Qualcomm

RF360
Europe GmbH

Data sheet

SAW Tx post PA filter

Small cell & femtocell
TD-LTE band 48

Part number:	B9651
Ordering code:	B39362B9651P810

Date:	June 22, 2021
Version:	2.0

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Table of contents

1 Application

- Low-loss SAW Tx Post PA filter for Band 48
- TD-LTE band 48: 3625 MHz
- Usable pass band 150MHz
- High power durability

2 Features

- Industrial grade qualified family
- Package size 2.0$_{\pm0.1}$ mm × 1.6$_{\pm0.1}$ mm
- Package height 0.45 mm (max.)
- Approximate weight 5 mg
- RoHS compatible
- Package for Surface Mount Technology (SMT)
- Ni/Au-plated terminals
- Electrostatic Sensitive Device (ESD)
- Moisture Sensitivity Level 2a (MSL2a)

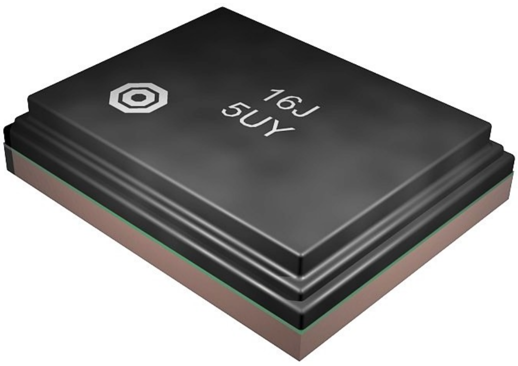


Figure 1: Picture of component with example of product marking.

3 Package

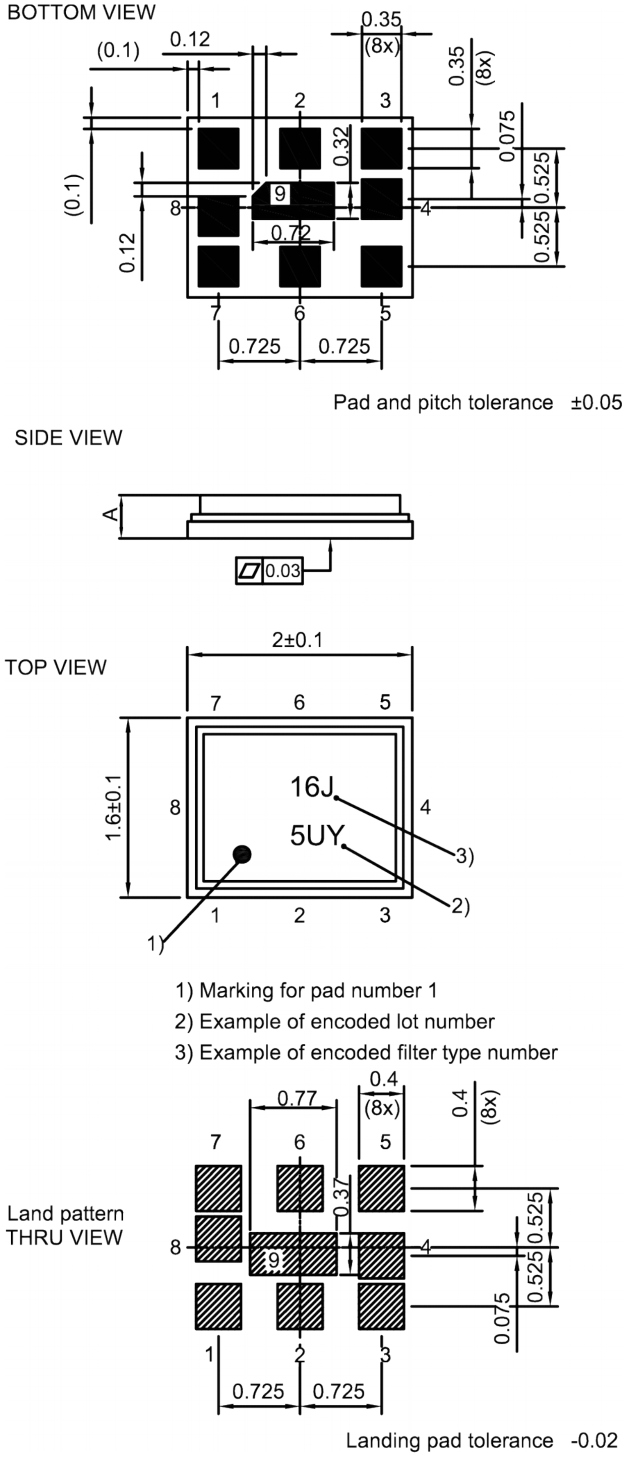


Figure 2: Drawing of package with package height A = 0.45 mm (max.). See Sec. Package information (p. 20).

