Qualcomm

RF360
Europe GmbH

Data sheet

SAW 2in1 Rx input diplex filter

GPS L1 + GPS L2 & L5

Part number:	B9973
Ordering code:	B39162B9973P810
Date:	September 08, 2020
Version:	2.0

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Table of contents

1 Application

- Low-loss 2in1 diplexer for GPS L1/BeiDou/GLONASS and L2/L5/BDS B2
- Usable pass bands:
- Filter 1: 8.4 MHz for L2, 4.1 MHz for B2 and 20.46 MHz for L5
- Filter 2: 2.0 MHz for L1, 4.092 MHz for BeiDou and 8.34 MHz for GLONASS
- Low amplitude ripple

2 Features

- Package size 1.5$_{\pm 0.1}$ mm × 1.1$_{\pm 0.1}$ mm
- Package height 0.45 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)

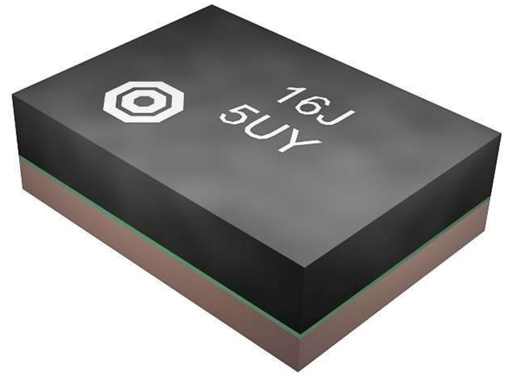

Figure 1: Picture of component with example of product marking.

3 Package

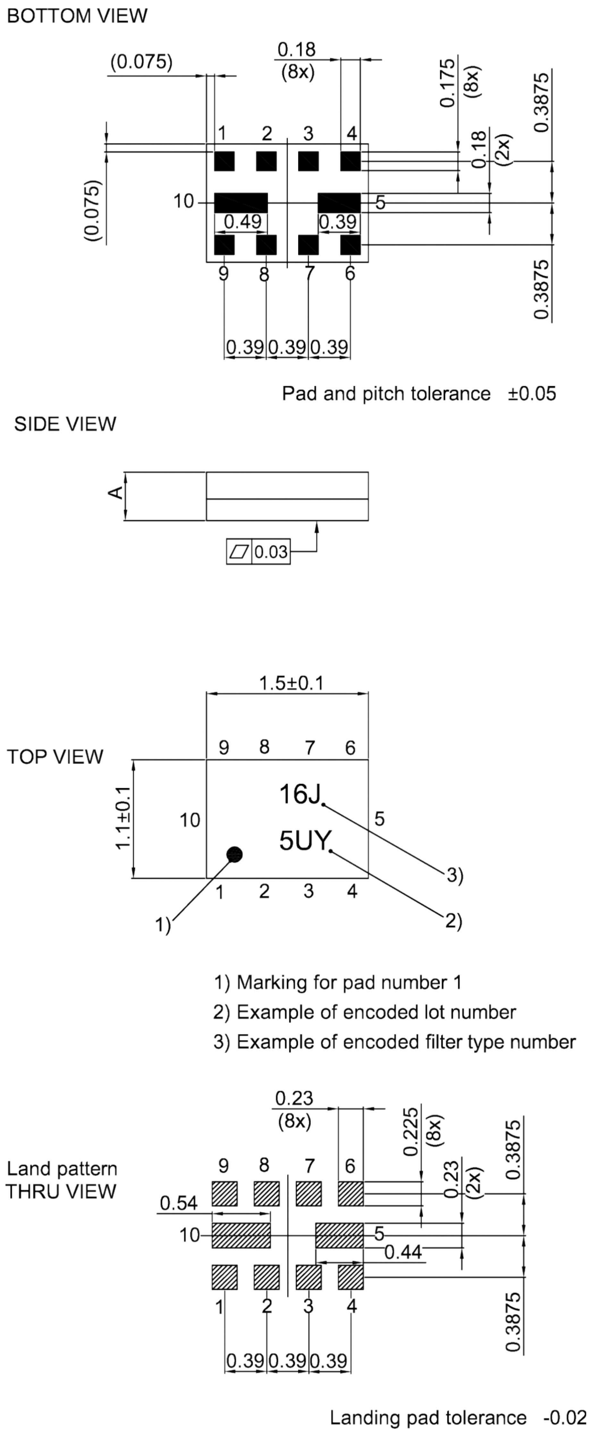

Figure 2: Drawing of package with package height A = 0.45 mm (max.). See Sec. Package information (p. 26).

4 Pin configuration

- 1 — Input (L1, L2, & L5)
- 6 — Output (L2 & L5)
- 9 — Output (L1)
- 2, 3, 4, 5, 7, 8, 10 — Ground

5 Matching circuit

- L_{p1} = 4.0 nH
- L_{p6} = 7.5 nH

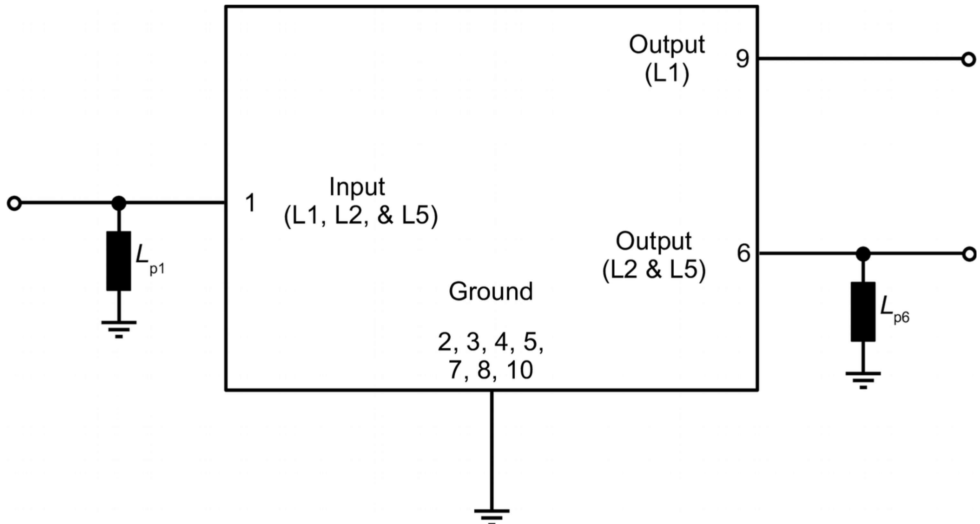

Figure 3: Schematic of matching circuit.

