IEC 62604-2

Edition 2.0 2017-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Surface acoustic wave (SAW) and bulk acoustic wave (BAW) duplexers of assessed quality – Part 2: Guidelines for the use

Duplexeurs à ondes acoustiques de surface (OAS) et à ondes acoustiques de volume (OAV) sous assurance de la qualité – Partie 2: Lignes directrices d'utilisation

IEC 62604-2:2017-11(en-fr)

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FOREWORD

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International Standard IEC 62604-2 has been prepared by IEC technical committee 49: Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection.

This bilingual version (2019-10) corresponds to the monolingual English version, published in 2017-11.

This second edition cancels and replaces the first edition published in 2011. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- diplexers are described;
- duplexers with a balanced RX port are considered in the measurement method subclause (7.3).

NOTE In this standard, SAW and BAW duplexers are treated simultaneously because both duplexers are used in the same manner especially in mobile phone systems and have same requirements of characteristics, test method and so on.

The text of this International Standard is based on the following documents:

CDV	Report on voting
49/1217/CDV	49/1251/RVC

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62604 series, published under the general title *Surface acoustic wave (SAW) and bulk acoustic wave (BAW) duplexers of assessed quality*, can be found on the IEC website.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

SURFACE ACOUSTIC WAVE (SAW) AND BULK ACOUSTIC WAVE (BAW) DUPLEXERS OF ASSESSED QUALITY –

Part 2: Guidelines for the use

1 Scope

This part of IEC 62604 concerns duplexers which can separate receiving signals from transmitting signals and are key components for two-way radio communications, and which are generally used in mobile phone systems compliant with CDMA systems such as N-CDMA in second generation mobile telecommunication systems (2G), W-CDMA / UMTS (3G) or LTE (4G). While in 2G systems mainly dielectric duplexers have been used, the ongoing miniaturization in 3G and 4G mobile communication systems promoted the development and application of acoustic wave duplexers due to their small size, light weight and good electrical performance. While standard surface acoustic wave (SAW) duplexers have been employed for applications with moderate requirements regarding the steepness of individual filters, applications with narrow duplex gap (e.g. Bands 2, 3, 8, 25), i.e. the frequency gap between receiving and transmitting bands, require the application of temperature-compensated (TC) SAW or bulk acoustic wave (BAW) technology, because of their better temperature characteristics and resonator Q-factors.

It is neither the aim of these guidelines to explain theory, nor to attempt to cover all the eventualities which may arise in practical circumstances. These guidelines draw attention to some of the more fundamental questions, which should be considered by the user before he places an order for SAW and BAW duplexers for a new application. Such a procedure will be the user's insurance against unsatisfactory performance. Because SAW and BAW duplexers have very similar performance for the usage, it is useful and convenient for users that both duplexers are described in one standard.

Standard specifications, such as those of IEC, of which these guidelines form a part, and national specifications or detail specifications issued by manufacturers will define the available combinations of centre frequency, pass bandwidth and insertion attenuation for each sort of transmitting and receiving filters and the isolation level between transmitter and receiver ports, etc. These specifications are compiled to include a wide range of SAW and BAW duplexers with standardized performances. It cannot be over-emphasized that the user should, wherever possible, select his duplexers from these specifications, when available, even if it may lead to making small modifications to his circuit to enable the use of standard duplexers. This applies particularly to the selection of the nominal frequency band.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60862-1:2015, *Surface acoustic wave (SAW) filters of assessed quality – Part 1: Generic specification*

IEC 62575-1:2015, *Radio frequency (RF) bulk acoustic wave (BAW) filters of assessed quality – Part 1: Generic specification*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
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4 Technical considerations

It is of prime interest to a user that the duplexer characteristics should satisfy particular specifications. The selection of the front-end circuits in user equipments and SAW and BAW duplexers to meet such specifications should be a matter of agreement between the user and the manufacturer.

