BS EN 62604-1:2015

BSI Standards Publication

Surface acoustic wave (SAW) and bulk acoustic wave (BAW) duplexers of assessed quality

Part 1: Generic specification

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National foreword

This British Standard is the UK implementation of EN 62604-1:2015. It is identical to IEC 62604-1:2015.

The UK participation in its preparation was entrusted to Technical Committee EPL/49, Piezoelectric devices for frequency control and selection.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

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EN 62604-1

September 2015

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English Version

Surface acoustic wave (SAW) and bulk acoustic wave (BAW) duplexers of assessed quality - Part 1: Generic specification (IEC 62604-1:2015)

Duplexeurs à ondes acoustiques de surface (OAS) et à ondes acoustiques de volume (OAV) sous assurance de la qualité - Partie 1: Spécification générique (IEC 62604-1:2015)

Oberflächenwellen-(OFW-) und Volumenwellen-(BAW-) Duplexer mit bewerteter Qualität - Teil 1: Fachgrundspezifikation (IEC 62604-1:2015)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

European foreword

The text of document 49/1143/FDIS, future edition 1 of IEC 62604-1, prepared by IEC/TC 49 "Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 62604-1:2015.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2016-05-20
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2018-08-20

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Endorsement notice

The text of the International Standard IEC 62604-1:2015 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60068-2-10:2005	NOTE	Harmonized as EN 60068-2-10:2005 (not modified).
IEC 60862-1:2003	NOTE	Harmonized as EN 60862-1:2003 (not modified).
IEC 60862-2:2012	NOTE	Harmonized as EN 60862-2:2012 (not modified).
IEC 61019-1:2004	NOTE	Harmonized as EN 61019-1:2005 (not modified).
IEC 62047-7:2011	NOTE	Harmonized as EN 62047-7:2011 (not modified).
IEC 62604-2:2011	NOTE	Harmonized as EN 62604-2:2012 (not modified).

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60027	series	Letter symbols to be used in electrical technology	-	-
IEC 60050	series	International Electrotechnical Vocabulary	-	-
IEC 60068-1	2013	Environmental testing - Part 1: General and guidance	EN 60068-1	2014
IEC 60068-2-1	-	Environmental testing - Part 2-1: Tests - Test A: Cold	EN 60068-2-1	-
IEC 60068-2-2	-	Environmental testing - Part 2-2: Tests - Test B: Dry heat	EN 60068-2-2	-
IEC 60068-2-6	-	Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)	EN 60068-2-6	-
IEC 60068-2-7	-	Basic environmental testing procedures - Part 2-7: Tests - Test Ga and guidance: Acceleration, steady state	EN 60068-2-7	-
IEC 60068-2-13	-	Basic environmental testing procedures - Part 2-13: Tests - Test M: Low air pressure	EN 60068-2-13	-
IEC 60068-2-14	-	Environmental testing - Part 2-14: Tests - Test N: Change of temperature	EN 60068-2-14	-
IEC 60068-2-17	1994	Basic environmental testing procedures - Part 2-17: Tests - Test Q: Sealing	EN 60068-2-17	1994
IEC 60068-2-27	-	Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock	EN 60068-2-27	-
IEC 60068-2-30	-	Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)	EN 60068-2-30	-

Publication	Year	Title	EN/HD	Year
IEC 60068-2-31	-	Environmental testing - Part 2-31: Tests - Test Ec: Rough handling shocks, primarily for equipment-type specimens	EN 60068-2-31	-
IEC 60068-2-45	-	Basic environmental testing procedures - Part 2-45: Tests - Test XA and guidance: Immersion in cleaning solvents	EN 60068-2-45	-
IEC 60068-2-52	-	Environmental testing - Part 2-52: Tests - Test Kb: Salt mist, cyclic (sodium chloride solution)	EN 60068-2-52	-
IEC 60068-2-58	-	Environmental testing - Part 2-58: Tests - Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)	EN 60068-2-58	-
IEC 60068-2-64	-	Environmental testing - Part 2-64: Tests - Test Fh: Vibration, broadband random and guidance	EN 60068-2-64	-
IEC 60068-2-78	-	Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state	EN 60068-2-78	-
IEC 60122-1	-	Quartz crystal units of assessed quality - Part 1: Generic specification	EN 60122-1	-
IEC 60617-DB	-	Graphical symbols for diagrams	-	-
IEC 60642	-	Piezoelectric ceramic resonators and resonator units for frequency control and selection - Chapter I: Standard values and conditions - Chapter II: Measuring and test conditions	-	-
IEC 60695-11-5	-	Fire hazard testing - Part 11-5: Test flames - Needle-flame test method - Apparatus, confirmatory test arrangement and guidance	EN 60695-11-5	-
IEC 60749-28	- [1)]	Semiconductor devices - Mechanical and climatic test methods - Part 28: Electrostatic Discharge (ESD) Sensitivity Testing Direct contact charged device model (DC-CDM)	FprEN 60749-28	- [1)]
IEC 61000-4-2	-	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	EN 61000-4-2	-
IEC 61340-3-1	-	Electrostatics - Part 3-1: Methods for simulation of electrostatic effects - Human body model (HBM) electrostatic discharge test waveforms	EN 61340-3-1	-

1) At draft stage.

Publication	Year	Title	EN/HD	Year
IEC 61340-3-2	-	Electrostatics - Part 3-2: Methods for simulation of electrostatic effects - Machine model (MM) electrostatic discharge test waveforms	EN 61340-3-2	-
IEC 62761	-	Guidelines for the measurement method of nonlinearity for surface acoustic wave (SAW) and bulk acoustic wave (BAW) devices in radio frequency (RF)	EN 62761	-
IEC 80000	series	Quantities and units	EN 80000	series
ISO 80000	series	Quantities and units -	EN ISO 80000	series

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 1: Generic specification

FOREWORD

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International Standard IEC 62604-1 has been prepared by IEC technical committee 49: Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection.

