
<tr><td>63 to 100V</td><td>30sec. max.</td><td>20sec. max.</td><td>240℃max.</td><td>2 times or less</td><td>230/ 240℃max.</td></tr>
<tr><td rowspan="2">KE0 to MN0</td><td>to 50V</td><td>30sec. max.</td><td>20sec. max.</td><td>240℃max.</td><td>2 times or less</td><td rowspan="2">230℃max.</td></tr>
<tr><td>63V and more</td><td>20sec.</td><td>—</td><td>230℃max.</td><td>2 times or less</td></tr>
<tr><td>D46, E46, F46</td><td>4 to 50V</td><td>40sec. max.</td><td>30sec. max.</td><td>250℃max.</td><td>2 times or less</td><td>—</td></tr>
</table>

●Recommended Solder Land on PC Board

Series : MVS/MVA/MV/MVE/MVK/MKA/MZA/MVY/MZD/
MLA/MVJ/MLD/MVL/MVH/MKB/MV-BP/MVK-BP




▨ : Solder land on PC board

| Case code | Terminal code : A | | | Terminal code : G | | |
|---|---|---|---|---|---|---|
| | a | b | c | a | b | c |
| **B55** | 0.8 | 2.2 | 1.6 | | | |
| **D46, D55, D60, D61, D73** | 1.0 | 2.6 | 1.6 | | | |
| **E46, E55, E60, E61, E73** | 1.4 | 3.0 | 1.6 | | | |
| **F46, F55, F60, F61, F73, F80, F90** | 1.9 | 3.5 | 1.6 | | | |
| **H63** | 2.3 | 4.5 | 1.6 | 2.3 | 4.5 | 2.5 |
| **HA0** | 3.1 | 4.2 | 2.2 | 3.1 | 4.2 | 3.5 |
| **JA0** | 4.5 | 4.4 | 2.2 | 4.5 | 4.4 | 3.5 |
| **KE0, KG5** | 4.0 | 5.7 | 2.5 | 3.4 | 6.3 | 9.3 |
| **LH0, LN0** | 6.0 | 6.9 | 2.5 | 4.7 | 7.8 | 9.6 |
| **MH0, MN0** | 6.0 | 7.9 | 2.5 | 4.7 | 8.8 | 9.6 |

## ◆PRECAUTIONS FOR USERS

### Soldering method
The capacitors of Alchip-series have no capability to withstand such dip or wave soldering as totally immerses components into a solder bath.

### Reflow soldering
Reflow the capacitors within recommended reflow soldering conditions. Verify there is no temperature stress to the capacitors because the following differences might degrade capacitors electrically and mechanically. Please consult us if other reflow conditions are employed.

1. Location of components : Temperature increases at the edge of PC board more than the center.
2. Population of PC board : The lower the component population is, the more temperature rises.
3. Material of PC board : A ceramic made board needs more heat than a glass epoxy made board. The heat increase may cause damage to the capacitors.
4. Thickness of PC board : A thicker board needs more heat than a thinner board. The heat increase may damage the capacitors.
5. Size of PC board : A larger board needs more heat than a smaller board. The heat increase may damage the capacitors.
6. Solder thickness
   If very thin cream solder paste is to be used for SMD types, please consult with us.
7. Location of infrared ray lamps : IR reflow as well as hot plate reflow heats only on the reverse side of the PC board to lessen heat stress to the capacitors.

### Rework of soldering
Use a soldering iron for rework. Do not exceed an iron tip temperature of 380±10℃ and an exposure time of 3±0.5 seconds.

### Mechanical stress
Do not use the capacitors for lifting the PC board and give stress to the capacitor. Avoid bending the PC board. This may damage the capacitors.

### Cleaning assembly board
Immediately after solvent cleaning, remove residual solvent with an air knife for at least 10 minutes. If the solvent is insufficiently dry, the capacitors may corrode.

### Coating on assembly board
1. Before curing coating material, remove the cleaning solvents from the assembly board.
2. Before conformal coating, a chloride free pre-coat material is recommended to decrease the stress on the capacitors.

### Molding with resin
Internal chemical reaction gradually produces gas in the capacitor; then, increasing internal pressure. If the end seal of the capacitor is completely coverd by resin the gas will be unable to escape causing a potentially dangerous situation. The chlorine contained resin will penetrate into the end seal, reach the inside element, and cause damage of the capacitor.

### Others
Refer to Precautions for Users of Aluminum Electrolytic Capacitors.

NIPPON CHEMI-CON

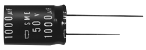
# STANDARDIZATION

**The following series are discontinued. Please use the replacements in the table.**

## ◆CONDUCTIVE POLYMER REPLACEMENT

| Discontinued series | Characteristics | Replacements |
|---|---|---|
| PX | 105℃ Super low ESR | PXA |

## ◆LEAD TYPE REPLACEMENTS



| Discontinued series | Characteristics | Replacements |
|---|---|---|
| SL | 85℃ standard | SMG |
| SM | | |
| SMC | | |
| SME | | |
| KM | 105℃ standard | KMG |
| KMC | | |
| KME | | |
| USM | | LXY |
| BSM | | |
| SHA | 95℃ L=7mm | LXY/LXZ |
| SM-BP | 85℃ bi-polar | SME-BP |
| KM-BP | 105℃ bi-polar | KME-BP |
| SR | 85℃ low profile | SRG |
| SRC | | |
| SRJ | | |
| SX | Low impedance | KY/LXV |
| SXA | | |
| SXC | | |
| RX | | |
| RXC | | |
| LXE | | |
| LXJ | | |
| SXE | | |
| KMF(6.3 to 100Vdc) | | |
| SXF | Low impedance Long life | LXY |
| LXF | | |
| TXF | | |
| LXA | Long life | KY/ LXY |
| LX(10 to 63Vdc) | | * |

| Discontinued series | Characteristics | Replacements |
|---|---|---|
| KX | High heat resistance | GXE |
| KXC | | |
| GX | | |
| EX | | |
| GXC | | |
| GXD | | |
| EU | High temperature performance | LXY |
| LL | Low leakage current | LLA/KY |
| LR | | LLA |
| KHA | High ripple current | KXG |
| KXB | | |
| KMF(160 to 450Vdc) | | |
| BX | JIS B-X characteristics | KMG |
| SM(VP-type) | 85℃ large radial | SMG/SMH |
| SRF | | |
| GX-VH | High operating temperature | * |
| SD | 2 volt | |
| SB | For memory backup | |
| KRL | 105℃ low leakage current | |
| KSA | Bi-polar high ripple | |
| SRE(5.2L) | L=5.2mm | |
| FTK | Appropriate shape | |

## ◆SNAP-IN REPLACEMENTS

| Discontinued series | Characteristics | Replacements |
|---|---|---|
| SM | 85℃ standard | SMH/SMM |
| SME | | |
| SMG | | |
| KM | 105℃ standard | KMH/KMM |
| KME | | |
| KMG | | |
| NM | Long case size | SMH |
| NMA | | |
| BK | Long height | |
| NM-HR | High ripple current | KMH/KMM |
| BX | JIS B-X characteristics | |
| LX | Long life | LXG/LXQ |
| LXA | | |
| KLG | Overvoltage resistant design | CHA |
| KLH | | |
| RZ | Low impedance | * |
| GX | High heat resistance | |
| VD | voltage doubler rectifier circuit | |

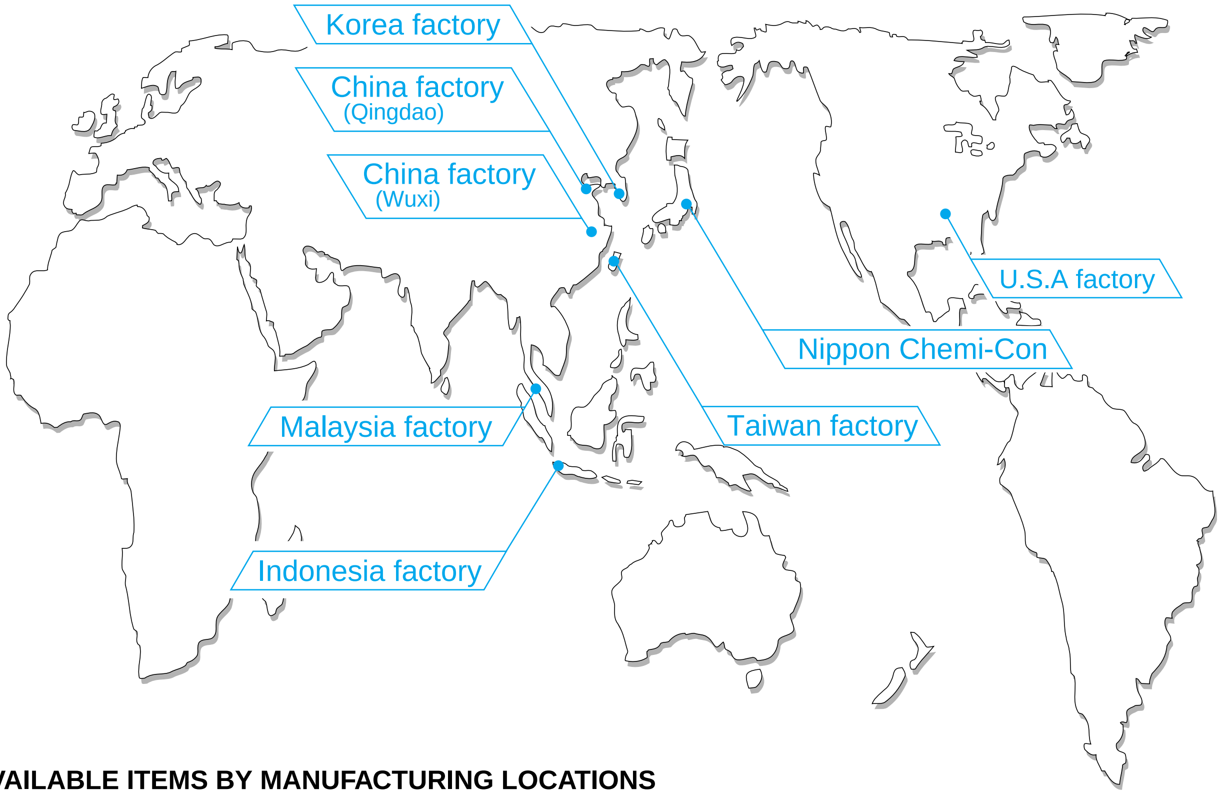
## ◆SCREW-MOUNT TERMINAL REPLACEMENTS

| Discontinued series | Characteristics | Replacements |
|---|---|---|
| EW | 85℃ standard | SME |
| PW | | |
| MW | | |
| GW | | |
| SW | 100℃ | KMH |
| RW | For inverters | RWE/RWF |
| RWA | | |
| KM | High reliability | KMH |
| KME | | |
| LX | 105℃ Long life | LXA/LXR |
| KW | Low impedance, Long life | * |
| FW | Low impedance | |

* Please contact us.

