



RF360 Europe GmbH

A Qualcomm – TDK Joint Venture

## SAW components

### SAW duplexer

LTE band 1

Series/type:	B8651
Ordering code:	B39212B8651P810
Date:	May 31, 2016
Version:	2.5

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## SAW components

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Data sheet

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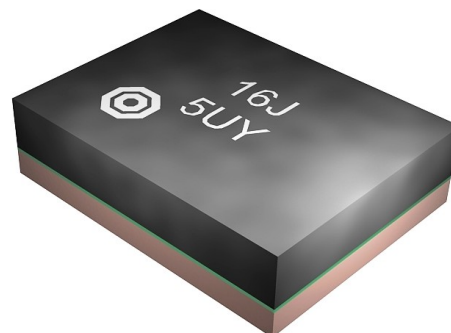
Data sheet

## 1 Application

- Low-loss SAW duplexer for mobile telephone LTE Band 1 systems, also suitable for CDMA applications
- Usable pass bands 60 MHz
- Low insertion attenuation
- Low amplitude ripple
- Terminating impedances 50 Ω
- External matching only needed at ANT port

## 2 Features

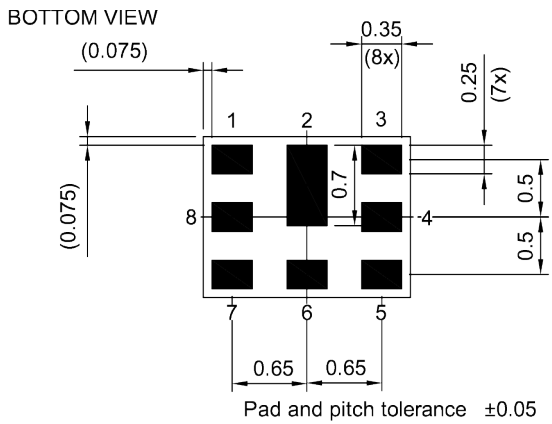
- Package size 1.8±0.1 mm × 1.4±0.1 mm
- Package height 0.475 mm (max.)
- Approximate weight 3 mg
- RoHS compatible
- Package for Surface Mount Technology (SMT)
- Ni/Au-plated terminals
- Electrostatic Sensitive Device (ESD)
- Moisture Sensitivity Level 3 (MSL3)



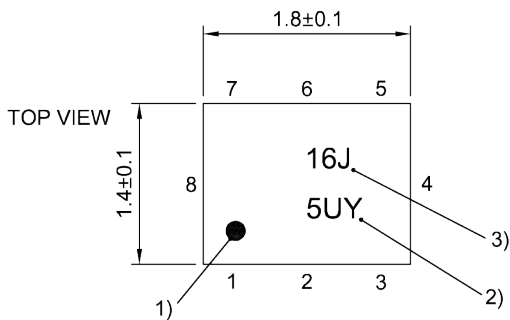
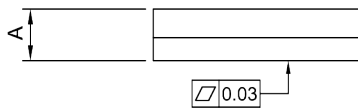
**Figure 1:** Picture of component with example of product marking.

Data sheet

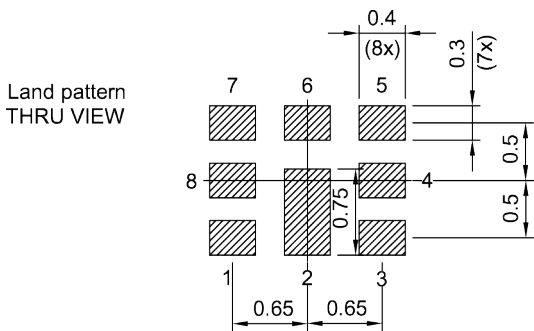
3 Package



SIDE VIEW



- 1) Marking for pad number 1
- 2) Example of encoded lot number
- 3) Example of encoded filter type number



**Figure 2:** Drawing of package with package height A = 0.475 mm (max.). See Sec. Package information (p. 25).

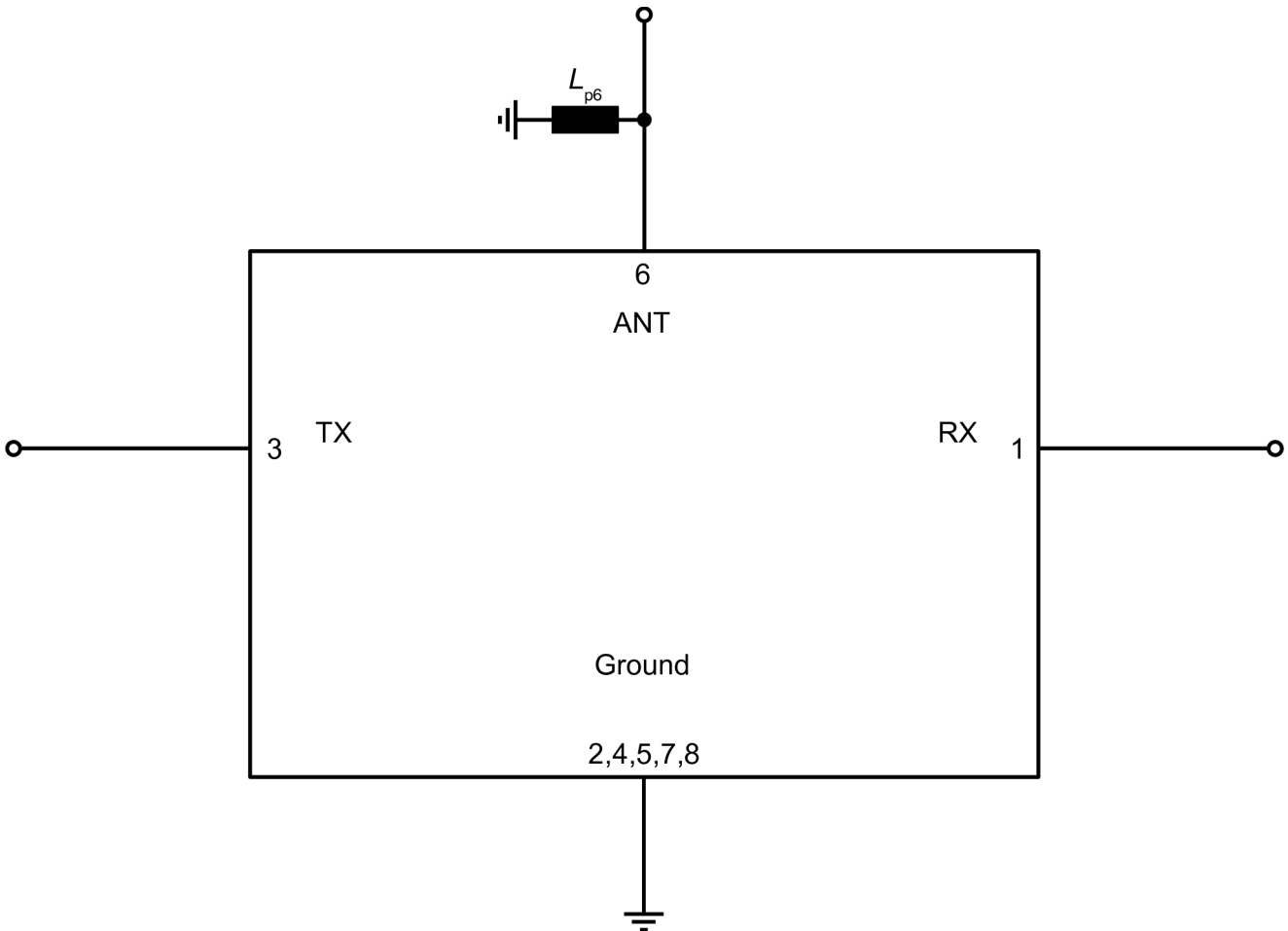
4 Pin configuration

- 1 RX
- 3 TX
- 6 ANT
- 2, 4, 5, 7, 8 Ground

Data sheet

### 5 Matching circuit

- $L_{p6} = 3.1 \text{ nH}$



**Figure 3:** Schematic of matching circuit.

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## 6 Characteristics

### 6.1 TX – ANT

Temperature range for specification	$T_{SPEC}$	= -30 °C ... +90 °C
TX terminating impedance	$Z_{TX}$	= 50 Ω
ANT terminating impedance	$Z_{ANT}$	= 50 Ω with par. 3.1 nH <sup>1)</sup>
RX terminating impedance	$Z_{RX}$	= 50 Ω

