PD IEC TR 63352:2022

BSI Standards Publication

Transmitting and receiving equipment for radiocommunication — Radio spectrum measurement method — 300-GHz spectrum measurement equipment

Documents
Document Sharing Hub

Full document details: PD IEC TR 63352:2022

National foreword

This Published Document is the UK implementation of IEC TR 63352:2022.

The UK participation in its preparation was entrusted to Technical Committee W/-, Consumer Products and Services Sector Policy and Strategy Committee.

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

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

This publication is not to be regarded as a British Standard.

© The British Standards Institution 2022
Published by BSI Standards Limited 2022

ISBN 978 0 539 15891 5

ICS 33.060.20

Compliance with a Published Document cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 30 September 2022.

Amendments/corrigenda issued since publication

Date	Text affected

Documents
Document Sharing Hub

Full document details: PD IEC TR 63352:2022

IEC TR 63352

Edition 1.0 2022-04

TECHNICAL REPORT

colour inside

Transmitting and receiving equipment for radiocommunication – Radio spectrum measurement method – 300-GHz spectrum measurement equipment

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.060.20

ISBN 978-2-8322-1096-0

Warning! Make sure that you obtained this publication from an authorized distributor.

® Registered trademark of the International Electrotechnical Commission

Documents
Document Sharing Hub

Full document details: PD IEC TR 63352:2022

CONTENTS

FOREWORD 4
INTRODUCTION 6
1 Scope 7
2 Normative references 7
3 Terms, definitions and abbreviated terms 7
3.1 Terms and definitions 7
3.2 Abbreviated terms 7
4 Background to measurement up to 300 GHz 8
4.1 IEEE Std 802.15.3d 8
4.2 FOD radar 8
4.3 Experimental frequency license above 95 GHz 8
4.4 ITU WRC-19 agenda item 1.15 9
4.5 Issue of conventional spectrum measurement for mmWave 9
5 300-GHz band spectrum measurement 10
5.1 Overview 10
5.2 300-GHz spectrum analyser configuration 11
5.3 mmWave pre-selector 13
5.4 Performance of mmWave spectrum analyser 15
5.4.1 General 15
5.4.2 Signal source for calibration and test 16
5.4.3 Spectrum measurement 17
5.4.4 Unwanted response 18
5.4.5 Displayed average noise level 20
5.4.6 Third-order intercept point 20
6 Spectrum analyser overall performance 21
6.1 General 21
6.2 Measurement examples 21
6.3 Integrated spectrum measurement system evaluation 22
6.4 Propagation loss measurement results 23
6.5 Evaluation with integrated spectrum measurement system 24
6.6 Discussion of evaluation results 27
Bibliography 29

Figure 1 – IEEE Std 802.15.3d-2017 (Amendment 2) frequency plan 8
Figure 2 – Spectrum observed by spectrum analyser without pre-selector 10
Figure 3 – External appearance of 300-GHz band spectrum analyser 11
Figure 4 – Standard spectrum analyser configuration 11
Figure 5 – 300-GHz spectrum analysis system with optical local signal generation 12
Figure 6 – 300-GHz spectrum analysis system with electrical local signal generation 12
Figure 7 – Standard spectrum-analyser configuration 13
Figure 8 – Image response mechanism 14
Figure 9 – Conventional preselection method 14
Figure 10 – Filter-bank type pre-selector 15
Figure 11 – Measurement results 15

AVA Documents
Document Sharing Hub

Full document details: PD IEC TR 63352:2022

Figure 12 – Measurement set-up 16
Figure 13 – System set-up for level calibration 16
Figure 14 – Signal source for level calibration and evaluation 16
Figure 15 – Signal source output power 17
Figure 16 – Signal source spurious performance 17
Figure 17 – Spectrum measurement result from 255 GHz to 315 GHz 18
Figure 18 – Relationship between input RF signal and displayed frequency 19
Figure 19 – Comparison of spurious response with and without pre-selector (RBW = 1 MHz, Detection = Positive/Negative) 19
Figure 20 – Displayed average noise level 20
Figure 21 – Third-order intercept point 20
Figure 22 – TOI measurement results (Span 0 Hz, ATT 0 dB, RBW 300 Hz) 21
Figure 23 – Integrated spectrum measurement system 22
Figure 24 – Integrated spectrum measurement system evaluation 23
Figure 25 – Propagation loss measurement system 23
Figure 26 – Propagation loss (propagation distance d = 500 mm) 24
Figure 27 – Spectrum evaluation in OTA measurement environment 25
Figure 28 – Integrated spectrum measurement system monitoring screens 26
Figure 29 – Output signal directivity 28