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

The text of this standard is based on the following documents:

FDIS	Report on voting
49/1143/FDIS	49/1160/RVD

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

This publication 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.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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 1: Generic specification

1 Scope

This part of IEC 62604 specifies the methods of test and general requirements for SAW and BAW duplexers of assessed quality using either capability approval or qualification approval procedures.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60027 (all parts), *Letter symbols to be used in electrical technology*

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at www.electropedia.org)

IEC 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-7, *Basic environmental testing procedures – Part 2-7: Tests – Test Ga and guidance: Acceleration, steady state*

IEC 60068-2-13, *Basic environmental testing procedures – Part 2-13: Tests – Test M: Low air pressure*

IEC 60068-2-14, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-17:1994, *Basic environmental testing procedures – Part 2-17: Tests – Test Q: Sealing*

IEC 60068-2-27, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-31, *Environmental testing – Part 2-31: Tests – Test Ec: Rough handling shocks, primarily for equipment-type specimens*

IEC 60068-2-45, *Basic environmental testing procedures – Part 2-45: Tests – Test XA and guidance: Immersion in cleaning solvents*

IEC 60068-2-52, *Environmental testing – Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)*

IEC 60068-2-58, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60068-2-64, *Environmental testing – Part 2-64: Tests – Test Fh: Vibration, broad-band random and guidance*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60122-1, *Quartz crystal units of assessed quality – Part 1: Generic specification*

IEC 60617, *Graphical symbols for diagrams* (available at http://std.iec.ch/iec60617)

IEC 60642, *Piezoelectric ceramic resonators and resonator units for frequency control and selection – Chapter I: Standard values and conditions – Chapter II: Measuring and test conditions*

IEC 60695-11-5, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

IEC 60749-28[1], *Semiconductor devices – mechanical and climatic test methods – Part 28: Electrostatic Discharge (ESD) Sensitivity testing direct contact charged device model (DC-CDM)*

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61340-3-1, *Electrostatics – Part 3-1: Methods for simulation of electrostatic effects – Human body model (HBM) electrostatic discharge test waveforms*

IEC 61340-3-2, *Electrostatics – Part 3-2: Methods for simulation of electrostatic effects – Machine model (MM) electrostatic discharge test waveforms*

IEC 62761, *Guidelines for the measurement method of nonlinearity for surface acoustic wave (SAW) and bulk acoustic wave (BAW) devices in radio frequency (RF)*

IEC 80000 (all parts), *Quantities and units*

ISO 80000 (all parts), *Quantities and units*

3 Terms, definitions, units and symbols

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

[1] To be published.

3.1.1 General terms

3.1.1.1
surface acoustic wave
SAW
acoustic wave, propagating along a surface of an elastic material, whose amplitude decays exponentially with the depth

[SOURCE: IEC 60862-1:2003, 2.2.1.1, modified — In the definition, "elastic substrate" has been replaced with "elastic material" and "substrate depth" has been replaced with "the depth".]

3.1.1.2
surface acoustic wave filter
SAW filter
filter characterized by one or more surface acoustic wave transmission line or resonant elements, where the surface acoustic wave is usually generated by an interdigital transducer and propagates along a material surface

[SOURCE: IEC 60862-1:2003, 2.2.1.2, modified]

3.1.1.3
bulk acoustic wave
BAW
acoustic wave, propagating inside an elastic material and then traversing the entire thickness of the bulk

3.1.1.4
bulk acoustic wave filter
BAW filter
filter characterized by a bulk acoustic wave which is usually generated by a pair of electrodes and propagates along a thickness direction

3.1.1.5
film bulk acoustic resonator
FBAR
thin film BAW resonator consisting of a piezoelectric layer sandwiched between two electrode layers with stress-free top and bottom surface supported mechanically at the edge on a substrate with cavity structure as shown in Figure 1 or membrane structure as an example

Note 1 to entry: This note applies to the French language only.

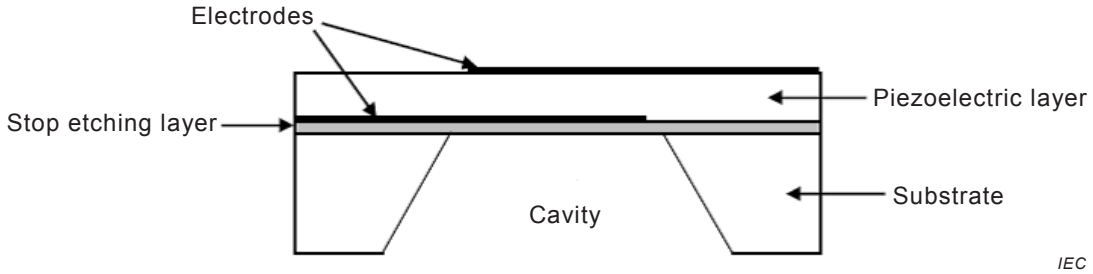

Figure 1 – FBAR configuration

3.1.1.6
solidly mounted resonator
SMR
BAW resonator, supporting the electrode/piezoelectric layer/electrode structure by a sequence of additional thin films of alternately low and high acoustic impedance with quarter

wavelength layer, these layers acting as acoustic reflectors and decoupling the resonator acoustically from the substrate, as shown in Figure 2 as an example

Note 1 to entry: This note applies to the French language only.

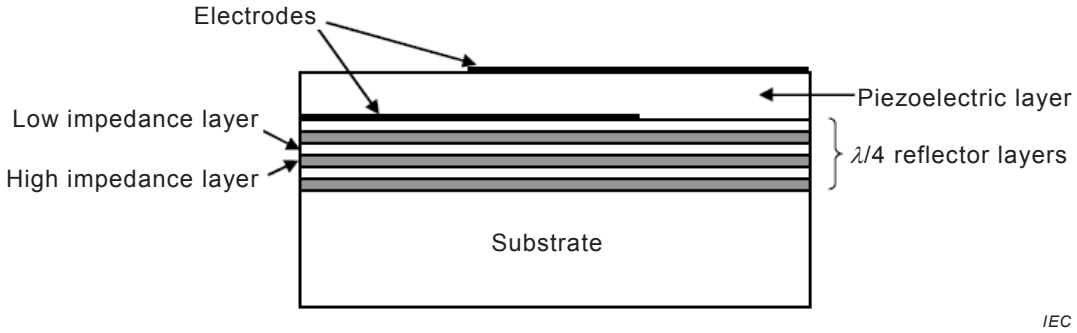

Figure 2 – SMR configuration

3.1.2 Response characteristics related terms

3.1.2.1
reference frequency
frequency defined by the specification to which other frequencies may be referred

[SOURCE: IEC 60862-1:2003, 2.2.2.3]

3.1.2.2
insertion attenuation
logarithmic ratio of the power delivered directly to the load impedance before insertion of the duplexer to the power delivered to the load impedance after insertion of the duplexer

[SOURCE: IEC 60862-1:2003, 2.2.2.6, modified — In the definition, "filter" has been replaced with "duplexer".]

