QUALCOMM®

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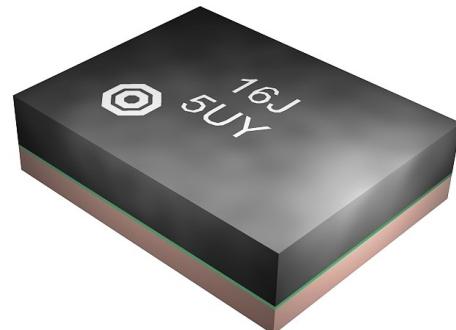
Figure 1: Picture of component
with example of product marking.

3 Package

BOTTOM VIEW

Pad and pitch tolerance ±0.05

SIDE VIEW

TOP VIEW

16J
5UY
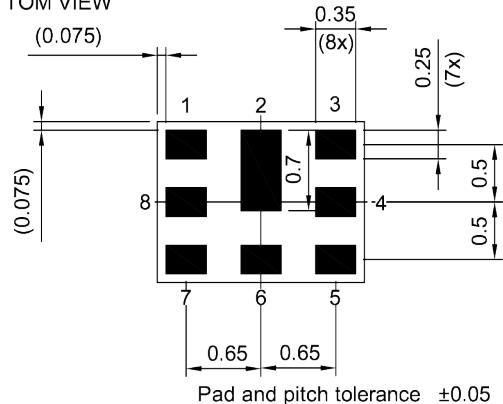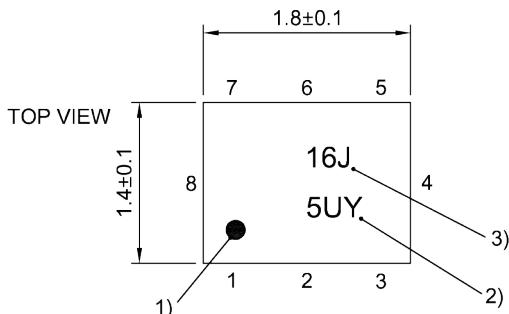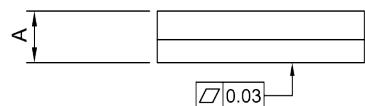
1) Marking for pad number 1
2) Example of encoded lot number
3) Example of encoded filter type number

Land pattern
THRU VIEW

Landing pad tolerance   -0.02
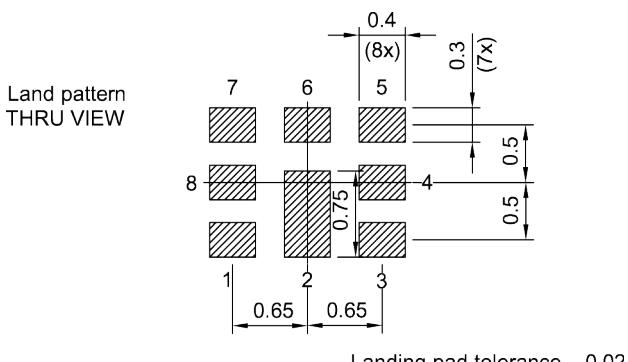
Figure 2: Drawing of package with package height A = 0.475 mm (max.). See Sec. Package information (p. 25).

4 Pin configuration

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

Please read **Cautions and warnings** and **Important notes** at the end of this document.

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5   Matching circuit

■ L_{p6} = 3.1 nH
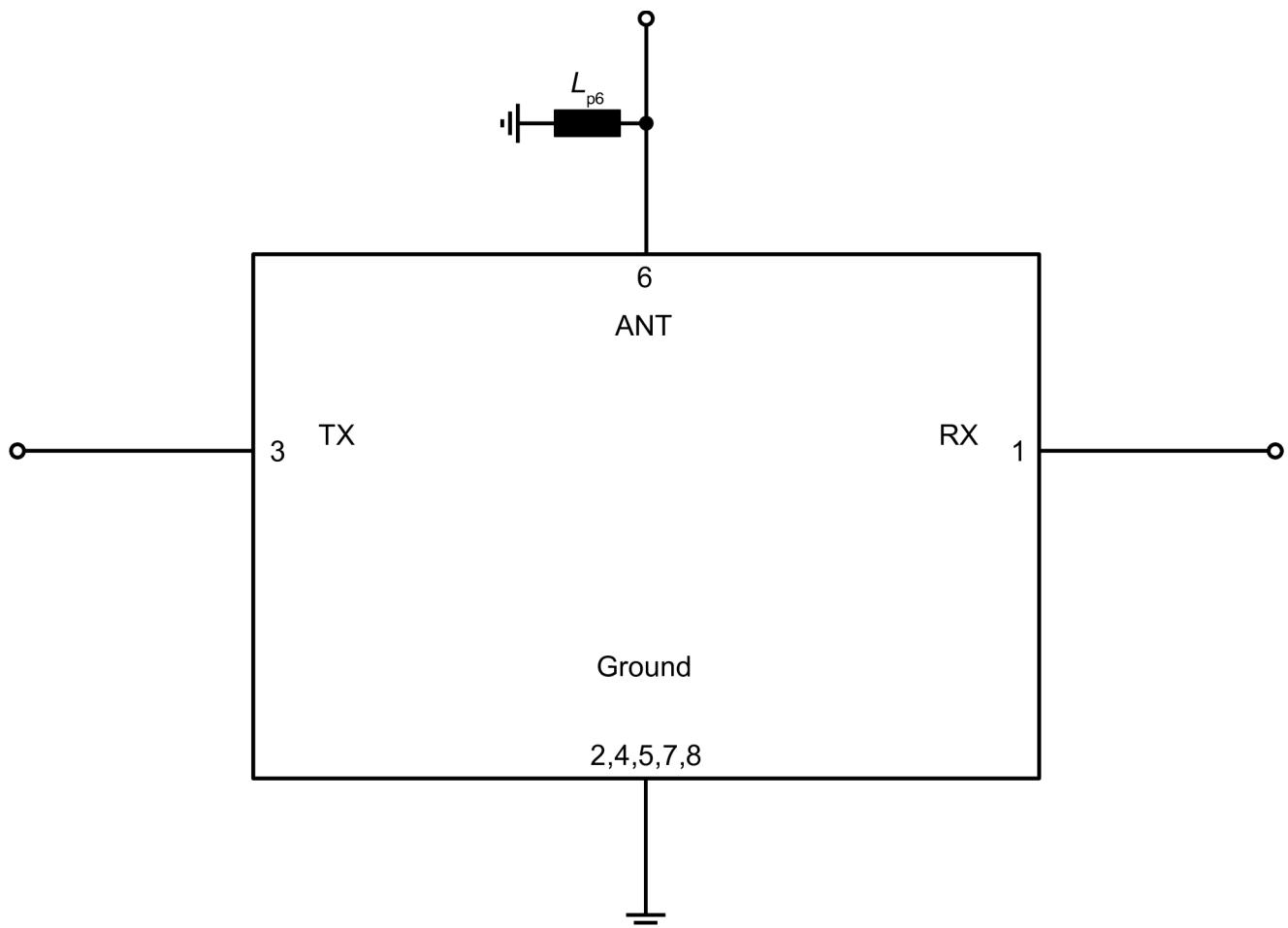
Figure 3: Schematic of matching circuit.

