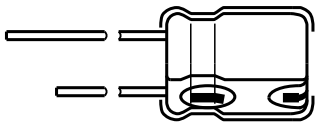
Aluminum Capacitors
Radial Miniature Semi-Professional



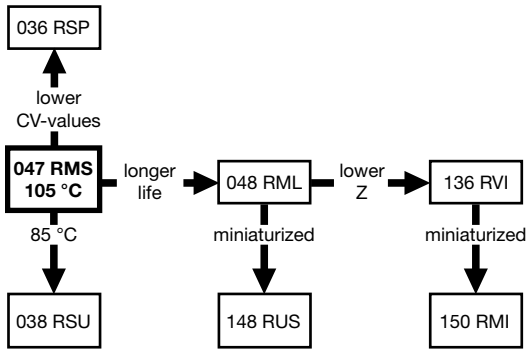


Fig. 1

FEATURES

- Useful life: 1500 h at 105 °C
- Miniaturized, high CV-product per unit volume
- Charge and discharge proof
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case with pressure relief, insulated with a blue sleeve
- Material categorization: For definitions of compliance please see www.vishay.com/doc?99912

Pb-free
RoHS
COMPLIANT

APPLICATIONS

- EDB, telecommunication, industrial, automotive and audio-video
- Smoothing, filtering, buffering in SMPS, timing
- Portable and mobile equipment (small size, low mass)

MARKING

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

- Rated capacitance value (in µF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for ± 20 %)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Upper category temperature (105 °C)
- Negative terminal identification
- Series number (047)

QUICK REFERENCE DATA	
DESCRIPTION	**VALUE**
Nominal case sizes (Ø D x L in mm)	10 x 12 to 18 x 35
Rated capacitance range, C_R	100 µF to 10 000 µF
Tolerance on C_R	± 20 %
Rated voltage range, U_R	16 V to 63 V
Category temperature range	-40 °C to +105 °C
Endurance test at 105 °C	1000 h
Useful life at 105 °C	1500 h
Useful life at 40 °C, 1.3 x I_R applied	150 000 h
Shelf life at 0 V, 105 °C	500 h
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	40/105/56

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

C_R (µF)	U_R (V)					
	16	**25**	**35**	**40**	**50**	**63**
100	-	-	-	-	-	10 x 12
220	-	-	10 x 12	-	10 x 16	10 x 20
330	-	-	10 x 16	10 x 20	-	12.5 x 20
470	10 x 12	10 x 16	10 x 20	-	12.5 x 20	12.5 x 25
1000	10 x 20	12.5 x 20	12.5 x 25	-	16 x 25	16 x 31
2200	12.5 x 25	16 x 25	16 x 31	16 x 35	18 x 35	18 x 35
3300	16 x 25	16 x 31	18 x 35	18 x 35	18 x 35	-
4700	16 x 31	18 x 35	18 x 35	-	-	-
6800	16 x 35	18 x 35	-	-	-	-
10 000	18 x 35	-	-	-	-	-

For technical questions, contact: aluminumcaps1@vishay.com

DIMENSIONS in millimeters AND AVAILABLE FORMS

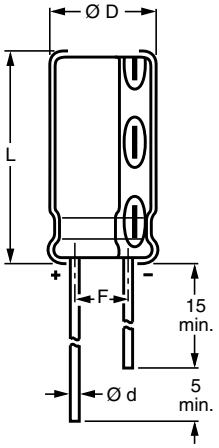


Fig. 2 - **Form CA:** Long leads

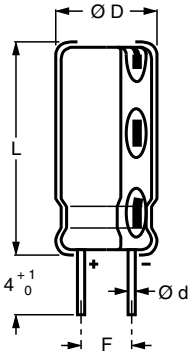


Fig. 3 - **Form CB:** Cut leads

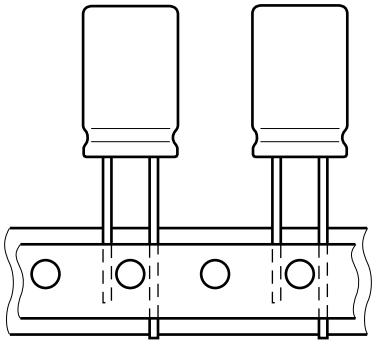


Fig. 4 - **Form TFA:** Taped in box (ammopack)

