BS EN 62575-1:2016

BSI Standards Publication

Radio frequency (RF) bulk acoustic wave (BAW) filters of assessed quality

Part 1: Generic specification

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National foreword

This British Standard is the UK implementation of EN 62575-1:2016. It is identical to IEC 62575-1:2015.

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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Date	Text affected

EUROPEAN STANDARD

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

Filtres radiofréquences (RF) à ondes acoustiques de volume (OAV) sous assurance de la qualité - Partie 1: Spécification générique (IEC 62575-1:2015)

Volumenwellen-(BAW-)Filter mit bewerteter Qualität für Hochfrequenz-(HF-)Anwendungen - Teil 1: Fachgrundspezifikation (IEC 62575-1:2015)

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

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European foreword

The text of document 49/1163/FDIS, future edition 1 of IEC 62575-1, 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 62575-1:2016.

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)	2016-09-03
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2018-12-03

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Endorsement notice

The text of the International Standard IEC 62575-1:2015 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 60368 Series	NOTE	Harmonized as EN 60368 Series.
IEC 60862-1:2015	NOTE	Harmonized as EN 60862-1:2015 (not modified).
IEC 61000-4-2	NOTE	Harmonized as EN 61000-4-2.
IEC 62604-1:2015	NOTE	Harmonized as EN 62604-1:2015 (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	EN 60027	Series
IEC 60050-561	-	International electrotechnical vocabulary (IEV) - Part 561: Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection	-	-
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 60068-2-21	-	Environmental testing - Part 2-21: Tests - Test U: Robustness of terminations and integral mounting devices	EN 60068-2-21	-
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)	EN 60749-28 [1)]	-
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	-
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	-
ISO 80000-1	-	Quantities and units - Part 1: General	EN ISO 80000-1	-

[1)] At draft stage.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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RADIO FREQUENCY (RF) BULK ACOUSTIC WAVE (BAW) FILTERS OF ASSESSED QUALITY –

Part 1: Generic specification

FOREWORD

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International Standard IEC 62575-1 has been prepared by IEC technical committee 49: Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection.

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

FDIS	Report on voting
49/1163/FDIS	49/1169/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 62575, published under the general title *Radio frequency (RF) bulk acoustic wave (BAW) filters 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 web site 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.

INTRODUCTION

RF BAW filters are now widely used in mobile communications. While the RF BAW filters have various specifications, many of them can be classified within a few fundamental categories.

Standard specifications, given in the IEC 62575 series, and national specifications or detail specifications issued by manufacturers, define the available combinations of nominal frequency pass bandwidth, ripple, shape factor, terminating impedance, etc. These specifications are compiled to include a wide range of RF BAW filters with standardized performances. It cannot be over-emphasized that the user should, wherever possible, select his RF BAW filters from these specifications, when available, even if it may lead to making small modifications to his circuit to enable standard filters to be used. This applies particularly to the selection of the nominal frequency.

This standard has been compiled in response to a generally expressed desire on the part of both users and manufacturers for guidance on the use of RF BAW filters, so that the filters may be used to their best advantage. To this end, general and fundamental characteristics have been explained in this part of IEC 62575.

It is not the aim of this standard to explain theory, nor to attempt to cover all the eventualities which may arise in practical circumstances. This standard draws attention to some of the more fundamental questions, which should be considered by the user before he places an order for an RF BAW filter for a new application. Such a procedure will be the user's insurance against unsatisfactory performance.

RADIO FREQUENCY (RF) BULK ACOUSTIC WAVE (BAW) FILTERS OF ASSESSED QUALITY –

Part 1: Generic specification

1 Scope

This part of IEC 62575 specifies the methods of test and general requirements for RF BAW filters of assessed quality using either capability approval or qualification approval procedures. Conventional crystal filters standardized in the IEC 60368 series are not covered by this standard.

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 60050-561, *International Electrotechnical Vocabulary (IEV) – Part 561: Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection* (available at http: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 environment test procedures – Part 2-17:Tests –Test Q: Sealing*

IEC 60068-2-21, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*

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

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*

ISO 80000-1, *Quantities and units – Part 1: General*

3 Terms, definitions, units and symbols

3.1 Terms and definitions

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

3.1.1
bulk acoustic wave
BAW
acoustic wave, propagating between the top and bottom surface of a piezoelectric structure and then traversing the entire thickness of the piezoelectric bulk

[1] To be published.

Note 1 to entry: The wave is excited by metal electrodes attached to both sides of the piezoelectric layer.

[SOURCE: IEC 62604-1:2015, 3.1.1.3 – modified, modification of the entire definition and addition of a note to entry]

3.1.2
bulk acoustic wave filter
BAW filter
filter characterised by a bulk acoustic wave which is usually generated by a pair of electrodes and propagates along a thin film thickness direction

[SOURCE: IEC 62604-1:2015, 3.1.1.4]

3.1.3
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.

[SOURCE: IEC 62604-1:2015, 3.1.1.5, modified]

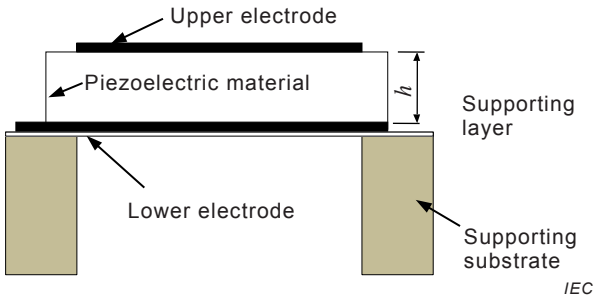


Figure 1a) – Back-side etched

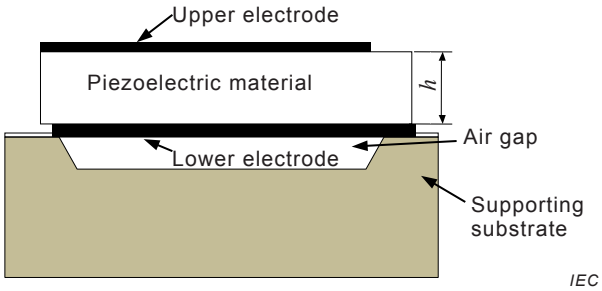


Figure 1b) – Front-side etched

Figure 1 – FBAR configuration

3.1.4
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 Z_a with quarter wavelength layer, and these layers act as acoustic reflectors and decouple 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.

