Aluminum Electrolytic Capacitors
Power High Ripple Current Long Life 4-Terminal Snap-In

LINKS TO ADDITIONAL RESOURCES

3D Models

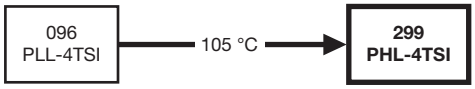


Fig. 1

QUICK REFERENCE DATA

DESCRIPTION	VALUE	
Nominal case size (D x L in mm)	35 x 50 to 45 x 100	
Rated capacitance range C_R	270 µF to 3300 µF	
Tolerance on C_R	± 20 %	
Rated voltage range, U_R	350 V to 450 V	500 V to 600 V
Temperature range	-40 °C to +105 °C	
Endurance test at 105 °C	2000 h	
Useful life at 105 °C	> 5000 h	
Shelf life at 0 V, 105 °C	1000 h	
Based on sectional specification	IEC 60384-4 / EN 130300	
Climatic category IEC 60068	40 / 105 / 56	25 / 105 / 56 (1)

Note

(1) Capacitors can be operated in temperature range of -40 °C to +105 °C but impedance at -40 °C must be taken into consideration with regards to IEC 60068

FEATURES

Pb-free

RoHS COMPLIANT

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Large types, minimized dimensions, cylindrical aluminum case, insulated with a blue sleeve
- **Rated voltages up to 600 V**
- Long useful life: > 5000 h at 105 °C
- Stable mounting and keyed polarity
- High ripple current capability
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

APPLICATIONS

- Switched mode power supplies
- Uninterruptible power supplies
- Renewable energy power converters
- Energy storage in pulse systems

MARKING

The capacitors are marked (where possible) with the following information:

- Rated capacitance (in µF)
- Tolerance code on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code
- Name of manufacturer
- Code for factory of origin
- "-" sign to identify the negative terminal, visible from the top and side of the capacitor
- (Partial) ordering code
- Climatic category in accordance with IEC 60068

SELECTION CHART FOR C_R, U_R, AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)

C_R (µF)	U_R (V)					
	350	400	450	500	550	600
270	-	-	-	-	-	35 x 50
						40 x 40
330	-	-	-	-	35 x 50	35 x 60
390	-	-	-	35 x 50	40 x 40	35 x 70
						40 x 50
470	-	-	35 x 50	35 x 60	35 x 60	35 x 80
			40 x 40	45 x 40	40 x 50	40 x 60
560	-	35 x 50	35 x 60	35 x 70	35 x 70	35 x 100
			40 x 50	40 x 50	40 x 60	40 x 70
						45 x 60
680	-	40 x 40	35 x 70	35 x 80	35 x 80	40 x 80
				40 x 60	40 x 60	45 x 70
				45 x 50		
820	35 x 50	35 x 60	35 x 80	35 x 100	35 x 100	40 x 100
	40 x 40	40 x 50	40 x 60	40 x 70	40 x 80	45 x 80
				45 x 60	45 x 60	

SELECTION CHART FOR C_R, U_R, AND RELEVANT NOMINAL CASE SIZES (Ø D x L in mm)						
C_R (µF)	U_R (V)					
	350	400	450	500	550	600
1000	35 x 60	35 x 70	35 x 100	40 x 80	45 x 70	45 x 100
	40 x 50		40 x 80	45 x 70	45 x 80	
			45 x 60			
1200	35 x 70	35 x 80	45 x 70	40 x 100	40 x 100	-
		40 x 70				
		45 x 60				
1500	35 x 80	35 x 100	40 x 100	45 x 100	45 x 100	-
	40 x 60	45 x 70	45 x 80			
1800	35 x 100	40 x 100	45 x 100	-	-	-
	40 x 80	45 x 80				
	45 x 60					
2200	40 x 100	45 x 100	-	-	-	-
	45 x 80					
2700	40 x 100	-	-	-	-	-
3300	45 x 100	-	-	-	-	-