3.1.2.3
nominal insertion attenuation
insertion attenuation at a specified reference frequency

[SOURCE: IEC 60862-1:2003, 2.2.2.7]

3.1.2.4
relative attenuation
difference between the attenuation at a given frequency and the attenuation at the reference frequency

[SOURCE: IEC 60862-1:2003, 2.2.2.8]

3.1.2.5
pass band
band of frequencies in which the relative attenuation is equal to or less than a specified value

[SOURCE: IEC 60862-1:2003, 2.2.2.9]

3.1.2.6
pass bandwidth
separation of frequencies between which the relative attenuation is equal to or less than a specified value

[SOURCE: IEC 60862-1:2003, 2.2.2.10]

3.1.2.7
pass band ripple
maximum variation in attenuation characteristics within a specified pass band

[SOURCE: IEC 60862-1:2003, 2.2.2.11]

3.1.2.8
minimum insertion attenuation
minimum value of insertion attenuation in the pass band

[SOURCE: IEC 60862-1:2003, 2.2.2.13]

3.1.2.9
maximum insertion attenuation
maximum value of insertion attenuation in the pass band

[SOURCE: IEC 60862-1:2003, 2.2.2.14]

3.1.2.10
stop band
band of frequencies in which the relative attenuation is equal to or greater than a specified value

[SOURCE: IEC 60862-1:2003, 2.2.2.15]

3.1.2.11
stop bandwidth
separation of frequencies between which the relative attenuation is equal to or greater than a specified value

[SOURCE: IEC 60862-1:2003, 2.2.2.16]

3.1.2.12
stop band rejection
minimum relative attenuation at a specified stop band

3.1.2.13
group delay
time equal to the first derivative of the phase shift, in radians, with respect to the angular frequency

[SOURCE: IEC 60862-1:2003, 2.2.2.18]

3.1.2.14
trap frequency
specified frequency at which the relative attenuation is equal to or greater than a specified value

[SOURCE: IEC 60862-1:2003, 2.2.2.21]

3.1.2.15
trap attenuation
relative attenuation at a specified trap frequency

[SOURCE: IEC 60862-1:2003, 2.2.2.22]

3.1.2.16
transition band
band of frequencies between the cut-off frequency and the nearest point of the adjacent stop band

[SOURCE: IEC 60862-1:2003, 2.2.2.23]

3.1.2.17
reflectivity
dimensionless measure of the degree of mismatch between two impedances Z_a and Z_b:

$$\frac{Z_a - Z_b}{Z_a + Z_b},$$

where Z_a and Z_b represent, respectively, the input and source impedance or the output and load impedance

Note 1 to entry: The absolute value of reflectivity is called the reflection coefficient.

3.1.2.18
return attenuation
value of the reflection coefficient given by the sign changed expression in decibels:

$$-20 \log \left| \frac{Z_a - Z_b}{Z_a + Z_b} \right| \text{ dB}$$

[SOURCE: IEC 60862-1:2003, 2.2.2.25, modified]

3.1.2.19
input level
power, voltage or current value applied to the input port of a duplexer

[SOURCE: IEC 60862-1:2003, 2.2.2.29, modified — In the definition, "input terminal pair of a filter" has been replaced with "input port of a duplexer".]

3.1.2.20
output level
power, voltage or current value delivered to the load circuit

[SOURCE: IEC 60862-1:2003, 2.2.2.30, modified — In the definition, "load" has been replaced with "load circuit".]

3.1.2.21
nominal level
power, voltage or current value at which the performance measurement is specified

[SOURCE: IEC 60862-1:2003, 2.2.2.31]

3.1.2.22
input impedance
impedance presented by the duplexer to the signal source when the output is terminated by a specified load impedance

[SOURCE: IEC 60862-1:2003, 2.2.2.32, modified — In the definition, "filter" has been replaced with "duplexer".]

3.1.2.23
output impedance
impedance presented by the duplexer to the load when the input is terminated by a specified source impedance

[SOURCE: IEC 60862-1:2003, 2.2.2.33, modified — In the definition, "filter" has been replaced with "duplexer".]

3.1.2.24
terminating impedance
impedance presented to the duplexer by the source or by the load

[SOURCE: IEC 60862-1:2015, 3.1.2.35, modified — In the definition, "filter" has been replaced with "duplexer".]

3.1.2.25
operating temperature range
range of temperatures, over which the SAW or BAW duplexer will function while maintaining its specified characteristics within specified tolerances

[SOURCE: IEC 60862-1:2003, 2.2.2.37, modified — In the definition, "SAW filter" has been replaced with "SAW or BAW duplexer".]

3.1.2.26
intermodulation distortion
IMD
non-linear distortion of a device response characterized by the appearance of frequencies at the output which is equal to the differences (or sums) of integral multiples of the two or more component frequencies present at the input

[SOURCE: IEC 60862-1:2003, 2.2.2.41, modified — The abbreviation "IMD" has been added. In the definition, "SAW transducer or filter" has been replaced with "device".]

Note 1 to entry: This note applies to the French language only.

3.1.2.27
duplex image frequency
f_{DIM}
undesired input frequency that is converted to the receiving frequency (f_R) by subtracting it from twice the transmitting frequency ($2f_T$)

$$f_{DIM} = 2f_T - f_R$$

3.1.2.28
isolation
isolation from TX port to RX port
leakage power ratio from the TX port to the RX port in a duplexer

Note 1 to entry: Figure 3c gives an example of isolation response.

3.1.2.29
guard band
unused part of the radio spectrum between radio bands, for the purpose of preventing interference

3.1.3 SAW and BAW duplexers related terms

3.1.3.1
duplexer
device used in the frequency division duplex system, which enables signal to be received and transmitted through a common antenna simultaneously

3.1.3.2
diplexer
device which separates composite signals into two parts of two frequency domains

Note 1 to entry: This can be used to combine signals in two frequency domains into composite signals, in reverse.

3.1.3.3
TX filter
filter used in a transmitter part to eliminate unnecessary signals

Note 1 to entry: This is a basic part of a duplexer.

Note 2 to entry: Figure 3a gives an example of TX filter response.

3.1.3.4
RX filter
filter used in a receiver part to eliminate unnecessary signals

Note 1 to entry: This is a basic part of a duplexer.

Note 2 to entry: Figure 3b gives an example of RX filter response.

3.1.3.5
phase shifter
device which changes the phase of signals, not the frequency of them

Note 1 to entry: This is a basic part of a duplexer.

