

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



### ADDITIONAL RESOURCES

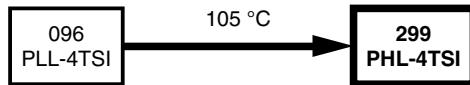


Fig. 1

QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case size (D x L in mm)	35 x 50 to 45 x 100
Rated capacitance range $C_R$	470 $\mu$ F to 2200 $\mu$ F
Tolerance on $C_R$	$\pm 20\%$
Rated voltage range, $U_R$	400 V to 450 V
Category 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

### FEATURES

- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Large types, minimized dimensions, cylindrical aluminum case, insulated with a blue sleeve
- Pressure relief on the side of the aluminum case
- Very long useful life: 5000 h at 105 °C
- Temperature range up to 105 °C
- Stable mounting and keyed polarity
- High ripple current capability
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



### APPLICATIONS

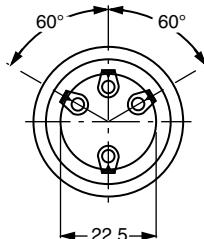
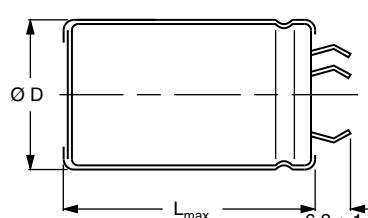
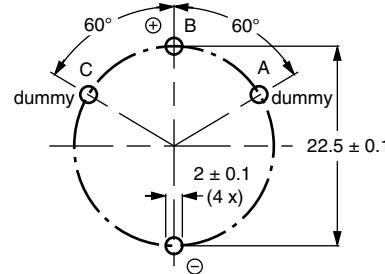
- Switched mode power supplies
- Renewable energy power converters
- Energy storage in pulse systems

### MARKING

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

- Rated capacitance (in  $\mu$ F)
- Tolerance code on rated capacitance, code letter in accordance with IEC 60062 (M for  $\pm 20\%$ )
- 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)		
$C_R$ ( $\mu$ F)	$U_R$ (V)	
	400	450
470	35 x 50	-
		35 x 50
		40 x 40
560	40 x 40	35 x 60
		40 x 50
		35 x 70
680	35 x 60	35 x 80
		40 x 60
		35 x 100
820	40 x 50	40 x 80
		45 x 60
		45 x 70
1000	35 x 70	45 x 80
		40 x 100
		45 x 100
1200	35 x 80	-
		45 x 100
		40 x 100
1500	40 x 100	45 x 80
		45 x 100
		-
1800	45 x 80	-
		45 x 100
		-
2200	45 x 100	-

**DIMENSIONS** in millimeters **AND AVAILABLE FORMS**
**4-TERMINAL SNAP-IN**

**Bottom view**

**Fig. 2 - 4-Terminal snap-in**

**Fig. 3 - Mounting hole diagram**
**Dummy terminals (A and C) must be free from the electrical circuit.**
**Table 1**

<b>DIMENSIONS</b> in millimeters, <b>MASS AND PACKAGING QUANTITIES</b>					
<b>NOMINAL CASE SIZE Ø D x L</b>	<b>Ø D<sub>MAX</sub></b>	<b>L<sub>max.</sub></b>	<b>MASS (g)</b>	<b>PACKAGING QUANTITIES (units per box)</b>	<b>CARDBOARD BOX DIMENSIONS L x W x H</b>
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 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

<b>ELECTRICAL DATA</b>	
<b>SYMBOL</b>	<b>DESCRIPTION</b>
C <sub>R</sub>	Rated capacitance at 100 Hz
I <sub>R</sub>	Rated RMS ripple current at 100 Hz and 105 °C
I <sub>L5</sub>	Max. leakage current after 5 min at U <sub>R</sub>
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<sub>amb</sub> = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %

