ALC12 Series, +85ºC

Overview

KEMET's ALC12 Series of capacitors is a high CV snap-in version of the ALC10 Series range. Both series are designed for applications where high reliability and compact sizes are important, such as switch mode power supplies (SMPS) and frequency converters.

Applications

KEMET's ALC12 Series of capacitors is designed for applications where high reliability and compact sizes are important, such as switch mode power supplies (SMPS) and frequency converters.

Benefits

- Compact size
- 2,000 hours at +85°C (V_R, I_R applied)
- Excellent surge voltage capability
- Optimized designs available upon request

Part Number System

ALC12	A	561	CB	200
Series	Termination	Capacitance Code (µF)	Size Code	Voltage (VDC)
Snap-In type Aluminum Electrolytic	See Termination Table	First 2 digits equals first 2 significant figures, 3rd digit is the number of additional zeros.	See Dimension Table	200 = 200 250 = 250 350 = 350 400 = 400 450 = 450

Performance Characteristics

Item	Performance Characteristics		
Capacitance Range	150 – 8,200 µF		
Rated Voltage	200 – 450 VDC		
Operational Temperature Range	-40 to +85°C		
Capacitance Tolerance	±20% at 100 Hz / +20°C		
Operational Lifetime	D (mm)	Rated Voltage and Ripple Current at +85°C (hours)	Rated Voltage at +85°C (hours)
	30–50	2,000	9,000
End of Life Requirement	Δ C/C < ±10%, ESR < 2 x initial ESR value, IL < initial specified limit		
Shelf Life	2,000 hours at +85°C or 30,000 hours at +40°C 0 VDC		
Leakage Current	I = 0.003 CV or 6,000 (µA, whichever is smaller)		
	C = rated capacitance (µF), V = rated voltage (VDC). Voltage applied for 5 minutes at +20°C.		
Vibration Test Specifications		Procedure	Requirements
	D ≤ 40 mm	0.75 mm displacement amplitude or 10 g maximum acceleration. Vibration applied for three 2-hour sessions at 10 – 500 Hz (Capacitor clamped by body).	No leakage of electrolyte or other visible damage. Deviations in capacitance and tanδ from initial measurements must not exceed: Δ C/C < 5%
	D > 40 mm	0.35 mm displacement amplitude or 5g maximum acceleration. Vibration applied for three 0.5-hour sessions at 10 – 55 Hz (Capacitor clamped by body).	
Standards	IEC 60384–4 long life grade 40/85/56		

Surge Voltage

Condition	Voltage (VDC)				
	200	250	350	400	450
≤ 30s Surge followed by a no load period of 330s, 1,000 cycles at +85°C	230	288	385	440	495
≤ 500 ms surge, 100 cycles at 20°C, occurring randomly throughout the life of the capacitor	350	400	500	520	550

Test Method & Performance

Endurance Life Test		
Conditions	Performance	
Temperature	+85°C	
Test Duration	2,000 hours	
Ripple Current	Rated ripple current in specified table	
Voltage	The sum of DC voltage and the peak AC voltage must not exceed the rated voltage of the capacitor	
Performance	**The following specifications will be satisfied when the capacitor is tested at +20°C:**	
Capacitance Change	≤ 160 V	Within 15% of the initial value
	> w160 V	Within 10% of the initial value
Equivalent Series Resistance	Does not exceed 200% of the initial value	
Leakage Current	Does not exceed leakage current limit	

Dimensions – Millimeters

Size Code	Dimensions in mm	
	D	L
	-0/+1	±2
CB	30	30
CC	30	35
CD	30	40
CE	30	45
CF	30	50
DB	35	30
DC	35	35
DD	35	40
DE	35	45
DF	35	50
DG	35	55
DH	35	60
DL	35	80
EB	40	30
EC	40	35
ED	40	40
EE	40	45
EF	40	50
EG	40	55
EH	40	60
Note: Dimensions include sleeving		

