Qualcomm

RF360
Europe GmbH

Data sheet

SAW duplexer
Automotive telematics
LTE band 1

Part number:	B4441
Ordering code:	B39212B4441P810
Date:	June 25, 2020
Version:	2.0

DCN: 80-PA243-492 Rev. A

RF360 Europe GmbH, Anzinger Str. 13, München, Germany

Table of contents

1 Application

- LTE band 1 uplink:
  1950 MHz (pass band 60 MHz)
- LTE band 1 downlink:
  2140 MHz (pass band 60 MHz)
- Low-loss SAW duplexer for LTE Band 1 systems
- Low insertion attenuation
- Low amplitude ripple
- Terminating impedances 50 Ω

2 Features

- Package size $1.8_{\pm 0.1}$ mm × $1.4_{\pm 0.1}$ mm
- Package height 0.45 mm (max.)
- Approximate weight 4 mg
- RoHS compatible
- Package for Surface Mount Technology (SMT)
- Ni/Au-plated terminals
- Filter surface passivated
- Electrostatic Sensitive Device (ESD)
- Overmold demonstrated with RF360 specific mold process
- Moisture Sensitivity Level 2a (MSL2a)
- AEC-Q200 qualified component family
  (Grade 3: −40 °C to +85 °C)

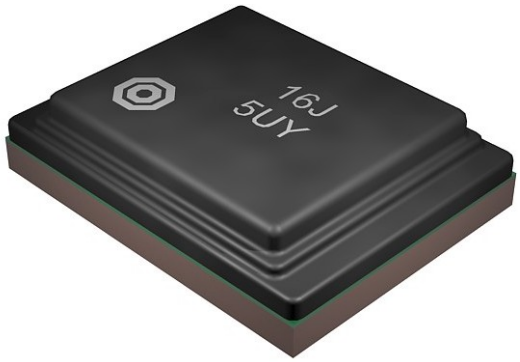

Figure 1: Picture of component with example of product marking.

3 Package

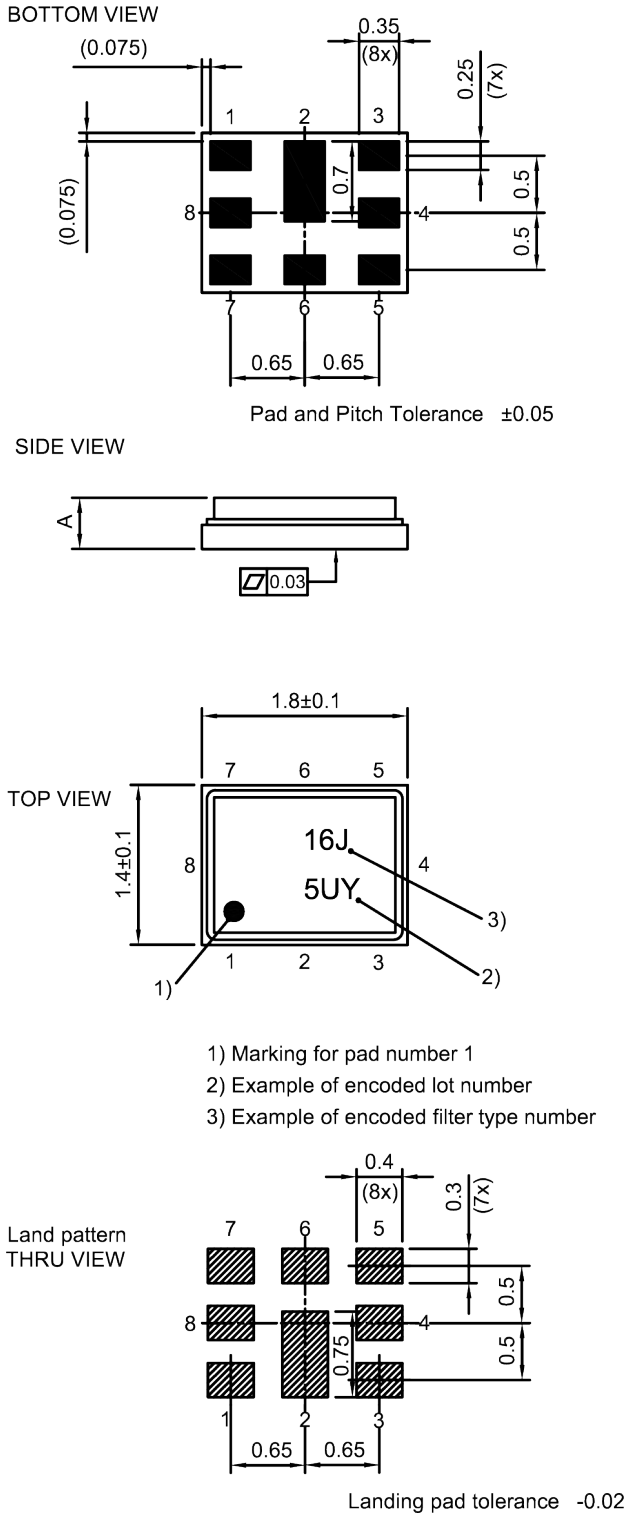

Figure 2: Drawing of package with package height A = 0.45 mm (max.). See Sec. Package information (p. 24).