6 Characteristics GPS L1

Temperature range for specification	T_{SPEC}	= −40 °C ... +85 °C
Input terminating impedance	Z_{IN}	= 50 Ω // 4.0 nH[1)]
L1 output terminating impedance	$Z_{L1\ OUT}$	= 50 Ω
L2 L5 output terminating impedance	$Z_{L2\ L5\ OUT}$	= 50 Ω // 7.5 nH[1)]

Characteristics GPS L1			**min.** for T_{SPEC}	**typ.** @ +25 °C	**max.** for T_{SPEC}	
Center frequency		f_C	—	1582.47	—	MHz
Maximum insertion attenuation		α_{max}				
ANT – BeiDou	1559.052 ... 1563.144 MHz		—	1.5	2.0	dB
ANT – GPS L1	1574.42 ... 1576.42 MHz		—	1.2	1.7	dB
ANT – GLONASS	1597.55 ... 1605.89 MHz		—	1.5	2.0	dB
Amplitude ripple (p-p)		$\Delta\alpha$				
	1559.052 ... 1563.144 MHz		—	0.1	0.8	dB
	1574.42 ... 1576.42 MHz		—	0.1	0.4	dB
	1597.55 ... 1605.89 MHz		—	0.1	0.8	dB
Maximum group delay		t_{max}				
	1559.052 ... 1563.144 MHz		—	18	28	ns
	1574.42 ... 1576.42 MHz		—	14	20	ns
	1597.55 ... 1605.89 MHz		—	16	23	ns
Group delay ripple		Dt_{var}				
	1559.052 ... 1563.144 MHz		—	3	11	ns
	1574.42 ... 1576.42 MHz		—	1	6	ns
	1597.55 ... 1605.89 MHz		—	3	9	ns
Maximum VSWR		$VSWR_{max}$				
@ input port	1559.052 ... 1563.144 MHz		—	1.6	2.0	
	1574.42 ... 1576.42 MHz		—	1.4	2.0	
	1597.55 ... 1605.89 MHz		—	1.3	1.8	
@ L1 output port	1559.052 ... 1563.144 MHz		—	1.6	2.0	
	1574.42 ... 1576.42 MHz		—	1.3	2.0	
	1597.55 ... 1605.89 MHz		—	1.4	1.8	
Minimum attenuation		α_{min}				
	50 ... 1330 MHz		40	49	—	dB
	1463 ... 1511 MHz		28	36	—	dB
	1660 ... 2000 MHz		33	39	—	dB
	2000 ... 2300 MHz		35	40	—	dB
	2300 ... 2483 MHz		35	39	—	dB
	2496 ... 2690 MHz		33	37	—	dB
	3400 ... 3800 MHz		26	32	—	dB
	4400 ... 4600 MHz		25	31	—	dB
	4600 ... 4900 MHz		20	31	—	dB
	5000 ... 6000 MHz		20	30	—	dB

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

7 Characteristics GPS L2 & L5

Temperature range for specification	T_{SPEC}	= −40 °C ... +85 °C
Input terminating impedance	Z_{IN}	= 50 Ω // 4.0 nH[1)]
L1 output terminating impedance	$Z_{L1\ OUT}$	= 50 Ω
L2 L5 output terminating impedance	$Z_{L2\ L5\ OUT}$	= 50 Ω // 7.5 nH[1)]

Characteristics GPS L2 & L5				min. for T_{SPEC}	typ. @ +25 °C	max. for T_{SPEC}	
Center frequency			f_C	—	1199.11	—	MHz
Maximum insertion attenuation			α_{max}				
ANT – GPS L5	1166.22... 1186.68	MHz		—	1.3	2.1	dB
ANT – BDS B2	1205.09... 1209.19	MHz		—	1.2	2.0	dB
ANT – GPS L2C	1223.6... 1232	MHz		—	1.7	3.0	dB
ANT – GPS L2	1226.58... 1228.62	MHz		—	1.6	2.1	dB
Amplitude ripple (p-p)			Δα				
	1166.22... 1186.68	MHz		—	0.3	1.1	dB
	1205.09... 1209.19	MHz		—	0.3	0.6	dB
	1223.6... 1232	MHz		—	0.3	1.7	dB
	1226.58... 1228.62	MHz		—	0.2	0.8	dB
Maximum group delay			t_{max}				
	1166.22... 1186.68	MHz		—	27	53	ns
	1205.09... 1209.19	MHz		—	15	25	ns
	1223.6... 1232	MHz		—	18	39	ns
	1226.58... 1228.62	MHz		—	17	29	ns
Group delay ripple			Dt_{var}				
	1166.22... 1186.68	MHz		—	14	35	ns
	1205.09... 1209.19	MHz		—	5	12	ns
	1223.6... 1232	MHz		—	5	23	ns
	1226.58... 1228.62	MHz		—	4	13	ns
Maximum VSWR			$VSWR_{max}$				
@ input port	1166.22... 1186.68	MHz		—	1.6	2.0	
	1205.09... 1209.19	MHz		—	1.4	2.0	
	1223.6... 1232	MHz		—	1.6	2.0	
	1226.58... 1228.62	MHz		—	1.5	2.0	
@ L2 L5 output port	1166.22... 1186.68	MHz		—	1.6	2.0	
	1205.09... 1209.19	MHz		—	1.3	2.0	
	1223.6... 1232	MHz		—	1.6	2.0	
	1226.58... 1228.62	MHz		—	1.6	2.0	
Minimum attenuation			α_{min}				
	50... 500	MHz		45	66	—	dB
	500... 1100	MHz		25	36	—	dB
	1320... 2000	MHz		25	30	—	dB
	2300... 2400	MHz		30	39	—	dB

Characteristics GPS L2 & L5			min. for T_{SPEC}	typ. @ +25 °C	max. for T_{SPEC}	
	2400... 2483	MHz	30	39	—	dB
	2500... 2690	MHz	30	40	—	dB
	3400... 3800	MHz	30	41	—	dB
	5000... 6000	MHz	20	30	—	dB

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

8 Characteristics GPS L2 & L5 – GPS L1

Temperature range for specification	T_{SPEC}	= −40 °C ... +85 °C
Input terminating impedance	Z_{IN}	= 50 Ω // 4.0 nH[1)]
L1 output terminating impedance	$Z_{L1\ OUT}$	= 50 Ω
L2 L5 output terminating impedance	$Z_{L2\ L5\ OUT}$	= 50 Ω // 7.5 nH[1)]