DIMENSIONS in millimeters AND AVAILABLE FORMS

4-TERMINAL SNAP-IN

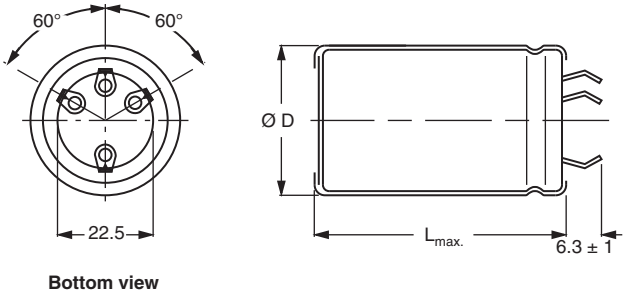


Fig. 1 - 4-terminal snap-in

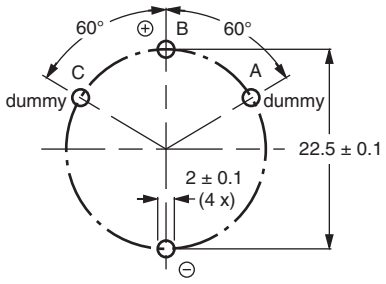


Fig. 2 - Mounting hole diagram

Dummy terminals (A and C) must be free from the electrical circuit.

Table 1

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES					
NOMINAL CASE SIZE Ø D x L	Ø $D_{max.}$	$L_{max.}$	MASS (g)	PACKAGING QUANTITIES (units per box)	CARDBOARD BOX DIMENSIONS L x W x H
35 x 50	36	52	72	50	390 x 198 x 60
35 x 60	36	62	91	50	390 x 198 x 70
35 x 70	36	72	103	50	377 x 375 x 97
35 x 80	36	82	115	50	377 x 375 x 107
35 x 100	36	102	151	50	377 x 375 x 127
40 x 40	41	42	70	50	440 x 223 x 60
40 x 50	41	52	94	50	440 x 223 x 70
40 x 60	41	62	118	25	230 x 230 x 80
40 x 70	41	72	134	25	230 x 230 x 90
40 x 80	41	82	150	25	230 x 230 x 100
40 x 100	41	102	176	25	230 x 230 x 120
45 x 40	46	42	88	36	377 x 375 x 60
45 x 50	46	42	119	36	377 x 375 x 77
45 x 60	46	62	150	36	377 x 375 x 87
45 x 70	46	72	170	36	377 x 375 x 97
45 x 80	46	82	190	36	377 x 375 x 107
45 x 100	46	102	250	36	377 x 375 x 127

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	Rated capacitance at 100 Hz
I_R	Rated RMS ripple current at 100 Hz and 105 °C
I_{L5}	Max. leakage current after 5 min at U_R
tan δ	Max. dissipation factor at 100 Hz
ESR	Max. equivalent series resistance at 100 Hz
Z	Max. impedance at 10 kHz

Note

- Unless otherwise specified, all electrical values in Table 2 apply at T_{amb} = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %

ORDERING EXAMPLE

Electrolytic capacitor 299 PHL-4TSI series

2200 µF / 400 V / 45 mm x 100 mm

4-terminal snap-in:

