

## Overview

KEMET's ALS32/33 Series of screw terminal capacitors meets the requirements of the Asian market. This range offers high CV per unit volume coupled with high ripple currents and long-life performance.

## Applications

KEMET's ALS32/33 Series of capacitors is designed for industrial and commercial applications such as switch mode power supplies (SMPS), uninterruptible power supply (UPS) systems, variable speed drives, frequency inverters, welding equipment, and energy storage in pulse discharge applications.

## Benefits

- Case sizes and terminals for the Asian market
- Long life, up to 20,000 hours at +85°C ( $V_R, I_R$  applied)
- High ripple current
- Excellent surge voltage capability
- Optimized designs available upon request



## Part Number System

ALS3	2	A	391	D2C	350
Series	Stud Option	Termination	Capacitance Code (µF)	Size Code	Rated Voltage (VDC)
Screw Terminal Aluminum Electrolytic	2 = Plain Can 3 = Threaded mounting stud	See Termination Table	First two digits represent significant figures. Third digit specifies number of zeros.	See Dimension Table	350 = 350 400 = 400 450 = 450 500 = 500

## Performance Characteristics

Item	Performance Characteristics		
Capacitance Range	220 – 18,000 $\mu$ F		
Rated Voltage	350 – 500 VDC		
Operating Temperature	-40 to +85°C		
Storage Temperature Range	-55 to +85°C		
Capacitance Tolerance	$\pm$ 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)
	36	11,000	22,000
	51	18,000	36,000
	63.5	19,000	38,000
	77.90	20,000	40,000
End of Life Requirement	$\Delta$ C/C < $\pm$ 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 = 0.006 CV or 6,000 ( $\mu$ A, whichever is smaller)		
	C = rated capacitance ( $\mu$ F), V = rated voltage (VDC). Voltage applied for 5 minutes at +20°C.		
Vibration Test Specifications	Case Length < 220 mm	0.75 mm displacement amplitude or 10 g maximum acceleration. Vibration applied for three 2-hour sessions at 10 – 55 Hz (Capacitor clamped by body).	No leakage of electrolyte or other visible damage. Deviations in capacitance from initial measurements must not exceed: $\Delta$ C/C < 5%
	Case Length $\geq$ 220 mm	0.35 mm displacement amplitude or 5 g 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)			
	350	400	450	500
$\leq$ 30s Surge followed by a no load period of 330 s, 1,000 cycles at +85°C	385	440	495	550
$\leq$ 500 ms surge, 100 cycles at 20°C, occurring randomly throughout the life of the capacitor	500	520	550	600

## Test Method & Performance

Endurance Life Test		
Conditions	Performance	
Temperature	+85°C	
Test Duration	5,000 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
	> 160 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	

## Termination Tables

Termination Code	A	C
Diameter (mm)		
34.9	•	
50.8	•	
63.5	•	•
76.2	•	•
88.9	•	•

Termination Code	Thread	Termination Style	T	DT	Thread Depth (TD)	Z
			±0.5	±0.5	Minimum	Nominal
Standard Termination Option						
A (D = 36)	M5	Round	7.14	8	10	
A (D > 36)	M5	Oval	5.5	13	10	10
Other Termination Options						
C	M6	Round	5.5	13	10	
<b>Dimensions in mm</b>						

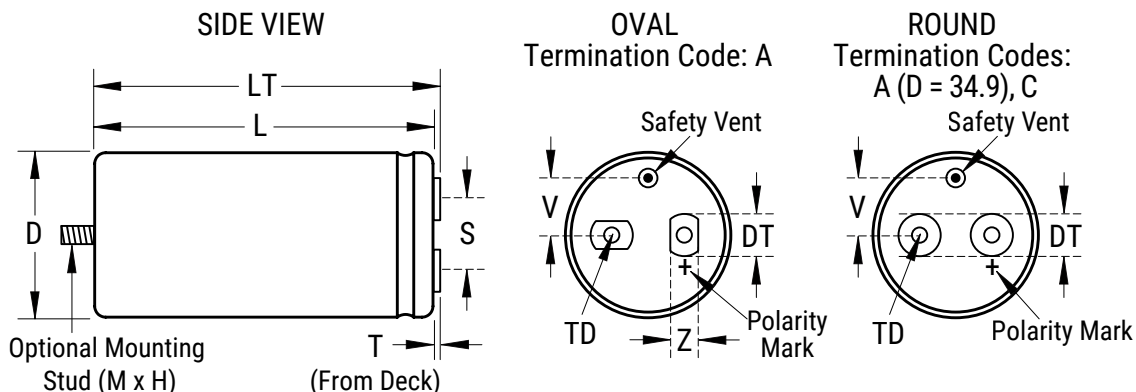
### Case Polarity

Due to the presence of electrolyte in the capacitor, the aluminum can and stud mounting will essentially be at the same polarity as the negative terminal. We recommend that the stud and can be insulated (see accessories for insulating nuts).