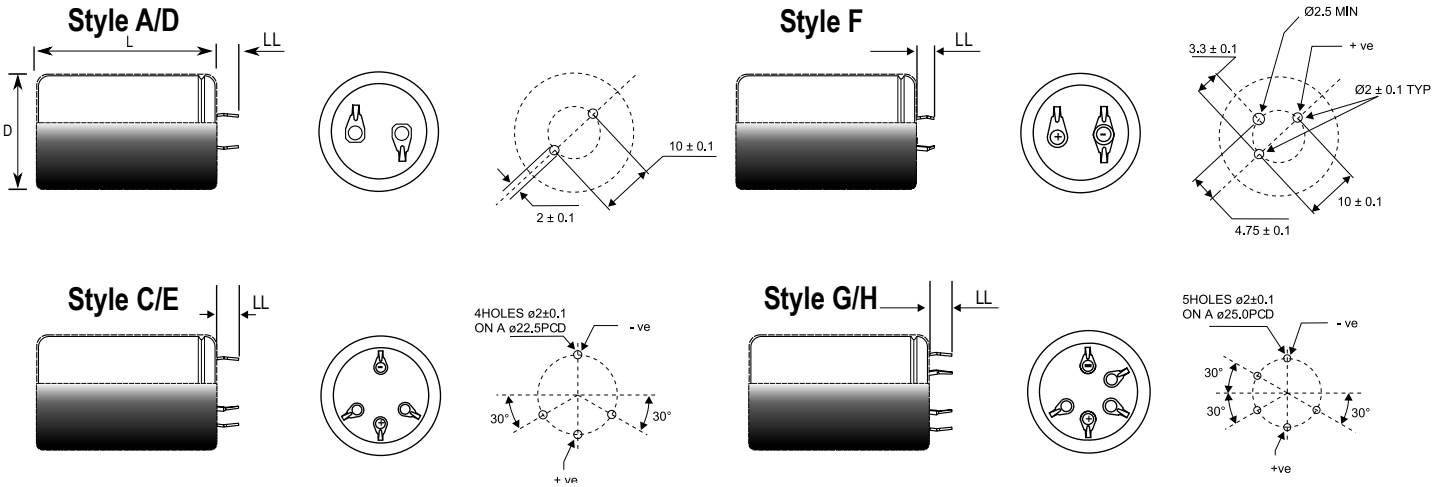
Size Code	Dimensions in mm	
	D	L
	-0/+1	±2
EL	40	80
EP	40	105
FB	45	30
FC	45	35
FD	45	40
FE	45	45
FF	45	50
FG	45	55
FH	45	60
FL	45	80
FP	45	105
KB	50	30
KC	50	35
KD	50	40
KE	50	45
KF	50	50
KG	50	55
KH	50	60
KL	50	80
KP	50	105
Note: Dimensions include sleeving		

Termination Tables

Termination Code / Diameter (mm)	A	D	F	C	E	G	H
30	•	•	•				
35	•	•	•	•	•		
40	•	•	•	•	•	•	•
45				•	•	•	•
50				•	•	•	•

Mounting: These capacitors are designed to be mounted by their terminations alone and may be used in any position. Dummy pins must be isolated on 4 and 5 pin styles.

Termination Code	Termination Style	LL ±1
Standard Termination Option		
A	2 Pin	6.3
G (D ≥ 45)	5 Pin	6.3
Other Termination Options		
D	2 Pin	4
F	3 Pin	4
C	4 Pin	6.3
E	4 Pin	4
H	5 Pin	4
Dimensions in mm		



Shelf Life

The capacitance, ESR and impedance of a capacitor will not change significantly after extended storage periods, however the leakage current will very slowly increase. KEMET products are particularly stable and allow a shelf life in excess of three years at 40°C. See sectional specification under each product series for specific data.

Re-age (Reforming) Procedure

Apply the rated voltage to the capacitor at room temperature for a period of one hour, or until the leakage current has fallen to a steady value below the specified limit. During re-aging a maximum charging current of twice the specified leakage current or 5 mA (whichever is greater) is suggested.