<b>Characteristics TX – ANT</b>		<b>min.</b> for $T_{SPEC}$	<b>typ.</b> @+25 °C	<b>max.</b> for $T_{SPEC}$	
<b>Center frequency</b>	$f_C$	—	1950	—	MHz
<b>Maximum insertion attenuation</b>					
	1920.59... 1979.41 MHz	$\alpha_{max}$	1.9	2.3	dB
	@ $f_{carrier}$ 1922.4... 1977.6 MHz	$\alpha_{WCDMA,max}^{2)}$	1.8	2.3	dB
<b>Amplitude ripple (p-p)</b>					
	1920.59... 1979.41 MHz	$\Delta\alpha^{3)}$	0.5	0.8	dB
	1920.59... 1979.41 MHz	$\Delta\alpha^{4)}$	1.0	2.0	dB
<b>Maximum VSWR</b>		$VSWR_{max}$			
@ TX port	1920.59... 1979.41 MHz		1.5	2.0	
@ ANT port	1920.59... 1979.41 MHz		1.4	2.0	
<b>Maximum error vector magnitude</b>		$EVM_{max}^{5)}$			
	1922.4... 1977.6 MHz		1.5	2.5	%
<b>Minimum attenuation</b>		$\alpha_{min}$			
	10... 1574 MHz		30	41	dB
	420... 494 MHz		44	54	dB
	843... 894 MHz		38	44	dB
	920... 960 MHz		39	44	dB
	1226... 1250 MHz		36	41	dB
	1470... 1496 MHz		35	41	dB
	1496... 1511 MHz		35	41	dB
	1559... 1563 MHz		36	42	dB
	1565.42... 1573.374 MHz		36	42	dB
	1573.374... 1577.466 MHz		36	43	dB
	1577.466... 1585.42 MHz		36	43	dB
	1597.551... 1605.886 MHz		36	43	dB
	1605.886... 1805 MHz		30	38	dB
	1805... 1865 MHz		20	29	dB
	1865... 1880 MHz		10	23	dB
	2010... 2025 MHz		13 <sup>6)</sup>	27	dB
	2110... 2170 MHz		36	44	dB
	2400... 2500 MHz		27	37	dB
	2620... 2690 MHz		15	33	dB
	3830... 3960 MHz		14	22	dB



<b>SAW components</b>	<b>B8651</b>
<b>SAW duplexer</b>	<b>1950 / 2140 MHz</b>

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<b>Characteristics TX – ANT</b>	<b>min.</b> for $T_{SPEC}$	<b>typ.</b> @+25 °C	<b>max.</b> for $T_{SPEC}$	
4900... 5950    MHz	6	12	—	dB
4905... 5840    MHz	6	12	—	dB

- <sup>1)</sup> See Sec. Matching circuit (p. 5).
- <sup>2)</sup> Attenuation of WCDMA signal ("power transfer function"). Please refer to definition of Power Transfer Function (PTF) of WCDMA signal (p. 24).
- <sup>3)</sup> Over any 5 MHz.
- <sup>4)</sup> Over any 20 MHz.
- <sup>5)</sup> Error Vector Magnitude (EVM) based on definition given in 3GPP TS 25.141.
- <sup>6)</sup> Valid for temperature  $T_{SPEC} = +15\text{ °C}...+90\text{ °C}$ .

<b>SAW components</b>	<b>B8651</b>
<b>SAW duplexer</b>	<b>1950 / 2140 MHz</b>

Data sheet

## 6.2 ANT – RX

Temperature range for specification	$T_{SPEC}$	= -30 °C ... +90 °C
TX terminating impedance	$Z_{TX}$	= 50 $\Omega$
ANT terminating impedance	$Z_{ANT}$	= 50 $\Omega$ with par. 3.1 nH <sup>1)</sup>
RX terminating impedance	$Z_{RX}$	= 50 $\Omega$

Characteristics ANT – RX		min. for $T_{SPEC}$	typ. @+25 °C	max. for $T_{SPEC}$	
<b>Center frequency</b>	$f_C$	—	2140	—	MHz
<b>Maximum insertion attenuation</b>	$\alpha_{max}$				
	2110.59... 2169.41 MHz	—	1.9	2.4	dB
<b>Amplitude ripple (p-p)</b>					
	2110.59... 2169.41 MHz	—	0.4	0.7	dB
	2110.59... 2169.41 MHz	—	0.5	1.5	dB
<b>Maximum VSWR</b>					
					VSWR <sub>max</sub>
@ ANT port	2110.59... 2169.41 MHz	—	1.5	2.0	
@ RX port	2110.59... 2169.41 MHz	—	1.7	2.0	
<b>Maximum error vector magnitude</b>					
					EVM <sub>max</sub> <sup>4)</sup>
	2112.4... 2167.6 MHz	—	1.2	2.5	%
<b>Minimum attenuation</b>					
					$\alpha_{min}$
	90... 1920 MHz	32	43	—	dB
	190 MHz	50	77	—	dB
	718... 748 MHz	40	55	—	dB
	814... 849 MHz	40	53	—	dB
	880... 910 MHz	40	52	—	dB
	1427... 1447 MHz	40	46	—	dB
	1447... 1463 MHz	39	45	—	dB
	1710... 1780 MHz	32	43	—	dB
	1730... 1790 MHz	30	43	—	dB
	1920... 1980 MHz	36	54	—	dB
	1980... 2010 MHz	25	40	—	dB
	2010... 2050 MHz	28	34	—	dB
	2050... 2070 MHz	18	27	—	dB
	2400... 2500 MHz	25	40	—	dB
	2500... 2570 MHz	32	42	—	dB
	4030... 4150 MHz	34	46	—	dB
	4220... 4340 MHz	29	41	—	dB
	4900... 5950 MHz	28	38	—	dB

<sup>1)</sup> See Sec. Matching circuit (p. 5).

<sup>2)</sup> Over any 5 MHz.

<sup>3)</sup> Over any 20 MHz.

<sup>4)</sup> Error Vector Magnitude (EVM) based on definition given in 3GPP TS 25.141.

Data sheet

**6.3 TX – RX**

Temperature range for specification	$T_{SPEC}$	= -30 °C ... +90 °C
TX terminating impedance	$Z_{TX}$	= 50 $\Omega$
ANT terminating impedance	$Z_{ANT}$	= 50 $\Omega$ with par. 3.1 nH <sup>1)</sup>
RX terminating impedance	$Z_{RX}$	= 50 $\Omega$

Characteristics TX – RX				min. for $T_{SPEC}$	typ. @+25 °C	max. for $T_{SPEC}$	
<b>Minimum isolation</b>							
	1574... 1577	MHz	$\alpha_{min}$	40	74	—	dB
	1920.59... 1979.41	MHz	$\alpha_{min}$	55	60	—	dB
	@ $f_{carrier}$ 2112.4... 2167.6	MHz	$\alpha_{WCDMA,min}^{2)}$	55	61	—	dB
	3830... 3970	MHz	$\alpha_{min}$	20	60	—	dB
	5750... 5950	MHz	$\alpha_{min}$	20	42	—	dB

<sup>1)</sup> See Sec. Matching circuit (p. 5).

<sup>2)</sup> Attenuation of WCDMA signal ("power transfer function"). Please refer to definition of Power Transfer Function (PTF) of WCDMA signal (p. 24).

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## 6.4 Linearity

Temperature range for specification	$T_{SPEC}$	= -30 °C ... +90 °C
TX terminating impedance	$Z_{TX}$	= 50 $\Omega$
ANT terminating impedance	$Z_{ANT}$	= 50 $\Omega$ with par. 3.1 nH <sup>1)</sup>
RX terminating impedance	$Z_{RX}$	= 50 $\Omega$

Characteristics linearity			min. for $T_{SPEC}$	typ. @+25 °C	max. for $T_{SPEC}$	
<b>IMD product levels<sup>2), 3)</sup></b>						
<b>IMD2</b>						
Blocker 1	190	MHz	—	-117	—	dBm
Blocker 3	4030... 4150	MHz	—	-102	—	dBm
<b>IMD3</b>						
SVLTE	1575	MHz	—	-85	—	dBm
Blocker 2	1730... 1790	MHz	—	-113	—	dBm
SVLTE	2145	MHz	—	-75	—	dBm
Blocker 4	5950... 6130	MHz	—	-118	—	dBm

<sup>1)</sup> See Sec. Matching circuit (p. 5).