Characteristics GPS L2 & L5 – GPS L1 output – output			**min.** for T_{SPEC}	**typ.** @ +25 °C	**max.** for T_{SPEC}	
Minimum isolation		α_{min}				
	1166.22 ... 1186.68	MHz	42	51	—	dB
	1205.09 ... 1209.19	MHz	50	62	—	dB
	1223.6 ... 1232	MHz	45	56	—	dB
	1226.58 ... 1228.62	MHz	45	57	—	dB
	1559.052 ... 1563.144	MHz	35	45	—	dB
	1574.42 ... 1576.42	MHz	35	41	—	dB
	1597.55 ... 1605.89	MHz	35	41	—	dB

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

9 Maximum ratings

Operable temperature	T_{OP} = −40 °C ... +85 °C	
Storage temperature	T_{STG} [1] = −40 °C ... +85 °C	
DC voltage	$\|V_{DC}\|$ [2] = 0 V	
ESD voltage		
	V_{ESD} [3] = 150 V	Machine model.
	V_{ESD} [4] = 250 V	Human body model.
Input power	P_{IN}	
@ input port: 1205.09 ... 1232 MHz	15 dBm [5), 6)]	Continuous wave for 5000 h @ 55 °C.
@ input port: 1559.052 ... 1605.89 MHz	15 dBm [5), 6)]	Continuous wave for 5000 h @ 55 °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.
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) Expected lifetime according to accelerated power durability simulation and wear out models.
6) TSPEC is the ambient temperature of the PCB at component position. Specified min./max values from section 6 "characteristics" for maximum input power 15dBm are valid for temperature up to 83°C.

10 Transmission coefficient GPS L1

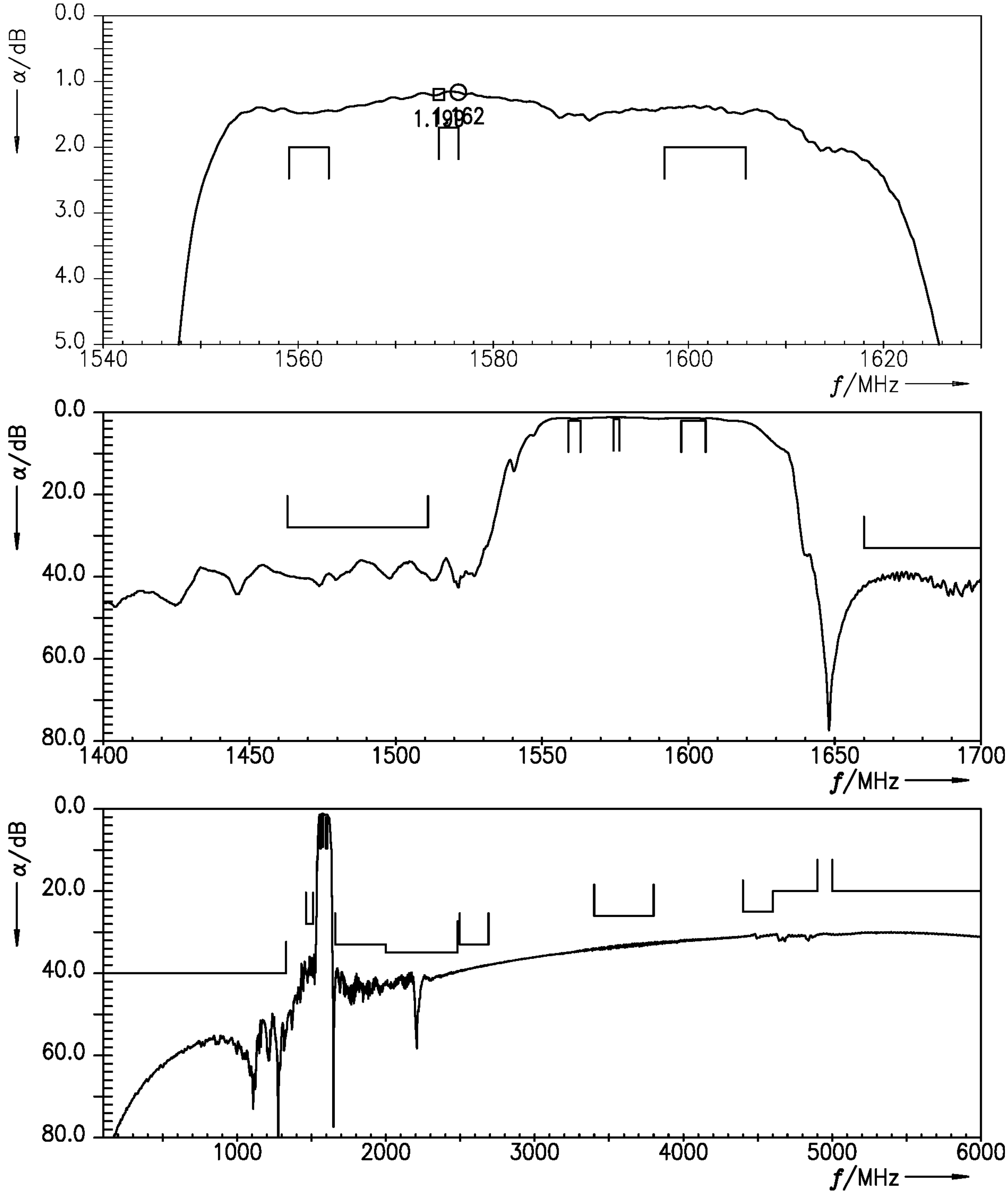

Figure 4: Attenuation GPS L1.