NIPPON CHEMI-CON

# WORLD-WIDE MANUFACTURING LOCATIONS




## ◆AVAILABLE ITEMS BY MANUFACTURING LOCATIONS

| Classification | Series | Korea factory | China factory (Qingdao) | China factory (Wuxi) | Indonesia factory | Taiwan factory | Malaysia factory | U.S.A. factory |
|---|---|---|---|---|---|---|---|---|
| SMD | MV | | | ● | ● | | | |
| Low Profile | SRE | | | | ● | | | |
| | SRA | ● | ● | | ● | | | |
| | KMA | ● | ● | | ● | | | |
| | SRG | ● | ● | | ● | | | |
| General purpose | SMG | ● | ● | ● | ● | ● | | |
| | KMG | ● | ● | ● | ● | ● | | |
| | KME | ● | ● | ● | ● | ● | | |
| Bi-polar | SME-BP | ● | ● | | ● | ● | | |
| | KME-BP | ● | ● | | ● | ● | | |
| Low impedance, High ripple | KMF | | | ● | ● | ● | | |
| | LXV | | | ● | | ● | | |
| | KY | ● | | ● | ● | ● | | |
| | KZE | ● | | ● | ● | ● | | |
| | KMX | | | ● | | ● | | |
| Snap-in | SMQ | | | ● | | | ● | |
| | KMQ | | | ● | | | ● | |
| | SMH | | | ● | | | ● | ● |
| | KMH | | | ● | | | ● | ● |
| | SMM | | | ● | | | ● | ● |
| | KMM | | | ● | | | ● | ● |
| Screw-mount Terminal | KMH | | | | | | | ● |
| | RWE | | | | | | | ● |
| | RWF | | | | | | | ● |
| | RWL | | | | | | | ● |
| | LXA | | | | | | | ● |

Please be sure to contact us before ordering as our product range is continuously improved and the product you require may have been superseded.

NIPPON CHEMI-CON

# PRECAUTIONS AND GUIDELINES (Conductive Polymer)

The NPCAP™ is a Conductive Polymer Solid Aluminum Capacitor that uses highly conductive polymer electrolytic material. Please read the following in order to get the most out of your NPCAP™ capacitor.
For aluminum electrolytic capacitors, please refer to PRECAUTIONS AND GUIDELINES.

## Designing Device Circuits

### 1 Types of Circuits Where NPCAP™ Capacitors are Not to be Used

The leakage current in conductive polymer solid aluminum capacitors (hereafter called capacitors) may vary depending on thermal stresses during soldering. Avoid the use of capacitors in the following types of circuits:

a) High-impedance circuits that are to sustain voltages.
b) Coupling circuits
c) Time constant circuits
Because the capacitance varies depending on the environment the capacitors are used in, there is a possibility that the capacitor can affect a time constant circuit where sensitivity to variation in capacitance is required.
d) Other circuits that are significantly affected by leakage current

### 2 Circuit Design

Verify the following before designing the circuit:

a) The electrical characteristics of the capacitor will vary depending on differences in temperature and frequency. Only design your after verifying the scope of these factors.
b) When connecting two or more capacitors in parallel, ensure that the design takes current balancing into account.
c) When two or more capacitors are connected in series, variability in applied voltage may cause over-voltage conditions. Contact Nippon Chemi-Con before using capacitors connected in series.

### 3 Use in High Reliable and Critical Applications

Consult with Nippon Chemi-Con before using these capacitors in applications involving human life: Aviation/space equipment, Nuclear power equipment, Medical equipment and Automotive equipment, or in applications where capacitor failure could have a major impact.

### 4 Polarity

The NPCAP™ is a polarized solid aluminum electrolytic capacitor. Do not apply either reverse voltages or AC voltages to the polarized capacitors, using reversed polarity may cause a short circuit. Refer to the catalog, product specifications or capacitor body to confirm the polarity prior to use.

### 5 Operating Voltage

Do not apply DC voltages exceeding the full rated voltage. The peak voltage of superimposed AC voltages (ripple voltages) on DC voltages must not exceed the full rated voltage. While there are specifications for surge voltages exceeding the rated voltage, usage conditions apply, and continued operation for extended periods of time under such conditions cannot be guaranteed.

### 6 Ripple Current

Do not apply currents in excess of the rated ripple current. The superimposition of a large ripple current increases the rate of heating within the capacitor. This may reduce the service life of the capacitor or damage the capacitor.

### 7 Operating Temperature

Do not use the capacitor at high temperatures (temperatures exceeding the maximum temperature for the capacitor category). Use of the capacitor outside of the maximum temperature for the capacitor category may decrease the service life of the capacitor.

### 8 Charging and Discharging the Capacitor

Do not use the NPCAP™ capacitor in circuits where the capacitor is repetitively charged and discharged rapidly. Repetitively charging and discharging the capacitor rapidly may reduce the capacitance or may cause damage due to internal heating. Use of a protective circuit to ensure reliability is recommended when rush currents exceed 20A.

### 9 Failures and Service Life

Based on the JIS C 5003 Standard, the failure rate for NPCAP™ capacitors (with a 60% reliability standard) is as follows:

0.5%/1,000 hours (applied rated voltage
at category temperature)

a) Failure Modes
The main cause of failure is thermal stress caused by the solder reflow process or thermal use environment, along with electrical and mechanical stresses. The most common capacitor failure mode is the short circuit mode, where the following phenomenon may occur after shorting:
(1) If the pass-through current when the product is shorted is 1A or less, then the product becomes heated, but no effects are visible, even when the current is continuously carried. However, larger currents may cause substantial internal heating that causes the rubber seal to separate from the case, causing the release of gas.
(2) Some flammable materials are used in the capacitor. If an extremely large electric current flows through the capacitor after shorting, the shorted part may spark, and in a worst-case scenario, may ignite. Ensure safety by fully considering the design issues described below when using this capacitor in equipment where safety is a priority.
- Increase safety by using in conjunction with a protective circuit or protective equipment.
- Install measures such as redundant circuits so that the failure of a part of the equipment will not cause unstable operation.

b) Service Life
NPCAP™ uses rubber as the sealing material, so the service life depends on the thermal integrity of this rubber. Consequently, it is recommended to use the capacitor at a lower temperature than the maximum temperature for the capacitor category.

### 10 Capacitor Insulation

Ensure electrical insulation between the capacitor case, negative electrode, positive electrode and circuit pattern.

### 11 Capacitor Usage Environment

Do not use/expose capacitors to the following conditions.

a) Oil, water, salty water, take care to avoid storage in damp locations.
b) Direct sunlight
c) Toxic gases such as hydrogen, sulfide, sulfurous acids, nitrous acids, chlorine and chlorine compounds, bromine and bromine compounds, ammonia, etc.
d) Ozone, ultraviolet rays and radiation.
e) Severe vibration or mechanical shock conditions beyond the limits advised in the product specification section of the catalog.

# PRECAUTIONS AND GUIDELINES (Conductive Polymer)

### 12 Capacitor mounting

a) For the surface mount capacitor, design the copper pads on the PC board in accordance with the catalog or the product specification
b) For radial capacitors, design the terminal holes on the PC board to fit the terminal pitch of the capacitor.

## Installing Capacitors

### 1 Installing

a) Do not reuse capacitors already assembled in equipment that have been exposed to power.
b) The capacitor may have self charge. If this happens, discharge the capacitor through a resistor of approximately 1kΩ before use.
c) If capacitors are stored at a temperature of 35℃ or more and more than 75%RH, the leakage current may increase. This may also occur if the capacitors are stored for a longer period than the period which is specified in the catalog or the product specification. In this case, they can be reformed by the voltage treatment through a resistor of approximately 1kΩ.
d) Verify the rated capacitance and voltage of the capacitors when installing.
e) Verify the polarity of the capacitors.
f) Do not use the capacitors if they have been dropped on the floor.
g) Do not deform the case of the capacitors.
h) Verify that the lead spacing of the capacitor fits the hole spacing in the PC board before installing the capacitors.
i) Do not apply any mechanical force in excess of the limits prescribed in the catalog or the product specification of the capacitors. Avoid subjecting the capacitor to strong forces, as this may break the electrode terminals, bend or deform the capacitor, or damage the packaging, and may also cause short/open circuits, increased leakage current, or damage the appearance. Also, note the capacitors may be damaged by mechanical shocks caused by the vacuum/insertion head, component checker or centering operation of an automatic mounting or insertion machine.

### 2 Heat Resistance during Soldering

Ensure that the soldering conditions meet the specifications recommended by Nippon Chemi-Con. Note that the leakage current may increase due to thermal stresses that occur during soldering, etc. Note that increased leakage currents gradually decrease when voltage is applied.
a) Verify the following before using a soldering iron:
- That the soldering conditions (temperature and time) are within the ranges specified in the catalog or product specifications.
- That the tip of the soldering iron does not come into contact with the capacitor itself.

b) Verify the following when flow soldering:
- Do not dip the body of a capacitor into the solder bath only dip the terminals in. The soldering must be done on the reverse side of PC board.
- Soldering conditions (preheat, solder temperature and dipping time) should be within the limits prescribed in the catalog or the product specifications.
- Do not apply flux to any part of capacitors other than their terminals.
- Make sure the capacitors do not come into contact with any other components while soldering.

c) Verify the following when reflow soldering:
- Soldering conditions (preheat, solder temperature and soldering time) should be within the limits prescribed in the catalogs or the product specification.
- The heat level should be appropriate. (Note that the thermal stress on the capacitor varies depending on the type and position of the heater in the reflow oven, and the color and material of the capacitor.)
- Vapor phase soldering (VPS) is not used.
- Except for the surface mount type, reflow soldering must not be used for the capacitors.

d) Do not reuse a capacitor that has already been soldered to PC board and then removed. When using a new capacitor in the same location, remove the flux, etc. first, and then use a soldering iron to solder on the new capacitor in accordance with the specifications.
e) Confirm before running into soldering that the capacitors are for reflow soldering.

