

# **Aluminum Electrolytic Capacitors** SMD (Chip), High Voltage



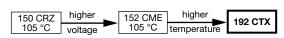


Fig. 1

QUICK REFERENCE D	ATA		
DESCRIPTION	VALUE		
Nominal case sizes (L x W x H in mm)	10 x 10 x 10 to 18 x 18 x 21		
Rated capacitance range, C <sub>R</sub>	2.2 μF to 33 μF		
Tolerance on C <sub>R</sub>	± 20 %		
Rated voltage range, U <sub>R</sub>	400 V		
Category temperature range	-40 °C to +125 °C		
Endurance test at 125 °C	1000 h to 2000 h		
Useful life at 125 °C	1000 h to 2500 h		
Useful life at 40 °C 1.8 x I <sub>R</sub> applied	75 000 h to 150 000 h		
Shelf life at 0 V, 125 °C	1000 h		
Based on sectional specification	IEC 60384-18 / CECC 32300		
Climatic category IEC 60068	40 / 125 / 56		

#### **FEATURES**

- Extended useful life: up to 2500 h at 125 °C
- · Polarized aluminum electrolytic capacitors, non-solid electrolyte, self healing



RoHS

COMPLIANT

· SMD-version with base plate, lead (Pb)-free

- reflow solderable
- · Charge and discharge proof, no peak current limitation
- · Advanced temperature reflow soldering according to JEDEC® J-STD-020
- Vibration proof, 4-pin version and 6-pin version
- AEC-Q200 qualified
- · High reliability
- · Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

#### **APPLICATIONS**

- · SMD technology, for high temperature reflow soldering
- Industrial and professional applications
- Automotive, general industrial, telecom
- · Smoothing, filtering, buffering

#### **MARKING**

- Rated capacitance (in µF)
- Rated voltage (in V)
- Date code, in accordance with IEC 60062
- Black mark or "-" sign indicating the cathode (the anode is identified by beveled edges)
- Code indicating group number (X)

#### **PACKAGING**

Supplied in blister tape on reel

SELECTION CHART FOR $C_R$ , $U_R$ , and relevant nominal case sizes (L x W x H in mm)					
C <sub>R</sub>	U <sub>R</sub> (V)				
(μF)	400				
2.2	10 x 10 x 10				
4.7	12.5 x 12.5 x 13				
5.6	12.5 x 12.5 x 16				
10	16 x 16 x 16				
15	16 x 16 x 21				
22	18 x 18 x 16				
33	18 x 18 x 21				

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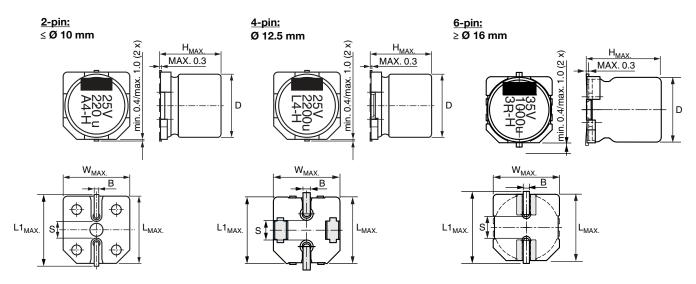


Fig. 2 - Dimensional outline

Table 1

DIMENSIONS in millimeters AND MASS									
NOMINAL CASE SIZE L x W x H	CASE CODE	L <sub>MAX.</sub>	W <sub>MAX.</sub>	H <sub>MAX.</sub>	Ø D	B <sub>MAX.</sub>	s	L1 <sub>MAX.</sub>	MASS (g)
10 x 10 x 10	1010	10.5	10.5	10.5	10.0	1.0	3.5	12.1	≈ 1.3
12.5 x 12.5 x 13	1213	12.9	12.9	14.0	12.5	1.3	3.6	14.9	≈ 2.6
12.5 x 12.5 x 16	1216	12.9	12.9	16.5	12.5	1.3	3.6	14.9	≈ 2.8
16 x 16 x 16	1616	16.6	16.6	17.5	16.0	1.3	6.5	18.6	≈ 5.5
16 x 16 x 21	1621	16.6	16.6	22.0	16.0	1.3	6.5	18.6	≈ 6.0
18 x 18 x 16	1816	19.0	19.0	17.5	18.0	1.3	6.5	21.0	≈ 8.0
18 x 18 x 21	1821	19.0	19.0	22.0	18.0	1.3	6.5	21.0	≈ 8.3