<sup>2)</sup> @  $f_{TX}$  = 1920...1980 MHz,  $f_{RX}$  = Blocker 1...4, IMD product levels for power levels  $P_{TX}$  = +21.5 dBm (ANT port output power) and  $P_{blocker}$  = -15 dBm (ANT port input power).

<sup>3)</sup> @  $f_{TX}$  = 1955 MHz,  $f_{ANT}$  = 1765, IMD product levels for power levels  $P_{TX}$  = +24.5 dBm (ANT port output power) and  $P_{blocker}$  = +14 dBm (ANT port input power).

<b>SAW components</b>	<b>B8651</b>
<b>SAW duplexer</b>	<b>1950 / 2140 MHz</b>

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## 7 Maximum ratings

Storage temperature	$T_{STG}^{1)} = -40\text{ °C} \dots +90\text{ °C}$	
DC voltage	$V_{DC}^{2)} = 5.0\text{ V (max.)}$	
ESD voltage		
	$V_{ESD}^{3)} = 125\text{ V (max.)}$	Machine model.
	$V_{ESD}^{4)} = 150\text{ V (max.)}$	Human body model.
	$V_{ESD}^{5)} = 600\text{ V (max.)}$	Charged device model.
Input power	$P_{IN}$	
@ TX port: 1920 ... 1980 MHz	29 dBm	Continuous wave for 5000 h @ 50 °C.
@ TX port: other frequency range(s)	10 dBm	Continuous wave for 5000 h @ 50 °C.

<sup>1)</sup> Extended upper limit: 168h@125°C acc. to IEC 60 Bb068-2-2.

<sup>2)</sup> 168h Damp Heat Steady State acc. to IEC600682-67 Cy.

<sup>3)</sup> According to JESD22-A115B (MM – Machine Model), 10 negative & 10 positive pulses.

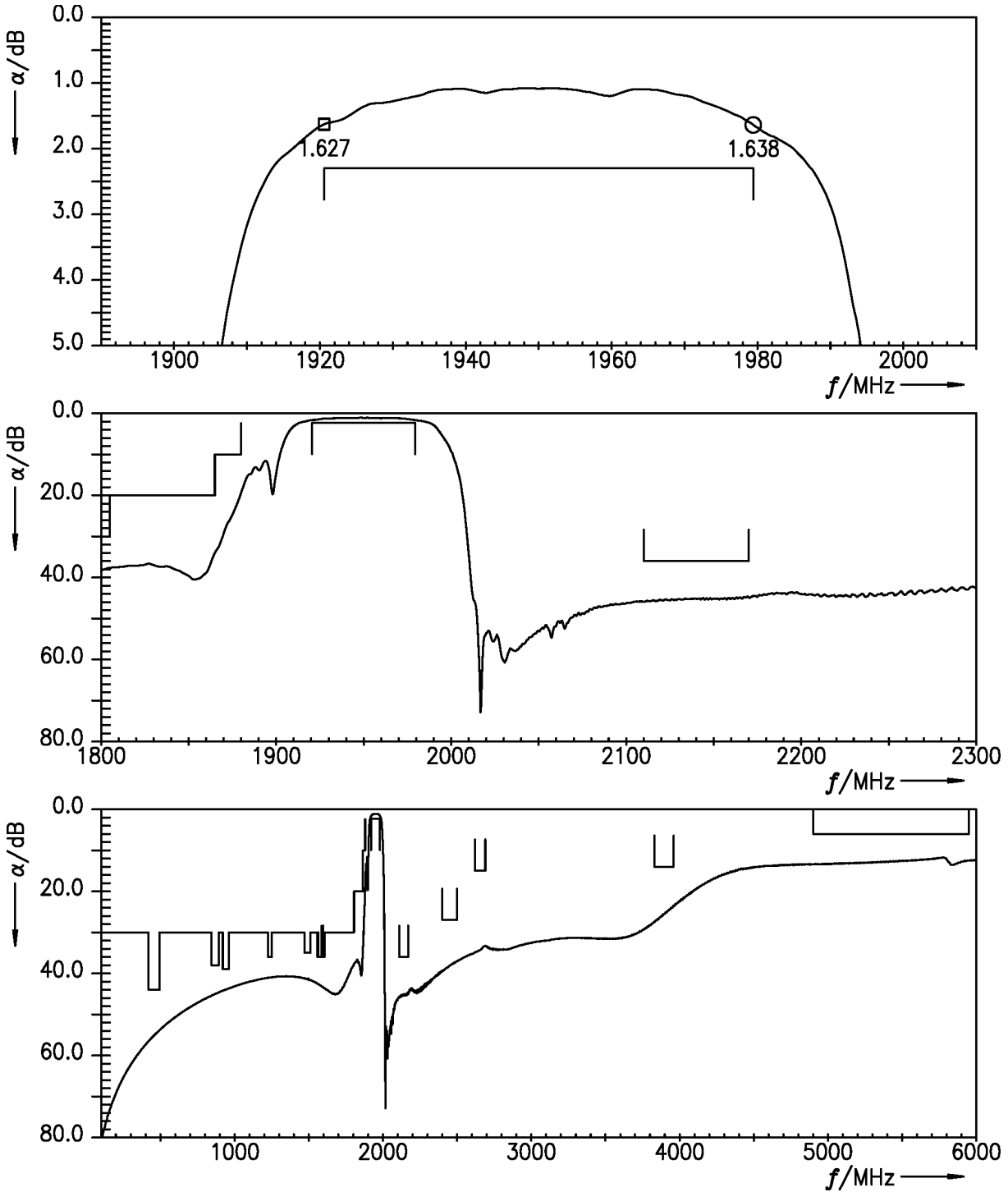
<sup>4)</sup> According to JESD22-A114F (HBM – Human Body Model), 1 negative & 1 positive pulse.

<sup>5)</sup> According to JESD22-C101C (CDM – Field Induced Charged Device Model), 3 negative & 3 positive pulses.