Ordering code: MAL229956222E3

Table 2

ELECTRICAL DATA AND ORDERING INFORMATION								
U_R (V)	C_R (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 105 °C (A)	I_{L5} 5 min (mA)	tan δ 100 Hz	MAX. ESR 100 Hz (mΩ)	MAX. Z 10 kHz (mΩ)	CATALOG NUMBER MAL2299.....
350	820	35 x 50	3.15	0.578	0.15	170	125	55821E3
	820	40 x 40	3.00	0.578	0.15	180	130	65821E3
	1000	35 x 60	3.70	0.704	0.15	140	105	55102E3
	1000	40 x 50	3.75	0.704	0.15	145	105	65102E3
	1200	35 x 70	4.15	0.844	0.15	120	85	55122E3
	1500	35 x 80	4.70	1.054	0.15	95	70	55152E3
	1500	40 x 60	4.60	1.054	0.15	100	75	65152E3
	1800	35 x 100	5.90	1.264	0.15	80	60	55182E3
	1800	40 x 80	5.40	1.264	0.15	85	65	65182E3
	1800	45 x 60	5.20	1.264	0.15	90	70	75182E3
	2200	40 x 100	6.45	1.544	0.15	65	50	55222E3
	2200	45 x 80	6.10	1.544	0.15	70	55	65222E3
	2700	40 x 100	6.85	1.894	0.15	55	45	55272E3
	3300	45 x 100	7.60	2.314	0.15	50	40	55332E3
400	560	35 x 50	2.70	0.452	0.15	220	160	56561E3
	680	40 x 40	2.79	0.548	0.15	190	140	56681E3
	820	35 x 60	3.44	0.660	0.15	150	110	56821E3
	820	40 x 50	3.51	0.660	0.15	160	110	66821E3
	1000	35 x 70	3.88	0.804	0.15	130	90	56102E3
	1200	35 x 80	4.34	0.964	0.15	110	80	56122E3
	1200	40 x 70	4.50	0.964	0.15	110	80	66122E3
	1200	45 x 60	4.61	0.964	0.15	110	80	76122E3
	1500	35 x 100	5.54	1.204	0.15	90	60	56152E3
	1500	45 x 70	5.20	1.204	0.15	90	70	66152E3
	1800	40 x 100	6.02	1.444	0.15	70	50	56182E3
	1800	45 x 80	5.74	1.444	0.15	80	60	66182E3
	2200	45 x 100	6.77	1.764	0.15	60	50	56222E3
450	470	35 x 50	2.54	0.427	0.20	240	160	57471E3
	470	40 x 40	2.45	0.427	0.20	240	170	67471E3
	560	35 x 60	2.96	0.508	0.20	200	130	57561E3
	560	40 x 50	3.05	0.508	0.20	200	140	67561E3
	680	35 x 70	3.34	0.616	0.20	160	110	57681E3
	820	35 x 80	3.76	0.742	0.20	140	90	57821E3
	820	40 x 60	3.73	0.742	0.20	140	100	67821E3
	1000	35 x 100	4.74	0.904	0.20	110	80	57102E3
	1000	40 x 80	4.41	0.904	0.20	110	80	67102E3
	1000	45 x 60	4.34	0.904	0.20	120	80	77102E3
	1200	45 x 70	4.84	1.084	0.20	100	70	57122E3
	1500	40 x 100	5.67	1.354	0.20	80	50	57152E3
	1500	45 x 80	5.39	1.354	0.20	80	60	67152E3
	1800	45 x 100	6.36	1.624	0.20	70	50	57182E3