3.1.3.6
stress migration
phenomenon of electrode defect caused by stress corresponding to distortion proportional to the input power in the resonator

3.1.3.7
breakdown
phenomenon of failure by insulation breakdown when applying high power

3.1.3.8
void
vacancy in the IDT electrode caused by stress migration resulting from diffusing and/or transfer of metal atoms forming part of the electrode

3.1.3.9
hillock
projection on the side or upper surface of the electrode caused by stress migration resulting from diffusing and/or transfer of metal atoms forming part of the electrode

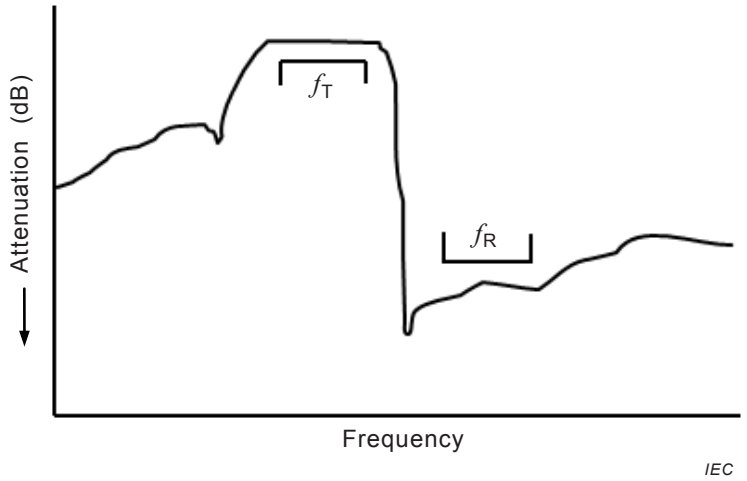

Figure 3a – Basic TX filter response example of SAW and BAW duplexers

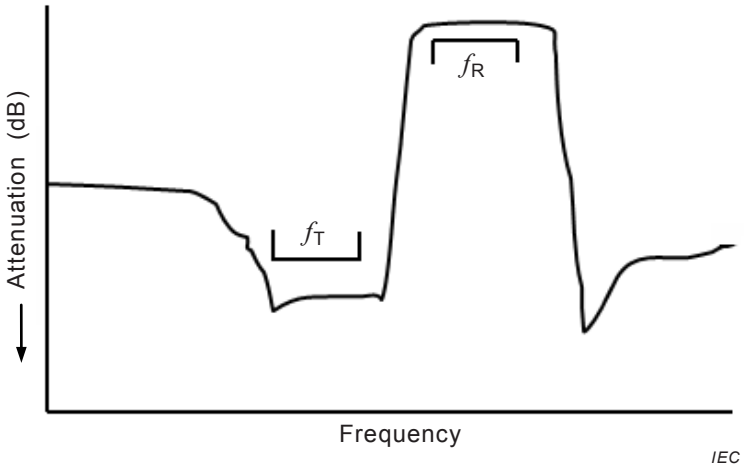

Figure 3b – Basic RX filter response example of SAW and BAW duplexers

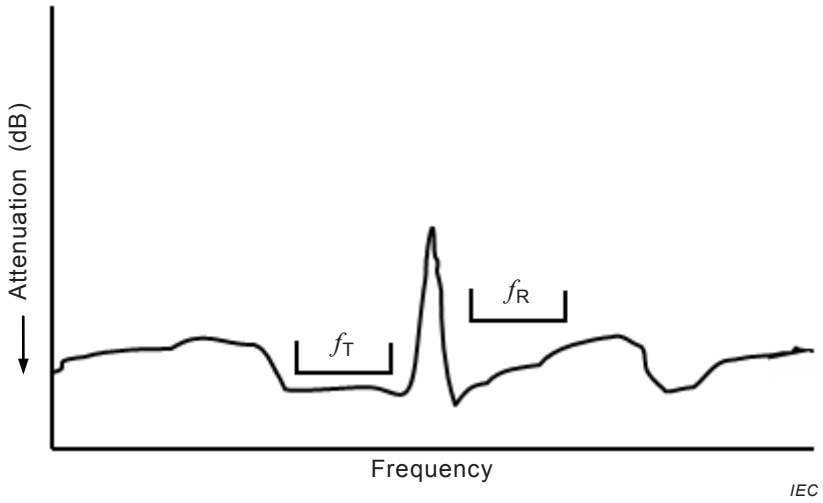

Figure 3c – Basic isolation response example of SAW and BAW duplexers

Figure 3 – Frequency response of SAW and BAW duplexers

3.2 Units and graphical symbols

Units, graphical symbols, letter symbols and terminology shall, wherever possible, be taken from the following International Standards:

– IEC 60027;
– IEC 60050-561;
– IEC 60617;
– IEC 60642;
– IEC 60122-1;
– IEC 80000;
– ISO 80000.

4 Order of precedence of documents

Where any discrepancies occur for any reason, documents shall rank in the following order of precedence:

– the detail specification;
– the sectional specification;
– the generic specification;
– any other international documents (for example, of the IEC) to which reference is made.

The same order of precedence shall apply to equivalent national documents.

5 Preferred values for ratings and characteristics

5.1 General

Values should be chosen from subclauses 5.2 to 5.8 unless otherwise stated in the detail specification.

5.2 Nominal frequency bands

Table 1 shows the frequency allocation of typical UMTS bands.

Table 1 – Frequency allocation of typical UMTS bands

Band	Transmitting frequency (MHz)	Receiving frequency (MHz)
I	1 920 to 1 980	2 110 to 2 170
II	1 850 to 1 910	1 930 to 1 990
III	1 710 to 1 785	1 805 to 1 880
IV	1 710 to 1 755	2 110 to 2 155
V	824 to 849	869 to 894
VIII	880 to 915	925 to 960

5.3 Operating temperature ranges, in degrees Celsius (°C)

–45 to +125

–40 to +85

–30 to +85

–20 to +75

–20 to +70

–10 to +60

0 to +60

Other temperature ranges may be used but the lowest temperature should be not lower than -60 °C and the highest temperature should not exceed 125 °C

5.4 Climatic category

- 40/085/56 (climatic categories are given in accordance with Annex A of IEC 60068-1:2013): for ceramic enclosures.

  For requirements where the operating temperature range of the SAW and BAW duplexers is greater than –40 °C to +85 °C, a climatic category consistent with the operating temperature range shall be specified.
- 20/085/21 (climatic categories are given in accordance with Annex A of IEC 60068-1:2013): for plastic packages.

5.5 Bump severity

(4 000 ± 10) bumps at 400 m/s^2 peak acceleration in each direction along three mutually perpendicular axes (see 8.6.5).

Pulse duration: 6 ms.