Reliability

The reliability of a component can be defined as the probability that it will perform satisfactorily under a given set of conditions for a given length of time.

In practice, it is impossible to predict with absolute certainty how any individual component will perform; thus, we must utilize probability theory. It is also necessary to clearly define the level of stress involved (e.g. operating voltage, ripple current, temperature and time). Finally, the meaning of satisfactory performance must be defined by specifying a set of conditions which determine the end of life of the component.

Reliability as a function of time, R(t), is normally expressed as: $R(t)=e^{-\lambda t}$
where R(t) is the probability that the component will perform satisfactorily for time t, and λ is the failure rate.

Failure Rate

The failure rate is the number of components failing per unit time. The failure rate of most electronic components follows the characteristic pattern:

- Early failures are removed during the manufacturing process.
- The operational life is characterized by a constant failure rate.
- The wear out period is characterized by a rapidly increasing failure rate.

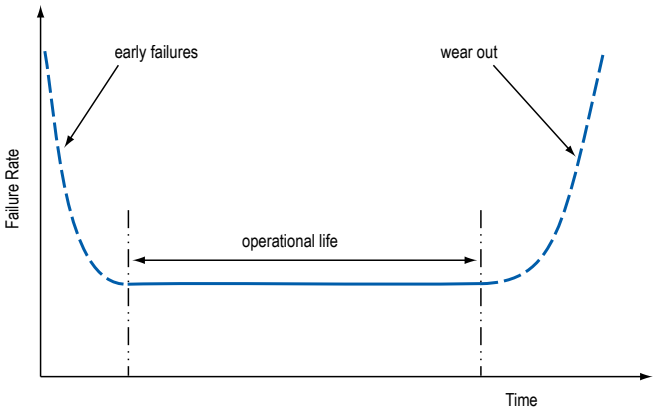
The failures in time (FIT) are given with a 60% confidence level for the various type codes. By convention, FIT is expressed as 1×10^{-9} failures per hour. Failure rate is also expressed as a percentage of failures per 1,000 hours.
e.g., 100 FIT = 1×10^{-7} failures per hour = 0.01%/1,000 hours

End of Life Definition
Catastrophic Failure: short circuit, open circuit or safety vent operation
Parametric Failure:

- Change in capacitance > ±10%
- Leakage current > specified limit
- ESR > 2 x initial ESR value

MTBF

The mean time between failures (MTBF) is simply the inverse of the failure rate.
MTBF= 1/λ



The failure rate is derived from our periodic test results. The failure rate (λ_R) is, therefore, only given at test temperature for life tests. An estimation is also given at 40°C. The expected failure rate for this capacitor range is based on our periodic test results for capacitors with structural similarity. Failure rate is frequently quoted in FIT (Failures In Time) where 1 FIT = 1 x 10^{-9} failures per hour. Failure rate per hour includes both catastrophic and parametric failures.

T_a	**Failure Rate per Hour**
85°C	250 FIT
40°C	12 FIT

Environmental Compliance

As an environmentally conscious company, KEMET is working continuously with improvements concerning the environmental effects of both our capacitors and their production. In Europe (RoHS Directive) and in some other geographical areas like China, legislation has been put in place to prevent the use of some hazardous materials, such as lead (Pb), in electronic equipment. All products in this catalog are produced to help our customers' obligations to guarantee their products and fulfill these legislative requirements. The only material of concern in our products has been lead (Pb), which has been removed from all designs to fulfill the requirement of containing less than 0.1% of lead in any homogeneous material. KEMET will closely follow any changes in legislation world wide and makes any necessary changes in its products, whenever needed.

Some customer segments such as medical, military and automotive electronics may still require the use of lead in electrode coatings. To clarify the situation and distinguish products from each other, a special symbol is used on the packaging labels for RoHS compatible capacitors.

Because of customer requirements, there may appear additional markings such as LF = Lead Free or LFW = Lead Free Wires on the label.