Data sheet

**8 Transmission coefficients**

**8.1 TX – ANT**



**Figure 4:** Attenuation TX – ANT.

Data sheet

8.2 ANT – RX

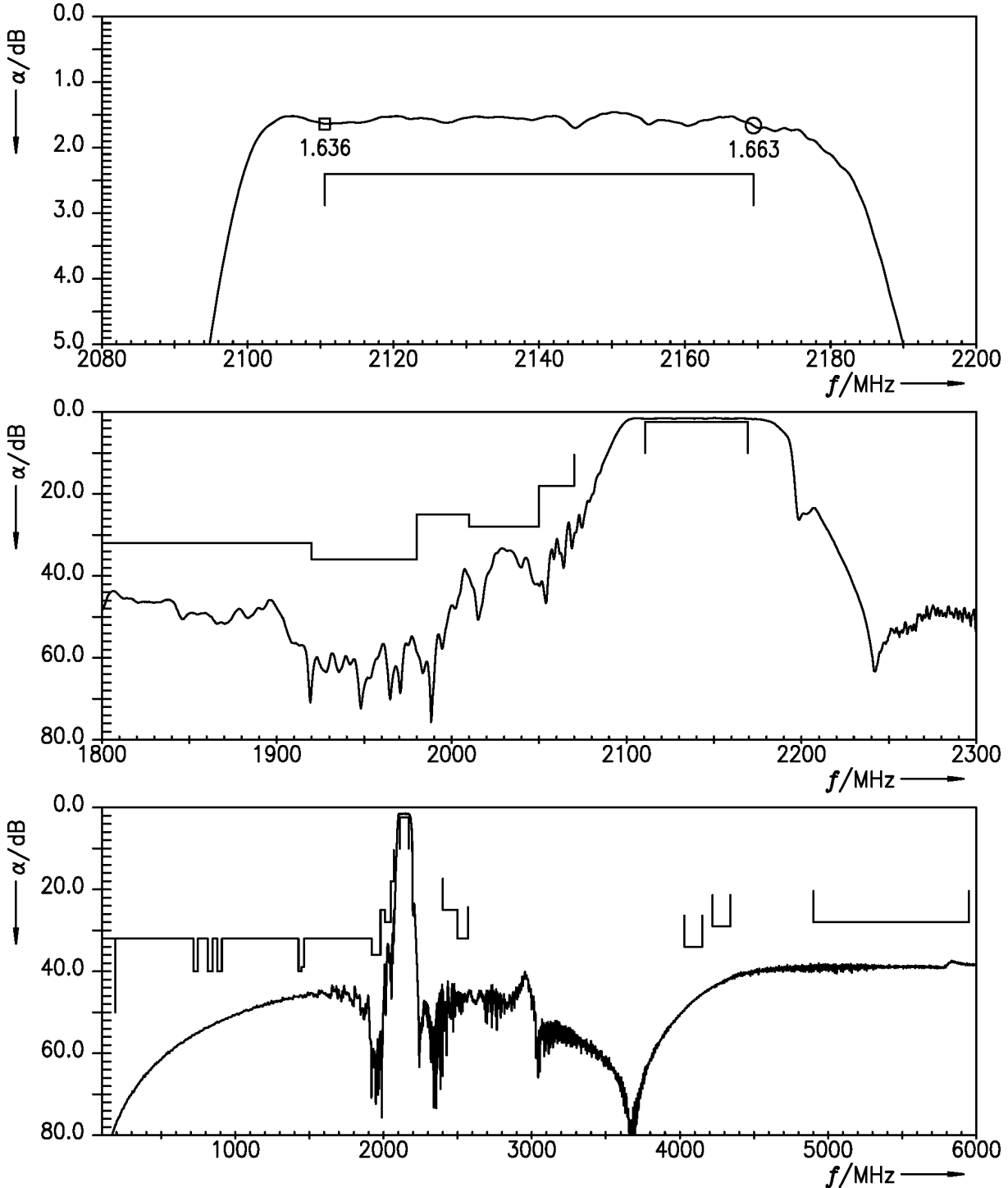
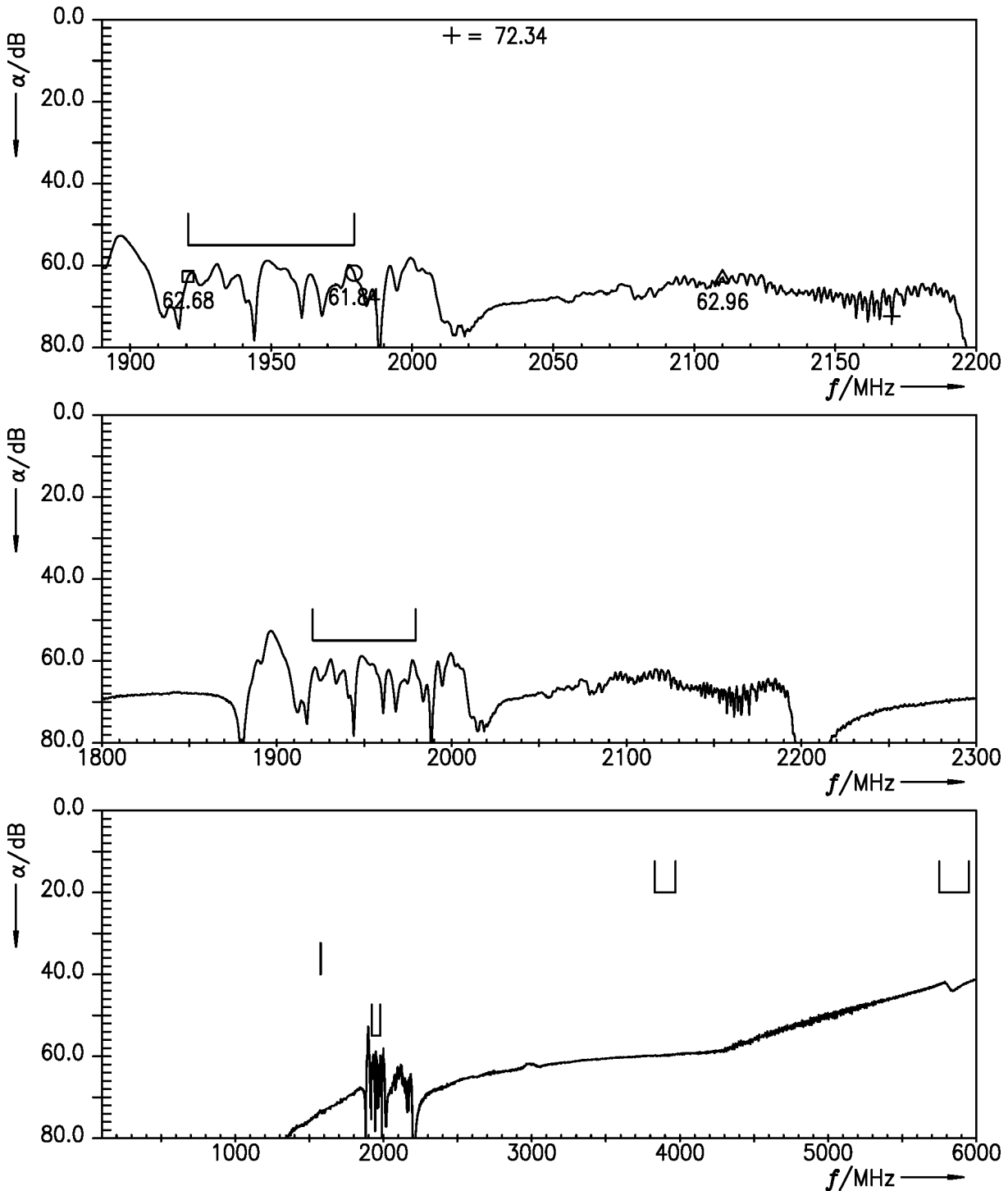


Figure 5: Attenuation ANT – RX.

Data sheet

**8.3 TX – RX**



**Figure 6:** Isolation TX – RX.



Data sheet

**9 Reflection coefficients**

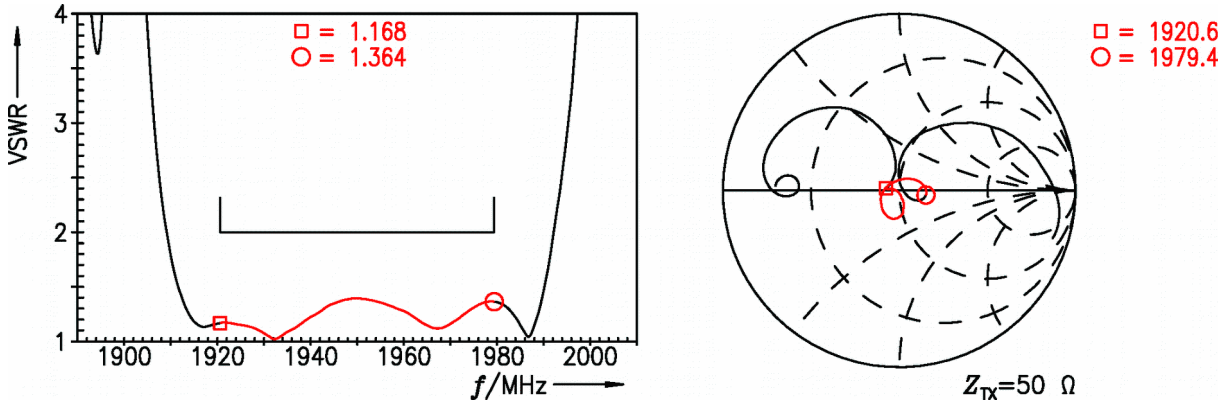


Figure 7: Reflection coefficient at TX port.

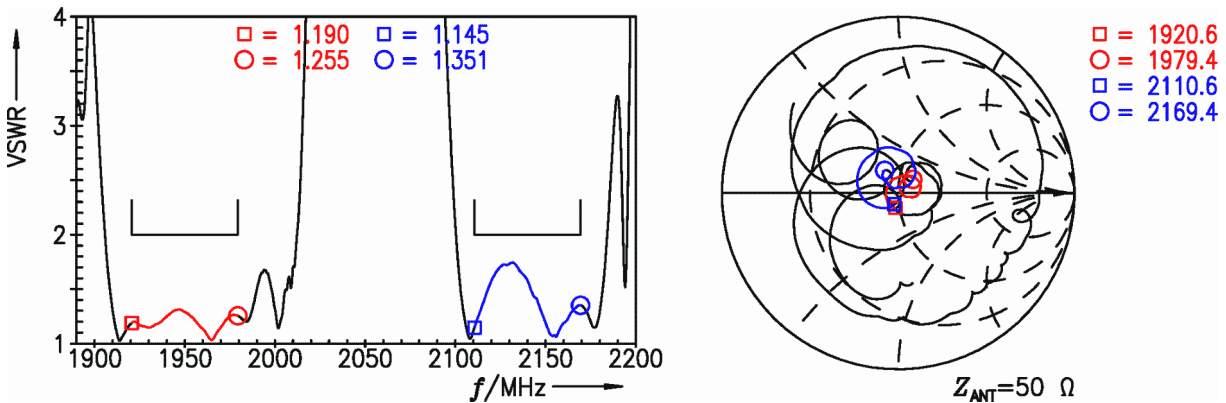


Figure 8: Reflection coefficient at ANT port (TX and RX frequencies).