4 Pin configuration

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

5 Matching circuit

- L_{p1} = 3.6 nH
- L_{p3} = 24 nH
- L_{p6} = 3.0 nH

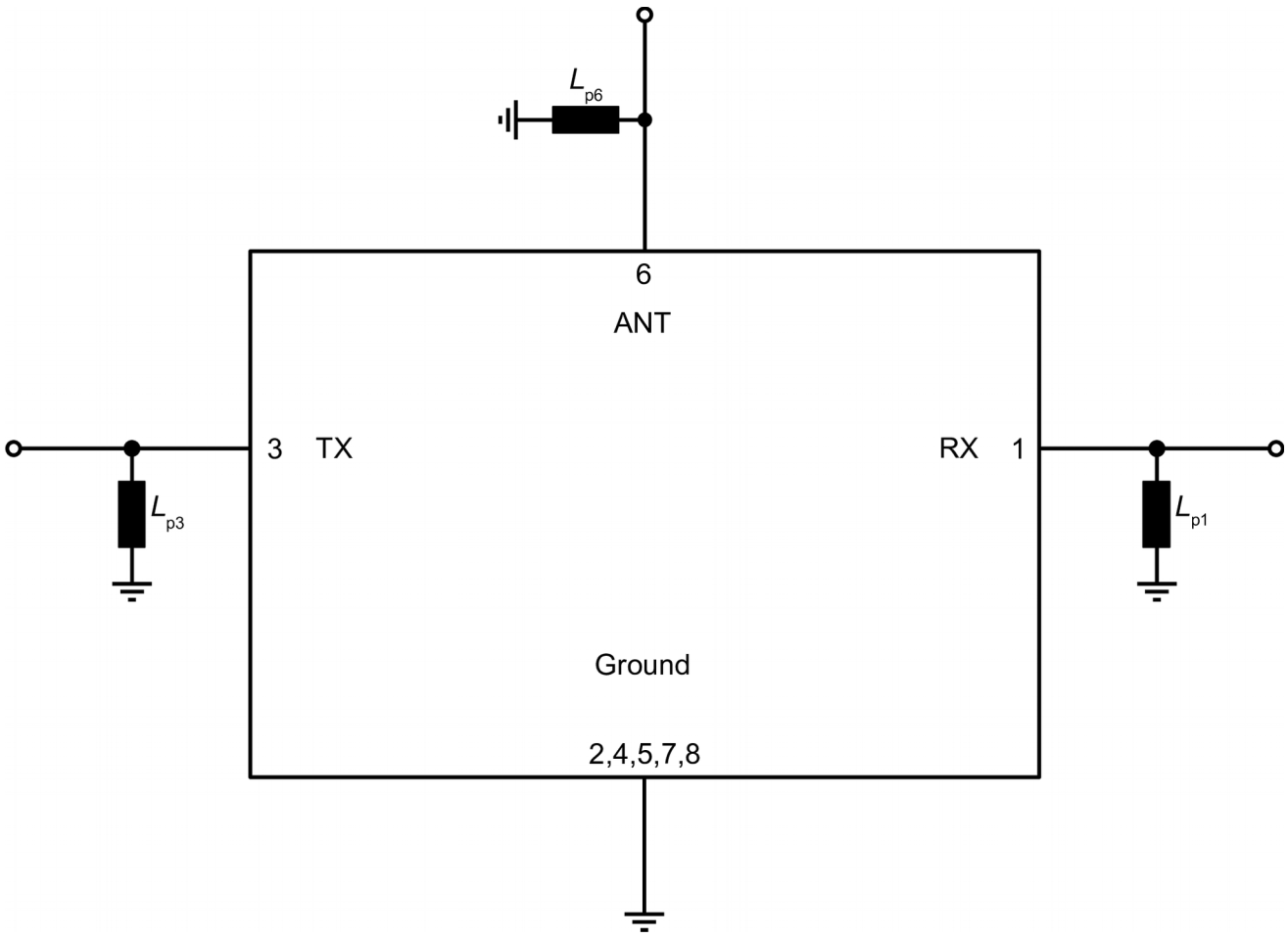

Figure 3: Schematic of matching circuit.

6 Characteristics

6.1 TX – ANT

Temperature range for specification T_{SPEC} = −30 °C ... +85 °C
TX terminating impedance Z_{TX} = 50 Ω // 24 nH[1)]
ANT terminating impedance Z_{ANT} = 50 Ω // 3.0 nH[1)]
RX terminating impedance Z_{RX} = 50 Ω // 3.6 nH[1)]

Characteristics TX – ANT				**min.** for T_{SPEC}	**typ.** @ +25 °C	**max.** for T_{SPEC}	
Center frequency			f_C	—	1950	—	MHz
Maximum insertion attenuation			α_{max}				
	1920 ... 1980	MHz		—	1.4	2.0	dB
Amplitude ripple (p-p)			$\Delta\alpha$				
	1920 ... 1980	MHz		—	0.5	1.2	dB
Maximum VSWR			$VSWR_{max}$				
@ TX port	1920 ... 1980	MHz		—	1.6	2.0	
@ ANT port	1920 ... 1980	MHz		—	1.5	2.0	
Maximum error vector magnitude			EVM_{max}[2)]				
	1920 ... 1980	MHz		—	0.6	3.0	%
Minimum attenuation			α_{min}				
	50 ... 1574	MHz		34	39	—	dB
	420 ... 494	MHz		50	55	—	dB
	815 ... 830	MHz		40	45	—	dB
	824 ... 849	MHz		40	44	—	dB
	843 ... 849	MHz		42	44	—	dB
	880 ... 915	MHz		38	43	—	dB
	925 ... 960	MHz		40	43	—	dB
	1226 ... 1250	MHz		38	40	—	dB
	1447.9 ... 1462.9	MHz		36	40	—	dB
	1475 ... 1496	MHz		38	40	—	dB
	1496 ... 1511	MHz		38	41	—	dB
	1559 ... 1563	MHz		40	42	—	dB
	1565.42 ... 1573.374	MHz		40	42	—	dB
	1573.374 ... 1577.466	MHz		40	43	—	dB
	1577.466 ... 1585.42	MHz		40	43	—	dB
	1597.551 ... 1605.886	MHz		41	44	—	dB
	1605.886 ... 1805	MHz		32	37	—	dB
	1805 ... 1865	MHz		32	34	—	dB
	1865 ... 1880	MHz		15	36	—	dB
	2010 ... 2025	MHz		15[3)]	30	—	dB
	2110 ... 2170	MHz		44	48	—	dB
	2400 ... 2500	MHz		33	36	—	dB
	2620 ... 2690	MHz		29	32	—	dB

Characteristics TX – ANT			min. for T_{SPEC}	typ. @ +25 °C	max. for T_{SPEC}	
	3840... 3960	MHz	20	22	—	dB
	4900... 5950	MHz	17	23	—	dB

1) See Sec. Matching circuit (p. 6).
2) Error Vector Magnitude (EVM) based on definition in 3GPP TS 25.141.
3) Valid for temperature T = +15 °C...+85 °C.