[SOURCE: IEC 62604-1:2015, 3.1.1.6, modified]

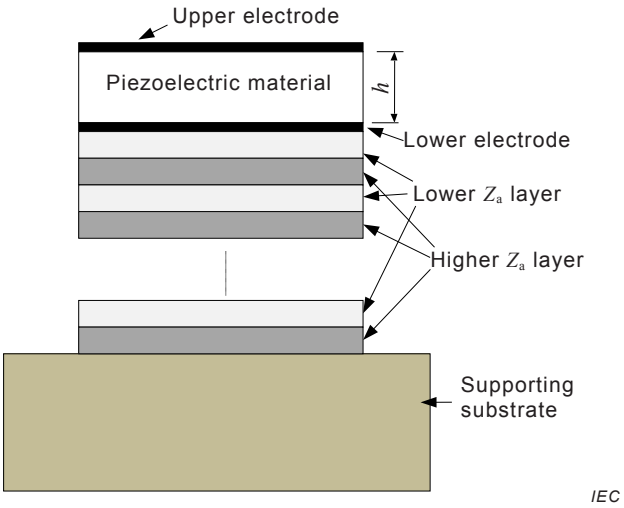


Figure 2 – SMR configuration

3.1.5
response characteristics
frequency response of BAW filters

SEE: Figure 3.

3.1.6
cut-off frequency

frequency of the pass-band at which the relative attenuation reaches a specified value

[SOURCE: IEC 60862-1:—, 3.1.2.4]

3.1.7
input impedance
impedance presented by the filter to the signal source when the output is terminated by a specified load impedance

[SOURCE: IEC 62604-1:2015, 3.1.2.22, modified – "duplexer" has been replaced by "filter".]

3.1.8
input level
power, voltage or current value applied to the input terminal pair of a filter

[SOURCE: IEC 62604-1:2015, 3.1.2.19, modified – "input port of a duplexer" has been replaced by "input terminal pair of a filter"]

3.1.9
insertion attenuation
logarithmic ratio of the power delivered directly to the load impedance before insertion of the filter to the power delivered to the load impedance after insertion of the filter

[SOURCE: IEC 62604-1:2015, 3.1.2.2– "duplexer" has been replaced by "filter"]

3.1.10
inter-modulation
unnecessary amplitude modulation of signals containing some different frequencies in a filter with nonlinearities

3.1.11
maximum insertion attenuation
maximum value of insertion attenuation in the pass band

[SOURCE: IEC 62604-1:2015, 3.1.2.9]

3.1.12
minimum insertion attenuation
minimum value of insertion attenuation in the pass band

[SOURCE: IEC 62604-1:2015, 3.1.2.8]

3.1.13
nominal insertion attenuation
insertion attenuation at a specified reference frequency

[SOURCE: IEC 62604-1:2015, 3.1.2.3]

3.1.14
nominal level
power, voltage or current value at which the performance measurement is specified

[SOURCE: IEC 62604-1:2015, 3.1.2.21]

3.1.15
operable temperature range
range of temperatures, over which the BAW filter shall continue to provide its specified response characteristics, though not necessarily within the specified tolerances

[SOURCE: IEC 60862-1:—, 3.1.2.40, modified – "SAW filter" has been replaced by "BAW filter".]

3.1.16
operating temperature range
range of temperatures, over which the BAW filter will function while maintaining its specified characteristics within specified tolerances

[SOURCE: IEC 62604-1:2015, 3.1.2.25, modified – "SAW or BAW duplexer" has been replaced by "BAW filter".]

3.1.17
output impedance
impedance presented by the filter to the load when the input is terminated by a specified source impedance

[SOURCE: IEC 62604-1:2015, 3.1.2.23, modified – "duplexer" has been replaced by "filter".]

3.1.18
output level
power, voltage or current value delivered to the load

[SOURCE: IEC 62604-1:2015, 3.1.2.20, modified – "load circuit" has been replaced by "load"]

3.1.19
pass band
band of frequencies in which the relative attenuation is equal to or less than a specified value

[SOURCE: IEC 62604-1:2015, 3.1.2.5]

3.1.20
pass bandwidth
separation of frequencies between which the relative attenuation is equal to or less than a specified value

[SOURCE: IEC 62604-1:2015, 3.1.2.6]

3.1.21
pass band ripple
maximum variation in attenuation characteristics within a specified pass band

[SOURCE: IEC 62604-1:2015, 3.1.2.7]

3.1.22
reference frequency
frequency defined by the specification to which other frequencies may be referred

[SOURCE: IEC 62604-1:2015, 3.1.2.1]

3.1.23
reflectivity
dimensionless measure of the degree of mismatch between two impedances Z_a and Z_b , i.e.,

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

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

[SOURCE: IEC 62604-1:2015, 3.1.2.17]

3.1.24
relative attenuation
difference between the attenuation at a given frequency and the attenuation at the reference frequency

[SOURCE: IEC 62604-1:2015, 3.1.2.4]