### 3 Handling After Soldering

Do not apply any mechanical stress to the capacitor after soldering onto the PC board.
a) Do not lean or twist the body of the capacitor after soldering the capacitors onto the PC board.
b) Do not use the capacitors for lifting or carrying the assembly board.
c) Do not hit or poke the capacitor after soldering to PC board. When stacking the assembly board, be careful that other components do not touch the aluminum electrolytic capacitors.
d) Do not drop the assembled board.

### 4 Cleaning PC boards

a) Do not wash capacitors by using the following cleaning agents. Solvent resistant capacitors are only suitable for washing using the cleaning conditions prescribed in the catalog or the product specification. In particular, ultrasonic cleaning will accelerate damage to capacitors.
- Halogenated solvents; cause capacitors to fail due to corrosion.
- Alkali system solvents; corrode (dissolve) an aluminum case.
- Petroleum system solvents; cause the rubber seal material to deteriorate.
- Xylene; causes the rubber seal material to deteriorate.
- Acetone; erases the markings.

b) Verify the following points when washing capacitors.
- Monitor conductivity, pH, specific gravity and the water content of cleaning agents. Contamination adversely affects these characteristics.
- Be sure not to expose the capacitors under solvent rich conditions or keep capacitors inside a closed container. In addition, please dry the solvent sufficiently on the PC board and the capacitor with an air knife (temperature should be less than the maximum rated category temperature of the capacitor) for 10 minutes. Aluminum electrolytic capacitors can be characteristically and catastrophically damaged by halogen ions, particularly by chlorine ions, though the degree of the damage mainly depends upon the characteristics of the electrolyte and rubber seal material. When halogen ions come into contact with the capacitors, the foil corrodes when a voltage is applied. This corrosion causes an extremely high leakage current which results venting and an open circuit.

If the new types of cleaning agents mentioned below are used, the following are recommended as cleaning conditions for some of new cleaning agents.

**-Higher alcohol cleaning agents**
Pine Alpha ST-100S (Arakawa Chemical)

# PRECAUTIONS AND GUIDELINES (Conductive Polymer)

Clean Through 750 H, 750K, 750L, and 710M (Kao)
Technocare FRW-14 through 17 (Toshiba)
Cleaning Conditions:
Using these cleaning agents, capacitors are capable of withstanding immersion or ultrasonic cleaning for 10 minutes at a maximum liquid temperature of 60℃. Find optimum condition for washing, rinsing, and drying. Be sure not to rub the marking off the capacitor which can be caused by contact with other components or the PC board. Note that shower cleaning adversely affects the markings on the sleeve.

**-Non-Halogenated Solvent Cleaning**
AK225AES (Asahi Glass)
Cleaning Conditions:
Ultrasonic or vapor cleaning for 5 minutes. However, from an environmental point of view, these types of solvent will be banned in near future. We would recommend not using them if at all possible.

**-Isopropyl Alcohol (IPA)**
IPA (Isopropyl Alcohol) is one of the most acceptable cleaning agents; it is necessary to maintain a flux content in the cleaning liquid at a maximum limit of 2 Wt.%.

### 5 Precautions for using adhesives and coating materials

a) Do not use any adhesive and coating materials containing halogenated solvent.
b) Verify the following before using adhesive and coating material.
- Remove flux and dust left over between the rubber seal and the PC board before applying adhesive or coating materials to the capacitor.
- Dry and remove any residual cleaning agents before applying adhesive and coating materials to the capacitors. Do not cover over the whole surface of the rubber seal with the adhesive or coating materials.
- For permissible heat conditions for curing adhesives or coating materials, follow the instructions in the catalog or the product specification for the capacitors.
- Covering over the whole surface of the capacitor rubber seal with resin may result in a hazardous condition because the inside pressure cannot be completely released. Also, a large amount of halogen ions in resins will cause the capacitors to fail because the halogen ions penetrate into the rubber seal and the inside of the capacitor.
- Consider that some solvents in the adhesives and coating materials may make the capacitor surface matt or result in whitening.

### 6 Fumigation

In many cases when exporting or importing electronic devices, such as capacitors, wooden packaging is used. In order to control insects it may become necessary to fumigate the shipment. Precautions during “Fumigation” using halogenated chemical such as Methyl Bromide must be taken. Halogen gas can penetrate packaging materials such as cardboard boxes and vinyl bags. Penetration of the halogenated gas can cause corrosion of Electrolytic capacitors. Nippon Chemi-Con gives consideration to the packaging materials not to require the Fumigation. Verify whether the assembled PC board, products and capacitors themselves are subjected to Fumigation during their transportation or not.

## The Operation of Devices

a) Do not touch the capacitor terminals directly.
b) Do not short-circuit the terminal of a capacitor by letting it come into contact with any conductive object. Also, do not spill electric-conductive liquid such as acid or alkaline solution over the capacitor.
c) Do not use capacitors in circumstances where they would be subject to exposure to the following materials
- Oil, water, salty water or damp location.
- Direct sunlight.
- Toxic gases such as hydrogen sulfide, sulfurous acid, nitrous acid, chlorine or its compounds, and ammonium.
- Ozone, ultraviolet rays or radiation.
- Severe vibration or mechanical shock conditions beyond the limits prescribed in the catalog or product specification.

## Maintenance Inspection

a) Make periodic inspections of capacitors that have been used in industrial applications. Before inspection, turn off the power supply and carefully discharge the electricity in the capacitors. Verify the polarity when measuring the capacitors with a volt-ohm meter. Do not apply any mechanical stress to the terminals of the capacitors.
b) The following items should be checked during the periodic inspections.
- Significant damage in appearance
- Electrical characteristics: leakage current, capacitance, tan$\delta$ and other characteristics prescribed in the catalog or product specification.
- We recommend replacing the capacitors if the parts are out of specification.

## Contingencies

a) If gas has vented from the capacitor during use, there is a short circuit and burning, or the capacitor discharges an odor or smoke, turn off the main power supply to the equipment or unplug the power cord.
b) If there is a problem with the capacitor or a fire breaks out, the capacitor may produce a burning gas or reactive gas from the outer resin, etc. If this happens, keep your hands and face away from the gas. If vented gas is inhaled or comes into contact with your eyes, flush your eyes immediately with water and/or gargle. If vented gas comes into contact with the skin, wash the affected area thoroughly with soap and water.

## Storage

We recommend the following conditions for storage.
a) Store capacitors in a cool, dry place. Store at a temperature between 5 and 35℃, with a humidity of 75% or less.

(table-1)

| | Befor the bag is opened | After the bag is opened |
|---|---|---|
| SMD | Within 3 years after manufacturing | Within 6 months after the bag is opend |
| Radial | Within 3 years after manufacturing | — |

SMD products are sealed in a special laminated aluminum bag. Use all capacitors once the bag is opened. Return unused capacitors to the bag, and seal it with a zipper. Please refer to (Table -1) for storage conditions. Be sure to follow our recommendations for reflow soldering.
b) Store the capacitors in a location free from direct contact with water, salt water, and oil.
c) Store in a location where the capacitor is not exposed to toxic gas, such as hydrogen sulfide, sulfurous acid, nitrous acid, chlorine or chlorine compounds, bromine or other halogen gases, methyl bromide or other halogen compounds, ammonia, or similar.
d) Store in a location where the capacitor is not exposed to ozone, ultraviolet radiation, or other radiation.
e) It is recommended to store capacitors in their original packaging wherever possible.
f) The JEDEC J-STD-020 (Rev. C) standard does not apply.

NIPPON CHEMI-CON

# PRECAUTIONS AND GUIDELINES (Conductive Polymer)

## Disposal

Please consult with a local industrial waste disposal specialist when disposing of aluminum electrolytic capacitors.

## Catalogs

Specifications in the catalogs may be subject to change without notice. For more details of precautions and guidelines for aluminum electrolytic capacitors, please refer to Engineering Bulletin No. 634A.

NIPPON CHEMI-CON

# PRECAUTIONS AND GUIDELINES

For conductive polymer aluminum electrolytic solid capacitors, please refer to PRECAUTIONS AND GUIDELINES (Conductive Polymer)

## Designing Device Circuits

### 1 Select the capacitors to suit installation and operating conditions, and use the capacitors to meet the performance limits prescribed in this catalog or the product specifications.

### 2 Polarity

Aluminum Electrolytic Capacitors are polarized.
Apply neither reverse voltage nor AC voltage to polarized capacitors. Using reversed polarity causes a short circuit or venting. Before use, refer to the catalog, product specifications or capacitor body to identify the polarity marking. (The shape of rubber seal does not represent the directional rule for polarity.)
Use a bi-polar type of non-solid aluminum electrolytic capacitor for a circuit where the polarity is occasionally reversed.
However, note that even a bi-polar aluminum electrolytic capacitor must not be used for AC voltage applications.

### 3 Operating voltage

Do not apply a DC voltage which exceeds the full rated voltage.
The peak voltage of a superimposed AC voltage (ripple voltage) on the DC voltage must not exceed the full rated voltage.
A surge voltage value, which exceeds the full rated voltage, is prescribed in the catalogs, but it is a restricted condition, for especially short periods of time.

### 4 Ripple current

The rated ripple current has been specified at a certain ripple frequency. The rated ripple current at several frequencies must be calculated by multiplying the rated ripple current at the original frequency using the frequency multipliers for each product series. For more details, refer to the paragraph on Aluminum Electrolytic Capacitor Life.

### 5 Category temperature

The use of a capacitor outside the maximum rated category temperature will considerably shorten the life or cause the capacitor to vent.
The relation between the lifetime of aluminum electrolytic capacitors and ambient temperature follows Arrhenius' rule that the lifetime is approximately halved with each 10℃ rise in ambient temperature.

### 6 Life expectancy

Select the capacitors to meet the service life of a device.

### 7 Charge and discharge

Do not use capacitors in circuits where heavy charge and discharge cycles are frequently repeated. Frequent and sharp heavy discharging cycles will result in decreasing capacitance and damage to the capacitors due to generated heat. Specified capacitors can be designed to meet the requirements of charging-discharging cycles, frequency, operating temperature, etc.