4 Pin configuration

■ 1	Input
■ 5	Output
■ 2, 3, 4, 6, 7, 8, 9	Ground

5 Matching circuit

- C_{p1b} = 1.2 pF
- C_{p5b} = 1.0 pF
- L_{s1a} = 2.0 nH
- L_{s5a} = 2.1 nH

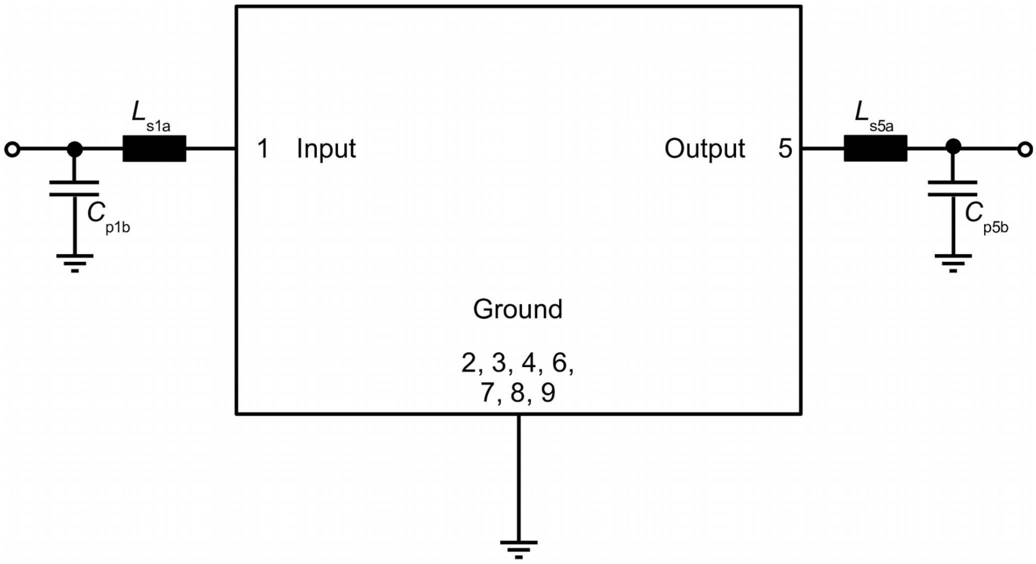


Figure 3: Schematic of matching circuit.

6 Characteristics

Temperature range for specification	T_{SPEC}	= −10 °C ... +85 °C
Input terminating impedance	Z_{IN}	= 50 Ω with ext. circuitry.[1]
Output terminating impedance	Z_{OUT}	= 50 Ω with ext. circuitry.[1]

Characteristics				min. for T_{SPEC}	typ. @ +25 °C	max. for T_{SPEC}	
Center frequency			f_C	—	3625	—	MHz
Insertion attenuation			α_{INT} [2]				
	3550 ... 3570	MHz		—	3.1	4.2	dB
	3570 ... 3680	MHz		—	3.2	4.5	dB
	3680 ... 3700	MHz		—	3.2	4.5	dB
Maximum insertion attenuation			α_{max}				
	3550 ... 3700	MHz		—	3.4	4.6	dB
Amplitude ripple (p-p)			$\Delta\alpha$				
	3550 ... 3700	MHz		—	0.7	1.9	dB
Group delay			t_{max} [3]				
	3550 ... 3700	MHz		—	8	25	ns
Group delay ripple			$\Delta\tau_{var}$ [3]				
	3550 ... 3700	MHz		—	4	20	ns
VSWR			$VSWR_{max}$				
@ input port	3550 ... 3700	MHz		—	1.9	2.3	
@ output port	3550 ... 3700	MHz		—	2.0	2.5	
Attenuation							
	50 ... 699	MHz	α_{min}	40	45	—	dB
	699 ... 894	MHz	α_{min}	40	44	—	dB
	894 ... 1710	MHz	α_{min}	40	43	—	dB
	1710 ... 1995	MHz	α_{min}	38	44	—	dB
	2110 ... 2200	MHz	α_{min}	36	46	—	dB
	2200 ... 2300	MHz	α_{min}	36	47	—	dB
	2300 ... 2400	MHz	α_{min}	36	48	—	dB
	2400 ... 2500	MHz	α_{min}	36	51	—	dB
	2500 ... 2690	MHz	α_{min}	30	48	—	dB
	3450 ... 3490	MHz	α_{min}	10	31	—	dB
	3490 ... 3510	MHz	α_{INT} [2]	6	26	—	dB
	3740 ... 3760	MHz	α_{INT} [2]	3	10	—	dB
	3760 ... 3800	MHz	α_{INT} [2]	7	20	—	dB
	5150 ... 5850	MHz	α_{min}	10	32	—	dB
	5850 ... 6000	MHz	α_{min}	10	32	—	dB

[1] See Sec. Matching circuit (p. 6).
[2] Integrated attenuation α_{INT}: Averaged power $|S_{ij}|^2$ over the center 18 MHz of LTE 20 MHz (100 RB) channels.
[3] Aperture of 1MHz.

Temperature range for specification	T_{SPEC}	= −40 °C ... +95 °C
Input terminating impedance	Z_{IN}	= 50 Ω with ext. circuitry.[1]
Output terminating impedance	Z_{OUT}	= 50 Ω with ext. circuitry.[1]

Characteristics				min. for T_{SPEC}	typ. @ +25 °C	max. for T_{SPEC}	
Center frequency			f_C	—	3625	—	MHz
Insertion attenuation			α_{INT} [2]				
	3550 ... 3570	MHz		—	3.1	4.7	dB
	3570 ... 3680	MHz		—	3.2	5.0	dB
	3680 ... 3700	MHz		—	3.2	5.0	dB
Maximum insertion attenuation			α_{max}				
	3550 ... 3700	MHz		—	3.4	5.1	dB
Amplitude ripple (p-p)			$\Delta\alpha$				
	3550 ... 3700	MHz		—	0.7	2.4	dB
Group Delay			t_{max} [3]				
	3550 ... 3700	MHz		—	8	35	ns
Group delay ripple			$\Delta\tau_{var}$ [3]				
	3550 ... 3700	MHz		—	4	30	ns
VSWR			$VSWR_{max}$				
@ input port	3550 ... 3700	MHz		—	1.9	2.5	
@ output port	3550 ... 3700	MHz		—	2.0	2.8	
Attenuation							
	50 ... 699	MHz	α_{min}	40	45	—	dB
	699 ... 894	MHz	α_{min}	40	44	—	dB
	894 ... 1710	MHz	α_{min}	40	43	—	dB
	1710 ... 1995	MHz	α_{min}	38	44	—	dB
	2110 ... 2200	MHz	α_{min}	36	46	—	dB
	2200 ... 2300	MHz	α_{min}	36	47	—	dB
	2300 ... 2400	MHz	α_{min}	36	48	—	dB
	2400 ... 2500	MHz	α_{min}	36	51	—	dB
	2500 ... 2690	MHz	α_{min}	30	48	—	dB
	3450 ... 3490	MHz	α_{min}	9	31	—	dB
	3490 ... 3510	MHz	α_{INT} [2]	5	26	—	dB
	3740 ... 3760	MHz	α_{INT} [2]	2	10	—	dB
	3760 ... 3800	MHz	α_{INT} [2]	5	20	—	dB
	5150 ... 5850	MHz	α_{min}	10	32	—	dB
	5850 ... 6000	MHz	α_{min}	10	32	—	dB