3.1.25
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 62604-1:2015, 3.1.2.18]

3.1.26
shape factor
ratio of the two bandwidths at specified values of relative attenuation

[SOURCE: IEC 60862-1:—, 3.1.2.18]

3.1.27
stop band
band of frequencies in which the relative attenuation is equal to or greater than a specified value

[SOURCE: IEC 62604-1:2015, 3.1.2.10]

3.1.28
stop bandwidth
separation of frequencies between which the relative attenuation is equal to or greater than a specified value

[SOURCE: IEC 62604-1:2015, 3.1.2.11]

3.1.29
stop band rejection
minimum relative attenuation at a specified stop band

[SOURCE: IEC 62604-1:2015, 3.1.2.12]

3.1.30
storage temperature range
minimum and maximum temperatures as measured on the enclosure, at which the BAW filter may be stored without deterioration or damage to its performance

[SOURCE: IEC 60862-1:—, 3.1.2.41, modified – "SAW filter" has been replaced by "BAW filter"]

3.1.31
terminating impedance
impedance presented to the filter by the source or by the load

[SOURCE: IEC 62604-1:2015, 3.1.2.24, modified – "duplexer" has been replaced by "filter"]

3.1.32
transition band
band of frequencies between the cut-off frequency and the nearest point of the adjacent stop band

[SOURCE: IEC 62604-1:2015, 3.1.2.16]

3.1.33
voltage standing wave ratio
VSWR
ratio of the votage amplitude of a standing wave at a maximum to that at an adjacent minimum, in an electrical transmission line

$$\mathrm{VSWR} = \frac{1+\Gamma}{1-\Gamma}$$

where Γ is the reflectivity

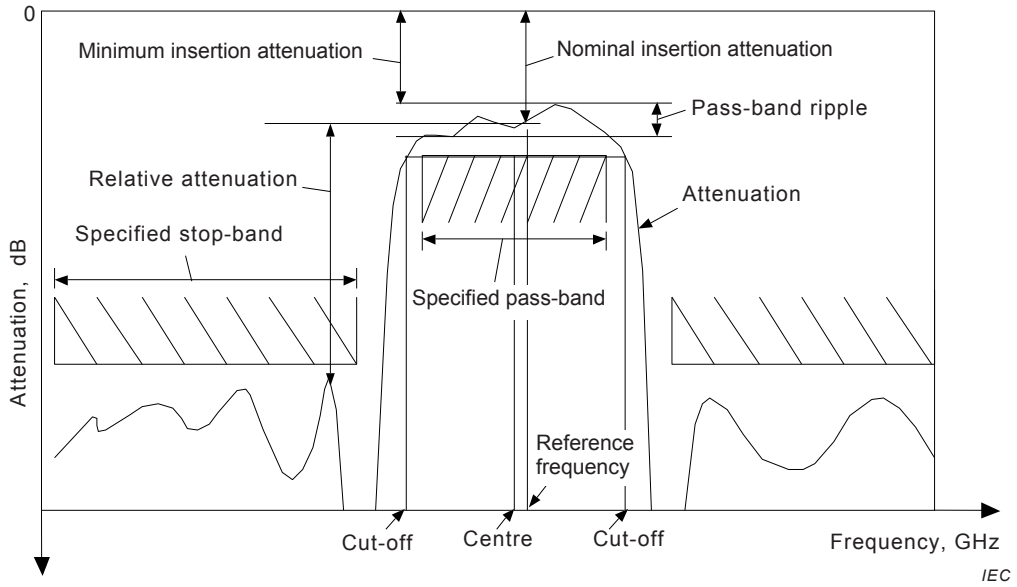


Figure 3 – Frequency response of RF BAW filters

3.2 Units and symbols

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

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

4 Preferred values for ratings and characteristics

4.1 General

Values should be chosen from the following paragraphs unless otherwise stated in the detail specification:

4.2 Nominal frequencies

Table 1 shows frequency allocation of typical UMTS bands.

Table 1 – Frequency allocation of typical UMTS bands

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

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

The range of temperature, over which the BAW filter will maintain its specified characteristics within specified tolerances, shall be specified in the following:

– 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.

4.4 Climatic category

The climatic category shall be 40/085/56 (climatic categories are given in conformity with Annex A to IEC 60068-1:2013) for ceramic enclosed BAW filters.

For requirements where the operating temperature range of the BAW filters is greater than –40 °C to +85 °C, a climatic category consistent with the operating temperature range shall be specified.

The climatic category shall be 20/085/21(climatic categories are given in conformity with Annex A to IEC 60068-1:2013): for plastic packaged BAW filters.

4.5 Bump severity

The test of (4 000 ± 10) bumps at 400 m/s^2 peak acceleration shall be performed in each direction along three mutually perpendicular axes (see 7.6.6).

The pulse duration is 6 ms

4.6 Vibration severity

a) Sinusoidal	
10 Hz to 55 Hz 0,75 mm displacement amplitude (peak value)	(peak value) 30 min in each of three mutually perpendicular axes at 1 octave/min (see 7.5.7)
55 Hz to 500 Hz or 55 Hz to 2 000 Hz 100 m/s^2 acceleration amplitude	
or	
10 Hz to 55 Hz 1,5 mm displacement amplitude (peak value	30 min in each of three mutually perpendicular axes at 1 octave/min(see 7.5.7)
55 Hz to 2 000 Hz 200 m/s^2 acceleration amplitude (peak value)	
b) Random	
(19,2 m/s^2)^2/Hz between 20 Hz and 2 000 Hz 196 m/s^2 acceleration	30 min in each of three mutually perpendicular axes at 1 octave/min(see 7.5.7)
or	
(48 m/s^2)^2/Hz between 20 Hz and 2 000 Hz 314 m/s^2 acceleration	30 min in each of three mutually perpendicular axes at 1 octave/min(see 7.5.7)
or	
(19,2 m/s^2)^2/Hz between 20 Hz and 2 000 Hz 62m/s^2 acceleration	30 min in each of three mutually perpendicular axes at 1 octave/min (see 7.5.7)

4.7 Shock severity

The test of 1 000 m/s^2 peak acceleration for 6 ms duration shall be performed three times in each direction along three mutually perpendicular axes (see 7.5.8) half sine pulse, unless otherwise stated in the detail specification.

