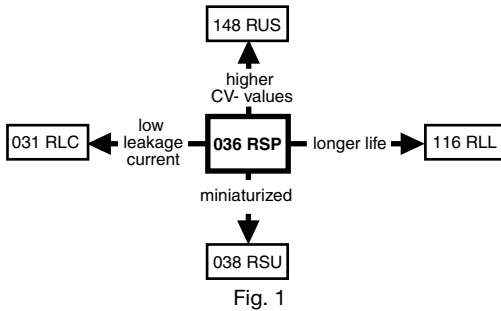
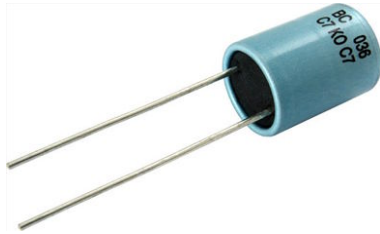


Aluminum Capacitors Radial Semi-Professional



FEATURES

- Useful life at + 85 °C: 3000 h
- Useful life at + 105 °C: 750 h
- Reduced leakage current
- Miniaturized, high CV-product per unit volume
- Natural pitch 2.5 mm and 5 mm
- Polarized aluminum electrolytic capacitors, non-solid electrolyte
- Radial leads, cylindrical aluminum case, all-insulated (light blue)
- Charge and discharge proof
- Material categorization: For definitions of compliance please see www.vishay.com/doc?99912


**RoHS
COMPLIANT**

APPLICATIONS

- Automotive, telecommunication, industrial, EDP and audio-video
- Coupling, decoupling, smoothing, filtering, buffering, timing
- Portable and mobile equipment (small size, low mass)

MARKING

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

- Rated capacitance (in μF)
- Tolerance on rated capacitance, code letter in accordance with IEC 60062 (M for $\pm 20\%$)
- Rated voltage (in V)
- Date code in accordance with IEC 60062
- Code indicating factory of origin
- Name of manufacturer
- Minus-sign on top to identify the negative terminal
- Series number (036)

QUICK REFERENCE DATA	
DESCRIPTION	VALUE
Nominal case sizes (\varnothing D x L in mm)	5 x 11 and 8.2 x 11
Rated capacitance range, C_R	2.2 μF to 470 μF
Tolerance on C_R	$\pm 20\%$; $\pm 10\%$ on request
Rated voltage range, U_R	6.3 V to 160 V
Category temperature range	- 55 °C to + 85 °C
Endurance test at 85 °C	2000 h
Useful life at 105 °C	750 h
Useful life at 85 °C	3000 h
Useful life at 40 °C, 1.4 x I_R applied	80 000 h
Shelf life at 0 V, 85 °C	500 h
Based on sectional specification	IEC 60384-4/EN130300
Climatic category IEC 60068	55/085/56

SELECTION CHART FOR C_R , U_R , AND RELEVANT NOMINAL CASE SIZES (\varnothing D x L in mm)										
C_R (μF)	U_R (V)									
	6.3	10	16	25	35	40	50	63	100	160
2.2	-	-	-	-	-	-	-	5 x 11	-	8.2 x 11
3.3	-	-	-	-	-	-	-	5 x 11	-	-
4.7	-	-	-	-	-	-	-	5 x 11	-	8.2 x 11
6.8	-	-	-	-	-	-	-	5 x 11	-	-
10	-	-	-	-	-	-	5 x 11	5 x 11	8.2 x 11	-
	-	-	-	-	-	-	-	8.2 x 11	-	-
15	-	-	-	-	-	5 x 11	-	5 x 11	-	-
	-	-	-	-	5 x 11	-	-	5 x 11	8.2 x 11	-
22	-	-	-	-	-	-	-	8.2 x 11	-	-
	-	-	-	-	-	-	-	8.2 x 11	-	-
33	-	-	5 x 11	-	-	-	5 x 11	8.2 x 11	-	-
47	-	5 x 11	-	-	5 x 11	-	8.2 x 11	8.2 x 11	-	-
68	-	-	-	5 x 11	-	8.2 x 11	-	8.2 x 11	-	-
100	5 x 11	-	5 x 11	8.2 x 11	-	-	8.2 x 11	-	-	-
150	-	5 x 11	8.2 x 11	-	8.2 x 11	-	-	-	-	-
220	-	8.2 x 11	8.2 x 11	8.2 x 11	-	-	-	-	-	-
330	8.2 x 11	-	8.2 x 11	-	-	-	-	-	-	-
470	-	8.2 x 11	-	-	-	-	-	-	-	-