[1] See Sec. Matching circuit (p. 6).
[2] Integrated attenuation α_{INT}: Averaged power $|S_{ij}|^2$ over the center 18 MHz of LTE 20 MHz (100 RB) channels.
[3] Aperture of 1MHz.

7 Maximum ratings

Operable temperature	T_{OP} = −40 °C ... +95 °C	
Storage temperature	T_{STG} = −40 °C ... +95 °C[1]	
DC voltage	$\|V_{DC}\|$ = 0 V[2]	
ESD voltage	V_{ESD}	
	150 V[3]	Machine model.
	250 V[4]	Human body model.
Input power @ input port: 3550 ... 3700 MHz	P_{IN} = 27 dBm[5), 6)]	5 MHz LTE downlink signal (25 RB) for 70000 h @ 55 °C. Source and load impedance 50Ω.

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) T_{SPEC} is the ambient temperature of the PCB at component position. Specified min./max values from section 6 "characteristics" for maximum input power 27dBm are valid for temperature up to 67°C.

8 Transmission coefficient

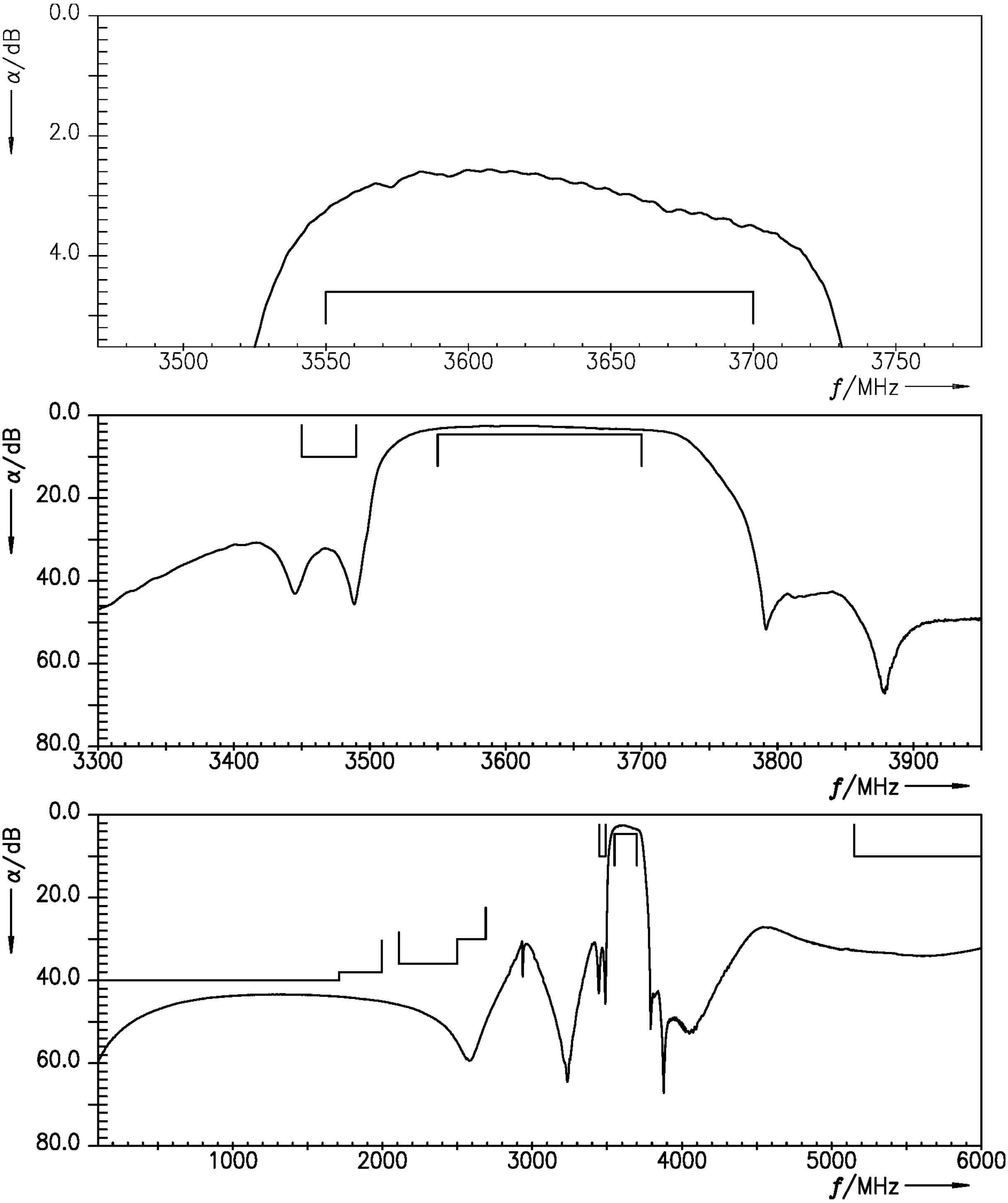
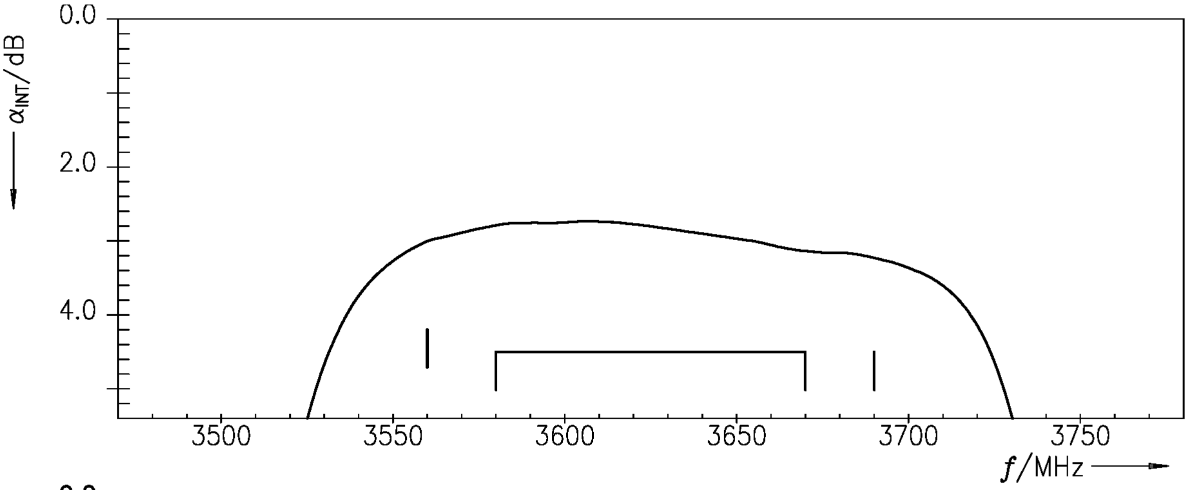
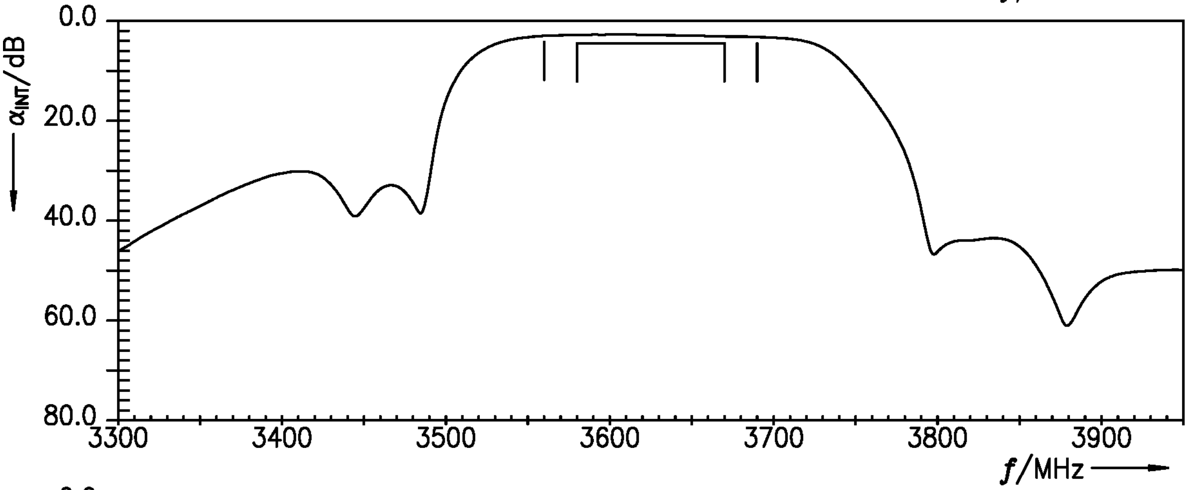


Figure 4: Attenuation.

9 Transmission coefficient (LTE)





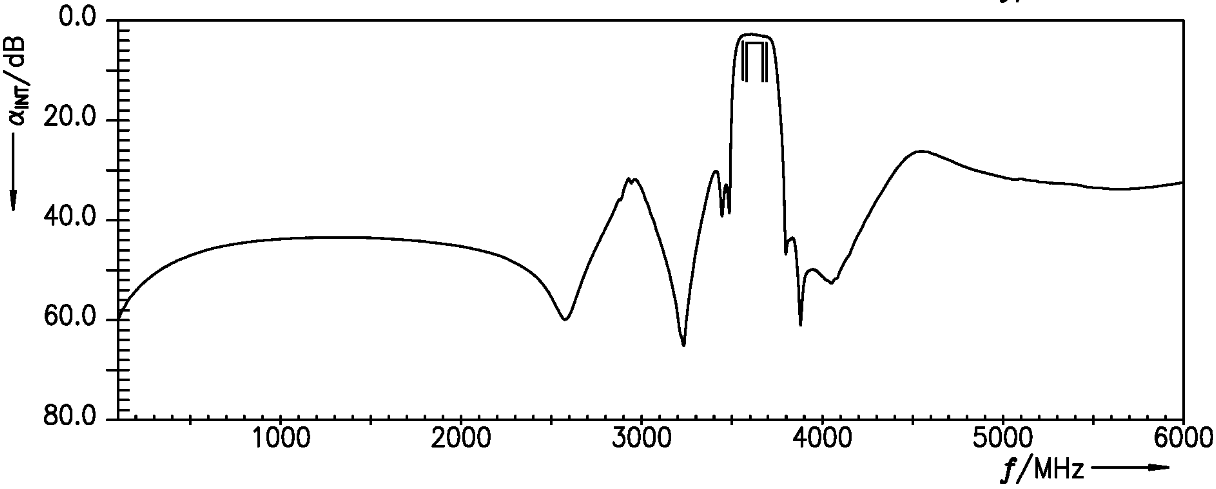


Figure 5: Attenuation (LTE) (integration window = 20 MHz).