4.8 Fine leak rate

The maximum leak rate shall be specified in the following, unless otherwise stated in the detail specification:

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

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

5 Marking

5.1 Filter marking

Bulk acoustic wave filters shall be clearly and durably marked (see 7.6.18) along with items a) to j) in the order given below if possible.

a) type designation as defined in the detail specification;

b) nominal frequency;

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 trade mark;

g) terminal identification;

h) designation of electrical connections;

i) serial number;

j) surface mounted device classification.

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

5.2 Package marking

The primary packaging containing the BAW filters(s) shall be clearly marked with the information listed in 5.1, except item g) and electrostatic sensitive device (ESD) identification where necessary.

6 Quality assessment procedures

6.1 General

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

6.2 Primary stage of manufacture

The primary stage of manufacture for a BAW filter is the final surface cleaning of substrates.

6.3 Structurally similar components

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

6.4 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.

6.5 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.

6.6 Manufacturer's approval

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

6.7 Approval procedures

6.7.1 General

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

6.7.2 Capability approval

Capability approval is appropriate when structurally similar BAW filters 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 BAW filters

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 6.8 and in the sectional specification.

6.7.3 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 BAW filter to be qualified, as prescribed in 6.9 and the sectional specification.

6.8 Procedures for capability approval

6.8.1 General

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

6.8.2 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 6.2 of this generic specification.

6.8.3 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.

6.8.4 Granting of capability approval

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

6.8.5 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/she so wishes, disclose part or all of it to a third party.

6.9 Procedures for qualification approval

6.9.1 General

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

6.9.2 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 6.2 of this generic specification.

6.9.3 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.

6.9.4 Granting of qualification approval

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

6.9.5 Quality conformance inspection

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

6.10 Test procedures

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

6.11 Screening requirements

Where screening is required by the customer for BAW filters this shall be specified in the detail specification.

6.12 Rework and repair work

6.12.1 Rework

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

6.12.2 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.

6.13 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.

6.14 Validity of release

BAW filters held for a period exceeding two years following acceptance inspection shall be re-inspected for the electrical tests detailed in 7.5 prior to release.

6.15 Release for delivery

BAW filters shall be released in accordance with the specified quality assessment system.

6.16 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, AQLs or defects per million and inspection levels specified. The test and measurement procedures shall be carried out in accordance with the relevant detail specification.

7 Test and measurement procedures

7.1 General

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

7.2 Test and measurement conditions

7.2.1 Standard conditions of 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 reference 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 RF BAW filter shall be stored at the measuring temperature for a time sufficient to allow the RF BAW filter to reach thermal equilibrium. Controlled recovery conditions and standard conditions for assisted drying are given in 4.4.2 and 4.4 of IEC 60068-1:2013.

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

7.2.2 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.

7.2.3 Precautions

7.2.3.1 Measurements

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

7.2.3.2 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).

7.2.4 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.

7.3 Visual inspection

7.3.1 General

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

7.3.2 Visual test A

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

7.3.3 Visual test B

The BAW filter shall be visually examined under 10 × magnification. There shall be no cracks in the glass or damage to the terminations. Minute flaking around the further edge of a meniscus shall not be considered a crack.

7.3.4 Visual test C

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

7.4 Dimensions and gauging procedures

7.4.1 Dimensions test A

The dimensions, spacing and alignment of the terminations shall be checked and shall comply with the specified values.

7.4.2 Dimensions test B

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

7.5 Electrical test procedures

7.5.1 General

The simplest and most popular method of testing RF BAW filters is to use a network analyser or vector voltmeter. The system impedance of such equipment is usually 50 Ω and, therefore, the termination condition between the filter and the equipment has to be considered.

7.5.2 Insertion attenuation measurement

7.5.2.1 Principle of measurement

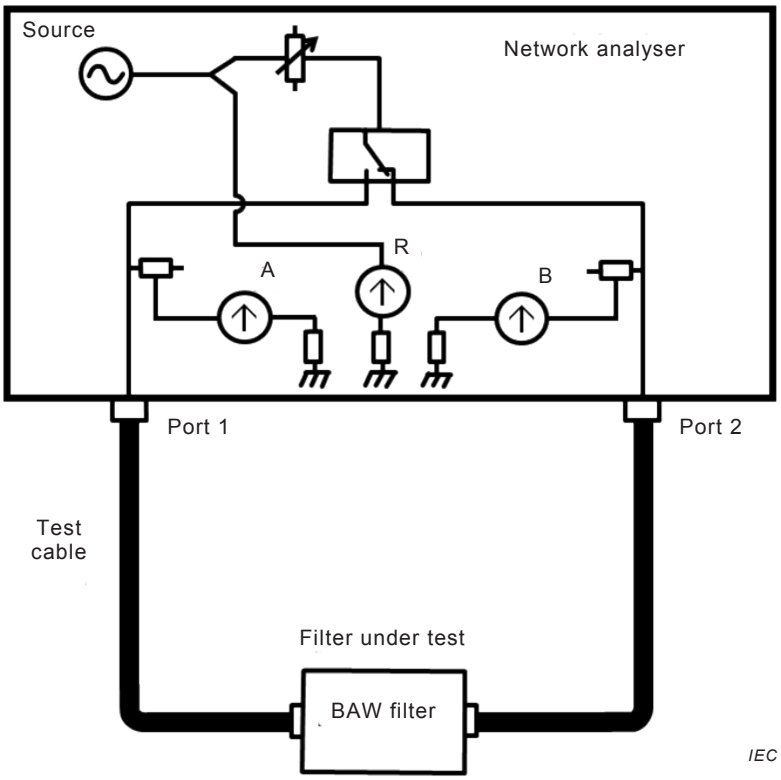
The insertion attenuation is obtained as a ratio of the signal level measured when the signal is fed through a straight line to that when it is fed through the filter.