Table 2

TAPE AND REEL DIMENSIONS in millimeters, PACKAGING QUANTITIES							
NOMINAL CASE SIZE L x W x H	CASE CODE	PITCH P <sub>1</sub>	TAPE WIDTH W	TAPE THICKNESS T <sub>2</sub>	REEL DIAMETER	PACKAGING QUANTITY PER REEL	
10 x 10 x 10	1010	16	24	11.6	380	500	
12.5 x 12.5 x 13	1213	20	24	16.2	380	250	
12.5 x 12.5 x 16	1216	24	32	18.5	380	200	
16 x 16 x 16	1616	28	44	18.9	380	150	
16 x 16 x 21	1621	28	44	23.4	380	100	
18 x 18 x 16	1816	32	44	18.9	380	125	
18 x 18 x 21	1821	32	44	23.4	380	100	

#### Note

• Detailed tape dimensions see section "PACKAGING"

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#### **MOUNTING**

The capacitors are designed for automatic placement on to printed-circuit boards.

Optimum dimensions of soldering pads depend amongst others on soldering method, mounting accuracy, print layout and / or adjacent components.

For recommended soldering pad dimensions, refer to Fig. 3 and Table 3.

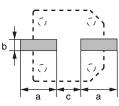
#### **SOLDERING**

Soldering conditions are defined by the curve, temperature versus time, where the temperature is that measured on the component during processing.

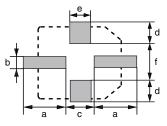
For maximum conditions refer to Fig. 4.

Any temperature versus time curve which does not exceed the specified maximum curves may be applied.

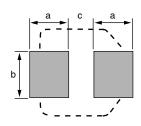
As a general principle, temperature and duration shall be the **minimum** necessary required to ensure good soldering connections. However, the specified maximum curves should never be exceeded.



Case size Ø D ≤ 10 mm



Case size Ø D = 12.5 mm



Case size Ø D ≥ 16 mm

Fig. 3 - Recommended soldering pad dimensions

#### Table 3

RECOMMENDED SOLDERING PAD DIMENSIONS in millimeters							
CASE CODE	а	b	С	d	е	f	
1010	4.4	2.5	4.0	-	-	-	
1213	6.3	2.5	4.0	4.2	5.0	5.6	
1216	6.3	2.5	4.0	4.2	5.0	5.6	
1616	7.8	9.6	4.7	-	-	-	
1621	7.8	9.6	4.7	-	-	-	
1816	8.8	9.6	4.7	-	-	-	
1821	8.8	9.6	4.7	-	-	-	