6.2 ANT – RX

Temperature range for specification	T_{SPEC}	= −30 °C ... +85 °C
TX terminating impedance	Z_{TX}	= 50 Ω // 24 nH[1)]
ANT terminating impedance	Z_{ANT}	= 50 Ω // 3.0 nH[1)]
RX terminating impedance	Z_{RX}	= 50 Ω // 3.6 nH[1)]

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 ... 2170	MHz		—	1.7	2.3	dB
Amplitude ripple (p-p)			$\Delta\alpha$				
	2110 ... 2170	MHz		—	0.4	1.0	dB
Maximum VSWR			$VSWR_{max}$				
@ ANT port	2110 ... 2170	MHz		—	1.4	2.0	
@ RX port	2110 ... 2170	MHz		—	1.4	2.0	
Minimum attenuation			α_{min}				
	50 ... 1920	MHz		46	50	—	dB
	718 ... 748	MHz		55	75	—	dB
	814 ... 849	MHz		55	71	—	dB
	880 ... 915	MHz		55	69	—	dB
	1427 ... 1447	MHz		45	60	—	dB
	1447 ... 1463	MHz		45	59	—	dB
	1710 ... 1785	MHz		50	60	—	dB
	1730 ... 1790	MHz		50	59	—	dB
	1920 ... 1980	MHz		44	48	—	dB
	1980 ... 2015	MHz		33	40	—	dB
	2015 ... 2050	MHz		30	43	—	dB
	2050 ... 2075	MHz		13	32	—	dB
	2400 ... 2500	MHz		40	47	—	dB
	2400 ... 6000	MHz		37	42	—	dB
	2500 ... 2570	MHz		40	46	—	dB
	4030 ... 4150	MHz		40	45	—	dB
	4220 ... 4340	MHz		40	45	—	dB
	4340 ... 6000	MHz		30	43	—	dB
	4900 ... 5950	MHz		40	43	—	dB

[1)] See Sec. Matching circuit (p. 6).

6.3 TX – RX

Temperature range for specification	T_{SPEC}	= −30 °C ... +85 °C
TX terminating impedance	Z_{TX}	= 50 Ω // 24 nH[1)]
ANT terminating impedance	Z_{ANT}	= 50 Ω // 3.0 nH[1)]
RX terminating impedance	Z_{RX}	= 50 Ω // 3.6 nH[1)]

Characteristics TX – RX			**min.** for T_{SPEC}	**typ.** @ +25 °C	**max.** for T_{SPEC}	
Minimum isolation	α_{min}					
	1574 ... 1577	MHz	50	60	—	dB
	1920.25 ... 1962	MHz	53	58	—	dB
	1962 ... 1979.75	MHz	50	53	—	dB
	2110.25 ... 2169.75	MHz	53	57	—	dB
	3830 ... 3970	MHz	40	54	—	dB
	5750 ... 5950	MHz	40	50	—	dB

1) See Sec. Matching circuit (p. 6).

7 Maximum ratings

Operable temperature	T_{OP} = −40 °C ... +85 °C	
Storage temperature	T_{STG} [1)] = −40 °C ... +85 °C	
DC voltage	$\lvert V_{DC} \rvert$ [2)] = 0 V (max.)	
Input power @ TX port: 1920.25 ... 1979.75 MHz	P_{IN} = 28 dBm	Continuous wave for 5000 h @ 50 °C.

1) Not valid for packaging material. Storage temperature for packaging material is −25 °C to +40 °C.
2) In case of applied DC voltage blocking capacitors are mandatory.

8 Transmission coefficients

8.1 TX – ANT

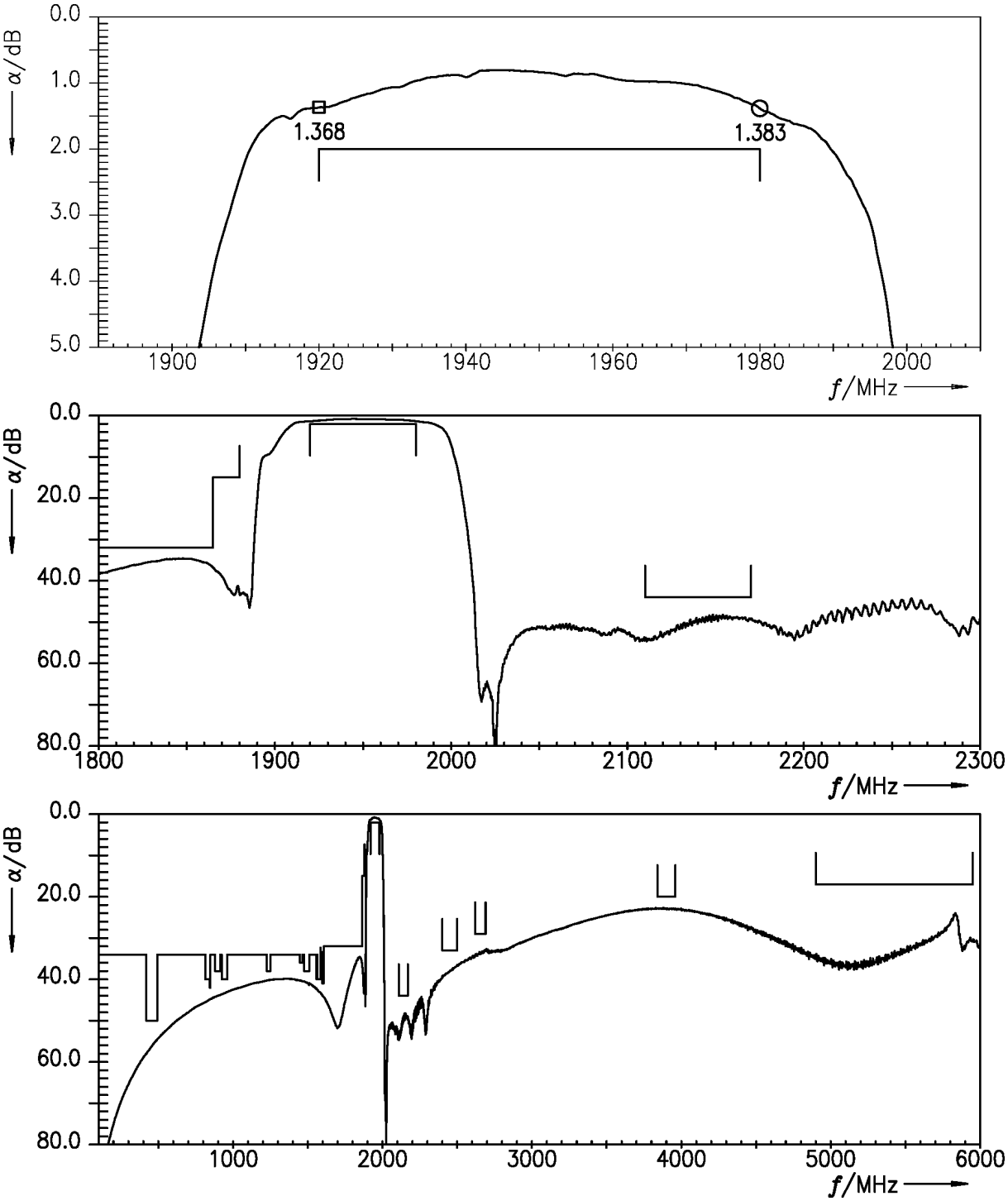

Figure 4: Attenuation TX – ANT.