Table 1

DIMENSIONS in millimeters, MASS, AND PACKAGING QUANTITIES									
NOMINAL CASE SIZE Ø D x L	CASE CODE	Ø d	Ø $D_{max.}$	$L_{max.}$	F	MASS (g)	PACKAGING QUANTITIES		
							FORM CA	FORM CB	FORM TFA
10 x 12	14	0.6	10.5	13.5	5.0 ± 0.5	≈ 1.6	1000	500	800
10 x 16	15	0.6	10.5	17.5	5.0 ± 0.5	≈ 1.9	500	500	800
10 x 20	16	0.6	10.5	22.0	5.0 ± 0.5	≈ 2.2	500	500	800
12.5 x 20	17	0.6	13.0	22.0	5.0 ± 0.5	≈ 4.0	500	500	500
12.5 x 25	18	0.6	13.0	27.0	5.0 ± 0.5	≈ 5.0	250	250	500
16 x 25	19	0.8	16.5	27.0	7.5 ± 0.5	≈ 8.0	250	250	250
16 x 31	20	0.8	16.5	33.5	7.5 ± 0.5	≈ 9.0	100	100	250
16 x 35	21	0.8	16.5	37.5	7.5 ± 0.5	≈ 11.5	100	100	-
18 x 35	22	0.8	18.5	37.5	7.5 ± 0.5	≈ 14.5	100	100	-

Note

- For detailed tape dimensions please see www.vishay.com/doc?28360

ELECTRICAL DATA	
SYMBOL	DESCRIPTION
C_R	Rated capacitance at 100 Hz, tolerance ± 20 %
I_R	Rated RMS ripple current at 100 Hz, 105 °C
I_{L1}	Max. leakage current after 1 min at U_R
tan δ	Max. dissipation factor at 100 Hz
Z	Max. impedance at 10 kHz or 100 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 047 series