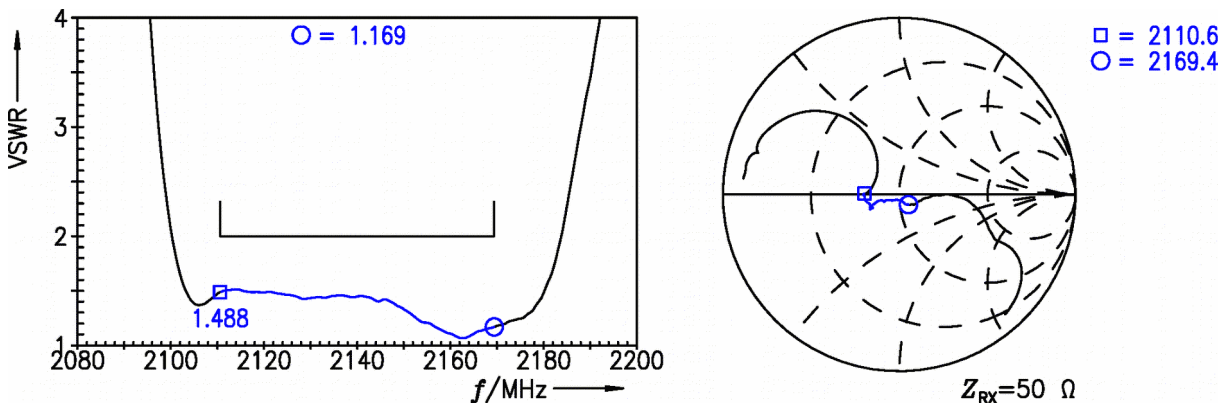
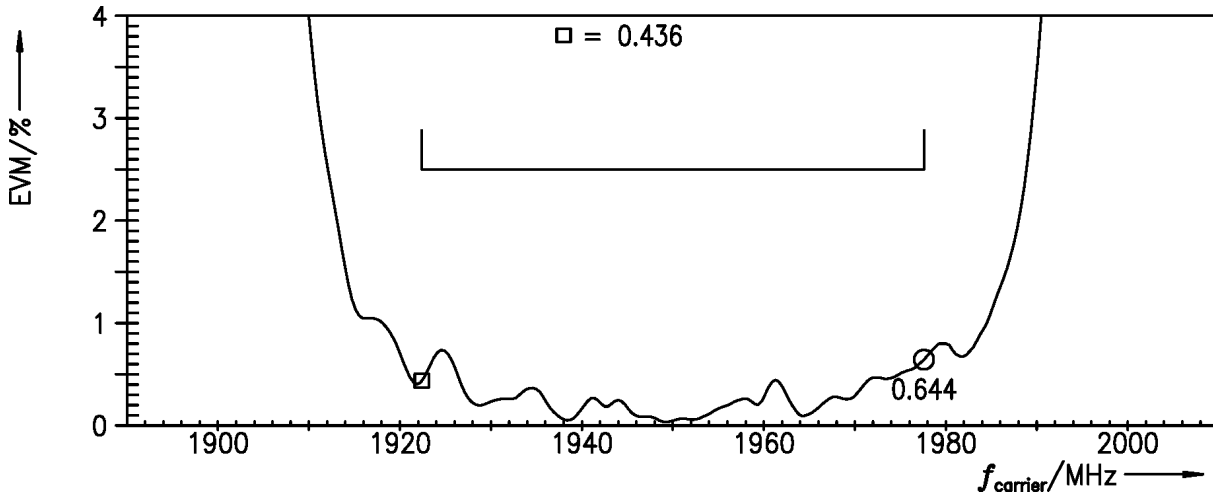


Figure 9: Reflection coefficient at RX port.