8.2 ANT – RX

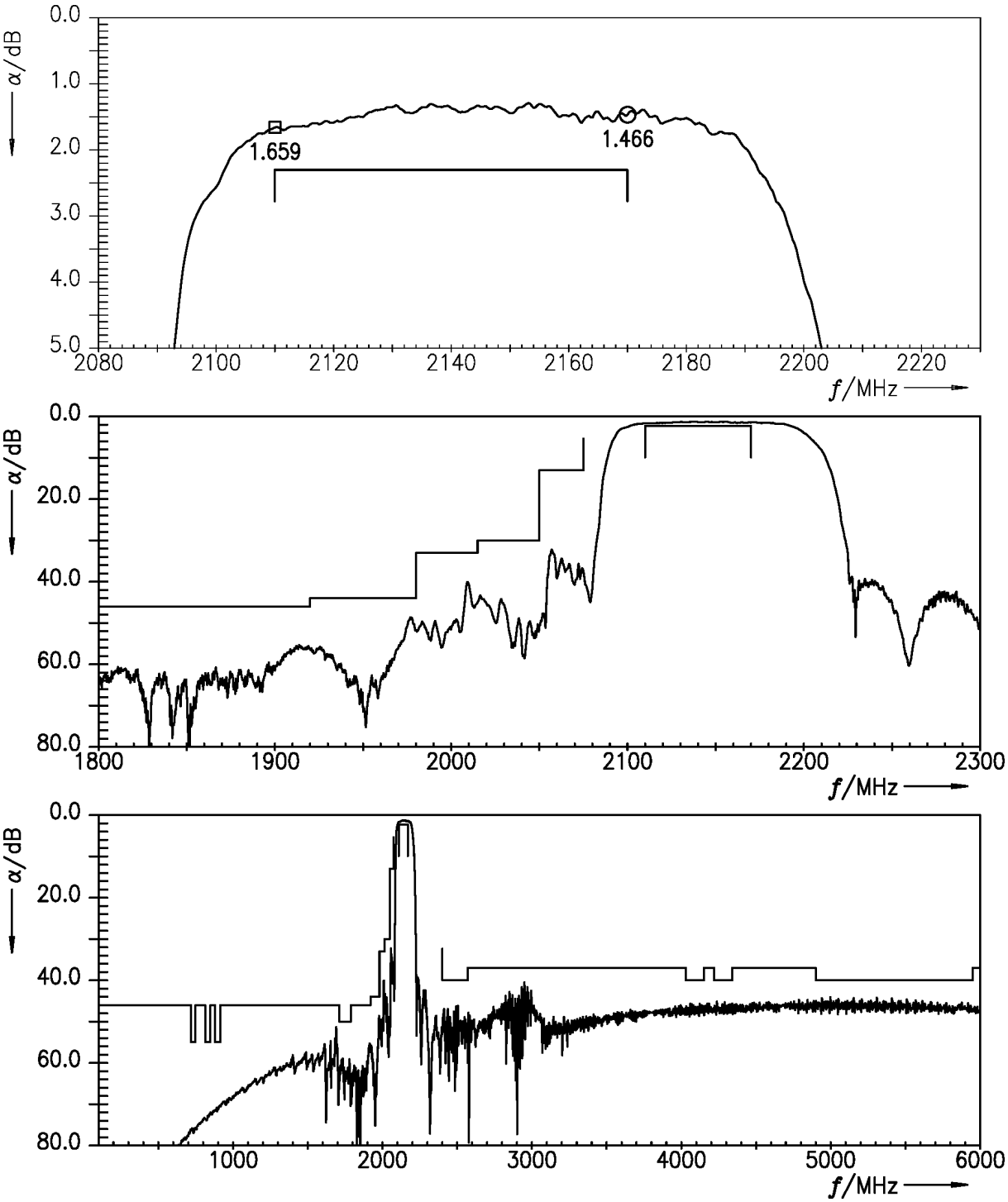

Figure 5: Attenuation ANT – RX.