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[1]
RX terminating impedance	Z_{RX}	= 50 Ω

Characteristics TX – ANT					min. for T_{SPEC}	typ. @+25 °C	max. for T_{SPEC}	
Center frequency				f_C	—	1950	—	MHz
Maximum insertion attenuation								
	1920.59... 1979.41	MHz		α_{max}	—	1.9	2.3	dB
@$f_{carrier}$	1922.4... 1977.6	MHz		$\alpha_{WCDMA,max}$[2]	—	1.8	2.3	dB
Amplitude ripple (p-p)								
	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
Maximum VSWR				$VSWR_{max}$				
@ TX port	1920.59... 1979.41	MHz			—	1.5	2.0	
@ ANT port	1920.59... 1979.41	MHz			—	1.4	2.0	
Maximum error vector magnitude				EVM_{max}[5]				
	1922.4... 1977.6	MHz			—	1.5	2.5	%
Minimum attenuation				α_{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[6]	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

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

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

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6.2 ANT – RX

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[1]
RX terminating impedance	Z_{RX}	= 50 Ω

Characteristics ANT – RX				min. for T_{SPEC}	typ. @+25 °C	max. for T_{SPEC}	
Center frequency			f_C	—	2140	—	MHz
Maximum insertion attenuation			α_{max}				
	2110.59... 2169.41	MHz		—	1.9	2.4	dB
Amplitude ripple (p-p)							
	2110.59... 2169.41	MHz	$\Delta\alpha^{2)}$	—	0.4	0.7	dB
	2110.59... 2169.41	MHz	$\Delta\alpha^{3)}$	—	0.5	1.5	dB
Maximum VSWR			$VSWR_{max}$				
@ ANT port	2110.59... 2169.41	MHz		—	1.5	2.0	
@ RX port	2110.59... 2169.41	MHz		—	1.7	2.0	
Maximum error vector magnitude			$EVM_{max}{}^{4)}$				
	2112.4... 2167.6	MHz		—	1.2	2.5	%
Minimum attenuation			α_{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

[1] See Sec. Matching circuit (p. 5).
[2] Over any 5 MHz.
[3] Over any 20 MHz.
[4] Error Vector Magnitude (EVM) based on definition given in 3GPP TS 25.141.

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6.3 TX – RX

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[1]
RX terminating impedance	Z_{RX}	= 50 Ω

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

[1] See Sec. Matching circuit (p. 5).
[2] 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 Ω
ANT terminating impedance	Z_{ANT}	= 50 Ω with par. 3.1 nH[1]
RX terminating impedance	Z_{RX}	= 50 Ω

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

[1] See Sec. Matching circuit (p. 5).
[2] @ fTX = 1920...1980 MHz, fRX = Blocker 1...4, IMD product levels for power levels PTX = +21.5 dBm (ANT port output power) and Pblocker = −15 dBm (ANT port input power).
[3] @ fTX = 1955 MHz, fANT = 1765, IMD product levels for power levels PTX = +24.5 dBm (ANT port output power) and Pblocker = +14 dBm (ANT port input power).

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7 Maximum ratings

Storage temperature	$T_{STG}{}^{1)}$ = −40 °C ... +90 °C	
DC voltage	$V_{DC}{}^{2)}$ = 5.0 V (max.)	
ESD voltage		
	$V_{ESD}{}^{3)}$ = 125 V (max.)	Machine model.
	$V_{ESD}{}^{4)}$ = 150 V (max.)	Human body model.
	$V_{ESD}{}^{5)}$ = 600 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.

1) Extended upper limit: 168h@125°C acc. to IEC 60 Bb068-2-2.
2) 168h Damp Heat Steady State acc. to IEC600682-67 Cy.
3) According to JESD22-A115B (MM – Machine Model), 10 negative & 10 positive pulses.
4) According to JESD22-A114F (HBM – Human Body Model), 1 negative & 1 positive pulse.
5) According to JESD22-C101C (CDM – Field Induced Charged Device Model), 3 negative & 3 positive pulses.

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8   Transmission coefficients

