



# Tantalum Chip Capacitors

Automotive

**Series/Type:** B45196L, B45198L

**Date:** July 2006



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SMD

### Construction

- Polar tantalum capacitors with solid electrolyte
- Conventional TaMnO<sub>2</sub> technology
- Flame-retardant plastic case (UL 94 V-0)
- Optionally tinned or gold-plated terminals



### Features

- Meets AEC-Q200 requirements
- Ultra-high volumetric efficiency
- Excellent solderability
- Stable temperature and frequency characteristics
- Low leakage current, low dissipation factor
- Low self-inductance
- High resistance to shock and vibration
- Suitable for use without series resistor (recommended operating conditions see [www.epcos.com/tantalum\\_gti](http://www.epcos.com/tantalum_gti), section 4.4)
- Lead-free and material content compatible with RoHS

### Applications

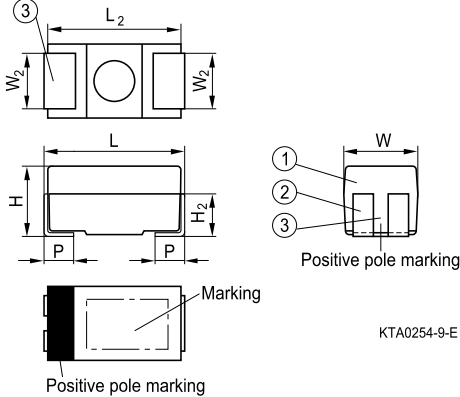
- Automotive electronics (e.g. safety applications e.g. airbags, ABS, motor management)
- Measuring and control engineering (e.g. voltage regulators)
- DC/DC converters

### Soldering

Suitable for reflow soldering (IR and vapor phase, in compliance with JEDEC J-STD-020 C) and wave soldering

### Delivery mode

Taped and reeled in accordance with IEC 60286-3

**Dimensional drawing**


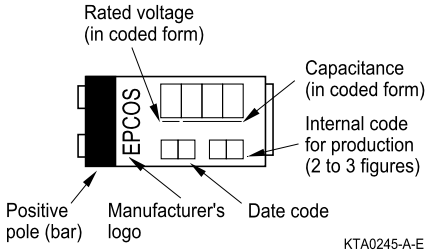
- ① Encapsulation: molded epoxy resin
- ② NiFe; tinned surface Sn100 or gold-plated
- ③ Reduced slot length for case size A

**Dimensions**

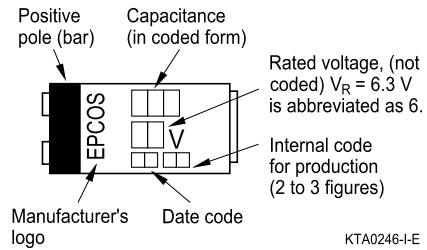
Case size		Dimensions in mm (inches)						
EPCOS	EIA/IECQ	L	W	H	L <sub>2</sub> typ.	W <sub>2</sub> ±0.1 ±(.004)	H <sub>2</sub> typ.	P ±0.3 ±(.012)
A	3216-18	3.2 ±0.2 (.126 ±0.008)	1.6 ±0.2 (.063 ±0.008)	1.6 ±0.2 (.063 ±0.008)	3.2 (.126)	1.2 (.047)	1.3 (.051)	0.8 (.031)
B	3528-21	3.5 ±0.2 (.138 ±0.008)	2.8 ±0.2 (.110 ±0.008)	1.9 ±0.2 (.075 ±0.008)	3.5 (.138)	2.2 (.087)	1.4 (.055)	0.7 (.027)
C	6032-28	6.0 ±0.3 (.236 ±0.012)	3.2 ±0.3 (.126 ±0.012)	2.5 ±0.3 (.098 ±0.012)	6.1 (.240)	2.2 (.087)	1.8 (.071)	1.3 (.051)
D	7343-31	7.3 ±0.3 (.287 ±0.012)	4.3 ±0.3 (.169 ±0.012)	2.8 ±0.3 (.110 ±0.012)	7.3 (.287)	2.4 (.094)	1.8 (.071)	1.3 (.051)
E	7343-44	7.3 ±0.3 (.287 ±0.012)	4.3 ±0.3 (.169 ±0.012)	4.1 ±0.3 (.161 ±0.012)	7.3 (.287)	2.4 (.094)	1.8 (.071)	1.3 (.051)