8.3 TX – RX

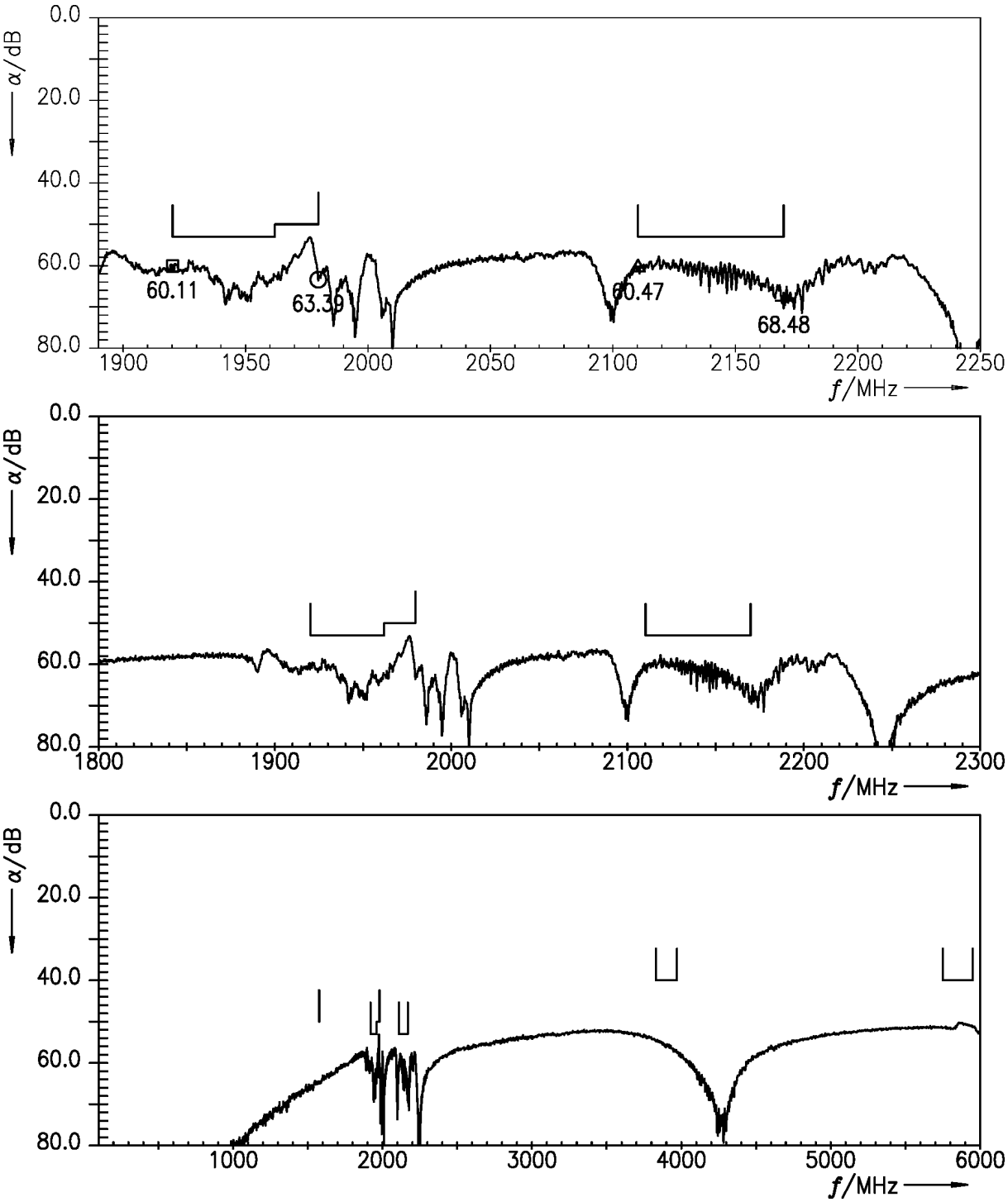

Figure 6: Isolation TX – RX.

9 Reflection coefficients

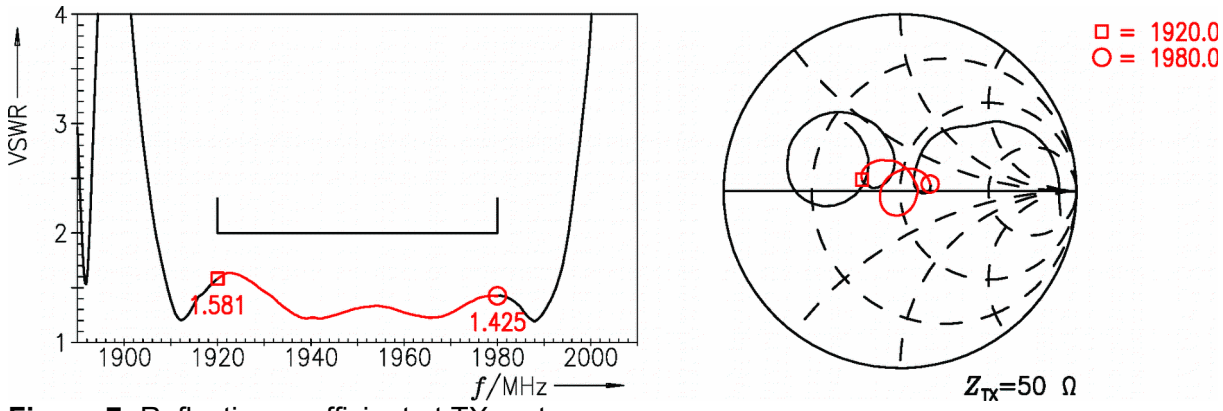

Figure 7: Reflection coefficient at TX port.

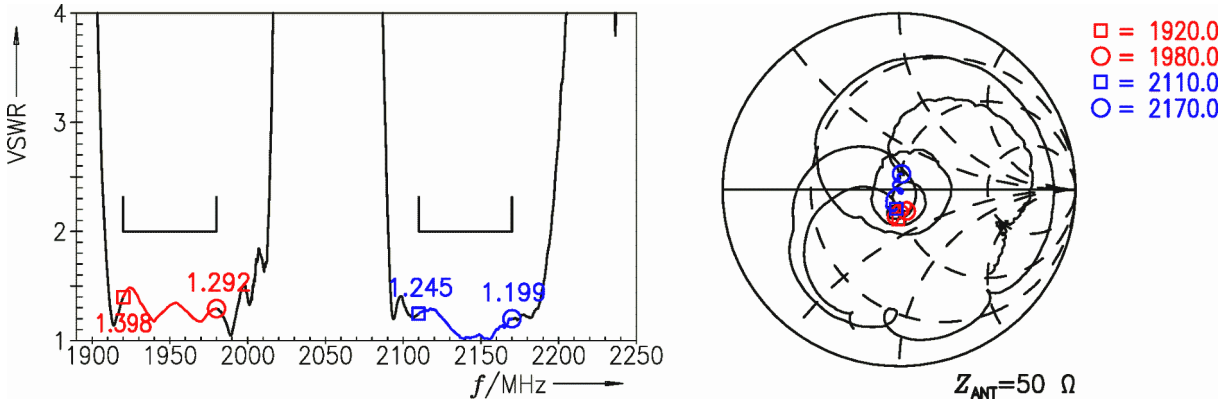

Figure 8: Reflection coefficient at ANT port.

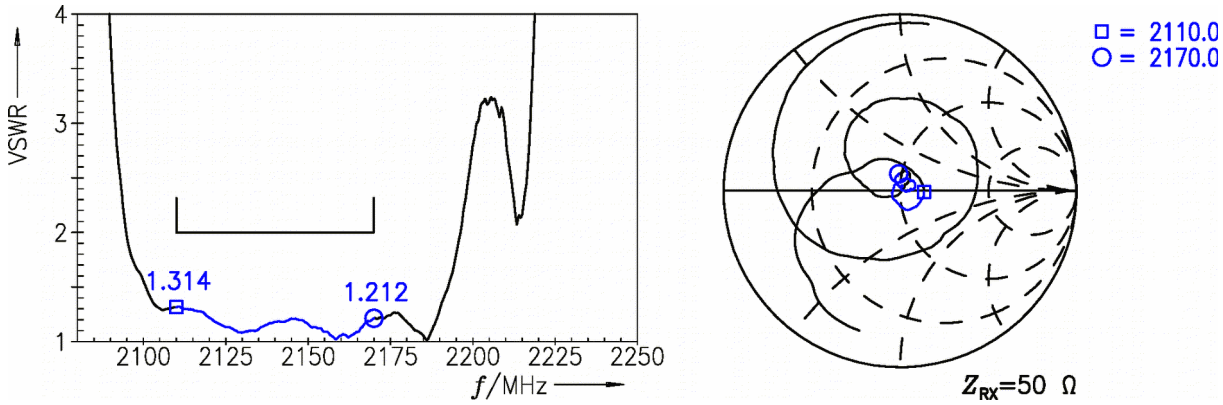

Figure 9: Reflection coefficient at RX port.