# ADVANCED SOLDERING PROFILE FOR LEAD (Pb)-FREE REFLOW PROCESS ACCORDING TO JEDEC J-STD-020

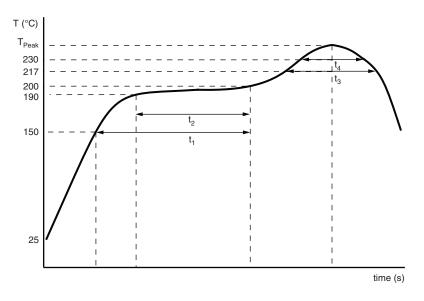


Fig. 4 - Maximum temperature load during reflow soldering

#### Table 4

REFLOW SOLDERING CONDITIONS for MAL219299xxxE3								
PROFILE FEATURES	CASE CODE 1010	CASE CODE 1213 TO 1216	CASE CODE 1616 TO 1821					
Max. time from 25 °C to T <sub>Peak</sub>	300 s	300 s	300 s					
Max. ramp-up rate to 150 °C	3 K/s	3 K/s	3 K/s					
Max. time from 150 °C to 200 °C (t <sub>1</sub> )	150 s	150 s	150 s					
Max. time from 190 °C to 200 °C (t <sub>2</sub> )	110 s	110 s	110 s					
Ramp up rate from 200 °C to T <sub>Peak</sub>	0.5 K/s to 3 K/s	0.5 K/s to 3 K/s	0.5 K/s to 3 K/s					
Max. time above T <sub>Liquidus</sub> (217 °C) (t <sub>3</sub> )	90 s	90 s	90 s					
Max. time above 230 °C (t <sub>4</sub> )	70 s	65 s	60 s					
Peak temperature T <sub>Peak</sub>	260 °C	250 °C	245 °C					
Max. time above T <sub>Peak</sub> minus 5 °C	40 s	30 s	30 s					
Ramp-down rate from T <sub>Liquidus</sub>	3 K/s to 6 K/s	3 K/s to 6 K/s	3 K/s to 6 K/s					

#### Notes

- Temperature measuring point on top of the case and on terminals
- Max. 2 runs with pause of min. 30 min in between



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ELECTRICAL DATA					
SYMBOL	DESCRIPTION				
C <sub>R</sub>	Rated capacitance at 100 Hz, tolerance ± 20 %				
I <sub>R</sub>	Rated RMS ripple current at 100 Hz, 125 °C				
I <sub>L1</sub>	Max. leakage current after 1 min at U <sub>R</sub>				
tan δ	Max. dissipation factor at 100 Hz				
Z	Max. impedance at 100 kHz				

#### **ORDERING EXAMPLE**

Electrolytic capacitor 192 CTX series

33  $\mu F$  / 400 V;  $\pm$  20 %

Nominal case size: 18 mm x 18 mm x 21 mm; blister tape on

ree

Ordering code: MAL219299607E2

#### Note

 Unless otherwise specified, all electrical values in Table 5 apply at T<sub>amb</sub> = 20 °C, P = 86 kPa to 106 kPa, RH = 45 % to 75 %

#### Table 5

ELECT	ELECTRICAL DATA AND ORDERING INFORMATION								
U <sub>R</sub> (V)	C <sub>R</sub> (μF)	NOMINAL CASE SIZE L x W x H (mm)	I <sub>R</sub> 125 °C 100 Hz (mA)	l <sub>L1</sub> 1 min (μΑ)	tan δ 100 Hz	Z 10 kHz 20 °C (Ω)	LIFE CODE (1)	ORDERING CODE MAL2192	
	2.2	10 x 10 x 10	30	96	0.20	14.5	L1	99601E3	
	4.7	12.5 x 12.5 x 13	50	126	0.20	5.9	L1	99602E3	
	5.6	12.5 x 12.5 x 16	65	137	0.20	5.2	L2	99603E3	
400	10	16 x 16 x 16	90	190	0.20	2.9	L2	99604E3	
	15	16 x 16 x 21	110	250	0.20	2.1	L3	99605E3	
	22	18 x 18 x 16	120	334	0.20	1.7	L2	99606E3	
	33	18 x 18 x 21	160	466	0.20	1.1	L3	99607E3	

#### Note

#### Table 6

ADDITIONAL ELECTRICAL DATA							
PARAMETER	CONDITIONS	VALUE					
Voltage							
Surge voltage for short periods	IEC 60384-18, subclause 4.14	U <sub>s</sub> ≤ 1.10 x U <sub>R</sub>					
Reverse voltage for short periods	IEC 60384-18, subclause 4.16; T <sub>A</sub> ≤ 125 °C	U <sub>rev</sub> ≤ 1 V					
Current							
Leakage current	After 1 min at U <sub>R</sub>	$I_{L1} \leq 0.03 \; x \; C_R \; x \; U_R + 70 \; \mu A$					
Leanage Current	After 5 min at U <sub>R</sub>	$I_{L5} \leq 0.015 \ x \ C_R \ x \ U_R + 30 \ \mu A$					
Inductance							
Equivalent series inductance (ESL)	Ø D = 10 mm	Typ. 16 nH					
Equivalent series inductance (ESE)	Ø D ≥ 12.5 mm	Typ. 18 nH					
Resistance							
Equivalent series resistance (ESR) at 100 Hz	Calculated from tan $\delta_{\text{max.}}$ and $C_{\text{R}}$ (see Table 5)	ESR = $\tan \delta/2\pi fC_R$					