**Marking**

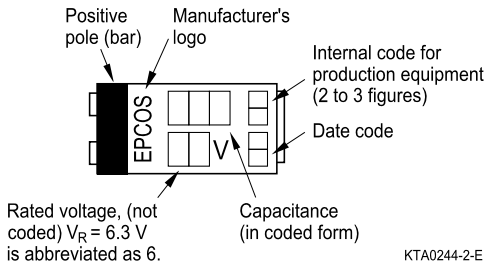
**Case size A**



**Case size B**



**Case sizes C, D, E**



**Voltage coding for case size A**

Rated voltage	4	6.3	10	16	20	25	35	50
Code letter	G	J	A	C	D	E	V	T

**Capacitance coding**

1st and 2nd digit	Capacitance in pF	
3rd digit	Multiplier:	6 = $10^6$ pF
		7 = $10^7$ pF
		8 = $10^8$ pF

**Date coding**

Year	Month	
S = 2004	1 = January	7 = July
T = 2005	2 = February	8 = August
U = 2006	3 = March	9 = September
V = 2007	4 = April	O = October
W = 2008	5 = May	N = November
X = 2009	6 = June	D = December

**Specifications and characteristics in brief**

Series		Automotive		
Ordering code		B45196L	B45198L	
Technology		Ta-MnO <sub>2</sub>	Ta-MnO <sub>2</sub>	
Terminals		Tinned	Gold-plated	
Rated voltage (up to 85 °C)	V <sub>R</sub>	4 ... 50		VDC
Rated capacitance (20 °C, 120 Hz)	C <sub>R</sub>	0.10 ... 1000		μF
Capacitance tolerance		±20%, ±10%		
Maximum impedance (20 °C, 100 kHz)	Z <sub>max</sub>	0.6 ... 27		Ω
Operating temperature range	T <sub>op</sub>	-55 ... +125		°C
Failure rate (at 40 °C; ≤ V <sub>R</sub> , R <sub>S</sub> ≥ 3 Ω/V) (1 fit = 1 · 10 <sup>-9</sup> failures/h) C <sub>R</sub> · V <sub>R</sub> ≤ 330 μF · V C <sub>R</sub> · V <sub>R</sub> > 330 μF · V		≤3 or 8 ≤10 or 24 (dependent on type)		fit
Service life		>500000		h
Leakage current (V <sub>R</sub> , 5 min, 20 °C)	I <sub>leak</sub>	10		nA/μC
Detail specification		CECC 30801-801		
Climatic category (to IEC 60068-1)	(-55 °C/+125 °C/56 days damp heat test)	55/125/56		

Overview of types

(VDC) (up to 85 °C)	4	6.3	10	16	20	25	35	50
$C_R$ (µF)								
0.1							A	A
0.15							A	A   B
0.22							A	B
0.33							A	B
0.47						A	A   B	B   C
0.68					A	A	A   B	C
1				A	A	A	A   B	C
1.5			A	A	A	A   B	B   C	C   D
2.2		A	A	A	A   B	B	B   C	C   D
3.3	A	A	A	A   B	A   B	B   C	C	D
4.7	A	A	A   B	A   B	B   C	B   C	C   D	D
6.8	A	A   B	A   B	A   B   C	B   C	C   D	C   D	D   E
10	A   B	A   B	A   B   C	B   C	C	C   D	D	E
15	A   B	A   B   C	A   B   C	B   C	C   D	C   D	E	
22	A   B   C	A   B   C	B   C	C   D	C   D	D		
33	A   B   C	B   C	B   C   D	C   D	D	D   E		
47	B   C	B   C   D	C   D	C   D	D   E	E		
68	B   C   D	C   D	C   D	D	E			
100	C   D	C   D	C   D	D   E				
150	C   D	C   D	D   E	E				
220	C   D	D   E	D   E					
330	D   E	D   E	E					
470	E	E	E					
680	E	E						
1000	E							