10 EVM

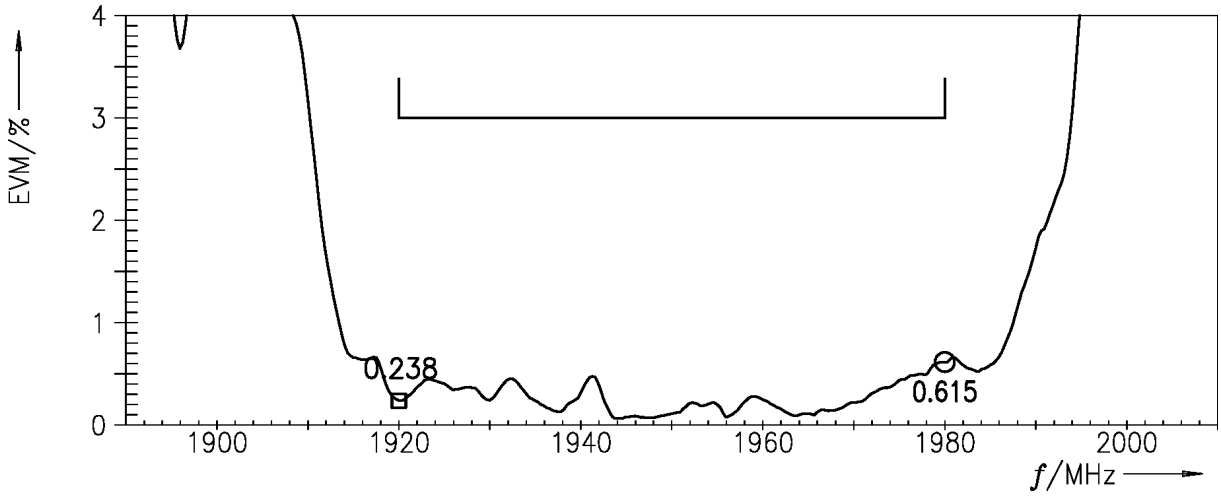

Figure 10: Error vector magnitude TX – ANT.

11 Packing material

11.1 Tape

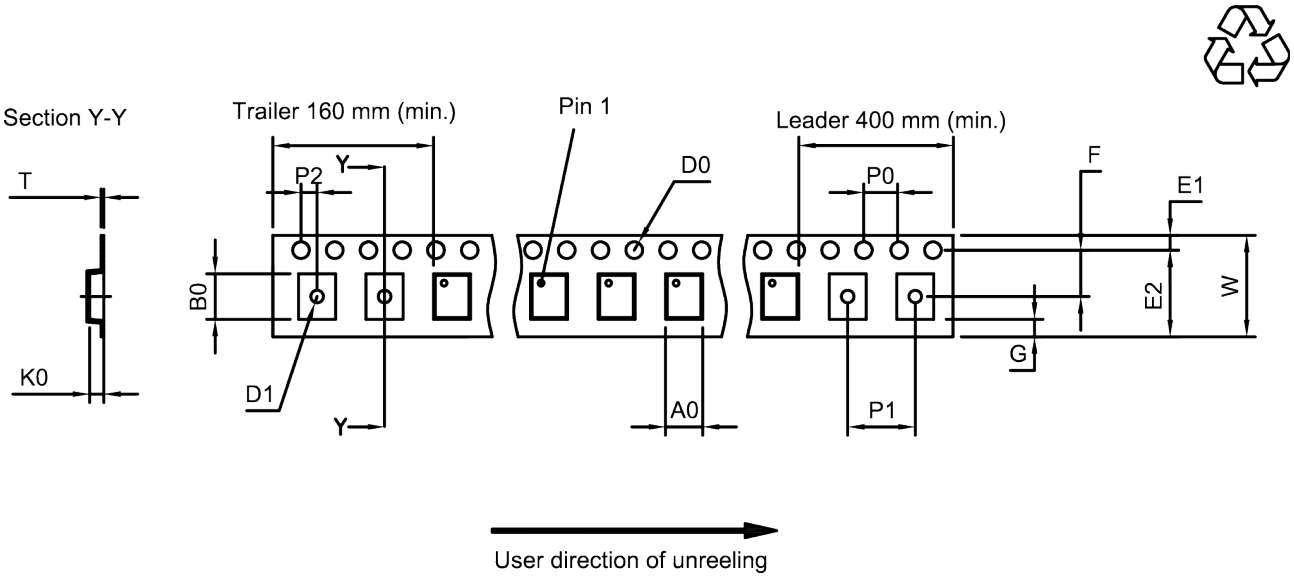

Figure 11: Drawing of tape (first-angle projection) for illustration only and not to scale. The valid tape dimensions are listed in Table 1.

A_0	$1.6_{\pm 0.05}$ mm
B_0	$2.0_{\pm 0.05}$ mm
D_0	$1.5^{+0.1/-0}$ mm
D_1	$0.8^{+0.1/-0}$ mm
E_1	$1.75_{\pm 0.1}$ mm

E_2	6.25 mm (min.)
F	$3.5_{\pm 0.05}$ mm
G	0.75 mm (min.)
K_0	$0.64_{\pm 0.05}$ mm
P_0	$4.0_{\pm 0.1}$ mm

P_1	$4.0_{\pm 0.1}$ mm
P_2	$2.0_{\pm 0.05}$ mm
T	$0.25_{\pm 0.03}$ mm
W	$8.0^{+0.3/-0.1}$ mm

Table 1: Tape dimensions.