### Terminations

Aluminum inserts with M5 threads as standard, maximum torque 2NM. Optional M6 threaded inserts have a maximum torque 4NM. Maximum torque for stud mounting M8:4NM and M12:8NM.

## Dimensions – Millimeters



Reference Size (mm)	Size Code	Dimensions in mm						Mounting Stud (M x H)	Mounting Clip	Approximate Weight Grams
		D	L	LT	S	T	V			
		±0.8	±1.6	±1	±0.5	±0.8	Nominal			
36 x 55	D2C	34.9	54.0	61.5	12.8	7.14	8	M8 x 12	V3/H2/2736	80
36 x 80	D3C	34.9	79.4	87.5	12.8	7.14	8	M8 x 12	V3/H2/2736	114
36 x 93	D3L	34.9	92.1	100.5	12.8	7.14	8	M8 x 12	V3/H2/2736	131
51 x 68	K2L	50.8	66.7	73.0	22.2	5.5	13.7	M12 x 16	V4/2737	165
51 x 93	K3L	50.8	92.1	98.0	22.2	5.5	13.7	M12 x 16	V4/2737	275
51 x 115	KJA	50.8	114.3	119.0	22.2	5.5	13.7	M12 x 16	V4/2737	340
51 x 131	K5C	50.8	130.2	136.0	22.2	5.5	13.7	M12 x 16	V4/2737	385
63.5 x 93	L3L	63.5	92.1	97.0	28.5	5.5	15.8	M12 x 16	V8	430
63.5 x 115	LJA	63.5	114.3	119.0	28.5	5.5	15.8	M12 x 16	V8	535
63.5 x 131	L5C	63.5	130.2	135.0	28.5	5.5	15.8	M12 x 16	V8	600
77 x 115	NJA	76.2	114.3	119.0	31.8	5.5	19	M12 x 16	V11	770
77 x 131	N5C	76.2	130.2	135.0	31.8	5.5	19	M12 x 16	V11	865
77 x 150	N5R	76.2	149.2	154.0	31.8	5.5	19	M12 x 16	V11	990
90 x 150	Q5R	88.9	149.2	154.0	31.8	5.5	25	M12 x 16	PYC6045	1360
90 x 194	Q7L	88.9	193.7	198.0	31.8	5.5	25	M12 x 16	PYC6045	1870
90 x 220	Q8L	88.9	219.1	224.0	31.8	5.5	25	M12 x 16	PYC6045	2000

Note: Add 0.4 mm to D (1.1 mm when D = 88.9) and 1.1 mm to L for sleeving. LT listed is for A-type termination code. Information for other termination codes is available upon request.

## 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  $\lambda$  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  $1 \times 10^{-9}$  failures per hour. Failure rate is also expressed as a percentage of failures per 1,000 hours.

e.g., 100 FIT =  $1 \times 10^{-7}$  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  $> \pm 10\%$
- Leakage current  $>$  specified limit
- ESR  $> 2 \times$  initial ESR value

## MTBF

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

$$MTBF = 1/\lambda$$



The failure rate is derived from our periodic test results. The failure rate ( $\lambda_R$ ) 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 =  $1 \times 10^{-9}$  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.