Ordering code structure

<b>B45</b>	<b>196L</b>	<b>0</b>	<b>685</b>	<b>+</b>	<b>10</b>	<b>*</b>
<b>Tantalum capacitor</b>						
<b>Series</b> 196L = Automotive, tinned terminals 198L = Automotive, gold-plated terminals						
<b>Rated voltage</b> 0 = 4 V, 1 = 6.3 V, 2 = 10 V, 3 = 16 V, 4 = 20 V, 5 = 25 V, 6 = 35 V, 7 = 50 V						
<b>Rated capacitance + exponent</b> C [pF] · 10 <sup>x</sup> E.g.: 686 = 68 pF · 10 <sup>6</sup> = 68 μF, 157 = 15 pF · 10 <sup>7</sup> = 150 μF						
<b>Capacitance tolerance</b> M = ±20%, K = ±10%						
<b>Case size</b> 10 = A 20 = B 30 = C 40 = D 50 = E						
<b>Reel diameter</b> 9 = 180 mm, 6 = 330 mm						

**Technical data and ordering codes**

$C_R$ (20 °C, 120 Hz)  $\mu\text{F}$	Case size	$DF_{\text{max}}$ (20 °C, 120 Hz)  %	$I_{\text{leak,max}}$ (20 °C, $V_R$ , 5 min)  $\mu\text{A}$	$Z_{\text{max}}$ (20 °C, 100 kHz)  $\Omega$	Ordering code
$V_R$ (up to 85 °C) = 4 VDC, $V_R$ (up to 125 °C) = 2.5 VDC					
3.3	A	6	0.5	9.0	B45196L0335+10*
4.7	A	6	0.5	7.0	B45196L0475+10*
6.8	A	6	0.5	6.0	B45196L0685+10*
10	A	6	0.5	4.5	B45196L0106+10*
10	B	6	0.5	4.5	B45196L0106+20*
15	A	6	0.6	4.0	B45196L0156+10*
15	B	6	0.6	3.5	B45196L0156+20*
22	A	8	0.9	3.5	B45196L0226+10*
22	B	6	0.9	3.0	B45196L0226+20*
22	C	6	0.9	2.4	B45196L0226+30*
33	A	8	1.3	3.0	B45196L0336+10*
33	B	6	1.3	2.5	B45196L0336+20*
33	C	6	1.3	2.0	B45196L0336+30*
47	B	6	1.9	2.3	B45196L0476+20*
47	C	6	1.9	1.6	B45196L0476+30*
68	B	6	2.7	1.8	B45196L0686+20*
68	C	6	2.7	1.5	B45196L0686+30*
68	D	6	2.7	1.1	B45196L0686+40*
100	C	8	4.0	1.4	B45196L0107+30*
100	D	8	4.0	0.8	B45196L0107+40*
150	C	8	6.0	1.3	B45196L0157+30*
150	D	8	6.0	0.8	B45196L0157+40*
220	C	15	8.8	1.2	B45196L0227+30*
220	D	8	8.8	0.8	B45196L0227+40*
330	D	10	13.2	0.9	B45196L0337+40*
330	E	8	13.2	0.8	B45196L0337+50*
470	E	8	18.8	0.6	B45196L0477+50*
680	E	12	27.2	0.6	B45196L0687+50*
1000	E	15	40.0	0.6	B45196L0108+50*
$V_R$ (up to 85 °C) = 6.3 VDC, $V_R$ (up to 125 °C) = 4 VDC					
2.2	A	6	0.5	10.0	B45196L1225+10*
3.3	A	6	0.5	7.0	B45196L1335+10*