8.1   TX – ANT
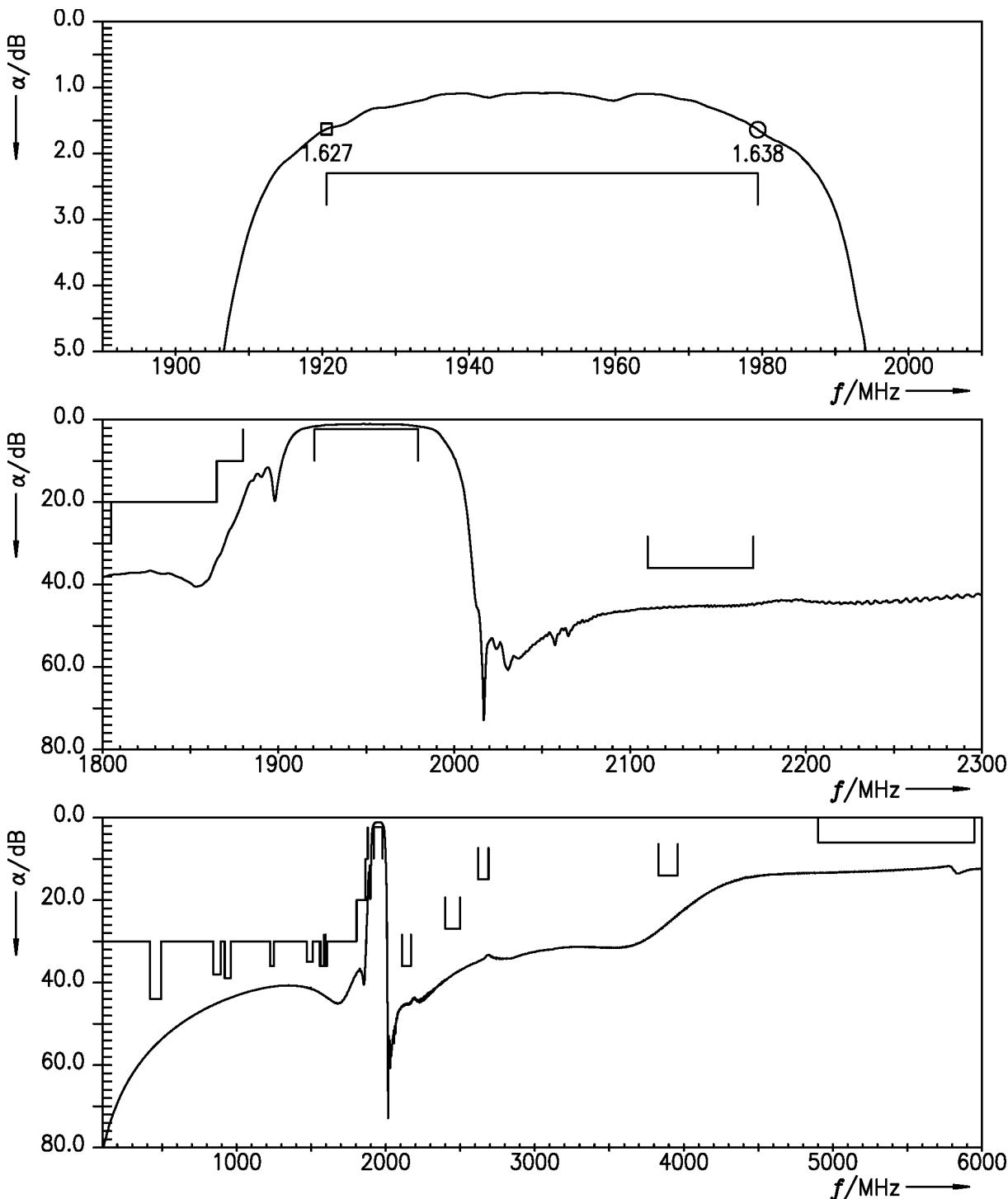
Figure 4: Attenuation TX – ANT.

8.2   ANT – RX
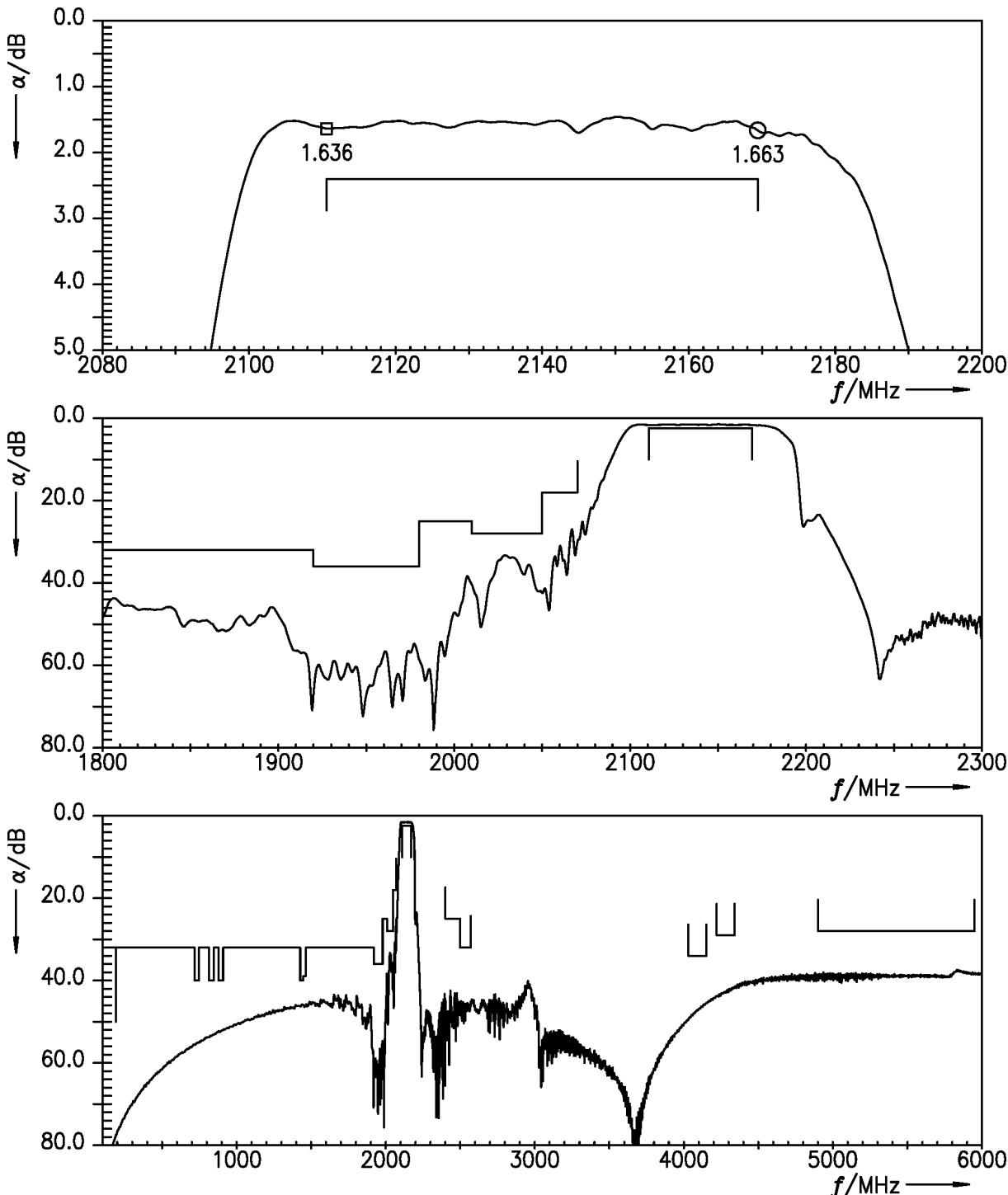
Figure 5: Attenuation ANT – RX.

8.3 TX – RX
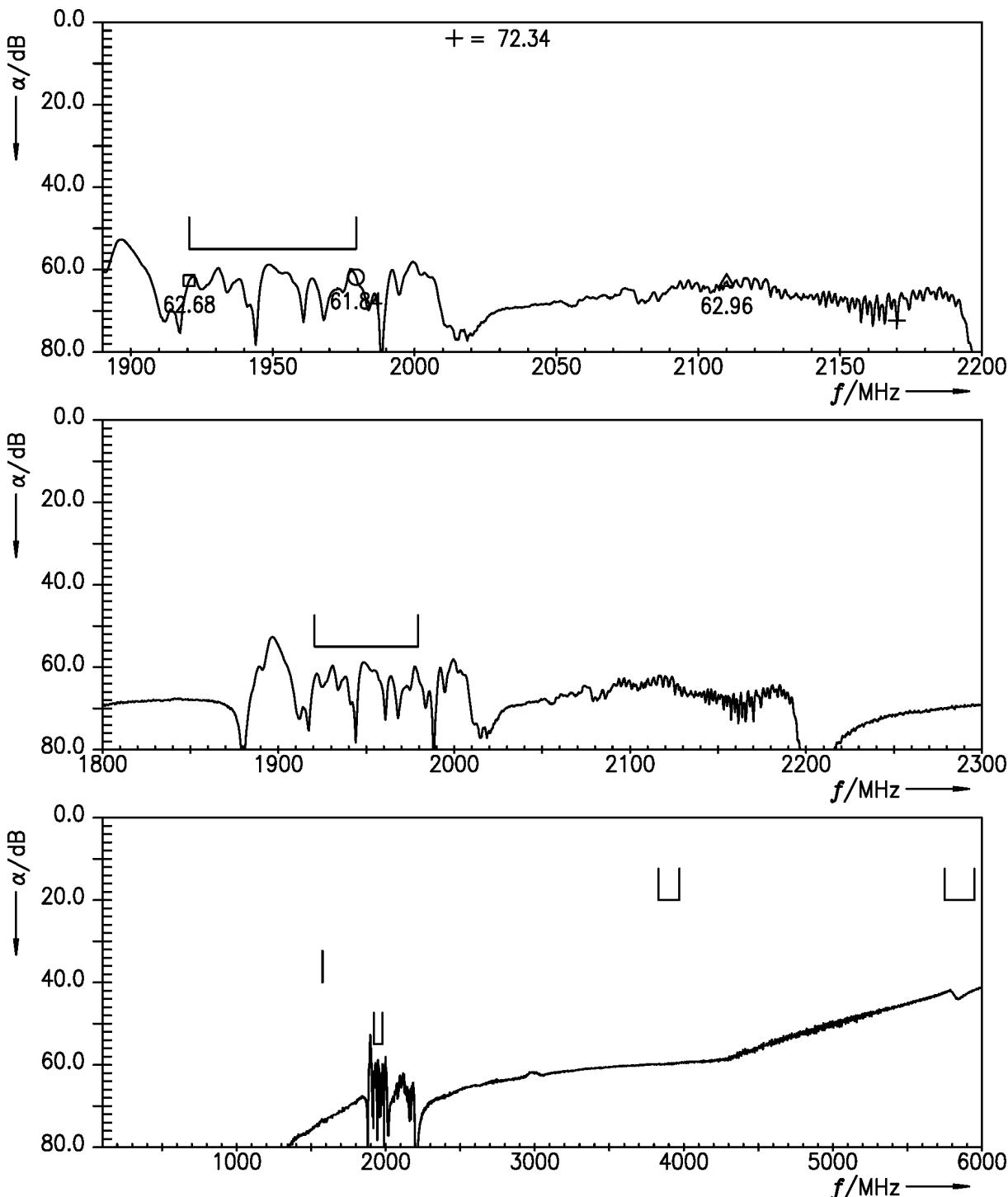
Figure 6: Isolation TX – RX.

9   Reflection coefficients
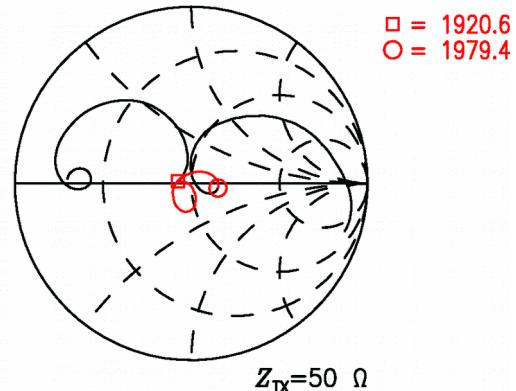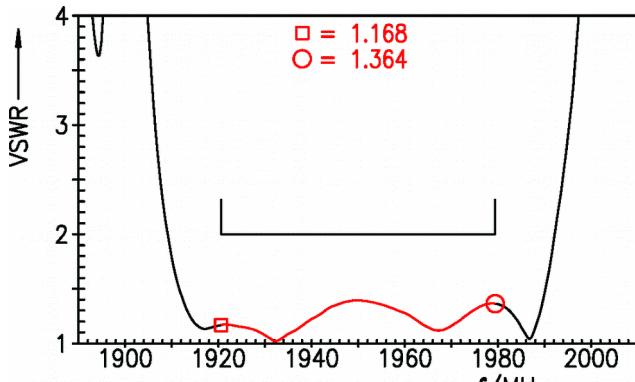