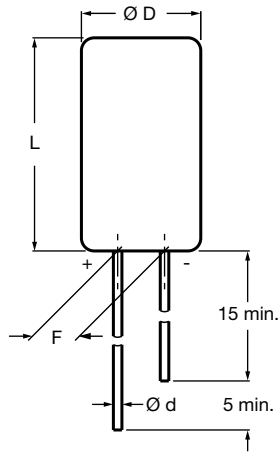
DIMENSIONS in millimeters AND AVAILABLE FORMS


Fig. 2 - Form CA: Long leads

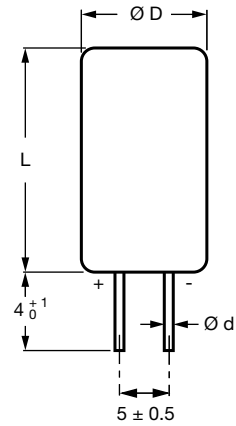

 Case $\varnothing D \times L = 8.2 \text{ mm} \times 11 \text{ mm}$ only

Fig. 3 - Form CB: Cut leads

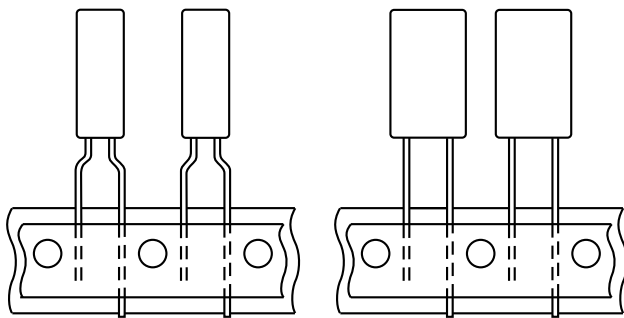

 Pitch $F = 5 \text{ mm}$
 Case $\varnothing D \times L = 5 \text{ mm} \times 11 \text{ mm}$ and $8.2 \text{ mm} \times 11 \text{ mm}$

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

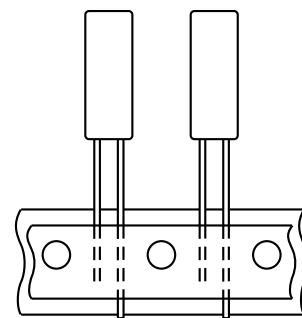

 Pitch $F = 2.5 \text{ mm}$
 Case $\varnothing D \times L = 5 \text{ mm} \times 11 \text{ mm}$ only

Fig. 5 - Form TNA: Taped in box (ammopack)

Table 1

DIMENSIONS in millimeters, MASS AND PACKAGING QUANTITIES								
NOMINAL CASE SIZE $\varnothing D \times L$	CASE CODE	$\varnothing d$	$\varnothing D_{\text{max}}$	L_{max}	F	MASS (g)	PACKAGING QUANTITIES	
							FORM CA, CB	FORM TFA, TNA
5 x 11	11	0.5	5.5	12	2.5 ± 0.5	≈ 0.4	1000	2000
8.2 x 11	13	0.6	8.7	12	5.0 ± 0.5	≈ 1.1	1000	1000

Note

- For 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, 85 °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 and 20 °C

ORDERING EXAMPLE

Electrolytic capacitor 036 series
 100 µF/16 V; ± 20 %
 Nominal case size: Ø 5 x 11 mm; Form TFA
 Ordering code: MAL203635101E3
 Former 12NC: 2222 036 35101