11 Reflection coefficients GPS L1

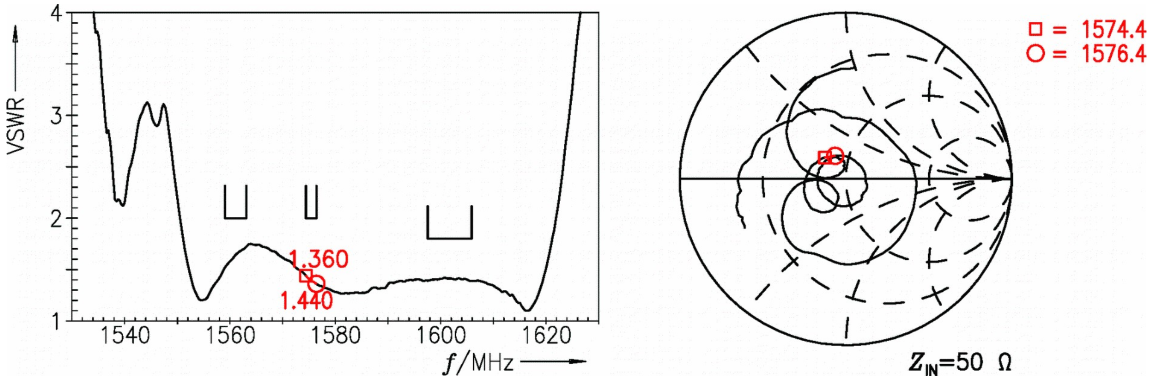

Figure 5: Reflection coefficient at input port.

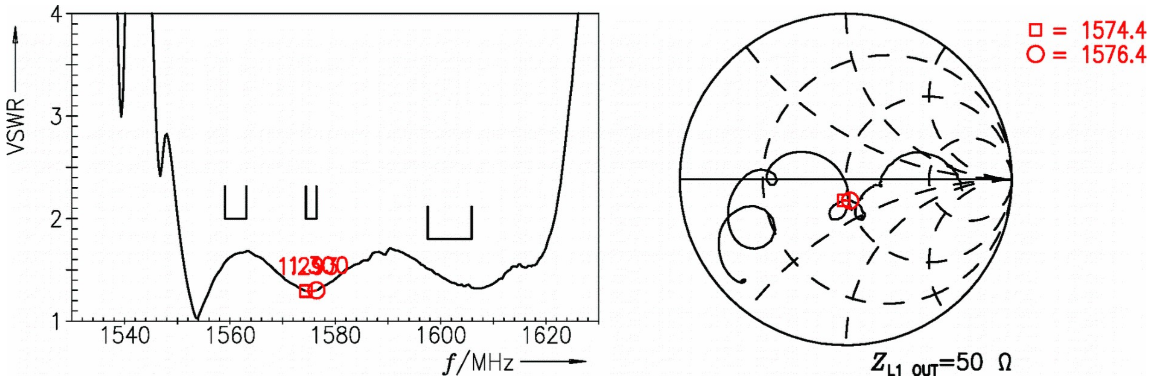

Figure 6: Reflection coefficient at L1 OUT port.

12 Group delay GPS L1

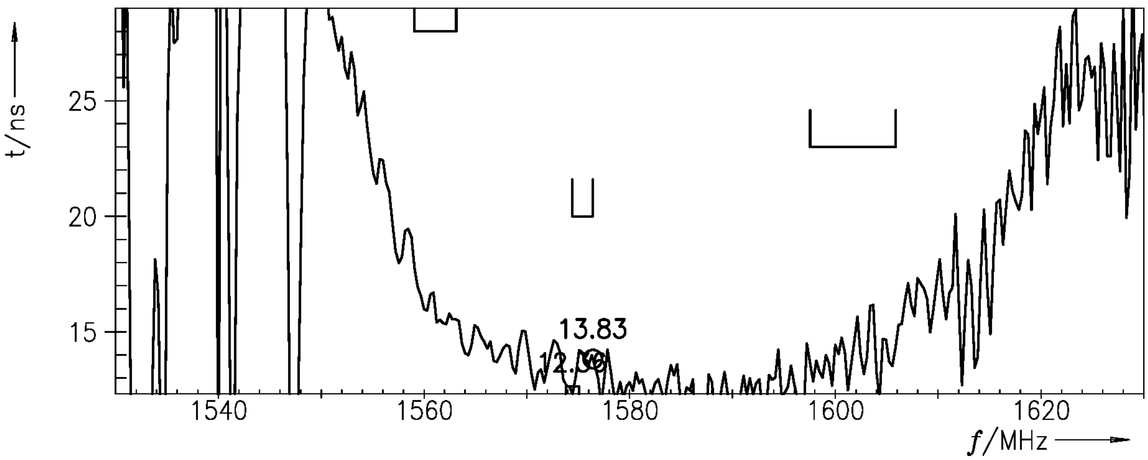

Figure 7: Group delay GPS L1.