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 105 °C (A)	I_{L5} 5 min (mA)	tan δ 100 Hz	MAX. ESR 100 Hz (mΩ)	MAX. Z 10 kHz (mΩ)	CATALOG NUMBER MAL2299.....
	390	35 x 50	2.35	0.394	0.20	290	200	59391E3
	470	35 x 60	2.75	0.474	0.20	240	165	59471E3
	470	45 x 40	2.45	0.474	0.20	250	175	69471E3
	560	35 x 70	3.05	0.564	0.20	200	140	59561E3
	560	40 x 50	3.05	0.564	0.20	205	145	69561E3
	680	35 x 80	3.45	0.684	0.20	165	115	59681E3
	680	40 x 60	3.45	0.684	0.20	170	120	69681E3
500	680	45 x 50	3.50	0.684	0.20	175	125	79681E3
	820	35 x 100	4.35	0.824	0.20	140	95	59821E3
	820	40 x 70	3.90	0.824	0.20	140	100	69821E3
	820	45 x 60	4.05	0.824	0.20	145	100	79821E3
	1000	40 x 80	4.40	1.004	0.20	115	80	59102E3
	1000	45 x 70	4.50	1.004	0.20	120	85	69102E3
	1200	40 x 100	5.20	1.204	0.20	100	70	59122E3
	1500	45 x 100	5.95	1.504	0.20	80	55	59152E3
	330	35 x 50	2.10	0.367	0.20	415	320	50331E3
	390	40 x 40	2.20	0.433	0.20	360	280	50391E3
	470	35 x 60	2.65	0.521	0.20	295	225	50471E3
	470	40 x 50	2.75	0.521	0.20	300	230	60471E3
	560	35 x 70	3.00	0.620	0.20	250	190	50561E3
	560	40 x 60	3.10	0.620	0.20	250	190	60561E3
	680	35 x 80	3.35	0.752	0.20	205	155	50681E3
550	680	40 x 60	3.35	0.752	0.20	210	165	60681E3
	820	35 x 100	4.25	0.906	0.20	170	130	50821E3
	820	40 x 80	3.95	0.906	0.20	170	140	60821E3
	820	45 x 60	3.90	0.906	0.20	175	140	70821E3
	1000	45 x 70	4.35	1.104	0.20	150	115	50102E3
	1000	45 x 80	4.50	1.104	0.20	145	110	60102E3
	1200	40 x 100	5.05	1.324	0.20	120	95	50122E3
	1500	45 x 100	5.75	1.654	0.20	100	75	50152E3
	270	35 x 50	1.90	0.328	0.20	620	515	51271E3
	270	40 x 40	1.85	0.328	0.20	630	520	61271E3
	330	35 x 60	2.25	0.400	0.20	510	420	51331E3
	390	35 x 70	2.55	0.472	0.20	430	355	51391E3
	390	40 x 50	2.50	0.472	0.20	440	365	61391E3
	470	35 x 80	2.85	0.568	0.20	360	295	51471E3
	470	40 x 60	2.85	0.568	0.20	360	300	61471E3
600	560	35 x 100	3.55	0.676	0.20	300	250	51561E3
	560	40 x 70	3.30	0.676	0.20	305	255	61561E3
	560	45 x 60	3.30	0.676	0.20	305	255	71561E3
	680	40 x 80	3.60	0.820	0.20	250	210	51681E3
	680	45 x 70	3.75	0.820	0.20	255	210	61681E3
	820	40 x 100	4.30	0.988	0.20	210	175	51821E3
	820	45 x 80	4.15	0.988	0.20	210	175	61821E3
	1000	45 x 100	4.90	1.204	0.20	175	145	51102E3

ADDITIONAL ELECTRICAL DATA		
PARAMETER	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage	≥ 350 V versions	$U_s = 1.1 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 1 min at U_R	$I_{L1} \leq 0.006\ C_R \times U_R + 4\ \mu A$
	After 5 min at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 4\ \mu A$
Inductance		
Equivalent series inductance (ESL)	All case sizes	Ca. 20 nH