**Table 1 – Ratings & Part Number Reference**

VDC	Rated Capacitance	Size Code	Case Size	Ripple Current		ESR Maximum	Impedance Maximum	Part Number
	120 Hz 25°C (µF)		D x L (mm)	120 Hz 85°C (A)	20 kHz 85°C (A)	120 Hz 25°C (mΩ)	20 kHz 25°C (mΩ)	
350	390	D2C	36 x 55	2.8	5.2	352	227	ALS3(1)(2)391D2C350
350	470	D3C	36 x 80	3.5	6.7	291	187	ALS3(1)(2)471D3C350
350	560	D3C	36 x 80	3.8	7.2	245	158	ALS3(1)(2)561D3C350
350	680	D3C	36 x 80	4.1	7.7	203	132	ALS3(1)(2)681D3C350
350	820	D3L	36 x 93	4.8	8.8	170	110	ALS3(1)(2)821D3L350
350	1000	D3L	36 x 93	5.2	9.3	141	92	ALS3(1)(2)102D3L350
350	1200	K2L	51 x 68	5.5	8.9	116	75	ALS3(1)(2)122K2L350
350	1500	K2L	51 x 68	5.8	8.9	99	66	ALS3(1)(2)152K2L350
350	1800	K3L	51 x 93	7.7	12.5	78	50	ALS3(1)(2)182K3L350
350	2200	K3L	51 x 93	8.2	12.5	67	44	ALS3(1)(2)222K3L350
350	2700	K5C	51 x 131	10.4	16.7	52	34	ALS3(1)(2)272K5C350
350	3300	K5C	51 x 131	11.1	16.8	45	30	ALS3(1)(2)332K5C350
350	3900	LJA	63.5 x 115	10.8	15.3	38	25	ALS3(1)(2)392LJA350
350	5600	NJA	77 x 115	16.4	22.7	30	21	ALS3(1)(2)562NJA350
350	6800	N5C	77 x 131	18.2	23.6	28	21	ALS3(1)(2)682N5C350
350	8200	N5R	77 x 150	19.9	25.5	24	18	ALS3(1)(2)822N5R350
350	10000	Q5R	90 x 150	25.5	33.5	18	13	ALS3(1)(2)103Q5R350
350	12000	Q5R	90 x 150	25.9	32.4	16	12	ALS3(1)(2)123Q5R350
350	15000	Q7L	90 x 194	32.4	41.2	13	10	ALS3(1)(2)153Q7L350
350	18000	Q8L	90 x 220	38.5	47.6	12	9	ALS3(1)(2)183Q8L350
400	330	D2C	36 x 55	2.6	5.4	351	207	ALS3(1)(2)331D2C400
400	390	D3C	36 x 80	3.3	6.9	295	174	ALS3(1)(2)391D3C400
400	470	D3C	36 x 80	3.6	7.5	246	146	ALS3(1)(2)471D3C400
400	560	D3C	36 x 80	3.9	8.0	208	123	ALS3(1)(2)561D3C400
400	680	D3L	36 x 93	4.5	8.7	182	112	ALS3(1)(2)681D3L400
400	820	D3L	36 x 93	4.9	9.2	152	94	ALS3(1)(2)821D3L400
400	1000	K2L	51 x 68	5.2	9.0	132	84	ALS3(1)(2)102K2L400
400	1200	K2L	51 x 68	5.6	9.1	113	74	ALS3(1)(2)122K2L400
400	1500	K3L	51 x 93	7.3	12.4	89	57	ALS3(1)(2)152K3L400
400	1800	K3L	51 x 93	7.8	12.5	76	50	ALS3(1)(2)182K3L400
400	2200	K5C	51 x 131	9.8	16.4	59	37	ALS3(1)(2)222K5C400
400	2700	L3L	63.5 x 93	11.3	18.3	49	31	ALS3(1)(2)272L3L400
400	3300	LJA	63.5 x 115	13.2	21.1	40	26	ALS3(1)(2)332LJA400
400	3900	L5C	63.5 x 131	14.6	22.1	37	25	ALS3(1)(2)392L5C400
400	4700	NJA	77 x 115	15.9	22.7	32	21	ALS3(1)(2)472NJA400
400	5600	N5C	77 x 131	17.6	23.7	30	21	ALS3(1)(2)562N5C400
400	6800	N5R	77 x 150	19.3	25.6	25	18	ALS3(1)(2)682N5R400
400	8200	Q5R	90 x 150	25.6	36.3	18	12	ALS3(1)(2)822Q5R400
400	10000	Q5R	90 x 150	26.5	35.6	16	11	ALS3(1)(2)103Q5R400
400	12000	Q7L	90 x 194	30.9	40.7	14	10	ALS3(1)(2)123Q7L400
400	15000	Q8L	90 x 220	37.4	47.7	12	9	ALS3(1)(2)153Q8L400
450	270	D2C	36 x 55	2.5	5.4	383	215	ALS3(1)(2)271D2C450
450	330	D3C	36 x 80	3.2	6.9	312	175	ALS3(1)(2)331D3C450
450	390	D3C	36 x 80	3.4	7.4	265	149	ALS3(1)(2)391D3C450
450	470	D3C	36 x 80	3.7	7.9	221	125	ALS3(1)(2)471D3C450
450	560	D3L	36 x 93	4.2	8.6	196	115	ALS3(1)(2)561D3L450
450	680	D3L	36 x 93	4.6	9.2	163	96	ALS3(1)(2)681D3L450
450	820	K2L	51 x 68	5.0	9.0	142	86	ALS3(1)(2)821K2L450
450	1000	K2L	51 x 68	5.3	9.1	120	75	ALS3(1)(2)102K2L450
450	1200	K3L	51 x 93	6.9	12.3	94	56	ALS3(1)(2)122K3L450
450	1500	KJA	51 x 115	8.1	14.5	75	45	ALS3(1)(2)152KJA450
450	1800	K5C	51 x 131	9.3	16.3	63	38	ALS3(1)(2)182K5C450
450	2200	L3L	63.5 x 93	10.7	18.3	53	32	ALS3(1)(2)222L3L450
450	2700	LJA	63.5 x 115	12.5	21.1	43	26	ALS3(1)(2)272LJA450
450	3300	L5C	63.5 x 131	14.6	24.1	36	22	ALS3(1)(2)332L5C450
450	3900	NJA	77 x 115	15.3	22.7	33	22	ALS3(1)(2)392NJA450
450	4700	N5C	77 x 131	18.0	26.5	28	18	ALS3(1)(2)472N5C450
450	5600	N5R	77 x 150	19.7	28.4	24	16	ALS3(1)(2)562N5R450
VDC	Rated Capacitance	Size Code	Case Size	Ripple Current		ESR	Impedance	Part Number