13 Transmission coefficient GPS L2 & L5

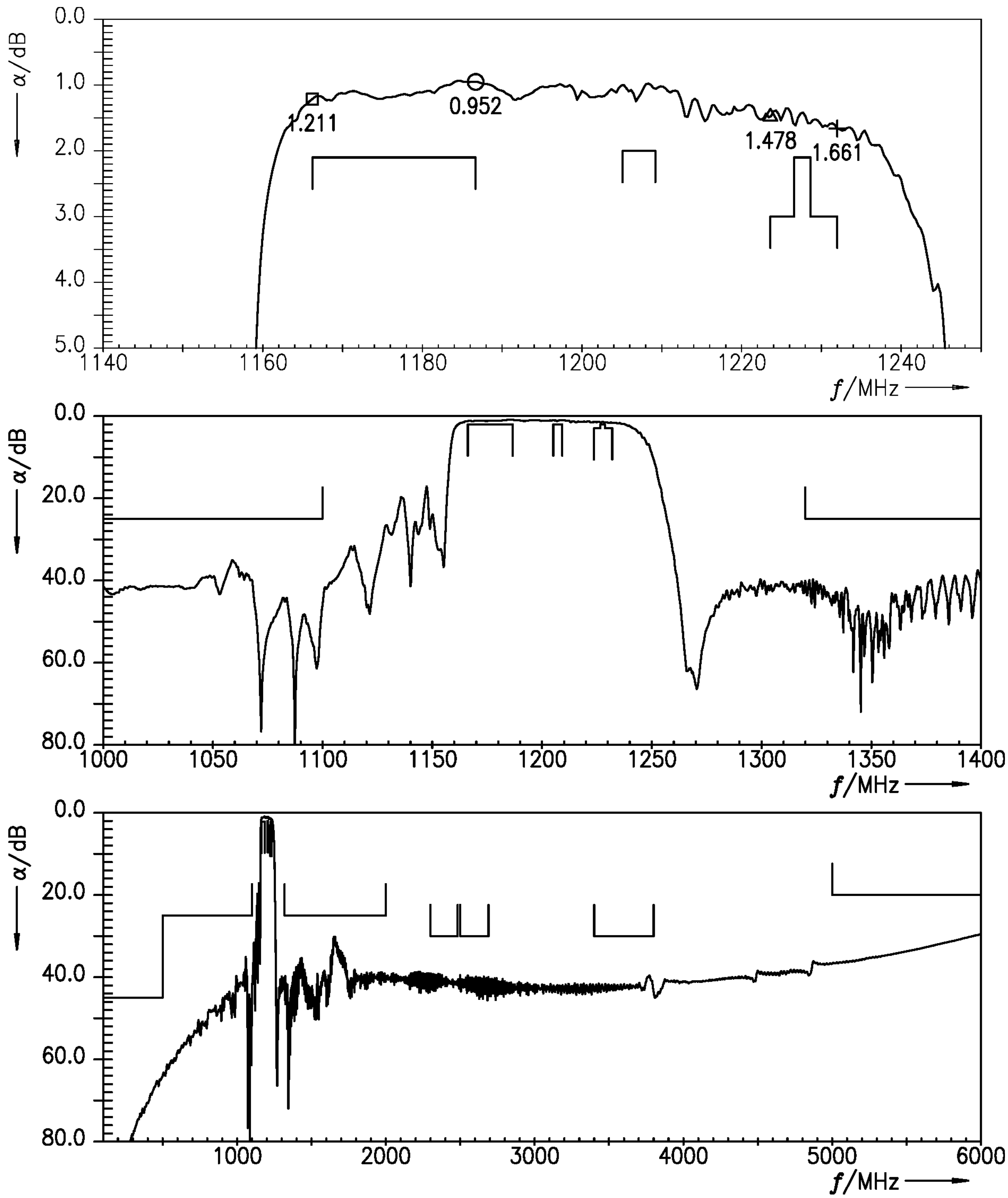

Figure 8: Attenuation GPS L2 & L5.

14 Reflection coefficients GPS L2 & L5

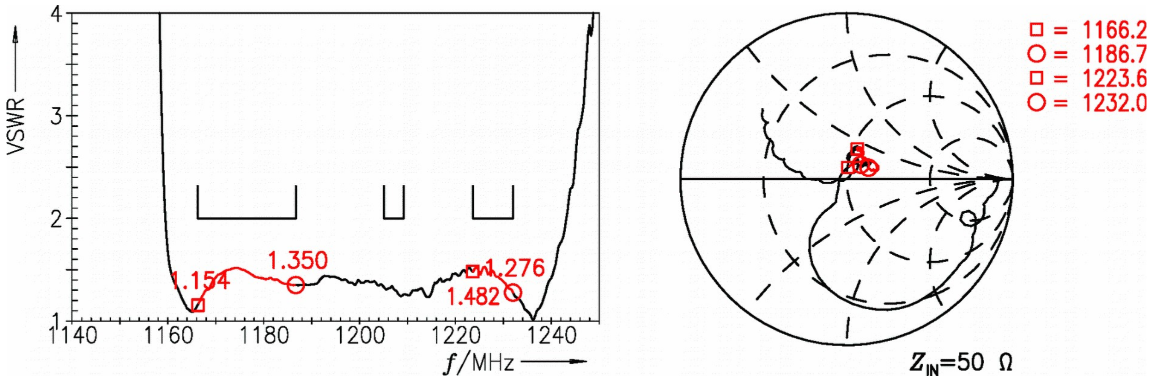

Figure 9: Reflection coefficient at input port.

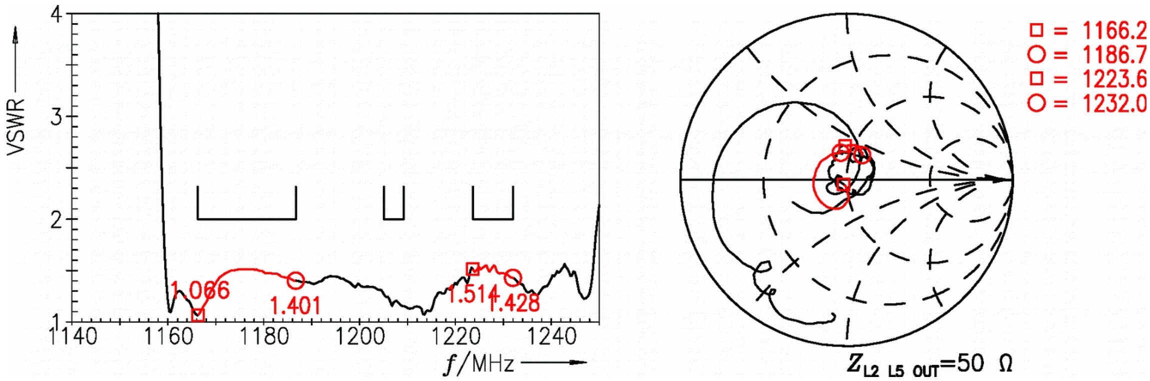

Figure 10: Reflection coefficient at L2 L5 OUT port.

15 Group delay GPS L2 & L5

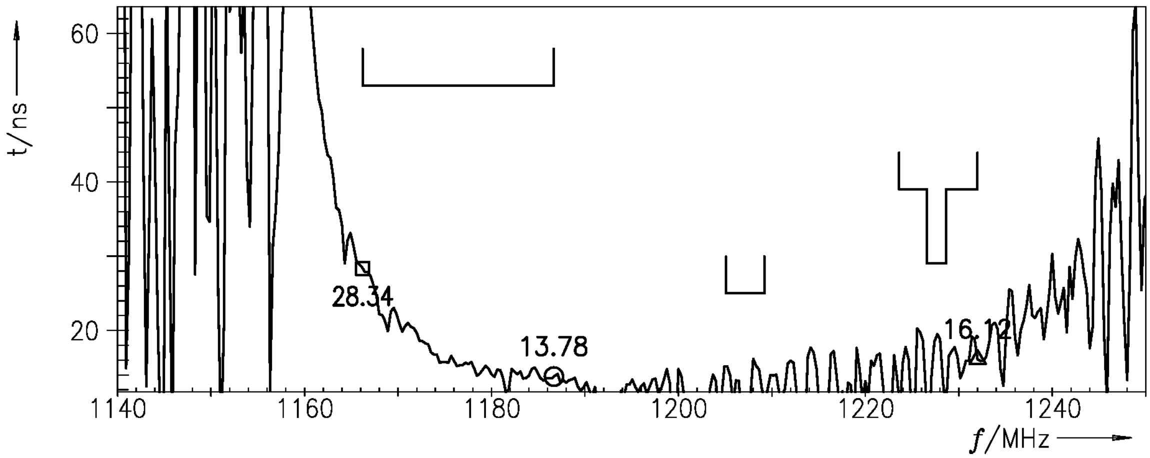

Figure 11: Group delay GPS L2 & L5.