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 %

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 85 °C (mA)	I _{L1} 1 min (µA)	tan δ 100 Hz	Z 10 kHz (Ω)	ORDERING CODE MAL2036.....							
							BULK PACKAGING				TAPED AMMOPACK			
							LONG LEADS		CUT LEADS		FORM TFA	F (mm)	FORM TNA	F (mm)
							FORM CA	F (mm)	FORM CB	F (mm)				
6.3	100	5 x 11	130	7	0.20	1.7	53101E3	2.5	-	-	33101E3	5.0	73101E3	2.5
	330	8.2 x 11	300	16	0.20	0.52	53331E3	5.0	63331E3	5.0	33331E3	5.0	-	-
10	47	5 x 11	95	6	0.16	2.8	54479E3	2.5	-	-	34479E3	5.0	74479E3	2.5
	150	5 x 11	150	12	0.20	1.3	54151E3	2.5	-	-	34151E3	5.0	74151E3	2.5
	220	8.2 x 11	260	17	0.16	0.59	54221E3	5.0	64221E3	5.0	34221E3	5.0	-	-
	470	8.2 x 11	400	31	0.20	0.43	54471E3	5.0	64471E3	5.0	34471E3	5.0	-	-
16	33	5 x 11	90	7	0.14	2.7	55339E3	2.5	-	-	35339E3	5.0	75339E3	2.5
	100	5 x 11	160	13	0.16	1.6	55101E3	2.5	-	-	35101E3	5.0	75101E3	2.5
	150	8.2 x 11	230	18	0.14	0.6	55151E3	5.0	65151E3	5.0	35151E3	5.0	-	-
	220	8.2 x 11	280	24	0.16	0.55	55221E3	5.0	65221E3	5.0	35221E3	5.0	-	-
	330	8.2 x 11	390	35	0.16	0.48	55331E3	5.0	65331E3	5.0	35331E3	5.0	-	-
25	68	5 x 11	140	13	0.14	1.8	56689E3	2.5	-	-	36689E3	5.0	76689E3	2.5
	100	8.2 x 11	210	18	0.12	0.7	56101E3	5.0	66101E3	5.0	36101E3	5.0	-	-
	220	8.2 x 11	310	36	0.14	0.55	56221E3	5.0	66221E3	5.0	36221E3	5.0	-	-
35	22	5 x 11	87	8	0.10	2.7	90001E3	2.5	-	-	90027E3	5.0	90389E3	2.5
	47	5 x 11	130	13	0.12	1.9	90094E3	2.5	-	-	90098E3	5.0	90391E3	2.5
	150	8.2 x 11	270	35	0.12	0.6	90099E3	5.0	90101E3	5.0	90103E3	5.0	-	-
40	15	5 x 11	72	7	0.10	3.7	57159E3	2.5	-	-	37159E3	5.0	77159E3	2.5
	68	8.2 x 11	180	20	0.10	0.81	57689E3	5.0	67689E3	5.0	37689E3	5.0	-	-
50	10	5 x 11	60	6	0.08	4.5	90004E3	2.5	-	-	90028E3	5.0	90392E3	2.5
	33	5 x 11	110	13	0.10	2.1	90104E3	2.5	-	-	90108E3	5.0	90393E3	2.5
	47	8.2 x 11	160	18	0.08	0.96	90011E3	5.0	90012E3	5.0	90031E3	5.0	-	-
	100	8.2 x 11	250	33	0.10	0.7	90109E3	5.0	90111E3	5.0	90113E3	5.0	-	-
63	2.2	5 x 11	25	4	0.06	18	58228E3	2.5	-	-	38228E3	5.0	78228E3	2.5
	3.3	5 x 11	38	5	0.06	12	58338E3	2.5	-	-	38338E3	5.0	78338E3	2.5
	4.7	5 x 11	45	5	0.06	8.5	58478E3	2.5	-	-	38478E3	5.0	78478E3	2.5
	6.8	5 x 11	55	6	0.06	5.9	58688E3	2.5	-	-	38688E3	5.0	78688E3	2.5
	10	5 x 11	70	7	0.06	4.0	58109E3	2.5	-	-	38109E3	5.0	78109E3	2.5
	10	8.2 x 11	120	7	0.04	2.8	90036E3	5.0	90041E3	5.0	90181E3	5.0	-	-
	15	5 x 11	80	9	0.07	3.1	58159E3	2.5	-	-	38159E3	5.0	78159E3	2.5
	22	5 x 11	100	11	0.08	2.7	58229E3	2.5	-	-	38229E3	5.0	78229E3	2.5
	22	8.2 x 11	150	11	0.05	1.4	90117E3	5.0	90118E3	5.0	90139E3	5.0	-	-
	33	8.2 x 11	160	16	0.06	1.2	58339E3	5.0	68339E3	5.0	38339E3	5.0	-	-
	47	8.2 x 11	190	21	0.07	1.0	58479E3	5.0	68479E3	5.0	38479E3	5.0	-	-
68	8.2 x 11	210	29	0.08	0.88	58689E3	5.0	68689E3	5.0	38689E3	5.0	-	-	
100	10	8.2 x 11	80	9	0.06	3.5	59109E3	5.0	69109E3	5.0	39109E3	5.0	-	-
	22	8.2 x 11	110	16	0.06	1.8	59229E3	5.0	69229E3	5.0	39229E3	5.0	-	-
160	2.2	8.2 x 11	45	75	0.05	14	90333E3	5.0	90334E3	5.0	90336E3	5.0	-	-
	4.7	8.2 x 11	62	115	0.07	9.6	90337E3	5.0	90338E3	5.0	90341E3	5.0	-	-



