



## Tantalum Chip Capacitors

Low Profile, Standard and Low ESR

**Series/Type:** B45190E/R, B45192E/R,  
B45194E/R, B450

**Date:** July 2005



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### Construction

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



### Features

- Reduced height:  $H_{\max} = 1.2 / 1.5 / 2.0$  mm
- 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 in compliance with RoHS

### Applications

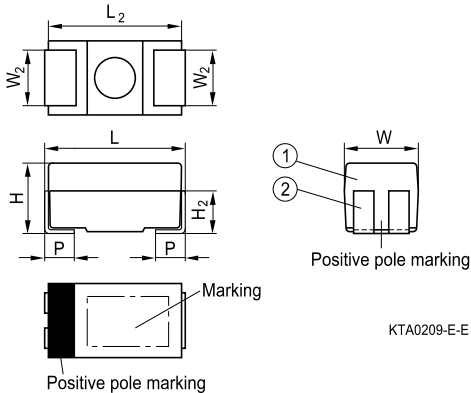
- Telecommunications (e.g. mobile phones, infrastructure)
- Data processing (e.g. laptops, mainframes)
- Measuring and control engineering (e.g. voltage regulators)
- Automotive electronics (e.g. navigation systems, electronic control units)
- Medical engineering
- Switch mode power supplies with very high clock frequencies (300 kHz)
- DC/DC converters

### Soldering

Suitable for reflow soldering (IR and vapor phase) and wave soldering

### Delivery mode

Taped and reeled in accordance with IEC 60286-3

**Dimensional drawing**


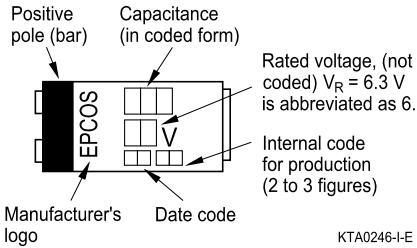
① Encapsulation: molded epoxy resin

② NiFe; tinned surface Sn 100

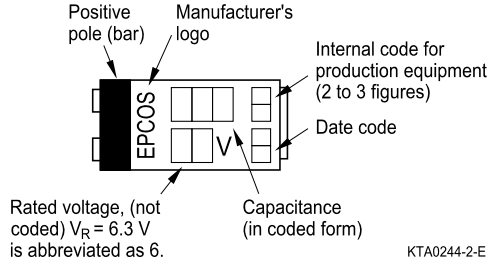
Case size EPCOS	EIA/IECQ	Dimensions in mm (inches)						
		L	W	H	L <sub>2</sub> typ.	W <sub>2</sub> ±0.1 ±(.004)	H <sub>2</sub> typ.	P±0.3 ±(.012)
R (Footprint B)	3528-12	3.5 ±0.2 (.138 ±0.008)	2.8 ±0.2 (.110 ±0.008)	1.2 max (.047 max)	3.5 (.138)	2.2 (.087)	1.0 (.039)	0.8 (.031)
W (Footprint C)	6032-15	6.0 ±0.3 (.236 ±0.012)	3.2 ±0.3 (.126 ±0.012)	1.5 max (.059 max)	5.9 (.232)	2.2 (.087)	1.3 (.051)	1.3 (.051)
U (Footprint C)	6032-20	6.0 ±0.3 (.236 ±0.012)	3.2 ±0.3 (.126 ±0.012)	2.0 max (.079 max)	6.1 (.240)	2.2 (.087)	1.8 (.071)	1.3 (.051)
X (Footprint D)	7343-15	7.3 ±0.3 (.287 ±0.012)	4.3 ±0.3 (.169 ±0.012)	1.5 max (.059 max)	7.2 (.283)	2.4 (.094)	1.3 (.051)	1.3 (.051)
V (Footprint D)	7343-20	7.3 ±0.3 (.287 ±0.012)	4.3 ±0.3 (.169 ±0.012)	2.0 max (.079 max)	7.3 (.287)	2.4 (.094)	1.7 (.067)	1.3 (.051)

**Marking**

Case size R



Case sizes W, U, X, V



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 for Standard and Low ESR series in brief**