16 Transmission coefficient GPS L2 & L5 – GPS L1

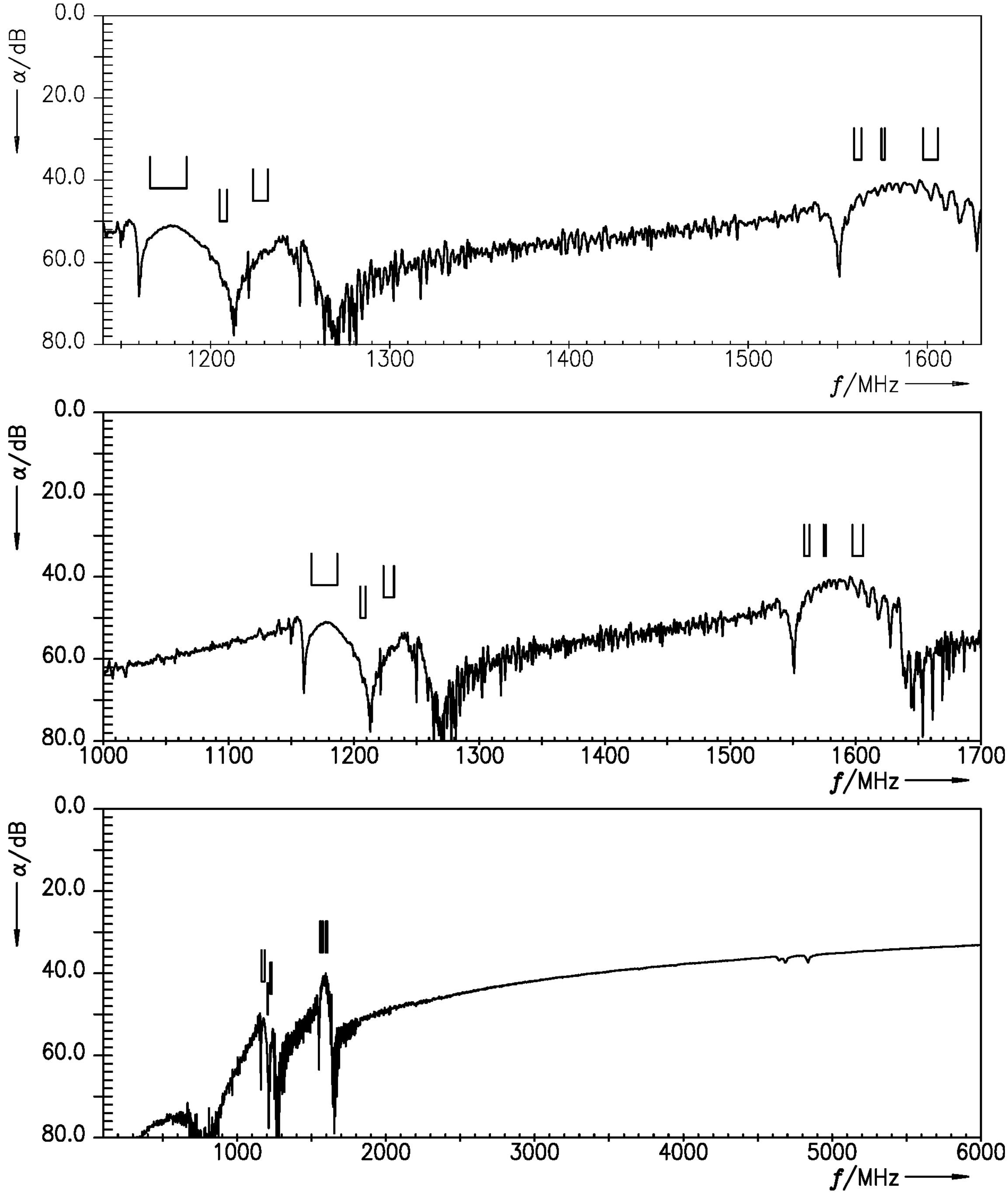

Figure 12: Isolation output – output.

17 Packing material

17.1 Tape

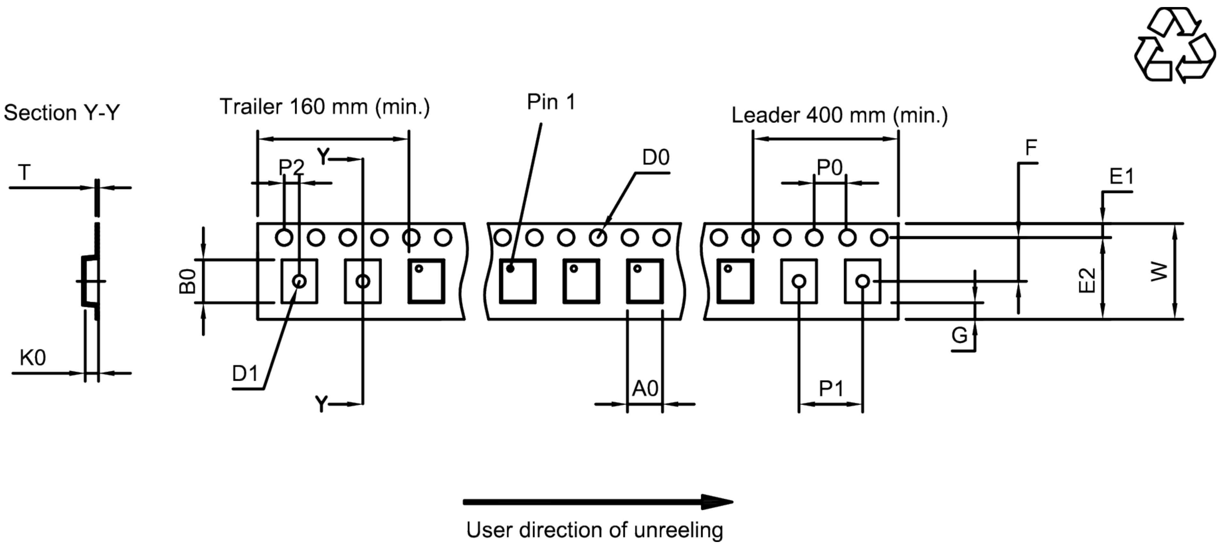

Figure 13: Drawing of tape (first-angle projection) for illustration only and not to scale. The valid tape dimensions are listed in Table 1.

