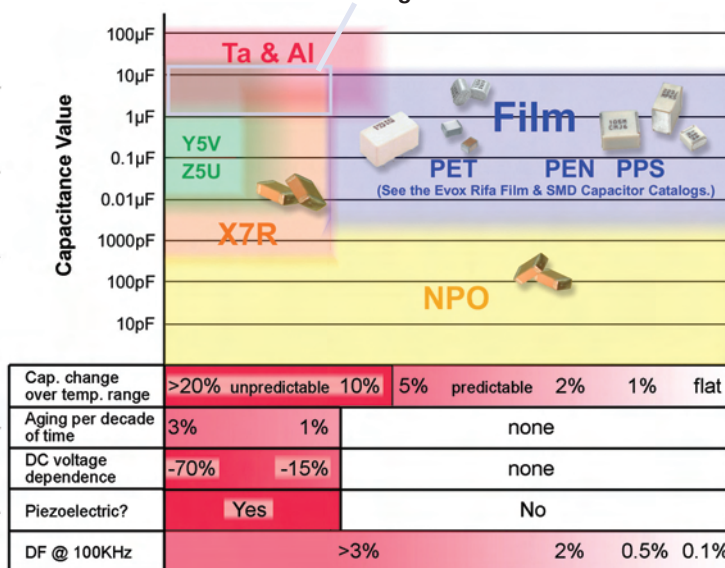


SELECTION GUIDELINES FOR SURFACE MOUNT CAPACITORS

Surface Mount Capacitor Application Chart

While variations do exist, the chart below provides a general guideline for selecting the correct surface mount capacitor. Begin at the left edge of the red stripes which denote the various electrical properties. Move to the right until all of the properties meet your design requirements. Then move upward to the capacitance value of interest.

Film capacitors are recommended for these applications if transients or surges may occur. "Self healing" metallized film capacitors are designed to recover from a transient over voltage.



TERMS AND DEFINITIONS

Rated capacitance (C_R)

The rated capacitance of a capacitor is the value which is indicated upon it. The capacitance is measured at 1 kHz and +23°C.

Rated voltage (U_R)

The rated voltage is the maximum direct voltage or the maximum RMS alternating voltage which may be applied continuously to the terminals of the capacitor at any temperature within the rated temperature range.

Rated temperature

The rated temperature is the maximum ambient temperature at which the rated voltage can be continuously applied.

Climatic category

The climatic category states the temperature range and the humidity class. For example 40/085/56 stands for -40°C to +85°C; 56 states that the steady state humidity test should take 56 days.

Tangent of the loss angle (Dissipation factor, tanδ)

The tangent of the loss angle is the power loss of the capacitor divided by the reactive power of the capacitor at a sinusoidal voltage of specified frequency. The tangent of loss angle is given in percent (Eg 0.01 tanδ=1%).

The dissipation factor is of interest especially when the capacitor is operated on AC. The dielectric loss causes heating of the capacitor which under unfavourable circumstances may lead to a destructive breakdown. This will not happen if the

capacitor is used within specified limits. The ability to withstand short duration thermal and voltage overload is greater for small capacitors than for large ones.

Insulation resistance

The values given in the catalogue indicate the insulation resistance after one minute of electrification at +23°C with the following voltages: 100 VDC for capacitors rated at 100 to 500 VDC and 500 VDC for capacitors rated at 500 VDC. Insulation resistance is temperature dependent and is approximately halved for each 7 °C of temperature rise.

Multilayer construction provides insulation resistance higher than that of single-layer types.

Pulse operation

Capacitors loaded with pulses with fast rise or fall times (high dU/dt) will be exposed to high current pulses. In order not to overload the internal connections the current must be limited. The current limits for a specific type are dependent upon:

- Amplitude and form of the pulse
- Rated voltage of the capacitor
- Capacitance
- Geometrical configuration of the winding

$$dU/dt = U_R / (R \times C)$$

- U_R = Rated voltage
- R = Discharge resistor
- C = Rated capacitance

At repeated pulse operation, self-heating, ambient temperature and cooling set the

load limit.