10 Reflection coefficients

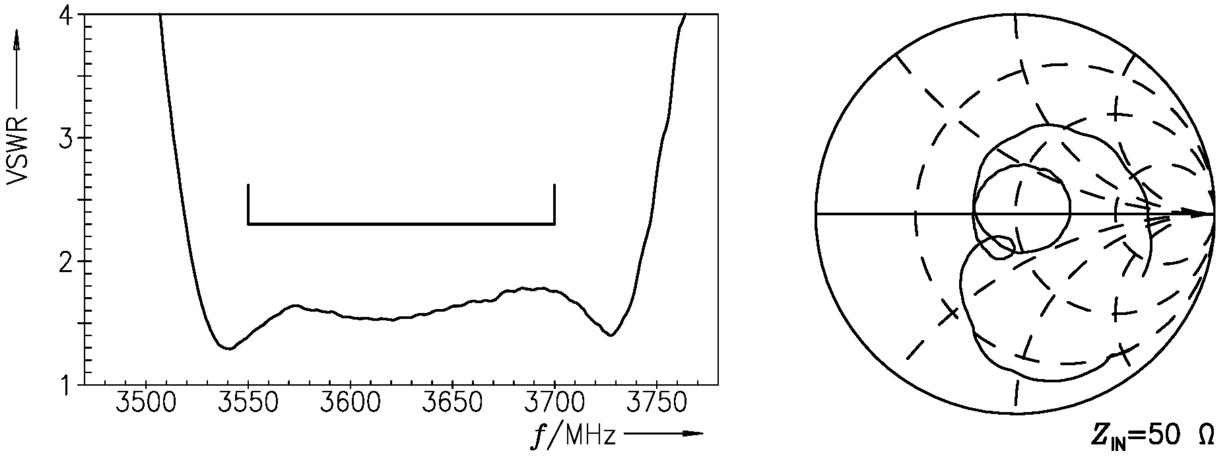


Figure 6: Reflection coefficient at input port.

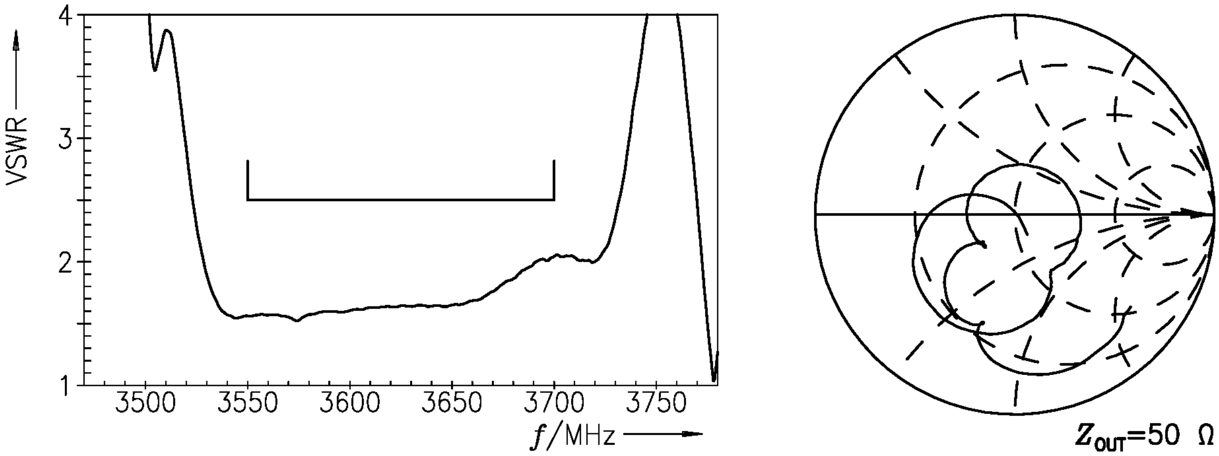


Figure 7: Reflection coefficient at output port.