A_0	$1.27_{\pm 0.05}$ mm	E_2	6.25 mm (min.)	P_1	$4.0_{\pm 0.1}$ mm
B_0	$1.67_{\pm 0.05}$ mm	F	$3.5_{\pm 0.05}$ mm	P_2	$2.0_{\pm 0.05}$ mm
D_0	$1.5_{+0.1/-0}$ mm	G	0.75 mm (min.)	T	$0.25_{\pm 0.03}$ mm
D_1	$0.5_{+0.1/-0}$ mm	K_0	$0.55_{\pm 0.05}$ mm	W	$8.0_{+0.3/-0.1}$ mm
E_1	$1.75_{\pm 0.1}$ mm	P_0	$4.0_{\pm 0.1}$ mm		

Table 1: Tape dimensions.

17.2 Reel with diameter of 180 mm

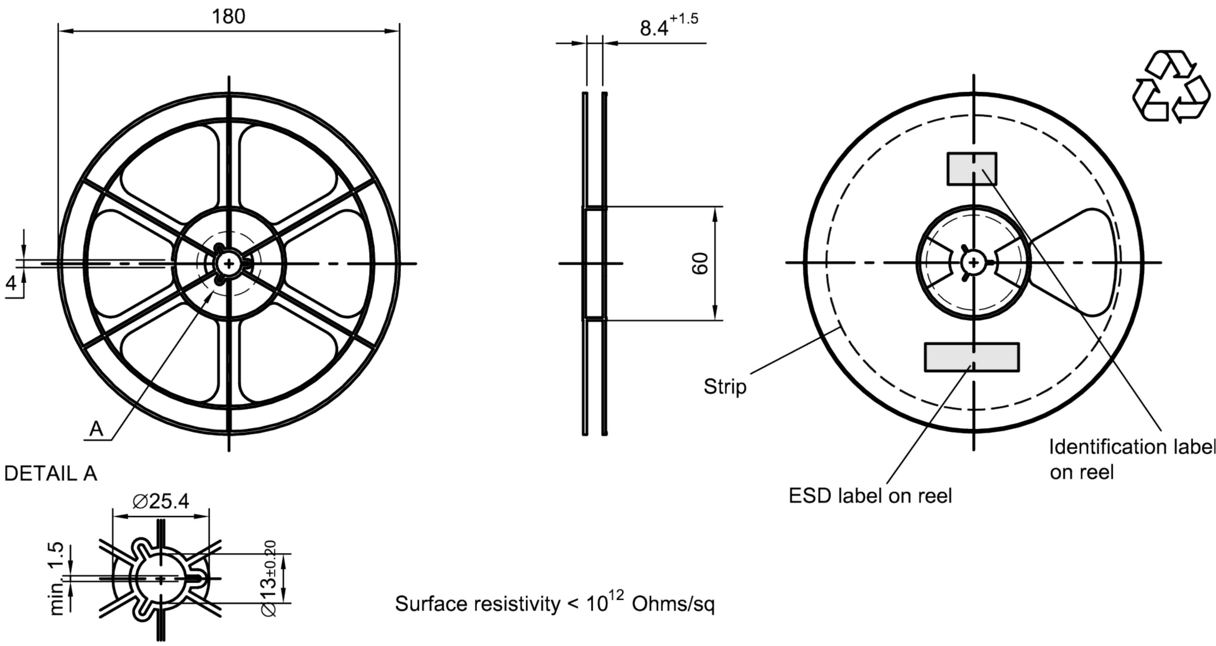

Figure 14: Drawing of reel (first-angle projection) with diameter of 180 mm.

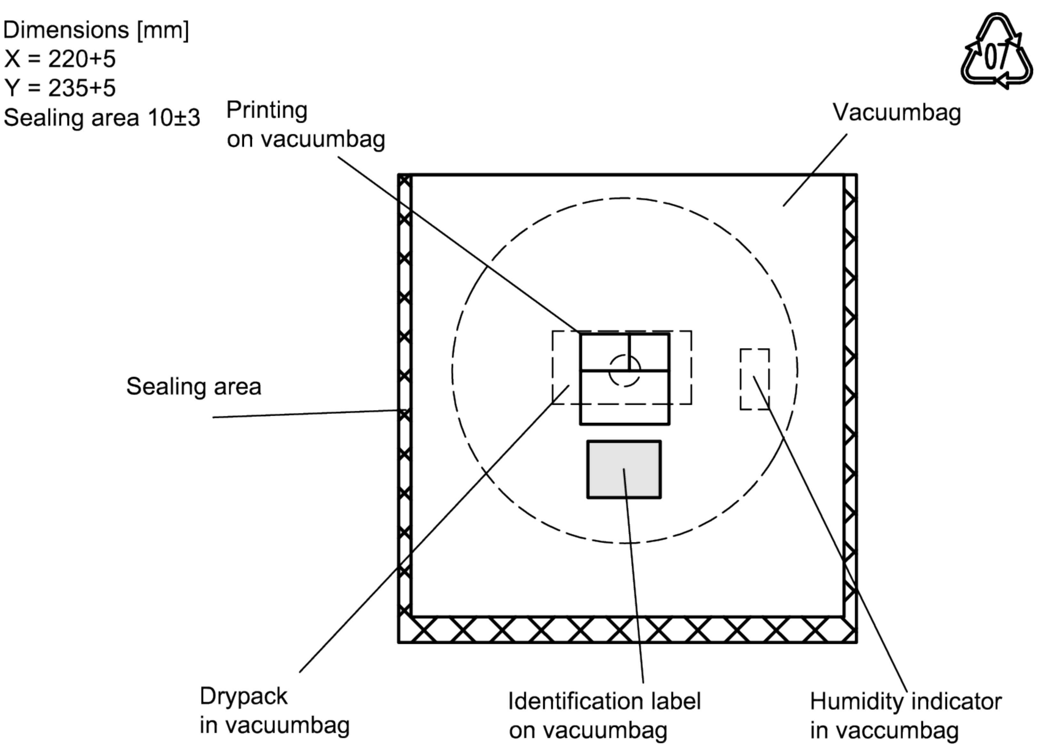

Figure 15: Drawing of moisture barrier bag (MBB) for reel with diameter of 180 mm.