### 8 Failure mode of capacitors

Non-solid aluminum electrolytic capacitors, in general, have a lifetime which ends in an open circuit, the period is dependent upon temperature. Consequently the lifetime of capacitors can be extended by reducing the ambient temperature and/or ripple current.

### 9 Insulating

a) Electrically isolate the following parts of a capacitor from the negative terminal, the positive terminal and the circuit traces.
  ・The outer can case of a non-solid aluminum capacitor.
  ・The dummy terminal of a non-solid aluminum capacitor, which is designed for mounting stability.

b) The outer sleeve of a capacitor is not assured as an insulator (Except for screw type). For applications that require an insulated outer sleeve, a custom-design capacitor is recommended.

### 10 Condition

Do not use/expose capacitors to the following conditions.
a) Oil, water, salty water storage in damp locations.
b) Direct sunlight
c) Toxic gases such as hydrogen sulfide, sulfurous acid, nitrous acid, chlorine or its compounds, and ammonium
d) Ozone, ultraviolet rays or radiation
e) Severe vibration or mechanical shock conditions beyond the limits prescribed in the catalogs or the product specification.

### 11 Mounting

a) The paper separators and the electrolytic-conductive electrolytes in a non-solid aluminum electrolytic capacitor are flammable.
Leaking electrolyte on a printed circuit board can gradually erode the copper traces, possibly causing smoke or burning by short-circuiting the copper traces.
Verify the following points when designing a PC board.
  ・Provide the appropriate hole spacing on the PC board to match the terminal spacing of the capacitor.
  ・Make the following open space over the vent so that the vent can operate correctly.

| Case diameter | Clearance |
|---|---|
| ϕ6.3 to ϕ16mm | 2mm minimum |
| ϕ18 to ϕ35mm | 3mm minimum |
| ϕ40mm and up | 5mm minimum |

  ・Do not place any wires or copper traces over the vent of the capacitor.
  ・Installing a capacitor with the vent facing the PC board needs an appropriate ventilation hole in PC board.
  ・Do not pass any copper traces beneath the seal side of a capacitor. The trace must pass 1 or 2mm to the side of the capacitor.
  ・Avoid placing any heat-generating objects adjacent to a capacitor or even on the reverse side of the PC board.
  ・Do not pass any via holes underneath a capacitor.
  ・In designing double-sided PC boards, do not locate any copper trace under the seal side of a capacitor.

b) Do not mount the terminal side of a screw mount capacitor downwards. If a screw terminal capacitor is mounted on its side, make sure the positive terminal is higher than the negative terminal.
Do not tighten the screws of the terminals and the mounting clamps over the specified torque prescribed in the catalog or the production specification.

c) For a surface mount capacitor, design the copper pads of the PC board in accordance with the catalog or the product specifications.

### 12 Others

a) The electrical characteristics of capacitors vary in respect to temperature, frequency and service life. Design the device circuits by taking these changes into account.
b) Capacitors mounted in parallel need the current to flow equally through the individual capacitors.
c) Capacitors mounted in series require resistors in parallel with the individual capacitors to balance the voltage.
d) Using capacitor for applications which always consider safety. Consult with our factory before use in applications which can affect human life.(space equipment, aerial equipment, nuclear equipment, medical equipment, vehicle control equipment, etc) Please note that the product, which is

NIPPON CHEMI-CON

# PRECAUTIONS AND GUIDELINES

designed only for specific usage can not be used in other usages.(ex. Photo flash type, etc.)

## Installing Capacitors

### 1 Installing

a) Used capacitors are not reusable, except in the case that the capacitors are detached from a device for periodic inspection to measure their electrical characteristics.
b) If the capacitors have self charged, discharge in the capacitors through a resistor of approximately 1kΩ before use.
c) If capacitors are stored at a temperature of 35℃ or more and more than 75%RH, the leakage current may increase. In this case, they can be reformed by applying the rated voltage through a resistor of approximately 1kΩ.
d) Verify the rated capacitance and voltages of the capacitors when installing.
e) Verify the polarity of the capacitors.
f ) Do not use the capacitors if they have been dropped on the floor.
g) Do not deform the cases of capacitors.
h) Verify that the lead spacing of the capacitor fits the hole spacing in the PC board before installing the capacitors. Some standard pre-formed leads are available.
i ) For pin terminals or snap-in terminals, insert the terminals into PC board and press the capacitor downward until the bottom of the capacitor body reaches PC board surface.
j ) Do not apply any mechanical force in excess of the limits prescribed in the catalogs or the product specifications of the capacitors.
Also, note the capacitors may be damaged by mechanical shocks caused by the vacuum/insertion head, component checker or centering operation of an automatic mounting or insertion machine.

### 2 Soldering and Solderability

a) When soldering with a soldering iron
- Soldering conditions (temperature and time) should be within the limits prescribed in the catalogs or the product specifications.
- If the terminal spacing of a capacitor does not fit the terminal hole spacing of the PC board, reform the terminals in a manner to minimize a mechanical stress into the body of the capacitor.
- Remove the capacitors from the PC board, after the solder is completely melted, reworking by using a soldering iron minimizes the mechanical stress to the capacitors.
- Do not touch the capacitor body with the hot tip of the soldering iron.

b) Flow soldering
- Do not dip the body of a capacitor into the solder bath only dip the terminals in. The soldering must be done on the reverse side of PC board.
- Soldering conditions (preheat, solder temperature and dipping time) should be within the limits prescribed in the catalogs or the product specifications.
- Do not apply flux to any part of capacitors other than their terminals.
- Make sure the capacitors do not come into contact with any other components while soldering.

c) Reflow soldering
- Soldering conditions (preheat, solder temperature and dipping time) should be within the limits prescribed in the catalogs or the product specifications.
- When setting the temperature infrared heaters, consider that the infrared absorption causes material to be discolored and change in appearance.
- Do not solder capacitors more than once using reflow. If you need to twice, be sure to consult with us.
- Make sure capacitors do not come into contact with copper traces.

d) Do not re-use surface mount capacitors which have already been soldered.
In addition, when installing a new capacitor onto the assembly board to rework, remove old residual flux from the surface of the PC board, and then use a soldering iron within the prescribed conditions.
e) Confirm before running into soldering that the capacitors are for reflow soldering.

### 3 Handling after soldering

Do not apply any mechanical stress to the capacitor after soldering onto the PC board.
a) Do not lean or twist the body of the capacitor after soldering the capacitors onto the PC board.
b) Do not use the capacitors for lifting or carrying the assembly board.
c) Do not hit or poke the capacitor after soldering to PC board.
When stacking the assembly board, be careful that other components do not touch the aluminum electrolytic capacitors.
d) Do not drop the assembly board.

### 4 Cleaning PC boards

a) Do not wash capacitors by using the following cleaning agents.
- Halogenated solvents; cause capacitors to fail due to corrosion.
- Alkali system solvents; corrode (dissolve) an aluminum case.
- Petroleum system solvents; cause the rubber seal material to deteriorate.
- Xylene; causes the rubber seal material to deteriorate.
- Acetone; erases the marking.

Solvent resistant capacitors are only suitable for washing using the cleaning conditions prescribed in the catalogs or the product specifications. In particular, ultrasonic cleaning will accelerate damaging capacitors.

b) Verify the following points when washing capacitors.
- Monitor conductivity, pH, specific gravity, and the water content of cleaning agents. Contamination adversely affects these characteristics.
- Be sure not to expose the capacitors under solvent rich conditions or keep capacitors inside a closed container. In addition, please dry the solvent sufficiently on the PC board and the capacitor with an air knife (temperature should be less than the maximum rated category temperature of the capacitor) over 10 minutes.
Aluminum electrolytic capacitors can be characteristically and catastrophically damaged by halogen ions, particularly by chlorine ions, though the degree of the damage mainly depends upon the characteristics of the electrolyte and rubber seal material. When halogen ions come into contact with the capacitors, the foil corrodes when voltages applied. This corrsion causes ; extremely high leakage current, which causes in line with, venting, and an open circuit.
Global environmental warnings (Greenhouse effects and other environmental destruction by depletion of the ozone layer), new types of cleaning agents have been developed and commercialized as substitutes for CFC-113,1,1,2-trichloroethlene and 1,1,1-trichloroethylene. The following are recommended as cleaning conditions for some of new cleaning agents.

**–Higher alcohol system cleaning agents**
Recommended cleaning agents:
Pine Alpha ST-100S (Arakawa Chemical)
Clean Through 750H, 750K, 750L, and 710M (Kao)
Technocare FRW-14 through 17 (Toshiba)
Cleaning conditions:

NIPPON CHEMI-CON

# PRECAUTIONS AND GUIDELINES

Using these cleaning agents capacitors are capable of withstanding immersion or ultrasonic cleaning for 10 minutes at a maximum liquid temperature of 60℃. Find optimum condition for washing, rinsing, and drying. Be sure not to rub the marking off the capacitor by contacting any other components or the PC board. Note that shower cleaning adversely affects the markings on the sleeve.

**–Non-Halogenated Solvent Cleaning**
AK225AES (Asahi Glass)
Cleaning conditions:
Solvent resistant capacitors are capable of withstanding any one of immersion, ultrasonic or vapor cleaning for 5 minutes; ex-ception is 2 minutes max. for KRE, and KRE-BP series capacitors and 3 minutes for SRM series capacitors. However, from a view of the global environmental problems, these types of solvent will be banned in near future. We would recommended not using them as much as possible.

**Isopropyl alcohol cleaning agents**
IPA (Isopropyl Alcohol) is one of the most acceptable cleaning agents; it is necessary to maintain a flux content in the cleaning liquid at a maximum limit of 2 Wt.%.

## 5 Precautions for using adhesives and coating materials

a) Do not use any adhesive and coating materials containing halogenated solvent.
b) Verify the following before using adhesive and coating material.
  - Remove flux and dust leftover between the rubber seal and the PC board before applying adhesive or coating materials to the capacitor.
  - Dry and remove any residual cleaning agents before applying adhesive and coating materials to the capacitors. Do not cover over the whole surface of the rubber seal with the adhesive or coating materials.
  - For permissible heat conditions for curing adhesives or coating materials, follow the instructions in the catalogs or the product specifications of the capacitors.
  - Covering over the whole surface of the capacitor rubber seal with resin may result in a hazardous condition because the inside pressure cannot release completely. Also, a large amount of halogen ions in resins will cause the capacitors to fail because the halogen ions penetrate into the rubber seal and the inside of the capacitor.

c) Some of coating material cannot be curred over the capacitor. Please note that loose luster and whitening on the surface of the outer sleeve might be caused according to the kind of solvents used for mounting adhesives and coating agents.