11 Group delay

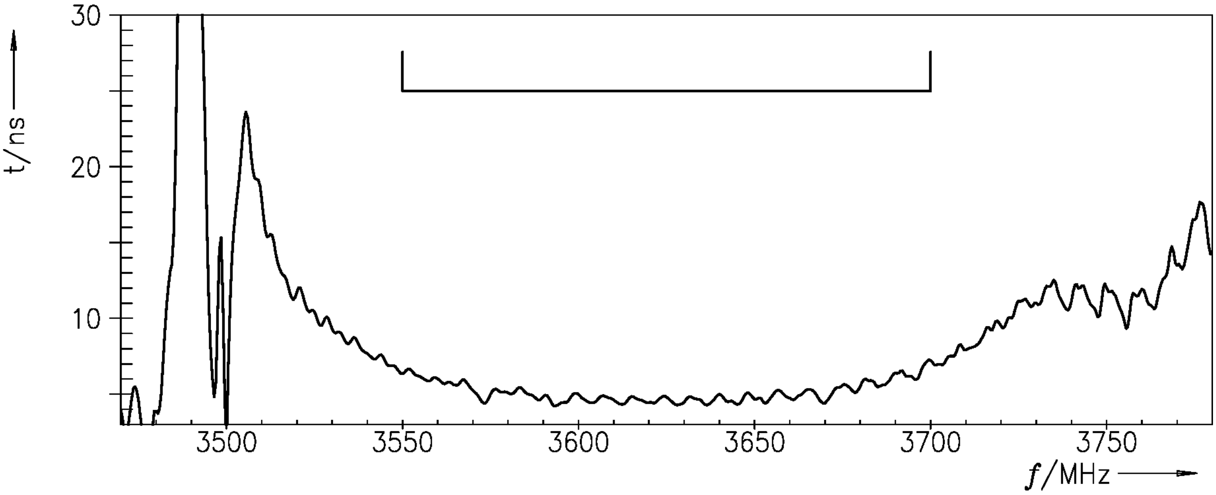


Figure 8: Group delay.

12 Packing material

12.1 Tape

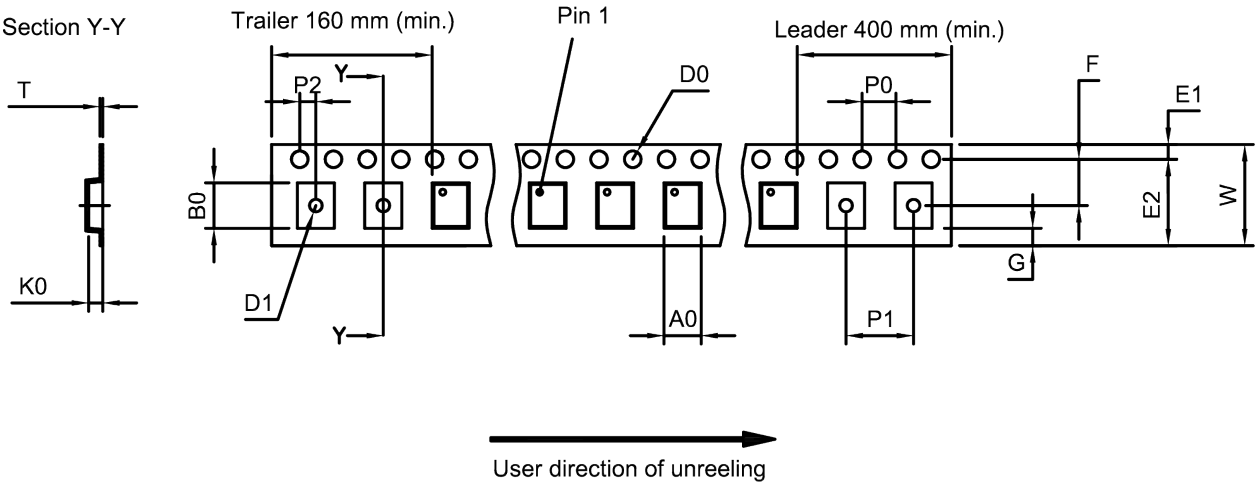


Figure 9: Drawing of tape (first-angle projection) for illustration only and not to scale. The valid tape dimensions are listed in Table 1.

A_0	$1.8_{\pm0.05}$ mm	E_2	6.25 mm (min.)	P_1	$4.0_{\pm0.1}$ mm
B_0	$2.25_{\pm0.05}$ mm	F	$3.5_{\pm0.05}$ mm	P_2	$2.0_{\pm0.05}$ mm
D_0	$1.5_{+0.1/-0}$ mm	G	0.75 mm (min.)	T	$0.25_{\pm0.03}$ mm
D_1	1.0 mm (min.)	K_0	$0.6_{\pm0.05}$ mm	W	$8.0_{+0.3/-0.1}$ mm
E_1	$1.75_{\pm0.1}$ mm	P_0	$4.0_{\pm0.1}$ mm		

Table 1: Tape dimensions.