\* = Code number for reel diameter  
 6 = 330-mm reel  
 9 = 180-mm reel

+ = Capacitance tolerance  
 M =  $\pm 20\%$   
 K =  $\pm 10\%$



$C_R$ (20 °C, 120 Hz)  $\mu\text{F}$	Case size	$DF_{\text{max}}$ (20 °C, 120 Hz)  %	$I_{\text{leak,max}}$ (20 °C, $V_R$ , 5 min)  $\mu\text{A}$	$Z_{\text{max}}$ (20 °C, 100 kHz)  $\Omega$	Ordering code
4.7	A	6	0.5	5.5	B45196L1475+10*
6.8	A	6	0.5	4.5	B45196L1685+10*
6.8	B	6	0.5	4.5	B45196L1685+20*
10	A	6	0.6	4.0	B45196L1106+10*
10	B	6	0.6	3.5	B45196L1106+20*
15	A	6	0.9	3.8	B45196L1156+10*
15	B	6	0.9	3.0	B45196L1156+20*
15	C	6	0.9	2.4	B45196L1156+30*
22	A	8	1.4	3.0	B45196L1226+10*
22	B	6	1.4	2.5	B45196L1226+20*
22	C	6	1.4	2.0	B45196L1226+30*
33	B	6	2.1	2.2	B45196L1336+20*
33	C	6	2.1	1.6	B45196L1336+30*
47	B	6	3.0	2.0	B45196L1476+20*
47	C	6	3.0	1.5	B45196L1476+30*
47	D	6	3.0	1.1	B45196L1476+40*
68	C	6	4.3	1.4	B45196L1686+30*
68	D	6	4.3	0.8	B45196L1686+40*
100	C	8	6.3	1.2	B45196L1107+30*
100	D	8	6.3	0.8	B45196L1107+40*
150	C	8	9.5	1.3	B45196L1157+30*
150	D	8	9.5	0.8	B45196L1157+40*
220	D	8	13.9	0.8	B45196L1227+40*
220	E	12	13.9	0.8	B45196L1227+50*
330	D	8	20.8	0.8	B45196L1337+40*
330	E	8	20.8	0.6	B45196L1337+50*
470	E	8	29.6	0.6	B45196L1477+50*
680	E	15	42.8	0.6	B45196L1687+50*
<b><math>V_R</math> (up to 85 °C) = 10 VDC, <math>V_R</math> (up to 125 °C) = 6.3 VDC</b>					
1.5	A	6	0.5	10.0	B45196L2155+10*
2.2	A	6	0.5	7.0	B45196L2225+10*
3.3	A	6	0.5	5.5	B45196L2335+10*
4.7	A	6	0.5	4.5	B45196L2475+10*
4.7	B	6	0.5	4.5	B45196L2475+20*