(1) Mounting Code: 2 = plain can, 3 = threaded mounting stud

(2) 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
	120 Hz 25°C (µF)		D x L (mm)	120 Hz 85°C (A)	20 kHz 85°C (A)	120 Hz 25°C (mΩ)	20 kHz 25°C (mΩ)	
450	6800	Q5R	90 x 150	24.6	36.3	19	13	ALS3(1)(2)682Q5R450
450	8200	Q5R	90 x 150	25.7	35.8	17	12	ALS3(1)(2)822Q5R450
450	10000	Q7L	90 x 194	30.0	40.7	15	10	ALS3(1)(2)103Q7L450
450	12000	Q8L	90 x 220	35.7	46.9	14	10	ALS3(1)(2)123Q8L450
500	220	D2C	36 x 55	2.3	4.1	602	427	ALS3(1)(2)221D2C500
500	270	D3C	36 x 80	2.9	5.3	489	347	ALS3(1)(2)271D3C500
500	330	D3C	36 x 80	3.2	5.8	402	285	ALS3(1)(2)331D3C500
500	390	D3C	36 x 80	3.5	6.2	341	243	ALS3(1)(2)391D3C500
500	470	D3L	36 x 93	3.9	6.8	303	221	ALS3(1)(2)471D3L500
500	560	D3L	36 x 93	4.3	7.3	256	187	ALS3(1)(2)561D3L500
500	680	K2L	51 x 68	4.6	7.4	219	162	ALS3(1)(2)681K2L500
500	820	K2L	51 x 68	4.9	7.7	186	138	ALS3(1)(2)821K2L500
500	1000	K3L	51 x 93	6.4	10.3	146	107	ALS3(1)(2)102K3L500
500	1200	KJA	51 x 115	7.2	11.0	142	109	ALS3(1)(2)122KJA500
500	1500	K5C	51 x 131	8.4	12.7	114	88	ALS3(1)(2)152K5C500
500	1800	L3L	63.5 x 93	9.9	15.3	83	61	ALS3(1)(2)182L3L500
500	2200	LJA	63.5 x 115	11.6	17.8	68	51	ALS3(1)(2)222LJA500
500	2700	L5C	63.5 x 131	13.2	19.3	65	50	ALS3(1)(2)272L5C500
500	3300	NJA	77 x 115	14.2	19.7	56	44	ALS3(1)(2)332NJA500
500	3900	N5C	77 x 131	16.9	23.5	42	32	ALS3(1)(2)392N5C500
500	4700	N5R	77 x 150	18.5	25.3	35	27	ALS3(1)(2)472N5R500
500	5600	Q5R	90 x 150	23.1	32.2	29	22	ALS3(1)(2)562Q5R500
500	6800	Q5R	90 x 150	24.1	32.3	25	19	ALS3(1)(2)682Q5R500
500	8200	Q7L	90 x 194	28.6	37.8	21	16	ALS3(1)(2)822Q7L500
500	10000	Q8L	90 x 220	34.4	44.3	18	14	ALS3(1)(2)103Q8L500
VDC	Rated Capacitance	Size Code	Case Size	Ripple Current		ESR	Impedance	Part Number

(1) Mounting Code: 2 = plain can, 3 = threaded mounting stud

(2) 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 in any position as long as the safety vent can operate. It is possible for some electrolyte to be expelled. As this is a conducting liquid, suitable precautions should be initiated by the system designer to avoid secondary short circuits.