Series		LowProfile, Standard	LowProfile, Low ESR		
Ordering code		B45190E, B45192E, B45194E	B45190R, B45192R, B45194R, B450		
Technology		Ta-MnO <sub>2</sub>			
Terminals		Tinned			
Rated voltage	(up to 85 °C)	V <sub>R</sub>	4 ... 35	4 ... 35	VDC
Rated capacitance	(20 °C, 120 Hz)	C <sub>R</sub>	6.8 ... 470	6.8 ... 470	μF
Capacitance tolerance			±20%, ±10%		
Maximum impedance	(20 °C, 100 kHz)	Z <sub>max</sub>	0.3 ... 4.0	–	Ω
Maximum equivalent series resistance	(20 °C, 100 kHz)	ESR <sub>max</sub>	–	100 ... 1500	mΩ
Operating temperature range		T <sub>op</sub>	–55 ... +125		°C
Failure rate (1 fit = 1 · 10 <sup>-9</sup> failures/h)	(at 40 °C; ≤ V <sub>R</sub> , R <sub>S</sub> ≥ 3 Ω/V)				fit
	C <sub>R</sub> · V <sub>R</sub> ≤ 330 μF · V		≤8	–	
	C <sub>R</sub> · V <sub>R</sub> > 330 μF · V		≤24	–	
Failure rate (1 fit = 1 · 10 <sup>-9</sup> failures/h)	(at 40 °C; ≤ V <sub>R</sub> , R <sub>S</sub> ≤ 0.1 Ω/V)				fit
	C <sub>R</sub> · V <sub>R</sub> ≤ 330 μF · V		–	≤40	
	C <sub>R</sub> · V <sub>R</sub> > 330 μF · V		–	≤288	
Service life			>500000		h
Leakage current	(V <sub>R</sub> , 5 min, 20 °C)	I <sub>leak</sub>	10		nA/μC
Detail specification	(tinned terminals)		CECC 30801-802	CECC 30801-805	
Climatic category (to IEC 60068-1)	(–55 °C/+125 °C/56 days damp heat test)		55/125/56		

**Overview of types ( $C_R$  ( $\mu\text{F}$ ) and  $V_R$  (VDC))**

$V_R$ (VDC)	4	6.3	10	16	20	25	35
$C_R$ ( $\mu\text{F}$ )							
6.8							V (1200) V (600)
10		R (4000) R (1200)	R (3000) R (1500)	R (2200) R (800)			V (1000) V (600)
15		R (3500) R (1000)	R (2800) R (1200)			V (1000) V (500)	
22		R (2500) R (1000)	R (2200*) R (1200*)	W (1500) W (500)	V (800) V (400)	V (800)	
33	R (1700) R (1200)	R (2500) R (800*)		W (1400) W (400) W (200*) V (1000) V (250)	V (800) V (400)		
47	R (2000) R (1000*)	R (2000*) R (1200*) V (700)	W (1400) W (400) V (700) V (200)	V (700) V (250)			
68	R (2000*) R (1500*)	W (1400) W (400) V (700)	W (1200) W (300) W (150*) V (700) V (200) X (1200) X (200)	V (800) V (250) X (800) X (250*) X (150*)			
100	R (1500*) R (1000*) W (1400) W (350)	W (1200) W (350) V (700) V (150)	W (700) W (200*) W (150*) U (180*) V (700) V (200) X (800) X (200) X (150*)	U (200*) V (800*) V (250*) V (100*) X (300*) X (100*)			
150	W (1300) W (350) W (200*)	W (600*) W (200*) V (700) V (150) X (800) X (250)	W (500*) W (200*) U (180*) V (700) V (200) X (800*) X (250*)				
220	X (800) X (250)	V (700) V (150) X (800*) X (250*)	V (700) V (200)				
330		V (700) V (150)	V (700*) V (200*) V (150*)				
470		V (700*) V (150*)					

\* Upon request

() The ESR value (in m $\Omega$ ) is stated in parentheses

**Ordering code structure for Standard and Low ESR types**

<b>B45</b>	<b>194R</b>	<b>1</b>	<b>337</b>	<b>+</b>	<b>40</b>	<b>*</b>
<b>Tantalum capacitor</b>						
<b>Series</b> 190E = Low Profile, H <sub>max</sub> = 1.2 mm, Standard, tinned terminals 192E = Low Profile, H <sub>max</sub> = 1.5 mm, Standard, tinned terminals 194E = Low Profile, H <sub>max</sub> = 2.0 mm, Standard, tinned terminals 190R = Low Profile, H <sub>max</sub> = 1.2 mm, Low ESR, tinned terminals 192R = Low Profile, H <sub>max</sub> = 1.5 mm, Low ESR, tinned terminals 194R = Low Profile, H <sub>max</sub> = 2.0 mm, Low ESR, tinned 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						
<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> 20 = R 30 = W, U 40 = X, V						
<b>Reel diameter</b> 9 = 180 mm, 6 = 330 mm						