\* = Code number for reel diameter  
 6 = 330-mm reel  
 9 = 180-mm reel

+ = Capacitance tolerance  
 M =  $\pm 20\%$   
 K =  $\pm 10\%$

$C_R$ (20 °C, 120 Hz)  μF	Case size	$DF_{max}$ (20 °C, 120 Hz)  %	$I_{leak,max}$ (20 °C, $V_R$ , 5 min)  μA	$Z_{max}$ (20 °C, 100 kHz)  Ω	Ordering code
6.8	A	6	0.7	4.0	B45196L2685+10*
6.8	B	6	0.7	3.5	B45196L2685+20*
10	A	6	1.0	3.8	B45196L2106+10*
10	B	6	1.0	3.0	B45196L2106+20*
10	C	6	1.0	2.4	B45196L2106+30*
15	A	6	1.5	3.2	B45196L2156+10*
15	B	6	1.5	2.5	B45196L2156+20*
15	C	6	1.5	2.0	B45196L2156+30*
22	B	6	2.2	2.3	B45196L2226+20*
22	C	6	2.2	1.6	B45196L2226+30*
33	B	6	3.3	2.0	B45196L2336+20*
33	C	6	3.3	1.5	B45196L2336+30*
33	D	6	3.3	1.1	B45196L2336+40*
47	C	6	4.7	1.4	B45196L2476+30*
47	D	6	4.7	0.8	B45196L2476+40*
68	C	6	6.8	1.2	B45196L2686+30*
68	D	6	6.8	0.8	B45196L2686+40*
100	C	8	10.0	1.2	B45196L2107+30*
100	D	8	10.0	0.8	B45196L2107+40*
150	D	8	15.0	0.8	B45196L2157+40*
150	E	8	15.0	0.8	B45196L2157+50*
220	D	10	22.0	0.8	B45196L2227+40*
220	E	8	22.0	0.6	B45196L2227+50*
330	E	10	33.0	0.6	B45196L2337+50*
470	E	12	47.0	0.6	B45196L2477+50*

 $V_R$  (up to 85 °C) = 16 VDC,  $V_R$  (up to 125 °C) = 10 VDC

1	A	4	0.5	10.0	B45196L3105+10*
1.5	A	6	0.5	8.0	B45196L3155+10*
2.2	A	6	0.5	6.5	B45196L3225+10*
3.3	A	6	0.5	5.0	B45196L3335+10*
3.3	B	6	0.5	5.0	B45196L3335+20*
4.7	A	6	0.8	4.0	B45196L3475+10*
4.7	B	6	0.8	3.5	B45196L3475+20*
6.8	A	6	1.1	3.8	B45196L3685+10*

\* = Code number for reel diameter

6 = 330-mm reel

9 = 180-mm reel

+ = Capacitance tolerance

M = ±20%

K = ±10%

$C_R$ (20 °C, 120 Hz)  $\mu\text{F}$	Case size	$DF_{\text{max}}$ (20 °C, 120 Hz)  %	$I_{\text{leak,max}}$ (20 °C, $V_R$ , 5 min)  $\mu\text{A}$	$Z_{\text{max}}$ (20 °C, 100 kHz)  $\Omega$	Ordering code
6.8	B	6	1.1	3.0	B45196L3685+20*
6.8	C	6	1.1	2.4	B45196L3685+30*
10	B	6	1.6	2.5	B45196L3106+20*
10	C	6	1.6	2.0	B45196L3106+30*
15	B	6	2.4	2.3	B45196L3156+20*
15	C	6	2.4	1.6	B45196L3156+30*
22	C	6	3.5	1.5	B45196L3226+30*
22	D	6	3.5	1.1	B45196L3226+40*
33	C	6	5.3	1.4	B45196L3336+30*
33	D	6	5.3	1.0	B45196L3336+40*
47	C	6	7.5	1.4	B45196L3476+30*
47	D	6	7.5	0.8	B45196L3476+40*
68	D	6	10.9	0.8	B45196L3686+40*
100	D	8	16.0	0.8	B45196L3107+40*
100	E	8	16.0	0.8	B45196L3107+50*
150	E	8	24.0	0.6	B45196L3157+50*

 $V_R$  (up to 85 °C) = 20 VDC,  $V_R$  (up to 125 °C) = 13 VDC

0.68	A	4	0.5	12.0	B45196L4684+10*
1	A	4	0.5	9.0	B45196L4105+10*
1.5	A	6	0.5	8.0	B45196L4155+10*
2.2	A	6	0.5	6.0	B45196L4225+10*
2.2	B	6	0.5	6.0	B45196L4225+20*
3.3	A	6	0.7	4.0	B45196L4335+10*
3.3	B	6	0.7	4.5	B45196L4335+20*
4.7	B	6	0.9	3.0	B45196L4475+20*
4.7	C	6	0.9	2.4	B45196L4475+30*
6.8	B	6	1.4	2.5	B45196L4685+20*
6.8	C	6	1.4	2.0	B45196L4685+30*
10	C	6	2.0	1.6	B45196L4106+30*
15	C	6	3.0	1.5	B45196L4156+30*
15	D	6	3.0	1.2	B45196L4156+40*
22	C	6	4.4	1.4	B45196L4226+30*
22	D	6	4.4	1.0	B45196L4226+40*
33	D	6	6.6	0.8	B45196L4336+40*