5.6 Vibration severity

a) Sinusoidal

10 Hz to 55 Hz	
0,75 mm displacement amplitude	
(peak value)	30 min in each of three
	mutually perpendicular axes
55 Hz to 500 Hz or 55 Hz to 2 000 Hz	at 1 octave/min (see 8.6.6)
100 m/s^2 acceleration amplitude	
(peak value)	
or	
10 Hz to 55 Hz	
1,5 mm displacement amplitude	
(peak value)	30 min in each of three
	mutually perpendicular axes
55 Hz to 2 000 Hz	at 1 octave/min (see 8.6.6)
200 m/s^2 acceleration amplitude	
(peak value)	

b) Random

(19,2 m/s^2)^2/Hz between	30 min in each of three
20 Hz and 2 000 Hz	mutually perpendicular axes
62 m/s^2 acceleration	at 1 octave/min (see 8.6.6)

or	
(19,2 m/s^2)^2/Hz between	30 min in each of three
20 Hz and 2 000 Hz	mutually perpendicular axes
196 m/s^2 acceleration	at 1 octave/min (see 8.6.6)
or	
(48 m/s^2)^2/Hz between	30 min in each of three
20 Hz et 2 000 Hz	mutually perpendicular axes
314 m/s^2 acceleration	at 1 octave/min (see 8.6.6)

5.7 Shock severity

1 000 m/s^2 peak acceleration for 6 ms duration; three shocks in each direction along three mutually perpendicular axes (see 8.6.7), half sine pulse, unless otherwise stated in the detail specification.

5.8 Fine leak rate

10^{-1} Pa cm^3/s (10^{-6} bar cm^3/s)

10^{-3} Pa cm^3/s (10^{-8} bar cm^3/s)

6 Marking

6.1 Duplexer marking

Surface acoustic wave and bulk acoustic wave duplexers shall be clearly and durably marked (see 8.6.17) along with items a) to g) in the order given below and, if possible, with as many of the remaining items as considered necessary:

a) type designation as defined in the detail specification;
b) nominal frequency in megahertz (MHz);
c) year and week of manufacture;
d) mark of conformity (unless a certificate of conformity is used);
e) factory identification code;
f) manufacturer’s name or trademark;
g) terminal identification (if applicable);
h) designation of electrical connections (if applicable);
i) serial number (if applicable);
j) surface mounted device classification (if applicable).

Where the available surface area of miniature SAW and BAW duplexers imposes practical limits on the amount of marking, instructions on the marking to be applied shall be given in the detail specification.

6.2 Package marking

The primary packaging containing the SAW and BAW duplexers shall be clearly marked with the information listed in 6.1, except item g), and electrostatic sensitive device identification where necessary.

7 Quality assessment procedures

7.1 General

Two methods are available for the approval of SAW and BAW duplexers of assessed quality: capability approval and qualification approval.

7.2 Primary stage of manufacture

The primary stage of manufacture for a SAW or BAW duplexer is the final surface cleaning of substrates.

7.3 Structurally similar components

The grouping of structurally similar SAW and BAW duplexers for the purpose of qualification approval, capability approval and quality conformance inspection shall be prescribed in the relevant sectional specification.

7.4 Subcontracting

These procedures shall be in accordance with the specified quality assessment system.

However, the final surface cleaning of the substrate and all subsequent processes shall be carried out by the manufacturer to whom approval has been granted.

7.5 Incorporated components

Where the final component contains components of a type covered by a generic specification in the IEC series, these shall be produced using the normal IEC release procedures.

7.6 Manufacturer’s approval

To obtain the manufacturer’s approval, the manufacturer shall meet the requirements of the specified quality assessment system.

7.7 Approval procedures

7.7.1 General

To qualify a SAW or BAW duplexer, either capability approval or qualification approval procedures may be used. These procedures conform to those stated in the specified quality assessment system.

7.7.2 Capability approval

Capability approval is appropriate when structurally similar SAW and BAW duplexers based on common design rules are fabricated by a group of common processes.

Under capability approval, detail specifications fall into the following three categories:

a) Capability qualifying components (CQCs)

   A detail specification shall be prepared for each CQC. It shall identify the purpose of the CQC and include all relevant stress levels and test limits.

b) Standard catalogue items

   When a component covered by the capability approval procedure is intended to be offered as a standard catalogue item, a detail specification complying with the blank detail specification shall be written.

c) Custom built SAW and BAW duplexers

The content of the detail specification shall be by agreement between the manufacturer and the customer in accordance with the specified quality assessment system.

Further information on detail specifications is contained in the sectional specification.

The product and capability qualifying components (CQCs) are tested in combination and approval given to a manufacturing facility on the basis of validated design rules, processes and quality control procedures. Further information is given in 7.8 and in the sectional specification.

7.7.3 Qualification approval

Qualification approval is appropriate for components manufactured to a standard design and established production process and conforming to a published detail specification.

The programme of tests defined in the detail specification for the appropriate assessment and severity level applies directly to the SAW or BAW duplexer to be qualified, as prescribed in 7.9 and the sectional specification.

7.8 Procedures for capability approval

7.8.1 General

The procedures for capability approval shall be in accordance with the specified quality assessment system.

7.8.2 Eligibility for capability approval

The manufacturer shall comply with the requirements of the specified quality assessment system and the primary stage of manufacture as defined in 7.2.

7.8.3 Application for capability approval

In order to obtain capability approval, the manufacturer shall apply the rules of procedure given in the specified quality assessment system.

7.8.4 Granting of capability approval

Capability approval shall be granted when the procedures in accordance with the specified quality assessment system have been successfully completed.

7.8.5 Capability manual

The contents of the description of capability manual shall be in accordance with the requirements of the sectional specification.

The capability manual shall be treated as a confidential document. The manufacturer may, if he so wishes, disclose part or all of it to a third party.

7.9 Procedures for qualification approval

7.9.1 General

The procedures for qualification approval shall be in accordance with the specified quality assessment system.

7.9.2 Eligibility for qualification approval

The manufacturer shall comply with the requirements of the specified quality assessment system and the primary stage of manufacture as defined in 7.2.

7.9.3 Application for qualification approval

In order to obtain qualification approval, the manufacturer shall apply the rules of procedure given in the specified quality assessment system.

7.9.4 Granting of qualification approval

Qualification approval shall be granted when the procedures in accordance with the specified quality assessment system have been successfully completed.

7.9.5 Quality conformance inspection

The blank detail specification associated with the sectional specification shall prescribe the test schedule for quality conformance inspection.

7.10 Test procedures

The test procedures to be used shall be selected from Clause 8. If any required test is not included then it shall be defined in the detail specification.

7.11 Screening requirements

Where screening is required by the customer for SAW and BAW duplexers, this shall be specified in the detail specification.

7.12 Rework and repair work

7.12.1 Rework

Rework is the rectification of processing errors and shall not be carried out.

7.12.2 Repair work

Repair work is the correction of defects in a component after release to the customer.

