IEC 61337-2

Edition 1.0 2004-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Filters using waveguide type dielectric resonators – Part 2: Guidance for use

Filtres utilisant des résonateurs diélectriques à modes guidés – Partie 2: Lignes directrices d'utilisation

IEC 61337-2:2004-07(en-fr)

IEC 61337-2

Edition 1.0 2004-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Filters using waveguide type dielectric resonators – Part 2: Guidance for use

Filtres utilisant des résonateurs diélectriques à modes guidés – Partie 2: Lignes directrices d'utilisation

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX U

ICS 31.140

ISBN 978-2-8322-1337-7

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FILTERS USING WAVEGUIDE TYPE DIELECTRIC RESONATORS –

Part 2: Guidance for use

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.

3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.

5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.

6) All users should ensure that they have the latest edition of this publication.

7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.

8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61337-2 has been prepared by IEC technical committee 49: Piezoelectric and dielectric devices for frequency control and selection.

This bilingual version (2014-02) corresponds to the monolingual English version, published in 2004-07.

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

FDIS	Report on voting
49/665/FDIS	49/683/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.

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

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

IEC 61337 consists of the following parts under the general title *Filters using waveguide type dielectric resonators:*

Part 1: Generic specification;[1]

Part 1-1: General information, standard values and test conditions – General information and standard values;[2]

Part 1-2: General information, standard values and test conditions – Test conditions;[2]

Part 2: Guidance for use;

Part 3: Standard outlines[3].

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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.

1 To be published.

2 To be merged and replaced by IEC 61337-1 in the near future.

3 Under consideration.

INTRODUCTION

This part of IEC 61337 gives practical guidance on the use of filters using waveguide type dielectric resonators that are used in telecommunications and radar systems. Refer to IEC 61337-1-1 and IEC 61337-1-2 for general information, standard values and test conditions.

These dielectric filters have the features of small size, low loss, high reliability and high stability against temperature and ageing. Dielectric filters are suitable for applications such as mobile communication service, mobile satellite communication service, microwave terrestrial communication service, and fixed satellite communication service. In particular, they are now widely used for duplexers and filters of portable phones and cellular base stations.

This standard has been compiled in response to a generally expressed desire on the part of both users and manufacturers for guidance for the use of filters using waveguide type dielectric resonators, so that the filters may be used to their best advantage. For this purpose, general and fundamental characteristics have been explained in this standard.

FILTERS USING WAVEGUIDE TYPE DIELECTRIC RESONATORS –

Part 2: Guidance for use

1 Scope

The scope of this part of IEC 61337 is limited to filters using waveguide type dielectric resonators that are used for microwave applications such as portable phones, cellular base stations and radio links.

It is not the aim of this standard either to explain the theory or to attempt to cover all the eventualities that 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 dielectric filters for a new application. Such a procedure will be the user's insurance against unsatisfactory performance.

Standard specifications, such as those given in IEC 61337, and national specifications or detail specifications issued by manufacturers, will define the available combinations of mid-band frequency, pass band, insertion attenuation, pass-band ripple, return attenuation, spurious response, operating power, and so on. These specifications are compiled to include a wide range of dielectric filters with standardized performances. It cannot be over-emphasized that the user should, wherever possible, select his dielectric filters from these specifications, when available, even if it involves making small modifications to his circuit to enable standard filters to be used.

2 Normative references

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

IEC 60068-1:1988, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-1:1990, *Environmental testing – Part 2: Tests. Tests A – Cold*

IEC 60068-2-2:1974, *Environmental testing – Part 2: Tests. Tests B – Dry heat*

IEC 60068-2-6:1975, *Environmental testing – Part 2: Tests. Test Fc: Vibration (sinusoidal)*

IEC 60068-2-7:1983, *Environmental testing – Part 2: Tests. Test Ga: Acceleration, steady state*

IEC 60068-2-13:1983, *Environmental testing – Part 2: Tests. Test M: Low air pressure*

IEC 60068-2-14:1984, *Environmental testing – Part 2: Tests. Test N: Change of temperature*

IEC 60068-2-20:1979, *Environmental testing – Part 2: Tests. Test T: Soldering*

IEC 60068-2-21:1999, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*

IEC 60068-2-27:1987, *Environmental testing – Part 2: Tests. Test Ea and guidance: Shock*