Ordering code structure for Low ESR types

B45	0	10	V	337	*	+	157
Tantalum capacitor							
<b>Series</b> 0 = SpeedPower, Low ESR; Low Profile, Low ESR; tinned terminals							
<b>Rated voltage</b> 04 = 4 V, 06 = 6.3 V, 10 = 10 V, 16 = 16 V, 20 = 20 V, 25 = 25 V, 35 = 35 V							
<b>Case size</b> R, W, U, X, V							
<b>Rated capacitance + exponent</b> C [pF] · 10 <sup>x</sup> 686 = 68 pF · 10 <sup>6</sup> = 68 μF, 157 = 15 pF · 10 <sup>7</sup> = 150 μF, 108 = 10 pF · 10 <sup>8</sup> = 1000 μF							
<b>Reel diameter</b> 9 = 180 mm, 6 = 330 mm							
<b>Capacitance tolerance</b> M = ±20%, K = ±10%							
<b>ESR value + exponent</b> R [nΩ] · 10 <sup>x</sup> E.g.: 106 = 10 nΩ · 10 <sup>6</sup> = 10 mΩ, 107 = 10 nΩ · 10 <sup>7</sup> = 100 mΩ, 108 = 10 nΩ · 10 <sup>8</sup> = 1000 mΩ, 109 = 10 nΩ · 10 <sup>9</sup> = 10000 mΩ,							



**Technical data and ordering codes for Standard types**

$C_R$ (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					
33	R	8	1.3	1.7	B45190E0336+20*
47	R	10	1.9	2.0	B45190E0476+20*
68	R	15	2.7	2.0	B45190E0686+20* ●
100	R	15	4.0	1.5	B45190E0107+20* ●
100	W	8	4.0	1.4	B45192E0107+30*
150	W	8	6.0	1.3	B45192E0157+30*
220	X	8	8.8	0.8	B45192E0227+40*
$V_R$ (up to 85 °C) = 6.3 VDC, $V_R$ (up to 125 °C) = 4 VDC					
10	R	6	0.6	4.0	B45190E1106+20*
15	R	6	0.9	3.5	B45190E1156+20*
22	R	8	1.4	2.5	B45190E1226+20*
33	R	6	2.1	2.5	B45190E1336+20*
47	R	10	3.0	2.0	B45190E1476+20* ●
47	V	6	3.0	0.7	B45194E1476+40*
68	V	6	4.3	0.7	B45194E1686+40*
68	W	6	4.3	1.4	B45192E1686+30*
100	V	8	6.3	0.7	B45194E1107+40*
100	W	8	6.3	1.2	B45192E1107+30*
150	V	8	9.5	0.7	B45194E1157+40*
150	W	8	9.5	0.6	B45192E1157+30* ●
150	X	8	9.5	0.8	B45192E1157+40*
220	V	8	13.9	0.7	B45194E1227+40*
220	X	8	13.9	0.8	B45192E1227+40* ●
330	V	8	20.8	0.7	B45194E1337+40*
470	V	15	29.6	0.7	B45194E1477+40* ●
$V_R$ (up to 85 °C) = 10 VDC, $V_R$ (up to 125 °C) = 6.3 VDC					
10	R	6	1.0	3.0	B45190E2106+20*
15	R	6	1.5	2.8	B45190E2156+20*
22	R	8	2.2	2.2	B45190E2226+20* ●
47	V	6	4.7	0.7	B45194E2476+40*
47	W	6	4.7	1.4	B45192E2476+30*