Pulse current limits are commonly expressed in the form of maximum permitted dU/dt in volts per microsecond. The figures stated in the type specifications refer to an unlimited number of pulses charging or discharging from rated voltage U_R.

Passive flammability

The ability of a capacitor to burn with a flame as a consequence of the application of an external source of heat.

Resonance frequency

The resonance frequency of a capacitor is reached when

$$\omega L = 1/\omega C$$

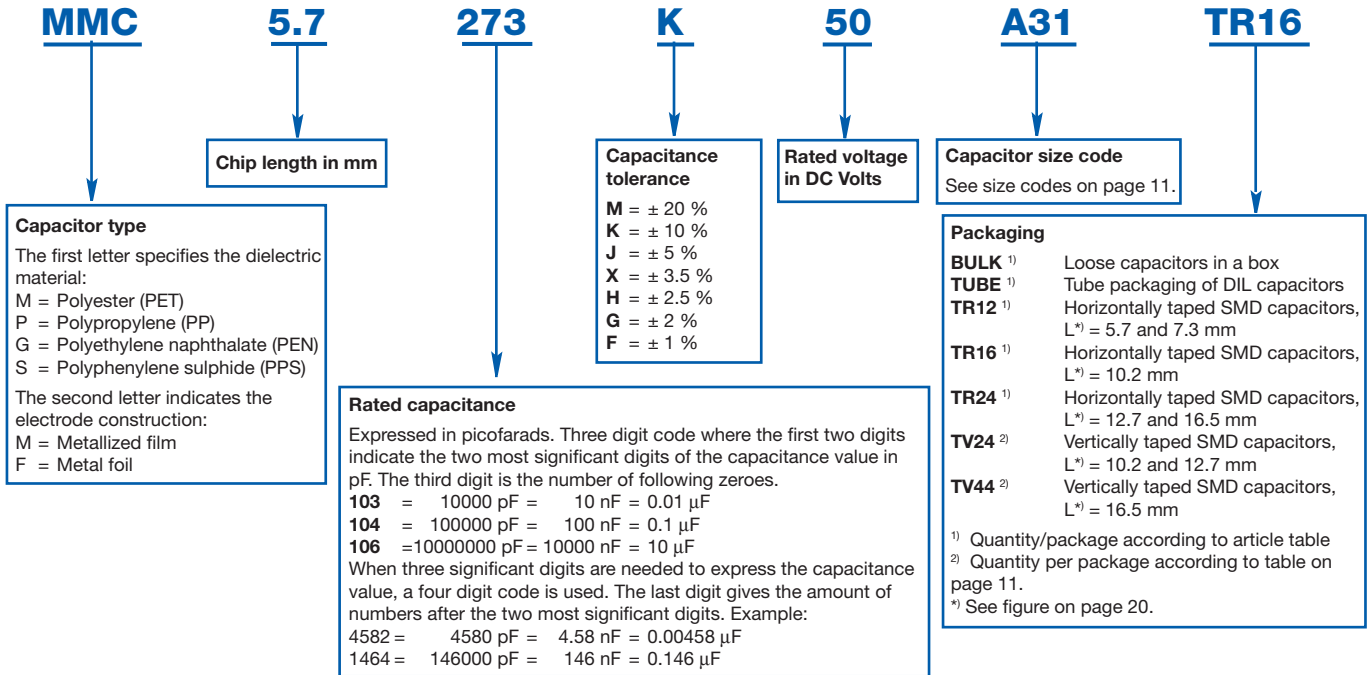
- ω = 2πf (f = frequency)
- L = inductance caused by the winding and the length of the leads
- C = the capacitance at f.