Components that have been repaired can no longer be considered as representative of the manufacturer's production and may not be released under the specified quality assessment system.

7.13 Certified records of released lots

When certified records of released lots (CRRL) are prescribed in the sectional specification for qualification approval and are requested by the customer, the results of the specified tests shall be summarized.

7.14 Validity of release

SAW and BAW duplexers held for a period exceeding two years following acceptance inspection shall be reinspected for the electrical tests detailed in 8.5.1 with a sample tested as described in 8.5.3, prior to release.

7.15 Release for delivery

SAW and BAW duplexers shall be released in accordance with the specified quality assessment system.

7.16 Unchecked parameters

Only those parameters of a component which have been specified in a detail specification and which were subject to testing can be assumed to be within the specified limits. It should not

be assumed that any parameter not specified will remain unchanged from one component to another. Should it be necessary for further parameters to be controlled, then a new, more extensive, detail specification should be used. The additional test method(s) shall be fully described and appropriate limits, acceptable quality limits (AQLs) or defects per million and inspection levels specified.

8 Test and measurement procedures

8.1 General

The test and measurement procedures shall be carried out in accordance with the relevant detail specification.

8.2 Test and measurement conditions

8.2.1 Standard conditions for testing

Unless otherwise specified, all tests shall be carried out under the standard atmospheric conditions for testing as specified in 4.3 of IEC 60068-1:2013:

Temperature	15 °C	to 35 °C
Relative humidity	45 %	to 75 %
Air pressure	86 kPa	to 106 kPa
	(860 mbar	to 1 060 mbar)

In case of dispute, the referee conditions are:

Temperature	25 °C ± 1 °C	
Relative humidity	48 %	to 52 %
Air pressure	86 kPa	to 106 kPa
	(860 mbar	to 1 060 mbar)

Before measurements are made, the SAW or BAW duplexer shall be stored at the measuring temperature for a time sufficient to allow the SAW or BAW duplexer to reach thermal equilibrium. Controlled recovery conditions and standard conditions for assisted drying are given in 4.4 of IEC 60068-1:2013.

The ambient temperature during the measurements shall be recorded and stated in the test report.

8.2.2 Precision of measurement

The limits given in detail specifications are true values. Measurement inaccuracies shall be taken into account when evaluating the results. Precautions shall be taken to reduce measurement errors to a minimum.

8.2.3 Precautions

8.2.3.1 Measurements

The measurement circuits shown for specified electrical tests are the preferred circuits. Due allowance shall be made for any loading effects in cases where the measuring apparatus modifies the characteristics being examined.

8.2.3.2 Electrostatic sensitive devices

Where the component is identified as electrostatic sensitive, precautions shall be taken to prevent damage from static charge before, during and after test (see IEC 61000-4-2).

8.2.4 Alternative test methods

Measurements shall preferably be carried out using the methods specified. Any other method giving equivalent results may be used except in case of dispute.

NOTE By “equivalent” is meant that the value of the characteristic established by such other method falls within the specified limits when measured by the specified method.

8.3 Visual inspection

8.3.1 General

Unless otherwise specified, external visual examination shall be performed under normal factory lighting and visual conditions.

8.3.2 Visual test A

The SAW or BAW duplexer shall be visually examined to ensure that the condition, workmanship and finish are satisfactory. The marking shall be legible.

8.3.3 Visual test B

The SAW or BAW duplexer shall be visually examined. There shall be no corrosion or other deterioration likely to impair satisfactory operation. The marking shall be legible.

8.4 Dimensions test

The dimensions shall be measured and shall comply with the specified values.

8.5 Electrical test procedures

8.5.1 S parameters measurement

8.5.1.1 Principle of measurement

The simplest and most popular method of testing SAW and BAW duplexers is to use a multi-port network analyzer. The system impedance of such equipment is usually 50 Ω and, therefore, the termination condition between the duplexer and the equipment has to be considered if necessary.

The measurement method shall be basically performed in accordance with the measurement method of IEC 60862-1. However, in the evaluation of the duplexer, the instructions given in the application notes from the manufacturer should be considered. Since the duplexer is a multi-port device, it is recommended to use multi-port network analyzers. Figure 4 shows a schematic diagram of a 4-port network analyzer, as an example.

However, a conventional 2-port network analyzer can also be used for measuring the characteristics between any two ports chosen from three ports of the duplexer with a 50 Ω termination of the un-chosen port. A vector voltmeter or other duplexer test equipment can also be used instead of the network analyzer.

Figure 4 shows a schematic diagram of duplexer characteristics, as an example. The scattering matrix elements, i.e. S parameters, S_{12}, S_{31} and S_{32}, are complex numbers and correspond to TX characteristics, RX characteristics and isolation between TX and RX ports, respectively, in this case.