ADDITIONAL ELECTRICAL DATA		
PARAMETER	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 $U_R = 6.3 V$ to $100 V$ $U_R = 160 V$	$I_{L1} \leq 0.006 C_R \times U_R + 3 \mu A$ $I_{L1} \leq 0.1 C_R \times U_R + 40 \mu A$
	After 5 min $U_R = 6.3 V$ to $100 V$ $U_R = 160 V$	$I_{L5} \leq 0.001 C_R \times U_R + 3 \mu A$ $I_{L5} \leq 0.015 C_R \times U_R + 10 \mu A$
Inductance		
Equivalent series inductance (ESL)	Case $\varnothing D \times L = 5 mm \times 11 mm$	Typ. 13 nH
	Case $\varnothing D \times L = 8.2 mm \times 11 mm$	Typ. 16 nH
Resistance		
Equivalent series resistance (ESR)	Calculated from $\tan \delta_{max}$ and C_R (see Table 2)	$ESR = \tan \delta / 2 \pi f C_R$

CAPACITANCE (C)

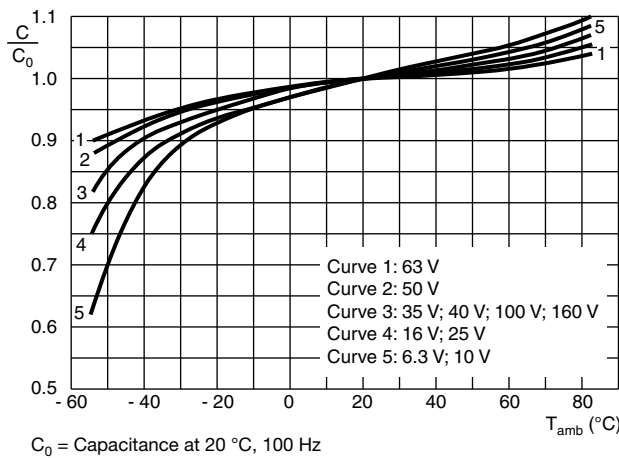


Fig. 6 - Typical multiplier of capacitance as a function of ambient temperature

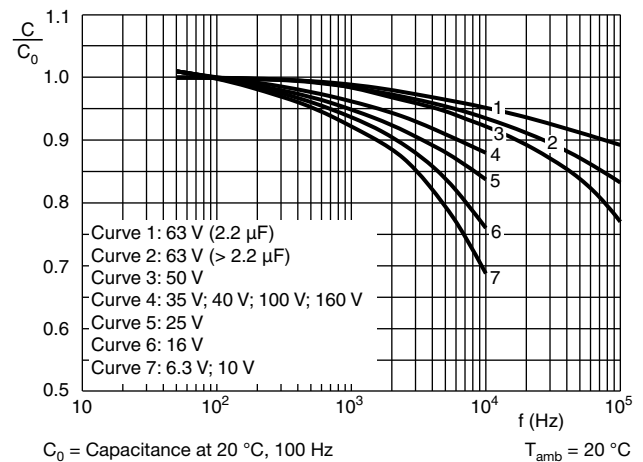


Fig. 7 - Typical multiplier of capacitance as a function of ambient temperature

IMPEDANCE (Z)