Dielectric absorption (DA)

Dielectric absorption describes the dielectric material's properties to "remember" the applied voltage. One method to define DA is: The capacitor is to be charged for one hour at rated voltage DC (U_R) then discharged through a resistor of 5 ohms for 10 seconds. The discharge resistor must then be disconnected and the recovery voltage U_r measured 15 minutes after disconnection. The dielectric absorption is defined by: DA = (U_r/U_R) x 100%

HOW TO ORDER SMD CAPACITORS

The Evox Rifa article code includes all the information needed to specify the product characteristics and type of packing. This article code construction applies for the following products in this catalogue: **MMC, SMC, GMC, GPC, SPC, GMW, SMW, MDC** and **MDS**.



THE MANUFACTURING CODE Y Z, ACCORDING TO IEC 60062

where Y = year, Z = month.

Year	Code	Year	Code	Year	Code	Month	Code	Month	Code
1991	B	2001	N	2011	B	Jan	1	July	7
1992	C	2002	P	2012	C	Febr	2	Aug	8
1993	D	2003	R	2013	D	March	3	Sept	9
1994	E	2004	S	2014	E	April	4	Oct	O
1995	F	2005	T	2015	F	May	5	Nov	N
1996	H	2006	U	2016	H	June	6	Dec	D
1997	J	2007	V	2017	J				
1998	K	2008	W	2018	K				
1999	L	2009	X	2019	L				
2000	M	2010	A	2020	M				

SIZE CODES OF SMD CAPACITORS

A size code has been added to the Evox Rifa SMD capacitors. The size code determines the size of the component and the packing quantities. The size codes are as follows:

Encapsulated SMD capacitors MMC, SMC, GMC, GPC, SPC

Size code in Article Code	Box dimensions in mm ± 0.2				Quantity per package			Packaging code		
	B	H	L	p	Bulk	Reel	Reel, vertical taping	Bulk	Reel	Reel, vertical taping
A31	9.1	5.5	10.2	10.2	1000	800	500	BULK	TR16	TV24
B31	11.5	6.5	12.7	12.7	1000	600	400	BULK	TR24	TV24
C31	15.0	7.0	16.5	16.5	800	500	200	BULK	TR24	TV44
J31	5.0	2.5	5.7	5.7	2000	3100		BULK	TR12	
J33	5.0	3.0	5.7	5.7	2000	2400		BULK	TR12	
J35	5.0	4.0	5.7	5.7	2000	2100		BULK	TR12	
K31	6.0	2.5	7.3	7.3	2000	3100		BULK	TR12	
K33	6.0	3.0	7.3	7.3	2000	2500		BULK	TR12	
K35	6.0	3.5	7.3	7.3	2000	2300		BULK	TR12	
K37	6.0	4.5	7.3	7.3	1000	1700		BULK	TR12	

Naked SMD capacitors SMW, GMW

Size code in Article Code	Dimensions in mm				Quantity per package		Packaging code	
	B ± 0.4	H _{max}	L ± 0.4	p	Bulk	Reel	Bulk	Reel
J91	5.0	2.0	5.7	5.7	2000	3100	BULK	TR12
J93	5.0	3.0	5.7	5.7	2000	2400	BULK	TR12
J95	5.0	4.0	5.7	5.7	2000	2100	BULK	TR12
K91	6.0	2.0	7.3	7.3	2000	3100	BULK	TR12
K93	6.0	2.7	7.3	7.3	2000	2500	BULK	TR12
K95	6.0	3.2	7.3	7.3	2000	2300	BULK	TR12
K97	6.0	4.2	7.3	7.3	1000	1700	BULK	TR12

SIZE CODES OF DIL CAPACITORS

The size code in the article code determines the size of the component and the packing quantities.