<sup>(1)</sup> Determines the applicable row in the table "Endurance Test Duration and Useful Life"



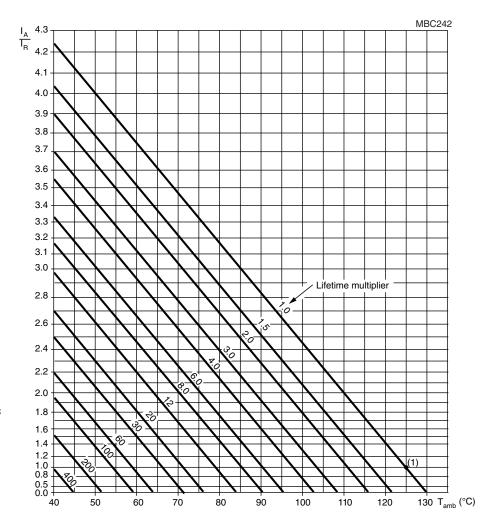
#### **RIPPLE CURRENT AND USEFUL LIFE**

#### Table 7

ENDURANCE TEST DURATION AND USEFUL LIFE							
LIFE CODE	ENDURANCE AT 125 °C (h)	USEFUL LIFE AT 40 °C 1.8 x I <sub>R</sub> APPLIED (h)					
L1	1000	1000	75 000				
L2	1000	1500	150 000				
L3	2000	2500	200 000				

#### Note

• Multiplier of useful life code: MBC242



 $I_{\rm A}$  = Actual ripple current at 100 kHz  $I_{\rm R}$  = Rated ripple current at 100 kHz, 125 °C  $^{(1)}$  Useful life at 125 °C and  $I_{\rm R}$  applied; see Table 7

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

#### Table 8

MULTIPLIER OF RIPPLE CURRENT (I <sub>R</sub> ) AS A FUNCTION OF FREQUENCY							
U <sub>R</sub>	FREQUENCY (Hz)						
(V)	50	100	300	1000	3000	10 000	≥ 30 000
400	0.75	1.00	1.30	1.60	1.90	2.20	2.50



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#### Table 9

TEST PROCEDURES AND REQUIREMENTS						
TEST		PROCEDURE	REQUIREMENTS			
NAME OF TEST	REFERENCE	(quick reference)	NEQUINEWEN 13			
Mounting	IEC 60384-18, subclause 4.3	Shall be performed prior to tests mentioned below; reflow soldering; for maximum temperature load refer to chapter "Mounting"	$\Delta$ C/C: ± 5 % tan $\delta$ ≤ spec. limit $I_{L2}$ ≤ spec. limit			
Endurance	IEC 60384-18 / CECC 32300, subclause 4.15	T <sub>amb</sub> = 125 °C; U <sub>R</sub> applied; for test duration see Table 7	$\begin{array}{l} U_R \geq 400 \text{ V; } \Delta C/C\text{: } \pm 20 \text{ \%} \\ \tan \delta \leq 2 \text{ x spec. limit} \\ I_{L2} \leq \text{spec. limit} \end{array}$			
Useful life	CECC 30301, subclause 1.8.1	$T_{amb}$ = 125 °C; $U_R$ and $I_R$ applied; for test duration see Table 7	$\begin{array}{l} \Delta C/C: \pm 50 \ \% \\ tan \ \delta \leq 3 \ x \ spec. \ limit \\ I_{L2} \leq spec. \ limit \\ no \ short \ or \ open \ circuit \\ total \ failure \ percentage: \leq 1 \ \% \end{array}$			
Shelf life (storage at high temperature)	IEC 60384-18 / CECC 32300, subclause 4.17	T <sub>amb</sub> = 125 °C; no voltage applied; 1000 h after test: U <sub>R</sub> to be applied for 30 min, 24 h to 48 h before measurement	For requirements see "Endurance test" above			
Reverse voltage	IEC 60384-18 / CECC 32300, subclause 4.16	T <sub>amb</sub> = 125 °C: 125 h at U = -1.0 V, followed by 125 h at U <sub>R</sub>	$\Delta$ C/C: ± 15 % tan $\delta$ ≤ 1.5 x spec. limit $I_{L2}$ ≤ 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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