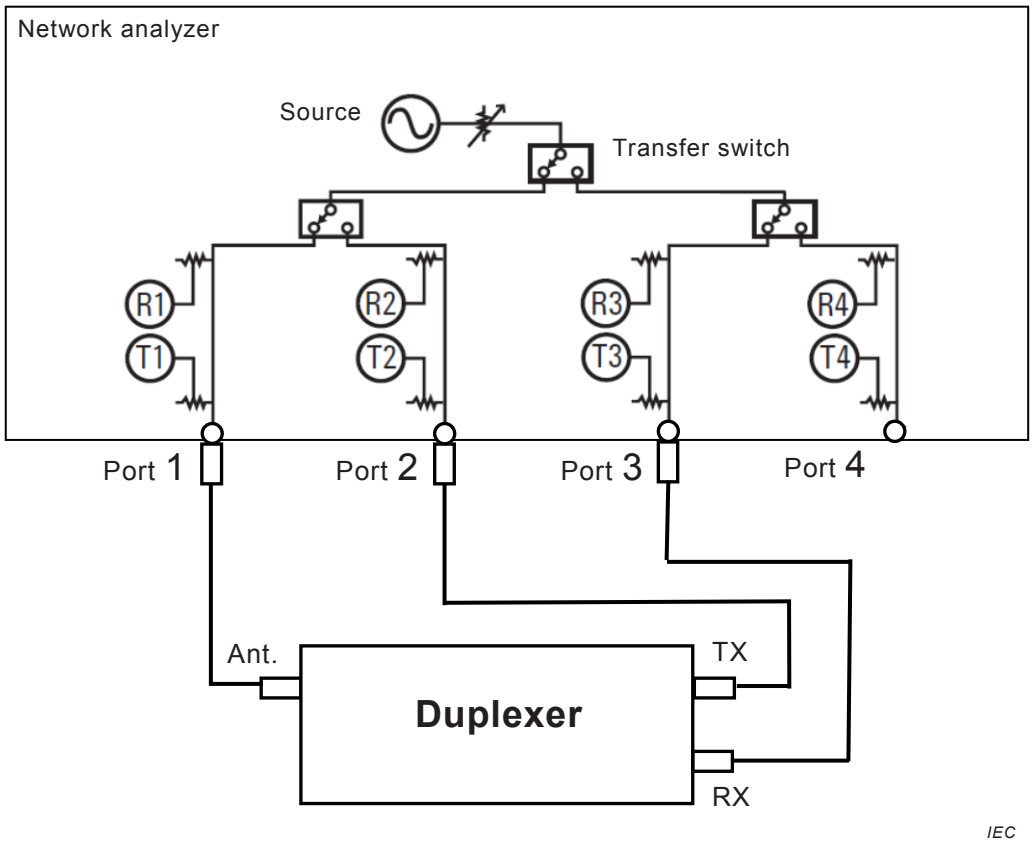

Figure 4 – S parameters measurement

8.5.1.2 Duplexer test fixture

Duplexers sometimes have terminating impedance different from that of the equipment system impedance. In these cases, the impedance matching networks are necessary in the test fixture, or for calculation of impedance transformation.

Any port of the test fixture shall be well-shielded from the other ports.

8.5.1.3 Measurement method

Before connecting the duplexer test fixture, a calibration of the network analyzer shall be made in order to eliminate systematic error in the network analyzer, cable and connectors. The full three-port calibration technique may be the best method to compensate for systematic errors (i.e. presenting open-circuit impedance, short-circuit impedance and the reference impedance, normally 50 Ω, and through standards at the ends of test cable connectors and storing the measured values for correction of duplexer impedance measurement.) After calibration, connect the duplexer test fixture at the place indicated in Figure 4. Connect a duplexer to the test fixture, then a scattering matrix (S parameters) of the duplexer can be achieved from the network analyzer.

8.5.1.4 Insertion attenuation, return attenuation and isolation measurement

Insertion attenuation, return attenuation and isolation of a duplexer can be calculated from the measured scattering matrix (S parameters). If terminating impedances of all ports of the duplexer under test are equal to the system impedance of the test equipment, calculation is very simple such as,

Insertion attenuation between TX and antenna ports $-20 \log |S_{12}|$ dB

Insertion attenuation between antenna and RX ports $-20 \log |S_{31}|$ dB

Isolation between TX and RX ports $-20 \log |S_{32}|$ dB

Return attenuation of port i (i = 1,3) $-20 \log |S_{ii}|$ dB

8.5.1.5 Phase and group delay measurement

Phase of any transmission or reflection characteristic can be calculated from the related complex S parameter. Group delay can be determined using the phase difference between two measuring frequencies as described in 5.5.4.1 of IEC 60862-1:2003.

8.5.2 Intermodulation distortion measurement

Refer to IEC 62761.

8.5.3 Insulation resistance

Insulation resistance shall be measured by means of direct voltage as specified in the detail specification. This voltage is applied between:

a) the terminations;

b) the terminations connected together and the metal portion of the case (if any).

Insulation resistance shall be not less than the value specified in the relevant detail specification.

8.5.4 Voltage proof

The duplexer shall pass the following tests without evidence of arcing, flashover, insulation breakdown or damage.

An alternating voltage of specified value shall be applied for a period of 5 s between:

a) the terminations;

b) the terminations connected together and the metal portion of the case (if any).

8.6 Mechanical and environmental test procedures

8.6.1 Sealing tests (non-destructive)

8.6.1.1 Gross leak test

This test shall be performed in accordance with the procedure specified in test method 1 or 2 of Test Qc of IEC 60068-2-17.

a) Method 1

   The liquid shall be degassed water and the pressure of air above the water shall be reduced to 8,5 kPa (85 mbar) or less, and it shall not be necessary to drain or remove the specimen from the water before breaking the vacuum.

b) Method 2

   The detail specification shall define the temperature at which the liquid shall be maintained.

   The immersion time shall be 30 s, unless otherwise specified in the relevant detail specification.

   During the test there shall be no evidence of leakage of gas or air from the inside of the SAW or BAW duplexer. The continuous formation of bubbles shall be evidence of leakage.

   After the test, there shall be no visible damage to the duplexer.

8.6.1.2 Fine leak test

The test shall be performed in accordance with 6.4, Test method 1 of Test Qk of IEC 60068-2-17:1994.

Unless otherwise stated in the detail specification, the pressure in the pressure vessel shall be 200 kPa (2 bar). However, the pressure shall be chosen so as not to cause mechanical damage to the device under test.

The maximum leak rate shall not exceed the value stated in 6.6 of IEC 60068-2-17:1994, unless otherwise stated in the detail specification.

8.6.2 Soldering (solderability and resistance to soldering heat) (destructive)

8.6.2.1 Solderability

This test shall be performed in accordance with Test Td of IEC 60068-2-58 for surface mounting devices. The terminations shall be examined for good wetting.

8.6.2.2 Resistance to soldering heat

This test shall be performed in accordance with Test Td of IEC 60068-2-58 for surface mounting devices.

8.6.3 Rapid change of temperature: severe shock by liquid immersion (non-destructive)

The test shall be performed in accordance with Test Nc of IEC 60068-2-14. The duplexers shall be subjected to one cycle in a downward direction from (98 ± 3) °C for 15 s to (1 ± 1) °C for 5 s.

8.6.4 Rapid change of temperature with prescribed time of transition (non-destructive)

The test shall be performed in accordance with Test Na of IEC 60068-2-14.

The low and high test chamber temperatures shall be the extreme temperatures of the operating range stated in the detail specification.

The SAW or BAW duplexer shall be maintained at each extreme of temperature for 30 min, unless otherwise specified in the detail specification.

The SAW or BAW duplexer shall be subjected to five complete thermal cycles and then exposed to standard atmospheric conditions for recovery for not less than 2 h.

8.6.5 Bump (destructive)

The test shall be performed in accordance with Test Ea of IEC 60068-2-27.

NOTE Bump test means repetitive shock test in comparison with non-repetitive shock test specified in 8.6.7.

The SAW or BAW duplexer shall be mounted or clamped as required by the detail specification. The three mutually perpendicular axes in which the bump is to be applied shall include:

– an axis perpendicular to the base of the SAW or BAW duplexer;

– an axis parallel to the base of the SAW or BAW duplexer.

The degree of severity shall be as stated in the detail specification.

8.6.6 Vibration (destructive)

8.6.6.1 Vibration (sinusoidal) (SAW or BAW duplexer not operating)

The test shall be performed in accordance with Test Fc of IEC 60068-2-6.