Size code in Article Code	Box dimensions in mm ± 0.2				Leads per side	Quantity per package		Packaging code	
	B	H	L	p		Tube	Reel	Tube	Reel
A52	12.2	6.05	11.0	10.0	3	43		TUBE	
A53	12.7	9.0	14.0	10.0	3 or 4	34	200	TUBE	TR32
A54	12.2	6.05	13.5	10.0	3 or 4	35		TUBE	
A55	12.2	6.05	16.5	10.0	3, 4 or 5	28		TUBE	
A57	12.7	9.0	23.0	10.0	7 or 8	21		TUBE	
A58	12.7	11.0	23.0	10.0	7 or 8	21		TUBE	
B53	16.5	6.05	11.0	15.0	3	43		TUBE	
B55	16.5	6.05	12.2	15.0	3 or 4	39		TUBE	

PROPERTIES OF DIELECTRICS

POLYESTER
(Polyethylene Terephthalate, PET)
Metallized and Film/foil

High dielectric constant and high dielectric strength provides good volumetric efficiency for metallized polyester film capacitors. Metallized polyester film has excellent self-healing properties. Typical applications: Bypassing, coupling, filtering.

POLYESTER
(Polyethylene Naphthalate, PEN)
Metallized

High temperature Polyester. Relatively high dielectric constant and dielectric strength, and availability of thin films, provide good volumetric efficiency for metallized construction. High melting point allows SMD constructions and service in high ambient temperatures. General purpose capacitor.

POLYPROPYLENE (PP) *)
Metallized and Film/foil

Very low losses, low dielectric absorption, high dielectric strength, very high insulation resistance, and negative temperature coefficient. Typical applications: Stable oscillators and filters. Sample & hold circuits, pulse handling circuits, AC applications and mains filtering.

POLYCARBONATE (PC) **)
Metallized and Film/foil

Very low temperature dependency, wide operating temperature range, good long term stability, and low losses. Typical applications: Timers and filters. Applications in high ambient temperatures.

POLYPHENYLENE SULPHIDE (PPS)
Metallized

Low losses, wide operating temperature range, low temperature coefficient, good stability. Typical applications: Timers and filters. Automotive and other applications in high ambient temperatures. Available in SMD constructions.

PAPER
Metallized

High dielectric constant. Excellent self-healing properties and transient handling capability. High ionisation level due to impregnated dielectric material. Outstanding reliability in mains connected and other low frequency applications.

*) Polypropylene capacitors are not available as SMD, only for comparison.

**) Polycarbonate is no longer available. Replaced by polyphenylene sulfide.

NUMERICAL COMPARISON OF FILM MATERIALS

Material (Trade names)	Abbreviation	Min. film thickness (µm)	Dielectric constant at 1 kHz, +23°C	Operating temperature (°C)	Temperature coefficient (ppm/°C)	Dissipation factor at 1 kHz, +23°C	Insulation time constant (s) at +23°C	Dielectric absorption %
Polyester (Mylar, Lumirror, Hostaphan, Diafoil)	PET	0.9	3.3	-55 ... +100 (... +125)	+400 (±200)	0.5%	25 000	0.5
Polyethylene Naphthalate	PEN	1.4	3.0	-55 ... +125 (... +150)	+200 (±150)	0.4%	25 000	1.2
Polycarbonate **) (Makrofol)	PC	2.0	2.8	-55 ... +125	0 (±100) nonlinear	0.15%	25 000	0.06
Polypropylene *) (Torayfan, Trespaphan)	PP	3.5	2.2	-55 ... +105	-200 almost linear	0.03%	100 000 (-100, +50)	0.01
Polyphenylene sulfide (Torelina)	PPS	1.2	3.0	-55 ... +125 (... +150)	0 (-50) up to +100 °C	0.06%	25 000	0.05
Paper Impregnated	P	7.0	5.5	-40 ... +115	+1200 (±200)	0.8%	15 000	

*) Polypropylene capacitors are not available as SMD, only for comparison.