7.5.2.2 Measurement circuit

The measurement set-up is shown in Figure 4. An RF signal from the RF output Port 1 of a network analyser is directly fed to Port 2 through a test fixture, and a vector ratio of B/R is measured for insertion attenuation. All of those connections have to be made with RF coaxial cables, the nominal impedance of which shall be exactly equal to the system impedance.

7.5.2.3 Filter test fixture

The output of the test fixture shall be well-shielded from the input.



NOTE R channel is to detect source power for the reference. A channel is to detect Port 2 power reflected from the input of filter and B channel is to detect Port 2 power transmitted through filter.

Figure 4 – Insertion attenuation measurement

7.5.2.4 Measurement method

Before connecting the filter test fixture, a calibration of the network analyser shall be made in order to eliminate systematic error in the network analyser, cable and connectors. The full 2-port calibration technique may be the best method to compensate the 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 filter impedance measurement). After calibration, connect the filter test fixture. The attenuation to the reference level is the insertion attenuation.

7.5.2.5 Calculation of total power loss

The total power loss of the filter coincides with the insertion attenuation, when the specified terminating impedances are equal to each other. If the impedances are not equal, the total power loss can be calculated as:

$$TPL = IA + 10\log\left[\frac{(Z_S + Z_L)^2}{4Z_S Z_L}\right]$$

where

TPL is the total power loss in decibels;

IA is the insertion attenuation in decibels;

Z_S is the input terminating impedance at the secondary port of the input impedance transformer;

Z_L is the output terminating impedance at the primary port of the output impedance transformer.

When calibration is made at the ends of the test fixture at which the filter under test is placed using in−fixture calibration standards, the insertion attenuation can be measured directly, not using straight-through line.

The in-fixture calibration standards value should be well-known or accurately characterised.

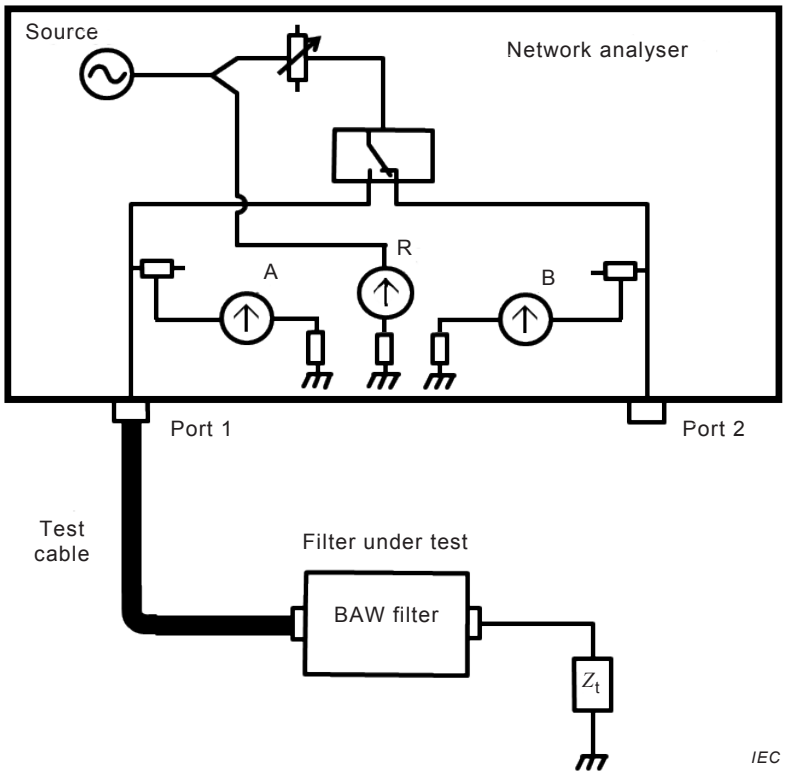
7.5.3 Return attenuation measurement

7.5.3.1 Principle of measurement

It is important to know the impedance of a filter in order to carry out practical installation correctly. The impedance (real and imaginary parts) of the filter, the other end of which is terminated by a specified terminating impedance, may be measured with either a conventional impedance bridge or a vector impedance analyser. The return attenuation can then be calculated from the impedance of the filter. On the other hand, a network analyser can also be used for measuring the magnitude and the phase of the return signal, as a vector ratio of A/R, reflected at the end of the filter. The impedance can be calculated from the measured results.

7.5.3.2 Measurement circuit

The measurement circuit is shown in Figure 5 below.



NOTE Other measurement equipment can be used instead of the network analyser. Some of these types of equipment offer the measured results in a Smith chart display. The impedance and return attenuation can be read directly.

Figure 5 – Return attenuation measurement

The distance between the test port and the filter under test should be as short as possible to ensure accurate measurement. It is preferred that the length of the reference signal cable be adjusted to keep the returned signal phase at zero degrees independent of the measuring

frequency when disconnecting the filter from the test fixture. The nominal impedance of the cable should be exactly equal to the equipment system impedance.