## 6 Fumigation

In many cases when exporting or importing electronic devices, such as capacitors, wooden packaging is used. In order to control insects, many times, it becomes necessary to fumigate the shipments. Precautions during “Fumigation” using halogenated chemical such as Methyl Bromide must be taken. Halogen gas can penetrate packaging materials used, such as, cardboard boxes and vinyl bags. Penetration of the halogenide gas can cause corrosion of Electrolytic capacitors.

## The Operation of Devices

a) Do not touch a capacitor directly with bare hands.
b) Do not short-circuit the terminal of a capacitor by letting it come into contact with any conductive object.
Also, do not spill electric-conductive liquid such as acid or alkaline solution over the capacitor.
c) Do not use capacitors in circumstance where they would be subject to exposure to the following materials exist or expose.
  - Oil, water, salty water or damp location.
  - Direct sunlight.
  - Toxic gases such as hydrogen sulfide, sulfurous acid, nitrous acid, chlorine or its compounds, and ammonium.
  - Ozone, ultraviolet rays or radiation.
  - Severe vibration or mechanical shock conditions beyond the limits prescribed in the catalogs or product specification.

## Maintenance Inspection

a) Make periodic inspections of capacitors that have been used in industrial applications. Before inspection, turn off the power supply and carefully discharge the electricity in the capacitors. Verify the polarity when measuring the capacitors with a volt-ohm meter. Also, do not apply any mechanical stress to the terminals of the capacitors.
b) The following items should be checked during the periodic inspections.
  - Significant damage in appearance : venting and electrolyte leakage.
  - Electrical characteristics: leakage current, capacitance, tan$\delta$ and other characteristics prescribed in the catalogs or product specifications.
  We recommend replacing the capacitors if the parts are out of specification.

## In Case of Venting

a) If a non-solid aluminum electrolytic capacitor expells gas when venting, it will discharge odors or smoke, or burn in the case of a short-circuit failure. Immediately turn off or unplug the main power supply of the device.
b) When venting, a non-solid aluminum electrolytic capacitor blows out gas with a temperature of over 100℃. (A solid aluminum electrolytic capacitor discharges decomposition gas or burning gas while the outer resin case is burning.) Never expose the face close to a venting capacitor. If your eyes should inadvertently become exposed to the spouting gas or you inhale it, immediately flush the open eyes with large amounts of water and gargle with water respectively. If electrolyte is on the skin, wash the electrolyte away from the skin with soap and plenty of water. Do not lick the electrolyte of non-solid aluminum electrolytic capacitors.

## Storage

We recommend the following conditions for storage.
a) Do not store capacitors at a high temperature or in high humidity. Store the capacitors indoors at a temperature of 5 to 35℃ and a humidity of less than 75%RH.
b) Store the capacitors in places free from water, oil or salt water.
c) Store the capacitors in places free from toxic gasses (hydrogen sulfide, sulfurous acid, chlorine, ammonium, etc.)
d) Store the capacitors in places free from ozone, ultraviolet rays or radiation.
e) Keep capacitors in the original package.
f) It is not applied to a regulation of JEDEC J-STD-020(Rev.C). But MSL (Moisture Sensitivity Level) is suitable for Level 1. A time limit for keeping goods under packed situation is within 3 years after manufacturing.

## Disposal

Please consult with a local industrial waste disposal specialist when disposing of aluminum electrolytic capacitors.

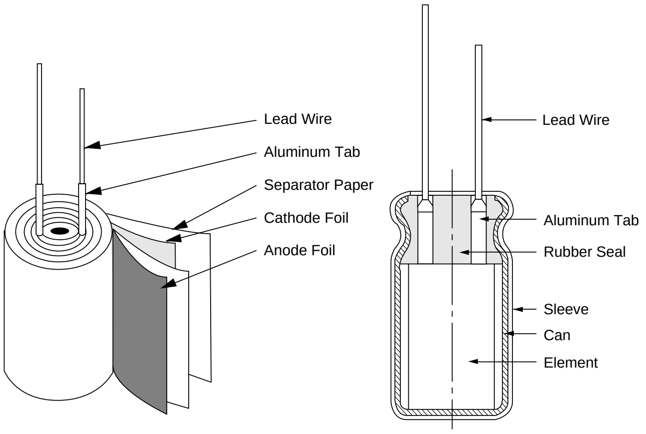
## Catalogs

Specifications in catalogs may be subject to change without notice. For more details of precautions and guidelines for aluminum electrolytic capacitors, please refer to Engineering Bulletin No. 634A.

# PRECAUTIONS AND GUIDELINES

## Structure of Aluminum Electrolytic Capacitors

The aluminum electrolytic capacitor contains an internal element of an anode foil, a cathode foil and paper separator rolled together, impregnated with an electrolyte, then attached to external terminals connecting the tabs with the anode or the cathode foils, and sealed in a can case.




Among various types of capacitors, an aluminum electrolytic capacitor offers large CV to volume and features low cost. The capacitance (C) of aluminum electrolytic capacitors, as well as other capacitors, is expressed by the following equation:

$$C=8.854\times10^{-12}\times\frac{\varepsilon S}{d}\ \text{(F)}$$

Where : ε=Dielectric constant
S=Surface area of dielectric ($m^2$)
d=Thickness of dielectric (m)

This equation shows that the capacitance increases in proportion as the dielectric constant becomes high, its surface area becomes large and the thickness of dielectric becomes thin. In aluminum electrolytic capacitors the dielectric constant of an aluminum oxide ($Al_2O_3$) layer is 8 to 10, which is not as high as compared with the other types of capacitors. However, the dielectric layer of the aluminum oxide is extremely thin (about 15Å per volt) and the surface area is very large. An electrochemical formed electrode foil makes the dielectric on the etched surface of aluminum electrode foil. Electrochemical etching creates 20 to 100 times more surface area as plain foil. Therefore, an aluminum electrolytic capacitor can offer a large capacitance compared with other types.

## Primary of Composition Material

**Anode aluminum foil:**
First, the etching process is carried out electromechanically with a chloride solution which dissolves metal and increases the surface area of the foil; forming a dense network like innumerable microscopic channels. Secondly, the formation process is carried out with a solution such as ammonium borate which forms the aluminum oxide layer ($Al_2O_3$) as a dielectric at a thickness of about 1.1 to 1.5nm / volt. The process needs to charge more the rated voltage into the foil.

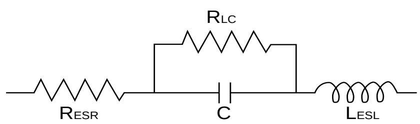
**Cathode aluminum foil:**
As in the first manufacturing process of the positive foil, the cathode foil requires etching process. Generally, it does not require the formation process; therefore, the natural oxide layer of $Al_2O_3$, which gives a characteristic dielectric voltage of 1.0 volts, is formed.

**Electrolyte and separator:**
In a non-solid aluminum electrolytic capacitor, the electrolyte, an electrically conductive liquid, functions as a true cathode by contacting the dielectric oxide layer. Accordingly, the "cathode foil" serves as an electrical connection between the electrolyte and terminal.
The separator functions to retain the electrolyte and prevent the anode and cathode foils from short-circuiting.

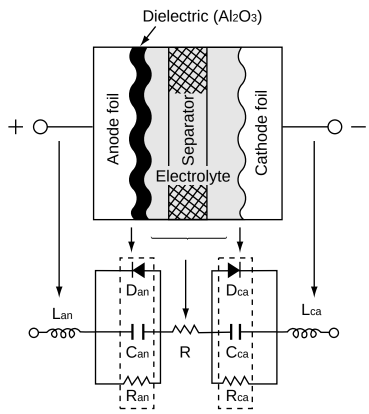
**Can case and sealing materials:**
The foils and separator are wound into a cylinder to make an internal element, which is impregnated with the electrolyte, inserted into an aluminum can case and sealed. During the service life of a capacitor, electrolyte slowly and naturally vaporizes by electrochemical reaction on the boundary of the aluminum foils. The gas will increase the pressure inside the case and finally cause the pressure relief vent to open or the sealing materials to bulge. The sealing material functions not only to prevent electrolyte from drying out but also to allow the gas to escape out of the can case in a controlled manner.

## The Equivalent Circuit

As the equivalent circuit of an aluminum electrolytic capacitor is shown below, it forms a capacitance, a series resistance, an inductance, and a parallel resistance.




$R_{ESR}$=Equivalent series resistance (ESR)
$R_{LC}$ =Resistance due to leakage current
C =Capacitance
$L_{ESL}$ =Equivalent series inductance




From a composition material point wise, the equivalent circuit is subdivided as follows.

$C_{an}$, $C_{ca}$=Capacitance due to anode and cathodes foils
R =Resistance of electrolyte and separator
$R_{an}$, $R_{ca}$=Internal resistance of oxide layer on anode and cathode foils
$D_{an}$, $D_{ca}$=Diode effects due to oxide layer on anode and cathode foils
$L_{an}$, $L_{ca}$ =Inductance due to anode and cathode terminals

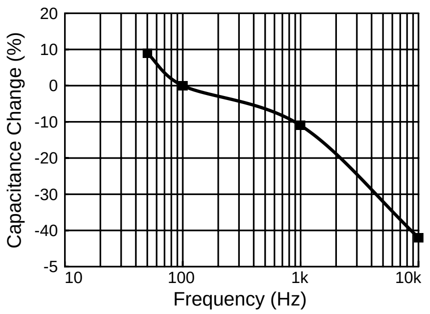
## Basic Electrical Characteristics

**Capacitance:**
The capacitance of capacitor is expressed as AC capacitance

NIPPON CHEMI-CON

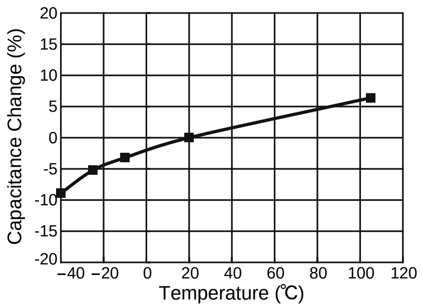
# PRECAUTIONS AND GUIDELINES

by measuring impedance and separating factors. Also, the AC capacitance depends upon frequency, voltage and other measuring methods. In fact, JIS C 5101 prescribes that the series capacitive factor of an equivalent series( ) circuit shall be the capacitance measured at a frequency of 120Hz and applying a maximum AC voltage of 0.5V rms with a DC bias voltage of 1.5 or 2.0V to aluminum electrolytic capacitors. The capacitance of an aluminum electrolytic capacitor becomes smaller with increasing frequency. See the typical behavior shown below.