Duplexer characteristics are usually expressed in terms of centre frequency, pass bandwidth and insertion attenuation for each of transmitting and receiving filter parts in the duplexer and isolation level between the transmitter and receiver ports. Since the SAW and BAW duplexer is used in RF front-end of the user equipments, lower insertion attenuation, higher isolation/rejection level, stronger power durability and smaller/thinner package dimensions are strictly required.

5 Fundamentals of SAW and BAW duplexers

5.1 Basic function

5.1.1 General

Duplexers are necessary for frequency division duplex (FDD) equipments to receive and transmit signals simultaneously. Duplexers are 3-port devices which consist of an antenna port, a transmitter port (TX port) and a receiver port (RX port), as shown in Figure 1. The duplexer has three basic functions;

– to transfer the transmitting signal from the TX port to the antenna port;

– to transfer the receiving signal from the antenna port to the RX port;

– to prevent transfer of the transmitting signal and noise from the TX port to the RX port.

The transmitting and the receiving frequencies are determined corresponding to each mobile communication system. For example, Table 1 shows typical allocated frequency bands for UMTS.

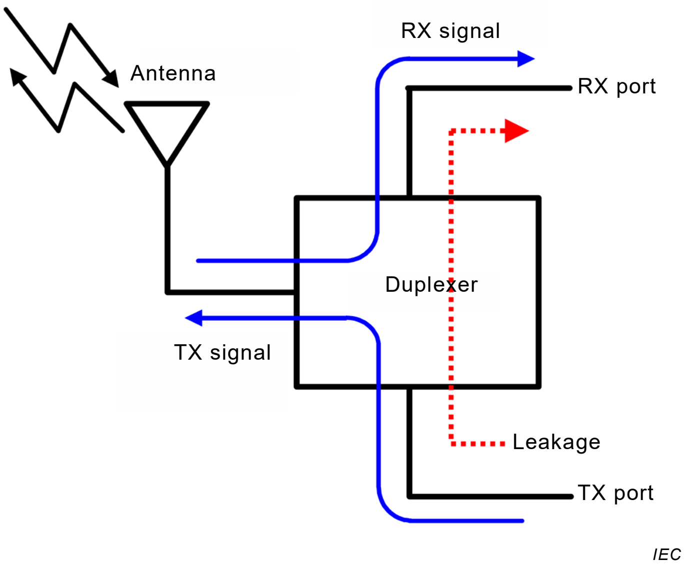

Figure 1 – Basic duplexer configuration

Table 1 – Frequency allocation for typical LTE frequency division duplex (FDD) bands

Band	Uplink frequency (MHz)	Downlink frequency (MHz)	Band	Uplink frequency (MHz)	Downlink frequency (MHz)
1	1 920 – 1 980	2 110 – 2 170	16	2 010 – 2 025	2 585 – 2 600
2	1 850 – 1 910	1 930 – 1 990	17	704 – 716	734 – 746
3	1 710 – 1 785	1 805 – 1 880	18	815 – 830	860 – 875
4	1 710 – 1 755	2 110 – 2 155	19	830 – 845	875 – 890
5	824 – 849	869 – 894	20	832 – 862	791 – 821
6	830 – 840	875 – 885	21	1 447,9 – 1 462,9	1 495,5 – 1 510,9
7	2 500 – 2 570	2 620 – 2 690	22	3 410 – 3 490	3 510 – 3 590
8	880 – 915	925 – 960	23	2 000 – 2 020	2 180 – 2 200
9	1 749,9 – 1 784,9	1 844,9 – 1 879,9	24	1 626,5 – 1 660,5	1 525 – 1 559
10	1 710 – 1 770	2 110 – 2 170	25	1 850 – 1 915	1 930 – 1 995
11	1 427,9 – 1 447,9	1 475,9 – 1 495,9	26	814 – 849	859 – 894
12	699 – 716	729 – 746	27	807 – 824	852 – 869
13	777 – 787	746 – 756	28	703 – 748	758 – 803
14	788 – 798	758 – 768	30	2 305 – 2 315	2 350 – 2 360
15	1 900 – 1 920	2 600 – 2 620	31	452,5 – 457,5	462,5 – 467,5

NOTE For a user equipment, uplink frequency means transmitting frequency and downlink frequency means receiving frequency respectively.