7.5.3.3 Filter test fixture

The test fixture shall have a connector to connect the filter to and disconnect the filter from the connector of test cable. The length of wiring between the test fixture connector and the filter shall be as short as possible. Reference is established by performing the calibration at one port (i.e. presenting open-circuit impedance, short-circuit impedance and reference impedance, normally 50 Ω at the end of test cable connector and storing the measured values for correction of filter impedance measurement).

7.5.3.4 Measurement method

Disconnect the test fixture from the connector of the test cable, and then the calibration shall be performed at one port at the end of the connector. The readings of the magnitude and phase of the network analyser are normalised to be the reference level and the phase. When the calibration is performed properly, the reading of the phase can be kept at zero degrees independent of the frequency. The relative attenuation and phase shift to the reference level and phase are the return attenuation for the system impedance of the network analyser.

7.5.3.5 Relation between filter impedance and return attenuation

Reflectivity at the fixture connector is represented by the following equation:

$$\gamma = |\gamma| \exp(j\varphi)$$

where

γ is the reflectivity and $|\gamma|$ is its absolute value, i.e. reflection coefficient, and

φ is the reflective phase shift in radians.

The impedance of the filter can be calculated from the following formula:

$$Z = Z_0 \frac{1+\gamma}{1-\gamma}$$

where

Z is the impedance of the filter, and

Z_0 is the system impedance of the test equipment.

When the measurements are made with a conventional impedance bridge, the return attenuation (RA) for the specified terminating impedance can also be calculated from the filter impedance Z_t as follows:

$$RA = -20 \log \left| \frac{Z - Z_t}{Z + Z_t} \right|$$

where

RA is the return attenuation expressed in decibels;

Z_t is the specified terminating impedance.

In this case, the voltage standing wave ratio (VSWR) can be calculated from the return attenuation, as follows:

$$\text{VSWR} = \frac{1+\Gamma}{1-\Gamma} \quad \left(\Gamma = 10^{-\frac{RA}{20}} \right)$$

where Γ is the reflectivity for the specified terminating impedance Z_t.

7.5.4 Intermodulation distortion measurement

7.5.4.1 Principle of measurement

When the two tone RF signals, being fed to filters, intermodulation distortion may be generated due to non-linearity of a BAW filter.

Usually the power levels of the 2nd and 3rd order intermodulation distortions are important to be tested, such as communication in use, and observed by spectrum analyser.

NOTE The 2nd order intermodulation distortion appears at frequencies $f_1 - f_0$ and $f_1 + f_0$, and the 3rd order intermodulation distortion appears at frequencies $2f_1 - f_0$ and $2f_0 - f_1$ where the two tone frequencies fed into the filter are set to f_0 and f_1.

7.5.4.2 Measurement circuit

The measurement set-up is shown in Figure 6. Two tone RF signals are fed through a power combiner into the filter test fixture. An attenuator or amplifier may be used between the power combiner and the test fixture to adjust the power level fed into the filter under test. The output signal from the test fixture is fed into the spectrum analyser.

7.5.4.3 Filter test fixture

The test fixture prescribed in 7.5.2.3 shall be used.

7.5.4.4 Measurement method

The two tone RF signals shall be set at specified frequencies such as channel spacing frequencies of various wireless communication standards. The signal levels shall be stated in the relevant detail specification. The level of intermodulation signal is observed by the spectrum analyser.

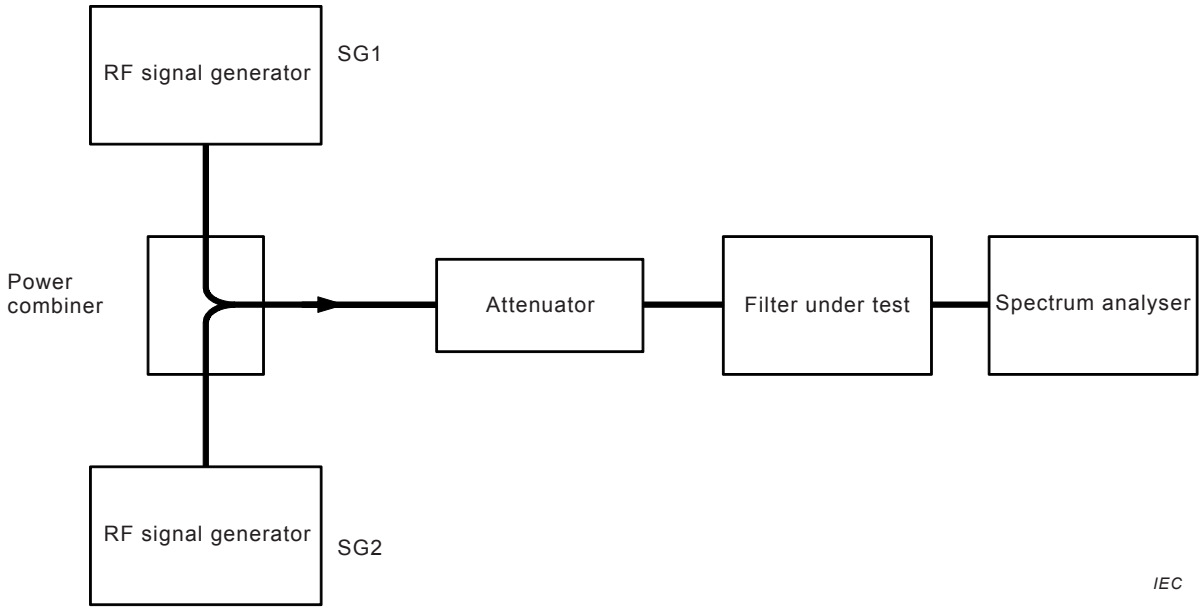


Figure 6 – Intermodulation distortion measurement

In order to avoid cross modulation between RF signal generators it is advisable to use directional couplers or isolators between each of the RF signal generators and the power combiners.