Capacitance VS. Frequency

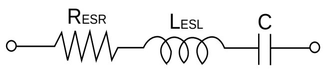
The capacitance value is highly dependent upon temperature and frequency. As the temperature decreases, the capacitance becomes smaller. See the typical behavior shown below.

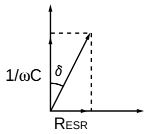



Temperature Characteristics of Capacitance

On the other hand, DC capacitance, which can be measured by applying a DC voltage, shows a slightly larger value than the AC capacitance at a normal temperature and has the flatter characteristic over the temperature range.

**tanδ(tangent of loss angle or dissipation factor):**
The tanδ is expressed as the ratio of the resistive component ($R_{ESR}$) to the capacitive reactance ($1/\omega C$) in the equivalent series circuit. Its measuring conditions are the same as the capacitance.

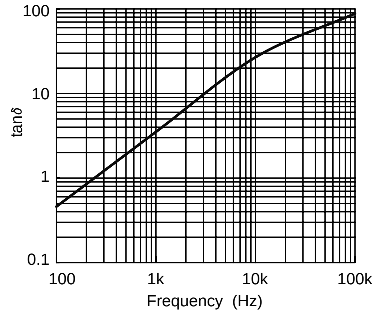


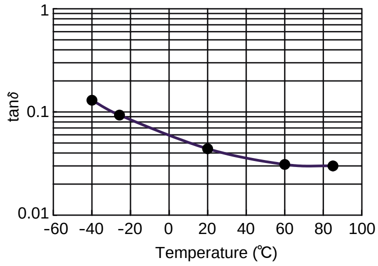

$\tan\delta = R_{ESR} / (1/\omega C) = \omega C R_{ESR}$

Where : $R_{ESR}$=ESR at 120Hz
$\omega = 2\pi f$
$f$ =120Hz

The tanδ shows higher values as the measured frequency increases and the measured temperature decreases.




tanδ VS. Frequency




Temperature Characteristics of tanδ

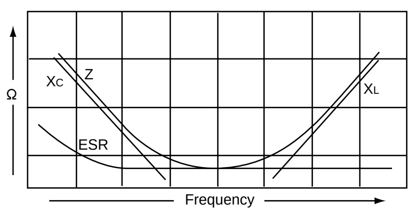
**Equivalent series resistance (ESR):**
The ESR is the series resistance consisting of the aluminum oxide layer, electrolyte/separator combination, and other resistance related factors, foil length, foil surface area and others.
The ESR value depends upon the temperature. Decreasing the temperature makes the resistivity of the electrolyte increase and leads to increasing ESR.
As the measuring frequency increases, the ESR decreases and reaches an almost constant value that mainly dominates the frequency-independent resistance relating electrolyte/ separator combination.

**Impedance (Z):**
The impedance is the resistance of the alternating current at a specific frequency. It is related to capacitance (C) and inductance (L) in terms of capacitive and inductive reactance, and also related to the ESR. It is expressed as follows:

$$Z=\sqrt{ESR^2+(X_L-X_C)^2}$$

Where : $X_C=1/\omega C=1/2\pi fC$
$X_L=\omega L=2\pi fL$

As shown below, the capacitive reactance (Xc) dominates at the range of low frequencies, and the impedance decreases with increasing frequency until it reaches the ESR in the middle frequency range. At the range of the higher frequencies the inductive reactance (XL) comes to dominate, so that the impedance increases when increasing the measuring frequency.

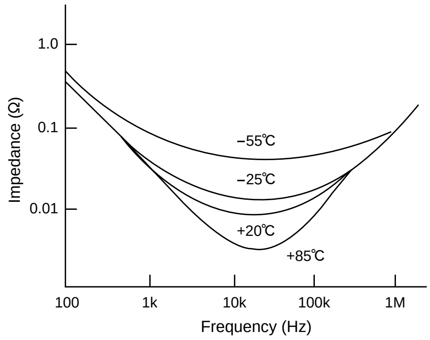



Impedance VS.Frequency

As shown at the next page, the impedance value varies with temperature because the resistance of the electrolyte is strongly affected by temperature.

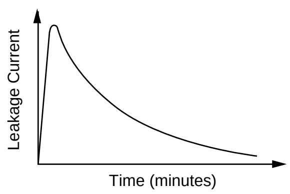
NIPPON CHEMI-CON

# PRECAUTIONS AND GUIDELINES



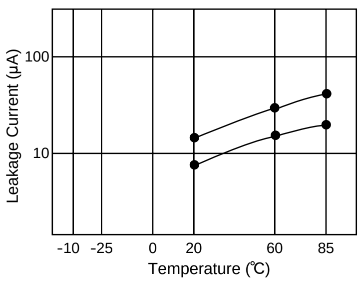

Temperature Characteristics of Impedance

**Leakage current:**
The dielectric of a capacitor has a very high resistance that does not allow DC current to flow. However, due to the characteristics of the aluminum oxide layer that functions as a dielectric in contact with electrolyte, a small amount of current, called leakage current, will flow to reform and repair the oxide layer when a voltage is being applied. As shown below, a high leakage current flows to charge voltage to the capacitor for the first seconds, and then the leakage current will decrease and reach an almost steady-state value with time.




Leakage Current VS. Time

Measuring temperature and voltage influences the leakage current. The leakage current shows higher values as the temperature and voltage increase.

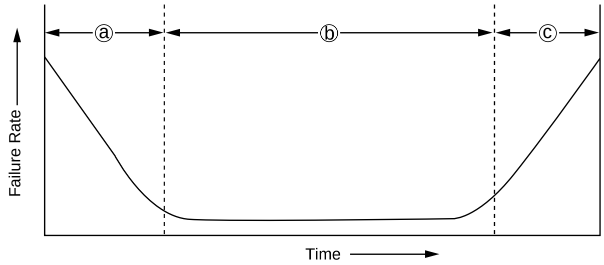



Typical Temperature Characteristics

In general, the leakage current is measured at 20℃ by applying the rated voltage to capacitor through a resistor of 1000Ω in series. The leakage current is the value several minutes later after the capacitor has reached the rated voltage. The catalog prescribes the measuring temperature and time.

## Reliability

**The bathtub curve:**
Aluminum electrolytic capacitors feature failure rates shown by the following bathtub curve.




a) Infant failure period
This initial period accounts for the failures caused by deficiencies in design, structure, the manufacturing process or severe misapplications. In other words the initial failures occur as soon as the components are installed in a circuit. In the case of aluminum electrolytic capacitors, these failures do not occur at customers' field because aging process reforms an incomplete oxide layer, or eliminate the defective parts at the aging process and the sorting process.
Misapplication of the capacitor such as inappropriate ambient conditions, over-voltage, reverse voltage, or excessive ripple current should be avoided for proper use of the capacitor in a circuit.

b) Useful life period
This random failure period exhibits an extremely low failure rate. These failures are not related to operating time but to application conditions. During this period, non-solid aluminum electrolytic capacitors lose a small amount of electrolyte. The electrolyte loss shows as a slow decrease in capacitance and a slow increase in tan$\delta$ and ESR. Non-solid aluminum electrolytic capacitors still exhibit lower catastrophic failures than semiconductors and solid tantalum capacitors.

c) Wear-out failure period
This period reflects a deterioration in the component properties of the capacitor ; the failure rate increases with time. Non-solid aluminum electrolytic capacitors end their useful life during this period.

**Failure types:**
The two types of failures are classified as catastrophic failures and wear-out failures as follows.

1) Catastrophic failures
This is a failure mode that destroys the function of the capacitor like a short circuit or open circuit failure.

2) Wear-out failures
This is a failure mode where gradually deteriorates; the electrical parameters of the capacitor. The criteria of judging the failures, vary with application and design factors. Capacitance decreases and tan$\delta$ increases are caused by the loss of electrolyte in the wear-out failure period. This is primary due to loss of electrolyte by diffusion (as vapor) through the sealing material. Gas molecules can diffuse out through the material of the end seal. High temperature increase the electrolyte vapor pressure within the capacitor and the diffusion rate is therefore increased. This increases internal pressure may cause the seal to bulge caused by elevated temperatures. This bulging may accelerate diffusion and mechanically degrade the seal. Factors that can increase the capacitor temperature, such as ambient temperature and ripple current, can accelerate the wear-out phase of a capacitor.