11.2 Reel with diameter of 180 mm

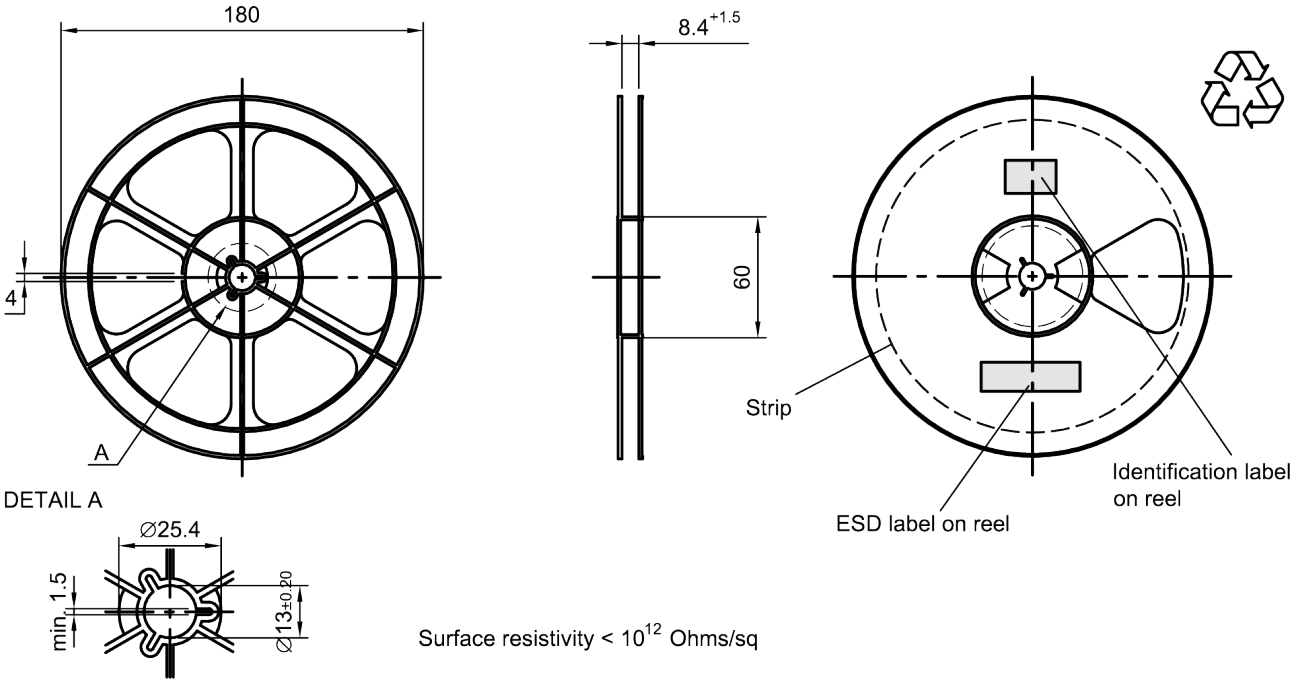

Figure 12: Drawing of reel (first-angle projection) with diameter of 180 mm.

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

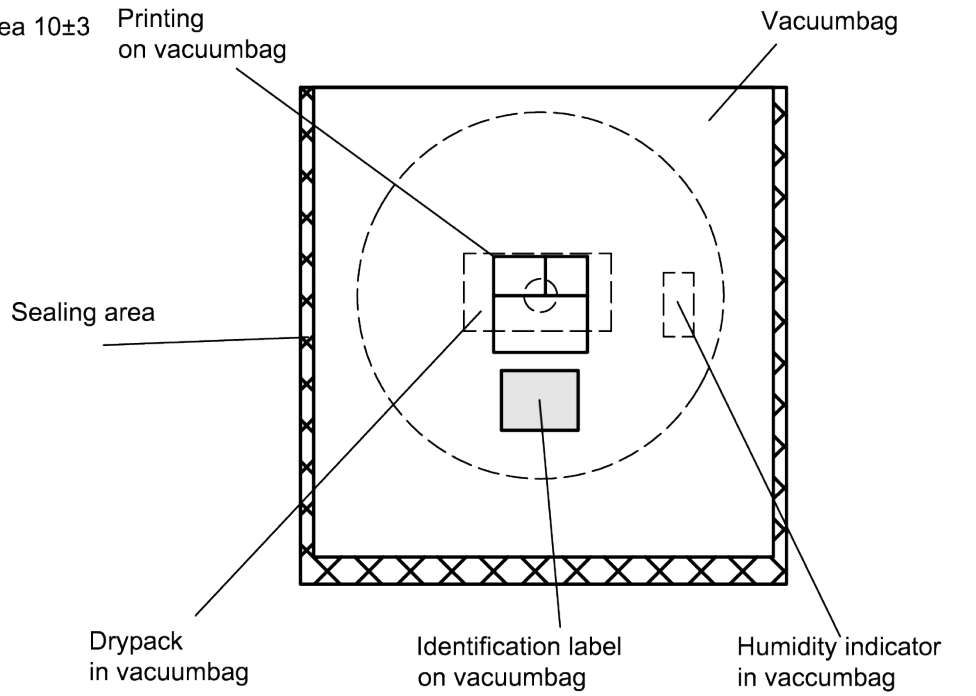

Figure 13: Drawing of moisture barrier bag (MBB) for reel with diameter of 180 mm.