Figure 7: Reflection coefficient at TX port.
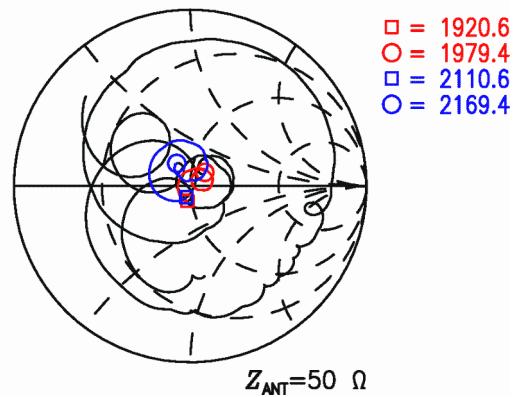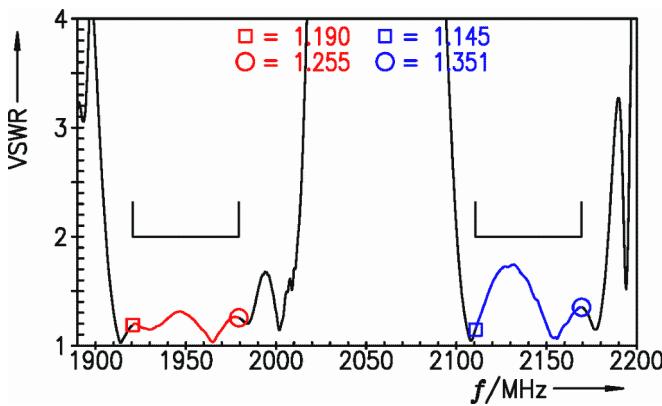
Figure 8: Reflection coefficient at ANT port (TX and RX frequencies).
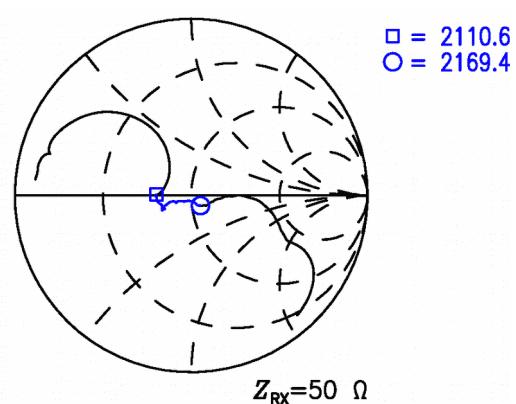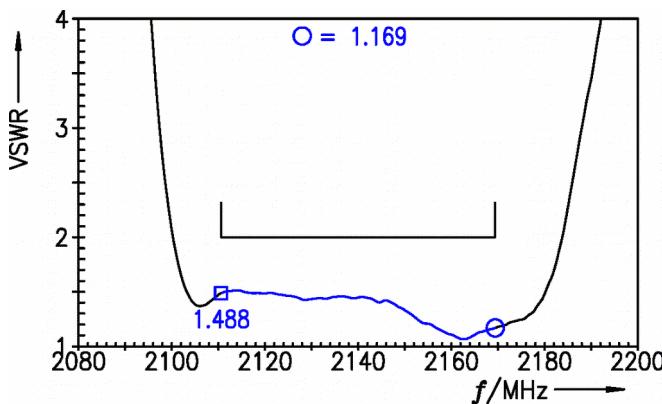
Figure 9: Reflection coefficient at RX port.