\* = Code number for reel diameter  
6 = 330-mm reel  
9 = 180-mm reel

+ = Capacitance tolerance  
M =  $\pm 20\%$   
K =  $\pm 10\%$

$C_R$ (20 °C, 120 Hz)  $\mu\text{F}$	Case size	$DF_{\text{max}}$ (20 °C, 120 Hz)  %	$I_{\text{leak,max}}$ (20 °C, $V_R$ , 5 min)  $\mu\text{A}$	$Z_{\text{max}}$ (20 °C, 100 kHz)  $\Omega$	Ordering code
47	D	6	9.4	0.8	B45196L4476+40*
47	E	6	9.4	0.8	B45196L4476+50*
68	E	6	13.6	0.8	B45196L4686+50*

$V_R$  (up to 85 °C) = 25 VDC,  $V_R$  (up to 125 °C) = 16 VDC

0.47	A	4	0.5	13.0	B45196L5474+10*
0.68	A	4	0.5	10.0	B45196L5684+10*
1	A	4	0.5	8.0	B45196L5105+10*
1.5	A	6	0.5	7.0	B45196L5155+10*
1.5	B	6	0.5	7.0	B45196L5155+20*
2.2	B	6	0.6	5.0	B45196L5225+20*
3.3	B	6	0.8	4.0	B45196L5335+20*
3.3	C	6	0.8	2.8	B45196L5335+30*
4.7	B	6	1.2	3.2	B45196L5475+20*
4.7	C	6	1.2	2.3	B45196L5475+30*
6.8	C	6	1.7	2.0	B45196L5685+30*
6.8	D	6	1.7	1.8	B45196L5685+40*
10	C	6	2.5	1.6	B45196L5106+30*
10	D	6	2.5	1.2	B45196L5106+40*
15	C	6	3.8	1.5	B45196L5156+30*
15	D	6	3.8	1.0	B45196L5156+40*
22	D	6	5.5	0.8	B45196L5226+40*
33	D	6	8.3	0.8	B45196L5336+40*
33	E	6	8.3	0.8	B45196L5336+50*
47	E	6	11.8	0.8	B45196L5476+50*

$V_R$  (up to 85 °C) = 35 VDC,  $V_R$  (up to 125 °C) = 23 VDC

0.1	A	4	0.5	28.0	B45196L6104+10*
0.15	A	4	0.5	23.0	B45196L6154+10*
0.22	A	4	0.5	19.0	B45196L6224+10*
0.33	A	4	0.5	15.0	B45196L6334+10*
0.47	A	4	0.5	11.0	B45196L6474+10*
0.47	B	4	0.5	11.0	B45196L6474+20*
0.68	A	4	0.5	8.0	B45196L6684+10*
0.68	B	4	0.5	8.0	B45196L6684+20*
1	A	4	0.5	7.0	B45196L6105+10*