Table 1 – Frequency bands covered by spectrum analyser 10
Table 2 – J-band spectrum analyser target specifications 11
Table 3 – Comparison of two local signal generation methods 13
Table 4 – Frequency bands covered by spectrum analyser 21
Table 5 – Standard gain horn antenna specifications 23
Table 6 – 12 Multiplier specifications 25
Table 7 – Output signal and spurious frequency (11,75 GHz input frequency) 25

Documents
Document Sharing Hub

Full document details: PD IEC TR 63352:2022

INTERNATIONAL ELECTROTECHNICAL COMMISSION

TRANSMITTING AND RECEIVING EQUIPMENT FOR RADIOCOMMUNICATION – RADIO SPECTRUM MEASUREMENT METHOD – 300-GHz SPECTRUM MEASUREMENT EQUIPMENT

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 itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
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.

IEC TR 63352 has been prepared by IEC technical committee 103: Transmitting equipment for radiocommunication. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
103/206/DTR	103/223/RVDTR

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

The language used for the development of this Technical Report is English.

Documents
Document Sharing Hub

Full document details: PD IEC TR 63352:2022

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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

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

IMPORTANT – The "colour inside" logo on the cover page of this document 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.

Documents
Document Sharing Hub

Full document details: PD IEC TR 63352:2022

INTRODUCTION

This document describes a high-dynamic-range spectrum measurement system to measure spectra in the frequency range 140 GHz to 300 GHz. Although millimeter-wave (mmWave) technology has high potential for both industries and users, there are no developed techniques for evaluating spectra suppressing the unwanted response generated in the measurement system. In addition, the commercialized spectrum analyser for this frequency band cannot accurately measure low power input signals due to the insufficient dynamic range while high power signals are input to the spectrum analyser simultaneously. This document describes the high-dynamic-range spectrum measurement system with low unwanted response for measuring spectra in the frequency range 140 GHz to 300 GHz, and proposes an mmWave pre-selector to suppress the unwanted response generated in the measurement system.

Documents
Document Sharing Hub

Full document details: PD IEC TR 63352:2022

TRANSMITTING AND RECEIVING EQUIPMENT FOR RADIOCOMMUNICATION – RADIO SPECTRUM MEASUREMENT METHOD – 300-GHz SPECTRUM MEASUREMENT EQUIPMENT

1 Scope

This document specifies spectrum measurement methods in the frequency range 140 GHz to 300 GHz. This document also provides background information, describes system configurations, key mmWave pre-selector technology, as well as some examples of the spurious measurement of antennas under test (AUTs) over the air.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

No terms and definitions are listed in this document.

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.2 Abbreviated terms

mmWave	millimetre-wave
ACLR	adjacent channel leakage power ratio
ATT	attenuator
AUT	antenna under test
DANL	displayed average noise level
DUT	device under test
FCC	Federal Communications Commission
FOD	foreign object debris
IF	intermediate frequency
IR	infra-red
LIDAR	light detection and ranging
LO	local oscillator
OOK	on-off-keying
OTA	over the air
PC	personal computer
PHY	physical layer
QAM	quadrature amplitude modulation

Documents
Document Sharing Hub

Full document details: PD IEC TR 63352:2022

RBW	resolution bandwidth
RF	radio frequency
SHM	sub-harmonic mixer
SPA	spectrum analyser
TE mode	transverse electric mode
TOI	third-order intercept
YIG filter	yttrium-iron-garnet filter
WRC	World Radiocommunication Conference

4 Background to measurement up to 300 GHz

4.1 IEEE Std 802.15.3d

The IEEE SA Standards Board approved the first edition of the IEEE Std 802.15.3 standard on March 15, 2016; it was also adopted and approved by the ISO/IEC national bodies. There are three amendments to IEEE Std 802.15.3. IEEE Std 802.15.3d-2017 (Amendment 2) considers non-coherent OOK and coherent QAM up to 64 on the 300-GHz band. Two PHY modes are defined that enable data rates of up to 100 Gb/s using eight different bandwidths between 2,16 GHz and 69,12 GHz. The current frequency plan is depicted in Figure 1, although it considers a broad range of possible channel allocations.