10   EVMs

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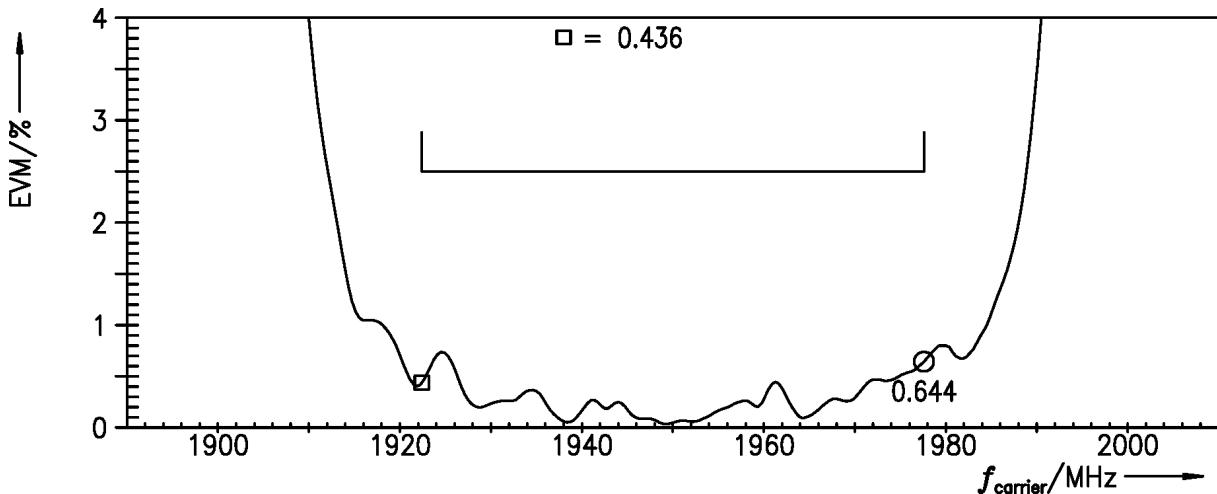
Figure 10: Error vector magnitude TX – ANT.

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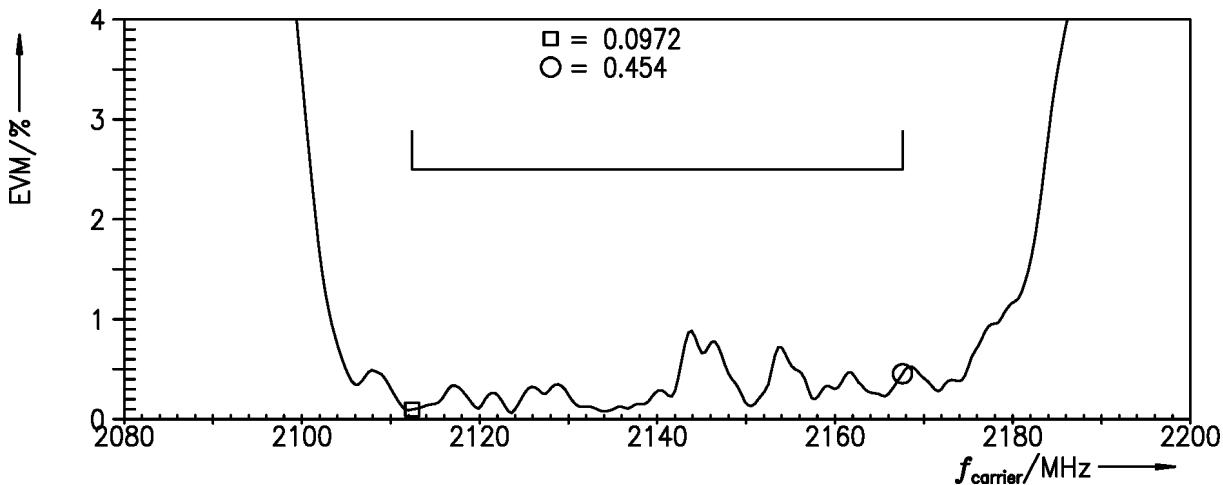
Figure 11: Error vector magnitude ANT – RX.