**ORDERING EXAMPLE**

Electrolytic capacitor 299 series

2200 µF / 400 V

**4-terminal snap-in:**

Ordering code: MAL2 299 56222 E3

Former 12NC: 2222 299 56222

**Table 2**

<b>ELECTRICAL DATA AND ORDERING INFORMATION</b>									
<b>U<sub>R</sub> (V)</b>	<b>C<sub>R</sub> (<math>\mu</math>F)</b>	<b>NOMINAL CASE SIZE Ø D x L (mm)</b>	<b>I<sub>R</sub> 100 Hz 105 °C (A)</b>	<b>I<sub>L5</sub> 5 min (mA)</b>	<b>TYP. ESR 100 Hz (m<math>\Omega</math>)</b>	<b>MAX. ESR 100 Hz (m<math>\Omega</math>)</b>	<b>TYP. Z 10 kHz (m<math>\Omega</math>)</b>	<b>MAX. Z 10 kHz (m<math>\Omega</math>)</b>	<b>CATALOG NUMBER MAL2299.....</b>
400	560	35 x 50	2.70	0.452	170	220	130	160	56561E3
	680	40 x 40	2.79	0.548	150	190	110	140	56681E3
	820	35 x 60	3.44	0.660	120	150	90	110	56821E3
	820	40 x 50	3.51	0.660	120	160	90	110	66821E3
	1000	35 x 70	3.88	0.804	100	130	70	90	56102E3
	1200	35 x 80	4.34	0.964	90	110	60	80	56122E3
	1200	40 x 70	4.50	0.964	90	110	60	80	66122E3
	1200	45 x 60	4.61	0.964	90	110	60	80	76122E3
	1500	35 x 100	5.54	1.204	70	90	50	60	56152E3
	1500	45 x 70	5.20	1.204	70	90	60	70	66152E3
	1800	40 x 100	6.02	1.444	50	70	40	50	56182E3
	1800	45 x 80	5.74	1.444	60	80	50	60	66182E3
	2200	45 x 100	6.77	1.764	50	60	40	50	56222E3
450	470	35 x 50	2.54	0.427	190	240	130	160	57471E3
	470	40 x 40	2.45	0.427	190	240	140	170	67471E3
	560	35 x 60	2.96	0.508	160	200	100	130	57561E3
	560	40 x 50	3.05	0.508	160	200	110	140	67561E3
	680	35 x 70	3.34	0.616	120	160	90	110	57681E3
	820	35 x 80	3.76	0.742	110	140	70	90	57821E3
	820	40 x 60	3.73	0.742	110	140	80	100	67821E3
	1000	35 x 100	4.74	0.904	90	110	60	80	57102E3
	1000	40 x 80	4.41	0.904	90	110	60	80	67102E3
	1000	45 x 60	4.34	0.904	90	120	60	80	77102E3
	1200	45 x 70	4.84	1.084	80	100	60	70	57122E3
	1500	40 x 100	5.67	1.354	60	80	40	50	57152E3
	1500	45 x 80	5.39	1.354	60	80	50	60	67152E3
	1800	45 x 100	6.36	1.624	50	70	40	50	57182E3