\* = Code number for reel diameter  
 6 = 330-mm reel  
 9 = 180-mm reel

+ = Capacitance tolerance  
 M =  $\pm 20\%$   
 K =  $\pm 10\%$

$C_R$ (20 °C, 120 Hz)	Case size	$DF_{max}$ (20 °C, 120 Hz)	$I_{leak,max}$ (20 °C, $V_R$ , 5 min)	$Z_{max}$ (20 °C, 100 kHz)	Ordering code
$\mu F$		%	$\mu A$	$\Omega$	
1	B	4	0.5	7.0	B45196L6105+20*
1.5	B	6	0.5	6.0	B45196L6155+20*
1.5	C	6	0.5	4.8	B45196L6155+30*
2.2	B	6	0.8	4.0	B45196L6225+20*
2.2	C	6	0.8	3.2	B45196L6225+30*
3.3	C	6	1.2	2.4	B45196L6335+30*
4.7	C	6	1.6	2.0	B45196L6475+30*
4.7	D	6	1.6	1.5	B45196L6475+40*
6.8	C	6	2.4	1.8	B45196L6685+30*
6.8	D	6	2.4	1.2	B45196L6685+40*
10	D	6	3.5	1.0	B45196L6106+40*
15	E	6	5.3	0.8	B45196L6156+50*
<b><math>V_R</math> (up to 85 °C) = 50 VDC, <math>V_R</math> (up to 125 °C) = 33 VDC</b>					
0.1	A	4	0.5	27.0	B45196L7104+10*
0.15	A	4	0.5	22.0	B45196L7154+10*
0.15	B	4	0.5	22.0	B45196L7154+20*
0.22	B	4	0.5	18.0	B45196L7224+20*
0.33	B	4	0.5	14.0	B45196L7334+20*
0.47	B	4	0.5	9.0	B45196L7474+20*
0.47	C	4	0.5	7.2	B45196L7474+30*
0.68	C	4	0.5	6.4	B45196L7684+30*
1	C	4	0.5	4.8	B45196L7105+30*
1.5	C	6	0.8	4.4	B45196L7155+30*
1.5	D	6	0.8	4.0	B45196L7155+40*
2.2	C	6	1.1	3.2	B45196L7225+30*
2.2	D	6	1.1	2.8	B45196L7225+40*
3.3	D	6	1.7	1.6	B45196L7335+40*
4.7	D	6	2.4	1.2	B45196L7475+40*
6.8	D	6	3.4	0.8	B45196L7685+40*
6.8	E	6	3.4	0.8	B45196L7685+50*
10	E	6	5.0	0.8	B45196L7106+50*

\* = Code number for reel diameter  
6 = 330-mm reel  
9 = 180-mm reel

+ = Capacitance tolerance  
M =  $\pm 20\%$   
K =  $\pm 10\%$



## Cautions and warnings

When using tantalum capacitors with a manganese dioxide coating, the following cautions and warnings should be taken into account:

### Polarity

Because tantalum capacitors are *polar capacitors*, it is important to observe their polarity markings (positive pole on the anode, negative pole on the cathode). Any incorrect polarity resulting from the sum of the AC and DC voltage components must be smaller than or equal to the permitted *polarity reversal voltage* (see “General technical information”, section 4.6 and section 4.8 under [www.epcos.com/tantalum\\_capacitors](http://www.epcos.com/tantalum_capacitors)). To avoid reducing their reliability, this voltage may only occur for a short time, at most five times for a duration of one minute per hour.

### Voltage

The *maximum continuous voltage* depends on the ambient temperature. Within the temperature range of  $-55$  to  $+85$  °C, the rated voltage is equal to the maximum continuous voltage. Between  $+85$  and  $+125$  °C the maximum continuous voltage must be reduced linearly from the full rated voltage to 2/3 of it (derating). At  $150$  °C (only B4519\*P series) the voltage must be reduced to 1/2 and at  $175$  °C (only B4519\*T series) to 1/3 of the rated voltage. Operation below the maximum continuous voltage has a positive effect on the capacitor's failure rate. The maximum continuous voltage must not be exceeded (see “Quality and environment”, section 1.11 under [www.epcos.com/tantalum\\_capacitors](http://www.epcos.com/tantalum_capacitors)).

All unfavourable operating conditions (such as possible line overvoltages, unfavourable tolerances of the transformation ratio of the line transformer in the equipment, repeated overvoltages when the equipment is switched on, high ambient temperatures) must be taken into account when determining the *operating voltage*.