● Preliminary Data

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

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

**Tantalum chip capacitors**
**B45190E/R, B45192E/R, B45194E/R, B450**
**Low Profile, Standard**

$C_R$ (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
$\mu F$		%	$\mu A$	$\Omega$	
68	V	6	6.8	0.7	B45194E2686+40*
68	W	6	6.8	1.2	B45192E2686+30*
68	X	6	6.8	1.2	B45192E2686+40*
100	V	8	10.0	0.7	B45194E2107+40*
100	W	8	10.0	0.7	B45192E2107+30*
100	X	8	10.0	0.8	B45192E2107+40*
150	V	8	15.0	0.7	B45194E2157+40*
150	W	12	15.0	0.5	B45192E2157+30* ●
150	X	6	15.0	0.8	B45192E2157+40* ●
220	V	8	22.0	0.7	B45194E2227+40*
330	V	12	33.0	0.7	B45194E2337+40* ●
$V_R$ (up to 85 °C) = 16 VDC, $V_R$ (up to 125 °C) = 10 VDC					
10	R	6	1.6	2.2	B45190E3106+20*
22	W	6	3.5	1.5	B45192E3226+30*
33	V	6	5.3	1.0	B45194E3336+40*
33	W	6	5.3	1.4	B45192E3336+30*
47	V	6	7.5	0.7	B45194E3476+40*
68	V	6	10.9	0.8	B45194E3686+40*
68	X	6	10.9	0.8	B45192E3686+40*
100	V	8	16.0	0.8	B45194E3107+40* ●
100	X	8	16.0	0.3	B45192E3107+40* ●
$V_R$ (up to 85 °C) = 20 VDC, $V_R$ (up to 125 °C) = 13 VDC					
22	V	6	4.4	0.8	B45194E4226+40*
33	V	6	6.6	0.8	B45194E4336+40*
$V_R$ (up to 85 °C) = 25 VDC, $V_R$ (up to 125 °C) = 16 VDC					
15	V	6	3.8	1.0	B45194E5156+40*
22	V	6	5.5	0.8	B45194E5226+40*
$V_R$ (up to 85 °C) = 35 VDC, $V_R$ (up to 125 °C) = 23 VDC					
6.8	V	6	2.4	1.2	B45194E6685+40*
10	V	6	3.5	1.0	B45194E6106+40*

● Preliminary Data

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

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

**Technical data and ordering codes for Low ESR types**

$C_R$ (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) $\mu\text{A}$	$ESR_{\text{max}}^{(1)}$ (20 °C, 100 kHz) $\text{m}\Omega$	$I_{\text{AC,max}}$ (20 °C, 100 kHz) A	Ordering code
<b><math>V_R</math> (up to 85 °C) = 4 VDC, <math>V_R</math> (up to 125 °C) = 2.5 VDC</b>						
33	R	8	1.3	1200	0.25	B45190R0336+20*
47	R	10	1.9	1000	0.27	B45190R0476+20* ●
68	R	15	2.7	1500	0.22	B45004R686*+158 ●
100	W	8	4.0	350	0.51	B45192R0107+30*
100	R	15	4.0	1000	0.27	B45004R107*+108 ●
150	W	8	6.0	200	0.67	B45004W157*+207 ●
150	W	8	6.0	350	0.51	B45192R0157+30*
220	X	8	8.8	250	0.66	B45192R0227+40*
<b><math>V_R</math> (up to 85 °C) = 6.3 VDC, <math>V_R</math> (up to 125 °C) = 4 VDC</b>						
10	R	6	0.6	1200	0.25	B45190R1106+20*
15	R	6	0.9	1000	0.27	B45190R1156+20*
22	R	8	1.4	1000	0.27	B45190R1226+20*
33	R	6	2.1	800	0.31	B45190R1336+20* ●
47	R	10	3.0	1200	0.25	B45006R476*+128 ●
68	W	6	4.3	400	0.47	B45192R1686+30*
100	V	8	6.3	150	0.91	B45194R1107+40*
100	W	8	6.3	350	0.51	B45192R1107+30*
150	V	8	9.5	150	0.91	B45194R1157+40*
150	W	8	9.5	200	0.67	B45006W157*+207 ●
150	X	8	9.5	250	0.66	B45192R1157+40*
220	V	8	13.9	150	0.91	B45194R1227+40*
220	X	8	13.9	250	0.66	B45192R1227+40* ●
330	V	8	20.8	150	0.91	B45194R1337+40*
470	V	15	29.6	150	0.91	B45194R1477+40* ●
<b><math>V_R</math> (up to 85 °C) = 10 VDC, <math>V_R</math> (up to 125 °C) = 6.3 VDC</b>						
10	R	6	1.0	1500	0.22	B45190R2106+20*
15	R	6	1.5	1200	0.25	B45190R2156+20*
22	R	8	2.2	1200	0.25	B45010R226*+128 ●
47	V	6	4.7	200	0.79	B45194R2476+40*
47	W	6	4.7	400	0.47	B45192R2476+30*
68	W	6	6.8	150	0.77	B45010W686*+157 ●