5.1.2 TX filter response (filter response from TX port to antenna port)

Figure 2 shows an example of frequency characteristics of the TX filter. The required frequency characteristics are low insertion attenuation in the transmitting frequency band (f_T), high insertion attenuation in the receiving frequency band (f_R) and good impedance matching.

5.1.3 RX filter response (filter response from antenna port to RX port)

Figure 3 shows an example of frequency characteristics of the RX filter. The required frequency characteristics are low insertion attenuation in the receiving band (f_R) and high insertion attenuation in the transmitting frequency band (f_T).

5.1.4 Isolation (isolation from TX port to RX port)

Figure 4 shows an example of isolation characteristics. One of the important functions for the duplexers is isolation characteristics, which show the frequency dependence of the leakage power from the TX port to the RX port.

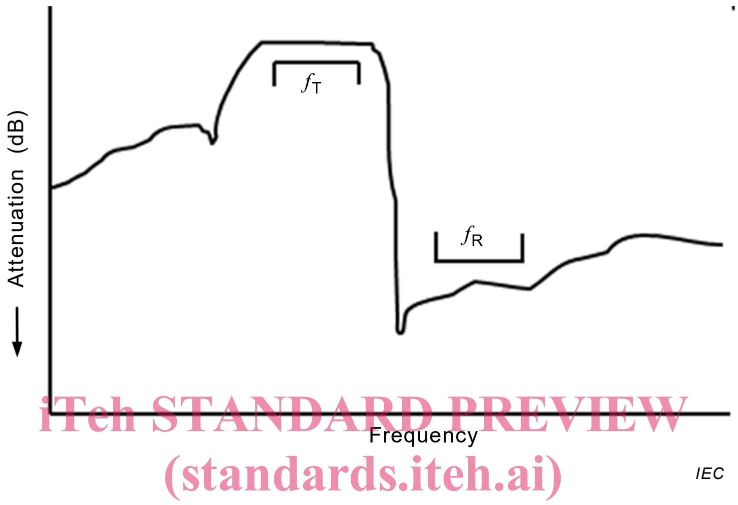

Figure 2 – Basic TX filter response example of SAW and BAW duplexers

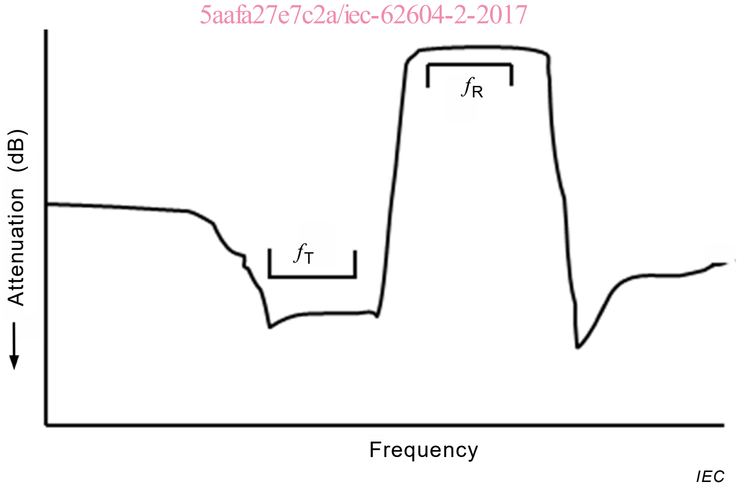

Figure 3 – Basic RX filter response example of SAW and BAW duplexers

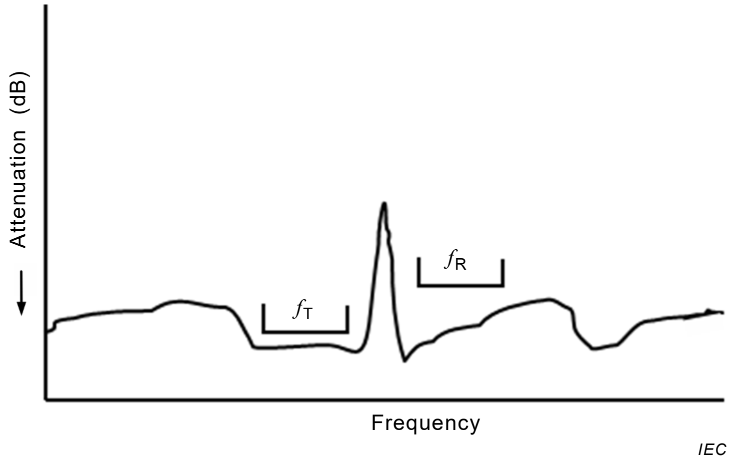

Figure 4 – Basic isolation characteristics example of SAW and BAW duplexers

5.2 Basic structure

Duplexers are 3-port devices/modules, which enable to transmit and receive signals simultaneously through a common antenna. A basic structure of duplexers is shown in Figure 5. SAW and BAW duplexers consist of a transmitter (TX) part and a receiver (RX) part. These two parts, which may add a phase shifter, are connected to an antenna port. The phase shifter