RoHS Compliant

Table 1 – Ratings & Part Number Reference

VDC	Rated Capacitance	Size Code	Case Size	Ripple Current		ESR Maximum	Impedance Maximum	Part Number
	100 Hz 20°C (µF)		D x L (mm)	100 Hz 85°C (A)	10 kHz 85°C (A)	100 Hz 20°C (mΩ)	10 kHz 20°C (mΩ)	
200	560	CB	30 x 30	1.75	2.81	342	224	ALC12(1)561CB200
200	680	CC	30 x 35	2.06	3.36	278	181	ALC12(1)681CC200
200	1000	CD	30 x 40	2.52	3.81	201	135	ALC12(1)102CD200
200	1000	DC	35 x 35	2.58	3.63	218	151	ALC12(1)102DC200
200	1200	CF	30 x 50	3.09	4.86	162	107	ALC12(1)122CF200
200	1200	DD	35 x 40	2.96	4.18	181	125	ALC12(1)122DD200
200	1200	EB	40 x 30	2.26	2.75	243	186	ALC12(1)122EB200
200	1500	EC	40 x 35	2.73	3.35	190	145	ALC12(1)152EC200
200	1800	DF	35 x 50	3.70	5.01	128	91	ALC12(1)182DF200
200	1800	ED	40 x 40	3.17	3.90	156	119	ALC12(1)182ED200
200	2200	DH	35 x 60	4.21	5.65	107	76	ALC12(1)222DH200
200	2200	EE	40 x 45	3.54	4.32	132	101	ALC12(1)222EE200
200	2700	DL	35 x 80	4.99	6.90	93	68	ALC12(1)272DL200
200	2700	EG	40 x 55	4.27	5.26	104	79	ALC12(1)272EG200
200	3300	EH	40 x 60	4.48	5.33	96	75	ALC12(1)332EH200
200	3900	EL	40 x 80	5.55	6.90	78	60	ALC12(1)392EL200
200	5600	EP	40 x 105	8.39	12.08	43	31	ALC12(1)562EP200
200	6800	FP	45 x 105	8.85	12.05	38	28	ALC12(1)682FP200
200	8200	KP	50 x 105	9.21	11.90	34	26	ALC12(1)822KP200
250	390	CB	30 x 30	1.56	2.66	456	299	ALC12(1)391CB250
250	470	CC	30 x 35	1.82	3.17	375	244	ALC12(1)471CC250
250	560	CD	30 x 40	2.12	3.69	314	204	ALC12(1)561CD250
250	680	DC	35 x 35	2.34	3.56	285	194	ALC12(1)681DC250
250	680	EB	40 x 30	2.12	2.94	316	225	ALC12(1)681EB250
250	820	CF	30 x 50	2.75	4.62	219	144	ALC12(1)821CF250
250	820	DD	35 x 40	2.69	4.09	236	160	ALC12(1)821DD250
250	1000	EC	40 x 35	2.58	3.41	232	170	ALC12(1)102EC250
250	1200	DF	35 x 50	3.38	4.96	167	115	ALC12(1)122DF250
250	1200	ED	40 x 40	2.99	3.96	192	140	ALC12(1)122ED250
250	1500	DH	35 x 60	3.87	5.58	136	95	ALC12(1)152DH250
250	1500	EE	40 x 45	3.36	4.35	160	118	ALC12(1)152EE250
250	1800	EG	40 x55	4.02	5.32	128	93	ALC12(1)182EG250
250	2200	DL	35 x 80	4.79	6.81	94	66	ALC12(1)222DL250
250	2200	EH	40 x 60	4.28	5.43	115	86	ALC12(1)222EH250
250	2700	EL	40 x 80	5.28	7.01	85	61	ALC12(1)272EL250
250	3900	EP	40 x 105	7.72	12.08	48	32	ALC12(1)392EP250
250	4700	FP	45 x 105	8.22	12.11	42	29	ALC12(1)472FP250
250	5600	KP	50 x 105	8.63	12.03	38	27	ALC12(1)562KP250
350	220	CB	30 x 30	1.30	2.55	643	397	ALC12(1)221CB350
350	270	CC	30 x 35	1.52	3.01	522	321	ALC12(1)271CC350
350	390	CD	30 x 40	1.90	3.55	370	231	ALC12(1)391CD350
350	390	DC	35 x 35	2.02	3.51	384	243	ALC12(1)391DC350
350	470	CF	30 x 50	2.31	4.42	304	188	ALC12(1)471CF350
350	470	EB	40 x 30	1.95	2.85	368	249	ALC12(1)471EB350
350	560	DD	35 x 40	2.44	3.97	279	181	ALC12(1)561DD350
350	560	EC	40 x 35	2.32	3.50	299	199	ALC12(1)561EC350
350	680	DF	35 x 50	2.92	4.93	225	144	ALC12(1)681DF350
350	680	ED	40 x 40	2.68	4.04	246	164	ALC12(1)681ED350
350	820	EE	40 x 45	3.02	4.50	207	139	ALC12(1)821EE350
350	1000	DH	35 x 60	3.51	5.45	163	107	ALC12(1)102DH350
350	1000	EF	40 x 50	3.39	4.92	175	118	ALC12(1)102EF350
350	1200	EH	40 x 60	3.89	5.62	146	99	ALC12(1)122EH350
350	1500	DL	35 x 80	4.37	6.64	111	73	ALC12(1)152DL350
350	1800	EL	40 x 80	4.85	6.89	100	68	ALC12(1)182EL350
350	2200	EP	40 x 105	5.61	7.99	81	55	ALC12(1)222EP350
350	3300	FP	45 x 105	7.53	11.79	49	32	ALC12(1)332FP350
350	3900	KP	50 x 105	7.95	11.73	44	29	ALC12(1)392KP350
400	180	CB	30 x 30	1.21	2.38	794	509	ALC12(1)181CB400
400	220	CC	30 x 35	1.42	2.82	648	414	ALC12(1)221CC400
VDC	Rated Capacitance	Size Code	Case Size	Ripple Current		ESR	Impedance	Part Number