The *surge voltage* is the maximum voltage (peak value) that may be applied to the capacitor for short periods, at most five times for a total duration of up to 1 minute per hour. The surge voltage must not be applied for periodic charging and discharging in the course of normal operation and cannot be part of the operating voltage. The permissible surge voltage for all capacitors in this data book is 1.3 x the rated voltage. The occurrence of voltage impulses (transient voltages) that exceed the surge voltage may lead to irreparable damage.

### Capacitance

The actual *capacitance* of a capacitor can deviate from the rated capacitance by as much as the full magnitude of the tolerance at delivery. The capacitance varies with the temperature (at  $+125$  °C  $+12\%$  up to  $+20\%$ ) and decreases with increasing frequency (see “General technical information”, section 5 under [www.epcos.com/tantalum\\_capacitors](http://www.epcos.com/tantalum_capacitors)).

**Low-resistance applications and voltage networks**

For *low-resistance applications*, EPCOS recommends a maximum operating voltage of half the permissible maximum continuous voltage, so that the capacitors have sufficient tolerance to withstand voltage peaks. Depending on the conditions of use, the early failure rate is higher here by a factor of 2 to 20 than in the range with a constant failure rate as specified in the data book (see“Quality and environment”, section 1.11 under [www.epcos.com/tantalum\\_capacitors](http://www.epcos.com/tantalum_capacitors)).

When operated directly in a *voltage network*, the capacitor should be protected against overvoltage, e.g. by a suppressor diode, and against polarity reversal by a diode. If a capacitor is operated in an unprotected low-impedance circuit and fails because the permissible conditions for the forward DC voltage, reverse DC voltage, surge current, power dissipation or temperature are exceeded, the continued current flow through the overstressed capacitor may produce overheating. The overheated capacitor may damage the surrounding components and the circuit board (see“Quality and environment”, section 1.11 and “General technical information”, section 4.11 under [www.epcos.com/tantalum\\_capacitors](http://www.epcos.com/tantalum_capacitors)).

**Storage conditions**

Capacitors with solid electrolyte may be stored at temperatures down to  $-80\text{ °C}$ . The upper *storage temperature* must not exceed  $+85\text{ °C}$  (for blister tape the temperature limit is  $+40\text{ °C}$ ). The storage conditions should not exceed  $+40\text{ °C}$  and 70% R. H. A drypack is useful to prevent the effects of humidity.

**Note**

For more detailed information about cautions and warnings for tantalum electrolytic capacitors (e.g. other electrical values beside those listed above), see “General technical information” and “Quality and environment” under [www.epcos.com/tantalum\\_capacitors](http://www.epcos.com/tantalum_capacitors).

The following applies to all products named in this publication:

1. Some parts of this publication contain **statements about the suitability of our products for certain areas of application**. These statements are based on our knowledge of typical requirements that are often placed on our products in the areas of application concerned. We nevertheless expressly point out **that such statements cannot be regarded as binding statements about the suitability of our products for a particular customer application**. As a rule, EPCOS is either unfamiliar with individual customer applications or less familiar with them than the customers themselves. For these reasons, it is always ultimately incumbent on the customer to check and decide whether an EPCOS product with the properties described in the product specification is suitable for use in a particular customer application.
2. We also point out that **in individual cases, a malfunction of passive electronic components or failure before the end of their usual service life cannot be completely ruled out in the current state of the art, even if they are operated as specified**. In customer applications requiring a very high level of operational safety and especially in customer applications in which the malfunction or failure of a passive electronic component could endanger human life or health (e.g. in accident prevention or life-saving systems), it must therefore be ensured by means of suitable design of the customer application or other action taken by the customer (e.g. installation of protective circuitry or redundancy) that no injury or damage is sustained by third parties in the event of malfunction or failure of a passive electronic component.
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