● Preliminary Data

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

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

1) Other values upon request

$C_R$ (20 °C, 120 Hz) μF	Case size	$DF_{max}$ (20 °C, 120 Hz) %	$I_{leak,max}$ (20 °C, $V_R$ , 5 min) μA	$ESR_{max}^{1)}$ (20 °C, 100 kHz) mΩ	$I_{AC,max}$ (20 °C, 100 kHz) A	Ordering code
68	V	6	6.8	200	0.79	B45194R2686+40*
68	X	6	6.8	200	0.74	B45192R2686+40*
68	W	6	6.8	300	0.55	B45192R2686+30*
100	X	8	10.0	150	0.86	B45010X107*+157 ●
100	W	8	10.0	150	0.77	B45010W107*+157 ●
100	U	8	10.0	180	0.75	B45010U107*+187 ●
100	V	8	10.0	200	0.79	B45194R2107+40*
100	X	8	10.0	200	0.74	B45192R2107+40*
100	W	8	10.0	200	0.67	B45010W107*+207 ●
150	U	12	15.0	180	0.75	B45010U157*+187 ●
150	V	8	15.0	200	0.79	B45194R2157+40*
150	W	12	15.0	200	0.67	B45010W157*+207 ●
150	X	8	15.0	250	0.66	B45192R2157+40* ●
220	V	10	22.0	200	0.79	B45194R2227+40*
330	V	12	33.0	150	0.91	B45010V337*+157 ●
330	V	12	33.0	200	0.79	B45194R2337+40* ●

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

10	R	6	1.6	800	0.31	B45190R3106+20*
22	W	6	3.5	500	0.42	B45192R3226+30*
33	W	6	5.3	200	0.67	B45016W336*+207 ●
33	V	6	5.3	250	0.71	B45194R3336+40*
33	W	6	5.3	400	0.47	B45192R3336+30*
47	V	6	7.5	250	0.71	B45194R3476+40*
68	X	6	10.9	150	0.86	B45016X686*+157 ●
68	V	6	10.9	250	0.71	B45194R3686+40*
68	X	6	10.9	250	0.66	B45192R3686+40* ●
100	X	8	16.0	100	1.05	B45016X107*+107 ●
100	V	8	16.0	100	1.12	B45016V107*+107 ●
100	U	6	16.0	200	0.71	B45016U107*+207 ●
100	V	8	16.0	250	0.71	B45194R3107+40* ●

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

22	V	6	4.4	400	0.56	B45194R4226+40*
33	V	6	6.6	400	0.56	B45194R4336+40*

● Preliminary Data

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

+ = Capacitance tolerance  
M = ±20%  
K = ±10%

1) Other values upon request

$C_R$ (20 °C, 120 Hz) $\mu\text{F}$	Case size	$DF_{\max}$ (20 °C, 120 Hz) %	$I_{\text{leak,max}}$ (20 °C, $V_R$ , 5 min) $\mu\text{A}$	$ESR_{\max}^{1)}$ (20 °C, 100 kHz) $\text{m}\Omega$	$I_{\text{AC,max}}$ (20 °C, 100 kHz) A	Ordering code
$V_R$ (up to 85 °C) = 25 VDC, $V_R$ (up to 125 °C) = 16 VDC						
15	V	6	3.8	500	0.50	B45025V156*+507
$V_R$ (up to 85 °C) = 35 VDC, $V_R$ (up to 125 °C) = 23 VDC						
6.8	V	6	2.4	600	0.46	B45035V685*+607
10	V	6	3.5	600	0.46	B45035V106*+607

● Preliminary Data

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

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

1) Other values upon request

## 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).

## Important Notes

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.
3. **The warnings, cautions and product-specific notes must be observed.**
4. In order to satisfy certain technical requirements, **some of the products described in this publication may contain substances subject to restrictions in certain jurisdictions (e.g. because they are classed as “hazardous”)**. Useful information on this will be found in our Material Data Sheets on the Internet ([www.epcos.com/material](http://www.epcos.com/material)). Should you have any more detailed questions, please contact our sales offices.
5. We constantly strive to improve our products. Consequently, **the products described in this publication may change from time to time**. The same is true of the corresponding product specifications. Please check therefore to what extent product descriptions and specifications contained in this publication are still applicable before or when you place an order.  
We also **reserve the right to discontinue production and delivery of products**. Consequently, we cannot guarantee that all products named in this publication will always be available.
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