12.2 Reel with diameter of 180 mm

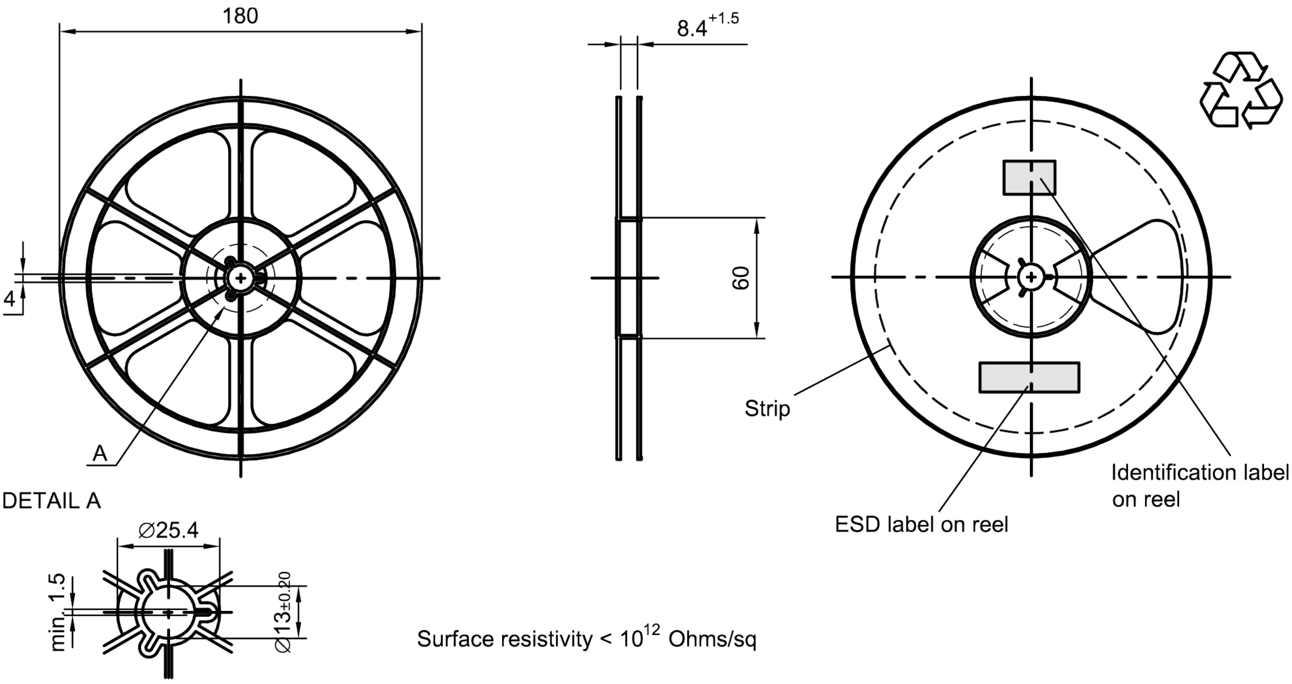


Figure 10: Drawing of reel (first-angle projection) with diameter of 180 mm.

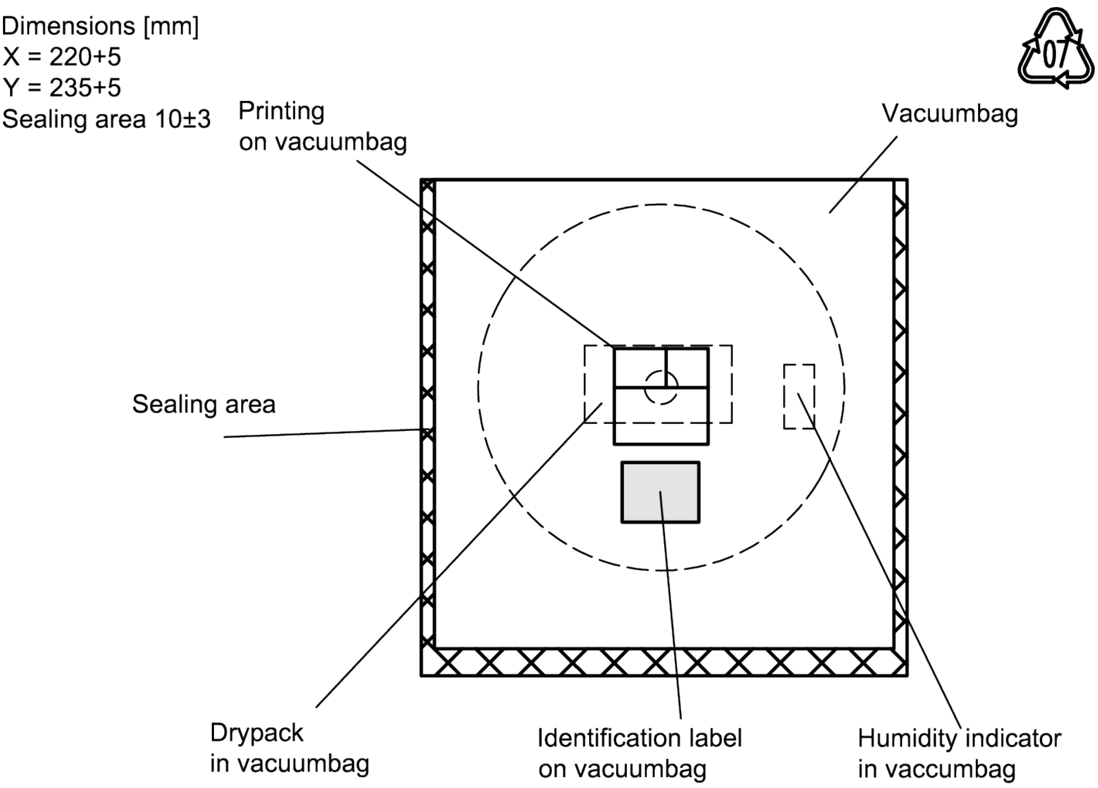


Figure 11: Drawing of moisture barrier bag (MBB) for reel with diameter of 180 mm.