**Failure modes:**
Aluminum electrolytic capacitors show various failure modes in different applications. (See Table 1.)

NIPPON CHEMI-CON

# PRECAUTIONS AND GUIDELINES

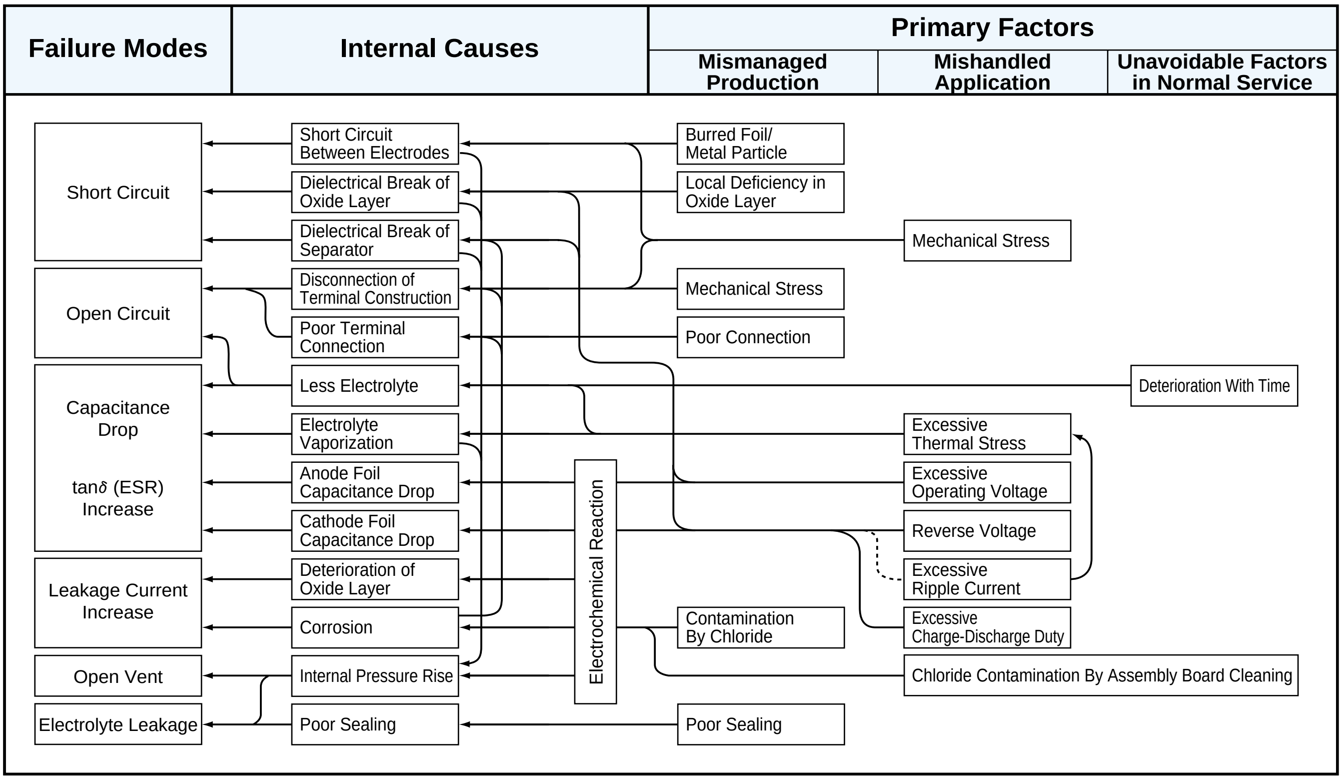



Table1

## Life of Aluminum Electrolytic Capacitors

The life of aluminum electrolytic capacitors is largely dependent on environmental and electrical factors. Environmental factors include temperature, humidity, atmospheric pressure and vibration. Electrical factors include operating voltage, ripple current and charge-discharge duty cycles. The factor of temperature (ambient temperature and internal heating due to ripple current) is the most critical to the life of aluminum electrolytic capacitors.

**General formula to estimate lifetime:**
The lifetime of non-solid aluminum electrolytic capacitors is generally expressed by using three elements representing the effects of ambient temperature, applying voltage and ripple current, which is shown by the following equation:

$$L_X = L \cdot K_{Temp} \cdot K_{Voltage} \cdot K_{Ripple}$$

Where : $L_X$ =Lifetime of capacitor to be estimated
$L_o$ =Base lifetime of capacitor
$K_{Temp}$ =Ambient temperature accelation term
$K_{Voltage}$ =Voltage accelation term
$K_{Ripple}$ =Ripple current accelation term

**$K_{Temp}$ (Effects of ambient temperature on life):**
Because an aluminum electrolytic capacitor is essentially an electrochemical component, increased temperatures accelerate the chemical reaction producing gas within the capacitor which is diffused through the end seal, and consequently accelerates a gradual decrease in capacitance and a gradual increase in tanδ and ESR. The following equation has been experimentally found to express the relationship between the temperature acceleration factor and the deterioration of the capacitor.

$$L_X = L_O \cdot K_{Temp} = L_O \cdot B^{(T_O - T_X)/10}$$
$$K_{Temp} = B^{(T_O - T_X)/10}$$

Where : $L_X$ =Lifetime (hour) of capacitor to be estimated
$L_o$ =Base lifetime (hour) of capacitor
$T_o$ =Maximum rated category temperature (℃) of capacitor shown in catalog
$T_X$ =Actual ambient temperature (℃) of capacitor
B =Temperature accelation factor (≃2)

This equation is similar to Arrhenius' equation that expresses a relationship between chemical reaction rates and temperature, and called Arrhenius' rule of aluminum electrolytic capacitors. The temperature acceleration factor (B) is approximately 2 over an ambient temperature range (Tx) from 40℃ to the maximum rated category temperature of each capacitor. It means that the lifetime is approximately halved with every 10℃ rise in ambient temperature and can be extended by using the capacitors at low temperatures. For an ambient temperature range (Tx) of 20℃ to 40℃, the factor B will be close to 2, and the lifetime will actually be extended. However, operating and surrounding conditions, especially the operating conditions influence ambient temperatures mutually. The ambient temperature in this range will be very changeable; therefore, lifetime estimation under 40℃ should use 40 as Tx.

**$K_{voltage}$ (Effects of applying voltage to life):**
Miniature and large sized aluminum electrolytic capacitors for popular applications, such as surface mount types, radial lead types, snap-in types and block types, have little voltage effect on their life. Other factors like temperature and ripple current determine the life in comparison with voltage, as long as the capacitors are used at voltages and temperatures within the specifications prescribed in the catalog. Consequently, $K_{voltage}$=1 is used for these capacitors. 350V and higher screw-mount terminal types of capacitors for customer-use power electronics applications allow the life time to extend by applying low voltage, relating to the characteristics of their aluminum oxide layer. RWE, RWY, RWL, RWF, LX(Screw-mount), LXA(Screw-mount) and LXR series are applicable to the method. For $K_{voltage}$ values of these products, please contact a representative of Nippon Chemi-Con.

**$K_{ripple}$ (Effects of ripple current to life):**
Aluminum electrolytic capacitors have higher tanδ than any other types of capacitors; therefore, the ripple current gives aluminum electrolytic capacitors higher internal heat. Be sure to check the rated ripple current which is specified in the catalog for assuring the life.

NIPPON CHEMI-CON

# PRECAUTIONS AND GUIDELINES

The ripple current through the capacitor produces heat by dissipating power from the capacitor. This leads to temperature increase. Internal heating produced by ripple currents can be expressed by:

$W=(I_{Ripple})^2 \cdot R_{ESR}+V \cdot I_{Leakage}$

Where : $W$ =Internal power loss
$I_{Ripple}$ =R.M.S. ripple current
$R_{ESR}$ =Internal resistance (ESR) at ripple frequency
$V$ =Applied voltage
$I_{Leakage}$=Leakage current

Leakage current may be 5 to 10 times higher than the values measured at 20℃, but compared with Iripple , the leakage current value is very small and negligible.
Thus, the above equation can be simplified:

$W=(I_{Ripple})^2 \cdot R_{ESR}$

The following equation gives the internal heat rise; it is heat rise to stable condition. ( It is necessary to input several factors.):

$(I_{Ripple})^2 \cdot R_{ESR}=\beta \cdot A \cdot \Delta T$

Where : $\beta$ =Heat transfer constant
$A$ =Surface area of can case
$A=(\pi/4) \cdot D \cdot (D+4L)$
Where : D=Can diameter
L=Can length
ΔT=An increase in core temperature by internal heating due to ripple current
(ΔT=Core temperature−Ambient temperature)

From the above equation, internal temperature rise (ΔT) produced by ripple current is given by:

$\Delta T=(I_{Ripple})^2 \cdot R_{ESR}/(\beta \cdot A)$

When the ripple frequency is 120Hz, $R_{ESR}$ at 120Hz is expressed by

$R_{ESR}=\tan\delta/(\omega \cdot C)$

$\Delta T=(I_{Ripple})^2 \cdot \tan\delta/(\beta \cdot A \cdot \omega \cdot C)$

Where : $\tan\delta$=120Hz value
$\omega$ $=2\pi \cdot f=2\pi \cdot 120$Hz
C =120Hz capacitance value

As above equation, ΔT varies with frequency of ripple, frequency and temperature dependent ESR, and application dependent $\beta$ (even ripple current is constant). We really recommend that customers measure ΔT with a thermocouple at the actual operating conditions of the application in lieu of using the above equation. (Another approximation of ΔT will be stated later.)
As mentioned in the paragraph of $K_{Temp}$, aluminum electrolytic capacitors will slowly increase in $\tan\delta$ and ESR during their service life. The application without ripple current has no influence on the life of the capacitor even though the ESR will increase during life. In other words, the application with ripple current makes ΔT increase; furthermore, a ΔT increase results in ESR increase. The ESR increase then makes ΔT increase. It is a chain reaction. Theoretically, the ripple current acceleration term ($K_{Ripple}$) cannot be simply expressed like the ambient temperature acceleration term ($K_{Temp}$). Practically, the ripple current acceleration term ($K_{Ripple}$) can be approximately expressed by an equation using a ΔT initially measured. The following table shows the ripple current acceleration term ($K_{Ripple}$) for each capacitor design group.

| $K_{Ripple}$ | | Products: Type | Products: Series |
|---|---|---|---|
| $2^{(-\Delta T/5)}$ | | Surface mount | MVS, MVA, MV, MVE, MVK, MKA, MZA, MVY, MLA MVJ, MVL, MVH, MV-BP, MVK-BP |
| | | Radial lead | KMA, KME-BP, KRE, KRG, LLA, SME, SMQ, SME-BP, SMG, SRA, SRE,SRG,SRM |
| | | Screw-mount terminal | KW |
| $2^{(\Delta To-\Delta T)/5}$ | ΔTo=5 deg | Radial lead | FL, GXE(To≦105℃), KLG, KME, KMQ, KMF, KMG, KMH, KMX, KXG, PAG, LBG, LXV, LXY, LXZ, KZM, KZH, KZE, KY, KXJ, GPA, KLJ, KMR |
| | | Pin terminal | KMH, KMM, KMQ, LXG, LXM, LXH, LXQ, CHA |
| | | Screw-mount terminal | LXA (10 to 250Vdc), KMH |
| | ΔTo=5 to 10 deg Contact us for details | Radial lead | SMH |
| | | Pin terminal | SMH, SMM, SMQ, SLM, RWE-LR |
| | | Screw-mount terminal | SME |
| $2^{[-2+(25-\Delta T)/b]}$ | | Screw-insert terminal | LXA (350 to 525Vdc), RWE, RWF, RWL, LXR, RWY, RWG |