**) Polycarbonate is no more available, only for comparison. Replaced by polyphenylene sulfide.

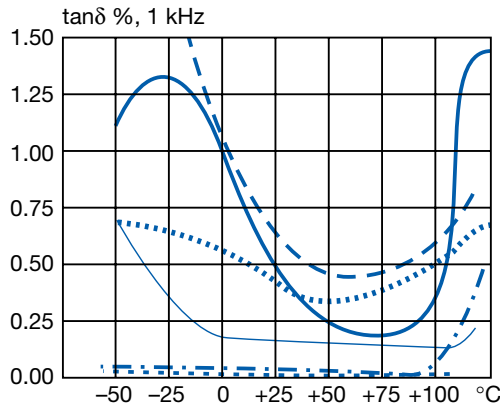
WARRANTY, PRODUCT LIABILITY

Evox Rifa warrants that the goods manufactured by Evox Rifa are free from defects in design, material and workmanship. Evox Rifa's liability under this warranty shall be limited to replacement or repair free of charge, at one of Evox Rifa's factories selected by Evox Rifa, provided that notification of such failure or defect is given to Evox Rifa immediately upon the same becoming apparent and that on Evox Rifa's request and instruction the goods are promptly returned to Evox Rifa carriage paid by buyer. In case the goods thus returned as defective, prove to be without fault or defect, Evox Rifa is entitled to charge buyer 100% of the value of the returned goods.

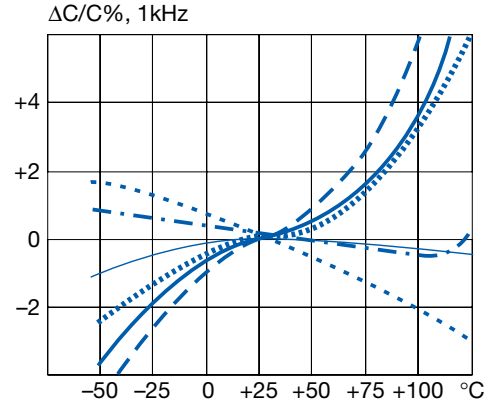
If the goods supplied or part thereof are not manufactured by or branded Evox Rifa, Evox Rifa will only extend to the buyer the benefit of the warranty granted by the manufacturer of the goods. Evox Rifa's liability is further limited to a period of 12 months from the date of shipment to buyer. Evox Rifa shall not be liable for any defect which is due to accident, fair wear and tear, negligent use, tampering, improper handling, improper use, improper operation or improper storage or any other default on the part of any person other than Evox Rifa. Evox Rifa shall have no other liabilities in case of defective goods than those stated above and shall under no circumstances

be liable for any consequential loss or damage arising from the use of goods sold by Evox Rifa. Liability under paragraph 823 BGB is expressly excluded. The above limitations of Evox Rifa's liability for defective goods shall apply also with regard to product liability, and Evox Rifa shall have no responsibility for injury to persons or for damage to goods or property of any kind. In case of product liability claims from third parties against Evox Rifa, not falling within Evox Rifa's liability in accordance with the above, buyer shall hold Evox Rifa harmless.

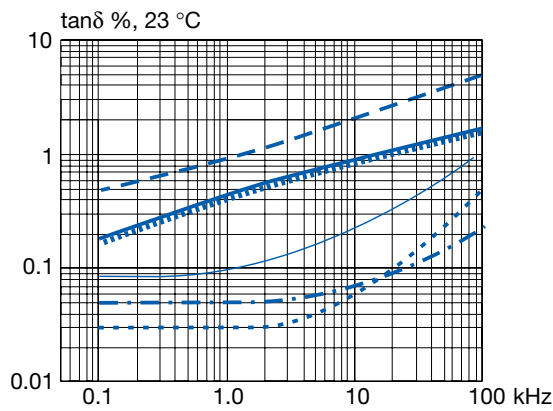
PROPERTIES OF DIELECTRICS



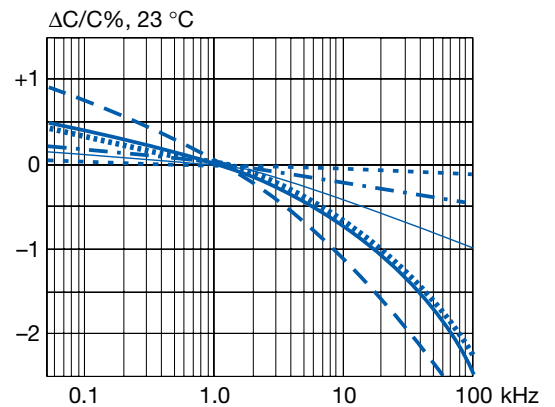
Typical dissipation factor vs. temperature