1000 µF/35 V; ± 20 %

Nominal case size: Ø 12.5 mm x 25 mm; form TFA

Ordering code: MAL2 047 30102 E3

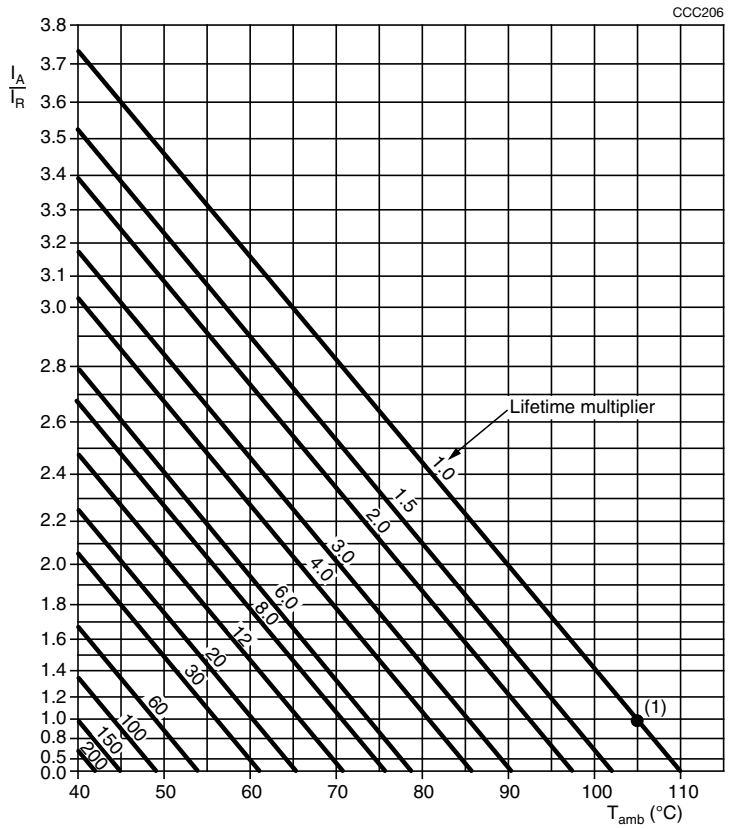
Table 2

ELECTRICAL DATA AND ORDERING INFORMATION

U_R (V)	C_R 100 Hz (µF)	NOMINAL CASE SIZE Ø D x L (mm)	I_R 100 Hz 105 °C (mA)	I_{L1} 1 min (µA)	tan δ 100 Hz	Z 100 kHz (Ω)	ORDERING CODE MAL2047...		
							BULK PACKAGING		TAPED
							FORM CA	FORM CB	FORM TFA
16	470	10 x 12	330	78	0.16	0.33	55471E3	65471E3	35471E3
	1000	10 x 20	540	160	0.16	0.17	55102E3	65102E3	35102E3
	2200	12.5 x 25	830	360	0.20	0.10	55222E3	65222E3	35222E3
	3300	16 x 25	1100	530	0.22	0.08	55332E3	65332E3	35332E3
	4700	16 x 31	1300	760	0.24	0.07	55472E3	65472E3	35472E3
	6800	16 x 35	1600	1100	0.28	0.06	55682E3	65682E3	-
	10 000	18 x 35	1800	1600	0.36	0.05	55103E3	65103E3	-
25	470	10 x 16	360	120	0.14	0.25	56471E3	66471E3	36471E3
	1000	12.5 x 20	630	250	0.14	0.13	56102E3	66102E3	36102E3
	2200	16 x 25	990	550	0.18	0.08	56222E3	66222E3	36222E3
	3300	16 x 31	1200	830	0.20	0.07	56332E3	66332E3	36332E3
	4700	18 x 35	1500	1200	0.22	0.05	56472E3	66472E3	-
	6800	18 x 35	1700	1700	0.26	0.04	56682E3	66682E3	-
35	220	10 x 12	270	80	0.12	0.38	50221E3	60221E3	30221E3
	330	10 x 16	350	120	0.12	0.28	50331E3	60331E3	30331E3
	470	10 x 20	450	170	0.12	0.22	50471E3	60471E3	30471E3
	1000	12.5 x 25	780	350	0.12	0.12	50102E3	60102E3	30102E3
	2200	16 x 31	1200	770	0.16	0.07	50222E3	60222E3	30222E3
	3300	18 x 35	1500	1200	0.18	0.05	50332E3	60332E3	-
	4700	18 x 35	1800	1600	0.20	0.04	50472E3	60472E3	-
40	330	10 x 20	380	140	0.12	0.26	57331E3	67331E3	37331E3
	2200	16 x 35	1200	880	0.16	0.06	57222E3	67222E3	-
	3300	18 x 35	1500	1300	0.18	0.04	57332E3	67332E3	-
50	220	10 x 16	310	110	0.10	0.33	51221E3	61221E3	31221E3
	470	12.5 x 20	540	240	0.10	0.17	51471E3	61471E3	31471E3
	1000	16 x 25	940	500	0.10	0.09	51102E3	61102E3	31102E3
	2200	18 x 35	1400	1100	0.14	0.05	51222E3	61222E3	-
	3300	18 x 35	1600	1700	0.16	0.04	51332E3	61332E3	-
63	100	10 x 12	210	66	0.09	0.65	58101E3	68101E3	38101E3
	220	10 x 20	350	140	0.09	0.32	58221E3	68221E3	38221E3
	330	12.5 x 20	470	210	0.09	0.22	58331E3	68331E3	38331E3
	470	12.5 x 25	620	300	0.09	0.16	58471E3	68471E3	38471E3
	1000	16 x 31	1100	630	0.09	0.08	58102E3	68102E3	38102E3
	2200	18 x 35	1500	1400	0.13	0.04	58222E3	68222E3	-

ADDITIONAL ELECTRICAL DATA		
DESCRIPTION	**CONDITIONS**	**VALUE**
Voltage		
Surge voltage		$U_s \leq 1.15\ U_R$
Reverse voltage		$U_{rev} \leq 1$ V
Current		
Leakage current	After 1 min at U_R	$I_{L1} \leq 0.01\ C_R \times U_R + 3$ µA
	After 5 min at U_R	$I_{L5} \leq 0.002\ C_R \times U_R + 3$ µA
Inductance		
Equivalent series inductance (ESL)	Case Ø D = 10 mm	Typ. 16 nH
	Case Ø D ≥ 12.5 mm	Typ. 18 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from tan $\delta_{max.}$ and C_R (see Table 2)	ESR = tan $\delta/2\pi fC_R$

RIPPLE CURRENT AND USEFUL LIFE



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

(1) Useful life at 105 °C and I_R applied: 1500 h

Fig. 5 - Multiplier of useful life as a function of ambient temperature and ripple current load

Table 3

MULTIPLIER OF RIPPLE CURRENT (I_R) AS A FUNCTION OF FREQUENCY			
FREQUENCY (Hz)	**I_R MULTIPLIER**		
	U_R = 16 V AND 25 V	**U_R = 35 V AND 40 V**	**U_R = 50 V AND 63 V**
50	0.95	0.85	0.80
100	1.00	1.00	1.00
300	1.07	1.20	1.25
1000	1.12	1.30	1.40
3000	1.15	1.35	1.50
≥ 10 000	1.20	1.40	1.60

Table 4

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; 1000 h	ΔC/C: ± 15 % tan δ ≤ 1.3 x spec. limit Z ≤ 2 x spec. limit I_{L5} ≤ spec. limit
Useful life	CECC 30301 subclause 1.8.1	T_{amb} = 105 °C; U_R and I_R applied; 1500 h	ΔC/C: ± 45 % tan δ ≤ 3 x spec. limit Z ≤ 3 x spec. limit I_{L5} ≤ spec. limit no short or open circuit total failure percentage: ≤ 1 %
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300, subclause 4.17	T_{amb} = 105 °C; no voltage applied; 500 h After test: U_R to be applied for 30 min, 24 h to 48 h before measurement	ΔC/C: ± 15 % tan δ ≤ 1.3 x spec. limit Z ≤ 2 x spec. limit I_{L5} ≤ 2 x spec. limit

Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, “Vishay”), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay’s knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer’s responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and / or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer’s technical experts. Product specifications do not expand or otherwise modify Vishay’s terms and conditions of purchase, including but not limited to the warranty expressed therein.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.