Data sheet

**10 EVMs**

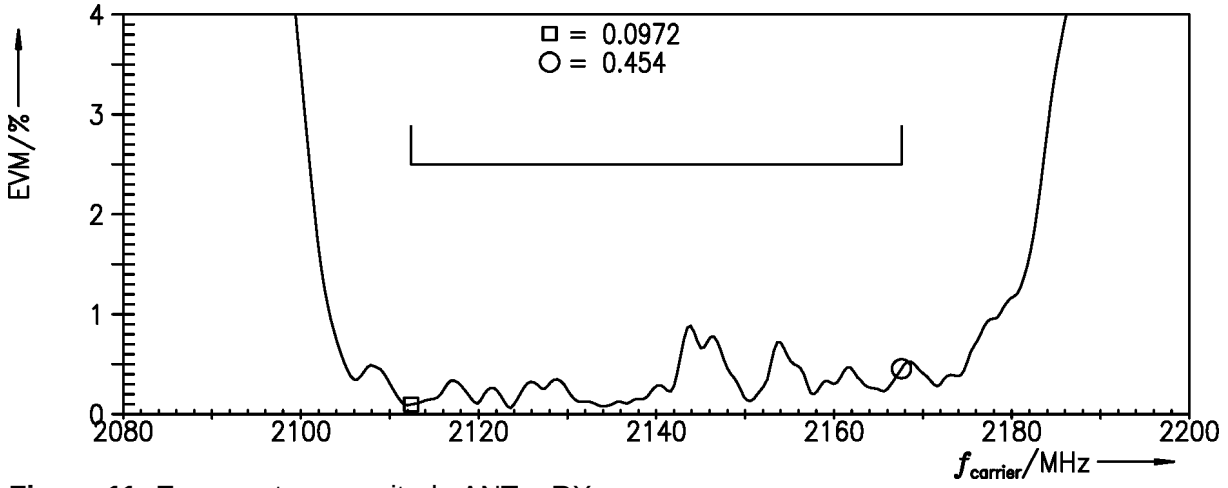
**10.1 TX – ANT**



**Figure 10:** Error vector magnitude TX – ANT.

Data sheet

**10.2 ANT – RX**

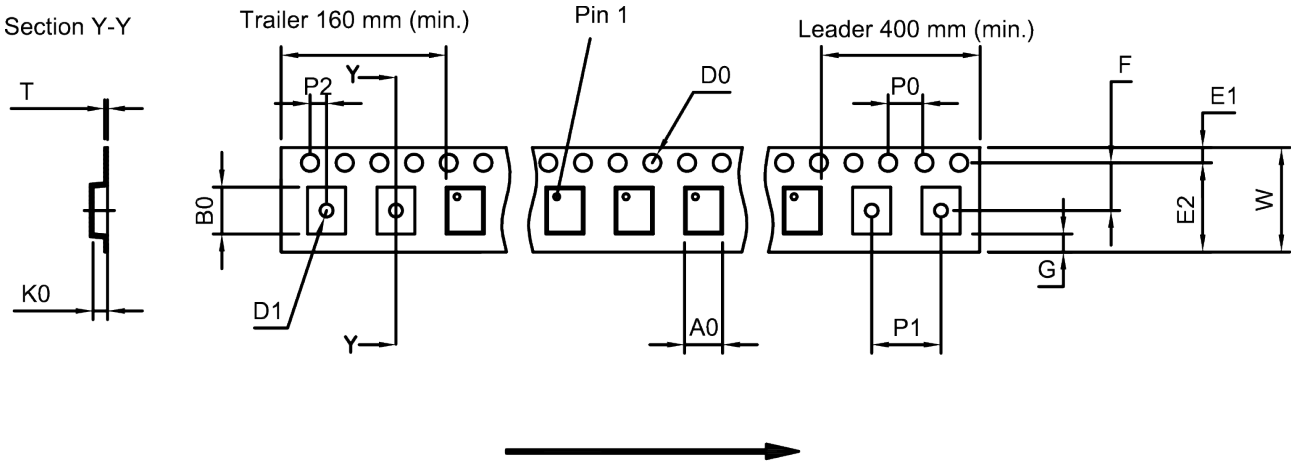


**Figure 11:** Error vector magnitude ANT – RX.

Data sheet

**11 Packing material**

**11.1 Tape**

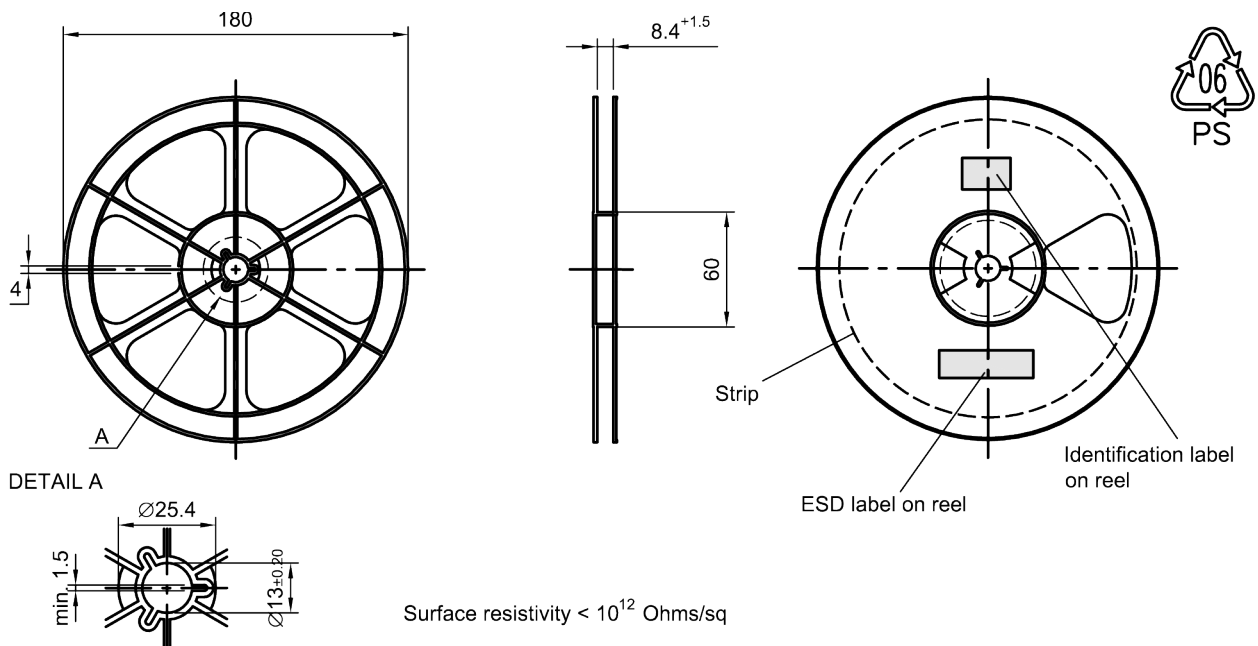


**Figure 12:** Drawing of tape (first-angle projection) with tape dimensions according to Table 1.

A <sub>0</sub>	1.62±0.05 mm	E <sub>2</sub>	6.25 mm (min.)	P <sub>1</sub>	4.0±0.1 mm
B <sub>0</sub>	2.04±0.05 mm	F	3.5±0.05 mm	P <sub>2</sub>	2.0±0.05 mm
D <sub>0</sub>	1.5±0.05 mm	G	0.75 mm (min.)	T	0.25±0.02 mm
D <sub>1</sub>	0.8±0.05 mm	K <sub>0</sub>	0.62±0.05 mm	W	8.0±0.1 mm
E <sub>1</sub>	1.75±0.1 mm	P <sub>0</sub>	4.0±0.1 mm		

**Table 1:** Tape dimensions.

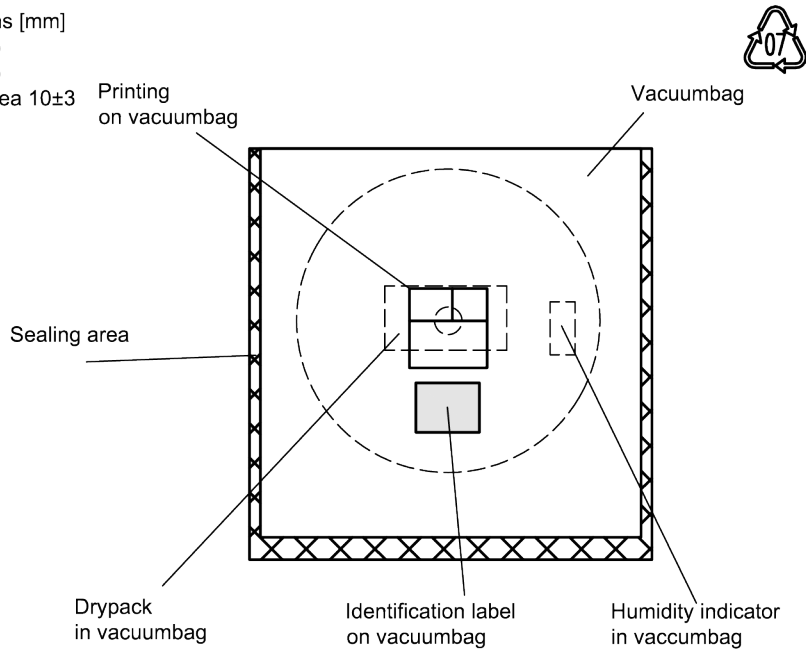
**11.2 Reel with diameter of 180 mm**



**Figure 13:** Drawing of reel (first-angle projection) with diameter of 180 mm.

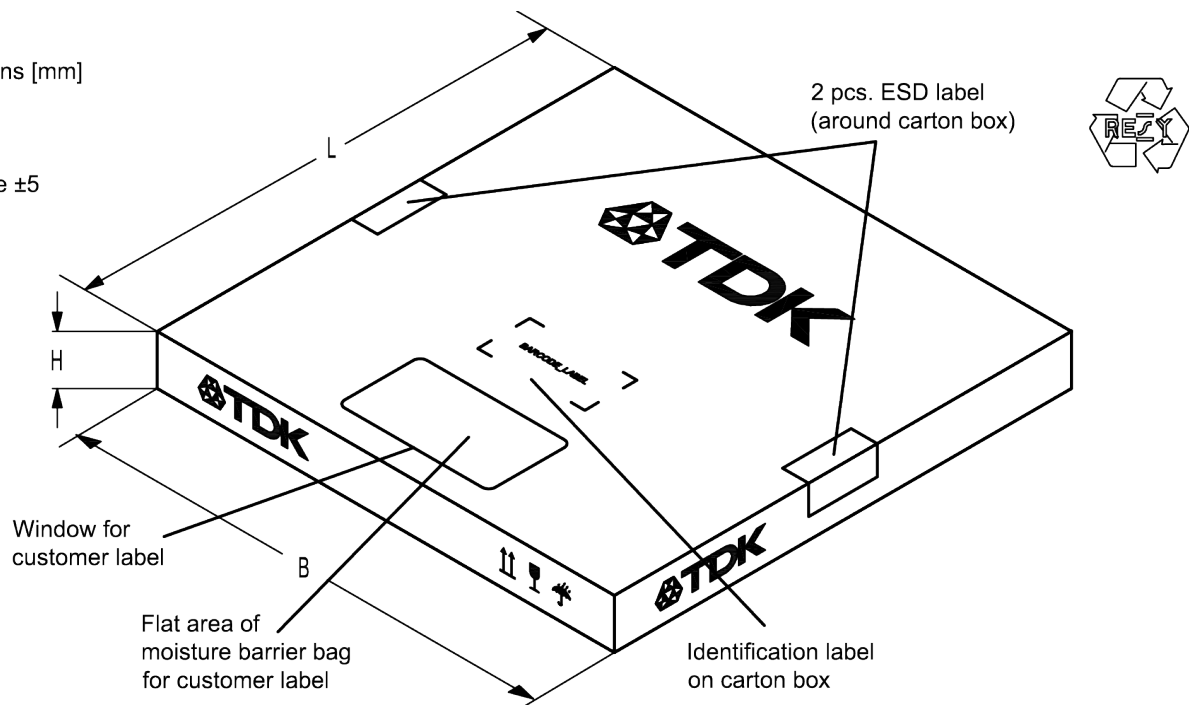
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Dimensions [mm]  
 X = 220±5  
 Y = 235±5  
 Sealing area 10±3