Note :ΔT = An increase (deg) in core temperature produced by internal heating due to actual operating ripple current. The ΔT is the difference between the core temperature and ambient temperature measured at the actual operating conditions.
ΔTo = An increase (deg) in core temperature by internal heating due to rated ripple current.
b = Factor b varies from 5 to 10 by the conditions of ripple frequency and ΔT. Please contact a representative of Nippon Chemi-Con for the details

Note that a ΔT over a certain maximum limit may over-heat the capacitors, though the lifetime estimation will not give you practical lifetime. For instance, the following shows a guide limit of ΔT at each ambient temperature for 105℃ maximum rated products.

| Ambient temperature Tx (℃) | 85 | 105 |
|---|---|---|
| Guide limit of ΔT (deg) | 15 | 5 |
| Core temperature (=Tx+ΔT) | 100 | 110 |

## Approximation of ΔT

Estimation of the lifetime requires two temperature measurements; first obtain ΔT by actually measuring the core temperature, inserting the thermocouple inside the operating capacitor and secondary, the ambient temperature. A more convenient way to get the ΔT is to convert the surface temperature of the capacitor case and the ambient temperature by using a coefficient specified for each case diameter as follows:

$\Delta T=Kc \cdot (Ts-Tx)$

Where : Kc=Coefficient from table below
Ts=Surface temperature (deg) of capacitor can case
Tx=Ambient temperature (deg)

No air flow conditions.

| Diameter (mm) | ϕ5 to ϕ8 | | ϕ10 | ϕ12.5 | ϕ16 | ϕ18 | ϕ22 | ϕ25 |
|---|---|---|---|---|---|---|---|---|
| Kc | 1.10 | | 1.15 | 1.20 | 1.25 | 1.30 | 1.35 | 1.40 |
| Diameter (mm) | ϕ30 | ϕ35 | ϕ40 | ϕ50 | ϕ63.5 | ϕ76 | ϕ89 | ϕ100 |
| Kc | 1.50 | 1.65 | 1.75 | 1.90 | 2.20 | 2.50 | 2.80 | 3.10 |

Also, you can roughly estimate a ΔT by using the following equation without need to measure.

NIPPON CHEMI-CON

# PRECAUTIONS AND GUIDELINES

$$\Delta T=\Delta T_0\cdot(Ix/Io)^2$$

Where : $\Delta T_0$=5 deg for 105℃ maximum rated capacitors.
Io =Rated ripple current ($A_{RMS}$) : if its frequency is different from operating ripple current Ix, it needs converting by using a frequency multiplier prescribed in the catalog.
Ix =Operating ripple current ($A_{RMS}$) actually flowing into a capacitor

Like switching power supplies, if the operating ripple current consists of commercial frequency element and switching frequency element(s), an internal power loss is expressed by the following equation.

$$W=(If_1)^2\cdot ESR_{f1}+(If_2)^2\cdot ESR_{f2}+\cdots+(If_n)^2\cdot ESR_{fn}$$

Where : W =Internal power loss
$I_{f1}\cdots I_{f1}$ =Ripple currents at every frequencies f1‥fn
$ESR_{f1}\cdots ESR_{fn}$=ESR's at every frequenciesf 1‥fn

The above equation can be transformed into another equation to get a ripple current value in accordance with the frequency of the rated ripple current, each of $ESR_{f1},\cdots ESR_{fn}$ is approximately equal to $ESR_{f0}$ divided by square value of the frequency multiplier ($F_{f1}\cdots F_{fn}$). Here $ESR^{f0}$ is the value at the frequency of the rated ripple current and $F_{f1}\cdots F_{fn}$ is a conversion coefficient from one frequency to another in accordance with the frequency f1‥fn.

$$ESR_{f1}=ESR_{f0}/(Ff_1)^2$$
$$\vdots$$
$$ESR_{fn}=ESR_{f0}/(Ff_n)^2$$

Relationship of $w=(L_{Ripple})^2\cdot R_{ESR}$ leads Ix as follows:

$$Ix=\sqrt{W/ESR_{f0}}$$

The above is rewritten in the following equation:

$$Ix=\sqrt{(I_{f1}/F_{f1})^2+(I_{f2}/F_{f2})^2+\cdots\cdots(I_{fn}/F_{fn})^2}$$

Where : Ix =Ripple current in accordance with the frequency of the rated ripple current
$I_{f1}\cdots\cdots I_{fn}$ =Operating ripple currents at every frequencyf1‥fn
$F_{f1}\cdots\cdots F_{fn}$=Frequency multipliers for every frequencyf1‥fn prescribed in the catalog, based on the fact that the internal resistance of a capacitor varies with frequency.

## Cleaning Agents

a. Cleaning agents penetrate into a capacitor.
Solvent contacts the rubber seal of a capacitor. Some percentage of solvent does not penetrate but a percentage suceeds in entering and defusing inside the capacitor.
b. Cleaning agents decompose and release halogen ions.
In the electrolyte of the inside element, the halides in the cleaning agents become hydrolyzed and release halogen ions as follows,

$$RX+H_2O\rightarrow ROH+H^++X^-$$

RX : Halide
$X^-$ : Halogen ion

c. Corrosion
The halogen ions attack the aluminum foil by the following anodic half-cell reaction:

$$Al+3X^-\rightarrow AlX_3+3e$$

The AlX3 further becomes hydrolyzed and release the halogen ion again:

$$AlX_3+3H_2O\rightarrow Al(OH)^3+3H^++3X^-$$

The halogen ions release by this hydrolysis reaction further attacks the aluminum according to the previous reaction formula, and these reactions are repeated and accelerated when voltage and temperature is applied. Also, the hydrogen ions increase the local acidity which causes the oxide dielectric to dissolve. Thus, localized corrosion accelerates to corrode both the aluminum metal and the dielectric. In addition, a terpene or petroleum system cleaning solvent will be absorbed into the rubber seal of the capacitor. The rubber seal finally weakens. An alkaline saponification detergent will damage the aluminum metal and marking. In summary, recommended cleaning agents are halogen free. Terpene, petroleum, alkali detergent and any solvent making the rubber seal material deteriorate are not recommended.

### Compatible cleaning agents:

In line with recent global environmental warnings (Greenhouse effect and other environmental destruction by depletion of the ozone layer), new types of cleaning agents have been commercialized and substituted as CFC-113,1,1,2-trichloroethlene and 1,1,1-trichloroethylene. The following are recommended cleaning conditions for some of new cleaning agents.

**Higher alcohol system cleaning agents**
Recommended cleaning agents:
Pine Alpha ST-100S (Arakawa Chemical)
Clean Through 750H, 750K, 750L, and 710M (Kao)
Technocare FRW-14 through 17 (GE Toshiba Silicones)
Cleaning conditions:
1) Capacitors are capable of withstanding immersion or ultrasonic cleaning for 10 minutes at a maximum liquid temperature of 60℃ using the above cleaning agents. Find the optimum conditions for washing, rinsing, and drying. Be sure not to rub the marking off the capacitor by contact with any other components on the PC board. Note that shower cleaning adversely affects the marking.
2) To rinse by water, control the conditions such as temperature and water pressure to avoid sleeve shrinkage.
3) Clean Through 750H and similar are weak-alkaline solvents. Do not leave the alkaline on the capacitor after cleaning process.

### CFCs substitute solvents (HCFC system)

Asahi Glass AK225AES solvent is usable only with solvent resistant type capacitors, which are designed with reinforced seal constructions and modified electrolyte. This product does not penetrate the capacitor and deactivate halogen ions. However, AK225AES is one of the solvents which will have a restricted usage in future from the environmental point of view.

# PRECAUTIONS AND GUIDELINES

Non-Halogenated Solvent Cleaning

**HCFC solvents: AK225AES (Asahi Glass)**
Cleaning conditions:
Solvent resistant type capacitors are capable of withstanding immersion, ultrasonic or vapor cleaning for 5 minutes; exception is 2 minutes max. for KRE and KRE-BP series capacitors for 3 minutes and SRM series capacitors.
Applicable series (only for solvent resistant products):

Surface mount : MVS, MVA(4 to 63Vdc), MV, MVE(6.3 to 63Vdc), MVK, MKA, MZA, MLA, MVY(6.3 to 63Vdc), MVJ, MVL, MVH(10 to 50Vdc), MV-BP, MVK-BP, PXF, PXE, PXA, PXH, MZD, MLD

Radial lead : SRM, KRE, KMA, SRG, KRG , SMG(6.3 to 250Vdc), SME-BP, KMQ(6.3 to 100Vdc), KMG(6.3 to 250Vdc), KME-BP, LXZ, LXY, LXV, FL, GXE(10 to 50Vdc), GXL, LBG, LLA, PS, PSC, PSA, GPA

**Isopropyl alcohol cleaning agents**
IPA (Isopropyl Alcohol) is one of the most acceptable cleaning agents; it is necessary to maintain a flux content in the cleaning liquid at a maximum limit of 2 Wt. %, because chlorides in flux dissolves in the cleaning liquid during the cleaning process.
Xylene -additive IPA may make the rubber seal deteriorate.

**Non-clean flux**
Both ionic halogen and non-ionic halogens damage the capacitor when they penetrate in through the rubber seal. Note that some of the fluxes called non-halogenated flux contains less ionic halogen activator but actually a large amount of non-ionic halogen.
Per our analysis, AHQ3100K(Asahi) and POZ6(Senjyu) minimize ionic and non-ionic halogens.

**Other Precautions to wash capacitors**
a) Monitor conductivity, pH, specific gravity and water content of cleaning agents. Contamination adversely affects the characteristics.
b) The solvent may stay between the end seal and the PC board if the capacitor is mounted directly onto the PCB without a small gap. The residual solvent can cause defects. Also, washing for more than the specified time causes solvent residual. Therefore, wash the assembly board for at least 10 minutes at the recommended temperature. Be sure not to expose the capacitors under solvent rich conditions or keep capacitors inside a closed container.
c) Reforming the leads of the capacitor to fit lead spacing on the PC board causes cleaning agents to get into the inside capacitor. This may result in corrosion to the foil. Therefore, use the capacitors, which fit the hole spacing on the PC board or reform the lead wires in a manner which will not cause mechanical stress to the capacitor body.