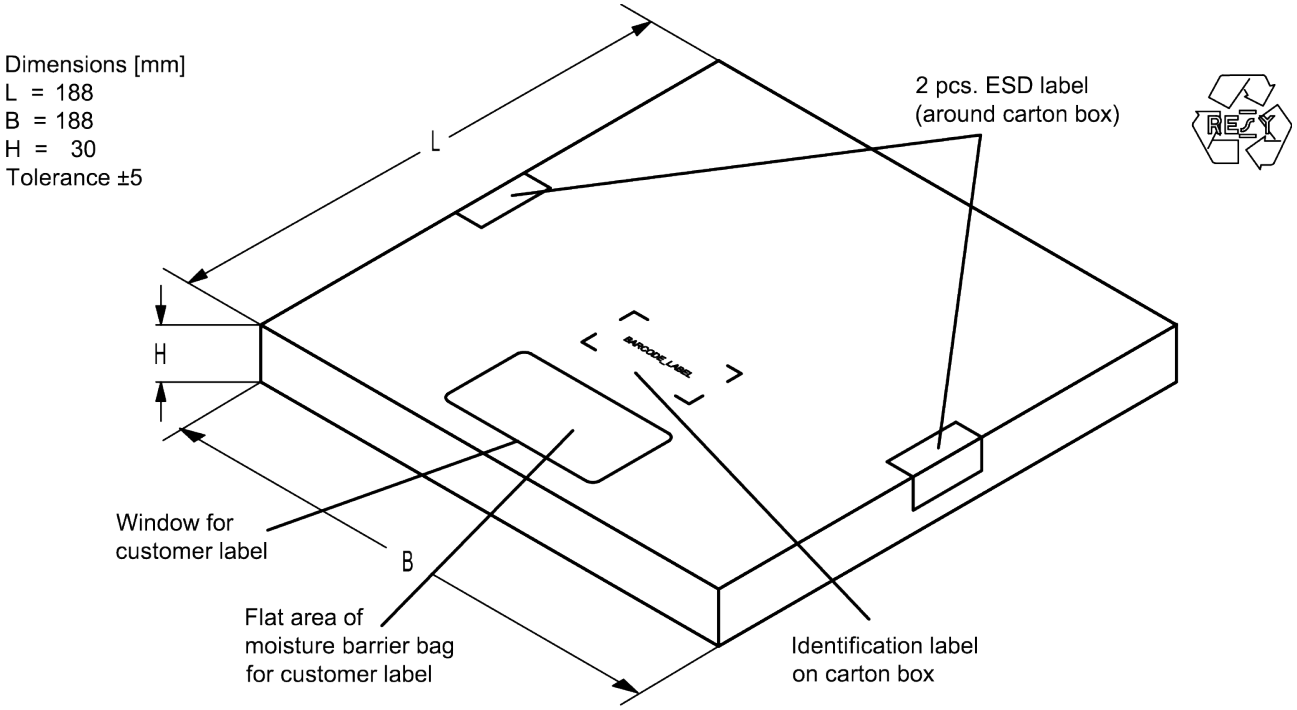

Figure 14: Drawing of folding box for reel with diameter of 180 mm.

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 B4441 is 4AS.

- 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**

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.

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 ≥ 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).

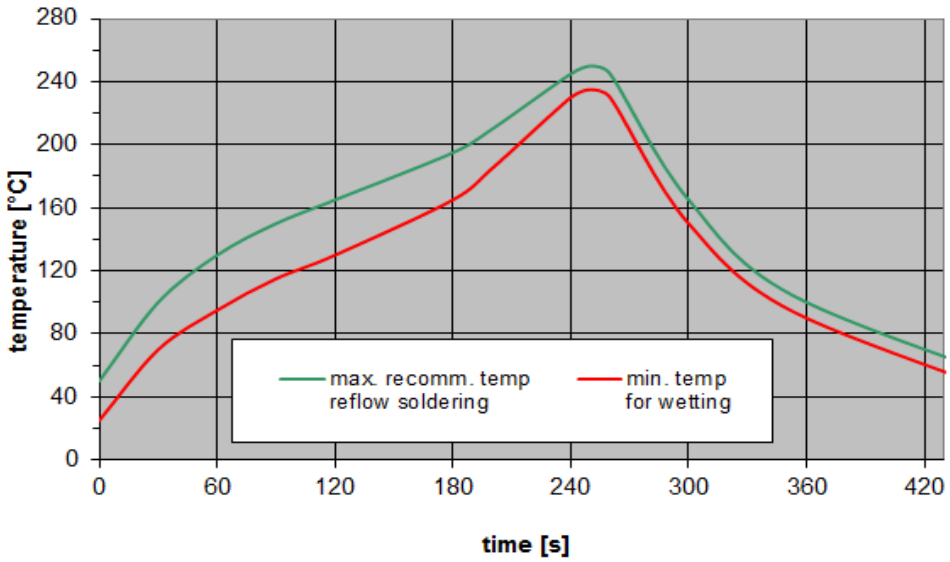

Figure 15: Recommended reflow profile for convection and infrared soldering – lead-free solder.

14 ESD protection of SAW filters

SAW filters are **E**lectro **S**tatic **D**ischarge sensitive devices. To reduce the probability of damages caused by ESD, special matching topologies have to be applied.

In general, “ESD matching” has to be ensured at that filter port, where electrostatic discharge is expected.

Electrostatic discharges predominantly appear at the antenna input of RF receivers. Therefore, only the input matching of the SAW filter has to be designed to short circuit or to block the ESD pulse.

Below three figures show recommended “ESD matching” topologies.

For wide band filters the high-pass ESD matching structure needs to be at least of 3rd order to ensure a proper matching for any impedance value of antenna and SAW filter input. The required component values have to be determined from case to case.

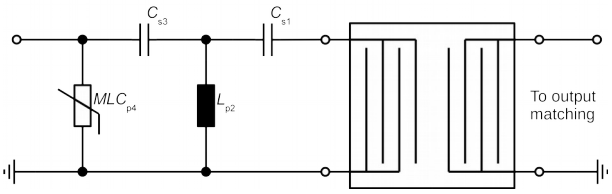

Figure 16: MLC varistor plus ESD matching.

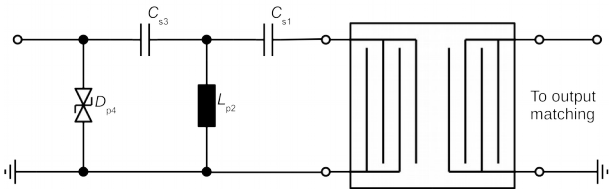

Figure 17: Suppressor diode plus ESD matching.

In cases where minor ESD occur, following simplified “ESD matching” topologies can be used alternatively.

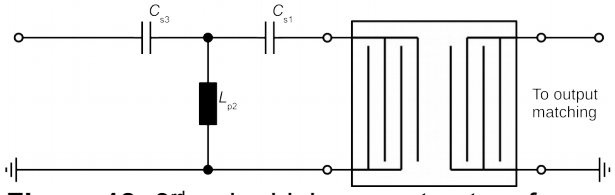

Figure 18: 3rd order high-pass structure for basic ESD protection.

In all three figures the shunt inductor L_{p2} could be replaced by a shorted microstrip with proper length and width. If this configuration is possible depends on the operating frequency and available PCB space.

Effectiveness of the applied ESD protection has to be checked according to relevant industry standards or customer specific requirements.

For further information, please refer to RF360 Application report: **“ESD protection for SAW filters”.** This report can be found under https://rffe.qualcomm.com.

15 Annotations

15.1 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.

15.2 Scattering parameters (S-parameters)

The pin/port assignment is available in the headers of the S-parameter files. Please contact your local RF360 sales office.

16 Cautions and warnings

16.1 Display of ordering codes for RF360 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 RF360, 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 https://rffe.qualcomm.com/.

16.2 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.

For information on recycling of tapes and reels please contact one of our sales offices.

16.3 Moldability

Before using in overmolding environment, please contact your local RF360 sales office.

16.4 Package information

Landing area

The printed circuit board (PCB) land pattern (landing area) shown is based on RF360 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 RF360, 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).

Dimensions do not include burrs.

Projection method

Unless otherwise specified first-angle projection is applied.

17 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, RF360 Europe GmbH and its affiliates are 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 RF360 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 (https://rffe.qualcomm.com). 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.