11 Packing material

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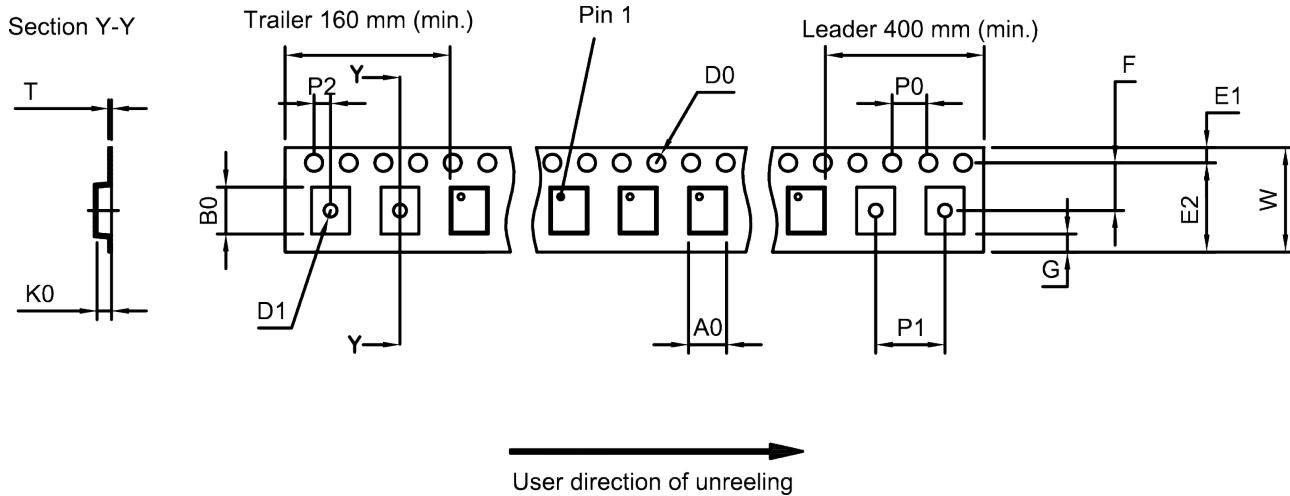
Figure 12: Drawing of tape (first-angle projection) with tape dimensions according to Table 1.

A_0	1.62±0.05 mm		E_2	6.25 mm (min.)		P_1	4.0±0.1 mm
B_0	2.04±0.05 mm		F	3.5±0.05 mm		P_2	2.0±0.05 mm
D_0	1.5±0.05 mm		G	0.75 mm (min.)		T	0.25±0.02 mm
D_1	0.8±0.05 mm		K_0	0.62±0.05 mm		W	8.0±0.1 mm
E_1	1.75±0.1 mm		P_0	4.0±0.1 mm			

Table 1: Tape dimensions.

11.2 Reel with diameter of 180 mm

Surface resistivity < 10^{12} Ohms/sq
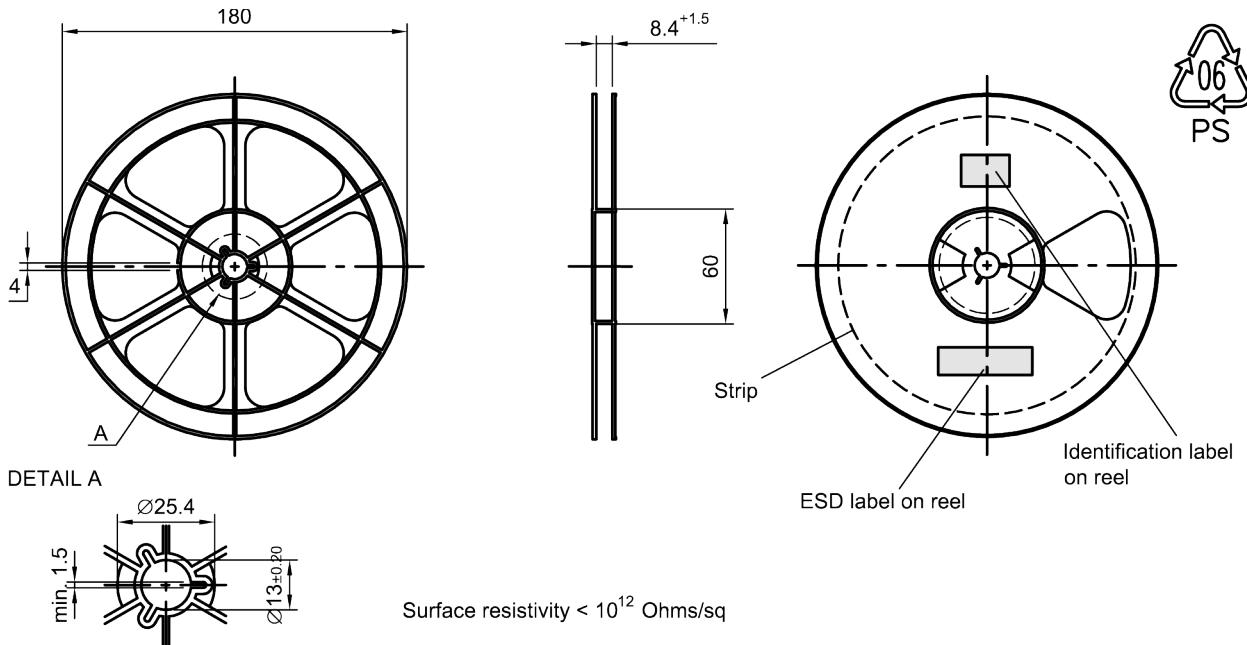
Figure 13: Drawing of reel (first-angle projection) with diameter of 180 mm.