(1) Termination code: See Termination Tables for available options.

Table 1 – Ratings & Part Number Reference cont'd

VDC	Rated Capacitance	Size Code	Case Size	Ripple Current		ESR Maximum	Impedance Maximum	Part Number
	100 Hz 20°C (µF)		D x L (mm)	100 Hz 85°C (A)	10 kHz 85°C (A)	100 Hz 20°C (mΩ)	10 kHz 20°C (mΩ)	
400	270	CD	30 x 40	1.66	3.28	529	339	ALC12(1)271CD400
400	330	DC	35 x 35	1.91	3.35	457	299	ALC12(1)331DC400
400	330	EB	40 x 30	1.79	2.86	485	326	ALC12(1)331EB400
400	390	CF	30 x 50	2.16	4.17	370	238	ALC12(1)391CF400
400	390	DD	35 x 40	2.18	3.85	385	252	ALC12(1)391DD400
400	470	EC	40 x 35	2.21	3.38	352	240	ALC12(1)471EC400
400	560	DF	35 x 50	2.75	4.72	270	178	ALC12(1)561DF400
400	560	ED	40 x 40	2.54	3.92	295	200	ALC12(1)561ED400
400	680	DH	35 x 60	3.14	5.34	226	149	ALC12(1)681DH400
400	680	EE	40 x 45	2.87	4.37	245	168	ALC12(1)681EE400
400	820	EF	40 x 50	3.22	4.80	207	143	ALC12(1)821EF400
400	1000	DL	35 x 80	3.90	6.52	155	102	ALC12(1)102DL400
400	1000	EH	40 x 60	3.71	5.46	172	119	ALC12(1)102EH400
400	1500	EL	40 x 80	4.64	6.71	115	80	ALC12(1)152EL400
400	1800	EP	40 x 105	6.11	11.06	82	53	ALC12(1)182EP400
400	2700	FP	45 x 105	7.11	11.40	59	39	ALC12(1)272FP400
400	3300	KP	50 x 105	7.60	11.38	51	35	ALC12(1)332KP400
450	150	CB	30 x 30	1.15	2.34	861	548	ALC12(1)151CB450
450	220	CC	30 x 35	1.45	2.83	596	382	ALC12(1)221CC450
450	270	CD	30 x 40	1.70	3.30	486	312	ALC12(1)271CD450
450	270	DC	35 x 35	1.82	3.30	500	324	ALC12(1)271DC450
450	330	CF	30 x 50	2.08	4.10	395	252	ALC12(1)331CF450
450	330	DD	35 x 40	2.10	3.79	410	266	ALC12(1)331DD450
450	330	EB	40 x 30	1.79	2.74	460	313	ALC12(1)331EB450
450	390	EC	40 x 35	2.13	3.35	379	255	ALC12(1)391EC450
450	470	DF	35 x 50	2.64	4.66	292	190	ALC12(1)471DF450
450	470	ED	40 x 40	2.45	3.88	314	211	ALC12(1)471ED450
450	560	EE	40 x 45	2.76	4.34	265	178	ALC12(1)561EE450
450	680	DH	35 x 60	3.23	5.22	206	136	ALC12(1)681DH450
450	680	EF	40 x 50	3.10	4.76	220	150	ALC12(1)681EF450
450	820	DL	35 x 80	3.69	6.26	182	123	ALC12(1)821DL450
450	820	EH	40 x 60	3.62	5.44	180	120	ALC12(1)821EH450
450	1000	EL	40 x 80	4.21	6.69	156	107	ALC12(1)102EL450
450	1500	EP	40 x 105	5.77	10.51	96	63	ALC12(1)152EP450
450	1800	FP	45 x 105	6.27	10.87	82	55	ALC12(1)182FP450
450	2200	KP	50 x 105	6.81	11.12	70	47	ALC12(1)222KP450
VDC	**Rated Capacitance**	**Size Code**	**Case Size**	**Ripple Current**		**ESR**	**Impedance**	**Part Number**