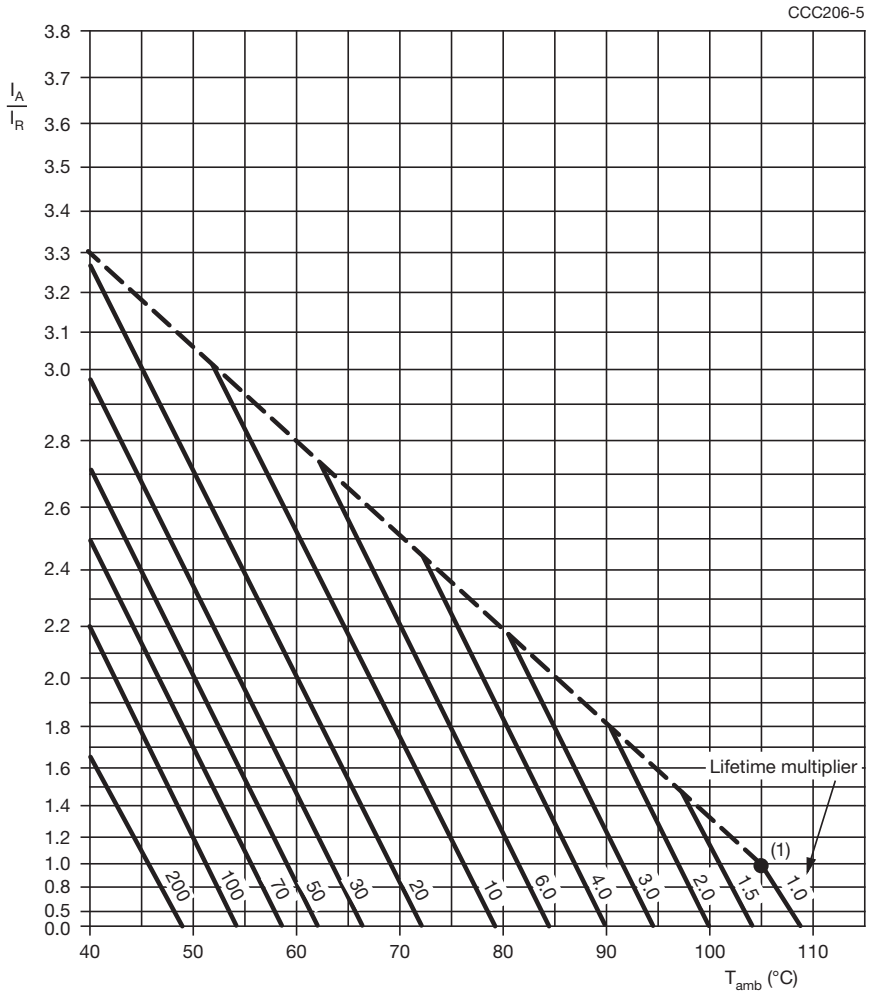
RIPPLE CURRENT AND USEFUL LIFE

Table 3

ENDURANCE TEST DURATION AND USEFUL LIFE	
ENDURANCE AT 105 °C (h)	**USEFUL LIFE AT 105 °C (h)**
2000	> 5000

Note

- Multiplier of useful life code: CCC206-5



I_A = Actual ripple current at 100 Hz
I_R = Actual ripple current at 100 Hz and 105 °C

(1) Useful life at 105 °C and I_R applied: > 5000 h

Fig. 3 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 4

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY					
FREQUENCY (Hz)					
50	100	200	400	1000	10 000
I_R MULTIPLIER					
0.9	1.0	1.2	1.3	1.4	1.5

Table 5

TEST PROCEDURES AND REQUIREMENTS			
TEST		PROCEDURE (quick reference)	REQUIREMENTS
NAME OF TEST	REFERENCE		
Endurance	IEC 60384-4 / EN130300 subclause 4.13	T_{amb} = 105 °C; U_R applied 2000 h	ΔC/C: ± 10 % ESR ≤ 1.3 x spec. limit Z ≤ 2 x spec. limit I_{L5} ≤ spec. limit
Useful life		T_{amb} = 105 °C; U_R and I_R applied; > 5000 h	ΔC/C: ≤ ± 20 % tan δ ≤ 2 times initial spec. limit I_{L5} ≤ spec. limit
Shelf life	IEC 60384-4 / EN130300 subclause 4.17	T_{amb} = 105 °C; no voltage applied; 1000 h After test: U_R to be applied for 30 min 24 h to 48 h before measurement	ΔC/C: ± 10 % ESR ≤ 1.2 x spec. limit I_{L5} ≤ 2 x spec. limit

Statements about product lifetime are based on calculations and internal testing. They should only be interpreted as estimations. Also due to external factors, the lifetime in the field application may deviate from the calculated lifetime. In general, nothing stated herein shall be construed as a guarantee of durability.

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