**Figure 14:** Drawing of moisture barrier bag (MBB) for reel with diameter of 180 mm.

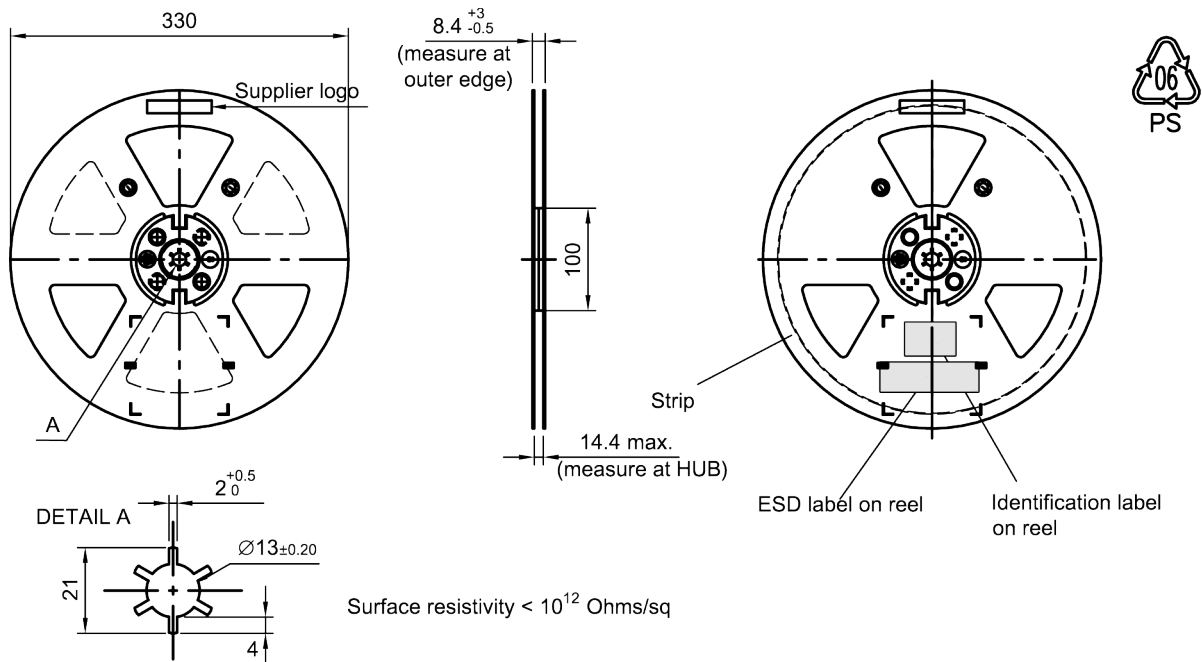
Dimensions [mm]  
 L = 188  
 B = 188  
 H = 30  
 Tolerance ±5



**Figure 15:** Drawing of folding box for reel with diameter of 180 mm.

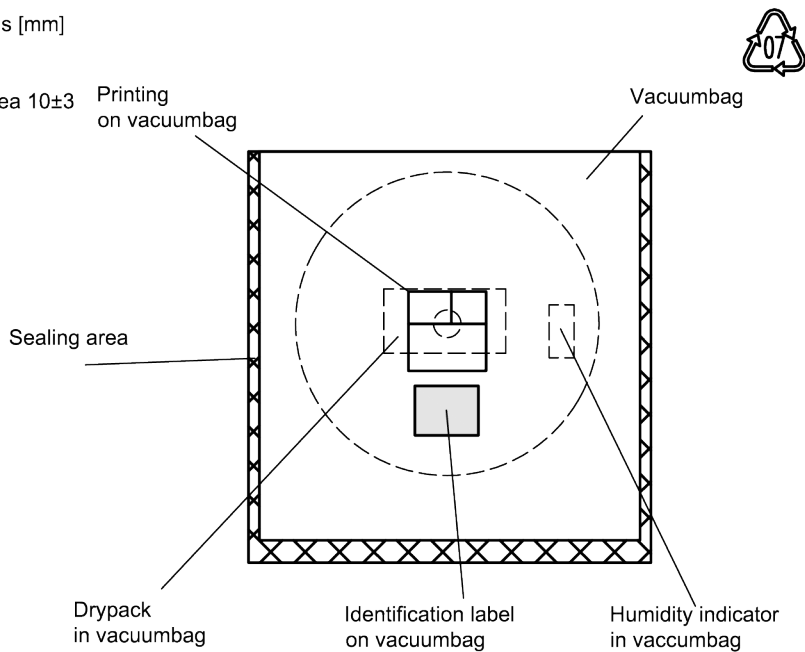
Data sheet

**11.3 Reel with diameter of 330 mm**



**Figure 16:** Drawing of reel (first-angle projection) with diameter of 330 mm.

Dimensions [mm]  
 X = 400±5  
 Y = 418±5  
 Sealing area 10±3



**Figure 17:** Drawing of moisture barrier bag (MBB) for reel with diameter of 330 mm.

Data sheet

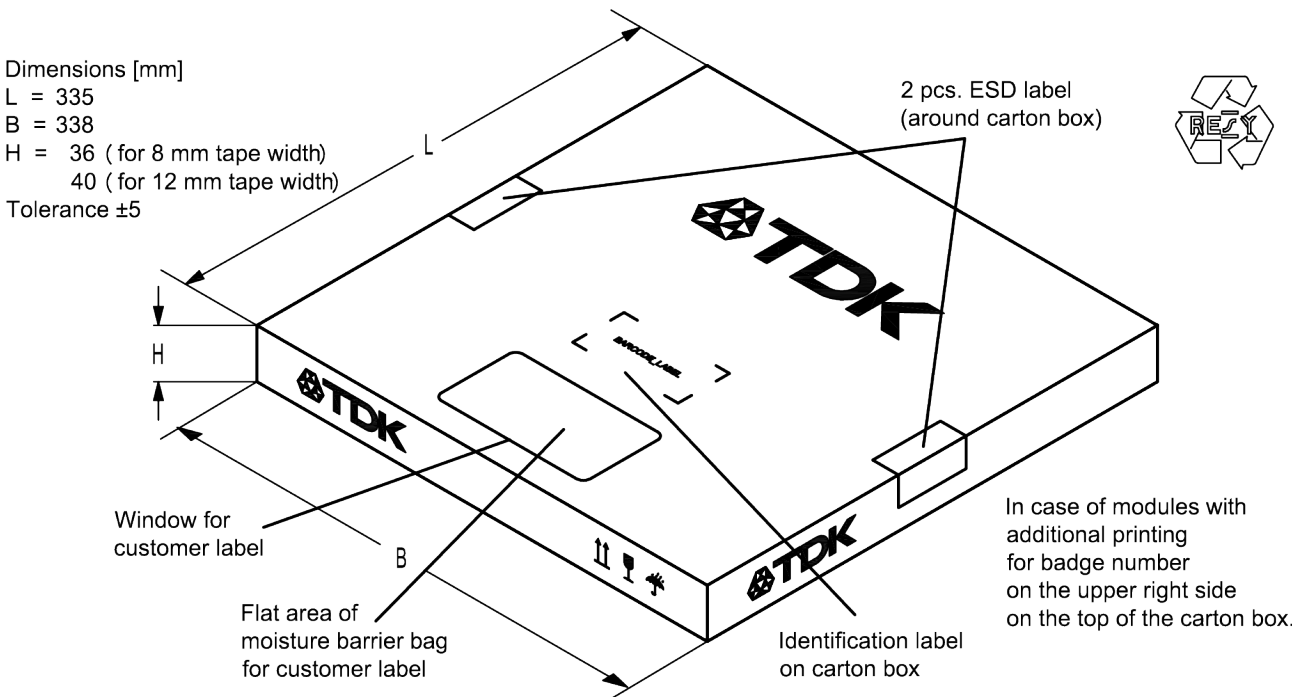


Figure 18: Drawing of folding box for reel with diameter of 330 mm.

12 Marking

Products are marked with product type number and lot number encoded according to Table 2:

■ Type number:

The 4 digit type number of the ordering code, e.g., B3xxxxB**1234**xxxx,  
is encoded by a special BASE32 code into a 3 digit marking.