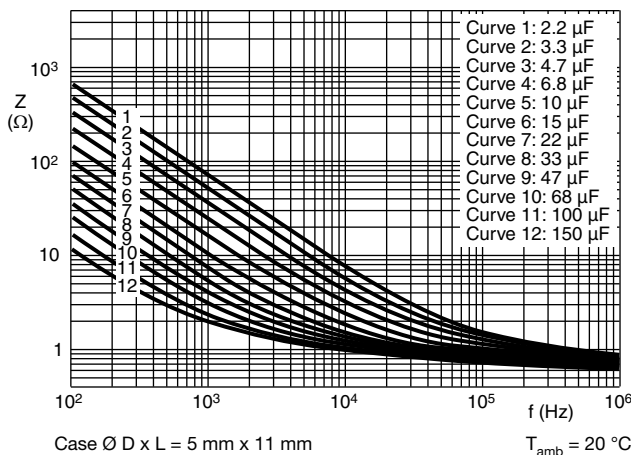


Fig. 8 - Typical impedance as a function of frequency

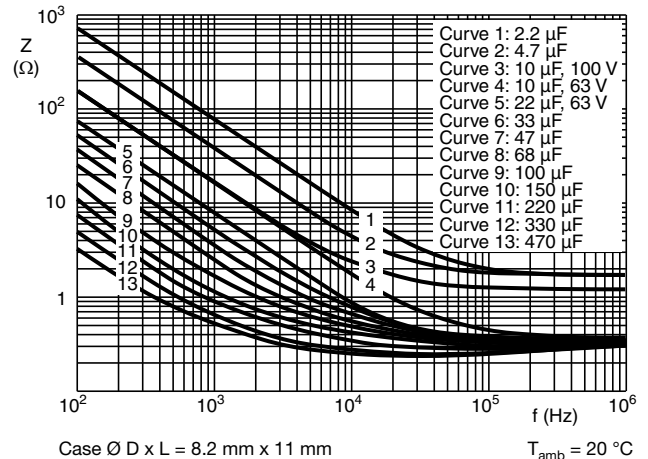


Fig. 9 - Typical impedance as a function of frequency

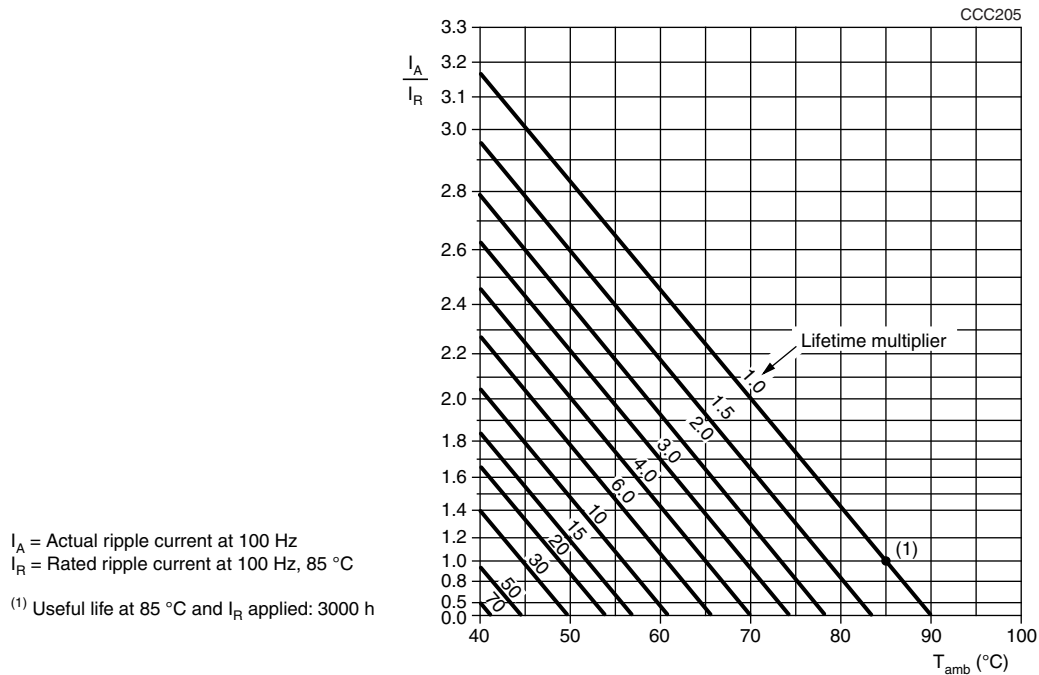
RIPPLE CURRENT AND USEFUL LIFE


Fig. 10 - 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		
	$U_R = 6.3 \text{ V TO } 10 \text{ V}$	$U_R = 16 \text{ V TO } 35 \text{ V}$	$U_R = 40 \text{ V TO } 160 \text{ V}$
50	0.90	0.85	0.80
100	1.00	1.00	1.00
300	1.12	1.20	1.25
1000	1.20	1.30	1.40
3000	1.25	1.35	1.50
$\geq 10\ 000$	1.30	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	$T_{amb} = 85 \text{ }^\circ\text{C}$; U_R applied; 2000 h	$U_R \leq 6.3 \text{ V}$; $\Delta C/C$: + 15 %/- 30 % $U_R > 6.3 \text{ V}$; $\Delta C/C$: $\pm 15 \%$ $\tan \delta \leq 1.3 \times \text{spec. limit}$ $Z \leq 2 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$
Useful life	CECC 30301 subclause 1.8.1	$T_{amb} = 85 \text{ }^\circ\text{C}$; U_R and I_R applied; 3000 h	$U_R \leq 6.3 \text{ V}$; $\Delta C/C$: + 45 %/- 50 % $U_R > 6.3 \text{ V}$; $\Delta C/C$: $\pm 45 \%$ $\tan \delta \leq 3 \times \text{spec. limit}$ $Z \leq 3 \times \text{spec. limit}$ $I_{L5} \leq \text{spec. limit}$ No short or open circuit Total failure percentage: $\leq 1 \%$
Shelf life (storage at high temperature)	IEC 60384-4/ EN130300 subclause 4.17	$T_{amb} = 85 \text{ }^\circ\text{C}$; no voltage applied; 500 h After test: U_R to be applied for 30 min, 24 h to 48 h before measurement	$\Delta C/C$, $\tan \delta$, Z : For requirements see "Endurance test" above $I_{L5} \leq \text{spec. limit}$



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.

Material Category Policy

Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as RoHS-Compliant fulfill the definitions and restrictions defined under Directive 2011/65/EU of The European Parliament and of the Council of June 8, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (EEE) - recast, unless otherwise specified as non-compliant.

Please note that some Vishay documentation may still make reference to RoHS Directive 2002/95/EC. We confirm that all the products identified as being compliant to Directive 2002/95/EC conform to Directive 2011/65/EU.

Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as Halogen-Free follow Halogen-Free requirements as per JEDEC JS709A standards. Please note that some Vishay documentation may still make reference to the IEC 61249-2-21 definition. We confirm that all the products identified as being compliant to IEC 61249-2-21 conform to JEDEC JS709A standards.