IEC 60068-2-30:1980, *Environmental testing – Part 2: Tests. Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle)*

IEC 60068-2-58:1999, *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 60068-2-78:2001, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 61337-1-1, *Filters using waveguide type dielectric resonators – Part 1-1: General information, standard values and test conditions – General information and standard values*

IEC 61337-1-2, *Filters using waveguide type dielectric resonators – Part 1-2: General information, standard values and test conditions – Test conditions*

3 Application guide for filters using waveguide type dielectric resonators

3.1 Classification of filters using waveguide type dielectric resonators

Filters using waveguide type dielectric resonators are classified into six types: $TE_{01\delta}$ mode dielectric filter, TM mode dielectric filter, TEM mode coaxial dielectric filter, stripline and microstripline dielectric filter, and multilayered chip-type filter.

These dielectric filters are classified according to their operating power and the unloaded Q of their resonance mode. Figure 1 shows the relationship between the unloaded Q and the maximum power durability for these filters in practical applications.

High-power durability of up to 100 W is the advantage of dielectric filters. The maximum operating power, however, should be limited by the construction of filters and by the Q value of the dielectric resonator used for the filters, because higher operating power causes a temperature rise that results in inferior electric characteristics such as a shift of mid-band frequency and an increase in insertion attenuation.

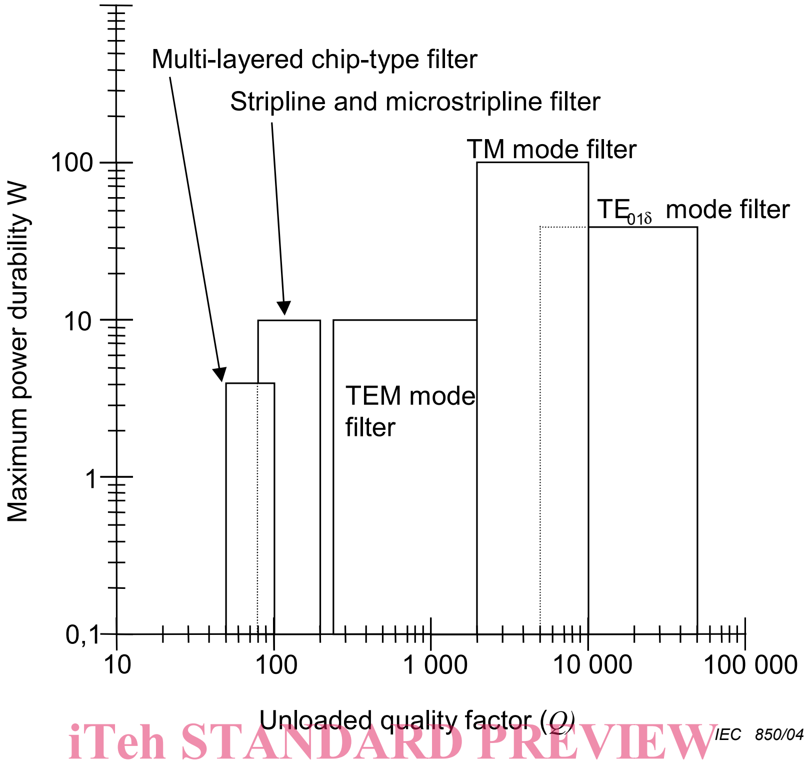

Figure 1 – Typical unloaded Q and maximum operating power of dielectric filters

3.2 Practical remarks for filters using waveguide type dielectric filters

3.2.1 $TE_{01\delta}$ mode dielectric filter

a) Features of the $TE_{01\delta}$ mode dielectric filter

The $TE_{01\delta}$ mode resonator obtains very high unloaded Q, as most of the resonance energy is stored in the dielectric element, and the copper loss due to the resistivity of the shielding conductor is minimized.

Figure 2 shows an example of the practically equivalent unloaded Q for the $TE_{01\delta}$ mode dielectric filter compared with the TE_{101} mode metal cavity. High unloaded Q from 5 000 to 10 000 is obtained by using high Q dielectric resonator materials with characteristics such as an ε' of 30 and a $Q \times$ f value of 150 000 GHz, or an ε' of 25 and a $Q \times$ f value of 300 000 GHz.