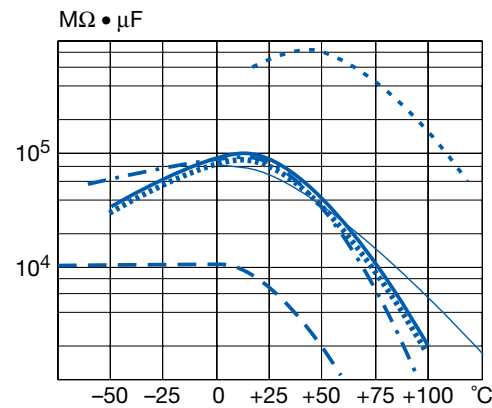
Typical capacitance vs. temperature



Typical dissipation factor vs. frequency



Typical capacitance vs. frequency

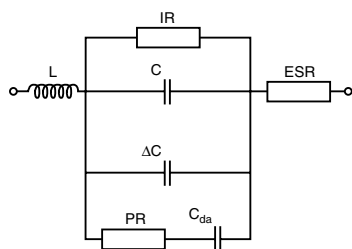


Typical insulation resistance vs. temperature

- Polyester PET
- Polyethylene Naphthalate PEN
- Polycarbonate PC *
- · - · - Polyphenylene sulfide PPS
- Polypropylene PP
- - - Paper

*) Please note: Polycarbonate is no longer available, only for comparison.

CAPACITOR EQUIVALENT DIAGRAM



- C = nominal value of the capacitor
- L = inductance (leads, metallization, winding)
- ESR = equivalent series resistance (leads, metallization, metal spraying)
- IR = insulation resistance (properties of the dielectric material)

- ΔC = capacitance change (depending on changes in temperature, DC voltage and/or frequency)
- PR = dielectric polarization resistance
- C_{da} = dielectric absorption

RELIABILITY

The reliability of a capacitor is mainly a function of:

- The construction; dielectric material and its thickness
- The manufacturing process
- The application; electrical stress and temperature

The failure rate, λ , vs. voltage and temperature for the most common dielectric materials is shown in the diagrams below. U_R = rated voltage.

The operating life (L) can be calculated as:

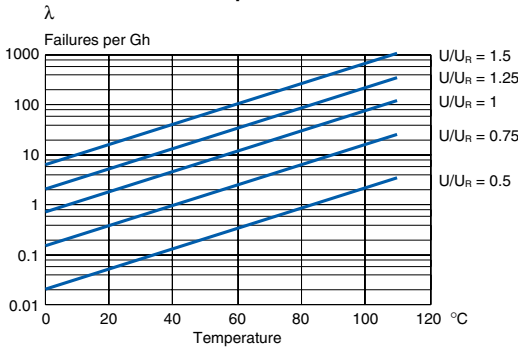
$$L = \frac{1}{\lambda} \times \ln \frac{1}{1 - F}$$

where F is the expected probability of failures.

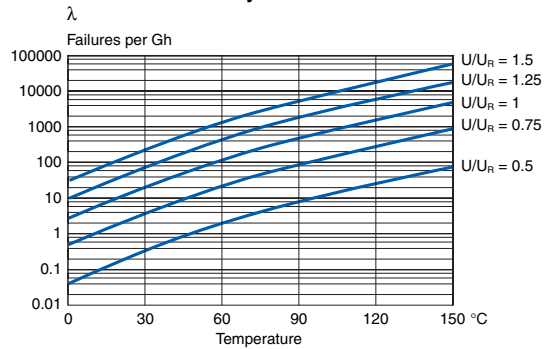
Example: if $\lambda = 20 \times 10^{-9}$ it takes 6 years to have
 $F = 0.001$ (0.1% failures)
 and 300 years to have
 $F = 0.05$ (5% failures)