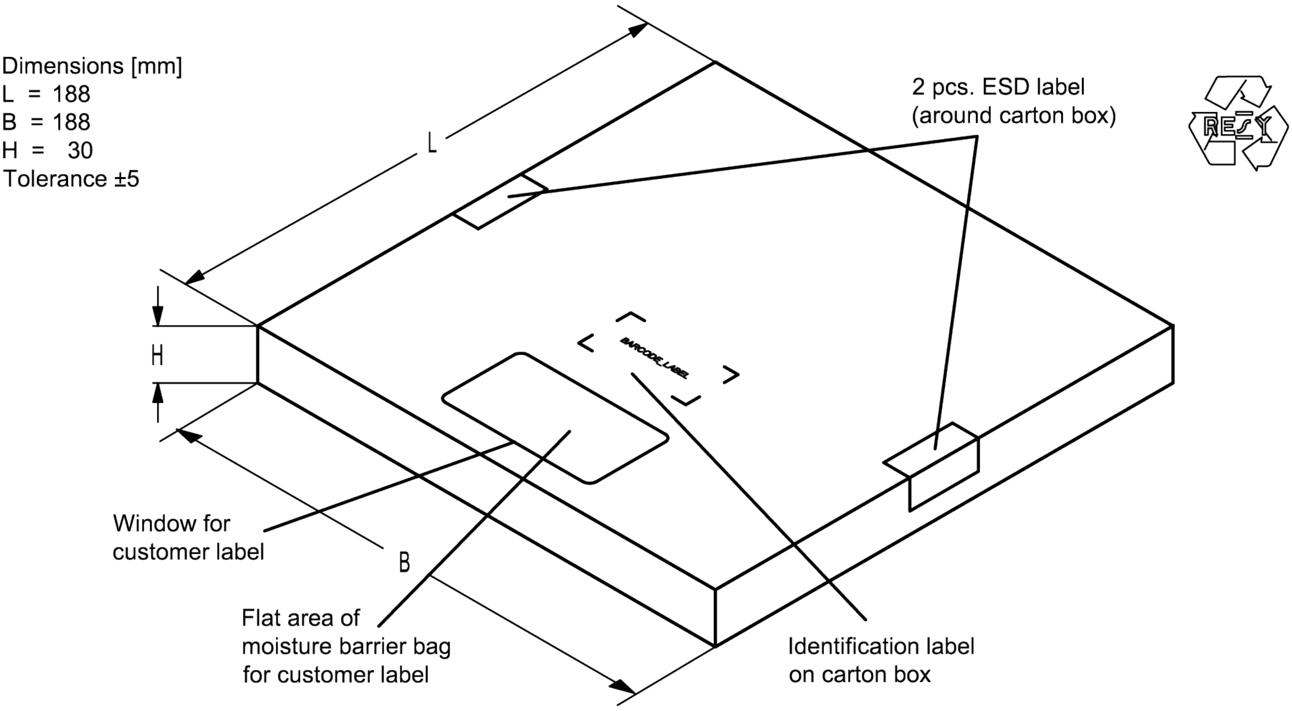


Figure 12: Drawing of folding box for reel with diameter of 180 mm.

13 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., B3xxxxB1234xxxx,
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 B9651 is 9DK.

- 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.

14 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).

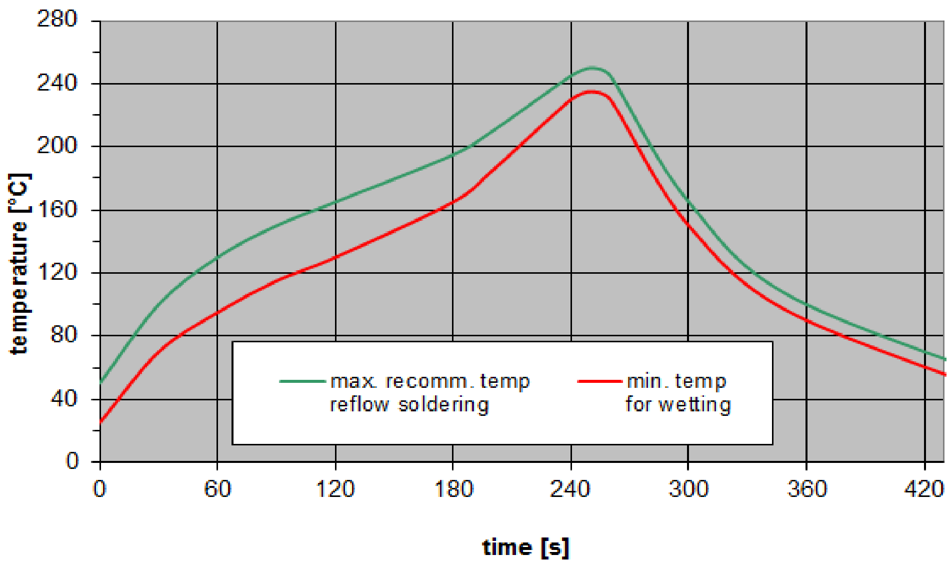


Figure 13: Recommended reflow profile for convection and infrared soldering – lead-free solder.

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.

15.3 Ordering codes and packing units

Ordering code	Packing unit
B39362B9651P810	5000 pcs

Table 4: Ordering codes and packing units.

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 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.

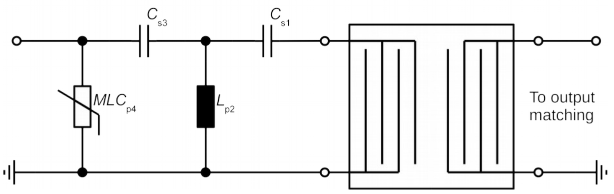


Figure 14: MLC varistor plus ESD matching.

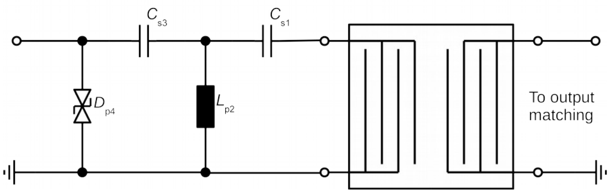


Figure 15: Suppressor diode plus ESD matching.

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

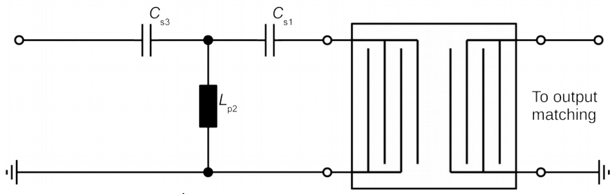


Figure 16: 3rd order high-pass structure for basic ESD protection.

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.

18 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.
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