(1) Termination code: See Termination Tables for available options.

Mechanical Data

Polarity and Reversed Voltage
Aluminium Electrolytic capacitors manufactured for use in DC applications contain an anode foil and a cathode foil. As such, they are polarized devices and must be connected with the +ve to the anode foil and the -ve to the cathode foil. If this were to be reversed then the electrolytic process that took place in forming the oxide layer on the anode would be recreated in trying to form an oxide layer on the cathode. In forming the cathode foil in this way, heat would be generated and gas given off within the capacitor, usually leading to catastrophic failure.

The cathode foil already possesses a thin stabilized oxide layer. This thin oxide layer is equivalent to a forming voltage of approximately 2 V. As a result, the capacitor can withstand a voltage reversal of up to 2 V for short periods. Above this voltage, the formation process will commence. Aluminium Electrolytic capacitors can also be manufactured for use in intermittent AC applications by using two anode foils in place of one anode and one cathode.

Mounting Position
The capacitor can be mounted upright or inclined to a horizontal position.

Insulating Resistance
≥ 100 MΩ at 100 VDC across insulating sleeve. UL recognized sleeving is available for custom parts in this range, upon request. (UL No. E358957)

Voltage Proof
≥ 2,500 VDC across insulating sleeve.

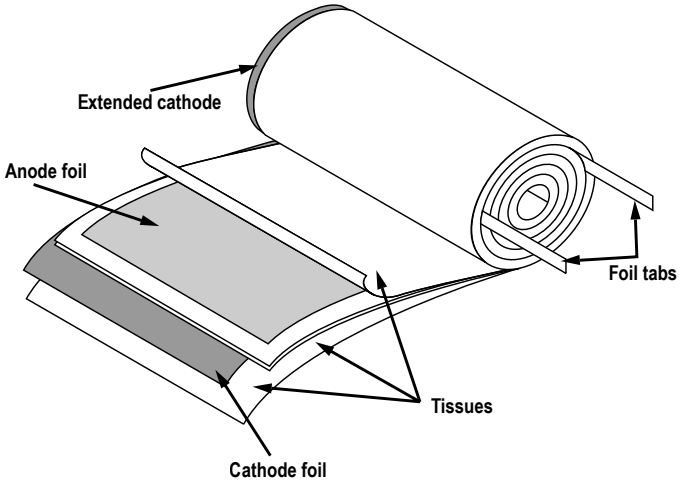
Safety Vent
A safety vent for overpressure is featured on either the base (opposing end to the terminals) or the side of the can. This appears in the form of a grooved section on the surface of the can, which is a weakened area and designed to relieve build-up of internal pressure due to overstress or catastrophic failure.