MTBF (mean time between failures) = $1 / \lambda$

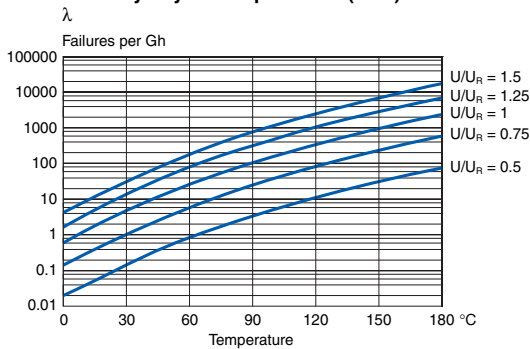
Failure rates vs. temperature and voltage
Paper



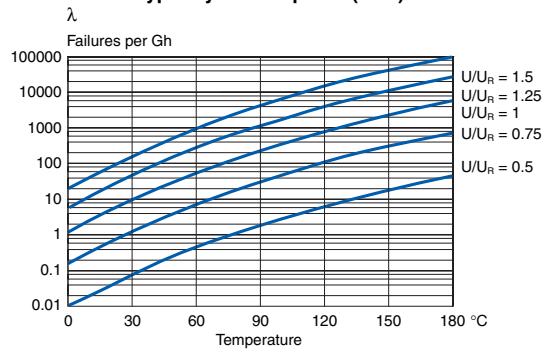
Failure rates vs. temperature and voltage
Polyester



Failure rates vs. temperature and voltage
Polyethylene Naphthalate (PEN)



Failure rates vs. temperature and voltage
Polyphenylene Sulphide (PPS)



EXVOX RIFA QUALITY

The quality of Evox Rifa's products and services is based on a continuous strive towards excellency throughout the whole organization. Skilled and motivated personnel, technical know-how and modern equipment combined with extensive quality assurance make Evox Rifa the supplier of components of the highest quality.

The up-to date quality tools like Statistical Process Control (SPC) in various forms, Failure Mode and Effect Analysis (FMEA), Accelerated Reliability Testing and Zero Defect Acceptance concept in final testing are the corner stones of the every day quality work. Cross-functional teams are routinely used in Problem Solving (8D method) with effective Failure Analysis support.

As a visible evidence of our quality, all the manufacturing units world wide are certified according to ISO 9001. In addition to that, the relevant factories have the automotive industry's QS9000 certifications, which is in process to be upgraded to ISO TS 16949 during 2006. The Finnish factory has also

IECQ approval. Our well known EMI suppression capacitors carry the important safety marks for world wide applications.

Evox Rifa companies have the following certificates:

ISO 14001
P.T. Evox Rifa, Batam, Indonesia

ISO 9001
BHC Components
Evox Rifa AB, Gränna, Sweden
Evox Rifa Oy, Suomussalmi, Finland
Nantong Evox Rifa Electrolytics, P.R. China
P.T. Evox Rifa, Batam, Indonesia

ISO TS 16949
Evox Rifa AB, Gränna, Sweden
Evox Rifa Oy, Suomussalmi, Finland
P.T. Evox Rifa, Batam, Indonesia

QS9000 (TS 16949 pending at the time of printing of this catalogue)

Nantong Evox Rifa Electrolytics, P.R. China
IECQ
Evox Rifa Oy, Suomussalmi Finland

Customer in Focus

The only real measure of our total quality performance is the acceptance of our customers.

Evox Rifa's quality work has always been focused on the customer. We have actively made quality agreements with ambitious goal settings with World-Class Companies – small and large.

This active quality cooperation has been most fruitful to Evox Rifa by bringing in most modern quality tools, but especially by providing us with reliable feedback on the performance quality of our products and services.