is utilized to prevent the interaction between the filters. In Figure 5, Z_t and Z_r correspond to the impedance of the TX and RX part at the antenna port side, whereas Z_o is the impedance of the antenna port. The following conditions shall be fulfilled to achieve the duplexer functions.

$$Z_o \cong Z_t \text{ and } |Z_o| << |Z_r| \quad \text{in the TX pass band}$$

$$Z_o \cong Z_r \text{ and } |Z_o| << |Z_t| \quad \text{in the RX pass band}$$

DMS (double mode SAW) type filters which are also known as LCRF (longitudinally coupled resonator filters)[1)], ladder type SAW[2)] and BAW filters and other type of SAW filters such as interdigitated interdigital transducer (IIDT) resonator filters[3)] can be adopted as TX and RX filters. High power durability is required in the TX filters.

5.3 Principle of operation

In the TX pass band, the impedance of the TX part in the antenna port side (Z_t) is almost the same as that of antenna(Z_o), while that of the RX part (Z_r) is much higher, which means that at the antenna port, the RX part has large reflection coefficient in this band.

$$Z_o \cong Z_t \text{ and } |Z_o| << |Z_r| \quad \text{in the TX pass band}$$

On the other hand, in the RX pass band, the impedance of the RX part at the antenna port side (Z_r) is almost the same as that of antenna (Z_o), while that of the TX part (Z_t) is much higher. This also means the TX part has large reflection coefficient in this band.

$$Z_o \cong Z_r \text{ and } |Z_o| << |Z_t| \quad \text{in the RX pass band}$$

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1) See IEC 60862-2:2012, 5.3.

2) See IEC 60862-2:2012, 5.2.

3) See IEC 60862-2:2012, 5.4.