The capacitors are designed to be mounted in free air and are not suitable for submersion in liquid.

### Vibration

10 – 55 Hz at 0.75 mm or 10 g for 3 x 2 hours duration, except 220 mm long cans 10 – 55 Hz at 0.35 mm or 5 g for 3 x 0.5 hours duration. Custom designs can be made in a 66 mm diameter (M6 deck), with a vibration capability of 20 g (10 – 56 Hz at 0.75 mm and 56 – 500 Hz 20 g for 3 x 0.5 hours duration)

### 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)

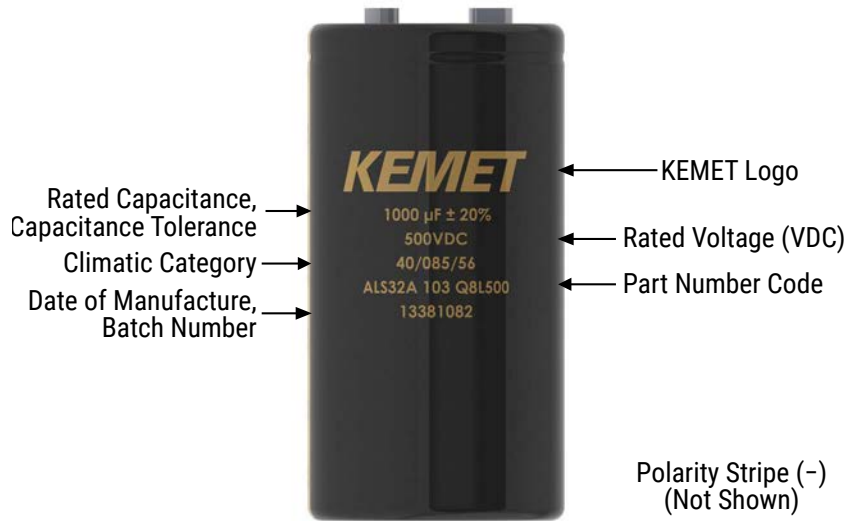
### Voltage Proof

≥ 2,500 VDC across insulating sleeve

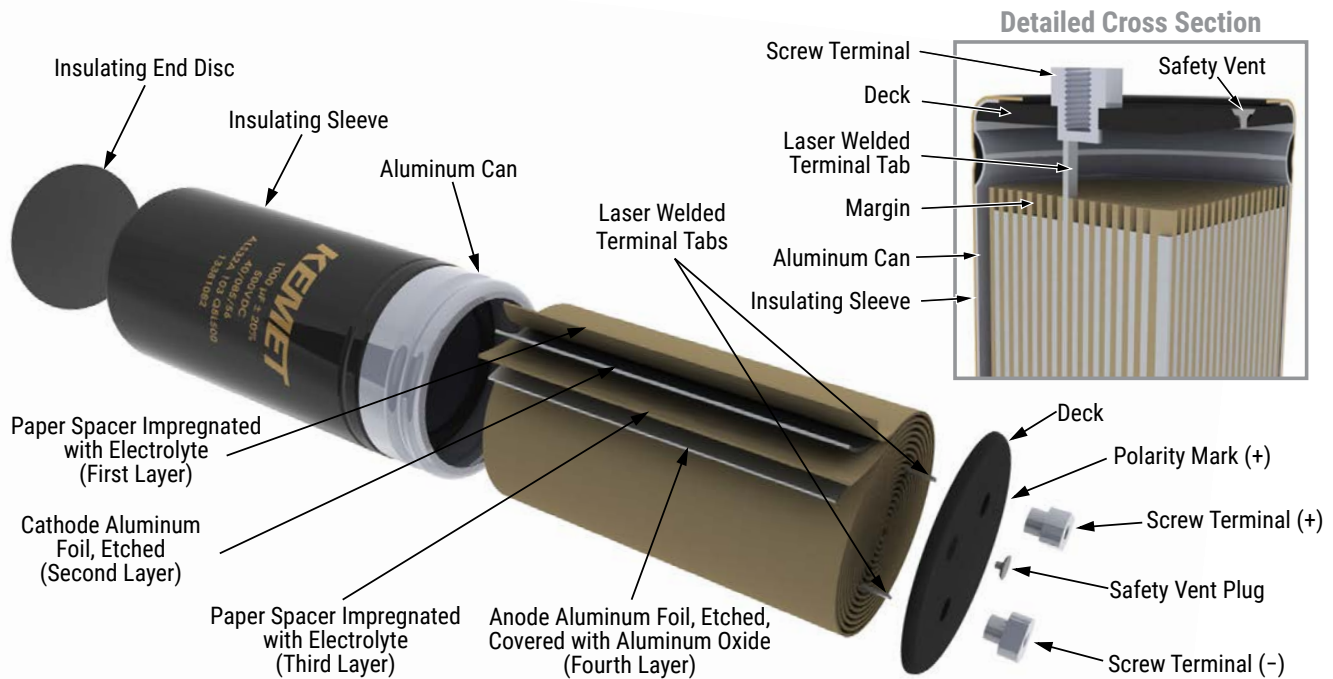
### Safety Vent

A safety vent for overpressure is featured on terminal deck. This is in the form of a rubber plug designed to relieve build-up of internal pressure due to overstress or catastrophic failure.