7.5.5 Measurement of insertion attenuation characteristics at specified terminating impedances and at standard atmospheric conditions

The filter shall be inserted in the test circuit of 7.5.2.2 with the specified terminating impedance given in the relevant detail specification.

Insertion attenuation characteristics shall be within the limits stated in the relevant detail specification.

7.5.6 Measurement of insertion attenuation characteristics as a function of temperature

The filter shall be inserted in the test circuit of 7.5.2.2 with the specified terminating impedance given in the relevant detail specification.

Insertion attenuation characteristics shall be within the limits stated in the relevant detail specification.

7.5.7 Measurement of return attenuation at specified terminating impedance and at the standard atmospheric conditions

The filter shall be inserted in the test circuit of 7.5.3.2 with the specified terminating impedance given in the relevant detail specification.

Return attenuation shall be within the limits stated in the relevant detail specification.

7.5.8 Measurement of intermodulation distortion at standard atmospheric conditions

The filter shall be inserted in the test circuit of 7.5.4.2 with the specified terminating impedance given in the relevant detail specification.

Intermodulation distortion shall be within the limits stated in the relevant detail specification.

7.5.9 Measurement method for the balanced type filter

Basically, insertion attenuation, return attenuation, and intermodulation distortion of the balanced type BAW filter are measured using the methods described in the preceding subclauses. Note that a filter is a two-port device, it is convenient for measurement to treat a filter having balanced terminals on both input and output sides as a four-port device and a filter having balanced terminals on one side and an unbalanced terminal on the other side as a three-port device. It is therefore recommended to use a multi-port network analyzer.

Figure 7 shows a block diagram of a four-port network analyser as an example that has balanced terminals on both input and output sides. A full four-port calibration is performed for the four ports to measure the filter's sixteen S-parameters (four ports × 4), and then their characteristics are calculated. In the case of a three-port device, which has an unbalanced terminal on one side, a full three-port calibration is performed, with the unused port terminated with a 50 Ω load as shown in Figure 8. Nine S-parameters (three ports × 3) are measured, and then similar calculations are made.

Imbalance is measured as the difference in insertion attenuation between the two balanced terminals as well as the phase error from the phase difference of 180 degrees.

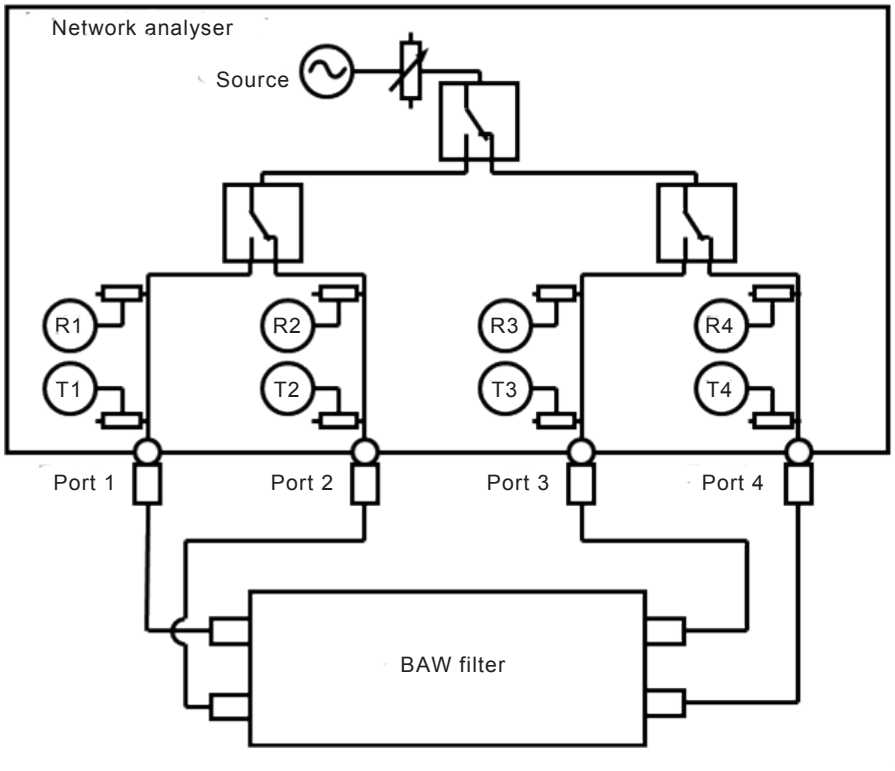


Figure 7 – Four-port network analyser measurement for balanced-balanced-connection filter