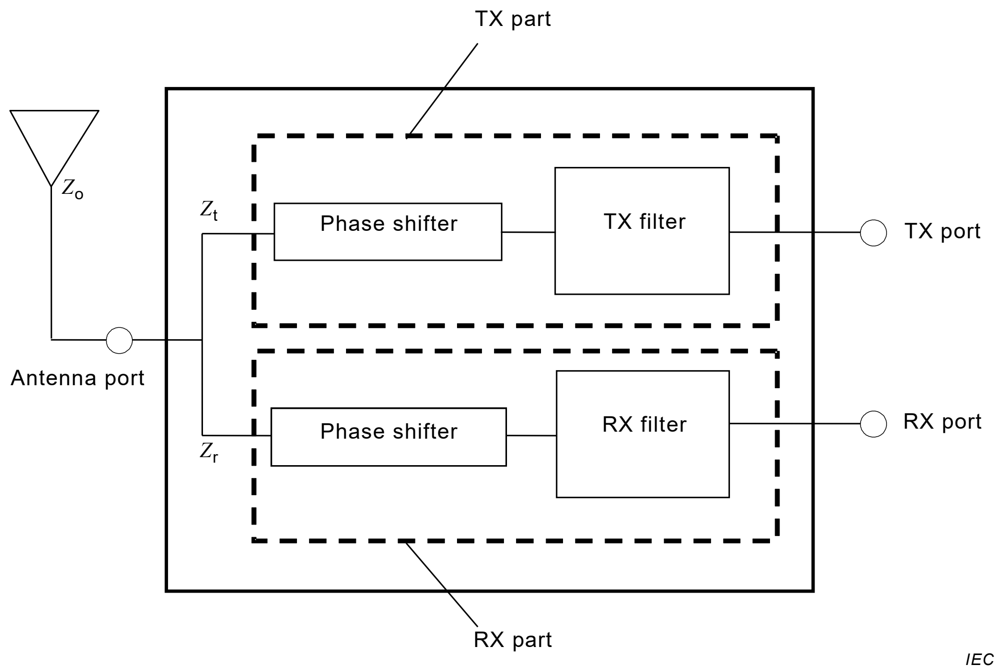

Figure 5 – The block diagram of a duplexer

The transmitting signal applied to the TX port passes through the TX filter and then flows to the antenna port, not the RX filter. The received signal from the antenna port does not flow to the TX filter, but to the RX filter. As a result, the TX part and the RX part can share the common antenna port. In the following explanation, the impedance of the antenna (Z_o) is assumed to be 50 Ω. The S_{11} curve of the TX part at the antenna port side shall satisfy the demanded condition indicated in Figure 6. The impedance of its pass band shall be around 50 Ω. In the rejection band, the impedance shall be sufficiently larger than 50 Ω. In the actual duplexer, the S_{11} trace in the Smith chart of the TX filter is rotated to its optimum state by a phase shifter, as shown in Figure 7. On the other hand, the frequency characteristics of the amplitude of S_{21} remains the same as that without phase shifter. Figure 8 shows the S_{21} frequency characteristics and S_{11} demanded condition of the RX part.