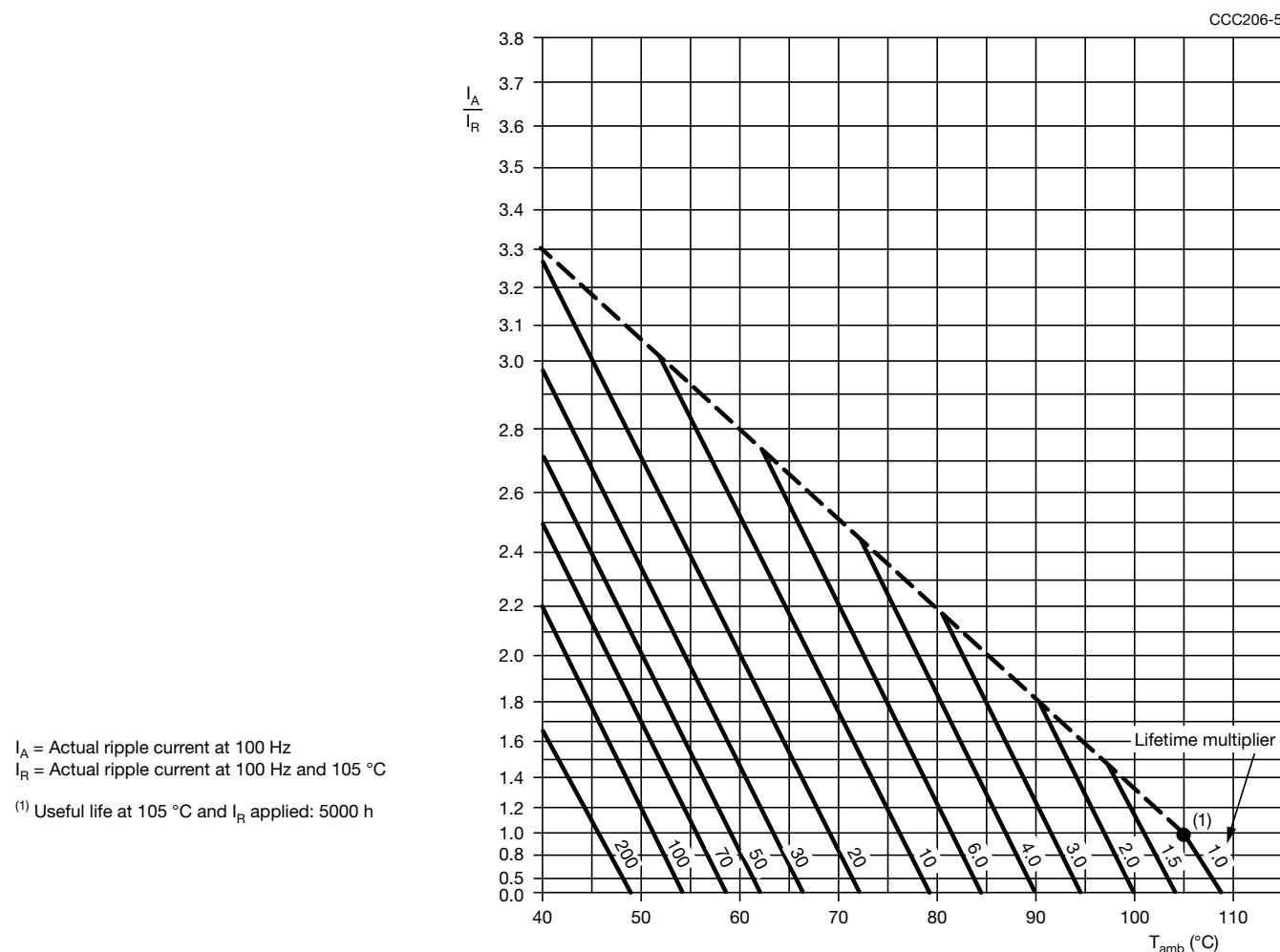
<b>ADDITIONAL ELECTRICAL DATA</b>		
<b>PARAMETER</b>	<b>CONDITIONS</b>	<b>VALUE</b>
<b>Voltage</b>		
Surge voltage	$\geq 400$ V versions	$U_s = 1.1 \times U_R$
Reverse voltage		$U_{rev} \leq 1$ V
<b>Current</b>		
Leakage current	After 1 min at $U_R$	$I_{L1} \leq 0.006 C_R \times U_R + 4 \mu A$
	After 5 min at $U_R$	$I_{L5} \leq 0.002 C_R \times U_R + 4 \mu A$
<b>Inductance</b>		
Equivalent series inductance (ESL)	All case sizes	Ca. 20 nH

**RIPPLE CURRENT AND USEFUL LIFE**
**Table 3**

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

**Note**

- Multiplier of useful life code: CCC206-5


**Fig. 4 - Multiplier of useful life as a function of ambient temperature and ripple current load**
**Table 4**

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

**Table 5**

<b>TEST PROCEDURES AND REQUIREMENTS</b>			
<b>TEST</b>		<b>PROCEDURE (quick reference)</b>	<b>REQUIREMENTS</b>
<b>NAME OF TEST</b>	<b>REFERENCE</b>		
Endurance	IEC 60384-4 / EN130300 subclause 4.13	$T_{amb} = 105 \text{ }^{\circ}\text{C}$ ; $U_R$ applied 2000 h	$\Delta C/C: \pm 10 \text{ \%}$ $ESR \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 4.13	$T_{amb} = 105 \text{ }^{\circ}\text{C}$ ; $U_R$ and $I_R$ applied; 5000 h	$\Delta C/C: \pm 30 \text{ \%}$ $ESR \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ no short or open circuit, no visible damage total failure percentage: $\leq 3 \text{ \%}$
Shelf life	IEC 60384-4 / EN130300 subclause 4.17	$T_{amb} = 105 \text{ }^{\circ}\text{C}$ ; no voltage applied; 1000 h  After test: $U_R$ to be applied for 30 min 24 h to 48 h before measurement	$\Delta C/C: \pm 10 \text{ \%}$ $ESR \leq 1.2 \times \text{spec. limit}$ $I_{L5} \leq 2 \times \text{spec. limit}$

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