The SAW or BAW duplexer shall be mounted or clamped as required by the detail specification. The three mutually perpendicular axes in which the acceleration is to be applied shall include:

– an axis perpendicular to the base of the SAW or BAW duplexer;
– an axis parallel to the base of the SAW or BAW duplexer.

The degree of the severity shall be stated in the detail specification.

8.6.6.2 Vibration (sinusoidal) (SAW or BAW duplexer operating)

The test shall be as specified in 8.6.6.1, except that during the test the duplexer shall be energized and electrical tests, as defined in the detail specification, shall be performed.

The degree of severity shall be stated in the detail specification.

8.6.6.3 Random vibration (SAW or BAW duplexer not operating)

The test shall be performed in accordance with Test Fh of IEC 60068-2-64.

The SAW or BAW duplexer shall be mounted or clamped as required by the detail specification. The three mutually perpendicular axes in which the acceleration is to be applied shall include:

– an axis perpendicular to the base of the SAW or BAW duplexer;
– an axis parallel to the base of the SAW or BAW duplexer.

The detail specification shall state the acceleration spectral density (ASD), the frequency range and the duration.

8.6.6.4 Random vibration (SAW or BAW duplexer operating)

The test shall be as specified in 8.6.6.3, except that during the test the duplexer shall be energized and electrical tests, as defined in the detail specification, shall be performed.

8.6.7 Shock (destructive)

The test shall be performed in accordance with Test Ea of IEC 60068-2-27.

The SAW or BAW duplexer shall be mounted or clamped as required by the detail specification. The three mutually perpendicular axes in which the shock is to be applied shall include:

– an axis parallel to the terminations;
– an axis parallel to the base of the SAW or BAW duplexer.

The degree of severity shall be as stated in 5.7, unless otherwise stated in the detail specification.

8.6.8 Free fall (destructive)

The test shall be performed in accordance with Procedure 1 of Test Ec of IEC 60068-2-31.

The SAW or BAW duplexer shall be suspended by its terminations at a height of 1 000 mm ± 5 mm and dropped onto a base, the material of which shall be defined in the detail specification. The number of falls shall be two, unless otherwise stated in the detail specification.

8.6.9 Acceleration, steady state (non-destructive)

8.6.9.1 Acceleration, steady state (duplexer not operating)

The test shall be performed in accordance with Test Ga of IEC 60068-2-7.

The SAW or BAW duplexer shall be mounted or clamped as required by the detail specification. The procedure and severity shall be as stated in the detail specification.

8.6.9.2 Acceleration, steady state (duplexer operating)

The test shall be as specified in 8.6.9.1, except that during the test the duplexer shall be energized and electrical tests, as defined in the detail specification, shall be performed.

The procedure and severity shall be as stated in the detail specification.

8.6.10 Low air pressure (non-destructive)

This test shall be performed in accordance with Test M of IEC 60068-2-13. The pressure in the chamber shall be reduced to 25 kPa for a duration of 2 h, unless otherwise stated in the detail specification.

8.6.11 Dry heat (non-destructive)

The test shall be performed in accordance with Test Bb of IEC 60068-2-2. The conditioning shall be carried out at the upper temperature indicated by the climatic category for a duration of 16 h, unless otherwise stated in the detail specification.

8.6.12 Damp heat, cyclic (destructive)

This test shall be performed in accordance with Test Db, Variant 1 of IEC 60068-2-30, at severity b), 55 °C for six cycles.

8.6.13 Cold (non-destructive)

This test shall be performed in accordance with Test Ab of IEC 60068-2-1 at the lower temperature indicated by the climatic category for a duration of 2 h, unless otherwise stated in the detail specification.

8.6.14 Climatic sequence (destructive)

The test and measurements shall be performed in the following order:

Dry heat	see 8.6.11;
Damp heat, cyclic	see 8.6.12 (first cycle only);
Cold	see 8.6.13;
Low air pressure	see 8.6.10 (when applicable);
Damp heat, cyclic	see 8.6.12 (remaining five cycles).

In the climatic sequence, an interval of not more than 3 days is permitted between any of these tests, except between the damp heat cyclic (first cycle) and cold test.

In such a case, the cold test shall follow immediately after the recovery period specified for the damp heat test.

8.6.15 Damp heat, steady state (destructive)

This test shall be performed in accordance with Test Cab of IEC 60068-2-78, for the appropriate climatic category stated in 5.4.

8.6.16 Salt mist cyclic (destructive)

This test shall be performed in accordance with Test Kb of IEC 60068-2-52. Severity 1 shall be used unless otherwise stated in the detail specification.

8.6.17 Immersion in cleaning solvents (non-destructive)

This test is applicable to superficial markings only. To establish the permanence of marking, this test shall be performed in accordance with Method 1 of Test XA of IEC 60068-2-45. The detail specification shall prescribe the solvent, the temperature of the solvent, the rubbing material and its dimensions, and the force to be used.

The marking shall be legible.

8.6.18 Flammability test (destructive)

This test shall be performed in accordance with IEC 60695-11-5. The detail specification shall state the duration of application of the test flame selected from 5 s, 10 s, 20 s, 30 s, 60 s, or 120 s, as appropriate to the design and materials of the test specimen.

The duration and extent of burning shall be stated in the detail specification.

8.6.19 Electrostatic discharge (ESD) sensitivity test (destructive)

SAW and BAW duplexers are required to have the property of withstanding electrostatic discharge (ESD).

ESD often occurs when devices are assembled to their equipment. Even after the assembly process, ESD will also be applied to devices through an electric path from outside, such as an antenna.

There are some models for the measurement of ESD sensitivity.

The following models explain the case in which the charged object applies ESD to the terminal of SAW and BAW devices:

a) HBM (Human Body Model)

   This test shall be performed in accordance with IEC 61340-3-1.

   This model simulates the ESD from the charged body of a person who handles the devices.

b) MM (Machine Model)

   This test shall be performed in accordance with IEC 61340-3-2.

   This model simulates the ESD from the charged metallic object which contacts the devices.

c) CDM (Charged Device Model)

   This test shall be performed in accordance with IEC 60749-28.

   This model simulates the case of a device being charged and discharged to the outside object from the device's terminal.

8.7 Endurance test procedure

Ageing (non-destructive): The SAW or BAW duplexer shall be maintained at a temperature of (85 ± 2) °C for a continuous period of 30 days, unless otherwise specified in the detail specification.

After the test period, the duplexer shall be kept at standard atmospheric conditions for testing until thermal equilibrium has been reached.

The specified tests shall be carried out and the final measurements shall be within the limits specified in the detail specification.

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