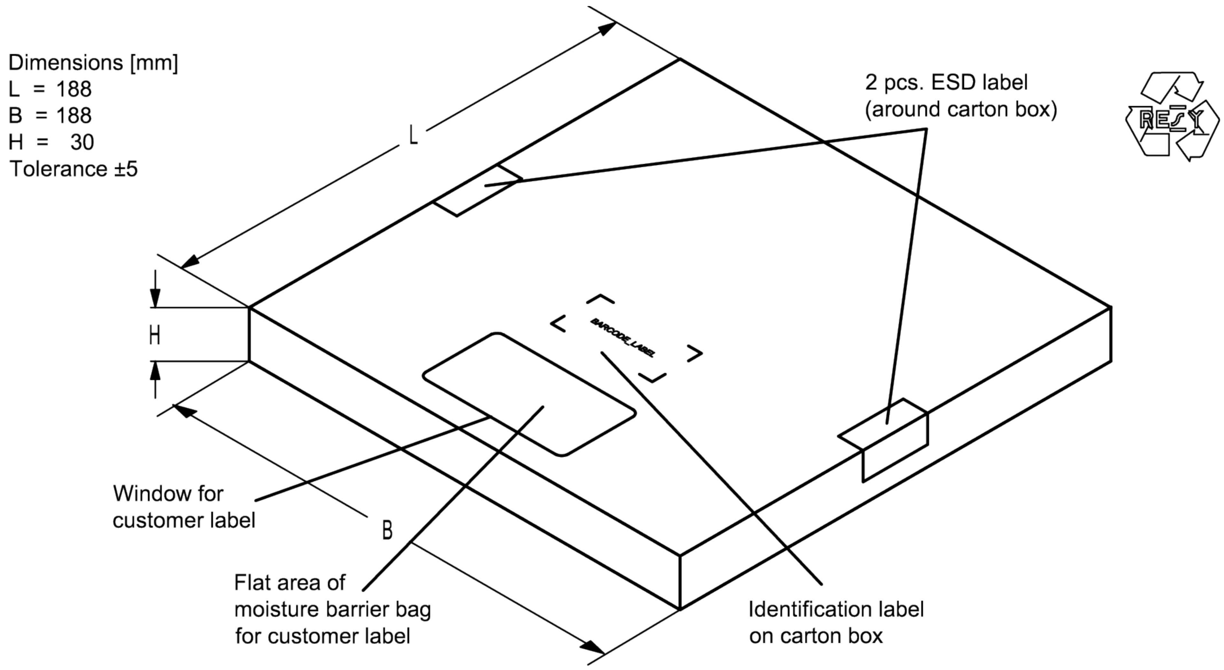

Figure 16: Drawing of folding box for reel with diameter of 180 mm.

18 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<u>**1234**</u>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**

  $\mathbf{1} \times 32^2 + \mathbf{6} \times 32^1 + \mathbf{18}\ \mathbf{(=J)} \times 32^0$ = **1234**

  The BASE32 code for product type B9973 is 9QN.

- 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**

  $\mathbf{5} \times 47^2 + \mathbf{27}\ \mathbf{(=U)} \times 47^1 + \mathbf{31}\ \mathbf{(=Y)} \times 47^0$ = **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.

19 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).

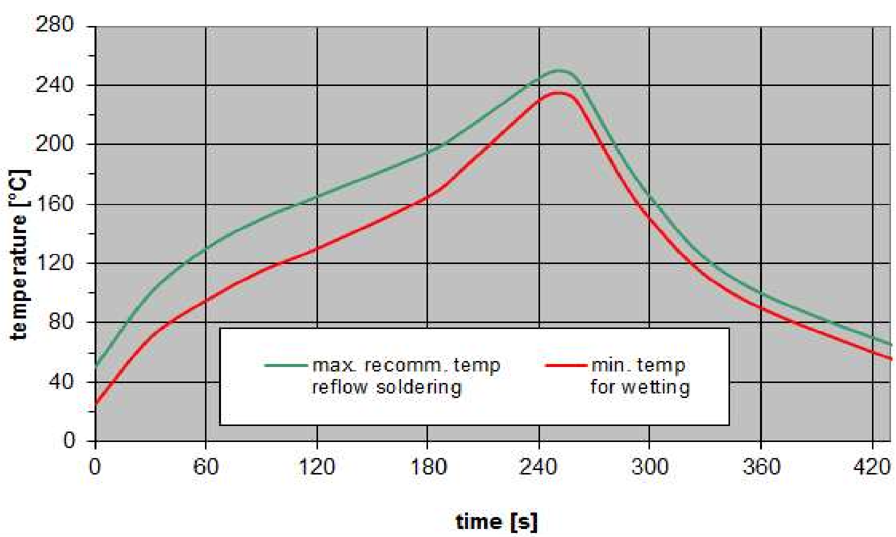

Figure 17: Recommended reflow profile for convection and infrared soldering – lead-free solder.

20 Annotations

20.1 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.

20.2 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.

20.3 Ordering codes and packing units

Ordering code	Packing unit
B39162B9973P810	5000 pcs

Table 4: Ordering codes and packing units.

21 Cautions and warnings

21.1 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/.

21.2 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.

21.3 Moldability

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

21.4 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).

Projection method

Unless otherwise specified first-angle projection is applied.

22 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.

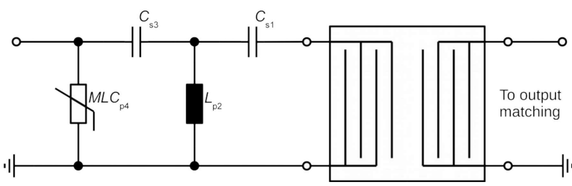

Figure 18: MLC varistor plus ESD matching.

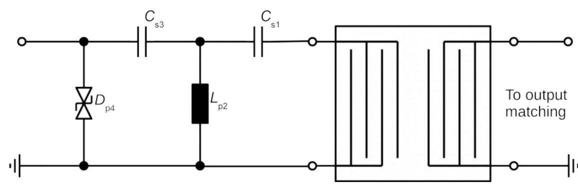

Figure 19: Suppressor diode plus ESD matching.

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

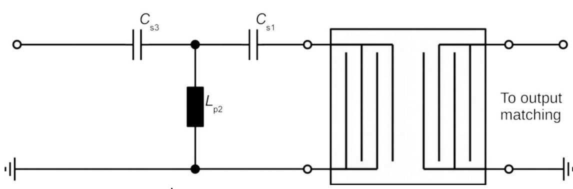

Figure 20: 3rd order high-pass structure for basic ESD protection.

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.

23 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.