Using these $TE_{01\delta}$ mode dielectric resonators, miniaturized dielectric filters with low insertion attenuation and high temperature stability are realized at the frequency range from 1 GHz to 20 GHz. The relative bandwidth of the $TE_{01\delta}$ mode dielectric band-pass filter is usually less than 1 % of the mid-band frequency.

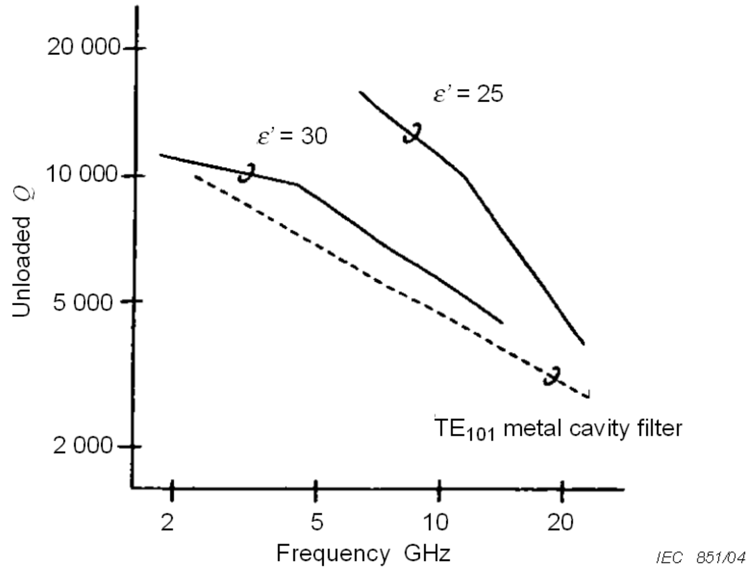

Figure 2 – Example of practically equivalent unloaded Q of a $TE_{01\delta}$ mode dielectric filter compared with a TE_{101} mode metal cavity filter

b) Construction of the $TE_{01\delta}$ mode dielectric filter

Figure 3 shows an example of the $TE_{01\delta}$ mode dielectric band-pass filter. Plural pieces of columnar or cylindrical dielectric resonators are fixed in a metal case.

The dimensions a and b of the filter are determined to constitute the cut-off waveguide of the dominant TE_{10} mode. The adjustment of the mid-band frequency by the trimming screw is less than 1 % of the mid-band frequency for the dielectric filter, while the adjustment of the mid-band frequency for the TE_{101} mode waveguide filter is 5 %.

Figure 4 shows an example of the $TE_{01\delta}$ mode dielectric band-stop filter. The columnar or cylindrical dielectric resonators are coupled with the microstrip line. The resonators are fixed at the three-quarters wavelength interval along the microstrip line.

The high unloaded Q of the dielectric resonators realizes the narrow bandwidth and the low insertion loss in the neighbouring frequency of the rejection band of the $TE_{01\delta}$ mode dielectric band-stop filter.