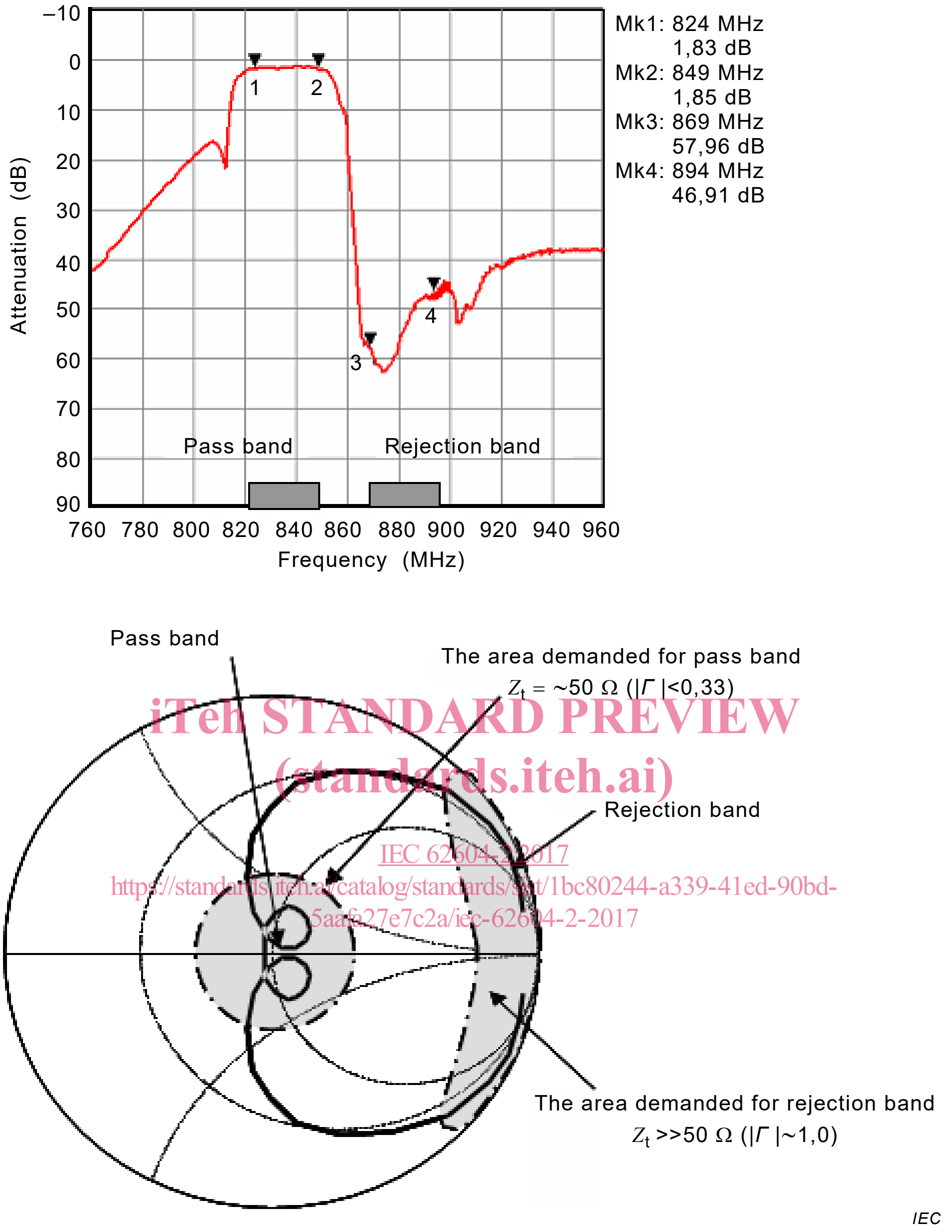

Figure 6 – Demanded condition of TX part for duplexers

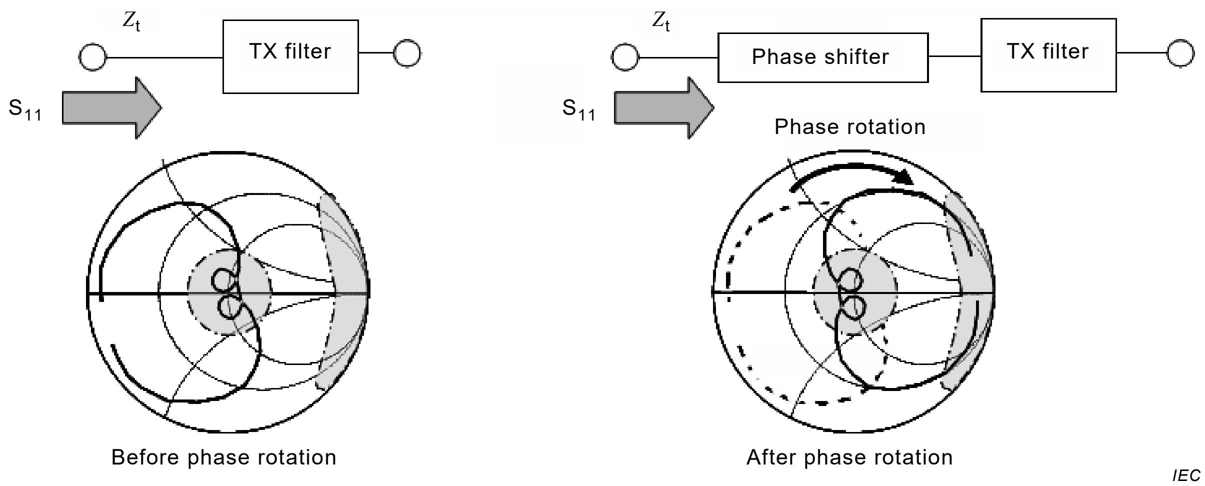