Example of decoding type number marking on device in decimal code.  
 $16J \Rightarrow 1234$   
 $1 \times 32^2 + 6 \times 32^1 + 18 (=J) \times 32^0 = 1234$

The BASE32 code for product type B8651 is 8EB.

■ Lot number:

The last 5 digits of the lot number, e.g., **12345**,  
are encoded based on a special BASE47 code into a 3 digit marking.

Example of decoding lot number marking on device in decimal code.  
 $5UY \Rightarrow 12345$   
 $5 \times 47^2 + 27 (=U) \times 47^1 + 31 (=Y) \times 47^0 = 12345$

## Data sheet

Adopted BASE32 code for type number			
Decimal value	Base32 code	Decimal value	Base32 code
0	0	16	G
1	1	17	H
2	2	18	J
3	3	19	K
4	4	20	M
5	5	21	N
6	6	22	P
7	7	23	Q
8	8	24	R
9	9	25	S
10	A	26	T
11	B	27	V
12	C	28	W
13	D	29	X
14	E	30	Y
15	F	31	Z

Adopted BASE47 code for lot number			
Decimal value	Base47 code	Decimal value	Base47 code
0	0	24	R
1	1	25	S
2	2	26	T
3	3	27	U
4	4	28	V
5	5	29	W
6	6	30	X
7	7	31	Y
8	8	32	Z
9	9	33	b
10	A	34	d
11	B	35	f
12	C	36	h
13	D	37	n
14	E	38	r
15	F	39	t
16	G	40	v
17	H	41	\
18	J	42	?
19	K	43	{
20	L	44	}
21	M	45	<
22	N	46	>
23	P		

**Table 2:** Lists for encoding and decoding of marking.



<b>SAW components</b>	<b>B8651</b>
<b>SAW duplexer</b>	<b>1950 / 2140 MHz</b>

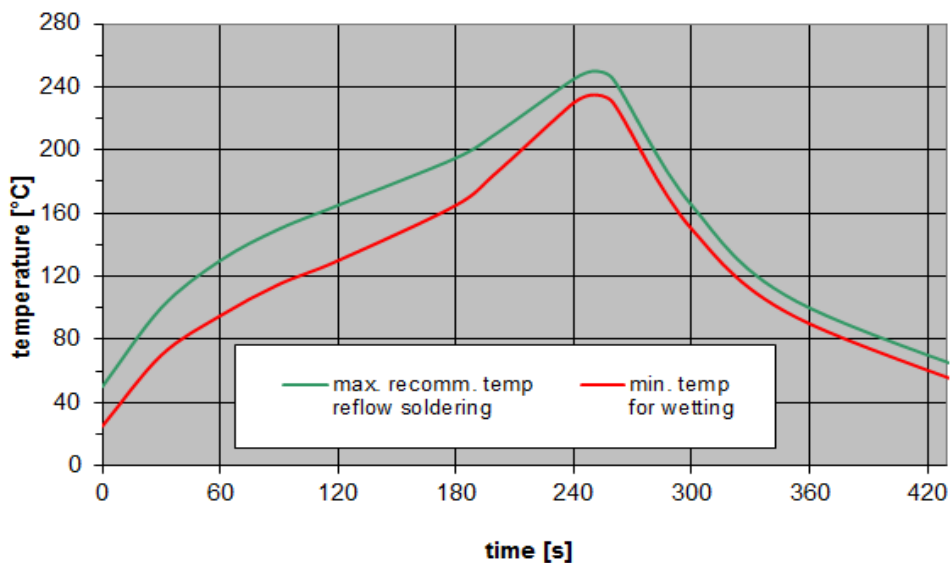
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### 13 Soldering profile

The recommended soldering process is in accordance with IEC 60068-2-58 – 3<sup>rd</sup> edit and IPC/JEDEC J-STD-020B.

ramp rate	≤ 3 K/s
preheat	125 °C to 220 °C, 150 s to 210 s, 0.4 K/s to 1.0 K/s
T > 220 °C	30 s to 70 s
T > 230 °C	min. 10 s
T > 245 °C	max. 20 s
T ≥ 255 °C	–
peak temperature $T_{peak}$	250 °C +0/-5 °C
wetting temperature $T_{min}$	230 °C +5/-0 °C for 10 s ± 1 s
cooling rate	≤ 3 K/s
soldering temperature T	measured at solder pads

**Table 3:** Characteristics of recommended soldering profile for lead-free solder (Sn95.5Ag3.8Cu0.7).



**Figure 19:** Recommended reflow profile for convection and infrared soldering – lead-free solder.

SAW components	B8651
SAW duplexer	1950 / 2140 MHz

Data sheet

## 14 Annotations

### 14.1 Matching coils

See TDK inductor pdf-catalog <http://www.tdk.co.jp/tefe02/coil.htm#aname1> and Data Library for circuit simulation <http://www.tdk.co.jp/etvcl/index.htm>.

### 14.2 Power Transfer Function (PTF) of WCDMA signal

Attenuation of WCDMA signal,  $\alpha_{\text{WCDMA}}$ , is defined by

$$\alpha_{\text{WCDMA}}(f_{\text{carrier}}) = 10 \log_{10} \left| \frac{1}{\text{PTF}(f_{\text{carrier}})} \right| \text{dB}$$

and

$$\text{PTF}(f_{\text{carrier}}) = \int_{-\infty}^{+\infty} |S_{21}(f) H_{\text{RRC}}(f - f_{\text{carrier}})|^2 df$$

with  $f_{\text{carrier}}$  according to 3GPP TS 25.101 (e.g., for the WCDMA B8 pass band,  $f_{\text{carrier}}$  ranges from 882.4 MHz to 912.6 MHz which correspond to the lowest and highest TX channels, respectively).  $H_{\text{RRC}}(f)$  is the transfer function of the root-raised cosine transmit pulse shaping filter according to 3GPP TS 25.101 using the normalization

$$\int_{-\infty}^{+\infty} |H_{\text{RRC}}(f)|^2 df = 1 \quad .$$

### 14.3 RoHS compatibility

ROHS-compatible means that products are compatible with the requirements according to Art. 4 (substance restrictions) of Directive 2011/65/EU of the European Parliament and of the Council of June 8th, 2011, on the restriction of the use of certain hazardous substances in electrical and electronic equipment ("Directive") with due regard to the application of exemptions as per Annex III of the Directive in certain cases.

### 14.4 Scattering parameters (S-parameters)

The pin/port assignment is available in the headers of the S-parameter files. Please contact your local EPCOS sales office.

### 14.5 Ordering codes and packing units

Ordering code	Packing unit
B39212B8651P810	15000 pcs
B39212B8651P810S 5	5000 pcs

**Table 4:** Ordering codes and packing units.

Data sheet

## 15 Cautions and warnings

### 15.1 Display of ordering codes for EPCOS products

The ordering code for one and the same product can be represented differently in data sheets, data books, other publications and the website of EPCOS, or in order-related documents such as shipping notes, order confirmations and product labels. The varying representations of the ordering codes are due to different processes employed and do not affect the specifications of the respective products. Detailed information can be found on the Internet under [www.epcos.com/orderingcodes](http://www.epcos.com/orderingcodes).

### 15.2 Material information

Due to technical requirements components may contain dangerous substances. For information on the type in question please also contact one of our sales offices.

### 15.3 Moldability

Before using in overmolding environment, please contact your local EPCOS sales office.

### 15.4 Package information

#### Landing area

The printed circuit board (PCB) land pattern (landing area) shown is based on EPCOS internal development and empirical data and illustrated for example purposes, only. As customers' SMD assembly processes may have a plenty of variants and influence factors which are not under control or knowledge of EPCOS, additional careful process development on customer side is necessary and strongly recommended in order to achieve best soldering results tailored to the particular customer needs.

#### Dimensions

Unless otherwise specified all dimensions are understood using unit millimeter (mm).

#### Projection method

Unless otherwise specified first-angle projection is applied.

## 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 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 an 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 an 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.  
The aforementioned does not apply in the case of individual agreements deviating from the foregoing for customer-specific products.
6. Unless otherwise agreed in individual contracts, **all orders are subject to the current version of the “General Terms of Delivery for Products and Services in the Electrical Industry” published by the German Electrical and Electronics Industry Association (ZVEI)**.
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