Print Detail

- KEMET Logo
- Rated capacitance
- Capacitance tolerance
- Rated voltage
- Climatic Category
- Date of manufacture & Batch No.
- Article code

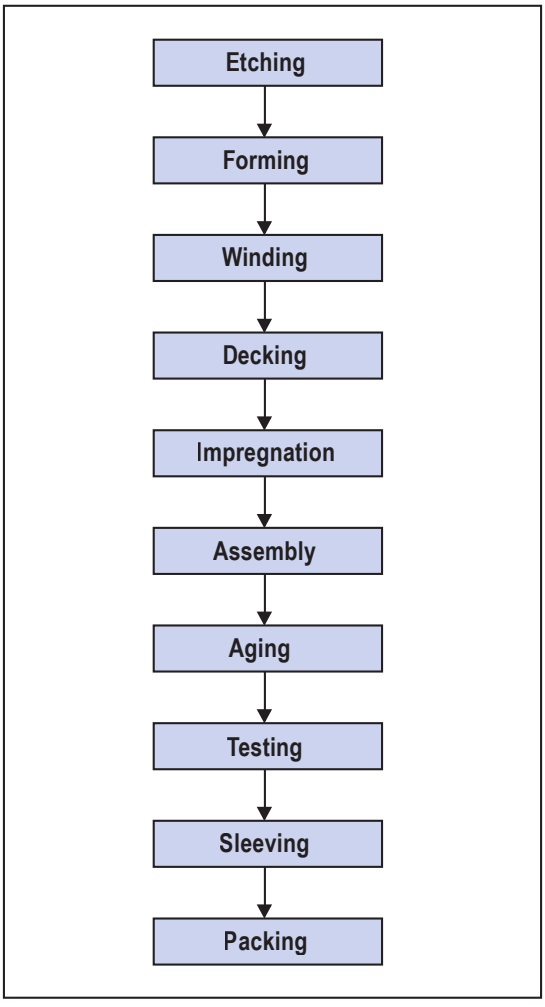
Construction

The manufacturing process begins with the anode foil being electrochemically etched to increase the surface area and then "formed" to produce the aluminum oxide layer. Both the anode and cathode foils are then interleaved with absorbent paper and wound into a cylinder. During the winding process, aluminum tabs are attached to each foil to provide the electrical contact.



The deck, complete with terminals, is attached to the tabs and then folded down to rest on top of the winding. The complete winding is impregnated with electrolyte before being housed in a suitable container, usually an aluminum can, and sealed. Throughout the process, all materials inside the housing must be maintained at the highest purity and be compatible with the electrolyte.

Each capacitor is aged and tested before being sleeved and packed. The purpose of aging is to repair any damage in the oxide layer and thus reduce the leakage current to a very low level. Aging is normally carried out at the rated temperature of the capacitor and is accomplished by applying voltage to the device while carefully controlling the supply current. The process may take several hours to complete.



Damage to the oxide layer can occur due to variety of reasons:

- Slitting of the anode foil after forming
- Attaching the tabs to the anode foil
- Minor mechanical damage caused during winding

A sample from each batch is taken by the quality department after completion of the production process.

The following tests are applied and may be varied at the request of the customer. In this case the batch, or special procedure, will determine the course of action.

Electrical:

- Leakage current
- Capacitance
- ESR
- Impedance
- Tan Delta

Mechanical/Visual:

- Overall dimensions
- Torque test of mounting stud
- Print detail
- Box labels
- Packaging, including packed quantity

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