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

Printing
on vacuumbag

Vacuumbag

Sealing area

Drypack
in vacuumbag

Identification label
on vacuumbag

Humidity indicator
in vaccumbag
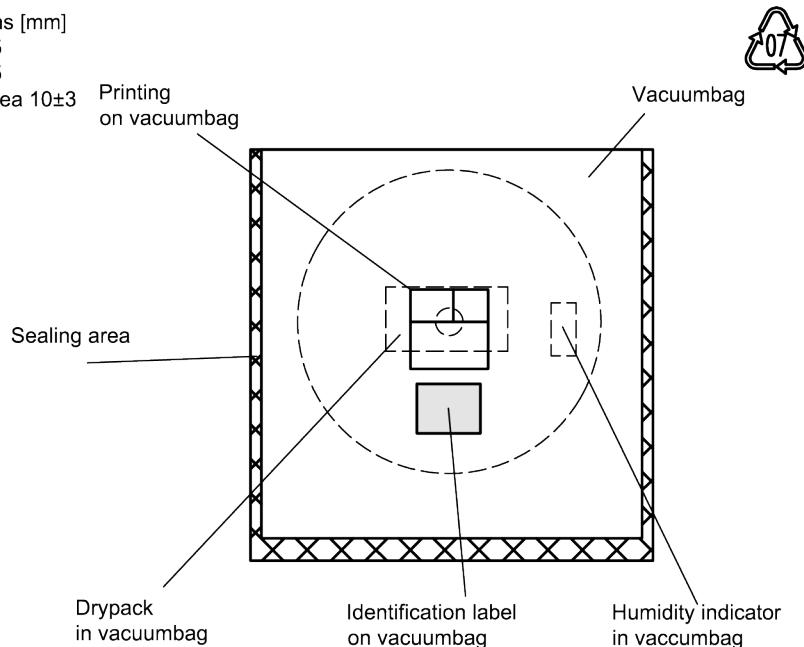
Figure 14: Drawing of moisture barrier bag (MBB) for reel with diameter of 180 mm.

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

L

H

B

2 pcs. ESD label
(around carton box)

Window for
customer label

Flat area of
moisture barrier bag
for customer label

Identification label
on carton box
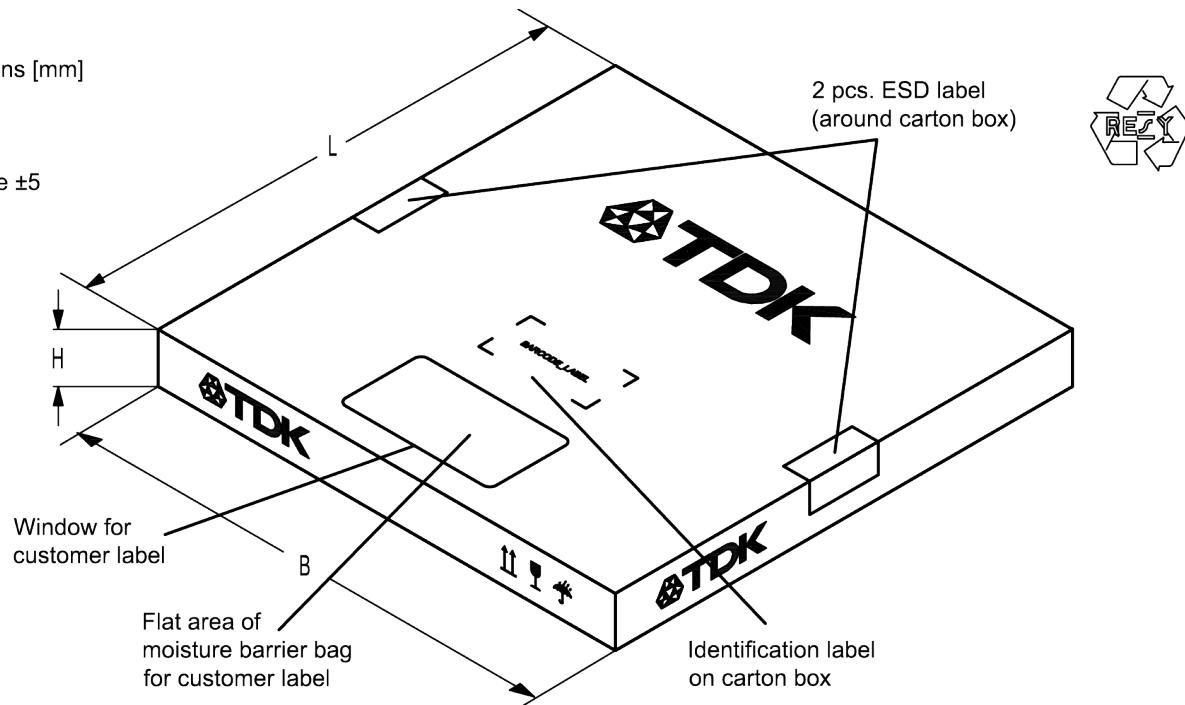
Figure 15: Drawing of folding box for reel with diameter of 180 mm.

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11.3 Reel with diameter of 330 mm

330

8.4 $^{+3}_{-0.5}$
(measure at outer edge)

Supplier logo

100

14.4 max.
(measure at HUB)

Strip

A

ESD label on reel

Identification label on reel

DETAIL A

2 $^{+0.5}_{0}$

⌀13±0.20

21

4

Surface resistivity < 10^{12} Ohms/sq

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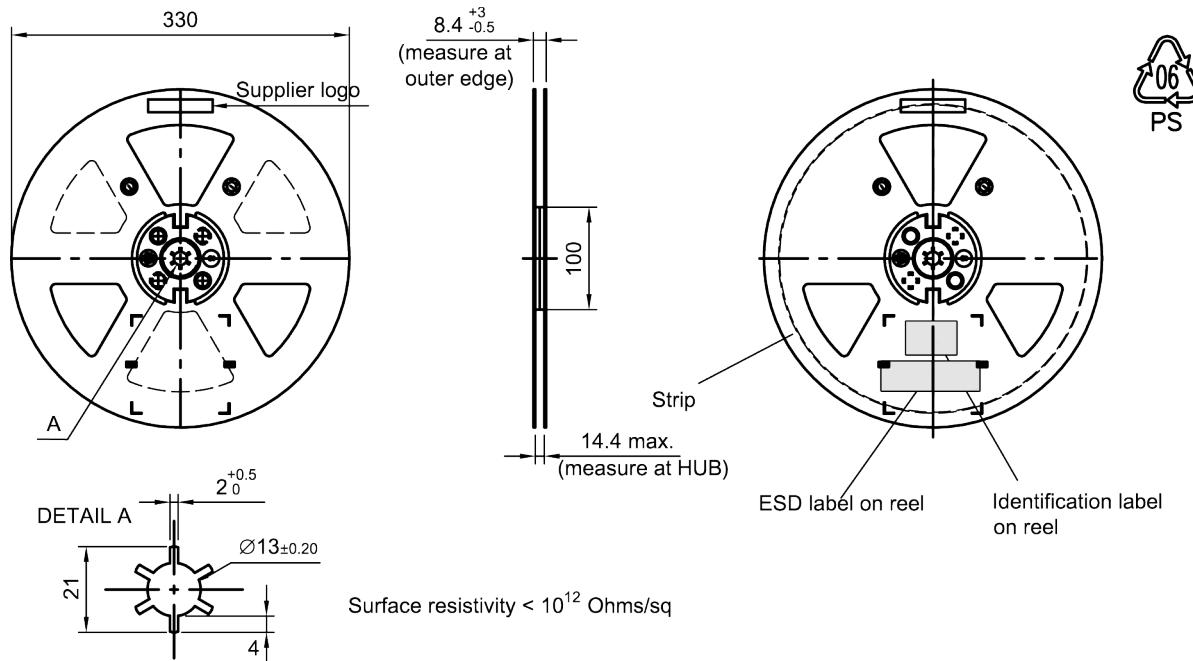
Figure 16: Drawing of reel (first-angle projection) with diameter of 330 mm.