The cooperation has not only lead to continuous improvement of the quality of our products, but sometimes also helped our customers to spot some weaknesses in their designs. A visible sign of these close links between Evox Rifa and various customers is the numerous prestigious customer approvals and the performance awards addressed to Evox Rifa and BHC Components.

ENVIRONMENTAL COMMITMENT

The SMD capacitors don't contain any substances which have been listed in the restriction of hazardous substances Directive 2002/95/EC (RoHS).

As an environmentally conscious company, Evox Rifa (including BHC Components) is working continuously with improvements concerning the environmental effects of both our capacitors and the production of them.

In Europe (RoHS Directive) and in some other geographical areas like China, legislation has been put on place to prevent the use of some hazardous materials, like Lead (Pb), in electronic equipment. All products

in this catalogue are produced to help our customer's obligations to guarantee their products to fulfil these legislative requirements. The Evox Rifa SMD capacitors have always been designed without using any RoHS restricted materials.

Evox Rifa will follow closely any changes in legislation world wide, and makes any necessary changes in its products, whenever needed.

A symbol is used on the packaging labels for RoHS compatible capacitors. See pictures to the right.

Because of customer requirements there may appear additional markings like LF =

Lead Free or LFW = Lead Free Wires on the label.

RoHS

Compliant

**RoHS Compliant****Examples of RoHS Compliance markings on packaging labels**

PRODUCT SPECIFICATION

All descriptions, drawings and other particulars (including dimensions, materials and performance data) given by Evox Rifa are as accurate as possible but, being given for general information, are not binding on Evox Rifa unless specifically agreed in writing. All dimensions and materials are, unless otherwise stated, subject to reasonable variations resulting from the raw material available or arising in the ordinary course of manufacture. Any performance data are based upon Evox Rifa's experience and are such as Evox Rifa normally expects to achieve.

VACUUM PACKAGING

Some of the SMD and DIL capacitors are vacuum packaged. The reels are then packaged in vacuum, according to EIA 583 standard "Packaging Material Standards for Moisture Sensitive Items". The vacuum package contains a desiccant, which can absorb 20% relative humidity (RH) at +20 °C. Therefore, the recommended maximum storage time is 12 months at the temperature lower than

+40 °C RH less than 90 %. When the package is opened, it should be used within 168 hours at the temperature lower than +30 °C RH less than 60 % according to JEDEC J-STD-020C (July 2004), Sensitivity level 3. If the circumstances for storage and usage differ from these recommendations, please consult Evox Rifa.

WASHING AND DRYING

Evox Rifa recommends not to wash the naked SMD capacitors. If washing is requested, it should be made gently, according to the following instructions:

Statement on Washing of Naked Wound SMD Capacitors:

Because the "naked" wound SMD capacitors do not have any encapsulation and the protection of the active element is made with extra deactivated turns of the same dielectric film, which forms the capacitor, the components of flux and/or washing detergent left over on the element at the time of washing may be activated and invade inside the capacitor. This may cause adverse effects.

If washing is used, use flux and solder paste with halogen content of 0.1wt.% or less. The internal evaporated electrodes may deteriorate due to activated halogens, if the concentration is high.

The ultrasonic agitation is not recommended during washing, because it can cause the washing agents to penetrate the outer layers of the capacitor element. When using a washing method, where water with detergent or the rinsing water is sprayed on to the substrate at high pressure, the protective film around the element surface may peel off slightly due to the water pressure. This is mainly a visual failure, and should not influence the performance of the capacitors. The capacitors have to be dried after water

washing so that no detergent is left over. If drying is insufficient, and the detergent is left over on the element surface, the insulation resistance may be reduced. The following solvents are suitable for washing of the "naked" SMD capacitors:

- Ethanol
- Isopropanol
- n-propanol

Even when suitable solvents are used, a reversible change of the electrical characteristics may occur in uncoated capacitors immediately after washing. If testing of the boards with these capacitors is performed immediately after washing, it is recommended that the capacitors are dried (e.g. 4 hours at 70 °C) before being subjected to electrical testing.