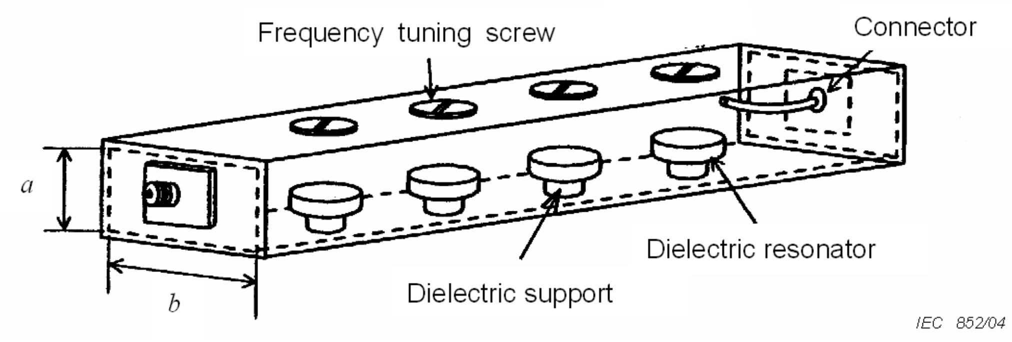

Figure 3 – Example of a $TE_{01\delta}$ mode dielectric band-pass filter

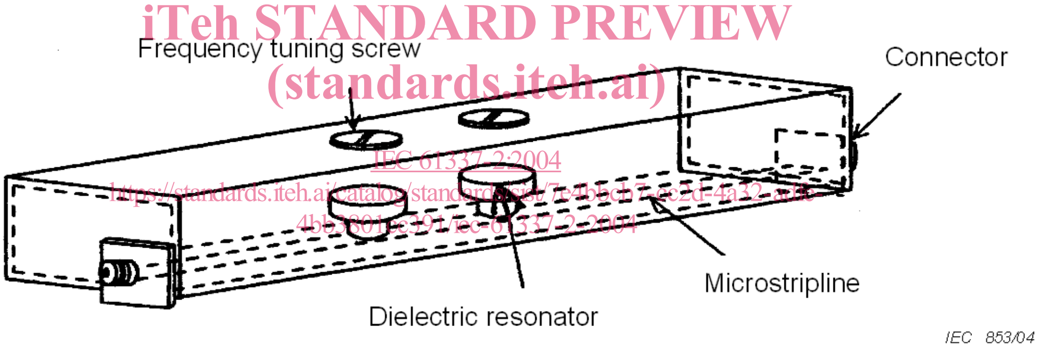

Figure 4 – Example of a $TE_{01\delta}$ mode dielectric band-stop filter

c) Characteristics of the $TE_{01\delta}$ mode dielectric filter

In the case of the $TE_{01\delta}$ mode dielectric filter, deterioration of the attenuation characteristics are caused by the unnecessary spurious resonances that exist over 1,2 times the mid-band frequency.

Figure 5 shows an example of the spurious response of the $TE_{01\delta}$ mode dielectric band-pass filter. This spurious response can be suppressed by using the quarter wavelength coaxial resonance elements for the first and last resonators of the filter. Figure 6 shows an example of the filter with the coaxial resonance elements.

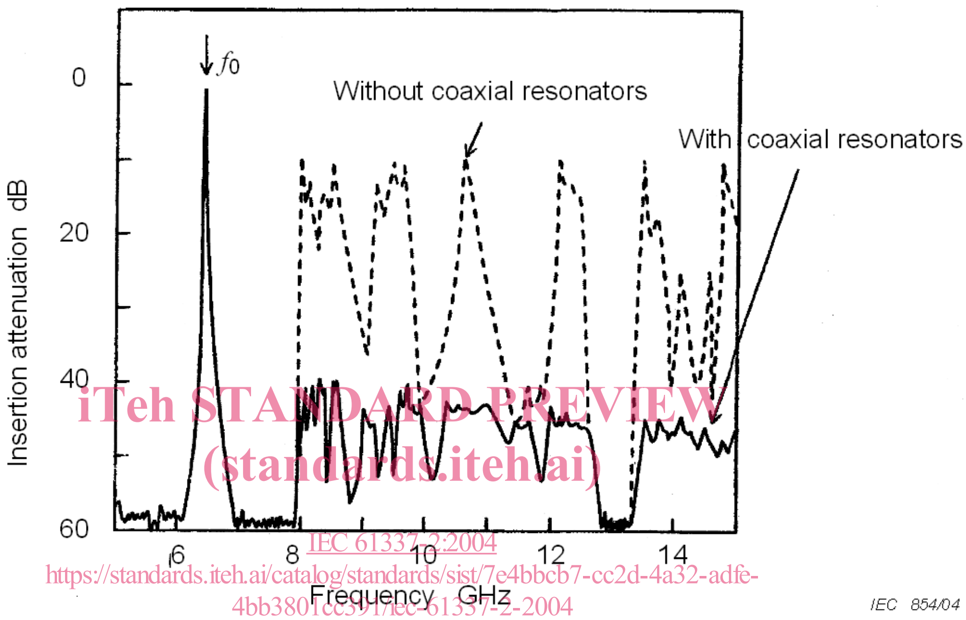

Figure 5 – Example of spurious responses for the $TE_{01\delta}$ mode dielectric band-pass filter