Figure 7 – Phase rotation in TX part

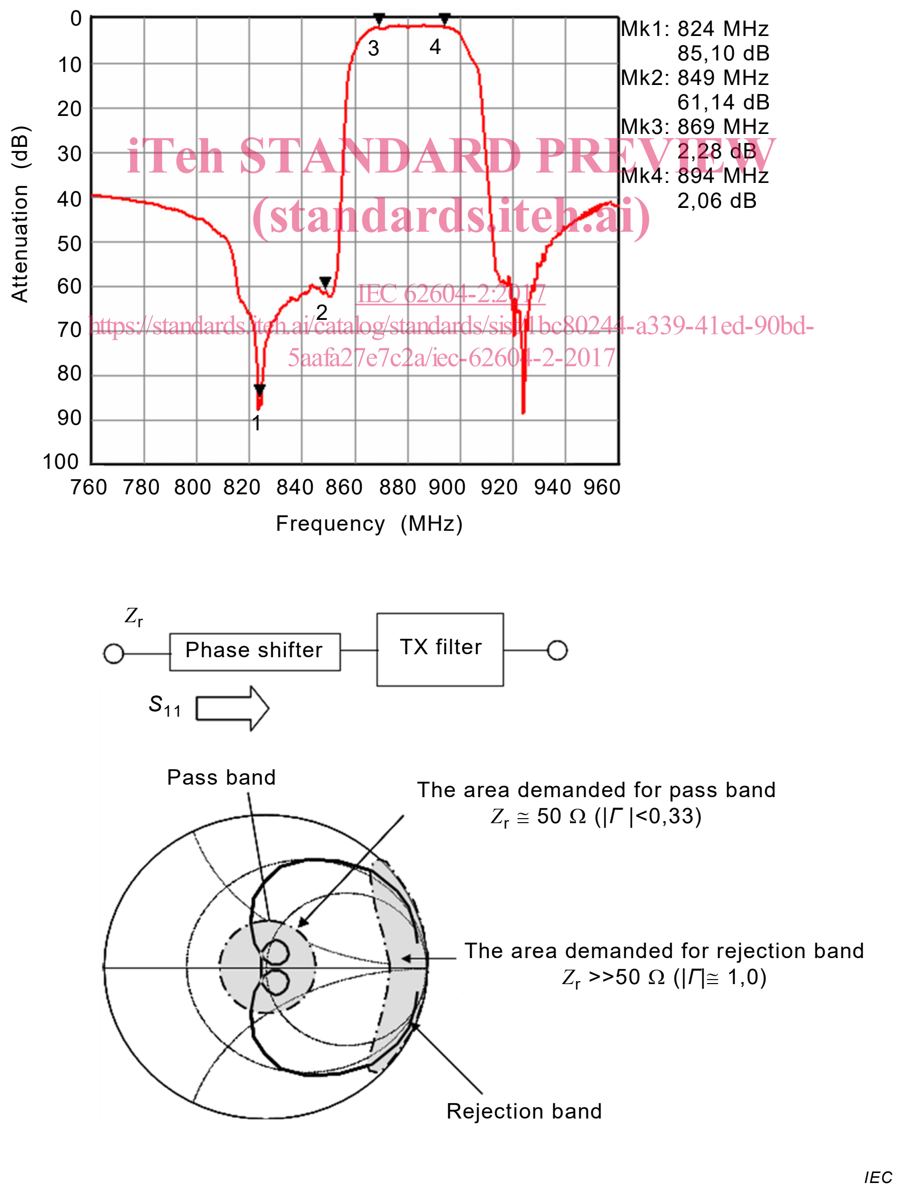

Figure 8 – Demanded condition of RX part for duplexers