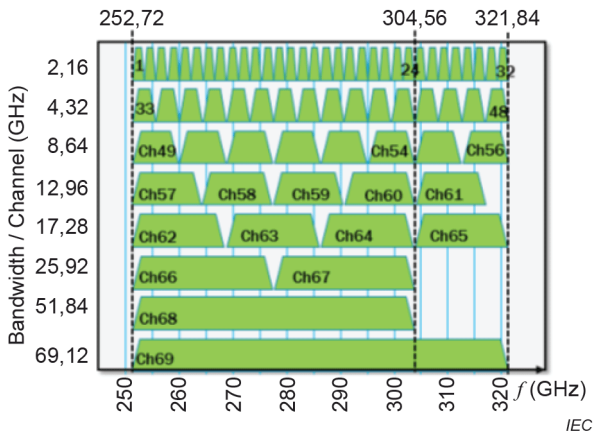

Figure 1 – IEEE Std 802.15.3d-2017 (Amendment 2) frequency plan

4.2 FOD radar

After the Air France Concorde crash in 2000, which was caused by engine ingress of runway debris, airport operators focused on the use of foreign object debris (FOD) detection systems. Several technologies, such as cameras, IR, LIDAR, and other sensors are being tested. One candidate is the mmWave radar because it can detect small metallic objects using converted automotive radar in the 77-GHz band. If the system requires finer resolution, the 92-GHz to 100-GHz band for radio location services should be used for the purpose.

4.3 Experimental frequency license above 95 GHz

The Federal Communications Commission (FCC) announced new rules to encourage the development of new communication technologies and expedite the deployment of new services in the spectrum above 95 GHz, such as data-intensive, high-bandwidth applications, as well as imaging and sensing operations. To enable innovators and entrepreneurs to readily access this spectrum, the Spectrum Horizons First Report and Order creates a new category of experimental licenses for use of frequencies between 95 GHz and 3 THz. These licenses will give innovators the flexibility to conduct experiments lasting up to 10 years, and to more easily market equipment during the experimental period.

AVA Documents
Document Sharing Hub
Full document details: PD IEC TR 63352:2022

4.4 ITU WRC-19 agenda item 1.15

Agenda item 1.15 covers the identification of frequency bands for use by administrations for land-mobile and fixed services applications operating in the 275-GHz to 450-GHz frequency range.

The 275-GHz to 296-GHz, 306-GHz to 313-GHz, 318-GHz to 333-GHz, and 356-GHz to 450-GHz frequency bands are identified for land-mobile and fixed service applications, where no specific conditions are necessary to protect Earth exploration-satellite service (passive) applications.

The 296-GHz to 306-GHz, 313-GHz to 318-GHz, and 333-GHz to 356-GHz frequency bands may only be used by land-mobile and fixed service applications when specific conditions to ensure protection of Earth exploration-satellite service (passive) applications are determined in accordance with Resolution 731 (Rev.WRC-19).

In those parts of the 275-GHz to 450-GHz frequency range where radio-astronomy applications are used, specific conditions (e.g. minimum separation distances and/or avoidance angles) may be necessary to ensure protection of radio-astronomy sites from land-mobile and/or fixed service applications on a case-by-case basis in accordance with Resolution 731 (Rev.WRC-19). Use of the above-mentioned frequency bands by land-mobile and fixed service applications does not preclude the use by, and does not establish priority over, any other applications of radio services in the 275-GHz to 450-GHz range.

4.5 Issue of conventional spectrum measurement for mmWave

Unwanted responses in the spectrum-analyser RF front-end prevent accurate spectrum observation of target signals. There are three main unwanted responses. The first is image response, which occurs when a signal is input to the spectrum analyser at the image frequency. The second is multiple response. The frequency components | m * RF frequency – n * Local frequency | (where m and n are integers) occur due to spectrum-analyser circuit non-linearity. The multiple response occurs when the frequency of the components equals the IF frequency. The third is residual response, which occurs due to multiples of internal frequency components, such as local oscillator frequency and local oscillator intermediate frequency. A pre-selector can be used to suppress image response. (The two other unwanted responses can be suppressed by frequency design.) However, there is no tunable pre-selector like a YIG filter for frequencies above 80 GHz. Figure 2 shows the results of observing a signal using a spectrum analyser without a pre-selector. Unwanted responses can be seen in addition to the wanted signal, making it difficult to recognize the wanted signal.

Documents
Document Sharing Hub

Full document details: PD IEC TR 63352:2022