## Marking



## Construction



## Construction Data

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. This sample size is controlled by the use of recognized sampling tables defined in BS 6001.

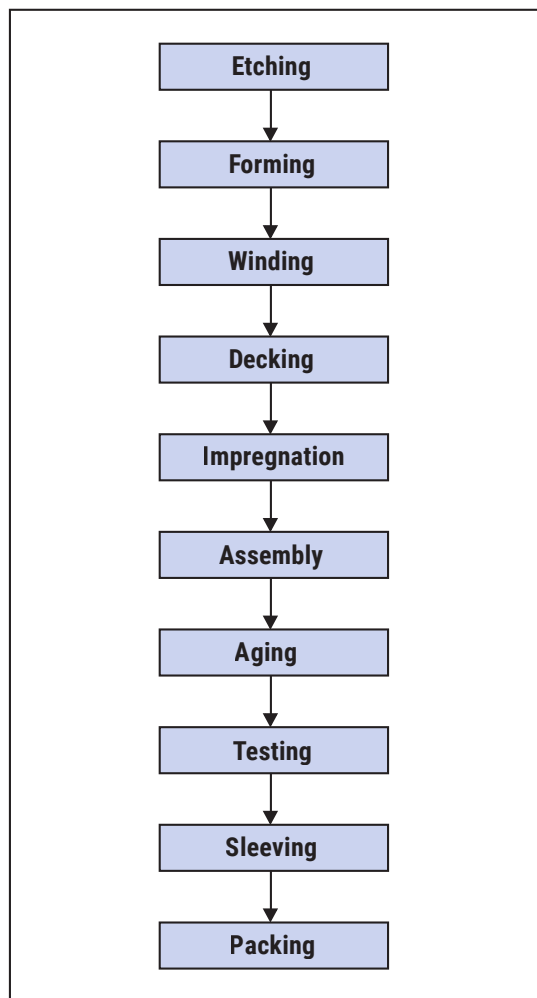
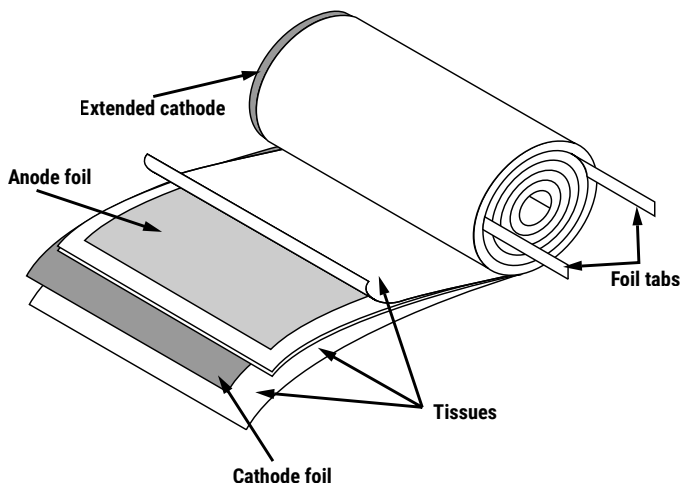
The following tests are applied and may be varied at the request of the customer. In this case the batch, or special procedure, will determine the course of action.

### 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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### Disclaimer

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