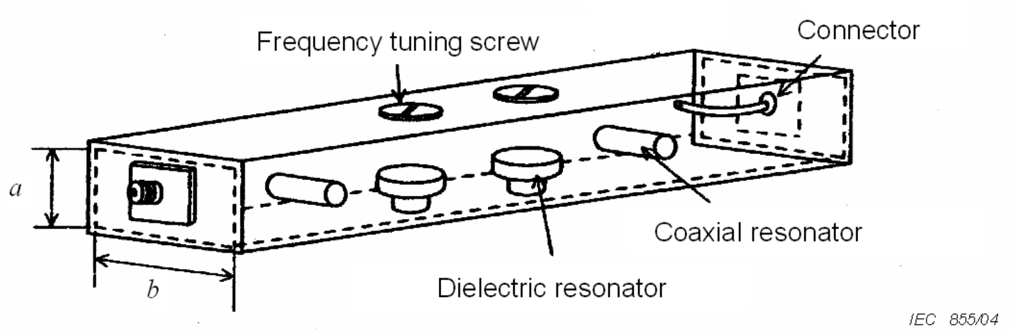

Figure 6 – Example of a $TE_{01\delta}$ mode dielectric band-pass filter with quarter wavelength coaxial resonators

3.2.2 TM mode dielectric filter

a) Features of the TM mode dielectric filter

Figure 7 shows the construction of the TM_{010} and the TM_{110} mode dielectric resonators. These resonators are often used for high-power applications such as filters for cellular base stations, due to the construction that aids in the release of heat.

As the electric field passes from the bottom to the top of the shielding conductor, undesirable frequency shift is caused if the air gap arises between the dielectric and the shielding conductor due to the difference of the thermal-expansion coefficients. To solve this problem, the practical TM mode resonator and the shielding cavity are made of a mono-block structure using the same dielectric material. The silver conductor is fired on the surface of this dielectric cavity. This mono-block structure realizes high temperature stability of the resonance frequency and high reliability for the release of heat.

The dielectric resonator materials used for the filters of cellular base stations must have low tanδ to restrain the heat generation and low intermodulation distortion level to restrain the interference between plural signals.

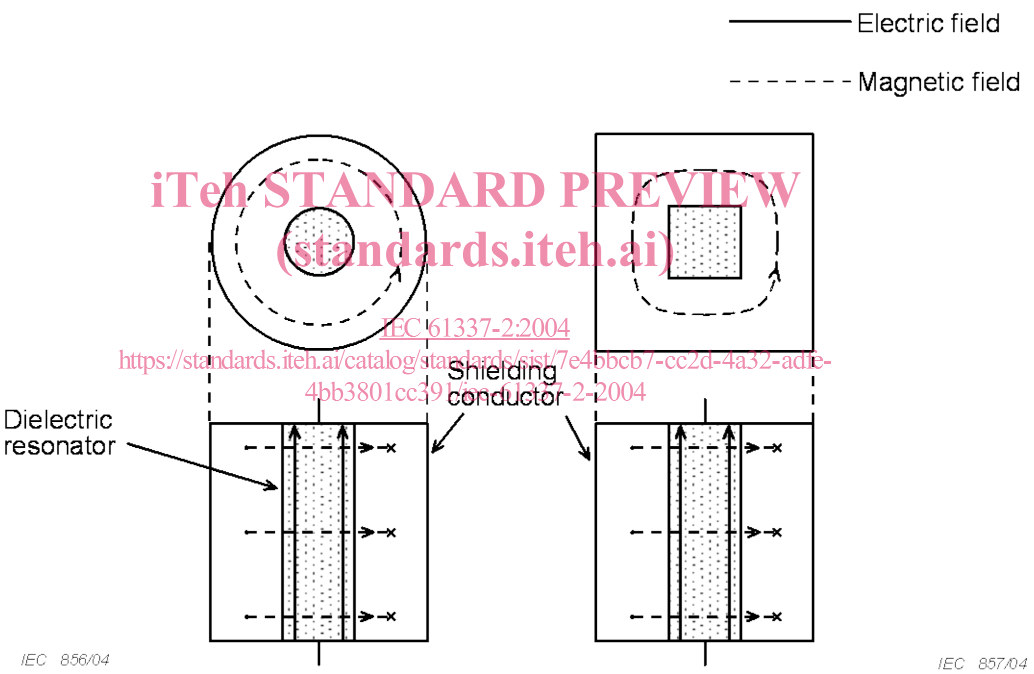

Figure 7a – TM_{010} mode

Figure 7b – TM_{110} mode

Figure 7 – TM_{010} and TM_{110} mode dielectric resonators