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

Printing
on vacuumbag

Vacuumbag

Sealing area

Drypack
in vacuumbag

Identification label
on vacuumbag

Humidity indicator
in vaccumbag
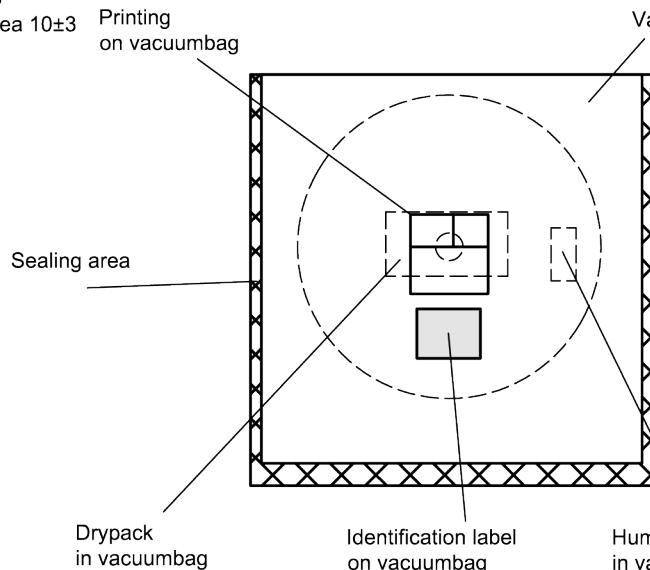
Figure 17: Drawing of moisture barrier bag (MBB) for reel with diameter of 330 mm.

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Dimensions [mm]
L = 335
B = 338
H = 36 (for 8 mm tape width)
     40 (for 12 mm tape width)
Tolerance ±5

2 pcs. ESD label
(around carton box)

Window for
customer label

Flat area of
moisture barrier bag
for customer label

Identification label
on carton box

In case of modules with
additional printing
for badge number
on the upper right side
on the top of the carton box.

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   **=>**   **1234**
          1 x 32^2 + **6** x 32^1 + **18 (=J)** x 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   **=>**   **12345**
          5 x 47^2 + **27 (=U)** x 47^1 + **31 (=Y)** x 47^0 **=**   **12345**

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Adopted BASE32 code for type number					**Adopted BASE47 code for lot number**			
Decimal value	Base32 code	Decimal value	Base32 code		Decimal value	Base47 code	Decimal value	Base47 code
0	0	16	G		0	0	24	R
1	1	17	H		1	1	25	S
2	2	18	J		2	2	26	T
3	3	19	K		3	3	27	U
4	4	20	M		4	4	28	V
5	5	21	N		5	5	29	W
6	6	22	P		6	6	30	X
7	7	23	Q		7	7	31	Y
8	8	24	R		8	8	32	Z
9	9	25	S		9	9	33	b
10	A	26	T		10	A	34	d
11	B	27	V		11	B	35	f
12	C	28	W		12	C	36	h
13	D	29	X		13	D	37	n
14	E	30	Y		14	E	38	r
15	F	31	Z		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.

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13   Soldering profile

The recommended soldering process is in accordance with IEC 60068-2-58 – 3rd 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
$T \geq 255$ °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).
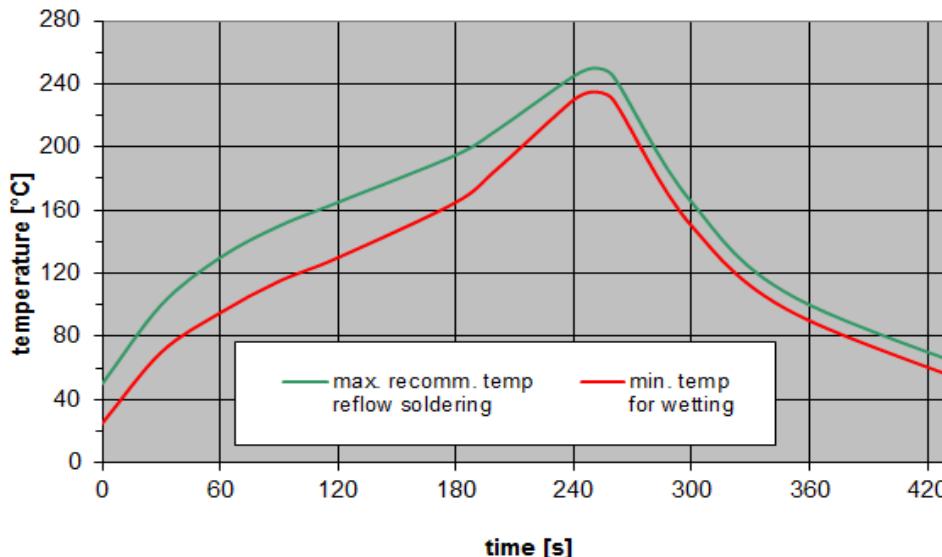
Figure 19: Recommended reflow profile for convection and infrared soldering – lead-free solder.

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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, α_{WCDMA}, is defined by

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

and

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

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

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

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.

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**.

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.

Please read **Cautions and warnings** and
Important notes at the end of this document.

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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). 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)**.

7. The trade names EPCOS, Alu-X, CeraDiode, CeraLink, CeraPad, CeraPlas, CSMP, CSSP, CTVS, DeltaCap, DigiSiMic, DSSP, ExoCore, FilterCap, FormFit, LeaXield, MiniBlue, MiniCell, MKD, MKK, MotorCap, PCC, PhaseCap, PhaseCube, PhaseMod, PhiCap, PQSine, SIFERRIT, SIFI, SIKOREL, SilverCap, SIMDAD, SiMic, SIMID, SineFormer, SIOV, SIP5D, SIP5K, TFAP, ThermoFuse, WindCap are **trademarks registered or pending** in Europe and in other countries. Further information will be found on the Internet at www.epcos.com/trademarks.