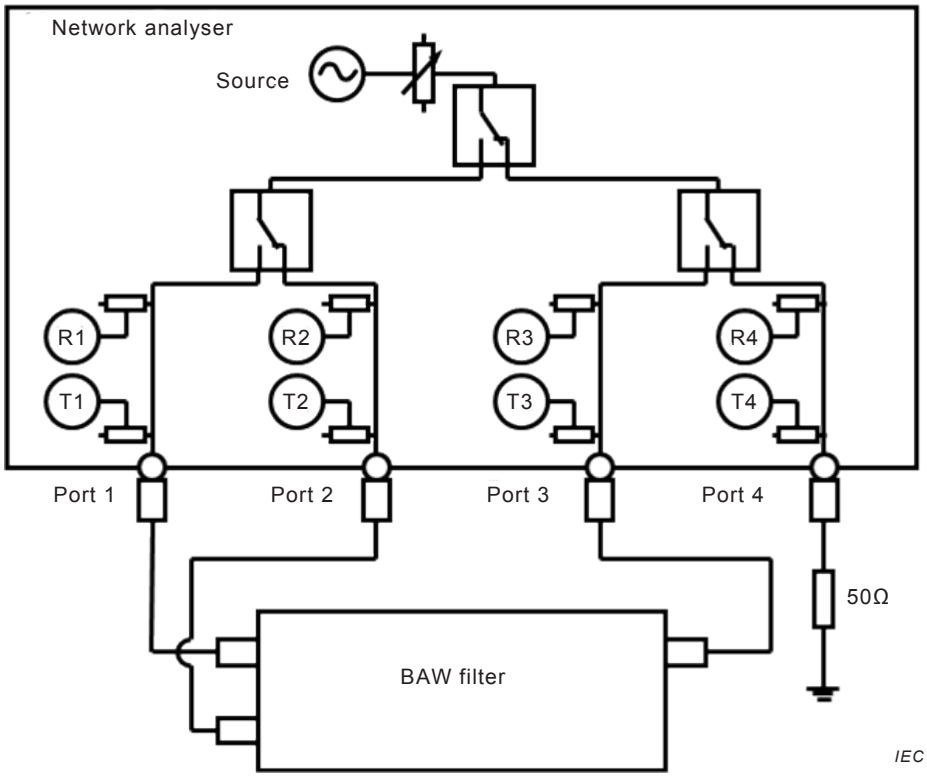


Figure 8 – Three-port network analyser measurement for unbalanced-balanced-connection filter

7.5.10 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.

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

7.5.11 Voltage proof

The filter 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.

7.6 Mechanical and environmental test procedures

7.6.1 Robustness of terminations (destructive)

7.6.1.1 Peel strength and thrust tests on terminations

The tests shall be performed in accordance with Test Ue_2 (peel strength and thrust) of IEC 60068-2-21.

7.6.1.2 Flexibility of terminations

The test shall be performed in accordance with Test Ue_1 (bending) of IEC 60068-2-21.

The detail specification shall define the loading force to be applied and the position at which the bend shall start.

7.6.2 Sealing tests (non-destructive)

7.6.2.1 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 60068-2-17:1994.

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 RF BAW filter. The continuous formation of bubbles shall be evidence of leakage.

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

7.6.2.2 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, care should be taken to ensure that the pressure chosen does not 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.

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

7.6.3.1 Solderability

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

7.6.3.2 Resistance to soldering heat

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

7.6.4 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 filters shall be subjected to one cycle in a downward direction from (98 ± 3) °C for 15 s to (1 ± 1) °C for 5 s.

7.6.5 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 RF BAW filter shall be maintained at each extreme of temperature for 30 min, unless otherwise specified in the detail specification.

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

7.6.6 Bump (destructive)

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

The RF BAW filter 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 parallel to the terminations;
– an axis parallel to the base of the RF BAW filter.

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

7.6.7 Vibration (destructive)

7.6.7.1 Vibration (sinusoidal) (RF BAW filter not operating)

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

The RF BAW filter 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 parallel to the terminations;
– an axis parallel to the base of the RF BAW filter.

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

7.6.7.2 Vibration (sinusoidal) (RF BAW filter operating)

The test shall be as described in 7.6.7.1, except that during the test the filter shall be energised and electrical tests, as defined in the detail specification, shall be performed.

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

7.6.7.3 Random vibration (RF BAW filter not operating)

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

The RF BAW filter 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 parallel to the terminations;
– an axis parallel to the base of the RF BAW filter.

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

7.6.7.4 Random vibration (RF BAW filter operating)

The test shall be as described in 7.6.7.3, except that during the test the filter shall be energised and electrical tests, as defined in the detail specification, shall be performed.

7.6.8 Shock (destructive)

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

The RF BAW filter 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 RF BAW filter.

The degree of severity shall be as stated in 4.7, unless otherwise stated in the detail specification.

7.6.9 Free fall (destructive)

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

The RF BAW filter 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.

7.6.10 Acceleration, steady state (non-destructive)

7.6.10.1 Acceleration, steady state (filter not operating)

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

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

7.6.10.2 Acceleration, steady state (filter operating)

The test shall be as described in 7.6.10.1, except that during the test the filter shall be energised and electrical tests, as defined in the detail specification, shall be performed.

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

7.6.11 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 30 kPa for a duration of 2 h, unless otherwise stated in the detail specification.

7.6.12 Dry heat (non-destructive)

The test shall be performed in accordance with Test B 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.

7.6.13 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.

7.6.14 Cold (non-destructive)

This test shall be performed in accordance with Test A 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.

7.6.15 Climatic sequence (destructive)

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

Dry heat	see 7.6.12;
Damp heat, cyclic	see 7.6.13 (first cycle only);
Cold	see 7.6.14;
Low air pressure	see 7.6.11 (when applicable);
Damp heat, cyclic	see 7.6.13 (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.

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

7.6.16 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 4.4.

7.6.17 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.

7.6.18 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.

7.6.19 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.

7.6.20 Electrostatic discharge (ESD) sensitivity test (destructive)

RF BAW filters are required to have their endurance property to electrostatic discharge (ESD).

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

There are some models for the measurement of ESD sensitivity.

The following models expalin the case in which charged object applies ESD to the terminal of RF 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 when the device is charged and discharged to the outside object from the device's terminal.

7.7 Endurance test procedure

Ageing (non-destructive): The RF BAW filter 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 filter 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.

Bibliography

IEC 60368 (all parts), *Piezoelectric filters of assessed quality*

IEC 60862-1:—[2], *Surface acoustic wave (SAW) filters of assessed quality – Part 1: Generic specification*

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

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

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2 To be published.

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